

UNCONVENTIONAL FUTURES:
ANTICIPATION, MATERIALITY, AND THE MARKET
IN OIL SHALE DEVELOPMENT

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To my daughter Suvi,
who was born, nursed and raised with this thesis.

Abstract

This thesis offers a political geography of unconventional energy development through a study of a particular fossil fuel resource called oil shale. Having long occupied a critical place in the politics and economy of certain states, most notably in Estonia, oil shale is now widely known as an ‘unconventional’ resource that is yet to become technically possible, commercially viable and socially acceptable to exploit. Following the movement through which oil shale becomes both unconventional and conventional, the thesis traces the resource through a series of geo-scientific, economic and political interventions. This study is based on analysis of technical literature and policy documents along with ethnographic fieldwork, interviews, and site visits conducted in Estonia, Colorado, Utah, Jordan, London and Brussels. Drawing together relational accounts of natural resources in political ecology and economic geography with insights from Science and Technology Studies, this project both contributes to critical research on the carbon economy and to recent debates on the concepts of materiality, anticipation, and marketization in social sciences. The thesis proposes a relational conceptualization of resource materiality, situating oil shale in multiple and conflicting forms which derive from geographically disparate practices in both resource assessment and technological development. The future of oil shale exploitation is not pre-determined by the process of global resource decline, nor is it precluded by international demands to move towards lower-carbon futures. Rather, it is determined through the conjunction of different future-oriented economic and political calculations that are entangled with resource materials and associated technological systems. Developing a non-essentialist account of markets as socio-technically distributed arrangements, the thesis argues that these rival calculations influence the design of market rules for both energy and emissions trading. The thesis concludes that what counts as ‘unconventional’ is not given, but continues to be both created and contested at the same time as it is ‘conventionalized’.

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Five years of writing a book takes a toll on one's life, especially if you are only just five years old! My daughter Suvi has grown up with the thesis and has suffered the most. I am not sure how to compensate her for such a distracted childhood.

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Chapter 1. Introduction

1.1 Unconventional worlds

Geographers have long recognized that natural resources are not simply ‘natural’, but instead certain components of the material world occasionally *become* resources when they are considered valuable in relation to technological invention, the creation of new markets, or the declining importance of other resources (Bridge 2009b). The relational and shifting status of resources is particularly evident in various lower quality fossil fuel sediments that are widely distributed in the Earth’s crust. Over the past century, as modern lifestyles have grown accustomed to the use of cheap oil, such deposits have, from time to time, been explored by some nation-states in response to their concerns about growing dependence on energy imports, volatile prices, and the possibility of depleting conventional crude supplies (see Yergin 2009). For the last decade, such national aspirations have come to resonate with growing demand for liquid fuels and record high prices, which combined with persistent fears about the imminence of global decline or ‘peak oil’ have widely restored interests in alternative sources of fossil fuel. Whereas the future importance of petroleum in the global economy is gradually placed under question in light of the degrading resource base and adverse effects on the climate that have resulted from intense production, the exploitation of such ‘non-conventional’ resources is even more contentious because of slow technological progress, high production costs and potentially larger environmental impacts.

This thesis studies a particular type of fossil fuel, *oil shale*, which has long been considered a substitute for traditional hydrocarbon supplies. There has been remarkably little social science research on oil shale development, but in the few published critical commentaries and policy reports such combustible rocks have

typically been regarded as an ‘unconventional oil’ resource of least potential after heavy oil and bituminous sands, while its production is often dismissed as economically inefficient, technologically underdeveloped, and environmentally outright destructive (Mitchell 2011; Klare 2012b; Bridge and Le Billon 2013). By contrast, my thesis displaces oil shale from the continuum of alternative oil resources and focuses instead on ‘the unconventional’. It documents and analyses how oil shale comes into existence as a resource, arguing that it does so in materially varied forms as a result of nationally specific practices in both resource assessment and technological development. It also argues that the resource is subsequently rendered technically possible, economically viable and socially desirable to exploit in geographically disparate and potentially contradicting ways, notwithstanding the future availability of conventional hydrocarbons. Rather than paying tribute to the unlimited potential of technological innovation or the invisible hand of the market to mitigate global resource scarcity, the emergence of oil shale illuminates contending attempts to rethink our political orientations towards the future, resource materiality, and market-efficiency in the midst of increasing uncertainty and controversy over the reconfiguration of carbon-intensive economies, with the effect that such “rival technical solutions become experiments in the composition of the collective world” (Mitchell 2011: 240). In turn, the local values and qualities attributed to oil shale help to reconfigure the political spaces and market arrangements in which global energy futures are worked out, and open up the potential for unconventional worlds, which may be subsequently less or more carbon intensive.

Etymologically, the term ‘convention’ stems from ‘the action of coming together, meeting or assembling’, whereas *unconventional* denotes those things and practices ‘not limited or bound down by convention’ (Oxford English Dictionary 1989). Starting with the unconventional, the thesis interrogates how a fossil fuel that for

decades has been exploited outside mainstream extractive economies enables the gathering of alternative energy systems, whereby the unconventional may eventually 'become conventional'. Oil shale is not an entirely novel solution to energy problems, but has always shadowed conventional oil and gas industries as a "resource of the future" that promises to bring energy independence, economic prosperity and social stability for many countries around the world, especially those that lack significant indigenous hydrocarbon reserves, but possess large deposits of rocks that are rich in organic matter. Such promises have repeatedly failed to be delivered, but are nevertheless revived by reference to a few examples of past and present exploitation, most notably in the country of Estonia, the world's leading producer of oil shale to date. What only has been tested or implemented at a small scale in other locations has dominated the energy economy of this former Soviet republic for nearly a century. Estonia is thus not a case of a globally existing phenomenon, but an already existing index of an energy economy to come. Contra to the popular literature on 'energy transitions',¹ however, I affirm that this process has not followed a pre-determined course from one state of the world to another, but continues to be contested and undermined by alternative visions of the future. Indeed, I contend that the extent to which oil shale may become exploited more globally hinges, in part, on the economic and political situation of the oil shale industry in Estonia.

The title of my thesis therefore addresses 'unconventionality' in a double sense. The first relates to the popular labelling of the resource. The thesis analyses a series of geoscientific, economic and political calculations through which oil shale is assembled, stabilized and mobilized as a unified 'unconventional resource' of global importance or, more specifically, a promising source of liquid fuel. An inquiry into the science and

¹ The term is widely established in practice. For critical analyses, see Smil (2003), Jiusto (2009), Bridge et al. (2012).

politics of oil shale development reveals, however, that the label conceals very heterogeneous resource materials, diverse histories of technical manipulation, and a multiplicity of political and market arrangements through which the exploitation of this resource has been rendered viable. What constitutes the unconventional is therefore not simply given in opposition to the conventional, but actively created in a careful interplay of the industry's past legacies and contending future possibilities.

The second sense of unconventionality interrogates how oil shale is entangled in the configuration of economic and political futures. Developing from the 'non-human turn' in critical political ecology and cultural geography informed by Science and Technology Studies (STS), resources with their specific material properties and technologies of exploitation are not external means to the functioning of socio-political systems or economic interactions, but rather the lively basis out of which 'the political' and 'the economy' continuously evolve (Mitchell 2002; Braun 2008; Braun and Whatmore 2010; Bridge 2011a). Assuming that political economies express a dynamic related to the materiality of resources, the thesis explores how oil shale, once constituted as an unconventional resource, works to 'become conventional' by being placed at the heart of national energy sector governance in relation to the building of international policy regimes and markets in energy and emissions trading. To this end, the thesis interrogates the precarious status of oil shale in the European Union, in which the position of Estonia's unique energy system is both reinforced and transformed against the possibility of a transition to alternative sources of supply. At the same time, the industry seeks opportunities to export its technological expertise elsewhere. The extent to which the industry will be maintained in the EU has in turn informed debates of whether oil shale exploitation is deemed possible in other parts of the world. In a move to trace the dual work of making the resource both 'unconventional' and 'conventional', my analysis travels from Estonia to other leading

developers, particularly the USA and Jordan. In this way, the thesis illuminates the complex, shifting and geographically varied interactions between the past and the future, local and global, economic and non-economic, and real and unreal in oil shale development.

In geographical scholarship, the expanding development of ‘unconventional resources’ has largely escaped the radar of critical inquiry, with the exception of the common but still underdeveloped reference to the Alberta tar sands (Bradshaw 2010b; Bridge 2010; Zalik 2010; Bridge 2011c), and in contrast to growing interests in the reconfigured geopolitics of ‘unconventional places’, such as deep water drilling in the Arctic seabed (Powell 2008; Dodds 2010; Powell 2010). Through a critical engagement with recent work on carbon energy economies, the thesis brings unconventional fuels to the fore by drawing on three fields of theoretical literature on market-making, materiality, and anticipation, which in turn contributes to three fields of emerging literature: the ‘geographies of marketization’ (Berndt and Boeckler 2012), ‘geographies of peak oil’ (Bridge 2010), and ‘geographies of the future’ (Anderson 2010a). The first explores how things such as resources are rendered ‘economic’ to produce and subjected to valuation and exchange across different geographical spaces and actors. Without delegating these processes to abstract market forces or the ubiquity of neoliberal convictions, this literature interrogates what is rendered to belong within the territory of ‘the economy’ in the formation of particular capitalist regimes, and how the balance between economic and non-economic affairs is continuously renegotiated, leading to spatial disjuncture in real-life markets. The second sets a research agenda for analyses of resource availability and materiality, hydrocarbon governance, and collective action beyond the contending concerns of energy security and climate change, and is therefore somewhat at odds with the proliferating research on ‘low-carbon transition’ (Bridge et al. 2012). The third

concerns broader attempts to re-theorize the space-time relationship in human geography (e.g. Massey 2005), which has more recently impinged on a number of case studies on the various logics and politics of anticipation, through which future affairs that cannot be fully known in advance are rendered actionable in the present. This shifts attention from the ‘resource of the future’ to the making of the *‘future of the resource’* in a situation of radical uncertainty over technological progress, market logics, and the possibility of political consensus.

Adding these different theoretical angles together, I ascribe a central role in the reconfiguration of carbon-based energy economies to the material and technical attributes of the resource, in response to calls for ‘materially informed’ studies of natural resources (Bakker and Bridge 2006). The thesis offers a relational account of resource materiality by documenting how ‘oil shale’ is enacted in multiple and potentially conflicting ways through geographically and historically contingent practices of measurement, technological manipulation and resource governance, but once stabilized as a resource assumes the potential to resist geo-scientific abstractions, the standardization of production, and the marketization of shale oil. By attending to the generative and promissory potentialities of unconventional resource materials, the thesis provides an empirically rich account of the anticipatory governance of technoscience, geographies of knowledge production and technology exchange, and the processes of market construction that characterize oil shale development. The rest of the introduction gives more insights into “the thing” and its social setting in turn, before outlining research questions and the content of the following chapters.

1.2 Fuelling the future?

The term 'oil shale' denotes a wide range of sedimentary rocks, which are found in variable quantity and quality all over the world. Unlike conventional hydrocarbon reservoirs, as well as liquid-bearing shale formations and bituminous sands that have become more extensively studied and exploited, these rocks contain no oil or gas as such.² Instead such mineral deposits are saturated with a specific type of organic compound, kerogen, which is sometimes also called an 'immature form of petroleum', referring to the lack of depth, pressure, and heat that would have otherwise transformed these sediments into liquid hydrocarbons (e.g. Knaus et al. 2010). The extraction of shale oil and gas from these rocks always requires artificial heating at high temperatures: compressing geological time of millions of years into a few hours in a purposely-built airtight retort, or three to four years if the shale is retorted 'in-situ' without ever stripping the earth and lifting it to the ground. Alternatively, when the stones are set on fire they also provide heat energy, albeit in smaller quantities than other carbonaceous fuels such as coal and lignite.

The possibility of converting vast sections of rocky subsoil terrains into useful energy resources brings into question the limits of geo-scientific abstraction, technological innovation and market efficiency. Although oil shale comes into existence primarily through geological accounts of abundant material stocks, paradoxically it also disrupts the geologists' proposition of 'peak oil' that anticipates the world running out of easily extractable conventional liquid crude (e.g. Bardi 2009).

² There is currently a remarkable confusion over the term 'shale oil' in both popular rhetoric and professional use as a result of the growing exploitation of liquid oil and gas found in shale formations, which has taken over the term that so far used to denote the resource embedded in solid rocks of oil shale. To the dismay of oil shale developers, 'shale oil' along with 'shale gas' is now associated with formerly inaccessible, yet conventional liquid petroleum and natural gas reservoirs. Some geologists have argued that the right to speak about 'shale oil' should reserved for the oil shale industry, and proposed that other source rocks could be called, 'oil-bearing shale' and 'gas shale', which respectively yield 'shale-hosted oil' and 'shale gas' (Boak et al. 2011). Whatever its name, the extraction of oil out of oil shales requires artificial heating, either in situ or post mining.

Whichever view one takes in the peak oil controversy, the entrance of unconventional sources such as oil shale into the frame of reserve calculations complicates the question of the timing of peak production, if not the neo-Malthusian projections of physical limits to petroleum availability altogether. Proponents of the peak oil theory tend to argue that unconvensionals will not be sufficient to offset the increasing gap between supply and demand (e.g. Bentley 2002) and denounce oil shale in particular as a potential substitute for crude oil (Laherrère 2005; Udall and Andrews 2005, 2006). Nonetheless, the idea of an imminent scarcity has had the adverse effect of helping oil shale developers to constitute the rock as a solution or, at least, part of the solution to ‘global energy dilemmas’ (cf. Bradshaw 2010b) and render the auxiliary resource more widely acceptable and worthy of investment, especially when supported with the evidence of its material abundance and prolonged experiments of exploitation. What determines the technological, political and economic viability of oil shale is not so much the inferior material quality of the resource, but how it comes to *matter* differently from conventional oil across specific locations of development.

To be clear, oil shale production is far from a recent phenomenon. The sedimentary rocks with a high content of organic matter have been known, tested and used for various purposes in several countries, spanning a timeline of more than hundred years of continuous production. Throughout the ‘age of oil’, this low-quality rock has been occasionally used to replace coal, petroleum or gas supplies in certain instances of energy deficiency and/or national self-determination which have been limited to particular places and times, such as the fuel shortages of the two World Wars and the oil crises of the 1970s. The rapid progress made today with commercializing tar sands and shale gas in spite of decades of failure, however, has encouraged the life-long advocates of oil shale exploitation to voice hopes that their industry is “on the brink of a similar renaissance” (Vawter 2011). The rhetoric of

‘unconventional resources’ as a common denominator for various lower-grade petroleum alternatives has thus strategically facilitated the establishment of oil shale industries at a larger scale worldwide. In conjunction with long-standing national aspirations of energy independence, oil shale development is increasingly premised on a coordinated response to global oil decline and geopolitical struggles over access to the remainder of world supplies. This is supported by growing trends in the exploitation of the resource (Figure 1). At present, Estonia, Brazil and China operate significant oil shale industries, but many other countries are either resurrecting earlier projects or considering the exploitation of their deposits for the first time.

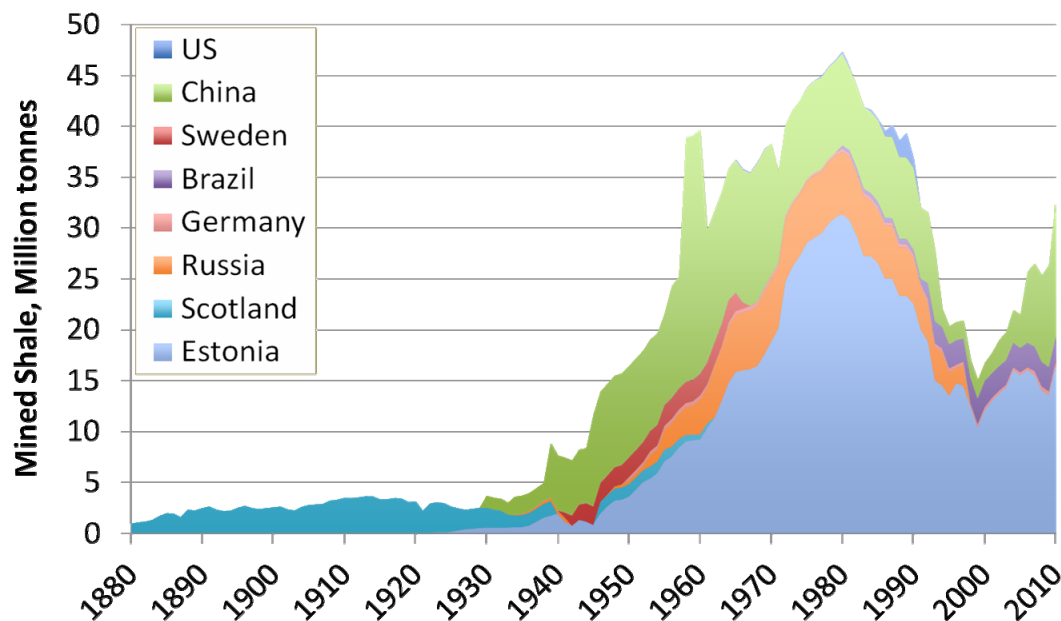


Figure 1 World oil shale production 1880–2010.

Source: This graph is based on John Dyni's (2006) calculations, which have recently been updated by Alan Burnham and disseminated by Jeremy Boak at the 31st Oil Shale Symposium in Golden, CO, 17 October 2011.

In light of the continued evidence of wide-spread, albeit limited exploitation in the past, it would be a mistake to consider the mineral deposits solely as a potential source of liquid hydrocarbons. To date, the majority of oil shale mined globally has

been used as *solid fuel* for electricity generation in Estonian power plants.³ Developing from the Estonian case, the thesis distinguishes between two options of oil shale processing, or two possible transformations of the resource material, which I have conveniently labelled as ‘shale to liquids’ (STL) and ‘shale to power’ (STP) discourses.⁴ Although both industries may utilize the same resource base and are often entangled, there are crucial differences between them. If the impressive history of burning shale directly for heat and power generation has rendered Estonia into a unique example of successful exploitation, *shale oil* occupies a much more precarious position worldwide. Its production is generally not considered “commercial”, nor even sufficiently advanced technologically to enable industrial use, whereas the technology for direct combustion is readily available and more widely established in practice, albeit with high environmental costs (Table 1). The continued failure of the alternative oil industry to ‘become economic’ raises doubts that oil shale is “the fuel of the future and always will be”, as the often quoted saying in Colorado goes (e.g. Youngquist 2000).

The main interests of this thesis emerge from the phenomenon that the resource has long been constituted in isolation from the making of global markets because of its central place in national imaginaries of self-determination, energy security and technological modernity based on the extraction of indigenous fossil fuels. This applies particularly to countries which are either running short of conventional reserves or never possessed them in the first place; “as a rule, nations don’t tap oil shale unless they are destitute” (Udall and Andrews 2005). Today, when an increasing number of governments have allocated their deposits for exploration

³ Alongside shale oil production and direct burning, oil shales have been used as a raw material in the chemical industry. The by-products and wastes (i.e. char and ashes) accumulated in the process have sometimes also been utilized for road pavement or the production of cement and fertilizers. For example, Germany has continuously used small quantities for cement production (Hilger 2003).

⁴ The term ‘shale to liquids’ has limited use within the industry’s rhetoric, notably in Australia.

and research, with first commercial licences recently signed in Jordan, oil shale embodies the promise of a straightforward solution to national energy independence more than ever before. At the same time, the politics of the future is subject to constant challenges and change because of widespread lack of trust in technology, regulatory constraints and public opposition associated with unconvensionals, and not least, the ‘recalcitrant materiality’ of the resource itself (cf. Bakker and Bridge 2006).

	Shale to power	Shale to liquids
Producing countries	Estonia, China, Israel	Estonia, China, Brazil
Emerging developers	Jordan, Morocco	USA, Australia, Jordan, Morocco, Syria, Israel, Egypt, Turkey, India, Serbia, and others
Utilization	Shale is burnt directly as solid fuel in thermal power stations similarly to the combustion of coal for electricity generation.	Shale is retorted into oil, for which there is no commercially proven technology, although many are under development, including for 1) surface processing, 2) in-situ processing, and 3) mixed techniques. Only surface retorting is currently in industrial use, whereas the alternatives are still in RD&D stage.
Resource calculations	Based on mineral mass (tonnage) or <i>heating value</i> (calorific value) measured with a bomb calorimeter.	Based on <i>oil yield</i> measured with the Fischer assay or alternative methods of assessment.
Environmental issues	Very high greenhouse gas emissions, wastes/tailings, water use, degradation of landscapes etc.	Water use, wastes/tailings, but fewer emissions compared to combustion (carbon is released by the consumers of the fuel).
Technology	Various combustion techniques have been adapted to oil shale and widely used, but require innovation for the reduction of emissions, improved energy efficiency, and readiness to adjust the process to feedstock of varied quality.	Except for some operational knowledge on surface retorting, all technologies invented so far are in need of major innovation, especially concerning environmental impacts and net energy gain (EROEI).
Estonian dilemmas	Transfer from oil shale combustion to alternative sources of energy?	Transfer from oil shale combustion to shale oil production?

Table 1 Shale-to-power and shale-to-liquids discourses of oil shale development.

The current development of oil shale amounts to a force-field with intersecting interests and agencies. The pursuits of national governments resonate with the agendas of many technical specialists, especially geologists, who are adamant that vast sections of the rocky earth could eventually provide humankind with a useful energy resource. Their shared desire to constitute the organic-rich rocks as indigenous energy resources is therefore exemplary of the attempts to render ‘vertical territory’ part of the nation-building projects of the last two centuries (Braun 2000). In parallel, the development of oil shale generates demands for innovation in both traditional retorting technology and ‘in-situ’ conversion not only for big multinationals, but also national energy companies and private enterprises.⁵ Many have sacrificed their careers to study and promote the future resource throughout a series of booms and busts (known as “spent-shalers” in America), while others have borne similar sacrifices by opposing it at any expense. As billions in government funds have been invested in exploration, technological experiments and political debates, oil shale has become an affectively charged field, a matter of unconditional success or failure. Having been long called forth as a solution to the physical finitude of oil, in a globalized energy market it becomes appealing as “untapped” petroleum available in regions that are thought to be more accessible than, for example, the Persian Gulf or the Arctic. In these circumstances, the proponents of the industry represent a closely aligned community of mixed ambitions ranging between geoscience and geopolitics. Moreover, in response to growing efforts to limit greenhouse gas emissions, it is not surprising that oil shale development has attracted mostly those countries that are *not*

⁵ In addition to several oil-majors involved in oil shale research, several national oil companies and smaller players have become interested in the field. For example, Statoil sent a team of executives on a ‘fact-finding mission’ to the 2011 Oil Shale Symposium in Colorado. The interests in oil shales seem to be growing within the industry, although in the public sphere they have become lately shadowed by the proliferation of projects in shale gas and tight oil development.

Annex I signatories of the Kyoto Protocol, and can be therefore seen as an alternative regime to that cooperating internationally to mitigate climatic changes.

Given the highly polarized views and remarkable scientific and technological uncertainty surrounding oil shale exploitation, the thesis aims to describe how the industry's contending histories and possible futures are envisioned, enacted and rendered actionable in the present. Without taking any sides or attempting to solve the peak oil controversy, my focus develops here from the specific national imaginaries and multiple practices in oil shale exploitation, which help change existing realities and bring new extractive sectors into being when combined with the threat of an impending global oil crunch. In other words, the future that "has not and may never happen" is already acted upon so that it comes to have real and material consequences in the present (Massumi 2007; Anderson 2010a).

Equally, the thinking in these pages distances itself from simplistic free market thinking, according to which 'mining for oil' (George 1998) would become commercial once market prices for oil are sufficiently high. To be sure, price hikes have been an important driver for oil shale development, while sudden drops indeed explain to some extent earlier failures with commercialization, such as the notorious 'Black Sunday' of May 2, 1982 when Exxon cancelled its U.S. 'Colony' project overnight (Gulliford 1989; Hanson and Limerick 2009; Yergin 2009: 698). Historically, however, oil prices have represented a function of power relations between petroleum exporting and importing states and, more recently, trade in oil futures, not a measure of geologically induced scarcity (Boal et al. 2006; Le Billon and Cervantes 2009; Bridge and Le Billon 2013). For oil shale to become 'economic', current price mechanisms are

but one factor amidst a myriad of other issues.⁶ Rather, the question is whether the industry manages to reconfigure the politico-economic rationales underlying resource governance, geopolitics and market arrangements in the first place. Again, such industries have not come on stream unless they are strongly backed by resource-holding governments. This thesis thus supports the idea that markets and pricing are a product of a series of future-making actions, not the other way around (cf. Callon 1998; Mitchell 2002; MacKenzie et al. 2007).

It is therefore beyond the scope of this work to predict what *is* actually going to happen: i.e. to what extent oil shale development may contribute to future energy mix or shape ‘new oil landscapes’ (Bridge 2010: 528). Neither does this thesis prescribe what *should* be done in order to realize certain possibilities, either in favour or against extraction. Instead of projecting possible scenarios or affirming normative accounts, my approach aligns with the view that social sciences are tasked to disclose the contested nature of technoscientific change, the complex relations between actors, and the logics and techniques with which a range of ‘contending geographical futures’ are being made (Adam in Brown et al. 2000; Bridge et al. 2012: 3). The thesis approaches oil shale development with sympathetic curiosity and equally healthy scepticism, whereas my main agenda is to find out *how* this happens, and theorize this process of ‘something happening’.

⁶ A typical list of such issues would include technological readiness, national security dilemmas and policy instruments, infrastructural bottlenecks in processing and transport, environmental costs and ‘social acceptability’ more broadly.

Estonia has been the largest oil shale producer worldwide for the last 70 years. Following from extensive industrialization by the Soviet government, the majority of oil shale mining and production is carried out by a state owned energy monopoly called Eesti Energia (Enefit), and to a lesser extent, two private companies called Viru Keemia Grupp (VKG) and Kiviõli Keemiatööstus. Estonians are eager to commercialize their technological expertise in other countries, and have already acquired concessions in Jordan and Utah, U.S.

China has recently revived its oil shale industry, after production was started in the 1930s, but stagnated during the 1960s with an over-abundant supply from new petroleum discoveries (Liang 2006; Jia et al. 2012). In addition to building many retorts based on the local 'Fushun' process, China is currently importing competing surface retorting technologies (ATP, Enefit), as well as expanding electricity production from direct firing (Qian 2008; Li et al. 2011). It is assumed that China has now overtaken Estonia in terms of shale oil production (IEA 2010).

Brazil is known for isolated cases of oil shale extraction from the end-19th century onwards, but sustained efforts to commence production were made only after the WWII under the responsibility of Petrobras, the national oil company (Russell 1990). Following research and development of the 'Petrosix' technology, which was adapted to the specific quality of local shales, commercial-scale mining and oil production has steadily progressed since the 1980s, making Brazil the third oil shale producing country today. Petrobras also seeks opportunities to help develop shale resources in other countries; having left Utah it is currently in negotiations with Jordanians.

Jordan is the forefront for commercial oil shale development in terms of the size of resources and the variety of technologies under testing. Unlike its Gulf neighbours, Jordan does not possess any conventional hydrocarbon reserves. After repeated attempts to develop oil shale deposits since the late 1960s, the government anticipates that the indigenous resource offers part of the solution to its import dependence, both in oil and power production, especially since the events of the Arab Spring disrupted supplies from Egypt. By 2020, oil shale is expected to account for 14% of national energy mix (Jeffreys 2011). Concession agreements have been signed for exploration and in-situ retorting with Jordan Oil Shale Company (JOSCo, a 100% Shell subsidiary) and for surface retorting with companies called Jordan Oil Shale Energy Co. (JOSE, 65% Eesti Energia), and Karak International Oil (100% Jordan Energy and Mining Ltd, a UK-based private company). Shell's concession alone covers a quarter of Jordan's territory. Further memorandums of understanding have been signed and concession agreements are under negotiation with up to eight national and international companies, including Total, Petrobras, and ExxonMobil (Al-Ramini 2011). Jordan will be the litmus test for the industry's worldwide establishment, not only in terms of technology demonstration, but also government regulation of the industry.

Australia is supposed to have significant oil shale resources, mostly in Queensland, but the industry lacks public and political support. After two earlier periods of development that started as early as in 1849, the latest attempt to launch shale oil production by Southern Pacific Petroleum (SPP) was suspended in 2004 with a Greenpeace-led protest campaign, resulting in the closure of the Stuart plant in Gladstone. Since then, a company called Queensland Energy Resources (QER) has acquired SPP assets and re-opened the site for technology demonstration. Whereas the previous project used the Canadian-developed 'ATP' technology, the new owners have betted on the US-based Paraho II, which has not been improved for the last 40 years. QER is trying to build up public support by affectively linking oil shale with Australia's future fuel supply options (Bowman 2011). The outlooks for commercial development will be mainly predicated on the federal government's climate policy.

In the U.S.A. oil shale has long been called forth as a solution to the nation's addiction to oil and dependence on foreign supplies. Today, the States are once again facing a surge in oil shale development, after having experienced two boom and bust cycles in the last century (see Hanson and Limerick 2009). The Rocky Mountains are thought to host the majority of world resources, out of which more than 70% are located on federal lands in Colorado, Utah and Wyoming. Since the U.S. government's Energy Policy Act of 2005 outlined its objectives for unconventional oil development, the Bureau of Land Management has issued six leases for oil shale research, development and demonstration (RD&D). This includes three leases secured by Shell Frontier Oil and Gas Inc., one by Chevron and one by American Shale Oil (AMSO – 50% Total, 50% Genie Energy) for in-situ testing in Colorado, as well as one further lease for traditional surface retorting in Utah for Oil Shale Exploration Company, which was recently overtaken by Enefit American Oil (100% Eesti Energia). A further round of three RD&D leases have been under consideration since 2009 to be allocated to ExxonMobil and Natural Soda Inc. in Colorado, and AuraSource in Utah (Leverette 2011). In addition, many companies have helped to re-establish oil shale mining and testing sites on state or private lands, especially in Utah, including Red Leaf Resources (EcoShale), TomCo Energy Plc, Shale Tech International (Paraho), Enshale, and others (see also Dammer 2007). Future commercialization of oil shale production depends on progress in technology testing, the results of the environmental impact assessment programme, and public acceptability in general. A serious drawback to the industry was Chevron's recent decision to halt research and 'divest' its RD&D lease in Colorado.

Israel has a small oil shale-fired power station in operation. More recently, Israeli Energy Initiatives, a subsidiary of the Genie Energy company involved in the AMSO project in Colorado, has recommenced resource studies under an exploration and production licence issued by the Israeli government for in-situ development.

Other countries, where oil shale development is being considered, include the MENA region (Turkey, Morocco, Egypt, Syria), the former communist bloc (Russia, Ukraine, Serbia), and India. Several countries have utilized their shale resources in the past, with large-scale industries operated in Scotland, France and Sweden (for global histories, see Duncan and Swanson 1965; Gulliford 1989; Russell 1990; Francu et al. 2007; Holmberg 2008).

Table 2 Leading countries of oil shale development.

1.3 Estonian dilemmas

Estonia is the leading producer of oil shale in the world with a century-long experience of exploiting its sole fossil fuel resource. For the small nation-state with a population of only 1.3 million people, the industry is central to its energy economy, political identity and conceptions of national security, providing the country with an independent supply of electric power and a competitive advantage in the globally expanding development of shale oil. In conjunction with emerging interests in non-conventional resources, the Estonian industry also serves as a reference point for the promotion of oil shale development worldwide, having positioned itself as a key actor in the exchange of knowledge and technology between the countries interested in exploiting their deposits.

Historically, the emergence of oil shale as a strategic energy resource has been inextricably bound up with the making of Estonian state and national economy under both capitalist and socialist regimes. Although Estonia's deposits have been known and studied since the 18th century, extraction began only in the war-time circumstances of fuel shortage.⁷ The industrial use of oil shale dates back to 1916, when Russian authorities opened the first experimental mines in order to compensate for the lack of coal available for the Empire's navy. After Estonia declared independence in 1918, the exploitation of indigenous "brown gold" played a critical part in the policy agenda of the national government between the two world wars. The low-calorific, but easily accessible resource swiftly replaced imports of coal by supplying solid fuel for general heating, larger industrial enterprises, railway, and to a lesser extent also for the generation of electricity. Not only did the nascent nation-state secure an independent supply of energy, but the government soon began to raise

⁷ This section has benefited from the historical overviews published by several experts on the industry (Aarna 1989; Kattai 2003; Veiderma 2003; Holmberg 2008; Toomik 2008).

hopes for a prosperous national economy based on oil revenues. When the first experiments to distil crude oil from the rock succeeded, shale oil production was taken over by private companies financed largely by British and German capital, while the state assumed responsibility for mining and electricity generation (for an early overview in English, see Kogerman 1927). Following a short interlude that saw German invasion and experiments during WWII, Estonia's oil shale business became subject to large-scale expansion under the industrialization programmes of the Soviet Union. In yet another post-war shortage, the industry was put to the service of delivering electricity and household gas to the North-western districts of Soviet Russia (the St Petersburg area) following the building of large thermal power plants and a shale oil gas plant laid down with the 1956-60 Five-Year Plan, while shale oil was reserved for the navy. With the Soviet republic's growing appetite for energy, the volume of mined shale skyrocketed over the next decades. As visualized in Figure 1, Estonia has been consequently responsible for the majority of oil shale mining worldwide, even though the country is, according to recent estimates, said to possess less than 1% of global resources (Laherrère 2005; Francu et al. 2007; IEA 2010).⁸

For the last 70 years, oil shale has played an integral part not just in Estonia's energy supply, but also in the process of technological modernization and social stability. Moreover, oil shale exploitation has been paralleled by the development of relevant expertise in engineering and the geosciences in Estonian universities, which supported the development of the resource even under the most repressive conditions imposed by the Soviet authorities, or as some have argued, precisely because of these conditions (Holmberg 2008). The extent to which Estonia relies on oil shale was maintained after independence from the Soviet Union in 1991, notwithstanding

⁸ Even though any such estimates of global resources are highly contestable (see Chapter 4).

accumulating evidence of the industry's devastating impacts on the environment, human health, and resource availability.⁹ Despite subsequent neoliberal market reforms and the state's admission to the European Union in 2004, the building blocks of its energy economy have changed little. Although the post-Soviet collapse of heavy industry caused the demand for mining to drop initially, the resource continues to account for approximately 60–70% of the country's primary energy supply and 90% of electricity generation, with a third of the mined shale used for oil production. Today, when Estonia has become the poster-child for meeting EU accession criteria (Kuus 2004), especially in recent times of financial austerity measures, oil shale continues to be a deeply controversial issue for the country's relations with the Union. Concealed behind the "Estonian exceptionalism" based on market liberalism combined with a strict fiscal policy, as *The Economist* has praised the newest entrant in the euro-zone,¹⁰ is a state-regulated electricity complex, that makes Estonia one of the least energy-dependent countries in Europe (Eurostat 2011), but also one of the most carbon-intensive economies in the world in terms of its per capita emissions (IEA 2011).

With the industry approaching its 100th anniversary, however, national energy economy's future prospects are uncertain. Regardless of the continued evidence of uninterrupted production, self-sufficiency in power supply, and growing opportunities to export electricity as well as shale oil, the energy sector is increasingly called into question because of its high energy intensity, wasteful production processes and extensive impacts on the environment. Having enjoyed repeated derogations from the EU *acquis communautaire*, Estonia is now reaching the end of the 'transitional period'

⁹ For example, oil shale-based electricity production accounts today for 70% of Estonia's CO₂ emissions, 92% of SO₂ emissions, and 82% of hazardous waste disposal, while the *shale oil* industry contributes to further pollution. The levels of pollution have risen again significantly in recent years due to electricity exports (NAO-Estonia 2012).

¹⁰ *The Economist* (6 July 2011), "Estonian exceptionalism: A rare bit of good news from a euro-zone economy", <http://www.economist.com/node/18959241> (accessed 6 December 2011).

outlined in the Treaty of Accession and is faced with the problem of how it is possible to continue to operate the industry within the context of the EU single market. The indeterminacy of the industry's future derives from three main factors: declining resources, EU environmental and climate policy measures, and open competition following energy market liberalization and integration with the EU networks.

To start with the latter, on 1 January 2013, Estonia became the last member state to open up its electricity sector for competition in the single market. This took place after several years of delay, which had been granted to allow for restructuring the Estonian energy sector after oil shale was guaranteed a “special status” during the accession negotiations.¹¹ Although a third of the electricity market has been open since April 2010, the state-owned energy company Eesti Energia remains a *de facto* monopoly even in the unregulated sectors, and is expected to maintain this position in the short term (Mäe 2009).¹² The long-term implications of market liberalization for the industry's competitiveness and electricity pricing are largely unclear and depend, amongst other things, on the state of competition in the Baltic Sea region and the construction of physical electricity transmission links to Western networks.

The second field of uncertainty pertains to the restrictions imposed by EU environmental and climate policy, particularly with regard to the dramatic cut in greenhouse gas emissions projected with the “20-20-20” targets and the ‘Energy 2050’ roadmap. Most urgently, from 2013, the changing rules of CO₂ emissions trading require the industry to start paying for its emissions quota, which since the introduction of carbon pricing in 2005 has been allocated free of charge and provided the energy sector with lucrative revenues due to a generous Kyoto baseline. In the

¹¹ Directive 2008/3/EC of the European Parliament and of the Council of 15 January 2008 amending Directive 2003/54/EC as regards the application of certain provisions to Estonia.

¹² Two months after the market was opened, Eesti Energia's market share had dropped to 73%, compared to 76% in 2011 and 89% in 2010 (Estonian Competition Authority 2012).

following years, the prospects of continuing business-as-usual will also become strained due to the continued non-compliance of Soviet-era power units with the EU requirements on air pollutants emitted from large combustion plants, including SO_x and NO_x emissions in particular. The obligation to constrain emissions and purchase allowances is considered a serious threat to the capacity of oil shale companies to withstand competition in open market circumstances, both for electricity and shale oil production. Local experts anticipate that the carbon price will become the most important driver for electricity pricing, which will challenge the competitiveness of the investments made into new oil shale-fired power stations and make state planning difficult due to price volatility (Mäe 2009; Maigre 2010; Elering 2011). Likewise, shale oil producers threaten that they will be forced to move production into a less stringent climate policy regime, especially if further constrained by the carbon footprint-related standards instituted with the Fuel Quality Directive. In this way, the integration of the industry into the EU market is claimed to generate 'carbon leakage' across the Estonia-Russia border.

A further uncertainty derives from the declining quality and quantity of Estonia's resource base. Although the measurement and calculation of mineral resources and reserves should be regarded as a historically contingent process which to date has largely been defined by the needs of the electricity sector, there is a remarkable consensus that oil shale mining peaked in 1980 and will not generate a new peak despite growing interests in shale oil production. By any accounts, Estonia appears to have reached a 'post-peak' situation, in which the industry has to navigate within the constraints imposed by resource decline, competition between the former state monopoly and emerging competitors in mining, power generation and oil production, as well as growing environmental awareness and public opposition to the opening of new mines. The rise of 'post-peak politics' in Estonia is an integral part of

national energy governance, even if the possibility of resource scarcity has become more recently concealed at the expense of the urgent issues associated with the EU requirements, as well as the prospects for technology exports to other oil shale-developing countries.

With only limited time left until a radical restructuring of the energy sector has to take place, the planning of resource use and electricity supply, which was previously considered a strictly expert domain, has become controversial at a national level. In Callon's terms, the 'overflow' of the market has produced a hot political situation (Callon 1998; Callon et al. 2009). This controversy over the reorganization of the oil shale industry is characterized by a particular set of dilemmas. The possession of an indigenous fossil fuel has long been considered the key guarantor of the country's independence from Russia's power supplies, if not its independence overall. Given Estonia's distrustful, if adverse energy policy towards its Eastern neighbour (Grigas 2012), oil shale is considered indispensable regardless of both technological lock-in and high production costs. At the same time, the industry has played a critical role in the large-scale industrialization of the region, fostering non-Estonian labour immigration and russification under the auspices of the Soviet authorities. Moreover, it remains responsible for a multitude of environmental hazards. If maintained by the independent state, the energy sector stays in stark contrast with the ongoing re-branding of the nation as a modern knowledge-based economy (Lehti 2005). Oil shale consequently mediates contradicting agendas – it is at once associated with Estonia's sole technological expertise *and* backward Soviet-era industrialism; a critical source of employment, economic growth and dividends that help balance the state budget *and* a heavily subsidized sector hidden at the heart of a free market economy; a main warranty of energy security *and* a subject of growing political dissensus. The last twenty years of energy governance in Estonia represent an ongoing debate over these

contradictions, without any resolution. Moreover, the lack of alternative sources of power in the Baltic region along with growing opportunities to export shale oil have lent further legitimacy to the continued operation of the industry without major changes.

This thesis provides a detailed empirical account of the national debate about the industry's future and its implications for both local and global agendas in the development of the unconventional resource. The following chapters are narrated in line with my main observation that this increasing state of uncertainty has not only undermined national conceptions of security, but simultaneously created a window of opportunity for the local energy elites to re-orient themselves as a global leader in shale oil development. In the situation of degrading resources and legal constraints at home, the state-owned energy company has assumed the role of a key technology holder and potential developer abroad, attempting to capitalize on its legacies and create new markets in other countries, notably those without Kyoto commitments. Indeed, the company has already entered into agreements to develop oil shale in Jordan and the United States, has assisted certain MENA states (Egypt, Morocco, Syria) in resource assessment and preparations for industrial exploitation, and is undergoing negotiations for technology sales to China, Serbia and other countries.

1.4 Research questions

The thesis aims to trace and analyse the constitution of oil shale as a contentious "resource of the future" in relation to the industry's socio-technical legacies, present evidence of its technical and economic progress, and globalizing future promises. To this end, I employ two, mutually complementary approaches. At one level, I investigate recent transformations in Estonia's energy sector at the intersection of local anxieties and global ambitions, where the strategic position of the resource is being both forged

and re-negotiated under ongoing struggles of nation-building, integration with the European economy, and improving opportunities for technology exports worldwide. My research on the Estonian industry concentrated on the following research questions with a triple focus on resource regulation, anticipatory governance, and economic transformations:

1. What are the criteria for constituting parts of the subsoil as an oil shale resource and, further, 'reserves'? How are oil shale reserves allocated for future use in a situation of potential scarcity?
2. How are possible energy futures anticipated, figured, and contested in the context of concerns about energy security and climate change?
3. To what extent is the post-Soviet industry able to retain its status when it enters the frame of economic calculations and market transactions in the context of the EU single market?
4. What is the role of Estonia in rendering oil shale exploitation technologically, economically and politically viable in other resource-rich regions?

At another level, I interrogate the difficulties of constituting oil shale as a *global* energy resource in the face of the very diverse geo-technical conditions, inconsistent practices of resource assessment and regulation, and divergent technological pathways associated with particular locations of development. My aim is to examine how oil shale development relates to the ongoing reconfiguration of our carbon-intensive economies and livelihoods, contributing to the nascent field of literature that makes the materiality of fossil fuel resources central to geographical and political studies of energy transformations (Mitchell 2009; Bridge 2011b, 2011c; Mitchell 2011). In this regard, the case of oil shale serves here to theorize the processes of

‘resource-making’ more broadly, and their relationship with future-oriented science and politics, the design of markets, and the geographies of knowledge exchange that characterize the creation of alternative carbon futures. Under these objectives, this research project has also sought answers to more general research questions, which underpin the empirical chapters that are introduced briefly in the following section.

1. What role does the materiality of oil shale play in the (de-)stabilization of the resource in geoscientific, political and economic calculations?
2. To what extent, and in what ways, do debates over the prospects of unconventional energy development reshape existing forms and spaces of knowledge-making, energy governance, and the organization of markets?
3. How do the techniques of resource assessment, processing and governance translate between geo-ecologically, culturally and politically disparate locations of present and potential oil shale exploitation?

1.5 Overview of chapters

The thesis comprises nine chapters, which trace and analyse the constitution of oil shale as an ‘unconventional’ energy resource, interrogating both the materiality of the resource and its critical place in the politics and economy of Estonia. The next two chapters represent a review of relevant literature and methodological considerations, followed by five chapters based on the empirical findings of this research project, and a conclusion. A short introduction to each chapter is given below.

Chapter 2 *Geographies of unconventional energy futures: anticipation, materiality, marketization*

Taking its lead from Mitchell’s (2011) contention that oil shale development necessitates a rethinking of the politics of nature, this chapter reviews recent

geographical research on the political ecology and economy of oil, which so far lacks attention to unconventional resources. This work has become increasingly interested in the materiality of resources, but rightly criticizes deterministic accounts that explain the availability and governance of hydrocarbons with their natural limits or specific qualities. Instead, it has emphasized that hydrocarbons are entangled in 'above-ground' political arrangements and market regulation (Bridge 2010; Bridge and Wood 2010). Following calls for 'materially informed' research on energy transformations beyond peak oil (Bakker and Bridge 2006; Bridge 2011b), however, this thesis revives the question of how 'below-ground' material realities are related to the organization of economic and political life. Following several lines of inquiry in geography, sociology and anthropology, broadly informed by Science and Technology Studies and poststructuralist thought, the thesis both draws upon and contributes to three further fields of theoretical literature on: (i) the anticipatory governance and politics of technoscience at times of growing uncertainty, when unknowable futures are rendered actionable in the present (Brown et al. 2000; Adam and Groves 2007; Callon et al. 2009; Anderson 2010a); (ii) relational accounts of materiality in the general pursuit of 're-materialized', but non-dualistic geographies (Whatmore 2002; Kearnes 2003; Anderson and Tolia-Kelly 2004; Latham and McCormack 2004; Whatmore 2006; Anderson and Wylie 2009), which further facilitate materialist accounts of politics and economy (Mitchell 2002; MacKenzie 2009b; Braun and Whatmore 2010), and (iii) analyses of the composite, dynamic and spatially distributed character of markets and economic agents (Callon 1998; Barry and Slater 2005a; MacKenzie et al. 2007; Berndt and Boeckler 2009; MacKenzie 2009b).

Chapter 3 *Fabricating research*

The methodology chapter outlines the epistemological and ontological strategies of this research project in relation to fieldwork realities, arguing for the need to study

how resource worlds are enacted through specific scientific, political and economic practices, based on a series of 'how-questions' and qualitative research methods. Rather than working with pre-defined hypotheses and macro-level concepts, the emphasis here is on 'studying up' the richness of empirical data, whereby facts are not just 'fabricated' with the help of a perspectival narrative (Latour 2005b), but 'co-fabricated' through a series of inventive interruptions, displacements and opportunities that emerged through transformative encounters between researcher and researched (Whatmore 2003). In this way, my fieldwork has shifted from extensive participant observation and key informant interviews in Estonia, to 'multi-sited' ethnographic engagements and site visits in the USA (Colorado and Utah) and Jordan, to additional interviews in London and Brussels. Disrespectful of the object/subject differentiation, the thesis seeks objectivity through highly precarious engagements in which the relationship with my own national identity and the materialities of the resource are put 'at risk' in a productive way (Stengers 2005).

Chapter 4 *Assembling 'oil shale': resources, materiality, unconventionality*

Situated against the background of popular debates on the potential event of 'peak oil' and energy security concerns, the first of five empirical chapters follows up the question raised in the literature review: what happens when we start 'defining other kinds of things as oil' that were never considered oil before (Mitchell 2011: 249)? My observations focus on the phenomenon that the constitution of certain components of Earth's crust as 'unconventional' sources of hydrocarbons often implies a radical translation of subsoil materiality from solid into liquid resources. Based on a survey of technical literature combined with insights from fieldwork, the chapter traces the making of 'oil shale' as a global resource through corporate rhetoric and complex calculations in the geo-sciences. Oil shale is assembled from heterogeneous organic-rich rocks that refute common scientific categorizations and measurement standards,

but are nonetheless promoted as a promising energy resource or, more specifically, a singular liquid oil resource. Yet the emergence of an alternative resource economy is simultaneously jeopardized by the material and spatial heterogeneity of world deposits. Moreover, oil shale comes into existence in two states of materiality as both a solid mineral ore and a liquid hydrocarbon resource, which underpin the difficulties of assembling and calculating the global resource and reserves, as well as their actual exploitation. By thinking through these multiple forms of existence, I propose a non-dualistic, relational account of resource materiality and argue that resources may come into being in multiple material states in parallel.

Chapter 5 *Post-peak politics: reserves, measurement, futures*

Building on the above, the next chapter explores *what* it is that is being called ‘oil shale’ in the leading producer country of Estonia at a time when production appears to have passed its peak capacity. Following a detailed analysis of both geo-scientific and economic practices of resource assessment, I contend that here the multiplicity of the resource is even more evident since the simultaneous prospects of scarcity and improving opportunities for shale oil exports have urged the nation to rethink not just the industry’s future outlook, but the nature of the resource itself. Drawing on STS analyses of the metrology of oil (Bowker 1994; Barry 2008; Mitchell 2010) and Latour’s work (1987, 1999), the chapter discloses that Estonia’s oil shale resource along with reserves have come to exist in historically contingent and multiple forms. At a time when oil shale development grabs global attention, the industry seeks to ensure continued resource availability by renegotiating access to the last unexploited reserves, as well as by opening up the ‘black box’ of national geoscience and redefining the criteria for categorizing reserves altogether. These observations strengthen the relational conceptualization of resource materiality, as I affirm that fossil fuels represent geographically specific and temporally dynamic formations that result from

the stabilization of resource materials through specific geoscientific, economic and technical interventions, rather than being pre-given fixed categories of the physical world or solely social constructs. Moreover, the situation of 'post-peak politics' may necessitate a reconfiguration of such framings. Being subsequently destabilized and re-framed, reserves acquire both a political and anti-political function as they enable future uncertainty to be operationalized and managed.

Chapter 6 *Securing supply or supplying security? Anticipatory energy politics in Estonia*

Having explained the '*resource* of the future', the following chapter interrogates how the '*future* of the resource' is being renegotiated following Estonia's integration with the European common market for energy trading. Specifically, the chapter investigates the wavering position of oil shale in the national energy economy in a situation of radical uncertainty over the implications of free market competition, environmental regulations and decarbonisation policies for the industry's future competitiveness, which have dominated Estonia's negotiations with Brussels over the last twenty years. Anticipatory energy politics, understood as a wider space of political debates that seek consensus over collective forms of life, forges new attachments between different sets of expert knowledge and political power. Moreover, these attachments transform future conditions of material reality or, in other words, the 'ontological politics' (Mol 1999) of the resource itself and related socio-technical systems. Although EU constraints on carbon-intensive production and market protectionism have repeatedly been deferred due to energy security considerations, they have equally rendered open and channelled disagreement over possible energy futures amongst local actors. Indeed, the future importance of the resource is decided and codified in a shifting body of national expertise, which enables actors to disentangle the dominant associations drawn between the patrimony of oil shale and state sovereignty, and explore

alternative accounts of both energy supply and security. The situation in Estonia therefore does not add up to single 'transition' from an energy-intensive planned economy to a market-led lower carbon economy. Rather, it exhibits multiple energy transformations simultaneously in the making, without any predictable implications for the future status of the oil shale resource.

Chapter 7 *On the borders of the market: negotiating energy and climate security*

International efforts intended to limit greenhouse gas emissions with the help of market-based instruments are widely acknowledged to constitute the most serious challenge to oil shale development in Estonia and in other parts of the world. This chapter follows the resistance of EU border states, including Estonia, to carbon pricing under the European climate and energy policy regimes. Based on the analysis of a five-year controversy that took place between the Estonian government and the European Commission over the allocation of emission quota to the oil shale sector, I document how the industry has fostered modifications in EU carbon trading rules after being attributed with concerns about national energy independence and economic stability. As the chapter highlights certain compromises made between energy and climate security in the post-Kyoto regime, it both draws on and interrogates the limitations of MacKenzie's (2009b, 2010) conceptualization of 'technopolitics' in the design of carbon markets. I argue that there is a need to complement recent work in economic sociology with a geographical perspective concerned with how such market experiments are territorialized in relation to other spatially distributed socio-technological systems, in this case electricity transmission networks, as well as the material properties of commodities that are subject to regulation, such as shale oil. The chapter thereby offers an empirically grounded contribution to recent sociological work on carbon markets and develops the nascent field of 'geographies of marketization' more generally.

Chapter 8 *'When unconventional becomes conventional': a shale oil technology in the making*

Many things have happened to oil shale development during the course of this research project. In particular, while the Estonian industry maintains an uncertain and contested position in the EU market, it has fostered relations with other countries that are interested in utilizing their resources. The last empirical chapter traces the recent exchange of knowledge and technology between Estonia and other developers intending to produce shale oil through above-ground extraction methods, particularly in Jordan and Utah, U.S. Outside the Kyoto climate policy regime, the industry's prospects hinge on finding a standard retorting technology with the potential to enable commercial-scale production. The case further testifies that the future viability of oil shale development is neither pre-determined by existing regulatory and market arrangements, nor precluded by the industry's slow technological progress. Rather, the prospects of a non-traditional industry to become 'economic' at the global level derive from specific localized arrangements that interfere with demands for further innovation as well as public contestation of the industry; a three-dimensional process that I will subsume under the notion of 'conventionalization'. In order to conventionalize surface retorting, the industry is required to not just adjust its technology to geo-technically varied contexts of exploitation, but also to reconfigure the political and economic conventions of energy provision in both recipient countries *and* back at home. Being thus translated between otherwise disparate sites of present and future exploitation, the Estonian energy economy becomes reconfigured and globalized as a convincing reference to "reality", which is mobilized to restore trust amongst other developers and potential investors alike. Moreover, while the undisputable material reality facilitates the industry's access to capital markets, the stabilization of heterogeneous resource materials in the form of a promising source of

synthetic crude may nonetheless jeopardize the actual marketization of shale oil products.

Chapter 9 *Conclusions: unconventional futures*

The concluding chapter draws together the key findings and theoretical arguments of the thesis. It argues that the ‘Estonian case’ does not represent a case of a globally existing phenomenon, but rather it has turned out to be the starting point for dreaming, projecting and globalizing alternative, potentially higher-carbon economies. Such ‘unconventional futures’ are neither foregrounded by the evidence of global resource decline, nor exclusively precluded by the linear political logics of low-carbon transitions. Rather, they are local achievements that are continuously fabricated in the present through a complex interplay of existing material realities with more virtual promises. However, such material realities remain multiple and contested, particularly in relation to other energy futures in the making, the logics of which can be identified only through contextual empirical research. In this way, the thesis offers a relational account of resource materiality, having documented how heterogeneous rocks come to be known as ‘oil shale’ in diverse and conflicting forms through geographically disparate practices of resource governance and technological development, but once stabilized as a liquid fuel resource assume themselves the potential to resist scientific abstraction, standardization, and marketization. The future viability of oil shale development depends on how the materiality of the resource becomes entangled in political attachments and market arrangements, whereas *what* counts as ‘the unconventional’ is created, contested and transformed at the same time as it is ‘conventionalized’.

Chapter 2. Geographies of Unconventional Energy Futures: Anticipation, Materiality, Marketization

2.1 A new politics of nature

In the last pages of his recent book, *Carbon Democracy*, Timothy Mitchell (2011) introduces oil shale into his analysis of the intimate relations between liberal democracy, on the one hand, and the economy of fossil fuel extraction, on the other. Since the increasing shortage of easily accessible oil reserves has led to “defining other kinds of things as oil that we never called oil before”,¹³ for Mitchell, the possibility of oil shale development along with tar sands and shale gas works as a smoke-screen for the modern economic order rooted in the idea of unlimited resource availability at a time when the evidence of ‘peak oil’ undermines its efforts to progressively overcome the question of nature’s limits. Drawing on Latour (2004), Mitchell argues that the future viability of non-conventional resources hinges on ‘opening up anew the politics of nature’ in the pursuit of new forms of collective life (2011: 252).

This thesis starts where Mitchell’s book stops. It explores how unconventional resources become resources in practice, thereby opening up a ‘new politics of nature’. My aim is to show that this has been achieved through a series of scientific, economic, and political interventions, which are specific to particular locations of development. Such interventions, I argue, reshape our collective orientations towards the future, but they are also mutually conflicting, disputed and in process. The study of unconventional energy development must address both the question of how certain components of the material world come to be known as alternative fossil fuel resources, such as ‘oil shale’, and how the possible futures of their exploitation are

¹³ The full quote comes from Mitchell’s earlier public lecture on the same topic (Mitchell 2010), but the same idea is given in the book (Mitchell 2011: 249).

imagined, forged and contested in the domains of economics and politics. To this end, this chapter provides a review of theoretical vocabularies and conceptual tools that inform the development of these arguments in the following empirical chapters.

The chapter takes as its starting point the recognition that fossil forms of energy are deeply embedded in and constitutive of social and economic life, rather than something that belongs exclusively to the realm of 'nature'. Oil, in particular, is often considered to be the 'lifeblood' of programmes of modernity, the key guarantor of global capital exchange, and the trigger of violent aggression against and within resource-rich regions (Boal et al. 2006; Mitchell 2009; Bridge and Le Billon 2013). Until the last few years, however, the processes through which hydrocarbons are appraised, produced and distributed have largely been overlooked by geographers, with notable exceptions. Indeed, research on unconventional resources is still in its infancy. Yet there is a great need for this research, considering that carbon energy supply is linked to fundamental questions of space, scale and place, as manifested most notably in the 'geographically expanding character' of resource appropriation and exploitation towards the global South and the Far North (Bridge 2009a; Bridge et al. 2012). The development of some unconventional sources, in turn, has in some cases relocated extractive frontiers from the globe's territorial margins to the heart of Western democratic societies. Having been staged as an ineluctable response to globally looming scarcity and insecurity in times of 'peak oil', unconventional energy development appeals to continued progress in scientific knowledge production, technological innovation, future-oriented policy decisions, and the rational behaviour of markets, while also potentially generating opposition to these processes.

Recent work by human geographers offers an increasingly rich account of the hydrocarbon economy drawing on the intellectual resources of political economy,

political ecology and geopolitics. Putting emphasis on the policies and politics of fossil fuel exploitation, these literatures have engaged with questions of resource availability, allocation and management, and thus concentrated on the struggles that arise from securing access to and control over worldwide supplies (Rees 1990). Political economists, in particular, have recognized that oil is a commodity that is central to any analyses of capital accumulation and foreign exchange between exporting and importing countries (e.g. Nitzan and Bichler 2002; Harvey 2003). This work highlights that the regulation of transnational energy flows plays a strategic role in defining international power games, with some host governments exerting increasing control over the allocation of their reserves and profits; a trend known as 'resource nationalism'. Up until recently, such scholarly endeavours have tended to overlook the ways in which the production and circulation of hydrocarbons may also become associated with wider political imaginations within producer countries and beyond. In political geography and related disciplines, however, a growing body of research has begun to address the conflicts that accompany the exploitation of generous reservoirs in certain regions such as the Caspian Sea Basin (O'Hara 2004; O'Lear 2004), the Russian North (Bradshaw 2010a), Latin America (Dunning and Wirpsa 2004; Sawyer 2004; Perreault and Valdivia 2010), and the Gulf of Guinea (Watts 1998, 2004c, 2004b, 2004a; Apter 2005; Oliveira 2007; Zalik 2009).¹⁴ A number of geographers also attend to the shifting geopolitics of liquid fuel trade, as manifested in the proliferation of conflicts and controversy along new pipeline routes that cut through national and ethnic borders (O'Hara 2004; Nuttall 2008; Barry 2009; Gilmartin 2009; Bouzarovski 2010; Bouzarovski and Konieczny 2010). The research on pipeline politics suggests that hydrocarbon flows cannot be reduced to mere

¹⁴ A number of these articles have been republished in a book *The geopolitics of resource wars: resource dependence, governance and violence* (Le Billon 2008).

economic objects and metrics, instead calling attention to the ways in which they become saddled with the notions and instruments of security, and subsequently contested across a multiplicity of sites and actors (see also Ciută 2010). Finally, geographers have also become interested in the transformations that take place in the management techniques and knowledge practices of major oil corporations at times when the industry faces various technical, political and cultural challenges arising from formerly unexploited territories, as well as the growing level of scrutiny by transnational non-government institutions (Bridge and Wood 2005; Ferguson 2005; Barry 2009).

While this scholarship is certainly on the rise, very little attention has been paid to the ways in which the emergence of both ‘unconventional places’ and ‘unconventional sources’ may reshape future energy landscapes (Bridge 2010), with the exception of the frequent but still under-developed reference to the Alberta tar sands (Bridge 2009b; Bradshaw 2010b; Bridge 2010; Zalik 2010; Bridge 2011c; Bridge and Le Billon 2013). In broad terms, the transition from ‘easy oil’ to ‘extreme oil’, as Klare (2012a) points out, has been hindered not only by the geographical barriers associated with the conquest of remote territories, but also geological and geopolitical barriers. A notable exception to the otherwise systematic gap in the literature is offered by critical inquiries into the reconfiguration of the Arctic as the ‘last resource frontier’ (Powell 2008; Dodds 2010; Johnson 2010; Powell 2010).¹⁵ Powell’s (2008) research, in particular, highlights the fact that political debates concerning the allocation of exclusive rights to authorize and regulate deep-water drilling in the Arctic are entangled with highly contestable scientific exercises, including

¹⁵ Another exception is the proliferation of postgraduate research on unconvensionals in relation to questions of nation-building, citizenship, pipeline politics, carbon engineering and other techno-futures. To my knowledge, there are a few projects which are going to be published in the next few years, and mostly focus on the Alberta tar sands and Marcellus shale gas. This also is evidenced by papers presented at the 2011–2013 AAG Annual Meetings in Seattle, New York, and Los Angeles.

geomorphologic explorations of the seabed and probabilistic techniques of resource assessment. Situating frontier-style extractive activities at the interface of the geosciences and geopolitics, these commentaries bring into focus the techno-scientific and rhetorical work that is required *before* any unfamiliar subsurface terrains can be carved out and constituted as new resources, allocated to economic valuation, brought to the market, and subjected to inter-state politics and civil mobilization.

These insights extend geographers' existing focus on the commodification of nature (e.g. Castree 2003) to the processes of 'resource-making' more broadly conceived, and invite us to interrogate how these processes bring into effect economic and political life within and beyond the routine operations of production and consumption. Here, oil shale emerges as a peculiar energy resource in the sense that *it has never become a resource*, at least not on a grand scale. The diverse organic-rich sedimentary rocks conveniently labelled with a single name make up a specific category of fossil fuels, which have occasionally been used in a few places and periods of time, but remain "untapped" in general. The presence of such resources is nevertheless often taken for granted, as they are invoked as physical, real-world formations that exist independently in 'nature', even though our knowledge about their qualities and quantities is limited, at best. In parallel to this deep-seated 'bedrock naturalism' (Bakker and Bridge 2006), such 'resources of the future' also figure strongly in the idealist sense, since they enjoy continued prominence in technological innovations, economic calculations, and debates over possible energy futures, notwithstanding whether such materials are ever brought to the market or even out of the ground. Placing both realist and idealist understandings at risk, the emergence of un conventionals uncovers the ontologically ambiguous and unstable character of hydrocarbons, since they tend to escape or shift foregoing scientific and political categorisations, and consequently blur the distinction between commodities,

resources, and non-resources. In fact, conventional crude is far from a homogeneous entity, but the possibility of creating new resources out of a variety of more or less viscose subterraneous sediments interrogates the limits of geoscientific abstraction, technological manipulation, and social acceptability. Moreover, the expansive ecological devastation and accumulation of wastes that results from the exploitation of lower-grade deposits down the 'resource pyramid' (Bridge 2009b) undermines the central place that carbon-rich fuels continue to occupy in the 21st century economies and livelihoods (Huber 2009; Mitchell 2011; Klare 2012b). Such socio-ecological dilemmas have become particularly salient in regard to the immense demands of technical manufacture and energy that are being invested into transforming hardly permeable sediments into useable liquid fuels, as also witnessed in the widespread public opposition to tar sands and shale gas development.

The 'non-conventionality' of oil shale therefore contains more than a technical alternative to conventional oil and gas. It necessitates a larger quest for negotiating techno-scientific progress, finding new grounds for political consensus, and reconfiguring the ways our economies are organized. Engaging critically with recent work on the politics of hydrocarbon development, this chapter identifies possible research avenues for geographical studies of energy transformations beyond the contending visions of global resource scarcity and techno-economic modernity, with a further aim to secure a special niche for research on un conventionals as contentious future resources. It does so by drawing on a diverse field of theoretical debates in critical political ecology, cultural geography, and economic sociology and geography, which are broadly informed by Science and Technology Studies (STS) and poststructuralist social theory. These literatures cover (i) research on anticipatory governance and politics in the context of uncertainty, (ii) relational theorizations of

natural resources, matter and materiality, and (iii) analyses of the construction and politics of markets.

The chapter begins with the question of ‘resource-making’ by exploring how the relationship between ‘nature’ and ‘society’ has been addressed in recent political ecology and economy literature, according to which the governance of hydrocarbons is not determined by their material properties or limited availability, but arises from historically, politically and geographically contingent conditions. The nascent field of ‘geographies of peak oil’ launched with a special issue of the *Geoforum* journal in 2010 adheres to the long-held conviction in geography that resources are socio-culturally constructed and dynamic categories rather than fixed entities; categories that are continuously ‘in-becoming’ and thus *relational* (Bridge 2009b). This literature rightly presents a critique of neo-Malthusian concerns about nature’s limits. However, it has hitherto tended to focus on how resources are entangled in ‘above-ground’ economic and political circumstances. By contrast, there has been little attention paid to their ‘below-ground geographies’ (cf. Bridge and Wood 2010: 527). In this context, my thesis returns to the problem of the materiality of fossil fuels by developing existing STS inquiries into the science and politics of oil reserve calculations. In this way, I argue that it is possible to interrogate the relations between subsoil realities and the organization of economies and politics.

The prospects of unconventional energy development may be less significantly affected by established politico-economic forces than undermined both by uncertainties in scientific knowledge production and by mistrust in sustained technological progress. The next section therefore approaches “post-oil” energy transformations as inextricably bound to the governance and politics of the future. The ‘above-ground’ governance of future resource use involves multifaceted issues that

will be decided within a plurality of voices, and hence convey the potential to reconfigure not only traditional modes and spaces of resource governance, as follows from political ecology and political theory literatures, but the practices of anticipation, the materiality of resources and the design of future markets. The subsequent section proceeds to strengthen a 'below-ground' re-reading of peak oil geographies. Following the call of Bakker and Bridge (2006) for materially informed resource studies, it paves the way to a relational theorization of resource materiality, which further echoes wider attempts to 're-materialize' human geography in pursuit of non-dualistic, 'more-than-human' ontologies (Whatmore 2002) and materialist accounts of politics and economy (MacKenzie 2009b; Braun and Whatmore 2010).

Lastly, no geographical analysis can evade the question of whether unconventional resources will ever become economically viable to produce. Drawing upon the convergence of STS and economic sociology, I argue for a non-essentialist, pluralist notion of economic systems and markets, understood as dynamic products of various calculations entangled with concrete socio-material circumstances. Rather than being ruled out by established market arrangements, unconventional energy development exhibits the potential to set up new rules of calculation in relation to alternative economic knowledges, the changing materiality of the resource base, and the socio-technical systems through which new commodities are produced and circulated. The concluding section discusses the value of these literatures for political geography research on unconventional energy development and introduces the main theoretical arguments of the thesis.

2.2 Resource-making

2.2.1 The political ecology of oil

Oil and gas are often credited for both their energy content and their fluidity, which enable concentrated forms of extraction, distribution and power. They are also known to be at least potentially limited, 'non-renewable' resources. Based on these observations, what is the relationship between the biophysical and geospatial qualities of high-energy resources, and the governance of their extraction and circulation; or, in other words, "the nature of oil and how it is produced, distributed and used" (Mitchell 2009: 400)? I begin by reviewing the contribution of political ecology and, in particular, the critical contribution of Michael Watts to this question.

Studies informed by political ecology have interrogated the politics of resource management in different parts of the world and, in doing so, have examined the 'metabolic' relations between nature and society, broadly conceived. A growing body of research in this field, indebted to Watts' research in the Niger Delta, has dissected the forms of social unrest, economic failures and violent conflicts that result from conventional oil development, and highlighted strong connections between resource-making, hydrocarbon governance, and nation-building. For Watts, petroleum is not solely a biophysical substance gushing from the ground or a commodity that enters the world markets. The 'black gold' also carries mythical and spectacular qualities; "it is the bearer of meanings, hopes, expectations of unimaginable powers" (2004c: 280, 2004a: 203; 2009). Insofar as the crude is pumped out of the ground, leaving behind undeniably real ecological destruction, Watts (1998) argues, it is also always *an artefact* of scientific measurements, technological manipulation, and social identities, discourses and imaginations. In what Watts (2004a) further identifies as a particular capitalist rationality, 'petro-capitalism', the spectacular, invisible, almost mystical resource envisaged through rent-seeking and imaginings of economic prosperity

figures centrally in the making of oil-producing communities and nations. What counts as 'nature' is therefore specific to particular places, being constituted through particular forms of political oppression and resistance revolving around the resource, and subsequently giving way to distinct rules of conduct and social orders. Following Watts' research, hydrocarbons have provided political ecology with a lens through which to interrogate the economies and geographies of violence in resource-rich regions (Peluso and Watts 2001; Boal et al. 2006), often considered to result in 'resource wars' within and between states (Le Billon 2004, 2007, 2012).

Watts' recent work has primarily interrogated the relations between economy, resources and society, and focused on the government of this relationship in different spaces and at multiple scales. In particular, he draws upon Foucauldian analyses of governmentality to interrogate what the post-Foucauldian sociologist Nikolas Rose (1999) once called 'governable spaces'. However, unlike Rose, Watts highlights the disjunctures and differences between distinct spaces of rule (Watts 2004a, 2004b, 2004c). As much as state authorities centralize petroleum rents at a national level, local communities, ethnic clans and other groups rely on lucrative revenues, both real and imagined, in order to activate claims over community and territory, thus undermining the aspirations of a unified nation. The spatial dynamics of resource governance are further underpinned by the distinctive 'enclave' character of the practices of transnational oil corporations in cooperation with the central government (Watts 2004b; Ferguson 2005). Petro-capitalism thus operates through an intricate complex of human associations and things, or what Watts (2004a) calls an 'oil complex', which is organized around mechanisms of rent distribution and apparatuses of security involving a state, a nationalized oil company, transnational financial institutions, and a multiplicity of oil-producing communities, and which is territorialized through oil concessions (cf. Bridge 2009a). As a result, the governable

spaces of oil contain problematically constructed subjects and objects of governance, which are both multiple and contentious, leading to unstable and often 'ungovernable' articulations of geographically overlapping territories (see also Rutherford 2007: 300; Bridge 2011c).

Having introduced political ecology to the study of oil, Watts takes issue with the paradigmatic social science scholarship in economics and political sciences. He is particularly critical of the widely applied thesis of the 'resource curse' based on observations that nations endowed with oil revenues tend to be paradoxically more corrupt and prone to poor economic performance than those countries that lack significant deposits (e.g. Auty 1993; Karl 1997; Ross 1999; Sachs and Warner 2001). Following his argument, economic failures and political unrest are not bound to the material qualities of oil in isolation from the social relations within which the resource is entangled. The claim that there is a direct causal link between oil and violence is flawed since it "substitutes oil (as one sector of industry) for a dominant capitalist core, and fixes on the character of a single commodity at the expense of the systemic imperatives of capital in general" (Boal et al. 2006: 67). Oil is a curse indeed, Watts argues, but only insofar as its extraction is understood against both the backdrop of historically and geographically contingent forms of identity politics and the larger capitalist dynamics epitomized in the growing dominance of multinational corporations. Having repeatedly warned against commodity determinism, Watts still entertains the idea that the unique qualities of oil matter, as do the biophysical properties of other highly valued resources (Le Billon 2001, 2004), but only when its development enters "into an already existing political landscape of forces, identities and forms of power" (Watts 2004b: 76). Rather than being exemplary of 'bad governance' or 'resource curse', oil in Watts' account generates new forms and spatialities of political organization (Bridge 2011c).

The work of Watts and his colleagues is invaluable since it demonstrates how myths of oil-wealth effectively tie the accumulation of petro-capital to the struggles of nation-building. At the same time, this work brings into focus the distinct spatial forms that hydrocarbon governance may take as a result of both the materiality of resources and local socio-political contingencies. These insights have inspired many geographers to follow similar lines of inquiry in other contexts (e.g. Kama 2007; Zalik 2009; Perreault and Valdivia 2010; Weszkalnys 2011). Critical political ecology thus expands on the insights of political economy, yet it also has important limitations, particularly when applied to less established extractive sectors, including unconventional resources. The first lies in the empirical scope of existing research. ‘Geographies of violence’ have almost exclusively focused on authoritarian and populist regimes in postcolonial contexts without paying much attention to the political ecology of extraction in liberal democratic societies. There are several oil and gas producing regions in the world, where such manifestations of violent conflict or even economic failures have either never occurred or taken very different forms. Further, as Watts himself affirms, violence cannot be explained deterministically by the specific material properties of hydrocarbons, as if such resources would have intrinsic qualities unrelated to socio-cultural relations (cf. Bakker and Bridge 2006). But although Watts (2009) explicitly rejects resource determinism, oil nonetheless iterates throughout his articles as a peculiarly maleficent resource prone to looting and blood-letting (cf. Le Billon 2004). In effect, while Watts draws attention to oil’s spectacular and artefactual qualities he does not explore, in any detail, the materiality of hydrocarbon resources.

The lack of critical inquiry into the relationship between resource materiality and governance is especially wanting in the context of unconventional energy sources, given that such lower-quality deposits have long fuelled hopes for oil-wealth in certain nation-states that aspire to solve structural energy dependence problems. Notably, the

development of unconvensionals has hitherto been less entangled with the capital accumulation strategies of multinational oil companies than with nationally specific identity politics. The distinct materiality of such resources compared to conventional hydrocarbons should not be understood solely in terms of their energy content, quantity or geographical distribution, but also in relation to their so-called artefactual qualities in conjunction of local political circumstances and economic cultures. In this context, Perreault and Valdivia (2010) make an important contribution to the political ecology of oil and gas, arguing in response to Watts, Le Billon and others that the politics of extraction cannot be reduced to resistance, opportunistic profit-making, or questions of resource scarcity or abundance. Their analysis of popular protest movements in Ecuador and Bolivia suggests that such struggles are also bound to the imaginative geographies of the nation, its historical formation and perceived role in resource governance. In producer states, hydrocarbon reserves tend to be considered *a patrimony*, defined as “the inheritance of the nation and its citizens, which is imbued with historical significance and purpose through its ability to promote national growth and modernization” (2010: 691). Thus, the materiality of hydrocarbons becomes the medium through which alternative imaginations of national sovereignty and collective life are articulated. Following their argument, geographers should also attend to the specific, contested, and shifting ways in which natural resources are imagined and experienced as *national* resources.

2.2.2 Geographies of peak oil

While political ecologists interrogate the politics of hydrocarbon development at national and sub-national scales, they tend to overlook how such local conflicts are linked to the possibility of worldwide scarcity. It is only recently that geographers have taken interest in the effects that perceptions of an impending shortage may have on both reshaping our carbon-based energy systems and inciting new forms of

political mobilization and citizenship. This has been expressed, in particular, in calls for critical geographical studies of 'peak oil' (Bridge 2010) and, in relation to climate change concerns, the making of 'carbon economies' more broadly (Bridge 2011c).

In the 1960s and early 1970s the rapid increase in resource consumption in conjunction with exponential population growth gave rise to a number of theoretical concerns. In this period, the proponents of the resource scarcity thesis upheld a neo-Malthusian understanding of resources as physically exhaustible, warning that continuous exploitation would necessarily lead to a crisis, whilst their various opponents saw solutions in market-efficiency and technological modernisation (for analysis, see e.g. Emel et al. 2002). Both sides have seen a remarkable revival of their arguments in the 2000s. In light of these inveterate debates, it is hardly a surprise that the timing and even the very possibility of 'peak oil' continues to be heavily contested. Broadly speaking, the controversy is polarized between "geologists" who herald resource-based limits to oil availability (e.g. Campbell and Laherrère 1998; Deffeyes 2001; Bentley 2002) and free-market "economists", including economic geographers, who interpret any shortage as a matter of balancing demand with sustained investment and innovation, and hence deny the importance of geophysical constraints (e.g. Adelman 1995; Odell 2001; Maugeri 2004; Odell 2010; Yergin 2011) (for popular literature on these camps, see Clarke 2007; Mills 2008). As I argue later, the controversy derives from the knowledge practices through which oil resources are mediated as 'reserves'. The inclusion of various unconventional sources into reserve calculations has served to cement the economists' standpoint (Odell 2004).

Responding to the neo-Malthusianism of the 1970s an earlier generation geographers has been critical towards the possibility of resource scarcity. In a groundbreaking article in 1974, David Harvey sharply criticized the 'limits to growth'

projections and argued that scarcity does not belong inherently to nature, but quite the contrary, it is instrumental for the maintenance of capital accumulation. When posed as a global problem, the ‘population-resources’ proposition not only underestimates technological change, but also the forms of social injustice that will result from any measures to regulate population growth. As Harvey explained, resources can be defined only in relationship to a given ‘mode of production’, since there is “no such things as a resource in abstract or a resource which exists as a “thing in itself”” (1974: 265). Drawing on his argument, subsequent research in human geography has tended to embrace an ‘anti-naturalist’ stance to the idea that non-renewable resources are ultimately finite (see Emel et al. 2002; Bridge 2009b, 2010). In this view, the problem of global oil scarcity is misconceived and overstated at the expense of wider socio-economic regulation of resources (see, in particular, Bridge 2011b). Furthermore, the connections between geographies of conflict and hydrocarbon extraction cannot be attributed to any ‘natural limits’ to resource availability. As explained above, any deterministic accounts that rest on the nature of hydrocarbon materials *per se* are flawed, because they ignore “the larger capitalist system of which oil is a constitutive part” (Boal et al. 2006: 59). Political economists and ecologists therefore reject the popular claim that scarcity is ‘a natural fact of economic life’ and a key determinant in explaining ‘resource wars’ (Boal et al. 2006; Huber 2011: 817; Le Billon 2012).

Building on this work, Gavin Bridge has sought to clarify further the concept of ‘natural resources’ and its relevance to the problem of fossil fuel availability (2009b, 2009c, 2011a). Contrary to popular apprehensions of resources as pre-given parts of physical nature availed through biological, ecological or geological processes, Bridge emphasizes that resources are not ‘natural things’. Historical evidence supports Harvey’s point that rather than representing the inherent and stable qualities of

material substances themselves, certain components of the material world can easily slip in and out of the category of resources, depending on profoundly ‘technical and cultural appraisals’ about their value and utility in relation to other materials that become available to serve the same functions. The division between resources and non-resources varies greatly between different times and geographical regions. As geographers have noted for nearly a century, ‘resources are not: they become’ (Zimmermann 1933; quoted in Bridge 2009b: 1220). In this way, resources occupy an unstable place between nature and society; they are ‘hybrids’ that defy the stabilization of the world’s rich experiences under neat dualistic categories (see also Watts 1998). Moreover, the question of what counts as a resource depends on *who* is entitled to speak in favour of extraction. As the history of resistance to extraction in postcolonial contexts makes clear, the category of “nature” is far too often established at the expense of other values and identities of the place where resources are “discovered”, such as those articulated by indigenous groups (Willems–Braun 1997; Castree 2005). Having thus effectively ‘denaturalized’ resources, geographers prefer to attribute them primarily with *social* meanings and relations; specifically, “what it is about the needs and wants of a society, and the way a society is organized, that transforms a component of the non-human world into a resource in a particular time and place” (Bridge 2009c: 649).

This ‘relational approach’ to the study of resources has helped illuminate the controversy over the idea of peak oil (Bridge 2010; Bridge and Wood 2010). The central line of argument that emerges here is that if resources embody social relations rather than exist as discreet natural ‘things’, then hydrocarbon availability has to be understood not so much as a product of absolute geophysical constraints than the constraints imposed by a capitalist economy. Historically, at least, the supply of petroleum to world markets has been governed by a combination of chronic

overproduction, price manipulation, and geopolitics. Indeed, “the problem of oil is not its scarcity but its abundance” (Labban 2008: 2). In these circumstances, scarcity has to be carefully manufactured: the key concern is how to maintain effective market demand at reasonably high prices in the face of surplus production, without hindering economic growth (Boal et al. 2006; Le Billon and Cervantes 2009; Mitchell 2009; Bridge and Wood 2010; Labban 2010; Bridge and Le Billon 2013). Given this background, the political economy approach to peak oil has tended to emphasize the ‘above-ground geographies’ of reserve allocation, market regulation and institutional changes in the oil business that characterize the strategic engineering of scarcity (cf. Bridge 2010; Bridge and Wood 2010). While this literature places scarcity internal to the economy, Bridge and Wood (2010) nevertheless contend that contrary to ‘resource optimists’ geographers must not simply advocate continued resource appropriation, valuation and extraction, but instead recognize the inescapably political and often extremely unjust character of these processes.

Another line of argument deriving from the above is that the stock availability of world petroleum is not given once and for all. Rather, oil reserves should be regarded as temporarily shifting formations that hinge upon advancements in technical knowledge, as much as upon the politicization of their availability. In this regard, as Bridge and Wood observe, the peak oil narrative legitimizes the inclusion of unconventional sources in industry’s reserve assets and investment portfolios, facilitates access to unexploited fields, and thus “naturalises a situation whose origins are political and economic in nature” (2010: 575). When conjoined with the commodification of greenhouse gases as the upstream end of the industry, the configuration of ‘carbon economies’ overall can be seen as a process of *resource-making*, which requires substantial amounts of political, economic and cultural work (Bridge 2011c). The extent to which the production of unconvensionals serves to

sustain the “old” carbon economy will equally depend on the political and market processes through which “new” economies of emissions control and trading are instituted.

The inclusion of new carbon energy materials and emissions into the economy of oil highlights an important agenda for relational conceptualizations of hydrocarbon resources. Moreover, this literature also suggests that the ‘below-ground geographies’ of resource availability cannot be detached from the ‘above-ground’ practices through which resources are *made* available. When Bridge (2011b) recommends to move “past peak oil” in another recent article, he remains faithful to the ‘anti-naturalist’ tradition, arguing that any limits to conventional oil availability will be driven by ongoing management of energy crises as a ‘normal state of affairs’, rather than by geophysical constraints. Having rightfully displaced resources from physical nature, however, this literature tends to prioritize the study of *social relations* at the expense of socio-material interdependencies. In other words, the ‘relationality’ of resources becomes understood primarily through the lens of ‘society’ as an antithesis to ‘nature’. As further explained below, this approach could be complemented with a ‘relational and distributed view of materiality’ in STS and related work in human geography, following the proposal of Bakker and Bridge (2006: 16). In this view, the material world is not separate, but always entangled with the social realm of scientific, economic and political calculations, since *both* categories represent contingent purifications that result from the ongoing negotiation of what Latour (2004) calls the ‘collective’ (Law and Mol 1995; Mitchell 2002; Latour 2005b).

On a further note on peak oil, recent geographical research also marks a departure from scarcity studies, since it brings into focus the effects that such a controversy has in reshaping national policies, company strategies, and forms of

public mobilization in response to either the globally looming threat or more localized perceptions of energy crises (Bailey et al. 2010; Kristoffersen and Young 2010; North 2010). In this context, the peak oil proposition becomes *strategically deterministic*, as Bridge notes, because it rehearses “a calculated recognition that arguments about imminent scarcity can ignite a deeply-rooted fear of running out, and provide a politically effective lever with which to drive economies away from oil”, towards lower-carbon energy futures (2011b: 315). Yet, again, one should not take for granted that such affective engineering of crises necessarily institutes ‘a transition away from oil’ (see also Bridge and Le Billon 2013). What is little emphasized is that such ‘post-oil’ perceptions can also drive economies *towards* alternative high-carbon resources and, in this way, instigate a re-negotiation of what it is meant to be ‘economic’ altogether.

2.2.3 The metrology of carbon

In one way or another, the changing nature of the resource base continues to pose an important problem for any geographical analyses of future hydrocarbon availability and politics. The key challenge for this thesis is therefore to advance relational understandings of fossil fuel resources through a renewed attention to their materiality, but without explaining hydrocarbon governance deterministically with their specific properties or natural limits. As discussed above, the political economy and ecology literature has declined to associate recent increases in market prices for oil and other key commodities with a measure of scarcity, and pointed instead towards mechanisms of ‘organized scarcity’ that are designed through ‘above-ground’ strategies of securing economic stability, while attributing little significance to ‘below-ground’ realities (but see Bridge and Le Billon 2013). On further examination, however, the relationship between the economy of oil and measurements of its availability is recognized to be much more complex, not least for the reason that fossil

energy is not just measured for its use value but itself becomes a metric for modern lifestyles, national economies, and the global circuits of goods and capital (Bridge 2011b; Mitchell 2011). The distinction between the material world and politico-economic calculations cannot be expected to stay intact, but is likely to be renegotiated the more extractive operations become constrained.

The above-ground/below-ground distinction can be overcome with the help of a few suggestions made in Science and Technology Studies concerning the calculation of oil reserves (Bowker 1994; Barry 2008; Mitchell 2009, 2010, 2011). The STS research has traditionally centred on the scientific and political processes through which certain ‘matters of fact’ about nature are established. Epistemologically speaking, STS argues that no parts of ‘nature’ are directly accessible, but always mediated by knowledges about the world; a process through which the objects of knowledge and reality overall are *created* rather than “found” (e.g. Latour 1987, 1999; Mol 2003; Law 2004). The peak oil controversy can be regarded as part of a larger process in which the nature/society difference is negotiated: to what extent is resource availability determined by the ‘natural laws’ discovered by geologists, or governed by the ‘laws of the market’ and politics? While the strategic engineering of market demand for resources is widely documented, the STS-inspired perspective brings into light the disciplinary work in the geosciences that goes into stabilizing the non-human world, so that it can be measured in the first place and subsequently ‘framed’ under the criteria of economics (Callon 1998), whereas the latter discipline comes to stand for a self-professed middle field between the “objective” facts of nature and the “subjective” sphere of culture and politics (Mitchell 2011).

The processes through which carbon energy becomes both a metric and a market currency are far from straightforward, but always marked by certain degrees

of uncertainty and inconsistency. The metrology of oil invites us to focus inquiry on these tentative moments of resource-making by analysing different forms of expertise through which energy content is calculated and valued with the help of certain instruments, logics, and probabilistic techniques. The key agenda it raises is to study discrepancies between the geoscientific and economic practices through which materially heterogeneous subsurface terrains are abstracted, stabilized, and subsequently concealed as 'reserves', so that *both* forms of calculation can be convened in the language of undisputable science, and the forms of politics that follow from that. Such practices of rendering resources knowable can be therefore regarded as distinct regimes of valuation, which need to be continuously translated into each other. Their techniques of measurement and calculation tend to be tailored to particular locations, with the result that such a translation is conducted locally, reflecting the 'geographies of science' at work (Powell 2007). Moreover, their controversies are never merely technical issues to be settled between two or more scientific disciplines, but they can easily overflow into wider disputes over desired forms of social order, or 'socio-technical controversies' (Callon et al. 2009).

In this way, the metrology of oil also opens up a further line of inquiry concerning how the realm of economic exchange relates to resource-making. As Bruce Braun (2008) argues, political economy literature on resources has begun to reject the nature/society distinction, but often tends to do so only by delegating social functions to 'the economy', as if it were another pre-given ontological structure against which the non-human world is measured and tested. By contrast, STS scholars have long argued that it is rather the constitution of 'the economy' and 'the market' that needs to be accounted for. As further explained later, these terms are considered technical inventions which are abstracted from complex real-life interactions incorporating both humans and nonhumans, and which in turn help to *remake reality* (e.g. Callon

1998; Mitchell 2002; Çalışkan and Callon 2009; MacKenzie 2009b). Drawing on this approach, Weszkalnys (2011) argues that the discipline of economics does not simply observe, but performs the conception and mitigation of socio-political effects associated with oil extraction, such as the ‘resource curse’. When it comes to the development of unconventional energy resources, one could regard resource-making and market-making as ‘mutually reinforcing processes’ alongside nation-building (cf. Wengle 2012). Their access to markets is not determined exclusively by calculations of production costs or net energy return, but also pertains to the making of ‘the economy’ *as such* at the interface of technoscientific innovation and the ongoing reorganization of carbon-heavy industries.

The STS perspective problematizes any causal linking of high-carbon resources with the economy of oil or market-based energy governance. Instead, it shifts attention to the constitution of such categories or states of affairs themselves, drawing from the contention that both knowledge and technology originate in situated and contestable practices (Hughes 1983; Haraway 1988; Knorr-Cetina 1999). Overall, this brings us back to the generative effects of future-oriented scientific, economic and political calculations in a situation where scarcity perceptions may foreground “transitions” to alternative energy futures, either higher or lower carbon. The major challenge here is to resist a kind of resource or energy determinism, which would define the future availability or economic viability of resources with their physical limits or other material characteristics (cf. Kennedy 2012). This calls for both renewed understandings of resource materiality, and the political and economic conditions under which exploitation continues to occur in a situation of remarkable uncertainty. Having drawn the contours of my main arguments, the following sections develop these propositions further by engaging with three intersecting theoretical fields associated with the notions of anticipation, materiality and marketization.

2.3 The politics of anticipation

2.3.1 The governance of prospective technoscience

The experiments carried out with various unconventional energy resources hold out the promise that the world's growing hunger for energy can be matched in time. This makes their development akin to other areas of techno-science, which are oriented towards progress and modernization, yet have proven to be highly uncertain, problematic and contested (Brown et al. 2000). As discussed in Chapter 1, the likelihood of oil shale development has been driven by calculations of their economic feasibility in relation to the potential scarcity of higher-grade resources, but also determined by, amongst other things, the industry's ability to demonstrate technological readiness, the international politics of mitigating greenhouse gas emissions as well as other environmental impacts, and the level of public support and opposition. Any alternatives to current energy economies, regardless of whether more or less carbon intensive, will be dependent on a plurality of social groups and interests, which feed on and magnify the problems of imperfect expert knowledge.

In this way, the politics of unconventional energy development overspill the territorial politics of nation-states in the management and allocation of their strategic resource assets. Political theorists have widely acknowledged that the authority and functions exercised by the state have been progressively displaced or complemented by other styles, scales and sites of governing (e.g. Rose and Miller 1992; Rose 1999; Barry 2001; Hibou 2004; Ong and Collier 2005; Jessop 2007). The proliferation of new modes and spaces of government has been particularly evident in a number of public controversies that have erupted in response to new scientific discoveries and technical inventions, especially concerning the possible negative impacts that accelerated progress may have on the environment and human health. As geographers have vigorously documented, environmental controversies emerge at the interface of

science and politics in situations where universal knowledge is either inaccessible or marked by a radical degree of uncertainty and risk, and subsequently spread across a whole breadth of social actors, depending on their motivation, skills and resources to participate in environmental governance (e.g. Hinchliffe 2001; Bickerstaff and Walker 2003; Bingham 2008; Chilvers and Burgess 2008; Whatmore and Landström 2011). Such controversies have thereby become considered ‘generative events’ that redistribute expertise between different disciplines, invent new techniques for public participation, and create new spaces, objects and subjects of politics (Barry 2001; Latour 2005a; Whatmore 2009; Barry 2012). Rather than calling for immediate resolution, contestation of prospective techno-science makes it possible to explore new forms of collective life for democratic societies, and thereby becomes entangled with the anticipation and creation of *the future* (Brown et al. 2000; Latour 2004; Callon et al. 2009).

Michel Callon’s ‘hybrid forums’ is one of the key concepts, which addresses the problem of the politics of the future in the context of scientific and technical uncertainty. In *The Laws of the Markets* (Callon 1998) and *Acting in an Uncertain World* (Callon et al. 2009), hybrid forums are promoted as alternative spaces of political mobilization which extend traditional practices and techniques of delegative democracy by facilitating debates on collective futures, as they mobilize concerned lay-persons and ‘non-experts’ against the monopoly of scientific advisory boards working for state authorities. The essence of the controversies explored in such forums is simultaneously social and technical, since what were initially supposed to be merely technical matters turn out to be social and political problems as the controversy unfolds. The distinction between technical and social is further renegotiated when new groups become concerned and enter the public space. The identities of these ‘publics’ are themselves not given but formed and transformed

together with the issues that they address (see also Marres 2005a; Marres and Lezaun 2011). Such forums are thus 'hybrid' in the sense that they both bring together heterogeneous social groups *and* relate to a variety of concerns covering different domains, including economy, politics, law and ethics. By disputing the authority of scientific and regulatory bodies, they act as meeting points for alternative sources of information, counter-expertise, and new knowledge. Hence, for Callon, scientific and technical controversies do not impede but actually facilitate democracy, because they make it possible to explore and learn about 'possible states of the world' in combination with new collective identities, and thus help bring about what Callon terms a 'technical democracy'.

Borrowed from the fields of logic and decision theory, the term 'possible states of the world' or 'possible worlds' iterates throughout Callon's work as alternative choices that are being tested in rational economic (and political) calculations, whereas "each state of the world [is] defined by a certain list of actors and goods, and by a certain distribution of these goods amongst actors" (1998: 4). Ideally, the decisions taken in these situations are grounded in an analysis of an exhaustive list of options, including their human and non-human constituents. However, in what Callon calls 'hot situations', participants will find it difficult to describe and weigh such options and subsequently identify the actions to be taken, because there exists "no shared information or shared prediction on the future" and no "stabilized knowledge base" (1998: 6, 260). Callon *et al.* (2009) therefore equate 'possible worlds', or what they also call 'scenarios', with situations in which risk is calculable, in contrast to situations of radical uncertainty where futures can be identified only through collective exploration and learning. Here, possible worlds look more like an unfinished "list" in process, rather than a given range of scenarios that can be established in advance. In either case, however, the future is reduced to a limited number of discreet options,

whereas perfect knowledge about the choices pending decision-making is possible, if not immediately available. Callon adheres here to the propositions of logics, where possible worlds are not necessarily given a temporal dimension, but refer to a series of unrealized, yet potentially co-present realities.

Whilst Callon is not entirely consistent in using this term, his analysis remains limited to describing how techno-scientific controversies bring forth new knowledge politics, without taking further the epistemological question of how *future* possibilities can be rendered known and actionable in the present. ‘Possible worlds’ do not seem to apply to situations which are both ‘unknown and unknowable’ (Kahn 1962); that is when anticipation cannot rely on linear projections from past occurrences and present experiences, but must account for novel possibilities, as is the case in radical uncertainty. Futures may be not just possible, but also potential, preferred, wanted and unwanted (Adam and Groves 2007). While Callon associates ‘possible worlds’ with identifiable options, he nonetheless admits the openness of the future by emphasizing that it is more important to acknowledge the path of collective learning than achieve final certainty and that hybrid forums are entitled to “devise scenarios rather than just choose between scenarios” (2009: 228).

2.3.2 Anticipatory practices

Callon’s work highlights a paradoxical shift in contemporary perceptions of time and related social practices, in which chance is increasingly produced by human activity, but transcends human control at the same time. Although ‘possible worlds’ provide a useful starting point for interrogating collective decision-making over alternative carbon economies, the term remains too under-theorized for situations of radical uncertainty, where future options are no longer given, but embed layers of complexity, disruption, or surprise, and are in turn continuously acted over in the present

(Anderson 2010a). Anticipation is now widely acknowledged by social and political theorists as a central mode of thought and action connecting the present to that which 'has not yet happened but is threatening' modernist societies characterized by increasing risk, indeterminacy and uncertainty (Beck 1992: 33; Adam and Loon 2000; Brown et al. 2000; Massumi 2005a; Adam and Groves 2007; Adams et al. 2009). Anticipation works through a wide range of practices and techniques that 'create, know and govern possible, potential or preferred futures' (Anderson 2007). Notably, it is the 'present anticipation' of the future in the face of its openness that defines the need for social science research (Beck and van Loon 2011) or, as the leading sociologist of the future, Barbara Adam, suggests:

The task for social science, therefore, is not to create ever better models to predict the future, identify trends and provide prognoses. Rather, it is to identify the field of contestation, show the intricate networks of interaction, establish the role of narratives, metaphors and 'grammars of the future', disclose power relations and their effects on alternative futures. (in Brown et al. 2000: xiii)

In geographical research, a linear conception of time is often taken for granted, regardless of recurrent attempts to think through the space-time relationship throughout the discipline's history (most recently by Massey 2005). This risks overlooking how future-oriented practices not simply aim to know what comes next, but have themselves unpredictable, and potentially multiple consequences in the present (Anderson 2010a). The following briefly recounts the making of resource futures through the notion of anticipation as a specific mode of knowing, governing, and disagreeing about the future. It does so by building on the growing body of research on the future in sociology, anthropology and critical geography, which have already begun to address the politics of anticipation (Anderson 2007; Adey 2009; de Goede and Randalls 2009; Anderson 2010b; Kinsley 2010b; Adey and Anderson 2011; Kinsley 2011; Lane et al. 2011).

Anderson (2010a), in particular, has argued that Western modalities of liberal government are increasingly staged as an anticipatory response to three ‘high-profile’ threats: terrorism, trans-species pandemics and climatic changes. Concerns about the scarcity of essential resources such as food, water and fossil energy present an inevitable supplement to this list. Drawing on a simple diagram of Adam’s (2005), it is possible to differentiate between three ways in which humankind engages with the potentially disruptive event of hydrocarbon scarcity: 1) how the future availability of conventional fuels as well as their alternatives comes to be *known*; 2) how resource futures are *created* by various political, economical and technological means; and 3) how future generations are *minded* and responsibility for their needs is assumed. This thesis attends mainly to the first two engagements, or what Anderson (2007) subsumes under the notion of ‘anticipatory practices’, including both anticipatory knowledge-making and the future-directed acts of governance and politics.

According to Anderson (2007), *anticipatory knowledge* functions through a range of exercises, models, scenarios and other methods, which enable us to codify the unknown and render it comprehensible and actionable in the present. In his account, such knowledge practices vary greatly in respect to, first, their inner logic, rationalities and constituent techniques; second, to the devices that are deployed to disclose, objectify and communicate the imagined futures; and third, their effects in producing certain ‘immaterialities’ such as risks and threats, but also opportunities and promises that are situated between the present and the future, the actual and the virtual. As explained in later chapters, evaluations of resource availability can be approached as a particular case of this kind of speculative knowledge, although there are many other techniques involved in the regulation of energy policies and markets.

In turn, the production of future-oriented knowledge serves *anticipatory governance*, which denotes a range of processes through which the future is rendered subject to present action. Promises and threats are made present and investigated, for example, in the form of certain epistemic objects, affective atmospheres, but also new or altered material trajectories, although Anderson (2010a) contends that the future must epistemologically still remain absent, when bad surprises are kept at bay. For Anderson and others writing in the field of non-representational geography, anticipatory governance functions necessarily in part through *affect*, most notably hope and fear.¹⁶ Affective modalities are considered central because they enable the unknown to launch new potentials into the present, and therefore reconfigure what can be known; affect in itself does not rely on solid facts, but nevertheless “underlies existing reality, allowing it to become real” (Bloch 1998: 341). Or, following Brian Massumi (2005a, 2005b), it is through affect that virtual possibilities, including risks, threats, but also opportunities, that are ‘nothing *yet* – just a looming’, nevertheless come to have real, material effects in the present. In Massumi’s words, affect renders chance ‘politically operational’ (2005a: 35).

Geographers have gone to some lengths to differentiate between precaution and pre-emption, a notion introduced by Massumi (2005b, 2007). However, focusing on unwanted, potentially disastrous ‘threats’, they tend to limit analysis to novel hazards that have never happened before and are thus highly contingent, similarly to Callon’s emphasis on radical uncertainty (de Goede and Randalls 2009; Anderson 2010a). Other modes of governing techno-scientific futures, however, may bridge the future and the present in distinct ways, while also generating other forms of affect

¹⁶ This refers to a Spinozist understanding of affect as a transversal ‘capacity to affect and be affected’, in which affect exceeds personal or interpersonal emotions by helping to bring otherwise distinct events or states of affairs into co-functioning and subject to present action (Massumi 2002; McCormack 2003; Anderson 2006, 2007).

(Adams et al. 2009). Certain instances of ‘preparedness’ do not actualize an entirely virtual future, but actuate an already unfolding threat, such that *anticipatory action* takes place “in the ‘interval’ between [the event’s] occurrence and its damaging ‘impacts’ and ‘effects’” (Adey and Anderson 2011: 15). For example, the prospect of peak resources is not unforeseeable, unwanted and uncertain in the sense that extractive operations have been populated by a myriad of alternative future imaginations since the very inception of potential scarcity. In this sense, scarcity has always been incubating in the present; it is a ‘latent future’ (Adam and Groves 2007) that is encoded into the hydrocarbon industry from the outset and hence continuously unfolding, even if never realized. Also, such threats are never clearly defined: what is a threat for some will almost certainly become an opportunity for others or, as Anderson (2010a: 782) affirms, “uncertainty is both threat and promise” at the same time. Rather, it is the difference between what is unwanted and what might actually be desirable that is at stake. Whilst the event of scarcity is continuously incubating, it can become materialized in multiple and contradictory ways.

Such dissensus over the normative value of virtual possibilities further directs attention to the *politics of anticipation*, including the ways in which future trajectories are noted, rationalized and disciplined with the help of certain logics, techniques and affects. “If politics is a range of forms of action that mark and code practices”, as defined by Sam Kinsley, “then *anticipatory* politics are those forms of action that mark and code practices that evoke and produce futurity” (2010b: 2774, 2011). Politics is here understood in the wider sense “as an index of the space of disagreement” that overflows the institutional spaces of government (Barry 2001; Amin and Thrift 2005; Barry 2005a: 86; Featherstone and Korf 2012). Broadly speaking, anticipatory politics encompasses all sorts of ways in which techno-scientific futures are ‘codified and contested’, as much as ‘performative and multiple’ (Kinsley 2010a). Unlike

institutionalized modalities of anticipatory governance such as pre-emption, the content of possible futures is not exclusively dictated by established authorities, but may be collectively explored and disputed across a multiplicity of actors and sites, similarly to Callon's hybrid forums. Anticipatory politics is defined precisely by the question of who assumes the power to speak for the future, and thereby exhibits a range of dispositions and disagreements, through which particular states of the world and materialities are actualized here and now, while others are carefully kept absent.

These recent studies of the anticipation and governance of techno-scientific developments offer useful theoretical resources for any geographical research on alternative energy futures, including my own analysis of the politics of oil shale in Estonia (Chapter 6). Much of this work, however, is primarily concerned with the ways in which possible futures are envisioned and responded to; or, in the terms of this thesis, the 'above-ground' practices of future-making. Despite the interest of theorists such as Adam, Anderson and others in materiality (Adam 2009; Anderson and Wylie 2009; Adey and Anderson 2011), existing literature on anticipation has had little to say about the future of specific materials and their geographies, including the making of future resources. In this context, it is important to bring together the analyses of future-making with theoretical accounts of materiality or 'below-ground' realities.

2.4 Relational materiality

In their 2006 review article, Bakker and Bridge called for a 'new' resource geography that would take interest in the material world, but preferably by theorizing the rich experiences of resources themselves rather than simply attributing them with existing theories from other fields. Their request is situated within renewed attempts to 'rematerialize' geographical thought in parallel to the prolonged 'cultural turn', which have sought to highlight the importance of the bodily, the natural, and the material in

conceptual work in contrast to the engagements with representations, texts, meanings and discourses (for analyses, see Kearnes 2003; Anderson and Tolia-Kelly 2004; Whatmore 2006; Braun 2008; Anderson and Wylie 2009). Natural resources, both living bodies and non-living things, however, pose a particularly troubling challenge for any conceptualizations of nature, matter and materiality. The stuff that makes up resources is conventionally regarded as physical, tangible and real, indeed the *material* components of nature, with fossil fuels and carboniferous rocks amongst the most concrete and inert ones (alongside wastes (cf. Moore 2012)). Even the 'relational approach' still tends to place resources *external* to socio-economic interactions of production and consumption, leaving the 'below-ground' realities that are assumed to be embedded in these relations largely unquestioned. Yet the subterranean world remains largely invisible and inaccessible to us, unless certain mechanized interventions, measuring instruments and abstraction techniques are involved. How then to reintroduce 'resource materiality' into the analysis of carbon futures without returning to a form of resource determinism?

Contrary to the mainstream environmental movement, critical geographical literature has developed a healthy scepticism towards the deep-rooted view of natural realism, according to which our knowledge claims can be checked against the truths of 'pure nature' as Kantian things-in-themselves that are divorced from our limited experiences of the world, yet still accessible to the practices of the mind. As noted above, phenomena that are conventionally considered "natural", such as natural resources or natural hazards, have been understood as essentially social. Given the general 'de-naturalising' stance in geography, the materialist return needs to be conciliated with the framework under which nature has predominantly been depicted as socially constructed or produced (Castree and Braun 1998; Castree 2001, 2005). In earlier calls for re-materialization, the 'matter of nature' was displaced from the 'out-

there' world as something not external but also not reducible to the social, yet still approached in realist terms as a physical, concrete and solid substance (Fitzsimmons 1989; Jackson 2000). According to an extensive critique by Kearnes (2003), however, this appeal to 'material physicality' continues to rest on an Aristotelian metaphysics of matter as a universal ontological base underlying all forms of existence, as though materiality is the essence of the 'real' against which our representations can be tested and weighed. Balancing natural realism and idealism, cultural and social geographers now seek to overcome this limited notion of physicality as a material reality detached from human relations, knowledge and language (Castree 2001; Anderson and Tolia-Kelly 2004). Instead of simply resurrecting an 'external nature' (Castree 2001: 6, 2003), the last decade has seen continued attempts to find new ways to account for the co-presence of non-human entities and phenomena in the socially lived world.¹⁷ The stuff of the world is thus deemed to require a radical rethinking as not merely socially embedded but itself capable of bringing about social change in a move 'toward a non-essentialist and non-dualistic geographical practice' (Kearnes 2003: 146).

Through a careful re-reading of poststructuralist philosophy and related work in STS and actor-network theory, geographical theorists have sought to break away from dualisms such as nature/culture, subject/object, and material/immaterial altogether (Braun and Castree 1998; Whatmore 2002; Braun 2005; Castree 2005; Hinchliffe 2007; Braun 2008). Following this view, such binaries can only be abstracted as limited fixations that emerge temporarily from a field of associations between more or less coherent 'things'. The virtue of this perspective for resource geography is that it makes it possible to move analysis from social relations to *relational materiality*, wherein materiality and sociality are understood to be 'co-

¹⁷ The term 'external nature' is attributed to Neil Smith, 1984 (Castree 2003).

produced' rather than pre-existing each other (Latour 1993; Law and Mol 1995; Latour 1999; Law 2004: 83-84). Relational materialism involves a radical rethinking of agency, since bodies and things other than intentional human beings, including inanimate matter, are presumed to acquire the capacity to 'make a difference' through their connections with other agencies represented by both human and non-human 'energies, artefacts and technologies' (Braun and Whatmore 2010).

How exactly do certain agentive things or bodies, or, to use the ANT term, *actants* assume the capacity to affect other bodies and things? At first sight, it may be tempting to distinguish here between 'matter' and 'materiality', whereas materiality would denote the relational state of affairs arising within the interactions of certain material things with other elements of matter. However, this invokes the essentialist, pre-discursive notion of physicality that Kearnes (2003) warns against. Rather, material entities are *both* 'the cause and consequence' of other related entities (Castree 2005: 228), although this should not be reduced to a linear causality between objects and subjects. Following the relational approach, matter *is* materiality in the sense that what we consider tangible, discreet objects likens to an uneven and unstable field of provisional network effects, which becomes individualized and objectified only through our practices of knowledge-making, including anticipatory techniques. Consider here something so indeterminate and unbounded as clouds (Adey and Anderson 2011), or indeed the bedrock. The exact nature of this kind of distributed agency is open to continued theoretical inquiry, particularly concerning whether it is an emergent property of a network (e.g. Latour 2005b) or a vital striving inherent to materialities themselves (Bennett 2010).

What would resource geography look like if one takes this non-dualistic view seriously and adheres to the actual messiness of the world as always co-habitated

and co-fabricated? When Bakker and Bridge (2006) call for materially informed studies, it is through this appeal to hybrid ontologies that they probe how both animate and inanimate resources can have simultaneously material and social existence. In their view, things other than human do not just “make a difference in the way social relations unfold”, but the biophysical heterogeneity and spatial variation of resource materials can produce different socio-political realities by both enabling and constraining production (2006: 15). Conversely, Bakker and Bridge also suggest that particular resources should themselves be regarded as ‘historical products’, since they gather different meanings and properties through concrete socio-economic practices. In making this apparently paradoxical connection between the relationality of resources and their agency, they make a first step towards a relational account of resource materiality. However, whereas they are certainly correct to emphasize the generative capacities of ‘a biophysically heterogeneous world’ to either resist or facilitate resource appropriation and commodification (see also Le Billon 2001; Bakker 2005; Bridge 2011b; Bumpus 2011), it is still crucially important to avoid the nature/society and matter/form dualisms that were just rejected. One is inclined to think here of ‘the biophysical’ as a series of given, discreet properties, which pre-exists the social embedment of resources within techno-scientific interventions and institutional regimes. This leaves unexplained how materiality is enacted in the first place (cf. Bridge 2011a). Moreover, while Bakker and Bridge make an important claim that any research on resource materiality must be a ‘situated strategy’, they tend to emphasize less the temporal dimension or ‘becoming’ of resources in favour of a more spatialized spectre of their heterogeneity and distribution.

An alternative way to account for the space-time dynamics of resources is to conceptualize materiality in non-essentialist, collective, and processual terms. Here, the thesis gains valuable insight from two theoretical shifts, as well as related studies

of the geographies of waste and urban lives, which have begun to test these theories in empirical contexts. The first is to deny any strict distinction between representation and physical materiality by acknowledging that matter is “simultaneously – and unevenly – discursive and physical” (Kearnes 2003: 150). This proposition is eloquently conveyed in the notion of ‘informed material’ that was first proposed for molecules by Bensaude-Vincent and Stengers (1996) in their account of the history of chemistry, and subsequently taken up in geography by Andrew Barry (2005b; see also 2009, 2010), as further discussed in Chapter 4. In this view, matter is never availed to us in any “pure”, physical sense, but always already ‘informationally enriched’ through the knowledge practices, language, and scientific techniques that surrender the reality to the mind. No forms of matter are intelligible outside their material-informational environments, since “representational practices are material at the same time as they *materialize*” (Castree and Braun 1998: 18, my emphasis). The purification and objectification of materials occurs through our abstractive perceptions, which is part of their informational saturation and may take different degrees depending on the concrete practices at play (cf. McCormack 2012).

The second and related shift is to no longer hold to the individualistic understanding of matter as a series of discreet ‘bodies’ and ‘things’. Instead, materiality is seen as emerging from a less coherent *agencement* of humans and nonhumans, whereby the ‘capacity to act’ emerges from their ‘coming together’ (Braun 2008). Here, the ANT view of decentred and distributed agency has been complemented with a Deleuzian reading of Spinoza’s philosophy of affects, most notably by Jane Bennett. Following Deleuze and Guattari (1988), the French term ‘agencement’ (or ‘assemblage’ or ‘arrangement’ as it is translated in English) denotes the gathering of heterogeneous elements and forces, where no single constituent has the power to determine its course in isolation from the affective capacities of others

(see also Anderson and McFarlane 2011). Bennett's vital materialism thereby progresses from an individualized, somewhat romanticized notion of 'thing-power' (2004) to agentic assemblages as collective forms of 'matter-energy' (2005, 2010). Instead of being singular or homogeneous, materiality effectuates from assembling and takes place in emergent, dynamic, and often unpredictable ways. For Bennett, this effect becomes itself agentic, 'an agency of assemblage'. Although this thesis does not take forward Bennett's equalization of materiality with affect, her explanation of materiality as a heterogeneous field always in the process of (dis)assembling highlights how concrete materials come into being only provisionally, including those classified as resources.

Drawing on both vital materialist and ANT theoretical accounts of relational materiality, recent reviews of waste geographies no longer regard the matter of garbage as external to the society; it is neither 'an asocial material remainder, nor simple social convention', but an emergent, relational, and situated category (Gregson and Crang 2010: 1028; Hawkins 2010; Moore 2012). Yet, while waste has no concrete properties unrelated to its social life, its vital materiality may nonetheless generate different political associations in different contexts. In a parallel move, urban geographers have sought to reconceptualize materiality in non-dualistic, dynamic terms as a *spatio-temporal process* that effectuates between a range of human/non-human agencies (Latham and McCormack 2004; Latham et al. 2009). Just as much as certain constituents of 'the material' occasionally emerge in the processual collision of hybrid agencies, they simultaneously come to *matter*, in multiple and ultimately dynamic ways. Further, materiality not only changes over time and across space, but incorporates also its 'excessive potential' in the form of representations, abstract qualities, and virtual phenomena. In this sense, Latham and colleagues refute distinctions between the material and 'immaterial', concrete and abstract, real and

unreal. Anderson and Wylie (2009) further emphasize this processual making of (im)materiality by attuning to the *multiplication* of matter, since it has the potential to take place with any element or material state, even in the case of the most obdurate and earthy materialities such as subsoil resources (see also Law and Mol 1995, 2001; Mol 2003).

Finally, relational materialism has moved from ontological questions to apprehending the political potential of matter; “what matter *does* rather than what its essence *is*” (Anderson and Tolia-Kelly 2004: 672; Whatmore 2006). If materiality is emergent and unstable, then the critical question is *how* specific matters nonetheless become arranged, objectified and stabilized in harmony (Braun 2008). In other words, how do such multiple registers “hang together” in practice (Mol 2003)? Further, the shift from social constructivism to agentic assemblages highlights the different ways in which specific materialities become or are made to *matter*, since “things are not just simultaneously material and meaningful; they are also *eventful*” (Braun and Whatmore 2010: xxi). When particular materialities emerge within human-nonhuman co-fabrications, they also generate various spatial configurations and possible futures. More recent commentaries have therefore encouraged us to pursue a critical political engagement with the concept by attending to the “interconnectivity and co-constitution of materialities and their geographies” (Tolia-Kelly 2013: 153).

In this sense, resources are nothing exceptional, but just one kind of socio-material assemblage, which results from the abstraction, manipulation and commodification of bodies and accumulations that are always already ‘more-than-human’ (Whatmore 2006). However, the assembling of ‘below-ground’ materialities arguably determines, at least partly, how the specific qualities of such materials (as the effects of assembling) come to matter ‘above ground’. Resources could have been

enacted otherwise, but *once they are stabilized* through technical, economic and political calculations, it becomes increasingly difficult to destabilize and disintegrate such an assemblage. As rightly noted by political economists and ecologists, the ‘becoming’ of resources conjoins the path-dependent and often irreversible dynamics of capitalist regimes and markets. Nevertheless, as argued below, the capitalist economy should not to be understood as an external force that will single-handedly determine the viability of exploitation, but something that is configured along with resources themselves.

2.5 Economies and markets in the making

2.5.1 Economization and marketization

If hydrocarbon availability and governance is not just the product of the imperatives of capitalism, but also bound to uncertainty and contestation over collective futures, and to the materiality of future resources, then a new light can be cast on the question of whether non-conventional resources will ever be *economic* to produce. As noted earlier, this thesis entertains the idea that unconventional resources do not simply enter the market for energy commodities when global oil prices turn out favourable. Rather, the extent to which the industry can be established commercially depends on how it effects negotiations over the future design of carbon economies, both ‘old’ and ‘new’ (Bridge 2011c). It also depends on how the ‘rules of the market’ are reworked in relation to both the materiality of new commodities and the associated socio-technical systems through which they become circulated in the marketplace. This argument is facilitated by writings in economic anthropology, sociology and geography concerning the configuration of economic systems and markets; a third body of work inspired by the STS/ANT perspective. The key tenet of this literature is that neither ‘the economy’ nor ‘the market’ should be regarded as a pre-given social force or sphere that exists

independently from everyday circuits of exchange and their abstractions in theory. Rather, regimes of economic valuation, circulation and exchange stand for contingent outcomes of a wide range of economic knowledges and practices, which vary across distinct locations and times according to concrete socio-technical systems and material assemblages that enable transactions to occur. Hence, the key question is not so much how un conventionals become situated within existing capitalist regimes, but how they help form future economic realities and, quite possibly, new markets.

In *The Laws of the Markets*, Michel Callon suggests that the economy is to a great extent the product of the discipline of economics (Callon 1998). As he argues, academic economists do not simply observe real-life economic affairs at a distance and represent them in theory, but they interfere actively in the construction and functioning of what becomes regarded as ‘the economy’. Economics is not external to economic life, but enables it to be brought into being. In other words, the economy is *performed* by economics, or as Callon (2007) later specified, by ‘economics at large’. The latter includes both the discipline of neoclassical economics and a wide range of economic practices and knowledges, including accounting, marketing and law. Callon’s performativity thesis has since grounded a large body of work that discusses the multiple ways in which economics is performative and the multiple *forms* that performativity can take, since economics involves not only theory, but also economic actors, institutions, procedures, techniques, and tools, which *create* as much as they reproduce the objects of economic knowledge (Barry and Slater 2005a; Callon et al. 2007; MacKenzie et al. 2007).

The arguments of Callon and others are underpinned by a thoroughly anti-essentialist approach. Instead of granting the capitalist economy inherent qualities or dynamics they invite social scientists to study *what it is to be ‘economic’* in concrete

historical circumstances, that is how something becomes rendered internal to the *frame* of economic calculation (see also Mitchell 2002; Thrift 2005; Callon et al. 2007; Mitchell 2007). Called either ‘economic agencement’ or, more briefly, ‘economization’, the act of ‘framing’ denotes “the processes through which behaviours, organizations, institutions and, more generally, objects are constituted as being ‘economic’” (Callon 1998; Çalışkan and Callon 2009, 2010: 2). Çalışkan and Callon distinguish between three key agents in ‘economization’: first, economic theories; second, the institutional and technical arrangements that enhance the capacities of human agents for calculative action and cognition; and third, the things that are being valued, whose materiality in turn influences the possibility of valuation and its outcomes. Hence, what is taken to be ‘economic’ results from economization, “a process that is historical, contingent and disputable” (Callon et al. 2007: 3) and hence takes geographically distinct forms (Berndt and Boeckler 2011a, 2012).

Likewise, ‘the market’ is argued to not have a universal form of existence in isolation from everyday marketplaces. Rather, markets take diverse forms and courses depending on the specific ways in which commodities and services are subjected to economic valuations and transactions (Callon 1998). Being ‘heterogeneous assemblages’, markets in turn are objects of constant measurement, calculation and regulation. The fact that markets do not exist as ‘quasi-natural realities’, as Callon (2009) emphasizes, is particularly evident in situations where framing is complicated by ‘overflows’ that prevail due to the uncertainty that results from technoscientific development. The construction of markets as spaces of circulation and exchange or ‘marketization’ is therefore at the constant risk of failure (Çalışkan and Callon 2010). In Callon’s analysis, theoretical economics has an important role in stabilizing and performing markets, although the extent of disciplinary influence depends on the maturity of established markets and demand for reforming their operations.

Furthering STS insights, Muniesa and Callon (2007) note that marketization is often mobilized through experimental research, whereas the importance of theory varies between different types and sites of experiment, which extend from confined laboratory setups to real-scale markets. The more such experiments are adjusted to real-life economic affairs the wider becomes the range of concerned actors, who participate in the construction of economic objects. As such, concrete markets enact “particular versions of what it is to be ‘economic’” (Callon et al. 2007: 4).

The anti-essentialist approach to markets draws upon a particular analysis of ‘calculation’. Market interactions emerge when economic actors identify and weigh ‘possible states of the world’. Markets can therefore be characterized as ‘calculative collective devices’. In this account, calculation is not limited to exchange in the strictest sense, but the act of calculation “starts by establishing distinctions between things or states of the world, and by imagining and estimating courses of action associated with those things or with those states as well as their consequences” (Callon and Muniesa 2005: 1231). Defined in such broad terms, calculation is not associated with a particular economic order or historical epoch, such as capitalism, but originates in the diversity of calculative agents, their relations, and their access to information and measuring equipment. Or, as Callon repeats elsewhere, calculation is “neither a universally homogeneous attribute of humankind, nor an anthropological fiction. It is the concrete result of social and technical arrangements” (Callon et al. 2007: 5). As calculative agents, ‘the economic man’ is real (see also Berndt and Boeckler 2009, 2012).

In response to critical insights received from research on concrete market experiments, Callon (2007) further concludes that the academic discipline does not possess a monopoly over the ‘performance’ of economies and markets. Rather, the

formatting of economic regimes is a *collective* activity, or ‘co-performance’, drafting a wide range of calculative agencies and economic practitioners with alternative viewpoints, whom Callon terms ‘economists in the wild’, as opposed to professional economists.¹⁸ Regimes of valuation, circulation and exchange thus stand for contingent constructions conditioned by both theoretical propositions and a plethora of economic (and non-economic) knowledges at work. In turn, these practices hinge on a range of material devices and elements that facilitate and distribute calculation. These practices together make up the ‘economics at large’.

2.5.2 Markets as socio-technical arrangements

The technicalities and materialities of calculation are further emphasized in Callon’s later definition of markets as ‘socio-technical agencements’ (Callon 2007; Çalışkan and Callon 2009; Callon 2009; Çalışkan and Callon 2010).¹⁹ This suggests that calculation rests on configurations of agency distributed not just between human actors, but also between technical devices and the material things that they arrange. Moreover, unlike ‘possible worlds’, the trajectories of such agencements are not necessarily known in advance, but alter and collide, giving way to what Callon (2007) briefly terms ‘unsuspected worlds’. Economic realities are made in the collision of different socio-technical agencements, and hence shift in time and space, although they may become subject to lock-in and path-dependency in equally heterogeneous ways (Callon 1998, 2007; Callon et al. 2007). The study of markets therefore requires “describing, analysing and making intelligible the shape, constitution and dynamics of a market socio-technical arrangement” (Çalışkan and Callon 2010: 3).

¹⁸ This term for amateur economists parallels his earlier distinction between ‘confined researchers’ and ‘researchers in the wild’ (see Callon et al. 2009).

¹⁹ Although the Deleuzian concept of ‘agencement’ is often translated as ‘arrangement’ or ‘assemblage’, Callon prefers to retain the French term in order to stress that there is no clear divide between human and non-human actors.

If markets are understood as ‘socio-technical agencements’, then the question is how concrete markets are set up and transformed in relation to the material qualities of commodities and the technical infrastructures that enable exchange, including markets for unconventional resources and the emissions that they generate. The STS-informed literature, however, has little investigated *what* exactly may influence the process of framing, and how, apart from the specific tools and devices that directly mediate calculations, both economic and political (Callon et al. 2007; MacKenzie 2009b; Çalışkan and Callon 2010; Marres and Lezaun 2011). Yet spaces of circulation and exchange are arguably a part of larger socio-technically and geographically distributed systems (cf. Berndt and Boeckler 2009, 2011b, 2012) and, moreover, intermingled with the materiality of resources “from the outset” (Braun 2008). At least historically, the invention of ‘the economy’, according to Mitchell (2008), was closely related to technoscientific innovation, particularly the building of large-scale technological networks in the early 20th century, most notably the electrification of Western societies (as studied by Hughes 1983). Since the rise of both national economies and markets is associated with particular historical periods, as Mitchell recounts, there was no exterior meta-structure into which such inventions were “embedded”. Rather, technological development forged rival calculative and metrological projects that “helped to bring into being the world they calculated” (2008: 1118).

This resonates with Callon’s earlier work on ‘techno-economic networks’ (TENs) in the sociology of innovation, which following the ANT model denote ‘a coordinated set of heterogeneous actors’, who “participate collectively in the conception, development, production and distribution or diffusion of procedures for producing goods and services, some of which give rise to market transactions” (Callon 1991; 1992: 73). TENs represent neither the familiar technical networks discussed by

Mitchell, nor are they solely institutional networks maintained through human interactions. Rather, defeating both technological and social determinism, such networks mark the dynamic, gradual enrolment of hybrid, collective ‘actants’ into economic processes. Callon’s concept explicitly ties economization with technological change and, further, emphasizes the networked topologies of this relationship.²⁰ Furthermore, what is deemed ‘economic’ also reflects prevailing norms or ‘conventions’ that result from past arrangements in technical science, economy and politics, and enable heterogeneous actors to form stable networks. Such networks can subsequently be either ‘strong’, following long periods of investment and coordination, or only weakly convergent.

Moreover, Callon emphasizes that there is no a-priori difference between local and global conventions, since local networks may resist generally approved logics, including capitalist imperatives, but they may also spread and take the place of broader arrangements, leading to the creation of new markets. Like Mitchell, Callon refutes the precedence of macro-structures, arguing instead that global economic relations represent “a double logic of local framing *and* connections between localities”, whereas some localities are simply more effective at forging global connections than others (in Barry and Slater 2005b: 110). Such framings, in turn, influence future trajectories, so that irreversibility and path-dependency are ‘integral to the dynamics of the economy’ (fn. 42, Callon 1991) or, as detailed elsewhere, “stabilize the forms and meanings of what is to be considered as economic in a particular site and a particular time” (Callon et al. 2007: 3). Path-dependency and irreversibility are not just coded into social conventions, which are historically and

²⁰ Having since been widely employed in the literature, TENs are understood to be organized around three areas or ‘poles’: science, technology and the market, although some have proposed to add the state as a fourth pole (Green et al. 1999). Although separated by definition, these ‘poles’ are closely related in practice, and may not always be present.

geographically contingent, but also entangled with resource materialities and technologies, although there always remains a possibility of destabilization.

2.5.3 Between economy and politics

This opens up a question of how the process of rendering things ‘economic’ encompasses different places with distinct socio-technical arrangements, and how this relates to the spaces of politics, including the politics of anticipation. According to Callon *et al.* (2007), economic abstraction occurs when things, behaviours or institutional arrangements are “transported” into a formal calculative space and made commensurable with each other, so that economization always represents a form of ‘translation’ that involves transformation as much as displacement. What constitutes the economy or the market is thereby, following Mitchell (2002), played out through the vision of a *territory* that can be framed or bordered in exclusion from its constitutive outside, the ‘non-economic’. Such idealized calculative spaces, however, need to be continuously reproduced in relation to various localities and subjects of economic experiments, not least because of the constant threat of overflows. Moreover, as theorists and practitioners may have equally performative roles in the creation and stabilization of economic objects, the process of marketization may also become widely contested and resisted, thus rendering the boundaries of markets disputable and re-negotiable. In Callon’s words, “the simple fact of framing economic activities creates, outside the market, emerging identities that are political *per se*”. (Barry and Slater 2005a, 2005b: 102).

This argument can be taken further by acknowledging that politics is not constrained to take place ‘outside the market’, for it is the question of what belongs inside the frame of calculations and exchange and what remains outside, that sparks debates and disagreements about the organization of markets (Barry 2005a). In this

way, the process of marketization generates new collective identities and sites of politics like any other socio-technical controversy, especially since such controversies are often fuelled by economic convictions or attempts to change the organization of markets (Barry and Slater 2005b; Muniesa and Callon 2007). Moreover, the politicization and resulting plurality of forms of exchange is not limited to the 'qualification' of products in existing markets (Callon et al. 2005). Rather, the very act of commodifying and economizing new things, such as carbon-rich energy resources or emissions, and rendering them internal to certain frames of calculation, may trigger contestation. In this way, the various programmes through which our carbon economies are currently being reconfigured offer a unique opportunity to study the 'politics of marketization' and how these processes vary geographically (Berndt and Boeckler 2011a; Blok 2011; Berndt and Boeckler 2012).

2.6 The political geography of unconventional energy development

Mitchell's argument that the development of unconventional sources of energy beyond peak oil necessitates a 'new politics of nature' opens up three sets of questions that I have sought to interrogate theoretically in this chapter. One set of questions concerns the changing 'nature' of hydrocarbon resources and how this affects their governance in allegedly constrained circumstances. The second set of questions relates to 'politics', particularly the processes of exploring, figuring and contesting 'collective' energy futures (cf. Latour 2004). A further and related set of questions invites us to interrogate how the materialities, technologies and politics of unconventional energy development may trigger a reconsideration of what counts as 'economic' altogether, although Mitchell curiously overlooks the possibility that the carbon economy might be reconfigured despite his own theoretical contributions. Since unconventional raise these questions alongside new research problems that do not sit well within existing

geographical literature, the chapter appealed to a variety of theoretical insights associated with the notions of anticipation, materiality and economization. The following summarizes the contributions of these theories and introduces the main arguments of the thesis.

Geographers writing on the political economy and ecology of oil agree that hydrocarbon resources are not 'natural things' coaxed out of physical reality, but hybrid, temporally and spatially shifting categories, which reflect the availability of knowledge, technology, and other resource materials. Based on in-depth empirical studies of extractive operations in post-colonial contexts, Watts, LeBillon, Bridge and others have started to take seriously the idea that the biophysical properties of petroleum and other key commodities are socio-politically generative, but warn against resource determinism. Either violent or non-violent, conflicts over resources do not occur solely because of their inherently scarce nature or other qualities, but reflect systematic capitalist imperatives of dispossession, whereby global developments intersect with locally specific identity politics. Likewise, scarcity is rejected in more recent commentaries on 'peak oil', which define supply continuity as a matter of both struggles over reserve appropriation and allocation, and the indeterminate, yet irrefutable dynamics of market speculation. These accounts highlight the importance of 'social relations' in the making of carbon futures, particularly the dynamics and practices of the capitalist economy, thus furnishing a *relational* understanding of fossil fuel resources. However, Bridge (2011b) has recently revived the question of 'the properties of oil itself' in response to Mitchell's work and welcomed further analyses that would go beyond the naturalist tendency of attributing intrinsic qualities to an essentially socio-cultural commodity, thereby raising the question of whether the materiality of hydrocarbons could be understood in broader terms than just physicality (see also Bridge 2011a). Moreover, recent

analyses of the metrology of oil, and STS insights more broadly, further help to erase this disjuncture between 'above-ground' and 'below-ground' geographies, opening up possible avenues of cooperation between wider fields of research concerning the politics of anticipation, relational accounts of materiality, and materially informed accounts of politics and economy.

Above ground, 'post-oil' energy futures are arguably neither exclusively determined by the mechanisms with which economics engineers competition over potentially scarce resources and triggers technical innovation, nor prescribed by the linear political logics of 'energy transition' (cf. Bridge and Le Billon 2013). Rather, any changes in production profile that take place due to the declining resource base are akin to other fields of prospective technoscience, which have been deemed problematic and risky in the context of enduring uncertainty, and hence increasingly contested. Unlike the unforeseen hazards and threats associated with novel technoscientific inventions, however, resource decline and scarcity are not radically unknown, but at least partly defined by unfolding possibilities coded into extractive sectors from the outset. Being neither fully open nor pre-defined options, post-peak worlds can be seen as a 'realm of latent futures in the making' (Adam and Groves 2007: 17) that are subject to contemplation and collective experimentation, whereas the difference between present threats and future opportunities is not settled, but subject to ongoing struggles over who gets to speak for the future (Kinsley 2010b). Since alternative carbon futures are made at multiple levels and scales of governance, as several geographers have begun to explore, anticipatory energy politics necessitates close empirical studies that would explore how the logics, mechanisms and techniques of anticipation are defined in specific locations in tandem with the politics of particular resource materials.

Below ground, resource materials can indeed be considered ‘historical products’ of temporally and spatially varied conditions of resource-making (Bakker and Bridge 2006). As I describe later in detail, it is only through our abstractive practices and specific mechanized interventions, including the anticipatory techniques of resource assessment, that certain sections of the subsoil are abstracted, classified, and enacted as ‘resources’ and ‘reserves’. However, if particular resources do not pre-exist their social construction or production, then it is not entirely clear how their biophysical properties or spatial heterogeneity nevertheless ‘make a difference’ in the creation of alternative resource futures. Here, the account of ‘relational materiality’ contributes an invaluable conceptual tool for rethinking the problem of hydrocarbon availability and, furthermore, apprehending the processes through which new materials enter the category of resources under the banner of the ‘unconventional’. Considered from the ANT/STS perspective, ‘the biophysical’ does not pre-exist socio-economic relations, or the other way around, but material and social realities are always co-constituted through local, contingent interactions involving a variety of ‘more-than-human’ agencies, techniques, and energies. Nevertheless, the STS literature tends to approach materiality as a general philosophical problem and therefore seems to assume a degree of ahistorical and non-local homogeneity across various materials, with the consequence that ‘materiality’ becomes an abstract, if empty concept, which is universalized alongside ‘sociality’. Although Law and Mol (1995) invite us to study the moments during which *specific, heterogeneous* and potentially *multiple materialities* are created, stabilized and destabilized, this literature has less been informed by empirically grounded research on particular materials and their agency, including resources. Hence, the key value of this literature is more methodological than theoretical, since it provides an orientation to study ethnographically *how* the materiality of resources is conceived and how their

difference from non-resources is achieved through particular practices, whilst resisting the dualisms originating in realism and idealism. The following chapters will argue that such material states of affairs are indeed local and contingent achievements, but equally they may become fixated through specific abstractions, technological settings, and politico-economic arrangements, although they remain always prone to destabilization. It is primarily through such temporary and localized fixations that resource materiality can be seen to make a difference in the anticipation of collective futures and the organization of economies and markets, and in this way open up the potential for a 'politics of things'.

Furthermore, since there is no a-priori distinction between 'above-ground' and 'below-ground' states of affairs, the thesis argues that the future viability of unconventional resources will be neither determined causally by their energy content or other qualities, nor unilaterally judged against established (geo)political relations or the backdrop of 'the market'. Rather, drawing upon recent work in economic sociology and anthropology, the process of rendering certain things 'economic', including alternative sources of energy, is a locally contingent and shifting process, which depends on whether such materials become either valued or disregarded as strategic resources in relation the ongoing reconfiguration of carbon economies. It further depends on how their development influences the setup of concrete regional markets, especially for energy products and carbon emissions. The exact organization of these markets cannot be known in advance, but it emerges in the cooperation of a variety of human actors equipped with different forms of economic expertise, which in turn need to be adjusted to wider socio-technically distributed practices and systems, as well as the materiality of both standard and new commodities that enter the marketplace.

As resource-making precedes commodification, the development of oil shale can be seen as an “immature” industry composed of a series of local ‘techno-economic networks’ (see Chapter 8), which not only seeks to improve its technology and products, but above all needs to become globally ‘economized’ and secure itself a place in the market or create new markets, without necessarily even fully existing yet. In this way, unconvensionals lend themselves to empirical studies of ‘geographies of marketization’, since their development may disrupt established distinctions between capitalist and non-capitalist regimes and redistribute economic landscapes in uneven and potentially contradicting ways (Berndt and Boeckler 2012; Boeckler and Berndt 2012). What I will later describe as the programme of *conventionalizing* ‘the unconventional’ thereby comes to act as a ‘rival calculative regime’ (Mitchell 2008) that involves the creation of alternative economic (and non-economic) knowledge, technical infrastructure, platforms of market exchange and political acceptability. In other words, I argue that this process necessitates both the renegotiation of existing social conventions *and* the materiality of ‘the unconventional’ in parallel. To this end, my research project takes a profoundly empiricist approach (Barry and Slater 2005a: 22), paying close attention to the particular combinations of people, things, and technologies that enable or disable the stabilization of oil shale as a resource, and its entrance into political and economic calculations and future market transactions.

Chapter 3. Fabricating Research

3.1 This is not an audit

[Your thesis] should outline our circumstances or choices in a compact and clear way from the beginning... If you look at the actual situation in Estonia, then choices are based here on very pragmatic considerations... In reality, however, there is an objective situation, which exists without any preferences. So, you should definitely outline these factors or choices above all at the so-called objective level, and then check whether these are attended to or not... This objective situation is given independently of our opinions. These problems exist; they do not depend on what we think. These problems are *real*.²¹

It was spring of 2005, when I first visited the oil shale production sites on the Estonian-Russian border, close to the town of Narva. I was 24 years old and had recently taken up the position of junior auditor for the National Audit Office, part of a team of only three people specialized in environmental performance auditing (Figure 2). With some excitement, we followed a Russian-speaking guide from the state energy company on a tour of the largest oil shale-firing power station in the world as well as the nearby ash disposal fields surrounding an artificial lake which was miraculously coloured turquoise from the chemical influx. The official purpose of our trip was to conduct a 'preliminary study' on the basis of which an audit of the industry would be proposed. However, it would be fair to say that we were equally driven by personal curiosity, having been granted the exceptional right to access the site. As performance auditors, we were not so much interested in inspecting the company's balance sheets or finding traces of incompliance with environmental law, but eager to learn about the *truth* of the country's energy situation and seek solutions for the future – a more ambitious objective that was relentlessly pursued by our boss, the country's Auditor General. After a pleasant day touring and photographing the site and subsequently studying the data we realized, however, that we had bitten off more than we could possibly chew. The industry appeared too complex, too irreducible and way too rooted

²¹ Interview, 18 August 2010 (my translation).

in our own national identity to audit it in any *objective* way. It has remained so up to the present time. No subsequent audits have been carried out, no truth has been disclosed, and no straightforward solutions to the problem of future energy supply have been proposed.²²



Figure 2 The author in 2005 at the ash disposal site of the ‘Eesti’ power plant.
Note: the power plant is visible in the background.

The difficulties of determining the “objective situation” of the oil shale industry have become aggravated since the original idea for an audit has turned into a doctoral research project. When I returned to the same site exactly five years later, I was no longer a young state representative, but an Oxford graduate researcher, and a mother. I was of course still speaking Estonian (and not much Russian), but accompanied by different people, many of whom spoke English as their first or second language. I was

²² A very recent exception is an “overview” published by the team in 2012, which contemplates on future alternatives to oil shale-based electricity supply (NAO-Estonia 2012). See also Chapter 6.

taken on a tour of the power plant and even of the nearby shale oil plant, but never again to the turquoise-coloured lake on top of the ash-fields. Later visits did not return there either. The site had physically changed little, but its representations and lessons were entirely different. So was my position in respect to the research field.

The auditor's imperatives to 'audit in an objective way' and 'discover truth' capture neatly the philosophical demands of logical positivism that have influenced many of my informants then and now, including the sympathetic professor quoted in the opening who, amongst many others, was keen to tell me from the start of the interview what my thesis should be about. As field research progressed, however, there was no single truth to be discovered, but increasing suspicion concerning whose side I was going to take and *whose truth* I would promote; each 'truth' was, for the most part, denounced by proponents of the others as 'mere opinion'. According to the positivist conviction, the researcher is tasked with collecting veritable data from the outside world, which in itself remains static and external to the observer. Empirical evidence reveals 'facts' and a careful analysis of facts makes way for conclusions, recommendations, and perhaps even predictions. In pursuit of objectivity, the researcher herself claims to remain absent from the world, she masters 'the god-trick of seeing everything from nowhere' (Haraway 1988). By contrast, this research has been a personally engaged, reflective and non-linear process; at times informed by abstract theoretical ideas, and at times muddling through the most mundane, technical pieces of information as well as everyday troubles, self-doubt, and painful crises.

How to put together a research methodology that would enable me to account for the complex, contradictory, and inherently dynamic character of 'the field', including my own extended presence there? Due to my previous career and native language skills, I had no problem identifying 'gatekeepers' and conducting individual

or group interviews according to clear methodological instructions. Due to my undergraduate studies in philosophy and subsequent reading at Oxford, however, I was also armed with a more conceptually informed habit of thought, and a more nuanced understanding of the politics of knowledge production as well as the ethical sensitivities of social science research. How are these different skills, agencies and subjectivities supposed to come together in the actual ‘event’ of research? The advice of the Belgian philosopher Isabelle Stengers (e.g. 2005) would be that I need to ‘slow down reasoning’ and put my previous knowledge of the field ‘at risk’ in a productive way – as well as the attempts to connect with the struggles of my own nation (see also Whatmore 2003). This is what I have attempted to do with this project. Occasionally, the auditor’s mindset prevailed as I sought for clear-cut problems and solutions, while my informants were more than happy to frame their responses in terms of compliance with EU requirements, which was no doubt a major issue towards the end of the transition period. At the same time, however, I tried to follow up any corrections made by my informants, surprise opportunities, and the revealing discussions sometimes nearing counselling, which over-spilled textbook definitions of semi-structured interviews and participant observation, now popular methods in both performance audit and social sciences.

As a result, this thesis does not resemble an audit. But what is it then? Perhaps an *exercise in sympathy* serves best to characterize the diffused, partly desultory and partly organized, highly precarious and emotionally draining engagements with an extremely technical subject that formed the expertise of the many people from various professions I met in different parts of the world, as well as with my fellow countrymen in Estonia. The facts presented in this thesis have been proudly ‘fabricated’ through these encounters, without discarding claims to their reality (Braun 2005; Latour 2005b). In other words, the thesis still seeks objectivity, but does so through specific,

situated, yet critical engagements (to use Haraway's terms), being disrespectful of the subject/object distinction. It has been like assembling a puzzle, so that a pattern eventually emerged, albeit in ill-fitting and cumbersome ways. Needless to say, this has required a lot of work. This chapter dives into some of these hesitations and attempts to make sense of the ontological and epistemological strategies of the research project, before proceeding to outline the unfolding realities of fieldwork.

The exercise began again in Estonia, in 2010, where I spent over five months living in central Tallinn. I carried out key informant interviews with the country's political, business and academic elites, attended various workshops and meetings, collected textual information, and made a few visits to oil shale industry districts. During this time I learnt that what I was aiming to study cannot be defined as a single truth, nor even alternative perspectives on an uncertain future voiced by incongruous but otherwise stable social groups. Rather, I needed to 'study up' and theorize a series of scientific, technical, political and economic interventions with and through which oil shale as the 'object' of my study (and its position in relation to 'the field') was being formed and reformed in multiple and incompatible, yet surprisingly persistent ways. At that point, my attention shifted away from the rather abstract concern with alternative energy futures and constellated around 'the *resource* of the future' as the site of research. As my knowledge and ambitions grew with improved access, I also became interested in how the future resource was enacted and maintained *more globally*, although the global's relation to 'the local' was far from straightforward. The research questions given in Chapter 1 were finalized during three subsequent field trips undertaken to the USA in October 2010 and 2011 and to Jordan in May 2012, as well as shorter stints of formal interviews in London and Brussels in the spring of 2011. In the meantime, the thesis took shape through a meticulous study of technical reports and online media, combined with continuous reading of theoretical literature.

An important part of fabricating the ‘research event’, however, has been an ongoing reflection on my relationship with the Estonian nation, which transformed researcher and researched in equal measure. Last, but not least, I have tried to be receptive to the material qualities of the multiple thing called “oil shale” itself and contemplate how my preoccupation with materiality has affected field research.

3.2 How-questions

What exactly were you studying?, he asked again. *What are your research questions?* The industry manager and I are seated together on a bumpy road through Jordan, so there’s no way for me to avoid the question. I am hesitating. Well, I’m studying *how* oil shale development becomes a new resource economy in relation to the theory of peak oil. *How can you ask ‘how’ questions?* He seems seriously puzzled. *What are your hypotheses? You must have some hypotheses, don’t you?* With an education in economics, he considers himself well versed in social science methodology, in contrast to the engineers and geologists who make up the majority of oil shale industry professionals. Our encounter started with the formalities of a two-hour interview and a signed consent form two years ago, but since then we have seen each other again several times on three different continents. He has asked these questions every time we have met. The handy keyword “socio-political issues” which has worked for most people in the industry does not convince him either. Now, in my final stages of field work, I am still struggling to find him a satisfactory answer about *what* it is exactly that I’m after here and, moreover, how to make sense of my relationship with him and other Estonians on these strange grounds.

Contrary to the popular ‘hypothetico-deductive model’ of explanation (see Jary 2006), the data presented in this work does not test the validity of established geographical theory. Although the thesis revolves around an in-depth study of the

Estonian case, this cannot be limited to an example of some broader phenomena. Rather, I have been struggling to find out ‘*what* the case is a case of’ (Flyvbjerg 2006: 238). It is not just that there exists little empirically grounded research on alternative fossil fuels; but worse – there is no well-suited theoretical framework available that could be put to trial. As explained in previous chapters, the ‘non-conventionality’ of the subject involves a resource and an industry that are not only non-traditional, but to a large extent *non-existent* for the time being, except for a small number of locations. The science and politics of oil shale development are future-oriented, prone to uncertainty and vigorously contested. The materiality of the resource does not provide a firm ground of external physicality on which technoscientific innovation and political consensus can rest, but rather raises the question of how the industry might eventually *materialize*. The economics of extraction ensues from these processes in a way that may potentially generate new markets. Overall, this calls for a deeply empiricist study which explores all the specific details that characterize the irreducibly complex, spatio-temporally contingent, and contested nature of social life in its entirety, without reducing such details to instances of macrostructures in the first place. Although the Estonian industry is an extreme example, which may be never replicated elsewhere, a critical inquiry into its role in national and international energy politics and markets can still provide useful insights into the constitution of the resource in both empirically informative and conceptually inventive ways.

Having said this, there is still an important place for theory or, as outlined earlier, even for several sources of theory. At large, my ‘how-questions’ derive from the emphasis on *practices* in a large body of literature informed by post-structuralist thought, particularly in science and technology studies and actor-network theory (for analysis, see Powell 2007). Borrowing from the anthropological tradition, STS scholars have employed ethnographic research methods for their investigations of laboratory

work, market interactions and political forums (e.g. Latour and Woolgar 1986; MacKenzie et al. 2007; Callon et al. 2009). A common observation made in this variety of contexts is that reality is not simply discovered, but *created* with the help of research routines, apparatuses, inscriptions and devices. In this sense, ethnography becomes 'praxiography', a craft of studying knowledge practices (Mol 2003). Instead of simply 'collecting data', such ethnographies fabricate or 'generate materials' through encounters with various actors, not represented by humans alone (Whatmore 2003).

The 'object' of this study is thus oil shale, but it is not a given object. Rather, I study how the resource *comes into being*, and in the process of becoming weaves together an intricate net of relations between intentional human beings *and* material and technical elements; hybrid networks that are increasingly global in reach. Conventional designs of ethnographic study involve the pitfall of presuming global phenomena, which can be linearly tracked across a series of sites. By contrast, following the more elaborated ethnographies pioneered by STS studies that move from single locales to multi-sited contexts (Marcus 1995), the phenomena and their scale are continuously in the making, slipping in and out of reality, flickering on its boundaries, and emerging only when geoscientists, engineers, politicians, and other actors, including the author, invest significant amounts of their work and time in making them visible. Hence, the hypotheses, or rather research questions of this project have been constantly transformed by the subject and, conversely, informed *what* the subject of this research is. Questioning the question has been a crucial part of research, a continuous process of 'beginning-again' (Allen 2003). Part of my agenda is to document the shifting relationship between theory and practice through a series of how-questions.

3.3 Reality, multiplied

Why is oil shale such a polarized issue that fuels contradicting views, hopes and frustration, pride and shame, all at once? Since the future resource is yet to secure itself a place within the realms of scientific expertise and economic exchange, it calls for a renewed knowledge and politics of nature (Mitchell 2011); a process which is inherently controversial and not necessarily approved across various sections of society. “Knowledges of nature are multiple in their origins, their meanings, their referents and their audiences”, writes Castree (2005: 18). The politics of ‘future natures’ can be expected to multiply this spectrum of signified and signifiers even further. Following this view, the resource seems to represent an aggregate of real-world phenomena, which are articulated and communicated in different ways, so that any contradictions in such knowledge claims manifest distinct ‘constructions’ of an otherwise unambiguous, singular nature. As indicated earlier, however, this thesis takes a step further from the dualisms underpinning both naive realism and social constructivism. First, I subscribe to the view that the social *and* the natural are temporary effects of an ongoing process of negotiation between human and non-human agencies rather than pre-given ontological spheres (Latour 1993; Stengers 1997; Mitchell 2002; Latour 2004, 2005b). Second, the practices through which our knowledge about the world is produced, stabilized and categorized are always locally, historically, culturally and materially situated, and hence contingent (Haraway 1988; Mol and Law 1994; Shapin 1998; Powell 2007). Oil shale development therefore can be addressed as a politics of things or *thing-politics*, which denotes the eventful constellation of matters that are explored for the sake of collective futures, as coined by analytical concepts such as Bruno Latour’s ‘dingpolitik’, Isabelle Stengers’

‘cosmopolitics’ and Annemarie Mol’s ‘ontological politics’.²³ *What* is at stake in oil shale science, management and politics cannot be reduced to inert external objects, but following these vocabularies the ‘solid objective reality’ stands for unruly assemblages that “could still fail” depending on the concrete practices through which the resource is rendered explicit and stabilized (Latour 2005b: 89, 91).

In Latour’s ‘dingpolitik’ (2005a), such practices have both scientific and political dimensions, since the scientific presentation of objects cannot be detached from their *re*-presentation in the sites of assembly where divided opinions over their properties are explored and judged. Things are thus no longer passive objects that pre-exist their recovery, but issues or ‘matters of concern’, as opposed to matters of fact (Latour 2004). The sites, or what Latour calls the ‘parliaments of things’²⁴, serve as a form and forum for ‘making things public’ – for raising and settling matters of concern, which in turn assume the potential to generate new political sites and publics when mediated with additional techniques and devices (Marres and Lezaun 2011). In close correspondence with Latour, the ‘cosmopolitics’ of Stengers (2005) further encourages us to attend to things that ‘provoke thought’ and become attached to collective experiments by way of various ‘spokespersons’ (see also Stengers 2010). Stengers strips theory of the power to manifest universal truth and opens both science and politics up to randomness and unforeseen consequences, where the potentiality of things cannot be subjugated under a single objective definition, but is always distributed through multiple modes of engagement with the matters of concern. Yet, since material phenomena provide the ‘cause for thinking’, their re-presentation

²³ The engagements with and between these three philosophers have informed a renewed interest in more-than-human ontologies and politics in a close cooperation between critical geographers and post-humanist political theorists (see Whatmore 2002; Braun and Whatmore 2010).

²⁴ Latour’s ‘parliaments’ liken to Callon’s (2009) ‘hybrid forums’, yet such gatherings are hybrid also in the sense that they account for both human and non-human presence (cf. Whatmore 2002).

generates active witnesses to the objectivity of knowledge claims. The ‘cosmos’ in cosmopolitics specifically “refers to the unknown constituted by these multiple, divergent worlds and to the articulations of which they could eventually be capable” (2005: 995). What one can derive from this ‘collective objectivity’ (Braun and Whatmore 2010: xxvi) is that reality is not a given, universal and static state of affairs, but always distributed, localized and in flux. Moreover, the world can become present in multiple forms, not simply because our engagements with reality are multiple, but because material phenomena themselves multiply through practices.

This is the point made explicit through Annemarie Mol’s theory of ‘ontological politics’, which proposes that reality itself is multiple (Mol 1999; see also, Mol 2003; Law 2004). The plurality of opinions that researchers encounter in the field does not boil down to different perspectives or standpoints held by various experts and non-experts; rather, reality is a product of *doing reality*, or as Mol says, ‘enacting’ or performing it through practices. Mol emphasizes that this is no pluralism. There are not simply ‘many aspects of a single reality’, but ‘different versions of the object’ (1999: 77). In fact, there can be many “versions” which do not necessarily overlap since they are enacted and objectified in different ways and with the help of different techniques. Multiple realities may nonetheless “hang together” and even collaborate in surprisingly single, inter-dependent and resistant ways (Mol 2003). The consequences of this philosophical approach are that things could have been *and* may still be different. For Mol, this multiplicity does not correspond to a list of foregone options, such as instances of path-dependence that complicate returns to alternative politico-economic configurations. Instead, things are enacted in multiple ways all the time, such that alternative options often *co-exist* in the present. The event of singularity, by contrast, is specific, particular and local, as it subsumes multiplicity (Law 2004).

The quest of research therefore is to explore and make visible the possibility of multiple coincident realities (Law 2004; Latour 2005b). Through the work of Latour, Stengers and Mol, ontological and epistemological questions become conjoined: questions about the conditions of possibility are always questions of knowledge. ‘*What is at stake*’ is no longer the actual stuff of the world or mere social constructions, but yet another how-question – ‘*how does the world make itself known?*’ (Whatmore 2003). Furthermore, the ability to enact realities through knowledge practices applies equally to a social science research project, which is “simultaneously a technology of practice and an intervention in the world” (Whatmore 2006: 601). Being thus empiricist in a further, ‘perspectival’ sense (Barry 2001: 22, 2010), the thesis works to detect not just a variety of sometimes incommensurable truths, but multiple versions of reality. These realities are not discreet options, but rather blurred and indeterminate, still unfolding futures that collapse into the present. The act of research thus becomes inevitably *political*. It assembles, amplifies and makes the ‘resource of the future’ present in concrete ways, which otherwise may go unnoticed, get diffused in the myriad of everyday agendas and possibilities; in effect, never enacted and storied at all. In a way, the thesis even contributes to the legitimization of the unconventional industry, as the act of rendering certain relations and inner workings visible simultaneously helps bring such unconventional worlds into being. If we attend to the multiplicity of reality, then by weaving together a particular narrative through the lens of oil shale or Estonia’s dilemmas at the intersection of various matters of concern, the thesis also makes a difference by rendering “some realities realer, others less so” (Law 2004: 67).

The politics of multiplicity opens up a number of further research questions. Following Mol (1999), one is invited to explore, for example, *where* the options are decided and located, *what* is at stake in relation to other objects and realities, *are* there really any options in cases of interdependence, and *how* should one choose between

such options?²⁵ These have been some of the starting points for my travels, while more specific questions have formed, failed, and reformed along the way. Through an initial study of how, where and why the nation's energy elites were active, it has become possible to make sense *what* they were doing, as the 'what' gradually emerged through the pieces of puzzle; a pattern perhaps novel, but not totally unrecognizable to the actors themselves.

3.4 Between the field and the study

What kind of methods, skills and encounters are necessary for studying the multiple realities of a resource-in-the-making? How can methodological strategies be reconciled with the unfolding realities of fieldwork? As said, this research cannot take a simple case study approach, since one could call the Estonian industry an 'extreme case' in the sense that it is not reducible to macro-structures and is thus "especially problematic or especially good in a more closely defined sense" (Flyvbjerg 2006: 229-230). Also, the promise of oil shale is not unique to Estonia, nor was my fieldwork limited to a single country. At large, the research covered a number of 'sites of assembly' where particular resource realities were enacted, tracing the circulation and exchange of scientific knowledge, technological solutions, people and resource materials between disparate geographies of development. These sites have varying degrees of engagement in terms of both knowledge and the time spent in the field: from more extensive fieldwork in Estonia, to short-term conference trips and site visits in the USA and Jordan, to day-trips for interviews in London and Brussels.

²⁵ For an example of how such questions have been used in research practice, see Lepawsky (2012).

3.4.1 Estonia

I returned to a freezing Estonia in February 2010, armed with lots of how-questions and a certain sense of unhappiness about my country's energy politics, but eager to learn more about the people specialized in the sector and their motivations. I had not been away for long, only three and half years, but had already become estranged in many ways. In between I had completed my Masters degree at Oxford, met a German man and had a baby – experiences which had changed my understanding of the world dramatically. Over the next months, between March and November, I made five more extended visits to Tallinn with my child, rented a small flat and paid for a private nursery place. Each visit lasted from two to seven weeks at a time, totalling 5.5 months, which alternated with desk study and family life in Oxford. But this was only the beginning of work and research.

Finding my way through the snowed-in capital with a 1.5 year-old toddler in tow turned out to be far more complicated than I would have ever imagined, although I was familiar with the city having lived there for two years before. Motherhood imposed serious constraints not just on my time, but on my mobility, too. With limited hours of childcare available, my methodological approach had to be extremely selective, for example I had to resist the temptation to conduct any archival research (as done by Holmberg 2008; Kesküla 2012). In the beginning, I simply acted according to textbook definitions of semi-structured interviews by snowballing from previous contacts and gradually expanding the range of informants (Valentine 2005; Dunn 2010). The troubles of single-mothering continued to haunt me throughout later, snow-free visits, however, affecting not only the number of interviews I was able to carry out among the country's political and business elites, academics, and non-

government activists (Table 3),²⁶ but particularly the number of visits to the oil shale industry sites three hours away from the capital. Despite a general sense of failure, I proceeded to arrange additional contacts via email and on the phone, went to a number of relevant workshops and events (which infrequently seemed to take place during the time I was back in Oxford), collected relevant literature, and continued to follow the national news media on daily basis until the submission of the thesis.

Although in my case fieldwork was not *work* in the manner of an anthropologist who participates in the activities of her research site and sometimes even contributes her labour to the production process (cf. Dunn 2004: 25; Kesküla 2012), it was nevertheless ‘ethnographic’, ranging from other forms of participant observation and formal interviews to innumerable informal encounters, unexpected surprises and acts of re-presentation (Crang and Cook 2007). The content of these materials was on occasion highly sensitive, which affected the ethics and politics of research. I took recordings and notes of all interviews and asked interviewees to sign their consent to recording and the anonymous use of interview data in the study.²⁷ I further backed up my handwritten notes in typescript, which for the most part were complemented with partial transcriptions of the audio files. These transcripts were usually supplemented with a separate file called “event notes” in order to store my immediate personal reflections on the encounters. I proceeded to take rigorous event notes during participation at various workshops and other gatherings, day visits to production sites, and after many informal meetings and discussions, some of them post interviews. Many of these events were photographed, and some recorded, strictly following the consent of my hosts. Following the principle that “everything is data”

²⁶ Each interview usually lasted two hours. In some cases, the discussions were followed up in person or by email, without recording.

²⁷ In three cases, where informants did not consent to tape recording, I took more comprehensive notes, which the informants later reviewed via email.

(Latour 2005b: 133), I also hoarded a collection of oil shales and other artefacts such as corporate brochures, maps, and the sketches drawn by my informants – a habit which became a key method during my later visits to other countries.

<i>Site</i> <i>Method</i>	Estonia March–Nov 2010	Colorado Oct 2010	London March 2011	Brussels June 2011	Colorado/ Utah Oct 2011	Jordan May 2012
Formal interviews (recorded, with consent forms)	36 key informants		2 key informants	6 key informants		
Extended, oftentimes cumulative talks (not recorded, written notes)	√	7+ foreign experts and 14 “Estonian” participants (out of 18) ²⁸			14+ foreign experts and 17 “Estonian” participants (out of 20)	6+ foreign experts and 16+ “Estonian” participants (out of 27)
Conference attendance & participant observation	√	√			√	√
Site visits	√				√	√

Table 3 Fieldwork statistics.

At the start of fieldwork, my main aim was to study the ‘politics of the future’ of a national economy undergoing an “energy transition” in relation to the EU accession requirements; a relatively clear objective delimited partly by my own precarious situation. However, my initial plan to gain first-hand experience with certain forms and forums of parliamentary and extra-parliamentary politics were hampered by stagnation in political decision-making in the anticipation of new elections as well as the remarkably short lifetime of the few initiatives that resembled ‘hybrid forums’. New themes and opportunities emerged instead, facilitated by better knowledge of the industry. My fieldwork coincided with the time when the state energy monopoly in cooperation with certain government officials made an abrupt attempt at privatization (which failed), launched a fierce competition with the growing suppliers of renewable

²⁸ Some Estonian participants had already been interviewed earlier in Estonia.

energy for state subsidies, and facilitated even more fierce debates with the European Commission over a number of important changes to environmental legislation, most importantly in relation to carbon pricing. These events had immediate implications for many of my informants and thus dominated the content of interviews both within the industry and outside. Yet, there were other, less immediately visible contexts that gradually emerged. As interviews progressed, it became clear that what I had tentatively considered ‘the field’ had undergone more profound, multiple transformations, since the objects, metrics, technologies, markets, and politics of ‘oil shale’ were all being redefined in ever-expanding public (and not so public) debates. Estonia’s forthcoming admission to the European electricity market and opportunities to export technological expertise were the most significant and controversial milestones marking these transformations. My interests and ambitions grew as more doors were opened to me, while others remained firmly shut or took too long to open. The lessons learnt from these encounters can be found in Chapters 7 and 8. Some of my original aims have been addressed and condensed into Chapter 6.²⁹

These trips were disrupted not just by changing methodological approaches, but by weeks spent at babysitting and desk-study in Oxford. Here, the observations made in the field intersected with meticulous study of technical literature on world oil shales available in Oxford libraries and online. As the ‘exercise in sympathy’ required a certain degree of *humility* – in addition to the practical circumstances that were long beyond my control – the research event was no longer fabricated by me alone, but took shape in a collaborative process through which both researcher and researched

²⁹ Note on the order of writing: The write-up started with Chapters 4 and 5, which were completed in tandem and assessed during the Confirmation of Status process in the summer of 2011. Nearly a year was spent on drafting Chapter 7 and subsequently rewriting it into an article submitted to *Geoforum*, followed by Chapter 8 and Chapter 1 in spring 2012. The middle empirical piece, Chapter 6, was the most difficult to conceive on paper, although its core arguments had been there from the very early stages of fieldwork. It was finalized only shortly before submission after the literature review and methodology (Chapters 2 and 3) were ready.

transformed. All of these interventions continued to inform and furnish the “object” of study equally. The extension of field research beyond Estonia therefore reflects progress in the ongoing co-production or ‘co-fabrication’ of knowledge, as new issues and opportunities emerged both from encounters with informants and the practicalities of fieldworking (Whatmore 2003; Barry and Slater 2005b).

3.4.2 Elsewhere

The shifting ‘objectivity’ of oil shale progressively opened up new research sites, as it turned out to be necessary to make a number of shorter visits to the USA, London and Brussels, and eventually, Jordan. Surprisingly, undertaking these short-term trips alone, without needing to take care of my child at the same time, turned out far more productive than my original fieldwork plans had been. Alongside improved access to the industry, the initial study of an ‘extreme case’ (Flyvbjerg 2006) became more and more reminiscent of a kind of ‘multi-sited ethnography’ (Marcus 1995).

The first shift in the orientation and scope of research came towards the end of fieldwork in Estonia, when I took advantage of the opportunity to spend a week at the 30th Oil Shale Symposium organized by the Colorado School of Mines in Golden, Colorado, which is the annual meeting for hundreds of oil shale experts and developers from all over the world. Besides educating myself during official conference sessions and “hanging out” at various informal dinners and settings, I decided to expand my interview base by arranging short one-on-one meetings with several international experts and company representatives. I also held conversations with the majority of the Estonian delegation representing the industry’s top management and government officials. This information significantly supplemented the data collected in Estonia and expanded my knowledge of oil shale technologies. The contacts made during this conference enabled me to carry out further interviews

with industry representatives in London. Meanwhile, I also conducted formal interviews in Brussels at the DG Climate Action and the Estonian permanent representation to the EU, which supplement data for Chapter 7. Combined with the study of policy documents and multiple sources of data online, these observations further blurred the distinction between 'the field' and 'the study' as places of knowledge production (Massey 2003).

When I returned to Colorado a year later for the 31st Oil Shale Symposium, the same occurred, except that this time I was more familiar with the audience and topics and consequently managed to generate more data from official sessions and personal communication with other delegates without feeling the need to arrange any separate meetings. With the generous help of the organizers, I was also allowed to participate in the official conference fieldtrip through the Rocky Mountains, which lasted for two days and took us to seven locations, from various outcrops to demonstration plants, including the notorious ExxonMobil development site in Colony, Colorado and the newly acquired Estonian property near Vernal, Utah (Figure 3).

Following repeated invitations to visit Jordan an opportunity finally emerged with the Jordan International Oil Shale Symposium in May 2012, which took place at the luxurious settings of the Kempinski Hotel on the Dead Sea. In its ventilated conference rooms, restaurants, and mud-pits, I again met many acquaintances from two previous conferences and familiarized myself with the latest updates on developments, particularly in the USA and Jordan. In addition, I was kindly offered an opportunity to join a private pre-conference fieldtrip to the Estonian concession in central Jordan, near the town of Al-Qatrana (Figure 4), as a well as the official post-conference trip to the Petra archaeological site with fellow delegates.



Figure 3 Visiting Enefit's (former OSEC) concession in Utah, October 2011.



Figure 4 Looking over Enefit's concession in central Jordan, May 2012.

As my fieldwork progressed and transformed together with the ‘field’, many formal interviews conducted in Estonia grew into cumulative conversations throughout the events in the USA and Jordan. Invaluable information was also gained from participants who were never interviewed, but nonetheless informed about my research objectives. A few others were happy to discuss my research interests at length on day-long trips together, without recording, note-taking or consent forms. As a rule, such “interviews” have been used in the thesis only if the information was supported by other observations and the informants’ public statements in the media. In all cases, references to my informants’ name and profession have been avoided in order to protect their confidentiality.³⁰ Additional impressions gained from these field trips and other informal settings were recorded by rigorous note-taking and photographing, strictly adhering to the instructions of event organizers and their confidentiality requirements (no audio-recording took place on either continent).

Extended throughout three conferences, the initial case study gradually acquired elements of ‘multi-sited ethnography’, in which the oil shale community became a kind of exotic tribe and I jokingly interpreted myself as their “body-sociologist”. Yet, the trips to the USA and Jordan were not long-term engagements with the tribe, but very short visits, each lasting only a week, and which were constrained by the formal settings of international conferences.³¹ If STS ethnographies have shifted from firsthand engagements in laboratory settings to other sites of knowledge production, then in this case the focus was not so much on the early stages of knowledge-in-the-making, but the communication of science-in-progress through speech acts and inscriptions in text, visualizations and smaller artefacts. The fieldwork

³⁰ If formal interviews took place, then reference is made to ‘Interview, [date]’. In a few cases, unstructured interviews and conversations are used with reference to ‘Field notes, [date]’.

³¹ Due to lack of funding, I was not able to attend the 32nd Oil Shale Symposium in Colorado in October 2012.

never took me to laboratories, but the multiplicity of ‘the thing’ in knowledge practices and corporate rhetoric was so obvious that the question became: how does it still “hang together” in practice? This kind of ‘conference ethnography’ became about witnessing how the multiple resource is fused together and mobilized under a coordinated agenda: the promise of energy supply to ‘post-oil’ worlds.

Yet, there was more involved in such conference ethnography. At each event, Estonians made up over 10% of the delegates (20-30 people out of 200-300).³² A core skill of research was to move swiftly between English and Estonian: between two languages, several companies, and intersecting subjectivities. As my impressions accumulated, I became convinced that Estonians are highly needed, but also barely tolerated “experts” for the international community of closely aligned science and industry. This situation turned out to be even more peculiar once Estonians did not perform as a uniform group, but represented their country under multiple professions and agendas. A supposedly independent researcher from Oxford only added confusion to such situations. The fact that I do not work for the national energy company was met with surprise for the most part, with relief in some and suspicion in other instances. Moving around as a young female in a predominantly male environment served as a further factor of excitement, taking occasionally the form of an intricate power game between company executives, as I was pampered with private dinners, conversations and good-byes. Again, none of this has been recounted in this thesis for ethical reasons, but such impressions nevertheless informed my understanding of the industry.

³² In reality, these identities were never as clear-cut as presented in Table 3. The Estonian industry team included a few non-Estonians hired by the company who had Estonian spouses but limited knowledge of the language. On the other hand, there were a few other Estonian-speaking experts, who were not directly associated (or even in open opposition) with the industry, and may have not lived in Estonia. All these categories are included under “Estonians”.

With my increasing awareness of shale oil development, in contrast to Estonia's preoccupation with electricity, the 'object' of my research shifted. So did 'the field' more broadly. To the surprise of many people back in Estonia, the state energy company not only formalized its ongoing cooperation with the Jordanian government in concession agreements, but took over a US-registered shale oil business in Utah. Throughout the same encounters in Estonia, Colorado and Jordan, I witnessed personally some of the deals that helped the national monopoly to go global. Continued correspondence (in person and via email) with Jordanian and American counterparts supplied firsthand information about the extent and expectations of this Estonian cooperation. This information is highly delicate, of course, and has been used here at a very abstract level, if supported by open conference speeches or other published materials. Since the company's rapid expansion has become much contested, both at home and elsewhere, it should be emphasized that my aim is *not* to give a journalistic account of some sort of 'Estonian conspiracy' by judging, for example, whether the Estonian technology is actually working or not, and whether the company's ambitions are justified. Quite the contrary, my account of these events, as given in Chapter 8, builds on the 'Estonian controversy' discussed throughout the thesis (cf. Whatmore 2009) by exploring how this expansion to exterior markets feeds into long-term debates on the position of oil shale in the country's energy economy.

3.5 Coming to terms with your own nation

In this way, the practicalities outlined above did not only reshape methodological choices, but had a significant impact on how I came to live with the field itself, concerning the "distribution of powers and affects between researcher and researched in the research event" (Whatmore 2003: 102). My previous understanding of social science research had seriously been shaken by the experience I gained while myself

serving as a research object for a doctoral project on Estonian students' changing self-perceptions in the UK (see Märtsin 2009).³³ *Is this the country I want my daughter to grow up in?* was the question that kept nagging at me during the early stages of fieldwork and – having replied ‘no’ – nonetheless came back to me throughout the long months of ‘writing up’. Past post-natal depression and on the verge of another crisis, I continued to reflect not just on the encounters made in the field, but reassess my very own relationship with my upbringing, my distant family, and my nation. After all, as Crang and Cook remind, “research is an embodied activity that draws in our whole physical person, along with all its inescapable identities” (2007: 9).

With 1.3 million people (68% ethnic Estonians), my country of origin is a tiny nation-state, where everybody seems to know everybody or, at most, have just one degree of separation from each other. Hundreds of years of oppression, bloodshed and betrayal have generated a specific set of moral demands on the relations between fellow natives. In the context of restricted budget for education and research and lack of qualified staff, academic freedom is here somewhat more constrained than in Anglophone geography departments. In any subjects related to energy studies, research programmes tend to be positivist, policy-oriented, and defined by either state funding bodies or the industry. It is no surprise then that local actors struggled to make sense of my research objectives and me as a person in general. As a native scholar, I was expected to be formally associated with the existing structures of power and knowledge production – or, at the very least, have an Estonian co-supervisor who is an expert in the industry. Moreover, given the fact that I had a state-funded education, I was implicitly assumed to have a great measure of patriotism, veneration and indebtedness related to my country's independence – qualities which despite their

³³ Märtsin analyses my early struggles as a Masters student in Oxford, which can be read in the section 8.6 of her thesis, “The case of P”.

presence in me were recollected in particularly strong forms by more senior informants. Representatives of state institutions and some academics usually did not (or pretended not to) understand how one could critically interrogate Estonia's choices, which are yet so unambiguously determined by the country's geopolitical situation and the strategic presence of an indigenous fossil fuel. Being the most vulnerable to critique, they made an especially difficult audience for me, even though I had personal contacts with many of them in my previous life. Industry representatives expressed themselves in equally deterministic terms, and were initially perhaps even more cautious. Some of them took a proactive stance by trying to gain authority rights over the thesis and, without success, gently governed my conduct through friendly relations, culminating with a sort of open comrade-ship during the Jordan trip.

While this situation was challenging enough, the expectations of other actors made ethical and political issues particularly demanding. The industry's opponents, including some maverick academics as well as people at the environmental front, often applauded the research for the reason that its findings were expected to reveal 'the truth' or at least give more weight to their own agendas. My refusal to pass on any preliminary findings or to start working for certain organizations as a non-governmental expert on the subject was met with some perplexity (and eventually, neglect). Whoever made up the audience, my claim that I am trying to act simply as a disinterested observer did not seem to make sense. This lack of understanding was not improved by the fact that throughout the project I was always very open about my previous professional affiliations and funding sources, and even tried to express some ideas about my future career options. I can, once again, confirm that I have not received any financial support apart from my state-funded scholarship and smaller conference grants, nor shared the research findings with any institutions or actors other than academic publics.

Such encounters, however, have not left my own subjectivity intact, but required an ethical and political transformation of myself alongside the research event, such that “an eventual becoming will be the researcher’s own becoming” (Stengers 2005: 994). As the field of study expanded, I became at first wary of the difficulties in moving beyond the approach typical to contemporary Estonian human geographers who have claimed a monopoly over studying their own country, but achieved little elsewhere (Peil 2006).³⁴ At the same time as I was afraid of becoming an expert in an overly narrow field, I was also constantly reminded of the possibility of not knowing enough about the field. Parallel to the exercise in sympathy and humility has been thus a constant fear of *humiliation*, risking the loss of respect and authority alongside the productive ‘risking of knowledge’. Anybody, who is not associated with a particular school of education may be belittled as a person who lacks the relevant expertise and is therefore not entitled to speak for or against the industry’s future. In fact, there are very few people who are entitled to do so (see Chapter 6). So, even if this thesis succeeds in reflecting the results of ‘co-fabrication’, I am uncertain about my own contributions to fabricating the everyday realities of the field.

And then there is just silence and isolation. My informants are busy winning their own bread, defending personal interests, and building political and business alliances. The worst and most unproductive feeling has been, perhaps surprisingly, a growing separation from Estonia. When not in sight for a while, my troubling person was doubtless soon forgotten, so that any personal communications died out quickly. The boundary between ‘the field’ and ‘the study’ gradually emerged again, which is particularly sad since the writing-up stage may well have coincided with the formative years of a renewed Estonian politics. Having enjoyed a long period of economic and

³⁴ There are a notable exceptions, with Merje Kuus, whose work is cited repeatedly in the following pages, being one of the most notable natives who have moved to study geographies elsewhere.

political stability, people's trust in the government wavered in 2012 in response to the powers' growing estrangement in the dawn of political stagnation. Former alliances between nationalist and liberal rationales, and representational and direct democracy are now challenged at all fronts, alongside shifting understandings of what actually constitutes "being Estonian" and appropriate political conduct. I have thus found myself oscillating between yawning indifference and growing anxiety about the country's future, with the latter gaining the upper hand the more people have publicly stood up against the prominence of macho politics or 'tough guy rhetoric', as one Estonian sociologist put it,³⁵ which resonated strongly with my personal experiences during fieldwork. In short, the more I tried to distance myself from the field in a vain attempt at objectivity, the more I clung to it in pursuit of an expanded subjectivity. Although these struggles have little visibility in the thesis, they have nonetheless influenced my thinking enormously, to the extent that the process of 'coming to terms with my own nation' has constituted a key research method in its own right.

3.6 Thinking through shale

The 'co-fabrication' of knowledge in research events is considered to expand into not just human but also non-human agencies (Whatmore 2003). Once in the field, there is more to oil shale development than intentional human beings with their shifting ambitions and subjectivities. There are also pieces of shale and other items, texts, maps, machines, infrastructures, light and heat, and innumerable other examples of matter-energy. The "resource" can be found everywhere, in all sorts of material and immaterial elements – both present and promised. What if all this material is not a 'product of thought' in the social constructivist sense, but itself 'forcing thought'

³⁵ Juhan Kivirähk (26 October 2010) "Eestis kipub domineerima "kõvade meeste" retoorika" ['Tough guy rhetoric' tends to dominate Estonia], <http://uudised.err.ee/index.php?06264477> (accessed 16 December 2012).

(Stengers 2010)? Following the Stengersian approach, my relationship with the material as the “object” of research needs to be placed ‘at risk’ similarly to my knowledge of the national politics. What difference does the ‘the stuff of the world’ make to the event of thinking? Thing-politics thus exceeds the Nation and interrogates matters of concern in their entirety.

Unfortunately, there is no established research method available for this sort of ‘apprenticeship’ to oil shale (cf. Whatmore and Landström 2011). Apart from rendering resource materials central to conceptual work, ‘doing materiality’ turns out to be a complex exercise (Bakker and Bridge 2006: 18), risking ‘surface geographies’ which do not engage with the material critically and politically (Tolia-Kelly 2013). For my part, the strategy has been from the very start to cultivate an active awareness of the presence of the materiality and immateriality of the multiple thing called ‘oil shale’ throughout all possible encounters and events (cf. Anderson and Wylie 2009), and to contemplate how this advances the affectivity and knowledge of my informants as much as that of myself. Building on the ‘*every-thing* is data’ approach I employed in Estonia, the collection and observation of various things became a habit during later field trips, which despite their limited visual presence in the thesis again informed my thinking immensely. I witnessed, photographed and collected small pieces of oil shale and shale oil, followed their presence in corporate brochures, public presentations, personal correspondence, and even in toasts given at private dinners. This may seem a relatively straightforward strategy if such samples have been staged deliberately by the industry to position itself. In the mindset of commodity chain analyses, it is also relatively straightforward to ‘follow the thing’ (Cook 2004) by diagramming its moves from the mined stuff to various products and wastes, extending to the uninterrupted supply of electricity in my Tallinn apartment. But here things get complicated. Oil shale often figures not just as a promise but, far worse, a threat of its absence – the

moment of ontological confusion, where the unexamined material fabric of everyday life is opened up for scrutiny (also see Chapter 6). As so many informants made clear, lights may go off and cars may no longer drive if oil shale development is discontinued. How to account for the impact that such (im)material references have on the *re*-presentation of the thing?

One way is to dispense with the mind/matter distinction altogether and follow Stengers in contending that the world ‘agitates’ us to think (Latour 1997). The nonhuman is thus not a passive ‘object’ waiting to be discovered, but an active agent in knowledge production (Haraway 1988), the *cause* for our thoughts, feelings and hesitations (Stengers 2010: 14). Similarly, Spinozist readings into non-representational geography emphasize that “knowing proceeds in parallel with the body’s physical encounters” (Thrift 2003: 111). According to this view, knowledge is co-produced in the affective encounters between researcher and researched, who are not limited to human bodies. Conceptual thinking is thus in itself a material practice: “the active cultivation of a commitment to think through the material not as the base from which thinking departs, but as the necessary yet insufficient condition of the event of thought” (Latham and McCormack 2004: 718). Thus, in my humble attempts to actively cultivate an engagement with the material, I was no longer an impartial observer of a resourced world, but rather a witness to the world taking an intelligible, yet particularized shape through a series of affectively charged encounters, including my own embodied struggles throughout the study.

In the end, I may still not be able to tell the difference between quartz and mudstone, but I account for the central position of such geological categorizations in my analysis, without being judgemental. I may not be able to smell the difference between higher-quality and inferior oil, but I have made note of the ways such samples

facilitate the enactment of the industry's potentially glorious future. In a further attempt to think through the resource, I have also noted how such materials have acquired increasing mobility, since the industry's global expansion requires more and more shale to physically leave its environment in the move between testing sites located far overseas, alongside the travels of machinery and expert knowledge. Even if this project has turned out *less* than ethnographical according to the standards of anthropological fieldwork or classical STS investigations in laboratories, then a result of this sort of 'active cultivation' is that the account is also *more* than ethnographical, considering my own long-term critical positioning to these matters of concern both conceptually and materially. The thesis does not address 'unconventionality' as an external phenomenon, but seeks objectivity in an unusual way. Although based on well-known methods, the research project is itself non-conventional in part.

The next chapter, the first milestone of my empirical research, finds itself in the middle of the abovementioned turning point in fieldwork, where the prolonged material presence, mobility and political capacity of 'oil shale' in its multiple forms and histories became acutely clear and convened to inform theory rather than being subjugated under structural analysis. The past and the future came together on the first day of the 2010 Colorado symposium, when the conference delegates were presented with a reprinted brochure from 1919, which opened with the following statement.

Chapter 4. Assembling 'Oil Shale': Resources, Materiality, Unconventionality

4.1 The 'heir apparent'

Recent years have been filled with stirring and far-reaching events, world wide in their effect, not the least of which has been the birth of a new industry, with a potential supply of raw material that almost defies mathematical computation and staggers the imagination. Can oil wells produce enough petroleum to meet the enormous demand now existing for oil and its products? The answer is doubtful. Will new oil be discovered to meet the increased demand in the future? The answer is extremely doubtful. Yet this is the age of oil. Oil we must have. The supply must come from our great deposits of oil shale. If oil is the "king" then oil shale is the "heir apparent" (Alderson 1919: 3).³⁶

When one first becomes informed about what is called 'oil shale' in English, the term seems to be inevitably associated with *oil*. Representing a group of sedimentary rocks little known beyond the discipline of geology, oil shale by its very name appears to be related to oil as it is conventionally understood. This association is neither novel nor recent, as demonstrated by the opening quote published nearly a hundred years ago, at a time when the imminence of oil scarcity was first raised in America (Yergin 2009: 178). Yet a century later the "king" is still reluctant to abdicate, leaving the "heir apparent" unable to seize the throne. More recent publications promoting oil shale development often reproduce their association through the use of figures that bring together and juxtapose two distinct categories of world oil resources; on the one hand crude petroleum, and on the other, shale oil.³⁷ Although such figures may occur in various shapes and incorporate a range of information, they deliver a unanimous message – the quantity of crude oil remaining is limited, but the impending global shortage can be overcome by an alternative oil resource, which is said to be impossible

³⁶ This quote is from a collection of articles from 1919 that was reproduced by the Colorado School of Mines in commemoration of the 30th Oil Shale Symposium in Colorado in 2010 and distributed to participants together with other conference materials.

³⁷ These figures are very popular in the publications of oil shale developers around the world. See also the *Oil Shale Guide* (Ellis 2010) published by the Oil Shale Information Centre in London associated with the Jordan Energy and Mining Ltd company.

to exhaust in the foreseeable future (see, *inter alia*, Ellis 2010). Regardless of any variations between the estimates of resource volumes, the total potential of shale oil is expected to exceed conventional crude reserves by many orders of magnitude (see also IEA 2010).³⁸

The centrality of such rhetoric to the promotion of oil shale development suggests that the meaning and significance of ‘oil shale’ as a global energy resource is determined by the *sheer quantity* of this kind of “untapped oil”. Geographical scholarship has long recognized that natural resources should not be taken for ‘natural things’, but instead certain components of the material world *become* resources when they are considered to be useful or valuable in some respect: “whether a material is classed by society as a resource or not depends on the way it is related to other things, to knowledge, to the opportunity to realize value by exchange, and to other materials that can fulfil the same functions” (Bridge 2009b: 1220). It appears that oil shale’s entitlement to the status of a resource is strongly linked to the evidence of the scale of the resource, in comparison to the scale of remaining traditional sources of liquid fuel. But, while this is so, how exactly does oil shale become a resource that can be likened to crude oil in the first place? This thesis emphasizes that the emergence of an alternative fossil fuel economy is not providential, but requires specific scientific, political and infrastructural work (cf. Bowker 1994; Bridge 2011c: 2). Before worldwide oil shale development can be taken seriously as a potential solution to scarcity, the diverse resource materials of different countries need to be brought together and subjected to systematic exercises of classification, standardization and calculation. As we shall see, this project involves both industry geologists and

³⁸ The persistence of such calculations in high-level political and economic circles was shown, once again, by the president of the World Energy Council in his keynote at the Jordan International Symposium in May 2012. In his view, oil shales exceed conventional resources by four times.

government authorities, and takes place in close collaboration with the industry's efforts to demonstrate that particular oil shales are both technologically malleable and valuable to produce under economic or political terms.

The aim of this chapter is therefore to examine how certain groups of diverse subsoil materials have come to be assembled under the name 'oil shale' and credited as a unified resource entity of global importance in response to increasing constraints on hydrocarbon availability and consequent pressures to develop alternative supplies. In these circumstances, the place of oil shale in the world energy economy is, at least partly, defined by the extent to which such diverse mineral materials are framed and rendered calculable with reference to conventional liquid fuels, alongside the more locally distributed practices analysed in later chapters. Like other non-renewable resources, all potential sources of hydrocarbons contained in Earth's crust are considered to be finite. It is a totally different question, however, whether such resources may or should ever become depleted *de facto*. The absolute quantity of the stuff that remains deposited under the ground is rarely a matter of interest, except perhaps for some geologists. What matters instead for oil-fuelled capitalist economies is the size and characteristics of deposits that will become available for exploitation in the foreseeable future. Rather than estimating the total scale of the resource, those who assess world resources tend to focus on those accumulations of non-renewables that are both geologically and economically feasible to recover, called *reserves* (see Bentley 2002; Klett 2004). Beyond these disciplinary terms, however, recoverability needs to be defined and categorized in particular contexts, for which there are several classification methods (e.g. Rudawsky 1986). It is no surprise, then, that estimates of reserves and total resources vary across particular resources and locations, and often become conflated in popular rhetoric on hydrocarbon availability.

The oil shale industry, as discussed throughout the thesis, needs to address the potential scarcity of fossil fuels in two ambiguous, but interrelated ways. The first corresponds to the much debated decline in *global* production of conventional oil, which is commonly referred to as ‘peak oil’ (e.g. Bardi 2009). The chapter argues that oil shale acquires at least some of its importance as “unconventional oil” through a paradoxical engagement with the peak oil thesis. Although such calculations are of central rhetorical importance, there are serious difficulties in extending the framework of ‘resources’ and ‘reserves’ developed for *liquid* hydrocarbons to oil shales, which are deposited in *solid* mineral form. Moreover, the practices of constituting an unconventional resource that is further expected to “become conventional” conceal long-term struggles in both the geosciences and industry, which seek to overcome the material heterogeneity of world discoveries, the incompatible resource assessment practices of resource-holding countries, and their different pathways to commercial exploitation. In this regard, the other case of scarcity refers to potential *local* shortages in using not oil, but oil shale, such as the ‘peak’ situation that the Estonian industry has reached at a time when shale oil is increasingly considered a promising substitute to conventional crude. The implications of the Estonian case for ‘resource-making’ elsewhere will be discussed in later chapters.

Focusing on oil shale’s ambiguous existence in the form of both solid and liquid resources, the chapter interrogates how the *materiality* of the resource is made manifest and assumes a critical role in establishing the global industry. In doing so, I am broadly drawing on the suggestion of Bakker and Bridge (2006: 21) that specific material properties of resources can both enable and constrain the creation of possible futures. As explained earlier, however, resource materiality is here not appealed to in physical terms as something external and restrictive to ‘society’, but non-human phenomena are understood to become eventful constituents in assembling the social

and the political (Mitchell 2002; Whatmore 2002; Bennett 2004; Latour 2005b; Whatmore 2006; Bennett 2010; Braun and Whatmore 2010). The following discussion thus refrains from regarding subsoil resources as solely physical things stored in the ground, nor does it attempt to ‘de-naturalize’ them as purely social objects resulting from complicated geological and economic calculations (cf. Castree 2005; Bridge 2011a). Instead, following insights from STS, the story of oil shale told in these pages reveals instead how resources should be understood in non-dualistic, relational terms as provisional outcomes of dynamic socio-material processes (cf. Latham and McCormack 2004; Latham et al. 2009: 62-69) or, drawing on the vocabulary of Bensaude-Vincent and Stengers (1996), as ‘informed materials’ (Barry 2005b, 2009, 2010). With a focus on the assembling of the global resource, I place emphasis upon the *multiple states* of oil shale materiality in order to explore “how heterogeneous materialities actuate or emerge from within the assembling of multiple, differential, relations and how the properties and/or capacities of materialities thereafter become effects of that assembling” (Law and Mol 1995; Anderson and Wylie 2009: 320).

The following sections therefore investigate the process of resource-making through both geoscientific calculations and corporate rhetoric, while the next chapter reveals that local framings of the resource may become subject to politically charged revisions and re-definitions when such socio-material formations undergo critical changes. Through a three-dimensional appeal to the materiality, temporality and contestability of resource estimates of oil shale, the thesis advances not only a relational understanding of natural resources (Bridge 2009b), but a relational understanding of *resource materiality*. Later chapters will more closely analyse the ‘constitutive powers’ of resource materials and technologies themselves in bringing together the political associations and social collectives that shape unconventional energy development (Braun and Whatmore 2010).

The next section addresses the absence of oil shale in ‘peak oil’ calculations and explains this through fundamental differences between the assessments of conventional and unconventional resources. The third section of the chapter describes how methodological differences related to the diverse characteristics of oil shale deposits and ambiguous perceptions of their materiality interfere with efforts to unify and calculate the global “resource”. The fourth section interrogates the mundane struggles of an unconventional industry against its globalizing agendas, leading to the observation that the material heterogeneity of resources remains a critical constraint on technological standardization and exploitation in practice. A short interstice then introduces the most exploited oil shale resource in Estonia, which is situated as a central ‘eventful place’ in relation to the global context (Massey 2005). The subsequent chapter develops the analysis presented in this chapter further. It dwells on the Estonian resource assessment exercise and revisits both the resources-reserves distinction and the problem of potential resource scarcity.

4.2 Peak oil and unconventional resources

In certain countries, mineral deposits with a significant content of organic matter have long been known and tested for the production of oil-like substances. It is only recently, however, that oil shales and other similar sediments have attracted attention world wide as alternative sources of crude oil. In the event that such ‘non-conventional’ fossil fuel sources become commercially exploited, they are expected to match the gap between world’s rising demand for energy and dwindling supplies of conventional oil (cf. Bradshaw 2010b), and hence mitigate or defer the looming energy crises in many petroleum-importing countries. To be sure, the prospects of oil shale exploitation have been associated with the peaking capacity of petroleum drilling ever since oil first replaced coal, especially in the USA. Besides local fears of scarcity, the

unconventional resource also emerged into the global spotlight in the immediate aftermath of the 1973 OPEC oil embargo (see Yen and Chilingar 1976), but lost its significance with the discovery of new petroleum fields. What is different this time is that oil shale has been resurrected in relation not just to rising market prices, but to the growing popularity of the ‘peak oil’ claim of physical limits to hydrocarbon availability. Moreover, the possibility of oil shale extraction is today associated with the “success story” of Canadian tar sands development (e.g. Bunger et al. 2004; Mills 2008; Vawter 2011) and credited as “part of the energy solution” by the advocates of the industry,³⁹ as well as certain resource-holding governments (for the USA, see Johnson et al. 2004; Hirsch et al. 2005; Dammer 2007; see also Liive 2010; Ogunsola et al. 2010). In opposition, those analysts and activists concerned about the emissions, environmental risks and financial burdens associated with the development of unconvensionals accuse the industry of “scraping the bottom of the barrel” and dismiss oil shales as a potential substitute for petroleum in favour of more sustainable energy futures (e.g. Leaton et al. 2009; Strahan 2009; see also Verbruggen and Al Marchohi 2010). Others prioritize less carbon intensive fossil fuel alternatives for the same reasons (Farrell and Brandt 2006; Brandt and Farrell 2007).

Beyond these highly polarized views, however, non-liquid sources such as oil shale have been largely excluded from more grounded calculations on future oil supply and its possible peak (e.g. Sorrell et al. 2009). Few energy analysts have critically discussed oil shales’ potential to attenuate the peak as ‘backstop resources’ which may become economically viable once the oil shortage materializes (Rogner 1997; Perrodon et al. 1998; Brandt and Farrell 2007; de Castro et al. 2009; Mohr and

³⁹ See, for example, the videos and texts published online by the American Shale Oil LCC (AMSO), Oil Shale Exploration Company LCC (OSEC), the National Oil Shale Association (NOSA) in the U.S., and the *Oil Shale Guide* of the Oil Shale Information Centre in London (Ellis 2010).

Evans 2010). None of these experts provides conclusive accounts of the extent to which oil shale could possibly substitute crude petroleum. Likewise, oil shale has not been addressed in the emerging scholarship on the political economy of peak oil, which barely mentions unconventional resources overall (Bradshaw 2010b; Bridge 2010; Bridge and Wood 2010; Bridge 2011b; but see Bridge and Le Billon 2013). This lack of scholarly attention is especially curious considering the fact that several oil corporations continue to carry out research and demonstration projects on shale oil production, with an increasing number of nation-states having development projects in the pipeline, thus giving the impression of a timely response to emerging supply constraints and rising prices. In other words, the 'oil transition' from conventional sources to unconvensionals has already begun, even if it is not necessarily registered (Farrell and Brandt 2006: 2).

In what follows, I describe how the absence of some unconventional resources such as oil shale from the calculations of global oil availability could be explained by fundamental differences between estimates of their resources, which derive at least partly from the role of geological and economic knowledge practices in mediating natural resources as 'reserves'. This concerns the ways in which the future production of conventional and unconventional oil is rendered calculable with respect to the ultimate quantities of resources *vis-à-vis* possible constraints on access, recoverability and commercial utilization. Indeed, the quantities that are available for exploitation are assessed in different ways, making it impossible to incorporate oil shales into the analyses of future crude oil production.

A few experts have attempted to estimate the total quantity of world oil shale resources. In doing so they have drawn on the data available on the larger and better known deposits from different countries and sought to develop a common

methodological framework for resource assessment (Duncan and Swanson 1965; Russell 1990; Dyni 2004, 2006; see also Dyni in WEC 2007). Such analyses claim that many of the diverse oil-bearing rocks that have been explored by geologists across the globe could be utilized as a substitute for liquid fuels, when economic conditions become more favourable. As a result, all such diverse earth materials are regarded as *potential* resources of crude oil ‘in place’, which may (or may not) become commercially exploited at some unknown point of time. Although geological differences between world oil shales have been long acknowledged (e.g. Duncan and Swanson 1965; Yen and Chilingar 1976), little attention is paid to the question how the material characteristics specific to particular deposits may impose technological and economic obstacles on their development, as well as political and regulatory constraints.

Following oil shale’s alleged promise as a substitute or at least a supplement to conventional oil, such calculations attempt to determine worldwide oil shale resources by their potential yield of liquid fuel. The estimates of resource volumes are given either in metric tons (i.e. tonnes) of *shale oil* or barrels of ‘oil equivalent’. In turn, corporate publications associated with the emerging industry have used such expert calculations to contrast the immense quantities of untapped mineral alternatives against the apparently shrinking reserves of petroleum, only to conclude that there remains many times more shale oil to be produced, once the world runs out of traditional crudes. Some opponents of the ‘peak oil’ theory have gone even so far that claim the resource to be “virtually infinite” if an environmentally and economically sound technology becomes available (Mills 2008: 164).

However, the methods used to estimate future potential oil shale resources are not necessarily compatible with the methodology used to evaluate the availability of

conventional liquid fuels. After all, reports of hydrocarbon resources have focused on *reserves*, not total resources. Neither the meaning of these terms nor the methodologies for resource evaluation are universally accepted (Bentley 2002), but here I will follow the definitions of the U.S. Geological Survey (USGS), because this institution has a central role in both conventional crude and oil shale appraisals. According to the USGS, oil and gas reserves are defined as quantities which are “expected to be commercially recovered from known accumulations under prevailing economic conditions, operating practices and government regulations” (Klett 2004: 595). For USGS, the term ‘resource’ incorporates both known quantities of liquid hydrocarbons in the Earth’s crust that are economically recoverable (i.e. reserves), and the quantities that have the potential to be added to reserves within a specified time range (called the ‘forecast span’), including those yet to be discovered. Resources that are considered to be commercially viable to exploit are divided into different reserve categories expressed with decreasing degrees of probability; respectively proven, probable and possible reserves. Nevertheless, the volumes to be recovered are still unknown, as resource assessments are said to be “estimates, not measurements” (Klett 2004: 595, 605).

This definition of ‘reserves’ indicates that estimates of conventional hydrocarbon supply rely strongly on currently available knowledge about the industry’s past and present affairs. However, ‘reserves’ simultaneously serve as projections of what can be produced in the future. The assessments are indeed made on the basis of presently available geological information about the stock of resources in the ground, as well as currently known economic and technical conditions. Nonetheless, they express a particular future dimension since such estimates can be verified as ‘measurements’ only after the resource has been extracted, according to future conditions. Statistical calculations of reserves thus perform as ‘projective

devices' or 'protentions' that enable future uncertainty to be managed (Born 2006; Barry 2008).

By contrast, assessments of global oil shale resources tend to focus only on their unlimited future promise as expressed in their spatial extension without specifying the 'forecast span' that is necessary to delimit reserves. Such "resources" also exist as projections, but differently. The reports on global oil shale resources cited above estimate the ultimate quantity of the oil-potent material in the ground without accounting for potential new discoveries, or the techno-economic conditions that would enable extraction to occur. According to John Dyni from the USGS, the 'resource' is to be defined as the "total amount of shale oil in a deposit, including those portions that are not economically or technologically recoverable at present" (2004: 739). The exclusion of recoverability criteria and the emphasis on *shale oil* reflects the USGS's aim to evaluate the "fundamental geological 'oiliness'" of each basin (Bentley 2002: 200).

The following paragraphs proceed to provide further insights into these discrepancies between accounts of conventional and unconventional oil by discussing a number of problems that have precluded experts from calculating world oil shale resources in a way that would make it possible to merge the results into the supply curves of oil reserves. First of all, it is difficult for analysts to take into account the economic feasibility of oil shale production. Very little knowledge is available about present economic affairs, because there is simply no example of an oil shale industry that has proven long-term commercial viability under capitalist modes of exchange. Historically, the majority of world production has occurred in Soviet Estonia, and since Estonia's re-independence, with the help of large-scale subsidies to the state-owned mining and power sector. The "transition" from a socialist system to a market

economy has been, at best, incomplete (see Chapter 6). Oil shale production in China and Brazil has been so far either too marginal or too inseparable from other mining and/or drilling operations to draw any significant conclusions. None of their shale oil plants are considered to have reached commercial-scale production (Chapter 8). In other countries that have launched oil shale industries in the past, the facilities have been closed down due to the availability of cheaper fuels, with the exception of a few scientific experiments (e.g. those recently revived in the USA and Australia). Considering this background, the prospects for economically sustainable production are highly uncertain. In the industry's public statements, its future survival and possible expansion is primarily associated with shale oil's competitiveness with conventional crudes in the global market. They envisage that the future price for oil will be the most decisive yet largely unknown factor affecting the possibility for oil shale development (e.g. Brendow 2003).

Even more problematically, experts have struggled to provide evaluations of world oil shale resources in purely geological terms. According to their own reports, any such calculations suffer from a lack of reliable and comparable information on particular discoveries. The extent of exploration drilling that informs the data made available by resource holding countries varies greatly, while many deposits are insufficiently studied to determine the size and grade of the resource. Moreover, country evaluations are based on different criteria and methodological approaches (Brendow 2003; Dyni 2004, 2006: 5; Francu et al. 2007; WEC 2007: 97-98). The general rule seems to be that the larger the deposit the less it has been studied, although the Green River Formation in the U.S. may be an exception.⁴⁰

⁴⁰ Field notes, 18 October 2010.

In the absence of an international standard for defining, measuring and grading oil shales, countries have developed their own resource classification systems. In the U.S., some authors have recently started to provide rough estimates of “recoverable resources” (Bartis et al. 2005; Dyni 2006), while the geologists of the USGS continue to report solely the total amount of ‘*in-place*’ resources of *shale oil*, because they “don’t really know what is going to be economic in the future” (Birdwell 2011; Johnson et al. 2011).⁴¹ Other countries have employed various categories such as ‘demonstrated resources’ in Australia (Dyny 2006: 5), ‘measured’ and ‘indicated reserves’ in Estonia (Valgma 2003), ‘proved explored reserves’ in Turkey (Altun et al. 2006) and ‘recoverable reserves’ in China (Qian et al. 2003), as opposed to the more common terminology of ‘proven’ and ‘probable reserves’ used to classify conventional hydrocarbons (cf. Klett 2004). Some of this terminology originates in the classification used for *mineral resources*, as explained later. In consequence, it is difficult for international analysts to understand which part of the geologically identified deposits have been included in country reports and which have not, and to frame up such estimates in their calculations of the global resource (see also Laherrère 2005).

Unlike the ‘peak oil’ controversy, the difficulties here are less related to the discrepancies between geological and economic practices of calculating ‘reserves’, but arise from an overall shortage of data (cf. Bowden 1985; Barry 2008; Hemmingsen 2010). Considerations of economic viability are rarely taken into account, except for a few deposits that are already under exploitation. Even to provide reliable information about the ‘geologic availability’ of world resources would require a lot more exploration drilling and analytical work to be done. But even then, and in this regard similarly to conventional oil, such knowledge will always remain partial, locally

⁴¹ All USGS reports on oil shale resource estimates are made publicly available at http://energy.cr.usgs.gov/other/oil_shale/pubs_data.html (accessed 16 February 2011).

situated, difficult to consolidate at the global level and therefore prone to disputation (cf. Bowker 1994; Mitchell 2011).

Taken together, in both geological and economic terms, the unconventional field lacks standardized information on past and present states of affairs that would give indications about the size of recoverable resources and the feasibility of future extraction. In Dyni's words, "the data are too sparse to differentiate between resources and reserves of oil shale" (2006: 33). Consequently, oil shales cannot (yet) be included within the same framework of 'resource' and 'reserves' that has been developed for liquid hydrocarbons, despite the fact that both conventional and unconventional sources may be evaluated by the same discipline or institution, such as the US Geological Survey.

Nonetheless, private oil shale companies that are, or intend to become, publicly listed for stock exchange need to provide their investors and shareholders with detailed information about the *reserves* they hold. Some companies have therefore reported their oil shale assets by using the codes developed for *mineral* resource classification, such as the Australian Joint Ore Reserves Committee (JORC) or the Canadian National Instrument NI 43-101. The latter code is also used for tar sands, which has already established a precedent of "a marriage between mining and conventional oil" (Schmidt 2011: 1). This means that commercial developers need to calculate their reserves in ambiguous terms as both mineral stocks and potential barrels of crude oil. As one company manager noted: "when we mine, it's a rock, when we sell, it's a liquid fuel".⁴²

⁴² Interview, 15 March 2011.

4.3 Solid materials, liquid potentials

In the history of misnomers, “oil shale” must rate as one of the greatest, since it isn’t shale and contains no oil (Nield 2007).

It is the thing itself that has been allowed to be deployed as multiple and thus allowed to be grasped through different viewpoints, before being possibly unified in some later stage depending on the abilities of the collective to unify them (Latour 2005b: 116).

The difficulties of distinguishing between unconventional resources and reserves are aggravated by the problem that there is no agreement amongst geologists regarding which subsoil formations should be included within the group of ‘oil shales’ and which should not, and further, what methodological approaches and criteria should be used for calculating the quantities of such a resource. The term ‘oil shale’ does not have a good geological definition, nor does its component of organic matter correspond to any specific chemical formula (Hutton 1987; Altun et al. 2006: 213). Moreover, the definition of ‘resources’ hinges on the future commercial potentialities that are being ascribed to particular discoveries, which vary greatly across different locations. This especially concerns the question of whether resource calculations should account for potential stocks of liquid fuel (shale oil) or for their depositional realities as solid rocky materials (oil shale). In either way, the resource denotes “a coexistence of multiple entities that go by the same name” (Mol 2003: 151). The following discusses the material heterogeneity and potential multiplicity of oil shale by focusing on the global assembling of the resource in relation to, first, its geophysical and spatial variation, and second, ambiguous forms of existence as both a solid and a liquid resource. The resulting discrepancies in evaluation methodologies are explained as different ways in which oil shales become ‘informed materials’ (Barry 2005b).

There are several classification systems for world oil shales that have been proposed on the basis of different criteria, such as their geological origin or hydrocarbon composition, but none has been internationally adopted. More recently,

however, Hutton's (1987) 'petrographic system' has been followed in the pursuit of calculating world resources (see Dyni 2004, 2006). The petrographic system is a combined approach based on depositional history, which focuses on the microscopic details of rocks by grouping oil shales according to their origins in terrestrial, lacustrine (lake) or marine organisms, and then sub-dividing them by determining the type and abundance of oil-yielding organic matter. With this approach, Hutton aimed to rationalize earlier approaches to oil shale classification by identifying the organisms that are the origin of organic matter with the help of modern techniques, particularly fluorescence-mode microscopy. At the same time, as discussed later, his system is equally conditioned by the identities and terminology already in use for particular oil shale occurrences and the evidence of their previous industrial use.

Some authors, who have aimed to bring all these diverse geological histories and characteristics under a common global name, have followed Hutton's directions, and defined 'oil shale' broadly as a fine-grained sedimentary rock containing organic matter, which yields significant amount of crude oil and gas when heated to high temperatures (Dyni 2004; Altun et al. 2006; Dyni 2006). As this vocabulary reveals, the global resource comes into being in relation to its potential utilization and not solely to its geological existence; it is primarily an energy commodity. This definition has become further instituted by the World Energy Council (WEC 2007) and Germany's Federal Institute for Geosciences and Natural Resources (BGR 2009) in their surveys of world energy resources. Indeed, as Dyni himself noted during the 2011 Oil Shale Symposium in Colorado, 'oil shale' is an "economic" term, not a strictly geological classification,⁴³ even though there is very little economics involved to date.

⁴³ Field notes, 18 October 2011.

Such definitions notwithstanding, oil shales represent a wide variety of rocks with different compositions of organic and inorganic materials. According to geochemical studies (e.g. Hutton 1987; Hutton et al. 1994; Dyni 2004; Altun et al. 2006), the common denominator for 'oil shale' is the abundance of organic matter, which is predominantly composed of *kerogen*. Kerogen is a naturally occurring insoluble mixture of organic chemical compounds that can be converted to hydrocarbons under thermal heating and is therefore considered something like an 'immature form of petroleum' (Knaus et al. 2010; Speight 2012). The term 'kerogen' was coined as early as 1912 specifically for oil shales, but has since been extended to all sedimentary rocks, including coal (Hutton et al. 1994). Although kerogen originates from different source materials, it can be found in all 'oil shales' and thus helps distinguish between organic-rich rocks and bituminous sediments (i.e. heavy oil and tar sands). However, the extent of organic content and consequent oil yield varies significantly between different deposits. Also, the composition of kerogen varies extensively, while "natural kerogen which behaves macroscopically and chemically as a single entity, is revealed under the microscope as grossly heterogeneous" (Yen and Chilingar 1976: 28). Certain oil shales may contain additional types of soluble organic matter such as bitumen. Likewise, their inorganic composition represents different types of minerals ranging from carbonates to silicates, as well as other chemical substances, depending on depositional conditions. This means that many oil shales are not even true shales according to the terms of lithology, that is a specific type of mudstones composed largely of clay minerals, but occur in a wide range of host rocks (Yen and Chilingar 1976: 13; Altun et al. 2006: 213; Boak et al. 2011).

The geochemical and geophysical heterogeneity of oil shales, combined with disparate histories of exploitation, not only confuses the terminology and nomenclature for defining the global "resource", but implies different methodological

approaches with which the evaluation and grading of this resource is being conducted in different countries. Such material variations subsequently become crucially important factors of quality and cost when particular deposits are subjected to technological experiments and utilization. To give just one example, the development of Jordanian oil shale entails desulphurization, leading to extra costs. An additional factor is that many oil shale deposits are actually mingled with other sedimentary rocks and ore minerals, some of which may also have economic value, such as uranium. In China, for example, exploitation of the Fushun resource is currently economic because the shale is an inevitable by-product of coal mining (Qian et al. 2003; Schmidt 2012).

Furthermore, the presence of oil-potent sediments across a broad range of host rocks and the use of various evaluation techniques indicates that 'oil shale' has come to be understood ambiguously as both a solid and a liquid material. One would assume that particular deposits 'in place' still exist in the form of static mineral stocks, rather than inherently fluid materials like petroleum, no matter how they are going to be measured or used. Yet this perception of resource materiality is far from straightforward since the nature of 'oil shale' is being 'redefined' from the outset, especially when the technoscientific manipulation required for resource appraisal or extraction takes place underground (Mitchell 2011). Indeed, despite oil shales' apparently natural form of existence as solid rocks, the alternative perception of their potential liquidity has become more prevalent in the pursuit of 'unconventional oil' and provides the basis on which resource calculations are made. Moreover, if one erases the present and accounts for either the formational history of the resource or its possible technological futures, then "solidity may itself be the product of a certain form of fluidity" (Barry 2010: 93), rather than the other way around. Oil shale thus

moves between being a solid fossil fuel similar to *coal* and manifesting an alternative potency of viscosity and fluidity characteristic of crude *oil*.

Having assumed a double identity of solidity and fluidity, world oil shale resources are not just composed of very diverse organic and inorganic materials but represent two distinct states of *materiality* (cf. Anderson and Wylie 2009) or, more precisely, have been ascribed contending modes of material transformation. In a way, this material ambiguity corresponds to the difference between ‘shale to power’ and ‘shale to liquids’ routes of development made elsewhere in this thesis.⁴⁴ The ‘shale to power’ discourse normally counts oil shales as mineral stocks, whereas ‘shale to liquids’ accounts for their potential fluidity. Here, I want to emphasize that one consequence of such diverging perceptions of resource materiality is that there are remarkable inconsistencies between the methodological criteria and analytical units used for the grading of resource stocks. With regard to oil shale’s potential supply of liquid fuel, the question is what counts as a “significant amount of crude oil and gas”, as implied by the definition given above. Grades based on oil yield have not been standardized, but reflect the vast differences in the abundance of organic matter that occur between world resources. In order to delimit ‘resources’ and ‘reserves’ national institutions have appealed to very different qualifications by determining the lower limit (i.e. threshold) for oil yield, which range from 25 to 200 litres per tonne of rock (Dyni 2004: 740, 2006). However, Estonia, the leading oil shale producer, has not based calculations on oil yield at all, but on the quantities of solid fuel that is expected to supply domestic power production (‘shale to power’). As a result of diverging material perceptions and industrial legacies, Estonia and some other countries have indicated their resources simply in total tonnage and/or heating energy,

⁴⁴ In this regard, oil shale can be assumed to bear similarities with the ‘coal to liquids’ discourse.

notwithstanding the potential oil yield. These values are being reported in an even larger variety of units. Once again, this methodological diversity makes it very difficult for international analysts to frame oil shales in their calculations and provide worldwide estimates, especially for *shale oil* resources. Moreover, as the Estonian case study reveals in the next chapter, changes in such perceptions may lead to the “resource” itself being re-defined.⁴⁵

Here, the problem of abstraction and systematization does not lie solely in the nationally distinct methodological practices and industrial histories, but in a remarkable degree of incommensurability between oil shale’s two modes of material existence as fuel. In effect, oil shale’s heating value cannot be directly converted into oil yield, nor is the reverse conversion possible. These values are determined by different laboratory techniques and equipment. There is inevitably some correlation between them, as the higher the overall content of organic matter, the more oil and heat energy can be attained. However, a specific formula is not available for this conversion, but needs to be determined through linear regression analysis for every given oil shale discovery (for example, see Kattai 2003: 20).

Oil yield from oil shale has traditionally been calculated by a technique called the Fischer assay. This method represents a laboratory procedure invented for measuring the produced amounts of oil, gas, water and residues, when a 100g sample of crushed material is heated in a small aluminium retort to 500°C under a standard set of conditions (Heistand 1976; Dyni 2004, 2006). The shale oil product gained by industrial retorting techniques is usually rated against the idealized results of the Fischer assay, making the laboratory test an internationally applied scale of measurement (see also Kattai 2003: 18-19). The Fischer assay thus provides a modern

⁴⁵ On the active properties of such solid realities to resist their transformation to liquidity, see Chapter 8.

‘trial of strength’ in which the material heterogeneity of world discoveries is overcome by being subjugated under a standardized process of assessment (cf. Schaffer 2005). The laboratory machinery is thus indispensable for consolidating a global, *singular* resource or, in essence, a shale oil resource.

However, according to Dyni (2004, 2006), the Fischer assay has several drawbacks despite being widely employed in determining the grade of many shales, especially in the U.S. Notably, the method does not account for the total hydrocarbon content, that is the total energy available in the resource, which has to be assessed by other laboratory models of testing, notably the bomb calorimeter (Koitmets et al. 2003; Francu et al. 2007). In oil processing plants the energy that cannot be distilled into oil becomes stored in the by-products of pyrolysis such as retort gas or residue char. In fact, these by-products can be recycled in the production process as they supply thermal energy to the retorts or power generation. Also, Dyni argues that Fischer assay does not necessarily even indicate the maximum amount of oil that can be produced from a particular oil shale. In fact, certain new technologies of retorting can produce several times more oil from some types of shales than laboratory conditions would indicate (Dyni 2004: 740, 742, 2006). There is thus a significant gap between the laboratory space of measurement and the actual field of application, which necessitates ‘translations’ between testing results and real world circumstances (Callon and Latour 1981; Latour 1987, 1999; Callon et al. 2009). Such translations are further complicated by the dramatic variability in the composition and quality of sediments across different deposits and, even more problematically, within the same deposit (Kattai et al. 2000; Terres et al. 2011; Vanden Berg 2011). There are now a number of other techniques that provide an alternative to the traditional Fischer assay, such as the Rock Eval method that makes it possible to assess both oil and gas content in the rock, and the well logging technique that is being transferred by

Schlumberger from conventional oil to oil shale deposits (Boak 2012). The problem of translation, however, remains the same no matter how much the assay is improved or replaced, since new techniques need to be assessed not only against real-life circumstances but also against the results of competing evaluation methods.

By contrast, heating value relates to the practice of burning the mineral material directly as a solid fuel in thermal power plants. Measured using a calorimeter, heating or calorific value does not provide any information about the potential yield of shale oil and gas which is gained by coking the stuff in an oxygen-free environment (Dyni 2006: 2). Thus, the two measurement systems based on oil shale's contending states of materiality and pathways to utilization appear to be largely incommensurable. In order to find an approximate relationship between the two values, a large number of laboratory experiments have to be carried out on a given oil shale. For example, for Estonian shale, the specific parameters (or regression coefficients) needed for the conversion have been found after 600 analyses (Kattai 2003: 87), but even these tests need to be updated, since they no longer reflect the changing characteristics of the deposits currently under exploitation (Soone 2005).

The various systems of measurement exercised across world oil shale industries correspond to a series of distinct 'metrological zones'. Following Barry (2006: 240), a metrological zone is characterized by common measurement standards and practices, which should make geoscientific information comparable between different locations and deposits. When geoscientists attempt to consolidate the global "resource", they need to know the specific formulae characterizing the relationship between these metrological regimes for every oil shale discovery, which are not always available. Furthermore, according to Dyni, an additional range of problems derives from the wide variety of units in use that derive from more general practices

specific to national systems of measurement. For example, if the size of an oil shale resource is known only in volumetric units (e.g. barrels, gallons, litres, cubic metres of shale oil), then in order to convert them to gravimetric units (i.e. tonnes), the specific gravity or density of shale oil must be known. The density is assessed again with the Fischer assay, and is not always known for specific shales (Dyni 2004: 749, 2006: 6).

To summarize, the degree of incommensurability between distinct metrological regimes of resource assessment derives from the ambiguous perceptions of resource materiality, associated with nationally specific traditions of measurement and intended use of such resources. Thus, the USGS evaluates oil shale resources with the help of the Fischer assay, accounting for the total potential of trillions of barrels of in-place *shale oil* locked in the Rocky Mountains – allegedly the world’s biggest resources (e.g. Birdwell 2011). New methods may provide different results, but their approach to oil shale as a liquid hydrocarbon remains the same. In contrast, the grades of many other countries reflect the geological assurance of total quantities of *oil shales* with respect to their mineral form of existence. Such perceptions of solidity may indicate other purposes of oil shale extraction, i.e. the feedstock supplied to power plants or cement production.

One way to make sense of discrepancies between the present material characteristics of oil shale discoveries and geoscientific exercises of calculating the potential future “resource” is to conceptualize resource materiality differently. Following the notion of ‘informed materials’ introduced by Bensaude-Vincent and Stengers, materials such as fossil fuels need to be regarded not as discrete objects but as heterogeneous and dynamic accumulations where “the material structure becomes richer and richer in information” through the practices of geoscientific invention (1996: 206, cited in Barry 2005b: 53). This idea of ‘informational enrichment’

indicates that material entities do not exist in isolation from their material and informational environments, but rather that the “environment of informational and material entities *enters into* the constitution of an entity” (Barry 2005b: 59, emphasis in original). Moreover, the object of manipulation tends to vary between practices of mechanized interventions and geoscientific appraisals. As a result, resource materials may also acquire *multiple forms of existence*, which “depend on the particular informational-material practices of experiment and field research” (Law and Mol 1995; Mol 2003; Barry 2010: 95).

Seen from this perspective, subsoil resources are not inert physical things stored in the ground that can be accessed in some “original” state independently of geoscientific interventions, akin to Kantian ‘things-in-themselves’ against which our knowledge claims can be tested. When oil shales are abstracted and assembled as a resource, they come to comprise a range of diverse ‘informed materials’ across resource-holding countries, which vary according to the extent of geological studies and local measurement practices. Although the juxtaposition of the informational and the material in this concept may suggest that matter exists in a pure state before it becomes enriched with information, Barry’s expansion of the concept in fact advances a non-dualistic, relational understanding of materiality associated with the STS/ANT approach. Elsewhere, he says that the “identity and properties of such a material are not given by its intrinsic properties, for these properties depend on the relations with other entities, including information” (Barry 2006: 242). On a different note to actor-network theory, Anderson and Wylie make a similar point that materiality emerges from “the assembling of multiple, differential, relations”, so that the properties and capacities of materialities “become effects of that assembling” (2009: 320). As explained in Chapter 3, this does not mean that there exists any singular reality before assembling the resource, which is addressed through different perspectives and only

subsequently 'deployed as multiple', as the above quote from Latour seems to indicate. Rather, as Mol (2003) would argue and Latour (2005b) would probably concur, materials *come into being* together with practices of scientific and technical manipulation and, consequently, may be multiple from the outset of their existence.⁴⁶ The concept of 'informed material' thus makes it possible to explain that resource materialities are not just heterogeneous and potentially dynamic over time, but exhibit multiple forms of existence *in the present* or, to use Mol's term, the 'multiplicity of reality' that results from various geoscientific, technological and economic-political interventions involved in resource-making (see also Law and Mol 1995).

Any differences in resource assessments therefore reflect the multiple ways in which such materials are always already informationally enriched in scientific discourses, as well as different stages in the inventive processes of assembling a singular resource. Moreover, resource realities can multiply not just due to contending modes of materiality, but also in terms of the degree of informational enrichment that brings resources into existence. For example, oil shales allocated for ex-situ and in-situ development can be understood as differently informed materials in respect of distinct appraisal and exploitation techniques. When oil shale becomes informed in liquid terms, the global "resource" is also different to the probabilistic calculations of conventional hydrocarbons. On the one hand, one could think of oil shales as "*more material*" compared to conventional reserves, because such resource formations tend to account for the entire physical stock of "*in-place-oil*", notwithstanding any considerations of techno-economic feasibility or the desirability of future extraction. On the other hand, unlike petroleum, shale oil is not actually found in the ground, and

⁴⁶ For a discussion of the differences between Latour and Mol, see Law (2004). Latour has later incorporated this critique and now advocates 'multiplicity of reality'. He affirms that realities go in plural and invites to study the procedures that ground their stability and unity (2005b: 119-120).

hence measured directly without additional manipulation, such that the resource still needs to be abstracted and converted to liquid through a series of ‘trials of strength’. In this sense, oil shale resources appear to be simultaneously “*more informed*”.

When measurements of solid stocks of *oil shale* are transformed into estimates of potential liquid resources of *shale oil* through the Fischer assay, oil shale materiality becomes progressively more informationally enriched. Similar processes take place when samples of shale are tested with other devices such as the calorimeter in order to find out other forms of energy content, resulting in a distinct, incompatible form of materiality. As discussed in the next chapter, this process of informational enrichment can be extended further, when either technique comes to account for ‘above-ground’ circumstances in addition to assembling the ‘below-ground’ realities; that is when resources become *reserves*. In both informational and material senses then, such ‘unconventional’ resources are comprised of very different informed materials not only in comparison with conventional oil, but also across world oil shale discoveries and industries. Here, the *geography* of oil shales becomes critically important, since the heterogeneous materialities and localities of oil shale condition the outlooks of the emerging industry.

4.4 Material heterogeneity versus stabilization

What the above demonstrates is that for oil shale to become a global energy resource – and furthermore, an oil resource – materially and spatially diverse rocks have to be unified and translated into liquid resources. The assembling of a singular resource, as expressed in its name, definition, classification systems, and resource calculations are essential for the industry’s worldwide establishment. Yet the material diversity and ambiguous materiality of oil shale cannot simply be stabilized with a single name, but

the co-existence of multiple realities re-emerges as a critical constraint on exploitation, technical standardization and, as explained later, the building of markets.

Following a Deleuzian school of thought, the unified entity of ‘oil shale’ can be thought to stand for an ‘agencement’ or a ‘global assemblage’ (cf. Deleuze and Guattari 1988: 280). As Ong and Collier suggest, this term involves inherent tensions, as “global implies broadly encompassing, seamless, and mobile; [while] assemblage implies heterogeneous, contingent, unstable, partial, and situated” (2005: 12). It is this material heterogeneity, geographical and historical contingency, and local situatedness of the resource that defines its future viability to ‘become conventional’, and which is yet to be overcome by scientific abstraction and technological innovation. Before returning to these questions in Chapter 8 in relation to the development of standard exploitation techniques, the following paragraphs briefly outline the industry’s everyday struggles as it faces material heterogeneity in three respects: first, its paradoxical approach to the possible scarcity of fossil fuels as opposed to their abundance, second, the inapplicability of the imperative of ‘abundance’ to prospective deposits, and, third, difficulties of transferring locally developed technological know-how to other deposits.

A central concern for the industry is the qualification of oil shales overall as an *oil resource*, rather than finding an accurate way of calculating global resources amidst unreliable and incompatible measurements. Given the variety of evaluation techniques and the resulting multiplicity of the resource, the question of what quantity of such “resources” could be eventually recovered as *reserves* cannot be answered on the basis of currently available knowledge. Even estimates of geologically defined resources are highly speculative, since many leading reports emphasize that quantities of oil shale, and especially *shale oil* are difficult to evaluate because of inconsistent data and

methodologies (Duncan and Swanson 1965; Brendow 2003; Dyni 2004, 2006; Knaus et al. 2010). Nevertheless, these reports still claim that such estimates are rather conservative, because information is available only on larger and/or well-known deposits. Following the analogue of conventional discoveries, oil shale resources are expected to increase when there is enough interest and money to explore more thoroughly the deposits that are currently less known.

In effect, the industry exhibits a paradoxical relationship with the proposition of resource scarcity. As a singular ‘unconventional’ resource, oil shale is enacted in relation to the ultimate physical finitude of conventional crude reserves. Its proponents do not just subscribe to the idea that conventional oil is increasingly scarce, but make the ‘peak oil’ thesis of special rhetorical importance for their efforts to promote the industry, as indicated in innumerable corporate publications and presentations. By contrast, oil shales themselves are claimed to be geographically ubiquitous and available in abundant quantities, regardless of the fact that the geological and economic recoverability of such a substitute resource is yet to be determined. The long-term availability of resources does not seem to concern the industry, because many places across the globe are expected to have plentiful “untapped” deposits of organic-rich rocks. At a time when the world is once again expected to run out of oil, oil shale continues to ‘stagger the imagination’ and ‘defy mathematical computation’ (Alderson 1919: 3).

Whilst the abundance of oil shale resources seems to be widely accepted, the huge diversity of geological occurrences and inconsistent information about recoverable quantities has become nonetheless a crucial impediment for commercial development projects ‘in the field’. Not only are the few published global estimates vulnerable to criticism, but the absence of an ‘industrial classification’ presents a

major obstacle for any company looking for new destinations and for the geologists working in their service (Oja 2007; Puura et al. 2010). Due to the lack of reliable and up-to-date studies, developers usually need to arrange extensive geological prospecting on their own – not to mention the studies of possible methods and costs of extraction, technological development, market analyses, environmental and social impact assessments, and so on. Geologists may, after covering the area with more frequent boreholes, sometimes discover new large-scale deposits. This was claimed to be the case in Jordan after Shell launched an extensive exploration programme (Terres et al. 2011), as well as in China (Li et al. 2011), although here again the heterogeneity of the resource casts doubt on such claims, with the Chinese being accused of including coal and other non-shale sediments in their calculations.⁴⁷ At the same time, the majority of in-place resources reported by the host country can also simply “vanish” in this process, if the deposit turns out to be poorly explored or unsuitable for extraction. In such highly uncertain conditions, geoscientific endeavours to produce a comprehensive scientific nomenclature and calculations can be hindered by the emerging industry itself, because companies may prefer not to share detailed findings with other potential developers.⁴⁸

In this way, the materiality of oil shales *matters* not only in the geoscientific stabilization of the resource, but also in its actual exploitation and production. In effect, resource materiality and locality matter to the extent that they jeopardize the invention of standard technological solutions required for a commercial-scale industry. As documented in the penultimate chapter, existing retorting solutions for shale oil extraction have been developed around a particular deposit, in correspondence with the specific qualities and composition of a given ore, while the

⁴⁷ Field notes, 19 October 2011.

⁴⁸ Field notes, 18 and 20 October 2010.

‘in-situ’ techniques that are invented in the USA for underground conversion are only going to be tested on other oil shales. The key hurdle for the industry is to “match” the technology with the shale deposit, according to the managers of the failed Stuart project in Australia (Henderson 2011; Schmidt 2011, 2012), who stress that the “transfer of a technology to another deposit will require a substantial amount of innovation” (Schmidt 2011: 2). Or, in the words of one of my Jordanian informants, “the technology needs to be built around the shale”.⁴⁹

Altogether, the material ambiguity and heterogeneity of the resource, combined with the localized characteristics of the machinery invented for exploitation and its socioeconomic legacies become critical issues for the industry’s worldwide expansion. Since the quality and composition attributed to diverse resource materials that “go by the same name” (Mol 2003: 151) varies widely even within the same deposit, their stabilization in scientific, economic and political calculations is highly complicated. The *place* of oil shale thus comes to stand in an awkward relationship to the globalized assemblage of the singular resource.

4.5 The eventful place of Estonian oil shale

Before turning to the stabilization of resource materiality in economic and political calculations in the next chapters, it is necessary to introduce briefly the Estonian oil shale against the backdrop of the globalized resource assemblage. Throughout this thesis, the relational materiality of the resource is recognized to have a central role in the construction of the EU state as a “unique” case of a successful industry, when selectively associated with its technological inventions and peculiar political economy (see Holmberg 2008), or what will be later termed the Estonian ‘techno-economic

⁴⁹ Field notes, 15 March 2011.

network' (Callon 1991). Borrowing from the vocabulary of Doreen Massey (2005), the national industry can be described as a central 'event of place', which simultaneously makes possible and complicates the worldwide exploitation of the resource.

Estonia comes to stand for an eventful place both because of the specific qualities of its resource *and* the long-lived national 'industrial science' in exploitation (cf. Bowker 1994). For Massey, the 'event of place' denotes an unprecedented and temporary "constellation of processes", rather than a fixed, physical setting. This constellation is inherently political, for the place requires an ongoing negotiation of its history and geography, as well as a "negotiation which must take place between both human and non-human". Further, the uniqueness of the 'event of place' also implies that the place is internally multiple and open to the future (Massey 2005: 138-142). As is the case with oil shale in general, the nature and position of the Estonian resource is not given, but carefully assembled in relation to attempts to establish oil shale as 'unconventional'. Moreover, as investigated in later chapters, the politics of the future of this particular place needs to continuously negotiated in response to the industry's attempts to 'become conventional'.

From a geologist's point of view, the Estonian oil shale deposit is very well known, having more than 10,000 exploratory drill holes (Kattai et al. 2000; Dyni 2006: 17, 33; Speight 2012). Since the deposit was first tested for oil production more than a century ago, its core part has undergone extensive measurements and experiments, making it one of the best studied oil shales in the world. Furthermore, Estonian geologists have accumulated substantial information on other oil shale regions within the borders of the former Soviet Union and beyond (see Aarna 1989; Kattai 2003; Oja 2007), which gives the field further credibility and echoes wider national claims to "unique knowledge" on the subject (e.g. Liive 2007). For both local and global

proponents of the industry, Estonian geo-science thus represents an extensive scholarship on the resource which, despite being methodologically somewhat outdated, may still give valuable insights for studies in other locations. Or, if not directly scientific insights, then the mere existence of this unique place of oil shale development lends significant credibility for the globally emerging industry, as illustrated by the word “reference” that is sometimes ascribed to the Estonian case amongst other developers.⁵⁰ Estonia thus serves as a vital reference point to prove that the industry can exist and does exist in quite conventional terms.

The Estonian resource is not only one of the best known oil shales, but also one of the richest by its organic matter content. Although Estonia’s reserves amount to a minor percentage of estimated world “resources”, it is thought to be among those of the highest quality both in terms of oil yield and heating value; a fact that is often used to explain the long history of utilization, risking a kind of resource determinism (Fraiman and Kuzmiv 1995; Kattai et al. 2000; Veiderma 2003; Altun et al. 2006; Francu et al. 2007; Puura et al. 2010). Yet the Estonian oil shale is far from a homogeneous and settled entity. Notably, during the long history of exploitation, which exemplifies Massey’s theorization of the ongoing negotiation of the ‘place’, only some of the local resource materials have acquired a special standing in both national and international accounts, while some have not.

Not all fine-grained sedimentary rocks that contain organic matter are commonly acknowledged as ‘oil shale’ in Estonia, and subsequently counted as ‘resources’. In local geoscientific literature (e.g. Raukas and Teedumäe 1997; Kattai et al. 2000; Kattai 2003; Väli et al. 2008), the organic-rich minerals⁵¹ discovered in Estonia are classified into two main types of ‘combustible rock’, called *kukersite* and

⁵⁰ Field notes in Colorado 19 October 2010, Jordan 8 May 2012.

⁵¹ Estonian geologists call them ‘sapropelites’.

graptolite argillite.⁵² Both discoveries are located in what is called the Baltic Oil Shale Basin. Kukersite, the first type of oil-potent rock, stands for a high-grade combustible fuel of major national importance, which has been extensively exploited for nearly a hundred years. Kukersite discoveries are further divided between two distinct areas within the Baltic basin, the ‘Estonia’ and ‘Tapa’ deposits (Figure 5). By contrast, graptolite argillite, which is more commonly known as Dictyonema shale or “black shale”, represents a total volume that is about ten times larger than kukersite discoveries. In fact, the layers of these two shales are partly overlapping, but they are of different geological age. Due to its older origin and minor organic matter content, the black-coloured argillite is characterized by significantly lower heating value and oil yield. As a result, it has not been given any significance as an oil shale resource in Estonia (Lippmaa et al. 2009).

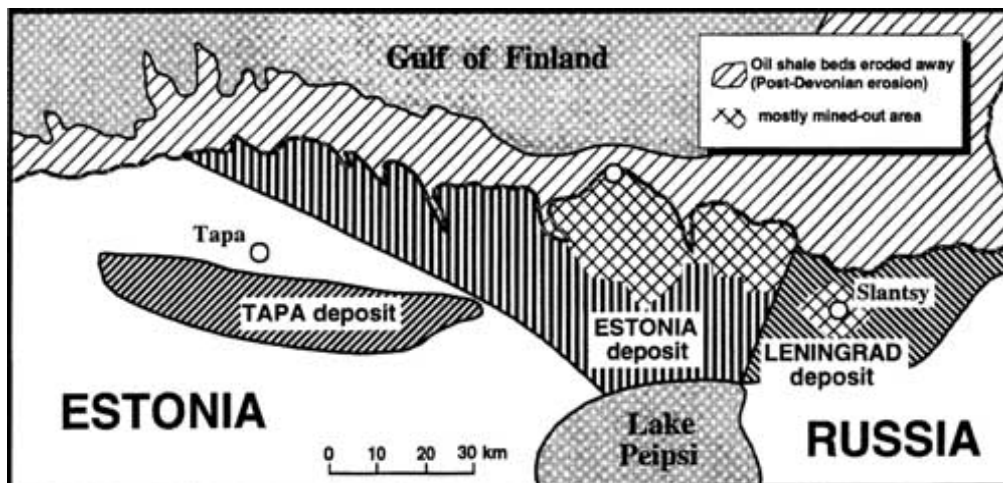


Figure 5 Kukersite deposits in the Baltic Oil Shale Basin.

Note: Permission to use this map has been granted by the author Heikki Bauert.

Owing to its better quality and accessibility for mining, only kukersite has been unambiguously identified as a specific oil shale resource. Here, the long history of exploration and exploitation of this group of earth materials lends it significant

⁵² In Estonian geological literature, both have been sometimes referred to as “põlevkivi”, meaning literally “combustible stone”, although the term is usually reserved for kukersite. A third type of local sapropelites is not combustible, and has not received any attention (Kattai et al. 2000: 10).

credibility, which cannot be overlooked by exercises of scientific abstraction and systematization. Although there is no single classification system approved for world oil shales, kukersite as the main Estonian resource has been long given an independent status in international reports due to its reputation for industrial utilization (e.g. Duncan and Swanson 1965), whilst the “black shale” is usually not mentioned at all. For example, in Hutton’s (1987) classification system, kukersite becomes known as a specific type of ‘marine oil shale’ by its Estonian name, despite sharing ‘genetic and petrographic characteristics’ with other oil shales from different locations. According to Hutton:

The terms for different types of oil shale [in this classification] have been derived from one or more distinctive features in the organic matter in the oil shale with the exception of torbanite, tasmanite and kukersite, which are used consistently and without ambiguity. Although the terms do not have genetic connotations they are well entrenched in the literature, are widely used terms at present and each is restricted to a specific oil shale type. The terms are useful in a petrographic classification and *replacement of these terms is therefore not only unnecessary but would be extremely difficult, if not impossible*. [...] The inclusion of kukersite in the primary group of marine oil shales and the inclusion of torbanite in freshwater oil shales illustrates that *classifications separate rocks which may have characteristics in common*. (Hutton 1987: 224-225, my emphasis)

Moreover, it is not just any kukersite oil shale, but *only* the kukersite from the ‘Estonia’ deposit that has gained the status of a resource. The other deposit near Tapa has lost its previous standing in the state’s official resource accounts, being no longer counted towards the Estonian resource base. The reasons for this relegation are related both to its material qualities and to socio-economic considerations, which have changed over time. Although the ‘Tapa’ deposit is significantly less explored than the ‘Estonia’ deposit, it has long assumed a distinct identity in the archives of the Geological Survey of Estonia. Nevertheless, in the official register of resources administered by the Estonian Land Bureau, the accumulation was downgraded twice and eventually removed from the register altogether in 1995 due to its lower quality and ‘complicated social and ecological conditions’ (Kattai et al. 2000: 124-128, 189).

Since then, the deposit has been relegated to a mere “occurrence” which may or may not become commercially exploitable in some distant future (Adamson et al. 2006). In fact, the shale found there is located not only very deep in the ground, but next to a densely populated settlement, the town of Tapa, which renders any future mining operations unrealistic because of disruption to water supplies and underground impacts on the built landscape. Likewise, graptolite argillite is excluded from the state register of resources. The ‘black shale’ had previously been valued as a source of rare metals, after a significant amount was extracted for uranium mining in the Soviet period. Recently, the deposit has again raised interests among academics and investors as a potential source of metal ores, but not as a fossil fuel resource (Lippmaa et al. 2009).

So, both nationally and internationally, only kukersite from the ‘Estonia’ deposit has gained exclusive standing as “the Estonian oil shale” due to its depositional characteristics *and* the evidence of industrial production. Such legacies cannot be ignored by international exercises in assembling the resource regardless of their abstraction criteria. Quite the contrary, kukersite has acquired a place among the most distinct and exemplary oil shales, while the black shale is simply dismissed. A curious exception, however, is offered by recent calculations of world total resources. For some reason, both Russell (1990) and Dyni (2006) have decided to include also the black-coloured argillite, drawing on rough estimates proposed by Estonian geologists (Kattai and Lokk 1998). The huge tonnage of black shale is counted towards resources despite the fact that its oil yield is measured to range only between 0–2.5% (Lippmaa et al. 2009), or at best, 2–6% as proposed by Kattai (2000: 10, 180). The inclusion of argillite hardly seems justified even if the threshold for oil yield is taken to be the lowest at 2.5% (see Brendow 2003). When delivered to wider public notice, this has resulted in the ascription of an abnormally large indigenous *oil* resource volume to

Estonia, despite the fact that the other shale has never provided any oil, and has not been seriously considered for any use at all.⁵³ This illustrates further the point that such estimates serve primarily as a rhetorical tool for the enactment of oil shales as a global resource, without providing much information on their actual usefulness.

4.6 The relational materiality of resources

This chapter started with the contention that natural resources should not be understood as fixed, pre-given categories that represent solely physical reality (Bridge 2009b). The status of oil shale as an ‘unconventional’ resource cannot be taken for granted, but is actively generated through specific geoscientific, economic and political interventions, which are partly, but by not means exclusively, facilitated by the changing materiality of other resources, most notably the possibility of conventional crude decline. In order to become a single resource, world oil shales need to be assembled together through careful exercises of resource classification and assessment. However, there is a remarkable mismatch between the estimated quantities of conventional and unconventional resources with respect to their accounts of future recoverability, since the latter refer to an unlimited, albeit presently estimated potentiality of supply, being thus impossible to integrate into the delimitations of future ‘reserves’ developed for liquid hydrocarbons. Any calculations of world oil shale resources are therefore highly speculative, being challenged by the diversity of discoveries and inconsistent assessment methodologies.

Nevertheless, the unreliability of such ultimate “resources” has little undermined the agenda of the emerging industry, which in the first place needs to

⁵³ Dyni’s report, in particular, has been resonated in a Wikipedia article on world “oil shale reserves”. Somehow, the editors of Wikipedia have mistakenly picked up *only* the figure for argillite, resulting in enormous oil resources. See http://en.wikipedia.org/wiki/Oil_shale_reserves (accessed 31 January 2011).

render oil shale visible as an alternative, promising source of oil. The constitution of oil shale as ‘unconventional’ thus centres around a political rhetoric, in which material heterogeneity becomes concealed and subsumed under a singular “resource of the future” that is claimed to offer the capacity to supply abundant energy to post-peak worlds for centuries to come. Under this agenda, the materiality of the resource is stabilized in liquid forms, with the solid deposits of *oil shale* being translated into the potential yield of liquid fuel locked in these rocks and measured in tonnes of *shale oil* or barrels of ‘oil equivalent’. Translated into such promises of liquid supplies, the provisional estimates of “resources” serve as a powerful tool for gaining public credibility and attracting investors, especially when compared against the apparently lower figures of conventional crude reserves.

Solidity and fluidity can be said to represent two distinct modes of oil shale’s materiality, if we assume the ‘multiplicity’ of material reality and its ability to “take place” with the properties and capacities of any element or state, including solid, liquid and gaseous (Law and Mol 1995; Mol 2003; Anderson and Wylie 2009). As the review of technical literature revealed, however, such a material transformation from solid realities to liquid resources is far from straightforward. The conversion between the two modes is compromised by the changing composition and quality of the resource across different deposits, as well as by ambiguous perceptions of materiality and the resulting variety of metrological practices employed by resource-holding countries. In particular, the discrepancy between measurements of heat value and oil yield, which correspond to ‘shale-to-power’ and ‘shale-to-liquids’ discourses, represents the co-existence of different ‘metrological regimes’ (Barry 2006) that need to be reconciled for every single oil shale discovery in order to calculate the global resource.

It was suggested that the diverging, even incommensurable, practices of resource appraisal should be understood as different ways in which resource materials become saturated with information, or ‘informed materials’ (Bensaude-Vincent et al. 1996; Barry 2005b), for the oil shale resource is enacted through independent laboratory evaluations and calculations. The concept of ‘informed material’ has the disadvantage that it may seem to suggest that resource materiality is accessible in some original, physical sense, which only subsequently becomes subjected to a range of informed measurements, technical expertise and political judgments, as though “matter simply exists as an undifferentiated yet dumb externality before its mechanical and institutional *formation*” (Kearnes 2003: 148). One aim of this thesis, however, is to substantiate a non-dualistic, relational account of resource materiality. If we take the non-human world and human calculation to be *outcomes* of the process of informational enrichment, rather than pre-given binary categories (Mitchell 2002), then oil shales come into being as informed materials in both solid and liquid forms *in parallel*. Since translations between such materialities rest on an ongoing redefinition of the nature/society divide (Mitchell 2010), oil shale comes into being in multiple states rather than just being seen through multiple perspectives. In the making of an unconventional resource, the material reality of oil shale is more often constituted like an underground reservoir of untapped liquid hydrocarbons, and less as inert stocks of mineral ores (or solid fuel), *both* of which are yet to be interpreted in terms of ‘reserves’ in order to account also for above-the-ground factors.

The material and spatial heterogeneity of the resource also illuminates another dilemma. At a time when geoscientists strive to make “oil shale” into something like a global assemblage in close collaboration with commercial developers, the materiality of the resource remains a critical impediment for prospective exploitation and

technological standardization. Instead of an abundant and homogeneous resource accumulation, there exists a plurality of material circumstances and socio-political constraints in particular locations. The future of the industry is therefore played out through a series of ‘events of place’ (Massey 2005), which include the specific qualities of resource materials, and their entanglement in locally developed technological systems and socio-economic regimes. It is around these eventful places that the viability of the industry is decided and its struggles become particularly visible.

This is why the rest of the thesis revolves mostly around Estonia – a central eventful place, which gives credit to the possibility of development as a “reference” to an existing industry, but compromises its global outlooks at the same time. As the analysis of the Estonian case will confirm, fossil fuel resources are not static substances, but provisional results of dynamic spatio-temporal processes, which may change over time. The subsequent chapters proceed to recount how the science and politics which constitute oil shale as a resource are conditioned by location-specific knowledge practices, technologies of extraction, economic arrangements, and the amount of ‘rhetorical and infrastructural work’ (Bowker 1994) that needs to be invested into the making of an alternative carbon economy.

Chapter 5. Post-Peak Politics: Reserves, Measurement, Futures

5.1 The events of 1980

Back in the year 1980, Tallinn bloomed in the colours of twenty-two national flags, tacky paint and fresh concrete. The Summer Olympics had given the small Estonian nation a unique opportunity to host the most spectacular sporting event in its entire history. The games were of course held in Moscow and eventually boycotted by many countries, but this did not deprive the Estonian capital from a major investment boost to be harnessed for celebrating the sailing competition. Thirty years later, the Olympic Regatta can be still witnessed by the presence of landmark socialist architecture completed on the very eve of this event, including Pirita harbour with its expansive yachting centre, the 28-floor hotel 'Olümpia' towering over the medieval old town, the passenger terminal at Tallinn airport, the central post office, the 4600-seat concert venue that was initially named after Lenin, and a 314 metre TV tower, the country's highest construction, along with many other houses and roads that define the image of the city today.⁵⁴ Needless to say, the hasty construction of such a massive infrastructure required major cooperation between Soviet authorities, immigrant labour and deficient building materials, and doubtless a lot of electric energy supplied by nearby oil shale-fuelled power stations.

In 1980, Estonia also hosted another global event which became evident only years later. While construction workers were busy giving the capital its final facelift, other heroes of socialist labour dug out a record amount of oil shale from the mines located at the country's eastern borders: 31 million tonnes. The collective effort of

⁵⁴ A video footage of this massive building campaign is made available under the title "Tallinn 1980" at <http://www.youtube.com/watch?v=m0Wba7gMrBg> (accessed 3 May 2011).

Estonian miners caused world production of oil shale to reach a peak at 47 million tonnes, which has not been repeated later, especially since international corporations withdrew their investments made in the immediate aftermath of the 1970s oil crises in other countries (Brendow 2003; Dyni 2006). In consequence, the year 1980 thrones the most famous depiction of the industry's global history; a graph that was originally prepared by John Dyni from the U.S. Geological Survey and is now available in numerous reproductions for anyone who searches Google Images for 'oil shale production'. This graph gives credit to the prolonged presence of exploitation, but also makes visible its limited lifetime in certain countries (see Chapter 1, Figure 1). At a time when its proponents herald the peak oil thesis, the industry has already experienced several booms and busts of its own – the Olympic year being its most remarkable highlight.

Although the two events of 1980 may not be directly related, they both mark the culmination of the Soviet-era industrial boom in Estonia. Over the previous two decades, the communist regime had progressively built, extracted and produced (and introduced a large immigrant population for all this backbreaking work), but this was interrupted by a sudden collapse of the planned economy and its material supplies. While the post-Olympic urban space was revived with new building events after the country regained its independence (see e.g. Kurg 2006), the oil shale industry never fully recovered. Rather, Estonians seem to have accepted that the extraction of their strategic resource has met its 'natural limits' and is now slowly but irreversibly in decline (e.g. Barabaner and Kaganovich 1993; Reinsalu 1998b; Toomik 2008). If Dyni's graph is ever going to see another peak, then this is unlikely to be dominated by Estonia again.

Was the peak caused purely by the changing economic order, or does it also indicate that Estonia is close to exhausting its indigenous fossil fuel? After the famous Hubbert's peak (1956) correctly predicted the decline in U.S. oil production, *peak production* is widely assumed to coincide with the *peak supply* of hydrocarbons. Similar trends of depletion have been ascribed to mineral resources, known as 'peak minerals', particularly to non-ferrous minerals that cannot be recycled (e.g. Giurco et al. 2010; Mason et al. 2011; Prior et al. 2012). Since Harvey's (1974) seminal critique of Malthusian projections of resource scarcity, however, geographers have traditionally adopted a sceptical, even 'anti-naturalist' stance to the idea that non-renewable resources are ultimately finite (see Emel et al. 2002; Bridge 2009b, 2010). As discussed in Chapter 2, recent commentaries have associated conventional oil availability with the challenge to match supply with demand due to 'above-ground' economic and political constraints, including climate change policy, which arguably indicates a potential for *peak demand* before any shortage would actually materialize (Bradshaw 2010b; Bridge and Wood 2010; Verbruggen and Al Marchohi 2010; Bridge 2011b) (for minerals, see Mudd and Ward 2008). Yet these studies do not document how the material finitude of fossil fuel resources may come to be perceived, made manifest and acted upon in particular locations and conditions of post-peak scarcity (but see Kristoffersen and Young 2010). Moreover, they leave unexamined the 'below-ground' realities of resources, without explaining *what* it is that has become classified as a resource and 'reserves' in a particular place, and how this may change over time.

The problem of resource availability is complicated by the fact that fossil fuels 'cannot be measured directly', but any calculations need to both account for inaccessible, geophysically and geochemically variegated subsoil formations and provide estimates of future production (Mitchell 2011: 244). On the one hand, the process of abstracting and measuring the messy subsoil world is anything but

straightforward. As Bowker suggests, it takes a lot of work to simultaneously define a unit of measurement for resource assessment *and* maintain this unit with the help of a set of technical, managerial and social techniques. Eventually this ‘infrastructural work’ comes to define how the invisible material world is pictured in the scientific discourse (Bowker 1994). Following Science and Technology Studies, resource estimates ‘create new objects and realities’ (Latour 1987; Barry 2005a; Barry and Slater 2005a: 11; Mitchell 2008). But if ‘reserves’ do not represent physical objects in themselves, does this necessarily imply that they are merely ‘socially constructed’, which in order to be valid have to be consistent with certain organizational interests (Bowden 1985)? On the other hand, the problem of calculation involves also the paradox that reserves are expected to have a cumulative effect in time. For conventional oil, at least, the quantity of resources suitable for extraction is not calculated once and for all, but only within a certain ‘forecast span’ and therefore expected to increase, for example, when technology improves and/or scarcity brings previously non-economic sources to the market (e.g. Klett 2004).

This chapter takes inspiration from the STS-informed analyses of peak oil, which affirm that “reserves are far from stable objects” and highlight instead their *multiple forms of existence* resulting from particular socio-material arrangements that enter into the frame of economic calculation (Barry 2008; Bridge 2010: 527; Mitchell 2011). Given the instability of such ‘framings’ (Callon 1998), reserves appear to be only temporarily fixed representations of material and economic potentials that are expected to change. First, resource availability depends on how below-ground materialities are rendered calculable as ‘reserves’ and whether there are any differences between their possible enactments (cf. Mol 1999; Lepawsky 2012). Second, it depends on considerations of what will become ‘economic’ to produce. This focus on the temporal dimension of such appraisals affirms that reserves “exist as

projections of what can be produced in the future, rather than accounts of what exists in the present” (Barry 2008: 3). As reserves stand for ‘projective devices’ (Born 2006) in addition to being representations of known material stocks, resource assessment and other related ‘anticipatory knowledge practices’ enable future uncertainty to be managed in the processes of resource governance and management (Anderson 2007).

Whereas the question of ‘peak resources’ is often associated with the *global* availability of hydrocarbon or mineral resources, the chapter’s title “post-peak politics” proposes to investigate scarcity from a more localized perspective, referring to Estonia’s national peak in exploiting oil shale. There are some notable differences between Estonia and other oil shale countries, which need clarification in order to learn more about the questions of resource heterogeneity and materiality raised in Chapter 4, which have implicated specific ‘geographies of knowledge’ in the geosciences (cf. Powell 2007). The first difference concerns the extent and reliability of exploratory drilling that implies the geologic assurance of resource estimates. Contrary to major world discoveries, the Estonian deposit is rather limited and shallow, but has been studied and exploited for a long time. Since there have been ample opportunities to measure the deposit and learn from mining outputs, the national geoscientific expertise has established an exceptional reputation: as a rule, local actors do not dispute the accuracy of geological measurements, but rather the ways in which such estimates are translated into ‘reserves’ that can be put into use. The second difference is the industry’s anomalous techno-scientific evolution under the socialist regime (Holmberg 2008) that has generated a nationally specific methodology for the qualification of resources and reserves, which is yet to be brought into conformity with international standards. And thirdly, although intense exploitation caused Estonia’s production to peak some time ago, the improving

prospects of unconventional energy development have had very interesting implications for local definitions of the resource and its future availability.

Moreover, the Estonian post-peak situation reveals that the problem of resource availability in a materially constrained situation concerns not only the size of remaining resources, but other matters-of-concern as well, such as the needs of future generations. For how long will or should the resource last? At which rate is it acceptable to exhaust the resource base before it is used up? Under what conditions can the remaining bulk of subsoil materials still be considered 'reserves' and allocated to extraction? Resource planning is thus always a political process, especially since it is likely that there are alternative calculative frames available to assess the remaining quantities, as well as the economic, technological and socio-political feasibility of exploitation (cf. Barry 2008: 4). Such projective framings do not only inform decision-making and rule out the possibility for disagreement, but may equally become politically conflicting. Instead of having 'anti-political' effects, the diverse knowledges, techniques and devices involved in the calculation of resources and reserves may open up new objects and sites of politics (Barry 2001, 2005a).

So, what happens when a fossil fuel industry is acknowledged to have passed its historical peak, but stakes at future resource use are unprecedentedly high? The Estonian case demonstrates that the calculation of carbon energy resources can be both spatio-temporally specific and politically conditioned. The following sections therefore provide a detailed discussion of the national resource assessment exercise in relation to the changing politics of the future. After giving an overview of local peak perceptions and their implications for resource governance in the next section, I trace and analyse in the two subsequent sections a series of practices through which certain parts of the subsoil world have become abstracted and enacted as oil shale 'resources'

and ‘reserves’ that can then be measured, calculated and governed. This analysis reveals that Estonia’s resource availability is defined by a gradual supplementation of Soviet-era metrological practices with new calculations based on economic and socio-political considerations, which has resulted in *multiple* and partially conflicting forms of resources that are being calculated in parallel. The last sections document how shifting understandings of what constitutes exploitable ‘reserves’ render possible a renewed politics of resource allocation and availability beyond ‘post-peak’ confines. In support of the relational conceptualization of resource materiality proposed earlier, I revisit the question of solid/liquid materiality to disclose how Estonians struggle to renegotiate the “nature” of their oil shale resources and its accessibility for mining in the contending circumstances of declining supplies and emerging opportunities for shale oil development.

5.2 Peak perceptions

How does a nation address the decline of their strategic energy resource, given that it has been exploited for a long time and is known to be potentially limited? Although Estonia can boast a “unique” experience in oil shale production having mined this resource continuously for nearly a hundred years (Liive 2007; Parts 2009; Liive 2010), such intense exploitation has also had profound impacts on both the quantity and quality of reserves that remain to be exploited. If the rest of the world may still expect to make new discoveries of their largely unexploited deposits, Estonia as the leading producer of the past is facing increasing constraints on resource availability. The following provides an extended introduction into this ‘post-peak’ situation by pinpointing the key factors and events that have urged the nation to think through the possibility of scarcity and its effects on the future outlooks of their energy economy.

As noted above, the peak production of oil shale took place more than three decades ago, when Estonia produced about 31 million tonnes (Mt) in one year (Figure 6). After 1980, mining outputs started to decline sharply, having dropped threefold by the millennium. Since then, however, the industry's needs for feedstock have steadily risen again, reaching a plateau at approximately 14-16Mt for some years, but soaring to 19Mt in 2011 due to growing exports of both shale oil and electricity.⁵⁵ In spite of this recent increase, there seems to be a remarkable consensus amongst state authorities, companies, and academic experts that production will never be allowed to return to its historical peak.

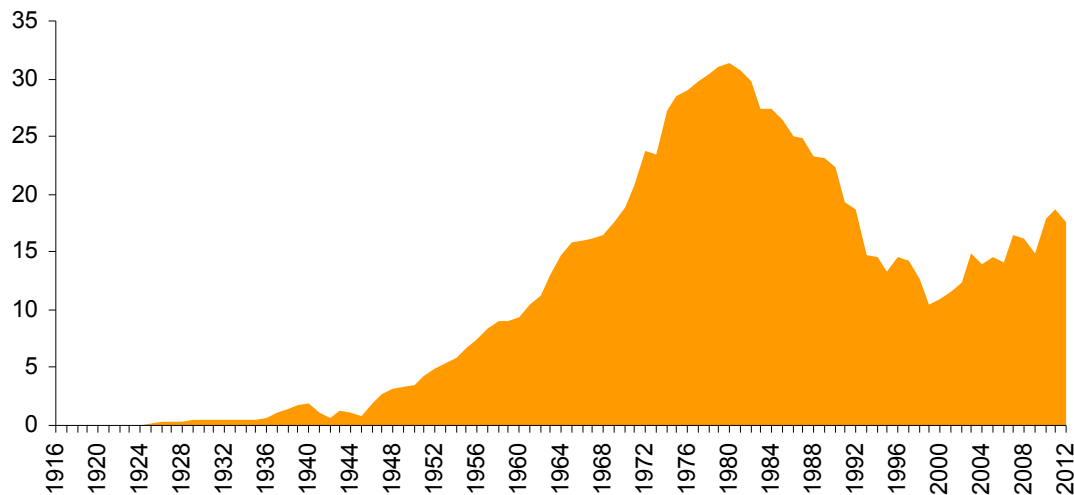


Figure 6 Oil shale production in Estonia 1916–2012.

Source: Data published by Enno Reinsalu (in Suuroja 2008) and Estonian Land Bureau.⁵⁶

Although the industry appears to have passed the maximum level of production long time ago, the peak was not initially understood as a consequence of

⁵⁵ As further explained in Chapter 6 and 7, this increase was partly made possible by the closure of Ignalina Nuclear Power Plant in Lithuania on 1 January 2010, which secured Estonian companies with fortunate revenues from selling electricity to other Baltic states and to the NordPool market through the Estlink submarine cable which was opened in 2007.

⁵⁶ Note that this graph reflects the amount of extracted material or 'trade oil shale' (see Table 4). In fact, the data sources are not directly comparable, because Reinsalu reports 'trade oil shale' for the years 1916-2005, whereas the Land Bureau accounts for the use of 'geological resources'. After comparing the differences, I decided to use an average coefficient of 1.18 to multiply the Land Bureau's production data for the years 2006-2012, which are not covered by Reinsalu.

physical constraints on resource availability. Peak production may simply reflect peak demand for oil shale, especially when one takes into account the rationale of the Soviet command economy, as opposed to free trade systems (cf. Bardi 2009: 324). Indeed, the sudden drop in production is often associated with the commissioning of a nuclear power plant near St Petersburg in the late 1970s, which soon ceased the import of electricity from the oil shale-fired power plants in neighbouring Estonia (e.g. Kattai et al. 2000: 31; Holmberg 2008: 178).⁵⁷ Likewise, the peak has also been explained by reference to the lack of money to compensate dropping demand with the expansion of shale oil production (Reinsalu 2006b: 17). Later, the post-Soviet collapse of heavy industry further reduced the need for oil shale, although it continues to serve as a major resource for electricity generation.

The measurement of oil shale resources was introduced in the early days of mining, but exploratory drilling reached full pace during the Soviet programme of large-scale industrialization. Along with the expansion of the area under exploration, estimates of total resources were multiplied several times (Kattai et al. 2000: 31), so that eventually oil shale became likened to an inexhaustible resource. According to Prof. Reinsalu, a mining engineer and the main author of the Estonian resource assessment methodology, the Soviet government had planned to raise production up to 70Mt during the 1970s oil crises, which is more than twice the actual peak of 1980 (Reinsalu 2006b). The plan involved building yet another power plant and oil factory, and opening three new mines. What Reinsalu (2008) calls ‘a conception of grand development’ was however brought to halt by closer scientific studies of resource availability. By 1983, local experts came to the conclusion that mining cannot proceed at any higher rates and has instead hit a decline. However, they claim to have been

⁵⁷ The record amount of electricity ever produced in these stations dates back to 1979 (Pajo 2012).

unable to confirm publicly that resources were in fact limited, because such views were suppressed by the regime.⁵⁸

It was not until nearly two decades later that the event of maximum production became associated with overall resource decline in terms similar to Hubbert's peak (1956), according to which unrestrained extraction of a given finite resource will cause production to decline symmetrically since about half of the resource has been used up (for analyses, see e.g. Bowden 1985; Campbell and Laherrère 1998; Bentley 2002; Bardi 2009; Hemmingsen 2010). Following Estonia's re-independence, the main author of the national methodology was the first to draw the famous bell-shaped curve (Reinsalu 1998b; Reinsalu 2008: 559) and suggest that if extraction is governed by a free market regime, then there may be actually less *mineable reserves* of oil shale left in the ground than what had already been extracted by then (Reinsalu 1998a, 1999; Toomik 2008: 15). Since then, more and more people have begun to question whether the deposits most favourable for mining are in fact approaching depletion (see also Barabaner and Kaganovich 1993). Although the threat of resource decline may not be always explicitly associated with the historical moment of peak production, no consideration is given to the possibility of several peaks either – both in the sense of production rates and resource availability, the year 1980 is deemed to mark the industry's maximum capacity. The peak is affirmed not only amongst local experts, but Jean Laherrère, a leading peak oil theorist, concludes explicitly that Estonia is a good example of the Hubbert curve 'with an unlikely second cycle in the long term' (Laherrère 2005).

Today, Estonians rarely dispute the significance of the peak, but focus instead on the future prospects of exploitation within post-peak confines. Since late 1990s, the

⁵⁸ Enno Reinsalu, personal communication 21 March 2011.

size of remaining reserves and the number of years during which mining can still take place at the current level of production (called the ‘age of resources’) have become a subject of both expert calculations and heated discussions. Many estimates have been put into circulation, which suggest quite different outlooks depending on the authors and their audiences. With regard to the size of reserves, there are striking differences between the quantities of shale that are expected to be still available for mining. If one follows the terms of Soviet-era resource accounts, then concerns about future availability may well seem ungrounded. According to a simplified overview that is so often presented to foreign audiences, nearly 2 billion tonnes of Estonian shale have already been extracted, but another 5 billion are still lying in the ground.⁵⁹ However, since Estonia started adopting the principles of market economy, geologists and mining economists have begun to think in terms of ‘reserves’ and proposed somewhat more humble numbers (see e.g. Barabaner and Kaganovich 1993). They have acknowledged, for example, that according to currently available knowledge on technical and economic criteria, there are only 1.5 billion tonnes of exploitable resources left, which is less than have already been extracted (Kattai et al. 2000: 167, 193). The fact that commercial resource availability may have peaked together with maximum production was confirmed with subsequent revisions in official state records, according to which reserves suitable for mining now account for only 1 billion out of nearly 5 billion tonnes of total resources (see Table 6 below).

Similarly confusing is the number of years that remain for the industry to survive. Optimistic scenarios circulated by mining engineers propose a century or even longer (e.g. Reinsalu 1998a). Yet more conservative estimates published in

⁵⁹ This figure is widely presented by Estonian oil shale scientists and the industry, and has also found its way to academic publications in English (e.g. Brendow 2003, Dyni 2006).

national energy plans⁶⁰ and elsewhere give the industry anything from another 15 to 50 years, while these calculations are not based on recent mining rates, but the lowest rate of only 10Mt (see Aarna 1989: 139; Barabaner and Kaganovich 1993; Valgma 2003; Gavrilova et al. 2005; Toomik 2008; Elering 2012; NAO-Estonia 2012).⁶¹ The discrepancies between these calculations seem to be a result of how they account for both the quality of remaining resources and the conditions under which they can be still counted towards ‘reserves’, although these subtleties are less disclosed in public. Most published estimates simply focus on the tonnage and ‘years left’.

At the same time, Estonia’s outlooks for sustaining a national fossil fuel industry have become constrained for other reasons, which have further invoked perceptions that production will never return to its peak. In mid-1990s, the country started to adopt gradually the *acquis communautaire*, a prerequisite to the EU accession process.⁶² In conjunction with raising public awareness of the extent and impacts of Soviet-era hazardous practices in the industrial zone, the EU environmental restrictions and economic reforms were certainly conceived as more of an imminent threat than resource decline. As further discussed in Chapter 6, the ‘transitional period’ agreed with the Accession Treaty was anticipated to reveal the industry to be uncompetitive in the free market and to further decrease demand for oil shale, as well as to directly hamper mining operations due to the expansion of nature conservation areas. It became soon common for both national and international experts to announce that the industry has arrived “at a crossroads” and may even come to a halt

⁶⁰ *Kütuse ja energiamajanduse pikaajaline arengukava aastani 2015* [Long-term development Plan for Fuel and Energy Economy until 2015], approved by the Parliament in 2004.

⁶¹ The original calculations have been discounted here by approximately 10 years, i.e. since these texts were first published.

⁶² Estonia filed the official application for membership in 1995 and joined the Union in 2004.

(Reinsalu 1998b; Veiderma 1999; Brendow 2003: 85; Veiderma 2003; Laherrère 2005; Reinsalu 2005).

Given the urgency and magnitude of EU requirements, it is perhaps not surprising that conflicting resource estimates have not led to a full-fledged 'socio-technical controversy', or at least not a *public* controversy (Callon et al. 2009). To be sure, the question "For how long will oil shale last?" has been increasingly voiced in personal communication and non-public documents. And certainly, concerns about scarcity, particularly regarding the imminent need to open new mines because of the depletion of those currently in operation, have also contributed towards a wider public debate on the industry's future prospects in the EU market. However, discussions of the problem of long-term resource availability, i.e. beyond the next decade or two, have become increasingly silenced and postponed in favour of fears about short-term threats to the industry's competitiveness (but see Elering 2012; NAO-Estonia 2012).

Nevertheless, other developments have encouraged the nation to restrict the potential expansion of mining and begin to rethink the industry's future trajectories. By the mid-2000s, the world market price of oil had started to increase steadily, restoring once again investors' interests in non-conventional sources. While the local industry for shale oil production was already in the process of being liquidated because of its financial losses, with some of its infrastructure being dismantled, new possibilities of survival suddenly dawned upon local companies. Overnight shale oil became a profitable product in European markets and, even more importantly, Estonia started to emerge on the global map as one of the key technology holders for its extraction. As further documented in Chapter 8, the industry quickly turned to look

for new business opportunities in order to delay the anticipated decline of their domestic operations and commercialize its legacies abroad.

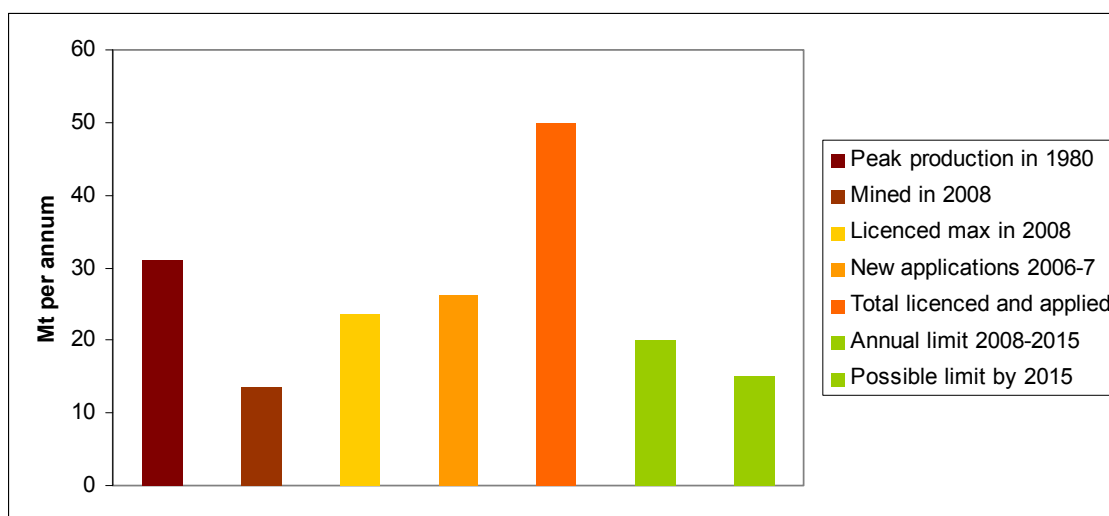


Figure 7 Estonia's actual and potential production rates.

Source: Statistics Estonia; Oil Shale Development Plan 2008–15.

At that point a number of other potential developers became also interested in getting hold of the national resource. During 2006-2007, within a very short period of time, 16 new applications were filed for booking rights over the last few concessions that were still available for mining.⁶³ If all these concessions would have been licensed and put into operation, then extraction rates would have more than doubled the maximum volumes already permitted by the government, raising potential annual production to an unprecedented number of 50Mt. This would have been more than three times higher than actual extraction in recent years and nearly twice the peak production of 1980 (Figure 7). It should be noted, however, that not all applicants were necessarily planning to start their own extractive business. Rather, they were driven by a growing awareness about the finiteness of mineable reserves, as well as general unhappiness with the exclusive rights of Eesti Energia, the state-owned energy

⁶³ In fact, there were only eight concessions remaining, so that some more abundant fields were requested by several applicants.

monopoly, over using these reserves.⁶⁴ So, the race for new concessions was more about booking the remaining resources in response to the promise of profitable oil production, rather than actually making this promise materialize in the near future.

Nevertheless, and in contrast to earlier debates, this race between existing and potential developers was perceived to have immediate and very real consequences. Indeed, it became a key political event during which the state government began to address the peak panic, and furthermore, to invent new techniques for 'post-peak' resource governance and politics. Although state officials were not at all prepared for this sudden wave of applications,⁶⁵ they quickly associated the problem with wider attempts to maintain state control over strategic national assets in the post-Soviet circumstances of rapid privatization (cf. Kuus 2002; Mandel and Humphrey 2002; Dunn 2004). In public, the government took a reluctant stance to agree to such a production increase because it would have triggered large-scale environmental problems and social mobilization against new mines. Another and somewhat more hidden concern was, however, that new entrants would have undermined the position of Eesti Energia, the state company, which had secured significant income from selling feedstock to private companies. Whatever the exact rationale, the state decided to call a temporary moratorium upon all licences to be issued for new mines, and proceeded to establish these restrictions legally by determining its 'national interests' in oil shale exploitation, for the first time in history. Instead of agreeing that resources are up for grabs without reservations, it subsequently put the industry's expansion on hold for another eight years. An effective measure to do so was to agree on a national strategy,

⁶⁴ Interviews 19 April, 4 May 2010; field notes 21-22 October 2011. It is possible that local interests were sparked by the presence of foreign audience at the international Oil Shale Symposium that took place in Tallinn just a few years earlier, in 2003. This was the second oil shale conference to be organized in Estonia. The first conference, *The United Nations Symposium on the Development and Utilization of Oil Shale Resources* took place in 1967 in the Soviet republic, the third one in the re-independent state in 2009, and the fourth one in 2013.

⁶⁵ Interview, 19 April 2010.

which has become known as the Oil Shale Development Plan.⁶⁶ Whereas previously there had been no nation-scale restrictions on production, the plan imposed an annual limit on the total amount of oil shale to be mined. Although individual licences that had been issued earlier summed up to 23.7Mt per year, the national limit was set at a lower rate of 20Mt, with a further objective to lower it to 15Mt by 2015.

The development plan takes as its main underlying principle that ‘oil shale reserves should last for as long as possible’. Unlike earlier national energy strategies,⁶⁷ however, the document makes no guesses as to how long the resource will actually last. The ‘years left’ are mentioned only with reference to particular mines approaching depletion, which was deemed to legitimize the need for new concessions. Also, although the plan indicates a need to define alternative options for resource use, these were in fact not much assessed. Instead, it was assumed that oil shale will continue to cover the nation’s growing demand for electricity, as well as limited exports of both power and shale oil. The calculations were based on the minimum supplies requested by Eesti Energia, whilst also taking into account the licences that were in the process of being issued to two privately owned companies that were already active in oil production. The majority of concession rights were reserved for Eesti Energia. Since the final document did not specify how much of the resource is used for power generation, or alternatively, how much could be allocated to the oil industry, the monopoly was given a free hand to change its production profile within the established limit.⁶⁸

⁶⁶ *Põlevkivi kasutamise riiklik arengukava 2008-2015* [National Development Plan for the Utilization of Oil Shale], adopted by the Estonian Parliament on 21 October 2008.

⁶⁷ Development Plans for the Fuel and Energy Economy (2002 and 2005 versions), *Elektrimajanduse Arengukava* [The Development Plan for Electricity Economy], 2005–2015.

⁶⁸ Eesti Energia’s concession rights account for approximately 17 million tonnes.

To summarize, the plan only restricted annual extraction rates without providing a rationale for the specific number of 20Mt. This outcome has since become much criticized, especially in association with the increasing profitability of shale oil. In a way, the government only magnified the situation of uncertainty, because it declined to make necessary calculations and take strategic decisions as to how long the high-grade, mineable reserves should last, and what would be the best ways to use the remaining resource base. Instead, the government simply established the status quo of operations undoubtedly dominated by the state company. The future of oil shale was not only defined on the basis of past and present affairs, but discounted in favour of short-term needs and opportunities.

That said, it can be argued that this ‘post-peak’ controversy was only temporarily concealed by the urgent need for regulation. The plan did not depoliticize resources and reserves, but instead rendered such figures open to further contestation. Subsequent debates have mostly centred at a specific question created with the plan: will the annual limit of 15Mt soon be lowered, as initially agreed, or left unchanged? Or will the state instead increase this limit or abolish it altogether in order to meet growing demand for shale oil?⁶⁹ However, more fundamental questions about long-term availability have not been cast aside. Not only have there been growing tensions within the industry and opposition from local populations to the expansion of mines, but the very conceptions of ‘resource’ and ‘reserves’ have become subject to contestation, revision and re-formulation. Indeed, oil shale as a ‘matter of concern’ can not be easily reduced to abstract ‘matter of fact’ numbers, such as those presented in Figure 7 (Latour 2004, 2005b). What do these numbers really mean and how do they relate to each other? Or, to put it more precisely, *what is the thing called ‘oil shale’* that

⁶⁹ Interviews, 8 March 2010, 19 April 2010, 27 April 2010, 4 May 2010.

such numbers claim to represent? This is the starting point for the following discussion of the multiple ways in which the resource can be framed and measured.

5.3 Contending ‘references’: geological resources and qualified products

Oil shale is a resource only in case we use it. Otherwise it is just a part of the bedrock. (Siirde 2008)

Given the post-peak circumstances of potentially limited supplies, it is important to understand why oil shale has become a *resource* in Estonia at all, and how? As noted in Chapter 4, only the kukersite found in the ‘Estonia’ deposit has acquired the standing of a resource, whereas other organic-rich sediments have been disregarded, mostly due to their lower quality. However, the deposit covers a large geographical area, which contains various compositions of organic and inorganic materials at different depths and in diverse depositional environments. Whilst still in the ground, oil shale does not exist apart from the rest of the bedrock. How does a particular mixture of such ‘below-ground’ materials then become knowable as ‘oil shale’, and measured and counted towards resources?

Developing from this question, the following appeals to Bruno Latour’s (1999) concept of ‘circulating reference’ in order to analyse the knowledge practices through which diverse subsoil realities can be abstracted and converted into volumes that add up to resources. This analysis supports the argument made in Chapter 4 that resources may come into existence in *multiple forms*, being deeply conditioned by nationally specific metrological practices that are related to the economies and technologies of extraction. In Estonia, such practices involve a whole cycle of abstraction with two notable extremes. On the one end are calculations of the ‘*in place*’ *mineral resource*, which are conducted mainly by geologists. On the other are distinct calculations that are induced by the daily operations of oil shale mining and processing, which qualify a

product that can be ascribed market value and supply raw material for production. Through both approaches, the actual messiness of the subsoil is translated into meaningful categories, whilst oil shale assumes the political life of an energy commodity by being circulated through different ‘centres of calculation’ (Latour 1987). As we shall see, these two modes of calculation are far from straightforward and may contradict each other, although both remain central to national understandings of what constitutes the remaining resource base.

5.3.1 Geological references: ‘oil shale’ purified

Within the ‘Estonia’ deposit, the sedimentary rocks rich in organic matter occur in the form of several more or less coherent mineral beds. According to local geological descriptions (Aarna 1989: 43-45; Kattai et al. 2000; Valgma 2003; Väli et al. 2008), only one mineral bed with the highest organic content is considered to be sufficiently “productive”. For this particular bed, which is buried under up to 100 metres of overburden (30-60 metres in operating mines), the diverse mixture of bedrock materials is further abstracted into seven layers of oil shale. Geologists label these layers with letters from A to F1, starting with the deepest one.⁷⁰ Such layers range from only 5 to 60cm in thickness, while their oil content and calorific value vary greatly between individual seams, as well as across the deposit. These organic-rich seams are striated by four to six layers of limestone. Although oil shale layers are visually distinguishable in most cases, they always contain pieces of limestone, whereas limestone inter-layers may feature a minor content of organic matter. In some places, however, it is not possible to distinguish between such layers at all, because the carbonate gets totally mixed with oil shale. The bed’s total thickness is only 2-3 metres at the core of the deposit, but decreases by more than double at its

⁷⁰ This system is used only for the ‘Estonia’ deposit. ‘Tapa’ and ‘Leningrad’ deposits have less layers.

margins. As a rule, any kukersite deposited higher or lower than the A-F1 section (such as the layer F2) is not counted towards the productive (i.e. mineable) bed, and usually not extracted during mining (see Figure 8).

Below, the photo on the left depicts a cross-section of the ‘productive bed’ in a particular mine, whereas the image on the right sketches its idealized presence, as found in all handbooks of Estonian geology. By switching between these images below, the messy subsoil reality appears to be somehow turned into a more or less meaningful representation. How does this abstraction take place and, even more importantly, inform the measurement and calculation of resources?

Here, the practices of Estonian geologists share remarkable similarities with those of the pedologists working in an Amazonian forest, who inspired Latour (1999) to develop his notion of ‘circulating reference’. Similarly to the topsoil, diverse subsoil materials need to undergo a series of transformations before they can be defined and constituted as ‘oil shale’. In Estonia, such stages are composed of, for example, exploratory drilling, studying borehole data, identifying and measuring the layers, determining their average quality at different depths of the mineral bed, modelling grids and contour lines that express the deposit’s ranging quality with the help of geo-information systems, and so on. Following Latour, at every such stage, the diverse materialities, localities and particularities of below-ground realities are reduced, although not completely lost. At the same time, Latour says, the phenomena of the material world are amplified by adding new potentialities to them. Through complex geoscientific practices of reduction and amplification, the circulated phenomena of oil shale are subjected to comparison, standardization and categorization. In other words, they become a *resource*.

Figure 8 has been removed due to Copyright restrictions

Figure 8 Oil shale layers pictured in Põhja-Kiviõli mine (left) and abstracted by geologists.
Note: 'roosa paas' and 'valge paas' mean pink and white limestone respectively. Photo courtesy of Väli et al. 2008; image adjusted from <http://www.ut.ee/BGGM/maavara/pqlevkivi.html> (accessed 15 April 2011).

For Latour, the notion 'reference' incorporates the entire quality of such a chain of transformations, where phenomena are being circulated. Contrary to writings in the philosophy of language,⁷¹ it does not indicate a thing in external reality which is being referred to by means of language. Rather, following the STS/ANT non-dualistic approach, 'reference' denotes a 'common operator' that can be identified at every stage of translation between the two opposite ends, and that does not necessarily bear any resemblance to the previous stage despite being still linked to it (Latour 1999: 69). Drawing on Latour's definition, I understand 'references' as the provisional results of a whole array of translations that take place between 'below-ground'

⁷¹ The most renowned example here is Gottlob Frege's distinction between 'sense' and 'reference'.

realities and their ‘above-ground’ circulations in the knowledge practices of geologists and many others who are occupied with the constitution of oil shale resources.⁷²

Looking back at Figure 8, it can be seen as a particular stage in a series of geoscientific transformations, which lead to the constitution of a resource. However, it is misleading to think of the left photo as belonging to the below-ground world of material reality and the right image as something closer to a meaningful abstraction of this world. Not only is the photo with letters already an abstract, but *both* images represent the process of ‘science-in-the-making’ that is mediated by human calculative techniques as much as non-human tools (Latour 1987). Drawing on Latour’s work, Mitchell (2002: ch.1) reminds us that what is called ‘nature’ or the ‘material world’ is itself on constant move through arrangements that are equally social and natural; they are just as much technical as material. According to Mitchell, the division of world into nature and human calculation should be regarded as the *outcome* of an ongoing ‘process of manufacture’ involving both human and non-human ingredients, rather than pre-given binary categories (see also Bowker 1994: 162).

These conceptual clarifications prove very helpful for thinking through the ways in which a ‘post-peak’ society defines and redefines its resource base. In Estonia, the collective process of constituting oil shale does not stop with depictions of ‘in place’ resources like those pictured above. Notably, resources can be abstracted from such representations in different ways. Moreover, the chain of transformations extends further to involve other, non-geologist abstractions, such as the measurement of mined quantities that can be converted into useful goods, or the calculation of *reserves* that is considered suitable for exploitation. Occasionally, such transformations are halted when the resource becomes ‘black-boxed’ as an

⁷² Chapter 8 will pick up this term again discuss the entire Estonian industry as a “reference”, as presented by the industry itself in building up a future market for shale oil production.

indisputable fact (Callon and Latour 1981; Latour 1987). This happens when oil shale takes the form of calculable assets in the state register of resources administered by the Estonian Land Bureau, as discussed below. Such a register operates through a certain 'exclusion zone' in which the strategic choices of metrological work required to produce meaningful categories become presented as a universal and non-local science (Bowker 1994).

The following proceeds to look behind the fixed categories inscribed in the state register by explaining how Estonia's oil shale resource comes into being in the first place, and how it may become revised in the situation of resource decline. First, I briefly discuss the practicalities of mining, because miners both rely on 'geological references' and rework them at the same time. The remainder of the chapter turns to another series of transformations: the categorization of 'reserves'. As we shall see, the diverse practices of stabilizing the resource can be simultaneously interdependent and contending.

5.3.2 Mining references: 'oil shale' extracted and traded

Miners and mining engineers encounter again the troubling messiness of the material world when they need to take oil shale out of the ground and prepare the feedstock for power stations and oil plants. Extracted at different depths and locations, the mined material accumulates moist oil shale of ranging quality in various compositions with limestone. This mixture cannot be immediately fed into combustion and retorting, because the design of these technologies precludes the processing of feedstock outside of certain quality range and granularity (Kattai et al. 2000: 84). This is why mining engineers have invented their own techniques for transforming 'oil shale' into a more homogeneous energy commodity that can be processed and, following the industry's gradual commercialization, ascribed economic value and

traded in the market. Amongst others practices, such techniques include selective mining and 'enrichment' of the mined material.

To start with the latter, enrichment is a special process that takes place after the mineral has been mined and transported to designated sites of purification, called separation plants. Here, the material is put through a series of treatments, from hand-picking to magnetic suspension, during which more and more kukersite is separated from carbonates and divided into different grades. In this way, the quality of the mixture is gradually increased; it will yield higher calorific value and more oil. Contrary to laboratory testing, however, it is impossible to purify oil shale completely, such that some limestone will always remain present in the raw material that is deemed suitable to enter into processing. In turn, the heaps of enrichment waste or 'spoil tips' that have been left towering next to separation plants are estimated to contain a high concentration of organic matter, up to 50%, which has caused repeated fires (Kattai et al. 2000: 109). Occasionally, the resource can be "too good" for combustion units or oil retorts to handle, i.e. its calorific value is higher than prescribed by the designers of the technology. In these cases, the mined material is mixed with that of lower quality. The feedstock supplied to power plants can also be supplemented with other types of fuel such as biomass or old tyres.

Since enrichment is expensive and time-consuming, the industry has looked for other options to obtain feedstock within the desired quality range. Selective mining is a common practice in open-cast mines such as the large Narva quarry (Figure 9). Here, only some oil shale is extracted, usually the most valuable middle layers, but if necessary also the sediments exterior to the A-F1 seam, for example, the most easily

accessible upper layers of lower quality.⁷³ The rest is either left in the ground or mixed with overburden and limestone and disposed as mining waste. Similarly, in underground mines a significant part of the organic-rich material remains unused. Although underground mining usually targets the entire “productive” bed, nearly a third of the resource is preserved in pillars that prevent the collapse of overburden into the mine (Kattai et al. 2000: 110; Francu et al. 2007). This technique of room-and-pillar mining combined with subsequent enrichment is the only underground mining technology currently used in Estonia (Fraiman and Kuzmiv 1995; Valgma 2003).



Figure 9 Selective mining with a terrain leveller in Narva quarry.

Note: The dark earth shows one of the upper oil shale layers under extraction, whereas the heaps of mining waste are much lighter due to their higher content of limestone.

In short, a lot of material is left behind in such transformations – and not only in the metaphorical sense. The process of converting oil shale into more homogenous

⁷³ See the decision of the Committee for Mineral Resources from November 1996, which follows the recommendations of the TU Tallinn Institute of Mining.

stuff thus corresponds to what Callon *et al.* (2005) term ‘qualification’, only that it applies to the process of supply, not market exchange.⁷⁴ Once the organic-rich material has left the ground, oil shale comes to stand for a *product* that acquires new qualities through processing, distribution and, eventually, consumption in the form of heat energy or liquid fuel. Following Callon, the qualification of a product involves a never-ending ‘sequence of transformations’, which stays in contrast to its objectified status in the form of particular *goods* that are said to be ‘temporarily stabilized’, delimited and definable things that enter economic calculations (Callon et al. 2005: 31-33). Through such transformations, only a part of the resource described by geologists becomes qualified and compatible enough to enter production. Oil shale, once again, becomes a resource, but this time in a different sense. Rather than representing an abstract geological accumulation estimated to be *below* ground, it now takes the place of a visible energy commodity *above* ground, the calculation of which is gradually transferred to the domain of market transactions, “in which it can be connected and compared to a finite list of other products” (Callon and Muniesa 2005: 1235).

The abstractive practices of Estonian geologists and miners induce radically different ways of calculating the resource with conflicting outcomes (Table 4). The state register administered by the Land Bureau is currently based solely on geological references. The register keeps accounts of all oil shale layers from A to F1 that are counted towards reserves (see next section), regardless of the method of mining and the amount of material that gets either wasted or added during this process. There is thus a remarkable gap between the geological imaginations of the ‘in place’ mineral resources and the bulk of materials that are circulated within the industry.

⁷⁴ The economic sociology literature tends to focus mainly on the valuation and distribution of goods among market participants once commodities have been settled, things produced and ready to undergo ‘qualification’. Less attention is paid to the processes in ‘the supply world’ through which commodities become qualified to enter calculation in the first place (see also Chapter 9).

This gap is further manifested in the Estonian notion of ‘trade oil shale’. Contrary to geological definitions, ‘trade oil shale’ refers to a certain state in the production cycle, when the material is qualified to the extent that it can be sold as a standard feedstock for both power and oil industries. It represents a moist mixture of oil shale, limestone and fluid inclusions, which is gained upon extraction and, if necessary, homogenized through selective mining or enrichment, so that it meets the quality range and criteria required by the Estonian Centre for Standardization.⁷⁵ It is important to note that the quality of trade oil shale is expressed in so-called ‘lower heating value’ that can be achieved during *actual* combustion process in power plants, which is inevitably less than the same indicator of dry oil shale measured in laboratory conditions with the bomb calorimeter (Koitmets et al. 2003). Geological references, by contrast, rely on laboratory measurements of ‘higher calorific value’ and account for only dry and “pure” oil shale layers, regardless of their initial water content and composition with limestone inter-layers,⁷⁶ although in most cases the carbonates are also extracted (Valgma 2003: 406). For local experts, “geological reserves of oil shale and trade oil shale are *two different things* – both are aggregates of various mineral components, which have not only different calorific value, but also different specific weight and other properties” (Koitmets et al. 2003: 16, my emphasis).

Taken together, Estonia’s oil shale resources come to have at least three distinct forms of existence; the geologically defined ‘in place’ resources, the material that is actually extracted, and the qualified product of ‘trade oil shale’. Geological resources and mineable/tradable resources⁷⁷ account for divergent ways of

⁷⁵ Estonian standard EVS 670:1998 for trade oil shale.

⁷⁶ However, limestone inter-layers E/F1 and A’/A are included, as they are less than 5cm in thickness and hence not distinguished from oil shale layers.

⁷⁷ If no enrichment takes place, then the quantities of extracted material and trade oil shale are the same. Hence, local experts sometimes use the notion ‘trade oil shale’ also for the mined amounts.

translation between below-ground and above-ground realities, which entail rather incommensurable categorizations of the ‘material’ and the ‘social’. All these resources are measured and calculated, but in different ways and for different purposes. In effect, the quantities of such categories can differ up to two times⁷⁸ as a result of the quality of the deposit and mining technology. The future of exploitation, as explained later, depends on the relationship between these three forms of measurement and the ways in which they will be converted into ‘reserves’.

Forms of existence	Mining terminology	Estonian interpretation
Geological references	In-place resource, mineral resource, “geological resource”	The total tonnage of “pure” and “dry” resources estimated to be in the ground and exhausted upon extraction, including all oil shale layers from A to F1, but excluding most limestone inter-layers and exterior sediments.
Extracted material	Run-of-mine	The actual mined tonnage of the moist mixture of oil shale and limestone, excluding material lost in selective mining or room-and-pillar mining.
Qualified product	Trade oil shale	Standardized oil shale product achieved via selective mining or enrichment, with currently required quality range between 8.4 and 11.6 MJ/kg in lower heating value that is compatible with the technology.

Table 4 The three forms of existence of Estonian oil shale resources.

Moreover, the comparison of such measurements involves a paradox, which leads to remarkable confusion when it comes to thinking in terms of reserves. On the one hand, ‘geological resources’ can be thought to represent a smaller tonnage than what is actually extracted, because they account only for purified oil shale that is assessed in laboratory conditions without the moist limestone content. As a result, the industry is considered to have cumulatively used up less mineral resources in history than produced ‘trade oil shale’ (Kattai 2003). On the other hand, in the case of underground mining or selective mining the geologically estimated resource base can

⁷⁸ Prof. Enno Reinsalu at <http://maavara.blogspot.com/2011/01/polevkivisoda-virumaal.html> (accessed 21 March 2011).

be much larger than the yield of ‘trade oil shale’, because significant quantities are always left behind in such mines.⁷⁹ For example, the peak production of 31Mt seems to represent the extracted, ‘run-of-mine’ material, when in fact 36Mt of the mineral resource was used up (Barabaner and Kaganovich 1993). The difference is usually regarded as mining losses, while the Estonian approach is to calculate resource use in terms of the total ‘geological resource’ that becomes exhausted. With the declining quality of the deposit, however, only half of the ‘geological resource’ can be turned into a mineable and tradable good (Barabaner and Kaganovich 1993; Reinsalu 2003).

Such discrepancies in measurement have given way to misinterpretations of historical production data (Reinsalu 2006a), as well as deliberate abuse by the industry. For instance, the Oil Shale Development Plan does not specify which reference to oil shale is being used when it establishes the annual limit to extraction. Where state authorities rely on geological references in calculating resource use and issuing mining licences, developers report their actual production in terms of ‘trade oil shale’, added estimated mining losses. This disjuncture between different calculative centres has enabled the industry to claim that they have a right to produce more ‘trade oil shale’ than the limited tonnage established by the government, which is denounced as just a “geological fiction” (Valgma 2003).⁸⁰ Moreover, the use of geological references in official accounts gives a flawed impression of plentiful resources, which may no longer be the case considering the declining yield of high-quality feedstock as mining approaches the margins of the deposit.

⁷⁹ Depending on the quality of the mined material, enrichment may result in even smaller amounts of the qualified product.

⁸⁰ See for example, the correspondence between the Ministry of Economic Affairs and the National Audit Office, made available at <http://www.scribd.com/doc/31654201/Vastus-Riigikontrolli-arvamusele-riigi-ariuhingu-Eesti-Energia-AS-investeeringute-rahastamisotsuste-ettevalmistamise-kohta-aastatel-2008-2010> (accessed 29 April 2011).

5.4 From geoscience to economy: reserves

The fact that the Estonian deposit is still rich in oil shale does not mean that mining will continue at the present level: the resources explored by geologists do not reflect the amount of the mineable reserve. (Reinsalu 1999: 289)

How much oil shale is still available for mining in Estonia? The size of remaining resources determines the ultimate termination of the post-peak industry, but there is no straightforward answer to this question. As explained above, the practices of geologists and mining operations have led to different measurements of the quantities yet to be produced, as well as those consumed in the past. Moreover, even if measurements are to be trusted, the problem is not how much rock exactly remains in the ground, but how much of the degrading resource base can be mined and turned into 'trade oil shale', and at what price and conditions (see also Prior et al. 2012). Rather than disputing the accuracy of total resource estimates, the Estonian controversy focuses on the definition and calculation of *reserves*.

In Chapter 4, nationally specific methods of resource assessment were argued to imply distinct and potentially multiple ways in which oil shale becomes an 'informed material' (Barry 2005b). In Estonia, the geoscientific inscriptions and mining techniques described above form only one part of the socio-technological complex through which some organic-rich sediments become saturated with information and constituted as a resource, while others are left behind. Having discussed the translation of below-ground materiality into measurable quantities, the following targets the next stage of abstraction: the grading of oil shale according to its quality, which enables certain sections of the subsoil to be designated as 'reserves' that are deemed 'economic' to produce, allocated for exploitation, and calculated in the state official records of resource assets. After describing how the national system for reserve classification has been tied to the needs of the electricity industry following the building of large oil shale-fired thermal plants in the 1960s, the remainder of the

chapter discloses that established understandings of reserves may become unsettled and challenged in response to the growing popularity of shale oil production.

The Estonian system for dividing mineral resources into different classes of reserves is complex and has its roots in two radically different economic regimes. Reserve classification was introduced for oil shale by the Soviet government in 1965, but went through significant revisions when the re-independent state of Estonia began to adjust to the tenets of market economy. The resources of the ‘Estonia’ deposit were first reassessed by geologists in 1995,⁸¹ and then re-calculated once again three years later after mining economists had worked out additional economic criteria, which were approved in 1997. All these revisions derived from methodological changes; as a general rule, no geological measurements were carried out in the field. Since then, the methodology has remained unchanged, although reserves have undergone minor adjustments: for example, when the resource has been re-categorized following improvements in the data system and mapping techniques; or actual production outputs after a mine has been exhausted; or political decisions imposing further restrictions on mining, such as new nature conservation areas.

It is widely acknowledged that the communist approach to a centrally controlled economy differed significantly from Western understandings of economic feasibility, particularly in the field of energy services (e.g. von Hirschhausen and Wälde 2000; Ürge-Vorsatz et al. 2006; Bouzarovski 2009). Within the state-regulated energy sector, there were simply no concerns about reasonable profit margins, although this does not mean that costs of production were totally unaccounted. Yet, as Ürge-Vorsatz and colleagues explain, “there was no market mechanism to signal

⁸¹ Kattai, V. *et al.* Eesti põlevkivimaardla varu ümberhindamine, seisuga 01.01.1995. [Re-assessment of the resource of ‘Estonia’ oil shale deposit, as of 01.01.1995]. Available in the Estonian Geological Survey.

resource scarcity, market shortages or environmental damage associated with the use of a resource” (2006: 2283).⁸² With regard to oil shale, Soviet-era reserves were primarily delimited by the industry’s capacity to mine and process the mineral, notwithstanding rudimentary economic calculations which were not always taken into account in decision-making. It is therefore no surprise that the re-independent state could not rely solely on geo-technical criteria, but had to decide which part of the resource is viable and acceptable to exploit under the conditions of a capitalist economy (Reinsalu 1998a). The new methodology of 1997 integrated not only cost-benefit calculations, but also environmental and social considerations (cf. Barry 2008: 10). Nevertheless, the Estonian system continues to be detached from the methodologies of other Western countries, especially from the USGS approach described earlier. Most notably, Estonia accounts for oil shale exclusively as a *solid fuel* required for electricity generation, not as a potential source of oil.⁸³

The criteria and analytical units used for the grading of oil shale reserves originate in what could be called a Soviet ‘industrial science’ (cf. Bowker 1994), as follows from a key article published by the main author of the Estonian methodology (Reinsalu 1998a). Within the territory of the former Soviet Union, oil shale resources are not unique to Estonia. However, despite various other organic-rich deposits, only the kukersite resources of the North-western USSR have become industrially exploited. The Soviet Russian oil shale industry shared with that of Soviet Estonia the same resource base and operated in a visible distance from the industrial zone of North-east Estonia (see Chapter 4). As Reinsalu describes, Estonian and Russian

⁸² For conventional oil, see also Labban (2008).

⁸³ Although the Estonian industry started off with hopes for a domestic transport fuel industry, during Soviet times shale oil became a supplementary product for power generation and the chemical industry, as part of the Soviet “complex management” rationale (Holmberg 2008). According to Prof. Enno Reinsalu, shale oil production was then secretly subsidized through the power industry through complex institutional arrangements, which made any evaluations of its economic viability impossible (personal communication, 26 April 2010).

deposits have very similar characteristics, except that the Eastern part (called either 'Leningrad' or 'Oudova' deposit) represents a much shallower bed and lower content of organic matter, because it is located towards the margins of the Baltic Basin. Despite its lower quality, the other deposit was also mined, which is why Soviet authorities decided to base the criteria for reserves on the depositional characteristics of the "Russian" shale.

Since both deposits were regarded as storehouses of solid fuel for Estonian power plants, the Soviet classification used in conjunction two geological criteria for the definition of reserves: the thickness of the mineral bed and the quality of oil shale measured as the bed's average calorific value. According to Reinsalu, a third important criterion, the depth of the bed (which is the same as the thickness of overburden) was initially not considered, although this affects significantly the economics of mining.⁸⁴ Since these criteria were established in relation to the characteristics of the Russian deposit, Estonia's reserves came to include very thin and deeply bedded layers at the margins of the deposit, which were in fact 'economically senseless or technologically infeasible' to exploit (Reinsalu 1998a). In consequence, the total quantity of reserves was calculated to be very large, regardless of the costs and feasibility of extraction. Although Soviet criteria were later considered "arbitrary", the overall approach to evaluating oil shale as stocks of solid fuel measured in heating value became nevertheless well established and served as the basis onto which further economic calculations of marginal production costs were rested.⁸⁵

After Estonia took the course towards market economy, in 1996–97 the Institute of Mining in the Technical University of Tallinn worked out an updated methodology for mineral resources. For oil shale, the mining economists relied on

⁸⁴ The deeper the deposit is the more expensive extraction becomes.

⁸⁵ Enno Reinsalu, personal communication, 26 April 2010.

existing geotechnical criteria and sought to find a reasonable ‘economic’ threshold below which production is not sensible, or according to their terminology, the ‘cut-off grade’ for reserves, defined as “the minimal ore grade that will be mined economically when blended with higher grade ore” (Rudawsky 1986: 57). Following the axioms of mineral economics, they concluded that a resource can be counted towards reserves if it is technically mineable and “its costs of mining and delivery to the consumer are lower than the consumer’s expenditure on the procurement of any other resource” (Reinsalu 1998a). The other resource was commonly taken to be coal, since only coal could provide a substitute fuel for electricity generation, while coal-fired power stations in Germany were taken as a reference point.⁸⁶ The feasibility of extraction was thus calculated in ‘coal equivalents’, not in ‘oil equivalents’ (cf. Dyni 2006). Mining was deemed economic if the estimated yield of ‘trade oil shale’ from a given field proved less expensive than importing coal (Adamson 2005; Reinsalu 2005).

Following this logic, the Estonian cut-off grade reflects the capacity of power stations to generate heat energy from oil shale combustion. Hence, the most important characteristic of resource quality is taken to be its calorific value. The Mining Institute established the overall energy rating of the bed (measured in GJ/m²) as the main economic criterion for delimiting reserves. Energy rating is calculated as a sum of the products of total thickness, density, and average calorific value (kcal/kg) of the bed. Paradoxically, although Estonia’s total resource estimates are based on ‘geological references’ (see Table 4), the cut-off grade follows miners’ references, accounting for the *whole mineable bed* including both organic-rich layers from A to F1 and limestone inter-layers (Reinsalu 1998a; Koitmets et al. 2003; Valgma 2003). In case of selective mining, the thickness of layers and their calorific value are used as auxiliary criteria, as

⁸⁶ This is a hypothetical comparison. In fact, the Estonian power plants would not be technically able to operate on coal. Prof. Reinsalu, personal communication, 26 April 2010.

well as additional limitations such as environmental restrictions.⁸⁷ Environmental restrictions and other similar limitations were also taken into account. Further criteria such as the distance of production from consumers were identified, but eventually not included in the calculations (Reinsalu 1998a; Adamson 2005).

In this way, Estonia departed from an earlier system of resource classification and measurement that, following Barry (2006), could be called a Soviet ‘metrological zone’. The country started to adopt the Western approach to economically defined reserves by following some international guidelines such as the UN Framework Classification on Natural Resources from the 1970s (Raukas and Teedumäe 1997). Nevertheless, since there was no standard classification methodology designed specifically for oil shale, Estonian experts worked out their own unique system instead of a ‘transition’ from one metrological zone to another (cf. Dunn 2005). This system incorporates elements from two economic-political rationales, taking into account both recent demands for ‘economization’ and the legacies of the previous system of measurement. Even though the new system corresponds to some extent to the Western terminology of ‘economic’ reserves and ‘sub-economic’ resources (e.g. Klett 2004: 601),⁸⁸ the actual meaning and content of these categories was defined locally. As a result, the Estonian resource assessment exercise stabilizes the materiality of oil shale resources in relation to power generation.

Against this nationally specific background, the aggregate estimated stock of oil shale is currently divided into five reserve categories, which are shared across all

⁸⁷ See the decision of the Committee for Mineral Resources from November 1996, which follows the recommendations of the TU Tallinn Institute of Mining.

⁸⁸ According to Raukas and Teedumäe (1997), “Category T corresponds to category R1, category R to R2, category P to R3 in the UN classification. The term “active” expresses the economic (E) status of resources; while the term “passive” marks their subeconomic (S) status.”

mineral resources. These categories are established by law⁸⁹ and inscribed into the daily routines of the Land Bureau in monitoring and calculating the use of state resource assets in the official register of deposits. Overall, the classification system for oil shale incorporates three areas of concern: (i) the extent of geological explorations and knowledge, (ii) the characteristics of the mineral bed summarized as energy rating, and (iii) additional technical, environmental and social conditions.

Geological categories	Measured reserves (T)		Indicated reserves (R)		Inferred reserves (P)
Economic categories	Active (aT)	Passive (pT)	Active (aR)	Passive (pR)	

Table 5 The Estonian classification system for mineral resources, including oil shale reserves.

Regarding the level of exploration, as seen in Table 5, mineral resources are divided into three distinct categories based on a decreasing degree of *geologic assurance*. In an attempt to imitate international terminology (see e.g. Rudawsky 1986), these categories are sometimes (but not consistently) expressed in English as ‘measured’, ‘indicated’ and ‘inferred’ *reserves* (e.g. Valgma 2003), even though the original Estonian terms translate differently.⁹⁰ Measured reserves (Estonian category T) have been studied most thoroughly by geologists to the extent that it is possible to allocate such resources to mining. Indicated reserves (category R) are studied to the extent that it is possible to estimate their approximate quantity, but mining cannot proceed before further geological studies are carried out, whereas inferred reserves (category P) are only assumed to be buried at the margins of the deposit deriving from its overall characteristics and some initial discoveries.

Regarding the actual prospects of production, the first two geological categories are divided between two further categories expressing *economic feasibility*,

⁸⁹ Earth Crust Act, § 10, entered into force 1 April 2005.

⁹⁰ The letters T, R and P denote in Estonian language *tarbevaru* (literally “consumable reserves”), *reservvaru* (“reserved reserves”) and *prognoosvaru* (“projected reserves”).

or what Estonians term 'active' and 'passive' reserves. According to the law, only 'active' reserves are considered to be possible to exploit on the basis of both production costs and additional conditions. 'Passive' reserves, by contrast, have only sub-marginal economic value and cannot be exploited on the basis of currently available knowledge of economic and technical feasibility or socio-environmental considerations, although they may nevertheless turn out to be worthy of production in the future. The third group, inferred reserves, are neither given any significance as "resources" at all outside geologists' descriptions, nor included in the state records.

As noted earlier, the main criterion used to distinguish between 'active' and 'passive' oil shale reserves is the bed's average energy rating. Following the proposals of mining economists, 'active' reserves were established at a marginal energy rating of 35 GJ/m².⁹¹ The economists chose this cut-off grade because they concluded that otherwise it would be uneconomic for the industry to turn 'geological resources' into the qualified product of 'trade oil shale' through enrichment or selective mining. This means that nearly all beds with energy rating above 35 GJ/m² are considered economically sensible to exploit at the time being,⁹² even though the level of geological knowledge may vary, depending on whether these reserves are classified as 'measured' or 'indicated'. Until recently, the quality of oil shale used to be well above this threshold in most mines in operation, from 36 to 42 GJ/m², so the criteria have also corresponded to the realities of extraction (see again Reinsalu 1998a).

On the contrary, beds with energy rating between 25–35 GJ/m² are called 'passive' reserves. Such reserves are not deemed 'economic' enough to extract with

⁹¹ Or alternatively, the heating value of 8MJ/kg. Both numbers indicate the thermal energy obtained from direct combustion of oil shale in power plants.

⁹² With the exception of mineral beds below 0.5m in thickness. See the decision of the Committee for Mineral Resources from November 1996, which follows the recommendations of the TU Tallinn Institute of Mining.

currently available technology, but only of marginal economic value, and hence not mineable. This means that 'passive' reserves may become only conditionally exploitable in the indefinite future. In addition, most of the resource deposited under nature protection sites and densely populated or otherwise restricted areas are also classified as 'passive', even if their energy yield is higher than 35 GJ/m². These resources are non-exploitable regardless of their actual quality.

All distinct accumulations of kukersite with an estimated energy rating below 25 GJ/m² are not included under the economic categories of 'active' and 'passive' reserves and, consequently, not really accepted as a resource at all. Such low-quality stocks are relegated to the status of 'inferred reserves' together with other parts of the deposit that are not thoroughly explored by geologists but rather just assumed to be in the ground. These "reserves" have been excluded from state records altogether, except for the geological reports archived in the Geological Survey. However, it should be noted that the distinction between sub-economic ('passive') reserves and non-economic resources (i.e. only "geologically" inferred) was created rather arbitrarily. According to Reinsalu (1998a), the threshold of 25 GJ/m² was chosen to demarcate sub-economic status simply because in this way the reserves that were 'passive' for purely "economic" reasons (that is, between 25–35 GJ/m²) made up approximately double the size of 'active' reserves (over 35 GJ/m²).⁹³

What follows from these criteria is that only reserves that are both 'measured' and 'active' (category aT) are licensed for mining (Table 6). This does not imply, however, that all such resources can be extracted without further considerations. Every case for issuing a mining licence is handled separately, whereas environmental

⁹³ This excludes reserves that are 'passive' for socio-environmental reasons, whatever their quality. Enno Reinsalu at http://www.loodusajakiri.ee/eesti_loodus/index.php?id=518 (accessed 30 March 2011).

impact assessments may impose additional restrictions on extraction. However, in exceptional circumstances, an ‘active’ and ‘indicated’ reserve (aR) can also be allocated for extraction, for instance, when a company wants to extend its mine to a less explored resource after an ‘active measured’ (aT) reserve has become nearly depleted, but it would make sense to exhaust the entire field.⁹⁴ On the contrary, all ‘passive’ reserves (pT, pR) cannot be mined for the time being, or at least not before they are upgraded to ‘active’ reserves.

	Exploitable reserves		Non-exploitable reserves	
Categories	Measured ‘active’ (aT)	Indicated ‘active’ (aR)	Measured ‘passive’ (pT)	Indicated ‘passive’ (pR)
Size in 2013	990,860,300	303,529,400	1,755,763,100	1,723,954,600

Table 6 The total tonnage of remaining reserves in Estonia.
Source: Estonian Land Bureau.

In 2013, the state register accounted for nearly 4.8 billion tonnes of total oil shale resources.⁹⁵ Out of this less than 1 billion tonnes are considered exploitable under current regulations, i.e. these reserves are both ‘measured’ in terms of geological assurance and ‘active’ under economic and political criteria. The addition of ‘indicated active’ reserves would increase this figure conditionally to only 1.3 billion tonnes. Although geologically indicated reserves account for nearly half of Estonia’s resource base, such estimates are much more uncertain and may well diminish after more prospecting takes place. Despite remarkable uncertainty, such numbers have nevertheless been popular in more politically charged calculations of the ‘years left’ that remain for the industry to operate at the current level of production. One could simply divide total ‘measured active’ reserves with the maximum rate of mining (20Mt/year) and conclude that the industry should be able to maintain production for

⁹⁴ Interview at the Land Bureau, 22 April 2010.

⁹⁵ Available at <http://geoportaal.maaamet.ee/est/Andmed-ja-kaardid/Geoloogilised-andmed/Maardlad/Maavaravarude-koondbilansid-p193.html> (accessed 17 June 2013).

another 50 years. However, although it has become commonplace to refer to some sort of number between 40–50 years, this impression of continued resource availability is deeply deceptive.

First of all, it is unclear whether the Oil Shale Development Plan uses geological or mining references when stating the annual limit. If 20Mt refers to ‘trade oil shale’, then these quantities are not directly comparable with the state register, because the latter is based solely on geologically “pure” resources measured in laboratory conditions. If not, then the plan does not match the realities of mining. Yet a more substantial problem is presented by the fact that the state register accounts only for the total tonnage, without considering the declining quality of oil shale and its depositional characteristics (and certainly not its potential oil yield). Although it uses estimates of the bed’s average calorific value to distinguish between ‘active’ and ‘passive’ reserves, remaining fields are of progressively worse quality, i.e. closer to the cut-off grade of 35 GJ/m² or even below. As a result, the ‘geological resources’ given in Table 6 will yield less and less feedstock when mine fields become gradually exhausted. In addition, environmental or technological limitations on mining at greater depths may also reveal production ‘uneconomic’. Even if estimates of the total ‘in place’ tonnage are to be trusted, this is not the same as to say that all this material can be extracted. As the scholars of ‘peak minerals’ remind us:

Ultimately, it is not only resource exhaustion that is of concern with respect to sustainability, but the change in costs and impacts from processing ‘easier, lower cost’ ores prior to peak production for a given mineral, to ‘more difficult, higher cost’ ores post-peak (Prior et al. 2012).

In Estonia, the specificity of particular mines adds further complications to post-peak resource availability. Although there seems to be still plenty of resources or, at least, tonnes, in fact several mines approach depletion within the next few years and

are already in the process of being closed.⁹⁶ Every request to open a new mine has faced fierce opposition from the local population affected by mining, competing claims over resource use from other developers, and environmental concerns voiced by wider social groups.⁹⁷ The first new licences issued by the government have been taken to court and ruled to be temporarily suspended. Indeed, it is in the proximity of expanding mining fields where post-peak politics takes its most vivid forms. The question of whether all remaining reserves should be taken out of the ground thus becomes a matter of intense political debate through which alternative imaginations of the industry's future are created and contested alongside the enactment of distinct resource materialities.

5.5 Resources revisited: space and time under re-negotiation

Throughout this chapter, I have applied STS vocabularies, particularly Latour's, to my analysis of how oil shale becomes a resource. It does so through multiple chains of transformations or 'references' through which the materiality of the resource is conceived, circulated by different knowledge institutions or 'centres of calculation', and black-boxed in the apparently given and stable quantities of resources and reserves. I also described how the use of different 'references' has incurred contending conceptions and calculations of resource use. The future viability of exploitation is primarily affected by the changing ratio of 'mineral resources' to the supply of 'trade oil shale', given that resource quality degrades progressively when mining moves to peripheral areas.

Such 'references', however, can never be stabilized fully, but must remain reversible at any point in time (Latour 1999: 69). The last paragraphs of this chapter

⁹⁶ Kiviõli, Põhja-Kiviõli I, Aidu, Kohtla and Viru mines.

⁹⁷ Ojamaa, Põhja-Kiviõli II and Uus-Kiviõli mines.

investigate what may happen to local conceptions of the resource and reserves when the possibility of scarcity is perceived to become a reality. As we shall see, post-peak politics consists of both negotiating access to the remaining resource base *and* re-opening the black box of national oil shale science altogether. Quite remarkably, the authors of the Estonian resource assessment methodology have themselves called into question their ‘ready-made-science’ and requested to return to the process of ‘science-in-the making’ in order to explore opportunities for prolonged resource availability and exploitation (cf. Latour 1987).

As shown in Figure 10, in Estonia, the rethinking of resource availability comprises certain engagements with the changing materiality of oil shale in relation to unfolding time. Such engagements can be abstracted into three forms, which have different spatial extensions in relation to the map of the ‘Estonia’ deposit, as indicated by the “scale” arrow, while the “time” arrow is more provisional and added at my discretion. First, the industry tries to extract more out of operating mines by improving the yield of quality feedstock through technological innovation. Second, with the depletion of several mines, the industry has sought to dig up the last patches of high-grade resources located *within* the present mining zone by opening new mines next to the old ones. Third, and most intriguingly, there have been calls to re-define the resource altogether. The latter approach would increase the size of exploitable reserves by advancing extraction *beyond* the industry’s present frontier towards unexplored fields that are of progressively lower quality and less accessible. It is in this third sense that both geoscientific and economic calculations may become most radically contested and reconfigured.

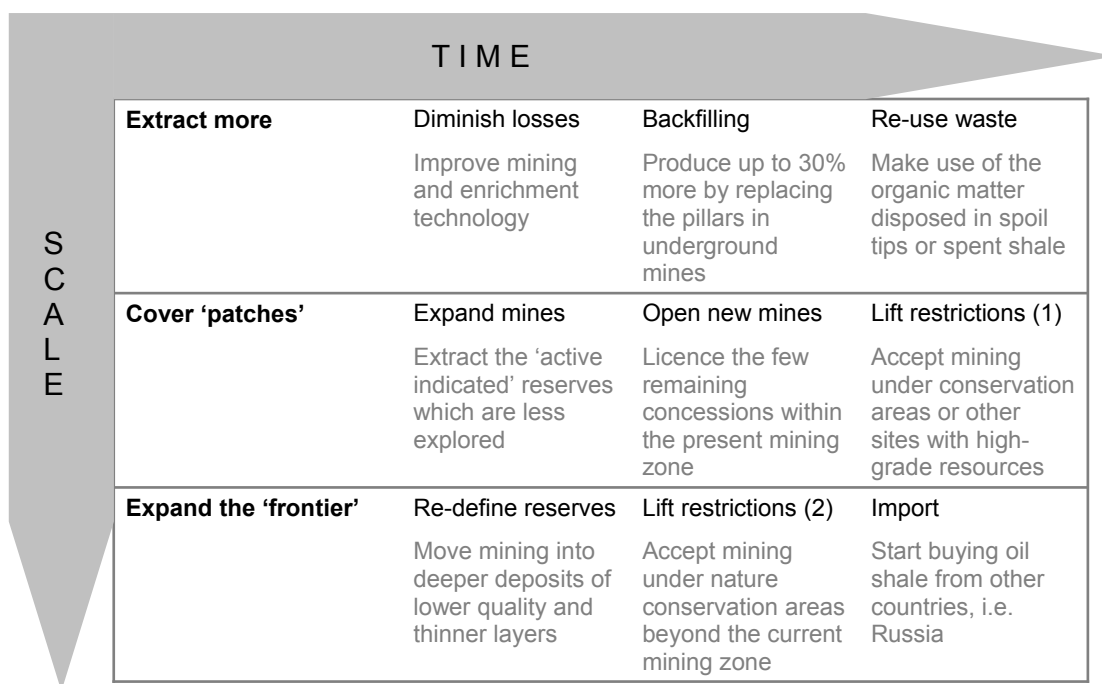


Figure 10 Examples of Estonian options for sustained resource availability situated in relation to unfolding time and space.

The first and most straightforward of these three main approaches is to maintain supply by improving efficiency in existing mines. The key challenge here is to increase the yield and value of 'trade oil shale' from degrading stocks through innovation in mining and enrichment technology. Although this course of action has been long called forth (e.g. Barabaner and Kaganovich 1993; Pastarus et al. 2008), there has so far been little interest in such improvements, possibly because the additional volumes to be gained may not be significant compared to the cost of investment required. Amongst these options, the most promising one is perhaps the idea of backfilling in underground mines. If currently a third of the in-place resource is "lost" due to being preserved in the pillars that prevent overburden collapse (e.g. Kattai et al. 2000: 89; Suuroja 2008: 439), then filling exhausted mines with an alternative material would enable significantly more organic-rich material to be extracted. Unfortunately, such a filling material is not yet available despite long-running experiments. At present, the industry is in the process of testing a mixture of

two types of production residues, the mining waste of limestone and the ashes gained from oil shale combustion (Meriste 2012). Although both materials are available in abundant quantities, their environmental safety is yet to be proven, especially considering the danger of harmful substances leaching from ashes into groundwater. However, even if these experiments are successful, then the technology can be introduced only in new mines, not in those that are already in operation.⁹⁸

Further possibilities of extending the 'age of resources' are made possible by rethinking resource materiality altogether. Notably, there are no pre-defined points at which the resource ceases to be oil shale, but rather flexible, shifting boundaries between various substances that make up the resource assemblage (cf. Lepawsky and Mather 2011). In the circumstances of potential shortage, the components and characteristics of the resource are rendered open for negotiation. The most extreme, albeit hypothetical example of this material transformation given in Figure 10 is to reuse the spoil tips of mining or enrichment waste in order to make use of their organic-rich residue, or alternatively, utilize the spent shale deposited next to oil factories, which also contains some organic matter. Although these latter options are not seriously considered, they illustrate the impossibility of physical resource depletion.

Technological innovation aside, another possibility is simply to open new mines. It is in response to certain mine closures and the pressure to open new mines that the post-peak controversy has acquired most publicity. As evidenced by recent events and debates over the development plan, Estonians are battling mainly over the last high-grade, unexploited reserves located within the present mining zone. These include not just a few 'active measured' fields still available for licensing, but also the

⁹⁸ Interview, 24 April 2010.

‘passive’ reserves locked under nature conservation areas that are potentially of economic value. Even though the government has halted the expansion of mining, having put more than ten applications on hold, a number of new mines are already being developed.⁹⁹ At the same time, the industry tries to extend the lifetime of existing mines¹⁰⁰ by requesting rights to the nearby blocks of ‘active indicated’ reserves, which may turn out not worthy of extraction once more geological studies have been carried out, as recently happened with Kiviõli mine.¹⁰¹ In the long term, however, the main option for sustained production would be to expand mines under conservation areas that cover a significant portion of remaining high-grade resources.¹⁰²

The process of opening new mines is far from straightforward, but hampered by competing requests from other developers to gain rights over the same resource (e.g. Uus-Kiviõli) and, even more disturbingly, opposition from local governments and inhabitants affected by mining. A further layer of complexity is added by regulatory constraints related to conservation areas. The possibility of extending extraction underneath vulnerable ecosystems has generated a heated controversy between local experts, with mining engineers being eager to prove that underground mining does not affect surface and groundwater levels, whereas a number of hydrogeologists, other scientists and laypeople claim the opposite (for only one snapshot of this debate, see Reinsalu 2006c).¹⁰³ While such debates will certainly continue for years to come, they

⁹⁹ Including the concessions of Ojamaa (soon to be opened by VKG), Põhja-Kiviõli II (licenced to Kiviõli Keemiatööstus) and Uus-Kiviõli (requested by both *Eesti Energia* and VKG).

¹⁰⁰ E.g. Aidu and Kiviõli mines

¹⁰¹ E24 online news “Kiviõli Keemiatööstus loobus kaevanduse laiendamise taotlusest” [Kiviõli Keemiatööstus gave up the idea to extend mine], <http://www.e24.ee/?id=332344> (accessed 18 April 2011).

¹⁰² Field notes, 1 September 2010.

¹⁰³ In the *Estonia* mine, for example, this highly controversial option may soon become a reality, since mining approaches rapidly a recently formed EU Natura 2000 site. See *Eesti Päevaleht* (30

have already imposed temporary constraints on supply, and possibly undermined the industry's confidence that access to the remaining resource base can be taken for granted.

In short, to paraphrase Corner (1999), such options are made possible by *remapping* the 'Estonia' deposit, whereby the first two spatialized engagements involve a 'downward excavation' *within* the map of the current mining zone. The industry needs to either maintain quality supply through technological innovation, or conquer the last unexploited plots scattered between operating and abandoned mine fields. A further possibility considered in Estonia is to expand the extractive frontier *beyond* the mining zone through an 'outward extension' towards lower-quality resources that are deposited much deeper in the ground – or even outside the territorial boundaries of the state.¹⁰⁴

The expansion of the frontier denotes a serious rupture in the making and 'economization' of the resource as such. At a time when companies compete over access to remaining fields and local people oppose new mines, there is also an increasing pressure to re-assess 'reserves' altogether. In the anticipation of scarcity, the authors of the national classification system have proposed that the 'cut-off grade' of 35 GJ/m² established in 1997 should be soon lowered to 30 GJ/m² in order to take

June 2009) "Põlevkivi ohustab Selisoo kaitseala" [Oil shale endangers Selisoo conservation area] available at <http://www.epl.ee/artikkel/472328> (accessed 18 April 2011).

¹⁰⁴ Although oil shale has been purchased in smaller amounts from nearby Russian mines up until 2005, large-scale imports are not considered for the time being, at least not publicly, since this would make Estonia vulnerable to uncontrollable pricing of a strategic feedstock (cf. Romanova 2008: 88). Romanova links the suspension of purchases to the introduction of EU emissions trading, but her argument is flawed since it applies only to the situation that Estonia sells the electricity produced back to Russia. If no electricity exchange takes place between the two countries, which has been the case in the last years, then the origin of the raw material does not make any difference, as combustion of domestic shale equally requires emissions quota. Rather, the reasons were related to security considerations. See also *Baltic Times* (3 August 2005), "Estonia cuts 'humanitarian' shale oil deal with Russia", <http://www.baltictimes.com/news/articles/13174/>; *ERR Uudised* (9 August 2005) "Savisaare Vene põlevkivi plaan kukub läbi" [Savisaar's Russian oil shale plan falls through], <http://uudised.err.ee/index.php?0553864> (accessed 25 June 2013).

into account ‘changing economic circumstances’ (Adamson 2005). If approved, this methodological trick would automatically increase the quantity of ‘active’ reserves and reveal many more areas accessible for development, many of which are located towards the periphery of the basin.¹⁰⁵

The proposal to re-calculate the ‘cut-off grade’ is given further weight by recent growth in *shale oil* production. With improvements in retorting technology (see Chapter 8), the oil industry may be able to accept lower-quality material straight from mines without the intermediate stage of enrichment, which is expected to raise the quantity of economically recoverable reserves even more (Reinsalu and Valgma 2007). If Estonia opts for increased oil production at the expense of electricity generation, as discussed in the following chapters, then this may bring the national system closer to Western perceptions of what makes oil shale *a resource* at all. If resource assessment is based on calculations of oil yield measured with the Fischer assay instead of the present laboratory measurement system originated by the calorimeter, then reserves would indeed become radically redefined.

But how is it possible to assess liquid fuel supply in a resource that for a long time has been experienced as an inferior coal, mined as coal, burnt as coal and calculated in ‘coal equivalents’? If at all, such a radical shift from measuring heating value to measuring oil yield cannot take place overnight. It would require not just a substantive switch between two distinct states of resource materiality (Chapter 4), but also an adjustment of metrological data to the changing geotechnical characteristics of the resource base. According to local experts, such re-calculations would make necessary an extensive study into the correlation between the two values, because existing data on oil yield are long outdated and no longer account for declining

¹⁰⁵ See also Oil Shale Development Plan, p. 26.

resource quality across particular fields and layers that are currently mined – not to mention differences between real-life retorting conditions and laboratory tests (Soone 2005). For the time being, the re-assessment is not yet officially considered. Nonetheless, mining engineers have already begun to experiment with the possible change in the metrological regime and speculated a new resource frontier at a potential oil yield of 0.8 tonnes per square metre, with a sub-economic frontier at 0.6 t/m².¹⁰⁶ If the increase in oil production is permitted by the government, then this will help companies to justify the expansion of mining under conservation areas and/or towards the margins of the basin, which has already triggered protest from environmental NGOs.¹⁰⁷

Prolonged resource availability is therefore achieved primarily through a re-consideration of oil shale materiality. When high-grade resources become depleted and the scale of mining expands, the resource may be accepted to contain less organic matter, or form delicate associations with other materials such as the mixture invented for backfilling, or even become resurrected from waste dumps. In all these cases, oil shale is still experienced as a *solid* substance. The shift to a different metrological regime based on oil yield, however, would be made possible only by a radical shift in the ‘ontological politics’ of the resource (Mol 1999), whereby oil shale is reinvented as a reservoir of *liquid* hydrocarbons. As discussed earlier, this switch between two states of materiality implies a radical ‘re-definition of nature’ (Mitchell 2010), since the Latourian ‘chains of transformations’ have to be taken back to their starting points.

¹⁰⁶ Field notes, 26 April 2010.

¹⁰⁷ Jüri Ott Salm, *Päevaleht* (2011, 31 January) "Põlevkivisõda Virumaal" [Oil Shale War in Virumaa], <http://www.epl.ee/artikkel/591890> (accessed 18 April 2011).

5.6 Multiple resources, multiple controversies

What the Estonian post-peak situation demonstrates is that fossil fuel ‘resources’ and ‘reserves’ are not fixed, pre-given categories, but dynamic and historically changing formations that result from locally situated practices of measurement and economization. This takes further the relational account of resource materiality proposed in previous chapters. Depending on how the distinction between ‘nature’ and ‘society’ is achieved through a series of geoscientific abstractions and other calculations, resources may come into being in multiple forms, as exemplified by the discrepancies between ‘in-place’ mineral resources, mining realities and standardized feedstock. The future viability of Estonia’s industry depends on the changing relationship between, and the definitions of, the abstracted ‘below-ground’ realities and ‘above-ground’ technical, economic and political constraints on mining.

In Estonia, the controversy over future resource availability, or what I have termed ‘post-peak politics’, takes various dimensions related to the multiple sites and constitutions of the resource. First, there is the nation-wide debate over access to remaining high-grade resources in the context of pressures to raise production after supply has become constrained due to the exhaustion of several mines. This debate acquired wide publicity with the preparation of the Oil Shale Development Plan, which set an annual restriction on the maximum rate of mining. Second, these national struggles resonate with more specific concerns articulated in the industrial region, where local governments and people fiercely oppose the expansion of mines. Given the rise of local opposition and more urgent problems related to Estonia’s admission to the EU, the question of long-term resource availability has become less salient in public, but it has not been cast aside. A further dimension of post-peak politics involves a possibility of rethinking the essence of the resource itself. Although there is no consensus over the size of remaining reserves and particularly the ‘age of

resources', no one disputes the fact that resource quality declines gradually when mining approaches the margins of the deposit. In these conditions, national experts have proposed that reserves should be redefined altogether by either lowering the 'cut-off-grade' based on heat energy or transitioning to a new metrological regime based on calculations of liquid fuel supply.

In sum, post-peak politics in Estonia revolves around both the question of the extent and rate of exploitation, *and* the renegotiation of resource materiality, thereby channelling into various forms and sites of controversies. While my analysis evidences the possibility of redefining the spatio-temporal scale of 'reserves', it does not indicate the timing and nature of actual resource depletion. There will be always some organic matter locked in the rocks along with abundant wastes dumped above the ground. To put it succinctly, the Estonian "oil shale age" will not end for lack of shale.¹⁰⁸ This is not to say that there will be no material constraints on production at a certain point of time when high-quality resources are used up. Indeed, if there is either no incentive to redefine reserves or the industry's expansion is deemed unacceptable for socio-political reasons, then scarcity may well become a reality. In the event of such 'economic resource depletion' (Prior et al. 2012), supply shortage may be encountered much sooner than acknowledged in public, for the lack of qualified feedstock comes to resonate with technological limitations and market competition amongst other, more political constraints related to the EU climate and energy policy.

The Estonian example therefore appears to support the 'anti-naturalist' idea that resources are deeply conditioned, if not exclusively defined by 'above-ground' outlooks for economic utilization and technological innovation. Nevertheless, I would

¹⁰⁸ This is my rewording of the famous quote ascribed to Sheik Zaki Yamani, a former Saudi oil minister: "The stone age did not end for lack of stone and the Oil Age will end long before the world runs out of oil" (see also Boal et al. 2006: 63).

argue that 'below-ground' resource materiality cannot be separated from the constitution of reserves in geoscientific, economic and political calculations. Rather, furthering Mitchell's (2002) argument, what counts as 'the material world' and 'the economy' are both *outcomes* of an ongoing 'process of manufacture' between various human and non-human agencies (see also Bowker 1994; Braun 2008). Hence, the case confirms that resources should be conceptualized in non-dualistic terms as a dynamic, historical index of both techno-economic and material factors – neither representations of physical reality, nor solely social constructs. Such formations may become subject to revisions or indeed “depleted” if the socio-material dynamics underlying the constitution of resources change.

This argument does not imply in any way that 'reserves' are useless concepts for political decision-making. Quite the contrary, categorical thinking in terms of reserves assists local actors in their attempts to alleviate mounting uncertainty and think through the future of their energy economy. Moreover, having both political and anti-political effects, such projective devices may serve contending aims. For example, the limited 'age of resources' measured in total tonnage and years supports the industry's opponents, such as environmental NGOs, in their calls for transition to alternative sources of energy. In turn, the very same figures serve opposite claims voiced by the government and the industry, which silences the fact that resource decline may call extraction to an end much sooner than this is commonly anticipated. In the meantime, future-oriented energy politics in Estonia has shifted from the controversy over the resource base to other mediums of radical uncertainty, as explained in the following chapter.

Chapter 6. Securing Supply or Supplying Security? Anticipatory Energy Politics in Estonia

6.1 There is no debate?

*Did you say your research focuses on the debate in Estonian society? My darling, you are totally misled. There is no debate!*¹⁰⁹ Juhan Parts, the Minister of Economic Affairs and Communications responsible for Estonia's energy policy, is a wise and straightforward man. A former Prime Minister and a former Auditor General, he has been leading the ministry for the last six years, after a successful political and civil service career. He is a strong advocate of oil shale exploitation, seeing it not just as a "backbone to our energy system", but a "backbone to our independence" (Parts 2009). He alone represents the owner of the largest state-led strategic enterprise, the Eesti Energia electricity monopoly, and has recently managed to avoid being forced to resign because of his close ties with the company. There is no debate, he says. Any dissenting analyses voiced by other experts are "based on nothing", just "mere opinions amongst many" which "deserve no discussion", he also says.¹¹⁰ Who is to contradict him? For the last 50 years, the majority of Estonia's electricity has come from burning the low-calorific indigenous resource. Even after two decades of re-independence that have seen growing national awareness about the industry's environmental impacts, economic inefficiency and resource decline, in conjunction with external pressures from international authorities, the electricity sector has showed few signs of change. Instead, it appears to be flying firmly in the face of EU climate and energy policy, since Parts and his colleagues strive to put national energy security issues on the map of the single market, even if they need to achieve this at the expense of environmental

¹⁰⁹ Field notes, 17th October 2010, Colorado (my translation).

¹¹⁰ *Postimees 'E24' online news* (29 October 2012) "Juhan Parts: 50 aastat vana romu tuleb välja vahetada" [The 50-year-old jalopy needs to be replaced], <http://www.e24.ee/1021838/juhan-parts-50-aastat-vana-romu-tuleb-valja-vahetada/> (accessed 29 January 2013).

sustainability, economic competitiveness and ‘security of supply’ in a narrower sense.¹¹¹ Nonetheless, despite Parts’ confidence in the continuing importance of the industry, in practice, there is no consensus about the future of the country’s energy economy. Nor is there consensus concerning who is entitled to contribute to this debate about the future or, as Parts’ remarks suggest, whether such a debate even exists.

If the scarcity of a resource has to be understood in more than geological terms, then how should one address the role of political and economic discourses in defining the trajectories of national energy systems ‘past the peak’ (Bridge 2011b)? This chapter approaches possible transformations in the energy sector as a geographically contextual, highly contested and continuously reproduced process (Jiusto 2009). For the Central European and Baltic countries whose admission to the EU coincided with the building of a common European market for electricity and gas,¹¹² ‘energy transition’ has tended to be equated with the restructuring of state-regulated systems under neoliberal principles of free market competition and consumer choice (Bouzarovski 2009). This has occurred at a time when the EU has assumed global leadership in moving towards a radically lower carbon economy by cutting 80–95% of all emissions, as outlined in the ‘Energy 2050’ roadmap.¹¹³ Despite the EU accession criteria, the new member states are notorious for their resistance to the liberalization, ‘unbundling’ and privatization of national energy sectors (von Hirschhausen and Wälde 2000; Bacon and Besant-Jones 2001; Ürge-Vorsatz et al.

¹¹¹ Juhan Parts (12 March 2008) “Eesti energiamajandus peab arenema turupõhiseks” [Estonia needs to develop a market-based energy economy]. Opening speech at the Energy Forum, <http://energiaforum.blogspot.com/2008/03/juhan-parts-eesti-energiamaajandus-peab.html> (accessed 11 March 2010).

¹¹² The EU joint electricity market was opened in July 2004 for wholesale and in July 2007 for retail.

¹¹³ Compared to the 1990 baseline instituted with the Kyoto Protocol. See http://ec.europa.eu/energy/energy2020/roadmap/index_en.htm (accessed 8 February 2013).

2006; Bouzarovski 2010; World Bank 2010). While there is now growing recognition in postsocialist studies that the theoretical vision of a linear “transition” from state-centred planning into a market economy has been misleading, at best (Mandel and Humphrey 2002; Dunn 2004; Pickles 2010; Smith and Timar 2010; Collier 2011), the everyday realities of energy sector reforms have taken on unexpected dimensions and unanticipated pathways (Bouzarovski 2009, 2010). The Baltic region has posed remarkable challenges for the consolidation of European markets, and continues to do so even in 2013, when Estonia became the last member state to open its electricity sector fully for competition. To echo the words of Merje Kuus, a native Estonian geographer and professor at the University of British Columbia, the country “has stumped Sovietologists, transitologists, and EU bureaucrats alike, as all have seen their most elaborate theoretical frameworks undermined by inconvenient developments on the ground” (Kuus 2007: 8).

The chapter therefore addresses the restructuring of Estonia’s energy system as a ‘socio-technical controversy’ (Callon et al. 2009), where the situation of radical uncertainty has led to heated debates over alternative technological, economic and political options. Given the EU requirements, the extent to which oil shale continues to be extracted has become a critical ‘political’ issue in Estonia, both within the formal institutions of parliamentary democracy and beyond. Following Callon and Barry, I take ‘the political’ to be “a space of dissensus and contestation which is not reducible to [state] politics” (Barry 2001: 207, 2005a). Furthermore, according the ‘object-oriented’ approach, it also denotes the tentative alliances of human actors with their ‘matters of concern’ and the places where possible forms of collective life are mapped into knowledge and action (Latour 2004, 2005a). The planning of Estonia’s energy policy is a ‘thing-politics’ in the most direct sense of the term: it revolves exclusively around oil shale and the associated socio-technological systems through which the

resource is rendered explicit and circulated. As a result of the controversy, collective conceptions of the strategic resource, national security, and the role of the state and ‘the market’ in governing the sector become adjusted and redefined.

While the politics of oil shale in Estonia revolve around a resource they also concern *the future*. They entail, in other words, a ‘politics of anticipation’. Following Barry’s definition of politics, Kinsley (2010a, 2011) argues that politics of anticipation stretch beyond the codified, institutionalized practices associated with scientific and political authorities to include frictions between multiple ways of anticipating and disciplining the future. What escapes Kinsley’s attention, however, is that anticipatory politics also involves dissensus about the ‘*matter* of politics’ (Braun and Whatmore 2010), including the conditions of future possibility or ‘realities’ that demarcate the forms and spaces of disagreement. Such realities do not precede the formulation of *what* is at stake, since it is no longer clear what counts as real or unreal, and how this reality will unfold and become materialized in the present. In this sense, anticipatory politics is always ‘ontological politics’ (Mol 1999). If the object called ‘oil shale’ has contending versions and forms of existence, as documented in Chapters 4 and 5, then which one of them is going to be performed: a feedstock for power plants, a source of oil, or no energy resource at all? In practice, such future options do not amount to a discreet list of ‘possible worlds’ subject to rational calculation (Callon 1998; Callon et al. 2009), but reflect contingent *outcomes* of an ongoing objectification of reality. The distinction between past, present and future becomes blurred; what has not yet arrived is partly open and partly defined by the decisions that have already been taken, at the same time as it reconfigures the present.

Drawing on Mol’s research questions (see Chapter 3), the chapter probes the ‘where?’, ‘what?’ and ‘how?’ in the politics of anticipation in Estonia. *Where* are the

options located when energy politics take place? *What* is at stake in relation to other objects, issues and realities? *How* can anybody distinguish and choose between apparently discreet options in cases of inter- and path-dependent trajectories? And underlying all these questions is the question of the actors *who* assume the authority to evoke, resist, debate, and decide between alternative futures, as well as their relations with other agencies in making certain options visible while concealing others, since anticipatory politics revolves around “the ongoing negotiation of control over what it is possible to say about the future” (Kinsley 2011: 238). The changing nature of ‘the thing’ is bound up with questions of the role of techno-scientific expertise, mere politics and lay knowledge in the formulation of national energy policy.

Some of these questions have already been answered in previous chapters, in which I explained *what* the ‘resource of the future’ is. The following turns to anticipatory energy politics as a further way of making the ‘*future* of the resource’. The chapter is divided into two parts. The first two sections discuss the entanglement of oil shale as a patrimony in national understandings of energy security in light of various options for energy sector reform. Instead of an ‘energy transition’ pre-determined by EU energy and climate policies, here one can witness multiple transformations simultaneously put to work which imply ‘contending geographical futures’ (Bridge et al. 2012). The second part of the chapter plunges deeper into the politics of anticipation by disclosing *who* acquires the expertise and authority to define the place of oil shale in the energy economy, and with what implications for conceptualizations of energy security, the resource’s meaning and its significance. The chapter concludes that the industry’s future is less foreclosed by external authorities than rendered open through a ‘reconfiguration of expertise’ at the national level, through which the

boundaries between market and non-market practices of energy governance are renegotiated alongside the resource itself.

6.2 Patrimony and security

In Estonia, there has been little dispute over *what* the oil shale resource is. As documented in the previous chapter, oil shale has primarily been understood as a resource for power generation. As a major feedstock for thermal plants, oil shale has long secured Estonian residents and businesses with affordable electricity, economic competitiveness, and increasingly, direct export revenues. With more than 90% of electricity (Figure 11) and about two thirds of primary energy supply (TPES) derived from oil shale over the last decade (Figure 12), the country continues to be a net exporter of electricity at the time when there is a recurrent deficiency in the Baltic region, especially from 2010 when the EU forced Lithuania to close down the Ignalina nuclear power plant. Although the statistical importance of oil shale in electricity generation has dropped in recent years, from 91% in 2008 to 86% in 2012, the amounts of mined shale have simultaneously gone up due to rapidly growing exports of both electricity and shale oil. In 2011, Estonia exported 60% of its total electricity produced.¹¹⁴ Following a “special status” attributed to oil shale in 1998, the state’s key objective enshrined in several national planning documents is to ensure continued supply of oil shale-based energy, and thereby guarantee the country’s energy independence.¹¹⁵ However, national energy policy conceals an inconvenient paradox:

¹¹⁴ Statistics Estonia press release (7 June 2012), “Introduction of renewable sources of energy has significantly reduced the share of oil shale in electricity production”, <http://www.stat.ee/57642> (accessed 7 February 2013).

¹¹⁵ According to Hamburg (2001), the planning of energy sector reforms started immediately with the restoration of Estonia’s statehood in the early 1990s, with the first document created under a grass-root initiative already in 1989. However, in 1998, the state authorities took decisions to give oil shale a “special status” during the EU negotiations and establish a monopoly in oil shale-based power production. Oil shale’s central position was later reaffirmed with the ‘Long-term

what serves today as the ‘backbone to independence’ was built by the occupying regime with little consultation. Despite the large-scale ecological devastation and non-ethnic immigration carried out under the aegis of the Soviet government, the restoration of Estonian statehood also restored the position of oil shale as a *patrimony*, the ‘wealth of the nation’ which is inherited with its territory and embedded in the labouring bodies and expert knowledge of the people, and which provides the key material warranty for economic growth, social security, and hence national sovereignty (cf. Perreault and Valdivia 2010). Seen as a patrimony, Estonia’s sole indigenous fossil fuel becomes inextricably bound to nationalist sentiments of security of supply, and energy security more broadly. As noted earlier, the European integration process was initially expected to create a major disruption to this seemingly uniform politics.¹¹⁶ Since Estonia started accession negotiations in 1995 and the implications of EU requirements became clear, expert calculations and national planning documents alike have prescribed that the share of oil shale in the energy mix will be lowered significantly (e.g. Laur and Tenno 1999; Francu et al. 2007; Tammeoja and Reinsalu 2008). Yet no decisions have been made over the last two decades as to how to achieve this goal. In spite of external pressures, various exercises in scenario-building, and public and less-public disputes, the situation has *de facto* remained largely unchanged: Estonia’s energy economy continues to be dominated by the high-carbon resource, with the government increasingly taking pride in the industry’s “unique” technological expertise in the field and growing capacity to export.

Development Plan for Fuel and Energy Economy’ (2004-2015), ‘Oil Shale Development Plan’ (2008-2015), and implicitly supported by ‘Electricity 2005-2015’ and ‘Electricity 2018’ plans.

¹¹⁶ Conversely, the process probably also helped to consolidate national energy politics, since this uniformity was not so evident before accession, but produced in opposition to *both* the Russian and EU imperialist threats.

In other words, the energy sector appears to ‘hang together’ in a surprisingly coherent discourse (cf. Mol 2003).

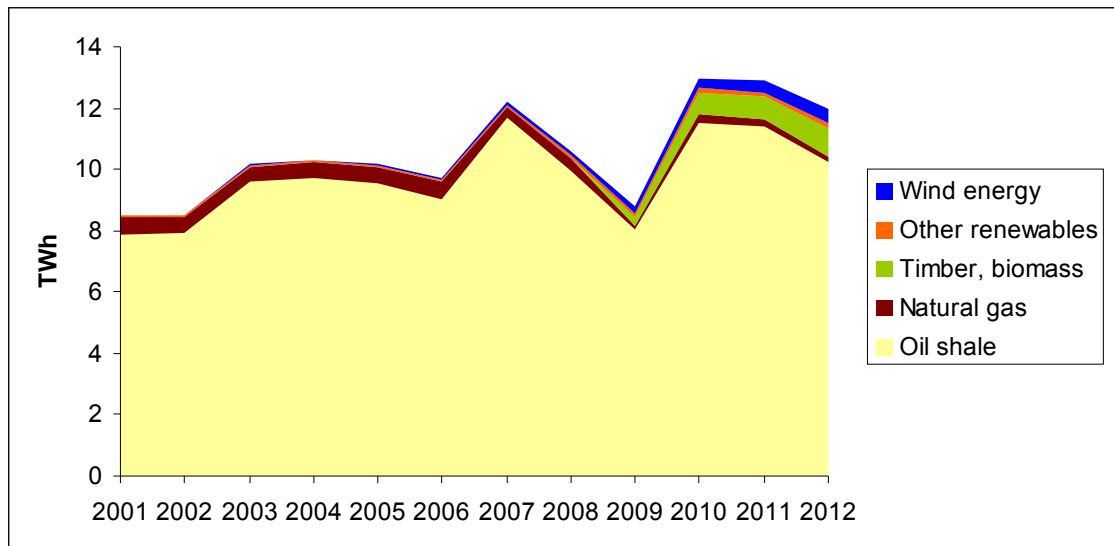


Figure 11 The share of oil shale in Estonia's electricity production¹¹⁷
Source: Statistics Estonia.

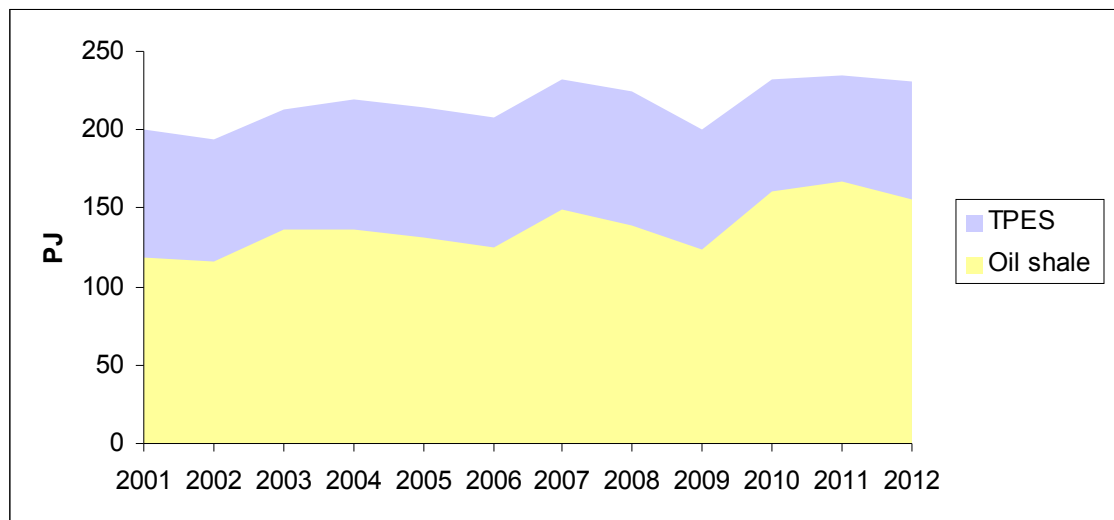


Figure 12 The share of oil shale in Estonia's total primary energy supply
Source: Statistics Estonia. *Note:* The data of oil shale includes only raw material, not final energy products, but the increasing share of oil shale is nevertheless directly related to growing exports of electricity and shale oil.

Yet, in principle things could have been otherwise. Oil shale could not have become a solid mineral resource, the substitute for coal that is so deeply embedded in local socio-technical networks and conceptualizations of (energy) independence. It

¹¹⁷ 'Oil shale' here includes minor amounts of shale oil and gas used for electricity production.

could have been enacted as a potential liquid fuel resource – and indeed, from time to time it has been. It could have turned out to be *a non-resource*, for there are many other ways to produce transport fuels or to generate electricity. All these other ‘framings’ of the resource have not been erased by history, but still coexist in the present, not least because the power and oil industries are techno-economically dependent on each other (Chapter 8). In part, the diverging trajectories and viewpoints characteristic of national energy politics can be explained by the multiplicity of the resource, the ‘shale-to-power’ and ‘shale-to-liquids’ discourses, but not exhaustively. While the essence of the resource as such is still little disputed, there is a debate over where, in what ways and to what extent oil shale should continue to be a power resource. Hence, one should resist the deterministic explanation that the resource’s rise to such dominance in Estonia is due to its high quality and the industry’s access to the right technology at the right time. Having previously explained how oil shale assumed this unique standing historically (see also Holmberg 2008), the following explores further how its continuing importance has been justified in terms of the demands of ‘energy security’. I also explain the extent to which this ‘reality’ has begun to be challenged by alternative voices, objects and possibilities, although, as we shall see, with difficulty.

In broad terms, ‘energy security’ is taken to denote “reliable and adequate supply of energy at reasonable prices” (Bielecki 2002: 237), but the concept is highly ambiguous in both theory and practice. There is no uniform definition as to how exactly, for whom, with what mechanisms, and at what costs energy is made available. As several analysts have argued, energy security has various elements or components based on distinct logics of security which mean different things to differently situated actors (Ciută 2010; Sovacool and Mukherjee 2011; Bridge and Le Billon 2013). For example, the European Commission tends to define energy security as ‘security of

supply' in combination with environmental sustainability and economic competitiveness. This notion of security forms part of an emerging knowledge-based lower-carbon economy, which is predicated on a regionally integrated, albeit subsequently 're-territorialized', energy market (cf. Newman 1998). The key tenets of this vision are liberalization and infrastructural integration, diversification of strategic hydrocarbon supplies, high energy efficiency, wider use of renewable sources, and technological innovation with the outlook for 'a new global industrial revolution'.¹¹⁸ In the absence of a common EU energy policy, however, the political elites of member states have prioritized and mobilized radically different components, which are legitimized through wider national sovereignty and security claims, notwithstanding the inherent multiplicity and contestability of these terms. In turn, as energy represents the invisible material fabric of daily life or 'a prime mover', it has assumed the potential to "normalize security and render it politically unexceptional" (Ciută 2010: 124). According to Ciută, the totalizing force of energy implies further that 'security' is at the heart of *all* action, for both expert and lay actors, no matter how the concept is understood. This makes it necessary to study contextually the political and normative underpinnings of practices through which energy security is articulated, legitimized, and contested.

While the EU vision precludes the development of such carbon-rich resources as oil shale, in Estonia the possession of an indigenous fuel invokes normative statements with contradicting implications. Whereas for proponents of exploitation it conveys a sense of security in the present, opponents emphasize a moral obligation to preserve the resource for future generations. Due to a strong association between

¹¹⁸ Directive 2005/89/EC of the European Parliament and of the Council of 18 January 2006 concerning measures to safeguard security of electricity supply and infrastructure investment; Communication from the Commission to the European Council and the European Parliament, *An Energy Policy for Europe* (2007) http://europa.eu/legislation_summaries/energy/european_energy_policy/l27067_en.htm.

resource patrimony and national security, however, very few local actors have been able to renounce oil shale as a non-resource. National energy governance revolves around this patrimony-security nexus, which renders political choices and operations highly complex and contradictory, but nonetheless impermeable to serious contestation. The dominant discourse, which is still prevalent at the time of market deregulation, compels the state to supply its citizens with reliable and affordable electricity produced within its territorial borders, and thereby remain immune to external forces of political and technical leverage, despite the fact that Estonia has one of the best grid connections amongst EU countries which would enable all consumption to be covered with imports (Elering 2011).¹¹⁹ Combined with the institutional and technical legacies of Soviet energy regulation (see Bouzarovski 2009), energy security is premised on self-sufficiency and state ownership in isolation from extra-territorial supplies.

What one may want to call a ‘nationalist’ framing of the energy sector is therefore strikingly at odds with the neoliberal framing of economic reform that Estonia adopted without reservations (see Gillies et al. 2002; Hannula et al. 2006). In contrast to the overall reform-oriented mindset of state leaders, all political parties have shown remarkable resistance to the liberalization, unbundling and privatization of the sector, rejecting the three neoliberal modes of energy governance that underpin the policies of the EU, OECD and international lending agencies (Bacon 1995; Bacon and Besant-Jones 2001; Bouzarovski 2009). Although “market opening” eventually became a reality in January 2013 following a three-year delay that was granted to Estonia to ensure ‘security of supply’,¹²⁰ Eesti Energia remains the only state-run

¹¹⁹ See also ‘Long-term Development Plan for Fuel and Energy Economy’ (2004-2015).

¹²⁰ Directive 2008/3/EC of the European Parliament and of the Council of 15 January 2008 amending Directive 2003/54/EC as regards the application of certain provisions to Estonia.

industrial complex that has been left fully under the control of the government despite repeated attempts to sell part of the company's shares to foreign investors. Today, the former electricity monopoly continues to act as a large vertically integrated company, incorporating oil shale mining as well as major capacities for power generation including several wind farms and the majority of network utilities, even though a few smaller independent companies have become involved in the distribution business. The operation of transmission networks was separated from electricity production only in 2010 and moved under a new state-owned company called Elering that now acts as the transmission system operator (TSO) for Estonia (Figure 13). Despite this, generation and distribution capacity is still largely controlled by the subsidiaries of Eesti Energia, which is expected to remain a *de facto* monopoly even after the retail market is fully opened, due to the lack of both competition and infrastructural connections within the Baltic Sea region.¹²¹

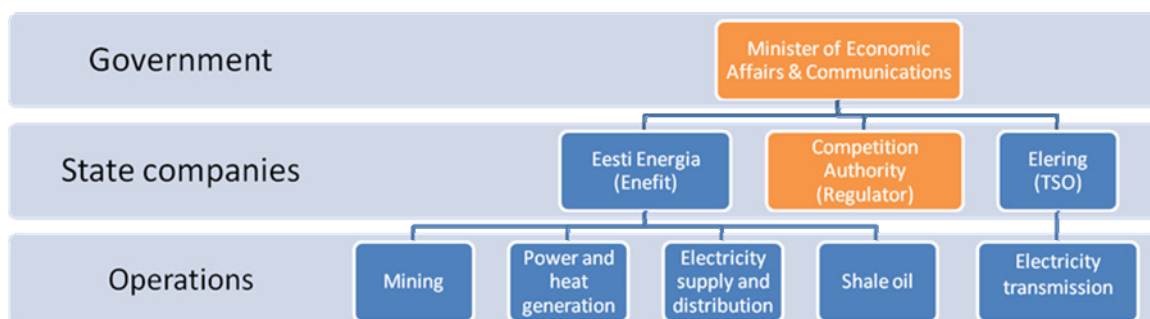


Figure 13 The organizational structure of the state-regulated electricity sector in Estonia.

The persistence of such ‘nationalist’ approaches to government policy implies that electricity continues to be regarded as a public and strategic good, rather than an exchangeable good traded like any other market commodity (Bielecki 2002; Westphal 2006). State-guided provision of energy services thus exemplifies Mitchell’s (2002,

¹²¹ For an overview, see e.g. the European Commission’s report on Estonia, http://ec.europa.eu/energy/gas_electricity/doc/ee_energy_market_2011_en.pdf (accessed 15 February 2013).

2007) argument that the smooth functioning of the free market always hides a range of non-market practices and institutions on which its existence depends. Instead of finding a clear-cut, territorially and temporally marked distinction between socialist and capitalist regimes or a “transitional region occupying some intermediate space” (Mitchell 2007: 246), it is precisely the protectionist mode of energy regulation that has played a key role in enabling a market economy to be realized in Estonia.

The government’s recurrent flirtations with privatization further demonstrate how energy security arguments have blurred the distinction between market and non-market practices in state policy, for conservative and liberal parties alike. Since Estonia restored its independence, there have been two serious attempts to draw in private investment capital in order to replace the Soviet-era thermal power units that were commissioned over 40 years ago (Veiderma 2003: 300). The first was the sale of 49% of the shares of Narva Power Plants, Eesti Energia’s subsidiary, to a U.S.-registered company called NRG Energy; an agreement from which the government abruptly pulled out in early 2002 following six years of negotiations.¹²² Kuus (2002) argues that the intense debates triggered by the ‘NRG’ deal effectively tied issues of security to national sovereignty. In what developed into ‘an unprecedented elite and popular protest campaign’ against the privatization of national assets, fears of higher electricity prices and loss of economic independence were pitted against wider political strategies of aligning the US interests against the alleged threat of Russian imperialist manoeuvres (2002: 405). According to Kuus, nationalist accounts of security and sovereignty were characteristic of pro- and contra-privatization arguments alike, since both were grounded on the need to continue to use oil shale instead of importing Russian power.

¹²² *The Baltic Times*, (17 January 2002), “U.S.-Estonian energy deal falls through” <http://www.baltictimes.com/news/articles/5891/> (accessed 24 January 2013). Also see Holmberg (2008: 216-217).

In the second attempt at privatization, involving the initial public offering (IPO) of a quarter of Eesti Energia's shares for 400-500 million EUR on the London stock exchange, security arguments acquired similar prevalence and, for some local actors, resonated strongly with the memories of the 'NRG' case. Again, the government vetoed privatization at the last minute at a closed cabinet meeting in May 2010, after ministers had made several moves in favour of the offer, with foreign consultants earning lucrative salaries from preparing what was about to become the largest privatization in London in years.¹²³ While the 'conservative' wing of the coalition along with Minister Parts used energy security rhetoric to rally public support behind the deal, the 'liberals' led by Prime Minister Ansip rejected the IPO for fear of losing state's control over its strategic assets. Those who attended the meeting were not convinced that the government would maintain its right to intervene in energy policy choices once the company was governed by UK law, whilst Eesti Energia did not manage to give an adequate explanation as to why the sector suddenly needed such a large-scale investment, especially for shale oil development in other countries, and why privatization was deemed better than the alternative option of the state injecting fresh capital into the company following a more detailed investment plan.¹²⁴ Ultimately, the company's hopes for world-scale business were undermined by multiple and conflicting fears over the loss of state control, security and reputation:

¹²³ *Financial Times* (11 May 2010), "Estonia's Eesti Energia eyes London IPO", <http://www.ft.com>. According to Estonian media, Eesti Energia paid over 3 million EUR to Lexicon Partners in London and other consultants for preparations, and timed the IPO with the building of a new shale oil plant in Estonia and deals with the governments of Jordan and Morocco (see also Chapter 8). Sulev Vedler and Tarmo Vahter, *Eesti Ekspress* (20 May 2010), "Kuidas Ansip hoidis ära Eesti suurima erastamise" [How Ansip turned down the largest privatization in Estonia] <http://www.ekspress.ee/news/paevauudised/eestiudised/kuidas-ansip-hoidis-ara-eesti-suurima-erastamise.d?id=31148707> (accessed 15 February 2013).

¹²⁴ The cabinet relied in its rejection on an independent analysis prepared by the National Audit Office ("Riigikontrolli arvamus riigi äriühingu Eesti Energia AS investeeringute rahastamisotsuse ettevalmistamise kohta aastatel 2008–2010"), as well as a secret analysis from the Ministry of Finance, which detailed the alternative option of using government bonds ("Memorandum valitsuskabineti nõupidamisele: Eesti Energia ASi omakapitali suurendamisest riigi poolt").

The politicians had many fears, which no explanation could dispel. They were afraid of the Russian capital. They were afraid that somebody might steal. They were afraid that somebody might become too rich. They were afraid that the (new) shale oil factory would fail. They were afraid that Brussels would screw up Eesti Energia's business altogether. They were afraid of giving promises that they could not fulfil, and that foreign investors might demand large sums for the damage in court. They were afraid of becoming the notorious people who bargained Eesti Energia away.¹²⁵

In this case, a mixture of hope and fear (and other affects) does not open up a sense of future possibility or a 'method' for reorientation (Bloch 1998; Miyazaki 2006), but paralyzes decision-making in the present. Although placed a decade apart, both the 'NRG' and 'IPO' events suggest that privatization may be considered equally to enhance and undermine energy security. Overall, these examples demonstrate that what is at issue here is not so much the traditional 'state versus market' dilemma (Barry and Slater 2005b), but the central role of oil shale as the material basis for security. Whether explicitly mentioned or not, oil shale is portrayed as the hidden material force that guarantees not only supply, competitiveness, jobs, vital income for the state and local municipalities, and social and political stability in an industrial district populated by non-ethnic workers (Meriküll et al. 2012), but in all these ways acts as a kind of security instrument against 'the omnipresent Russian threat to the Estonian statehood' (Kuus 2002: 409). Although state authorities increasingly recognize that there are other possible definitions of 'energy security',¹²⁶ in practice security is 'modulated' into oil shale (cf. Ciută 2010). Ultimately, security arguments 'shift the site of the decision elsewhere', so that the shale-based energy system appears to be 'no decision, but a fact' (Mol 1999: 80); an objectively given situation which deserves no debate.

¹²⁵ My translation from Sulev Vedler & Tarmo Vahter, *Eesti Ekspress* (20 May 2010), "Kuidas Ansip hoidis ära Eesti suurima erastamise" [How Ansip turned down the largest privatization in Estonia].

¹²⁶ See e.g. <http://www.vm.ee/?q=en/node/4116>. According to the *National Security Concept of Estonia* approved by the Parliament in 2010, 'energy security' has five constituents: security of supply, security of infrastructure, connectedness to the EU energy infrastructure, diversity of energy sources and energy efficiency, which can be supported by strengthening the EU energy policy. See http://www.vm.ee/sites/default/files/JPA_2010_ENG.pdf (accessed 19 February 2013).

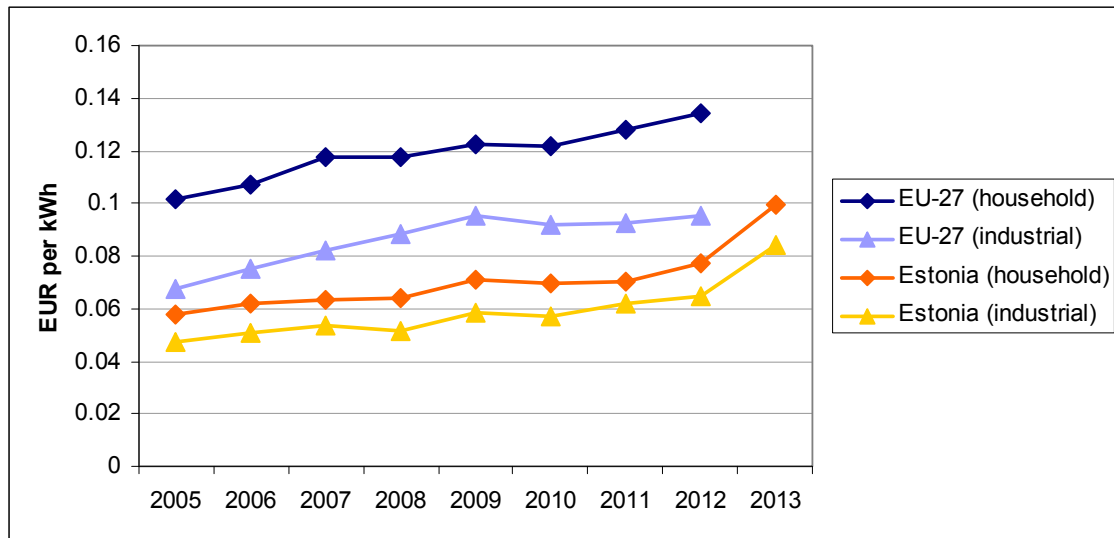


Figure 14 Average electricity prices in the EU and Estonia.

Source: Eurostat. Note: Among the 27 member states only Bulgaria offers cheaper prices.

At the same time, one can easily identify mixed, if alternative views to patrimony and security. The extent to which oil shale exploitation was rapidly expanded in association with the electrification of the entire Soviet Union (Hughes 1983; Holmberg 2008), and the enormous social and environmental destruction that resulted, provides one entry point for deconstruction of the paradigmatic discourse. The highly polluting and energy-inefficient process of burning such a low-calorific material was contested by local experts as far back as in the 1960s, when large-scale power units were first commissioned under the auspices of Moscow authorities (Holmberg 2008: 177, 185). Alternative ways of utilizing the patrimony have thus been recognized as a result of decades of inherent tensions and disagreements within expert circles, although there has been neither clear incentive nor opportunity to reform the sector. Re-independence made possible a situation wherein dissenting views could be fully released and gather pace in parallel to the EU enlargement process. The industry has since been viewed in highly controversial terms – at once a showcase of technological expertise *and* a relic of backward Soviet industrialism; a critical source of economic growth, employment and state dividends *and* a heavily

subsidized sector; a warranty of political stability *and* a potential factor of instability confronting mainstream EU policies.

Whereas oil shale is continuously set up as a strategic weapon against the imperialist threat, these alternative interpretations have disclosed certain elements of insecurity within the same discourse. For example, the most cited risk is embedded in the physical dependence of the Baltic electricity grid on the frequency of the transmission network uniting Russia and Belarus, although Estonia has proscribed any commercial exchange of power with its Eastern neighbour for energy security reasons (see Chapter 7).¹²⁷ Another risk, which was often recalled by my informants, resides in the fact that the dam that provides power plants with essential cooling water from the Narva River bordering Estonia is fully controlled by Russians.¹²⁸ So, whereas the dominant paradigm of 'energy security' ties oil shale to national sovereignty and defies other definitions, including the EU low-carbon vision, it conceals security risks that exist due to the geography of the Soviet-era infrastructure (cf. Hughes 1987). Mocking the desire for isolation, a local journalist has suggested that the ultimate "touchstone for Estonian nationalism should be to forsake the electricity enabled by the occupiers".¹²⁹ Furthermore, such inconsistent, if conflicting logics and elements of security may shift in time when actors choose to prioritize other elements. In consequence, oil shale becomes politically productive precisely because it is actively securitized and de-politicized through deterministic accounts of both the resource and state sovereignty.

¹²⁷ The previous *Concept of National Security* from 2004 acknowledged "the great dependence of Estonia's gas and electrical systems upon foreign monopolistic energy systems and suppliers" as a major threat. This statement has been excluded in the 2010 document, which now provides an extended discussion of energy security without mentioning the infrastructural risk. See http://web-static.vm.ee/static/failid/067/National_Security_Concept_2004.pdf (accessed 19 February 2013).

¹²⁸ Interviews 4 May, 14 June, 24 August, 20 September 2010.

¹²⁹ My translation from Andrei Hvostov's column in *Eesti Ekspress* (8 February 2013), "Eesti haigus" [Estonian disease], <http://www.ekspress.ee/news/paevauudised/elu/eesti-haigus.d?id=65640362> (accessed 15 February 2013).

In brief, in Estonia politics is oil shale and oil shale is politics (to paraphrase Bijker 2005). The science and technology of exploitation are permeated by political disputes just as much as politics is permeated by specific technical choices. To say this does not mean that oil shale has always acquired high visibility in parliamentary and extra-parliamentary politics. Quite the contrary, the availability of cheap electricity (see Figure 14) has long been taken for granted and has hitherto attracted little public attention. Nevertheless, pervading all forms of social and economic life, oil shale has always been present in debates that at first sight may seem to have nothing to do with its extraction. Indeed, its matter-energy has been part and parcel of the building of the Estonian state and economy from the very beginning (cf. Mitchell 2002; Braun 2008). It would therefore be a mistake to say that the EU imposed an alternative ‘technological frame’ on an otherwise homogeneous energy system created by the planned economy (Bouzarovski 2010) because, as Bouzarovski also admits, the Soviet frame was never fully stabilized in the first place. Rather, the accession process penetrated a space that has always been characterized by multiple options and alternative framings of both the resource and the organization of energy provision. It only highlighted the complexity of the situation by opening these two black boxes at the same time. Even if public debate about the sector’s future has been limited, the failed vision of a “transition” has facilitated other, far-reaching transformations, because the ‘things’ and ‘realities’ at stake have helped to reconfigure expertise, reconceptualize security and, at least potentially, mobilize new ‘publics’ that open energy issues up to wider political contestation.

6.3 Disrupted transitions

What happens when the invisible material fabric of everyday life that is usually left unexamined is rendered visible and open to public interrogation in the face of

enduring uncertainty? The ‘transitional period’ prescribed by the Accession Treaty marks a major rupture to the paradigm of electricity provision in Estonia, because neither the course of the open market nor the technical solutions required to restructure the sector in order to fulfil the various criteria of *acquis communautaire* were known in advance.¹³⁰ European policies on environmental pollution and energy regulation potentially undermine the competitiveness of the Estonian oil shale industry and, for some actors at least, entail the need to move from a carbon-intensive, state-planned economy to a progressively lower-carbon and/or market-led system. Over the last several years, various prerequisites of this ‘transition’, particularly the constraints imposed by the Landfill directive, the LCP and IED directives, the internal energy market packages, and most seriously the recent EU climate and energy policy with its ‘20-20-20’ objectives, changing rules of carbon trading and the ‘Energy 2050’ roadmap have all required major investments, technical innovation and institutional reforms, and were anticipated to call extraction to a halt (Table 7). Challenging the conventions previously held by Estonia’s political elites, the EU regime has enabled previous disagreements to be channelled into a nation-wide ‘socio-technical controversy’ with radically new possibilities for re-defining the resource, security, state-market relations and the role of non-government actors, whereas the EU regime has not proven immune to contestation either. As explained below and in the next chapter, post-accession governments have not passively accepted external European requirements, but assumed an active role in both their design and their translation into practice (see also Kuus 2004; Lehti 2005).

¹³⁰ Estonia’s success in meeting the EU requirements has from time to time depended on novel technical inventions, some of which have turned out successful, while others have not. Amongst the techniques mentioned in the following there has been remarkable uncertainty over the processes of fluidized bed combustion (FBC), ash disposal, and de-sulphurization and de-nitrification, as well as problems with frequency and intermittency in the electricity grid in the event of large-scale admission of renewable energy or separation from the Soviet grid.

EU legislation	Deadline	Consequences
Internal Market in Electricity Directive 2003/54/EC Derogations for Estonia 2004/85/EC, 2008/3/EC	2008, but extended until the end of 2012	Estonia was granted a transitional period for joining the EU electricity market in order to restructure the oil shale sector and, meanwhile, ensure security of supply. The transition to a fully open market was completed by 2013, with 35% of the market opened earlier in April 2010.
The Large Combustion Plant Directive (LCPD), 2001/80/EC Industrial Emissions Directive (IED), 2010/75/EU (combines LCPD, IPPC and other acts)	2012	Following Estonia's accession treaty, national SO _x emissions were limited to 25.000 tonnes in total, resulting in a closure of two units with 302MW capacity in the 'Balti' power plant. Compliance has also required large-scale investments into deSO _x systems for four units (with eight boilers), as well as additional deNO _x systems, which are currently being tested.
	2016, but extended to the end of 2023	SO _x and NO _x limit values will be bound to 'stack emissions', which requires another four to six older pulverized combustion units with 636MW-948MW capacity to be closed down. Alternatively, they can be put in reserve until 2023 with limited operating hours.
The Landfill Directive, 1999/31/EC	16 July 2009, but was cancelled	Estonia was required to discontinue liquid waste disposal in landfills by gradually replacing the current 'hydro-pulp' transport system for oil shale ashes with a 'semi-dry' technique and decreasing the amounts of high alkaline hazardous waste disposed. However, the requirement was abolished after experiments with inventing a novel disposal technique failed.
Directive 2009/29/EC on the Emissions Trading Scheme (EU ETS)	2005–2012 (Phase I and II)	Estonia received generous emissions allowances under the National Allocation Plan and initially earned lucrative revenues from the sale of spare allowances.
	2013–2020 (Phase III)	Free allocations are halted in principle, with the exception of 'optional derogation' which gives Estonia a right to phase out free emissions gradually.
National Emissions Ceilings (NEC) Directive, 2001/81/EC	After 2016	National levels of SO _x and NO _x emissions are expected to be lowered across the EU after 2016, which may restrict the burning of heavy fuel oils, including shale oil (e.g. in boiler houses), and affect the sales in the EU market.
The Fuel Quality Directive		At the time of writing, the directive is being revised in order to set a lower 'default value' on carbon-heavy fuels, including those produced from oil shale and tar sands. Estonia continues lobbying for an exemption which would enable shale oil to be competitive in the EU market.

Table 7 The most significant restrictions imposed on the Estonian industry by EU legislation.
Source: EU documents, Elering (2010, 2011, 2012), interviews.

At the core of this socio-technical controversy has been the possibility of replacing the ‘shale-to-power’ discourse with alternative sources of supply, including nuclear energy, renewables and natural gas, whereas the ‘shale-to-liquids’ framing of the resource has been recovered in parallel. The primacy of oil shale and its association with wider technological systems and markets is interrogated with two strategic planning documents titled the ‘Energy 2020’ plan¹³¹ and the ‘Electricity 2018’ plan¹³², which were approved in 2008. Contrary to the Oil Shale Development Plan and earlier policy documents,¹³³ these plans did not foresee any physical limits to resource availability, but the critical factors necessitating change were the EU requirements on environmental protection and market competition. Most urgently, Estonia was expected to be forced to close down all of its Soviet-era power units based on pulverized combustion of oil shale by 2016 due to the LCP Directive. These units account for up to 66% of national generation capacity, with only two recently built units based on the fluidized bed combustion (FBC) technology allowed to stay in operation (Francu et al. 2007; Elering 2010).¹³⁴ Even if some older units could be renovated, it was feared that they would turn out uncompetitive due to the upcoming changes in carbon trading rules (Mäe 2009; Maigre 2010; Elering 2011). The preparation of Estonia’s energy plans was further affected by the moves that the EU coincidentally took in 2007-2008 towards a common energy policy by accepting the

¹³¹ In Estonian *Energiamajanduse arengukava aastani 2020* [‘Development Plan for the Energy Economy until 2020’], also known as ‘ENMAK’

¹³² In Estonian: *Elektrimajanduse arengukava aastani 2018* [‘Development Plan for the Electricity Economy until 2018’], also known as ‘ELMAK’.

¹³³ *Kütuse ja energiamajanduse pikaajaline arengukava aastani 2015* [‘Long-term Development Plan for Fuel and Energy Economy until 2015’], approved in 2004.

¹³⁴ Estonia has 2437MW of total installed generation capacity (excluding wind power), out of which 1614MW is not compatible with the LCP directive on SO_x emissions. However, some of this capacity can be maintained if equipped with de-SO_x units. In 2010, Elering predicted that 1358MW (55%) will be closed down (Elering 2010). The first two FBC units were commissioned in 2005.

‘climate and energy package’ and the ‘third energy market package’.¹³⁵ The state officials responsible for the planning process considered the ‘20-20-20’ targets the main culprit for the industry’s potential dissolution following deregulation. Following requirements to increase the share of renewables in production, curb greenhouse gas emissions despite a generous Kyoto baseline, and tackle the economy’s extremely high energy intensity, the status of oil shale as a warranty of supply was quickly cast into doubt. The period following the 2013 and 2016 milestones, in particular, was anticipated to mark the beginning of a major uncertainty, and created a sense of emergency for decision-makers against the background of longer-term constraints.

Unlike earlier national strategies, which had also indicated the intention to diversify supply and lower the share of oil shale, but failed to either inform or predict the future,¹³⁶ these new plans did not foresee a single transition route to a less carbon-intensive economy. Instead, the ‘Electricity 2018’ document outlines five possible ‘scenarios’ or combinations of generation capacity based on oil shale, other fossil fuels (including natural gas, oil shale gas, and coal), combined power and heat plants (CHP) and windmills (Figure 15). None of these ‘possible worlds’, which were originally devised by Eesti Energia¹³⁷, was officially selected, although the government favoured the ‘C1’ scenario for economic and security reasons, combined with elements of ‘B’ as the most environmentally friendly alternative (Figure 16). Despite heading towards diversification, the core principle of both plans is that all generation capacity – and

¹³⁵ The Presidency Conclusions of the European Council (8/9 March 2007) emphasized environmental sustainability and climate change mitigation for achieving security of supply and competitiveness, while respecting the states’ “choice of energy mix and sovereignty over primary energy sources”. The Council supported an action plan for 2007-2009, which culminated with the ‘energy and climate package’ approved by the European Council and Parliament in December 2008.

¹³⁶ The earlier ‘Electricity 2005-2015’ plan opted for natural gas as the main alternative source of supply, but this has since become unattractive due to the dependence on Russia as a single supplier.

¹³⁷ Interview, 20 April 2010.

ideally also the resources for feedstock – should originate within the borders of the state, whereas exports are acceptable only after domestic needs are met.

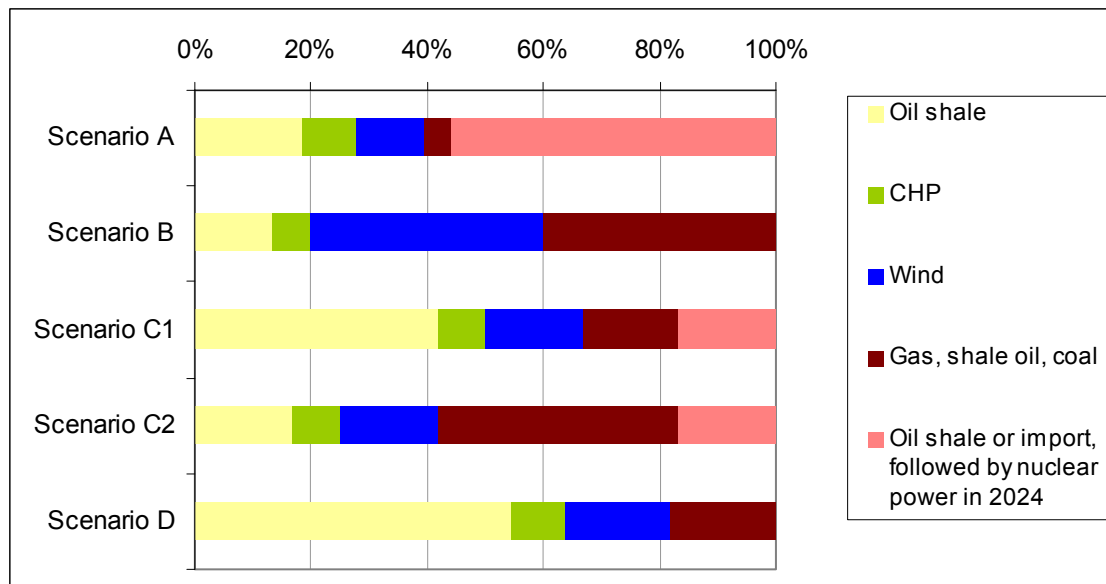


Figure 15 Scenarios of electricity supply after 2018 according to the ‘Electricity 2018’ plan.

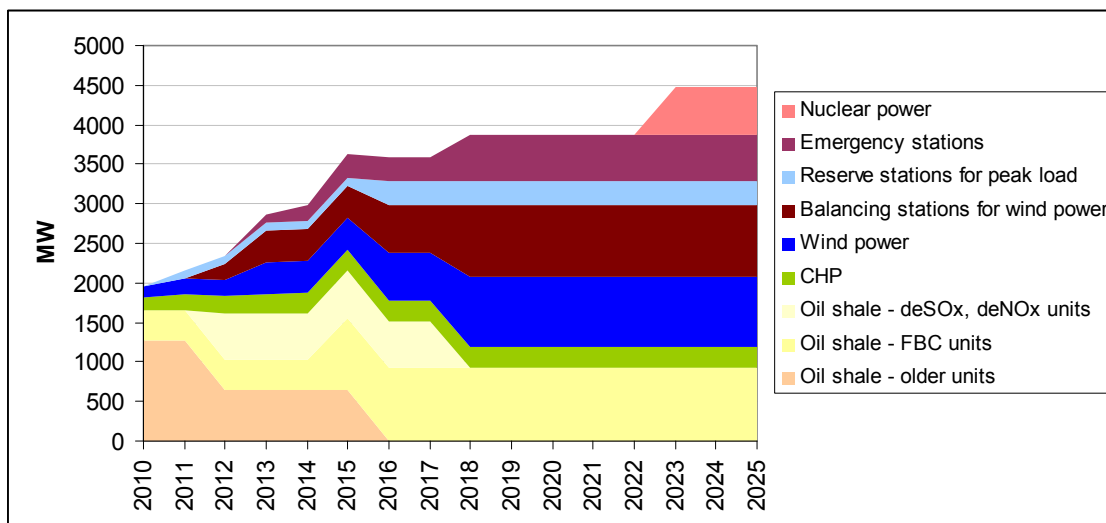


Figure 16 The preferred electricity mix foreseen in the ‘Electricity 2018’ plan.¹³⁸

These energy plans together with their scenarios provide a ‘framing’ of the resource in certain ways. Oil shale is considered to provide the state with security even in the event of marketization by covering up to 70% of electricity supply before

¹³⁸ Note that this reflects total installed capacity, not regular generation, where emergency and reserve stations do not participate and any deficit in wind is compensated by balancing stations.

the development of new nuclear power plants in the region.¹³⁹ However, while nuclear power was considered a serious alternative to oil shale by some local experts and entrepreneurs before the Fukushima incident, it has since lost favour in the public realm. Following the vision of self-sufficiency, 'shale-to-liquids' is mentioned only as a second-rank option after electricity needs are covered. Although the 'Energy 2020' plan indicates that there is potential for the 'export of expertise', the local market is considered too small for a large-scale oil industry, whereas 'Electricity 2018' values shale oil only as a supplement to gas turbine plants alongside imports of gas and coal.

Paradoxically, whereas the energy plans served to restore certainty over the future by affirming the continuing importance of oil shale, the final documents capitulated before the radical uncertainty that pervades future trajectories of market competition and pricing in both electricity and carbon trading. The state was deemed unable to exert its energy policy preferences on the private sector after deregulation without subsidizing the construction of strategic generation capacity, which principally meant a new oil shale-fired power station. This revelation once again diffused the boundaries between market and non-market practices *and* between different enactments of the resource. The open market located options everywhere, so that no single transition seemed possible.

Real life, meanwhile, has followed none of the scenarios outlined above. The statistical importance of oil shale has only started to decline, while production has in fact increased. Instead of anticipating and disciplining the future, the exercise of scenario-building opened up a space for inventive action in which the EU requirements were both translated into practice in previously unforeseen ways and themselves redesigned. The most remarkable example here is the harnessing of shale-

¹³⁹ There have been plans to either build a small nuclear power station in Estonia or participate in the investments made into new capacities in Lithuania or Finland.

fired power plants to meet one of the EU '20-20-20' targets – to cover 20% of gross energy consumption with renewables by 2020 (25% for Estonia)¹⁴⁰ – alongside the national objective to produce 15% of electricity from renewables by 2015 and 20% by 2020. Having missed earlier milestones,¹⁴¹ Estonia has managed to rapidly raise the share of renewables, and became the first member state to already reach its target in 2012 at 25.9%¹⁴² - whereas the 2015 target for electricity was also met in 2012.¹⁴³ A key secret behind this achievement is the practice of adding timber and other biomass to the combustion of oil shale in the furnaces of Narva power plants.¹⁴⁴ In consequence, Eesti Energia has turned out to be the main beneficiary of subsidies for renewable energy since they were introduced in 2007, having received over 30% of the entire national support for burning biomass with oil shale (NAO-Estonia 2012).

Disputed as an inefficient use of bio-energy, which not only deprives other companies from market share and subsidies, but also distorts the local timber market, the practice has sparked furious protest amongst Eesti Energia's competitors, consumer associations, the forestry industry, oppositional political parties, and several energy experts.¹⁴⁵ The Narva furnaces, both existing and yet-to-be-built, have thereby developed into the major 'thing' or 'issue' (Latour 2004, 2005a) around which the

¹⁴⁰ Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

¹⁴¹ With regard to electricity, renewables accounted for only 1.75% in 2007, but the 5.1% target for 2010 required with the Accession Treaty was already met in 2009 (Elering 2011).

¹⁴² See also Statistics Estonia press release (07 June 2013) "Introduction of renewable sources of energy has reduced the share of oil shale in electricity production", <http://www.stat.ee/65326> (accessed 7 June 2013). According to Eurostat data ('share of renewable energy in gross final energy consumption, %'), Estonia reached 24.3% in 2010.

¹⁴³ Elering press release (30 January 2013), "Renewable Energy Grows to Nearly 15% of Total Consumption Last Year", <http://elering.ee/renewable-energy-grows-to-nearly-15-of-total-consumption-last-year/> (accessed 9 June 2013).

¹⁴⁴ Another equally important factor is the large-scale use of timber and biomass in heat generation.

¹⁴⁵ The intensity of these debates can even be seen in the titles of published articles, e.g. Kaja Kallas, *Postimees* (8 September 2010) "Energiatiivikud poliitika tuules" [Energy mills in the wind of politics]; Rene Tammist, *Eesti Päevaleht* (1 July 2011), "Puit Narva kateldes on hullumeelsus" [Timber in Narva furnaces is madness]; Tiit Kolk, *Postimees* (1 August 2012) "Riiklik experiment – toetus rikastele" [State experiment – support for the rich]; *E24* online news (27 August 2012) "Tants ümber Narva hakkpuidukatla" [Dance around Narva billet furnaces].

dimensions of anticipatory energy politics are demarcated (Figure 17). Whereas there has been little coordinated debate on the industry's overall future, the matter-of-concern nevertheless has the potential to occasionally generate specific 'sub-issues' alongside new 'publics' (Marres and Rogers 2005; Marres and Lezaun 2011). Amidst hot contests, the nitty-gritty details of law have repeatedly been adjusted to either enable or disable co-combustion, while Eesti Energia suspended the practice in late-2012. However the case will ultimately be judged, it illustrates that different regulatory regimes can be inventively arranged to co-exist in the same socio-material assemblage, without major technical innovation or demarcation between low- and high-carbon pathways (cf. Barry 2001).



Figure 17 The 'Eesti' power station near Narva town.

Note: The 'Eesti' power station along with the nearby 'Balti' station forms Narva Power Plants, a subsidiary of Eesti Energia.

The industry's socio-technically "unique" position has simultaneously enabled a careful adjustment of EU law. Following negotiations over the IED directive, Eesti

Energia was not just allowed to maintain four older units equipped with de-SOx installations, but was exceptionally permitted to use the rest with limited working hours until 2023. In consequence, only two units out of twelve, which accounts for 12% of total generation capacity, were permanently decommissioned (Elering 2011). This decision follows an earlier derogation from the Landfill Directive which allowed Estonia to continue dumping the highly alkaline ashes of oil shale combined with water until 2009 (Francu et al. 2007: 24; Mäe 2009), but was eventually removed from the Treaty altogether after the industry failed to find alternatives to the ‘hydro pulp’ transport technique and reduce the amounts of liquid waste disposed (Figure 2, Chapter 3). As detailed below, these derogations have rendered the industry’s long-term prospects even more multifaceted and contested, since there is no immediate need to close power stations and no technical capacity for large-scale imports to the Baltic ‘energy island’, except from Russia.

Although a sense of urgency has now been lifted, the government has moved forward with its original plan to support the construction of a new oil shale power plant with two FBC-based units¹⁴⁶ in addition to the maintenance of older ones. The development of new units was prescribed under the ‘C1’ scenario and strongly supported by Minister Parts as the only way to guarantee security in case ‘the market’ renders investments into generation capacity unattractive or uncompetitive. Following a compromise made in the ‘IPO’ case, the government agreed to support Eesti Energia to the same extent as was expected from private investors,¹⁴⁷ even though it was unclear where the money should come from and whether Brussels would approve State aid. Amidst enduring uncertainty over the pricing of both electricity and emissions, widespread contestation within the political coalition and

¹⁴⁶ Each 300 MW or 275MW in net capacity.

¹⁴⁷ The sum was fixed at 7 billion Estonian kroons before Estonia joined the euro-zone.

opposition, serious shortcomings in procurement procedures and investigations into possible corruption, Parts eventually forced through the decision in the name of security even against the will of Eesti Energia's managers who began to oppose the plant.¹⁴⁸ The company has since begun to receive a series of state investments in addition to corporate bonds issued in London, possibly also for foreign development projects.¹⁴⁹ Although it continues to be widely disputed whether Estonia needs to build any fossil fuel power stations or even to renovate old ones, the first new unit is now under construction, with the second one currently suspended.¹⁵⁰

Meanwhile, other actors have pointed out that Estonia has enough capacity until 2020-23 to secure continued supply, given that IED restrictions have been deferred, while investments into grid connections with the Nordic market continue to be enforced (Elering 2011; NAO-Estonia 2012). In effect, while the 'Electricity 2018' plan does not define 'energy security', but tasks the state to "guarantee continuous and sustainable electricity supply with reasonable prices", the narrower concept of 'security of supply' defined by generation adequacy and grid reliability has begun to work against the paradigmatic discourse that sees no alternative to oil shale. In practice, the circulation of various security logics between political institutions has resulted in a schizophrenic situation, where investments are made to figure in all possible scenarios at the same time.

¹⁴⁸ The government decided to support the new station at a cabinet meeting on 5th May 2011 with 560MEUR secured for the Alstom corporation despite contrary advice supplied by the Auditor General, who also informed the government of the new derogation until 2023. See also Sulev Vedler, *Eesti Ekspress* (11 October 2011) "Kelle huvides lasi Parts kulutada sadu miljoneid eurosid?" [In whose interests is Parts' decision to spend hundreds of millions of Euros?] <http://www.ekspress.ee/news/paevauudised/majandus/kelle-huvides-lasi-parts-kulutada-sadu-miljoneid-eurosid.d?id=65091936>

¹⁴⁹ The government has decided to make a 150 MEUR capital increase in 2012, to be followed by up to 200 MEUR in 2013 and another 200 MEUR in 2014. At the same time, Eesti Energia paid the state 73.5 MEUR dividends in 2012.

¹⁵⁰ See *ERR News* (17 January 2013), "Eesti Energia puts brakes on plant expansion", <http://news.err.ee/economy/f6f4d60f-99de-4dcc-989c-0e0fbce7b918> (accessed 10 April 2013).

At a time when the significance of ‘transition’ continues to be tested at home, Estonians have been surprisingly successful in protecting the ‘uniqueness’ of their industry in Brussels. This resonates strongly with the observations that Kuus (2004, 2007) has made on the communication of national security and geopolitical matters in the EU and NATO expansion. According to Kuus, security programmes were not single-handedly authored by Western politicians and intellectuals and imprinted on candidate states, but the former relied equally on vernacular notions of security and a handful of ‘gatekeepers’ fluent in the local language and familiar with local problems. The repeated derogations from the *acquis* that Estonia has received due to oil shale’s “special status” support Kuus’ argument. The formation of expert knowledge and judgments is a ‘two-way’ process, as Kuus suggests, where local actors strategically deploy some Western concepts while transforming their content and meaning. With respect to energy, Estonia has developed into a proactive policy regime (cf. Bouzarovski 2010), where the government has not just deferred transition, but installed national security considerations amidst ongoing EU policy dialogues over the design of the internal market and its relations with third countries (see Kisel 2009; Mäe 2009).¹⁵¹ Kuus’ analysis stops half way, however, for she does not explain how expertise is formed and defended *within* the recipient country. She emphasizes the role of a small circle of ‘elites’ in silencing alternative views, but does not explore how this concealment is achieved. Whose expertise counts as legitimate? How is the (in)competence of experts or non-experts disclosed and defended?

In order to address these questions, the second half of the chapter pursues two lines of argument. First, the Estonian case reveals that the ‘elite’ process of informing

¹⁵¹ In addition to the political engineering of environmental and market regulations, Estonia has also started to rework the power relations vested in physical infrastructure, by (i) renovating domestic power capacity and investing in the Lithuanian NPP in opposition to competing projects, notably the Kaliningrad NPP, (ii) disintegrating itself from the Russian electricity grid, (iii) competing with Finland over the siting of a strategic LNG terminal (see also Grigas 2012).

European authorities' knowledge may become challenged by alternative claims to national expertise. Contrary to Callon's analysis of the dynamics of knowledge controversies (Callon et al. 2009), however, one can find no clear boundaries here between experts and lay people, which are distributed across discreet political spaces and 'publics'. Rather, drawing on Mitchell (2002), anticipatory energy politics is underpinned by shifting knowledge and power relations between different sets of expertise and even *within* the 'monopoly of expertise' itself that has been imposed over the use of oil shale, sovereignty issues, and energy governance overall. Importantly, the rule of experts is neither homogeneous nor stable. The second argument is that the securitization and depoliticization of oil shale does not just delimit the space of 'the political', but simultaneously opens up new possibilities of contestation alongside novel conceptualizations of security, state-market relations, and the resource's future position. It has both anti-political and political effects similarly to resource assessments (cf. Barry 2001, 2005a).

6.4 Conflicting expertise

Energy issues have long formed a strictly expert realm in Estonia. Few people have the opportunity to familiarize themselves with what often requires highly specialist knowledge and access to restricted sources of information. These *energy elites*, I argue, define what options are acceptable to pursue under the banner of 'energy security', and what options are rejected as irrelevant, incompetent, and unconceivable. Yet, at a time when oil shale has effectively been securitized, depoliticized and rendered a matter of expert decision-making, it has also become the object of a form of re-politicization. This has occurred not just due to the EU deregulation and decarbonisation agendas, but due to the ongoing contestation and reconfiguration of national expert knowledge that has occurred in parallel. As we shall see, the rise of a

new generation of managerially educated experts at the expense of technical expertise has enabled the self-sufficiency vision to be carefully adjusted or even renounced in favour of market-oriented, neoliberal convictions, alongside alternative enactments of the resource itself.

From the early days of the Estonian industry, oil shale has not just been integral to the construction of the national economy, but also underpinned aspirations for a national 'industrial science' (cf. Bowker 1994). As Holmberg (2008) documents, both the industry's establishment by Estonia's first national government and its Soviet-era expansion for electrification purposes took place in parallel to the 'scientification of oil shale' in what is today called the Tallinn University of Technology (TUT). Oil shale has always helped invigorate the academic community and dominated other areas of technical research, with several TUT departments established with the sole purpose of supporting the industry. Moreover, in the close relations between the industry and academia, a central role was played by the Estonian Academy of Science which positioned itself as the main source of scientific knowledge about the industry, helped establish further research institutions and laboratories, and coordinated both international cooperation and national discussions.

The two decades of re-independence, however, have made long-running disagreements within the scientific community public and demonstrated their failure to fulfil the dream of a technocratic government (cf. Wengle 2012). For the scientific community, the first problem is that their research is no longer prioritized by the government, which has significantly cut state funding. Following the closure of two trans-disciplinary research bodies in recent years, the Oil Shale Institute and the

Estonian Energy Institute¹⁵², today there is no nation-wide or even university-level collaboration between oil shale experts. The prominence of the Academy of Science in influencing decision-making has also faded, although its energy council occasionally issues critical statements, especially against privatization. While the Estonian industry is renowned for its longevity, its infrastructure and personnel have become increasingly aged (for analysis, see Meriküll et al. 2012). The majority of leading researchers has reached emeritus status, with only a few academics able to present their work before English-speaking audiences, mostly in the ISI-recognized *Oil Shale* journal published by the Academy itself. Apart from the absence of a new generation of researchers, the ability of the ageing scientific elite to contribute to energy policy has been challenged by insurmountable personal conflicts. The re-independence years have revealed serious discords within the circles of technical experts, especially concerning their communication with authorities in Tallinn and Brussels. In these circumstances, the scientification of oil shale once necessitated by nation-building “has gone through a period of dramatic decline” (Oja 2007: 97).

A telling example of fragmentation and dissensus that occurs amongst technical experts is the discrepancy between two scientific reports, which feature among the very few overviews of Estonia’s industry ever published in English. These reports were prepared independently in different TUT departments, but came to confront each other during the debates of the European Parliament in 2007. One of them, *A study on the EU oil shale industry – viewed in light of the Estonian experience*, was prepared by the European Academies Science Advisory Council (EASAC) with the help of two TUT professors. Aiming to give an objective, ‘academic perspective’ on the

¹⁵² The Oil Shale Institute was first established by the Academy of Sciences and later taken over by the TUT. The Energy Institute had 300 employees, but was closed shortly after it was moved from an independent institution under the Ministry of Economic Affairs to the TU Tallinn in 2002. Interview, 20 April 2010, personal communication 28 August 2010.

industry's global progress, the report identified significant shale resources in many European states and advised the EU to support research in their exploration and utilization if deemed necessary for energy security reasons. Without downplaying environmental hazards, the authors showed faith in technological innovation and were remarkably optimistic about Estonia's ability to meet the EU criteria in time (Francu et al. 2007). By contrast, another report titled *The Life-Cycle Analysis of Estonian Oil Shale Industry* ('LCA') was prepared earlier by Estonian experts who sought to give a first objective overview of the sector's cumulative impacts on the environment and water use, resource availability, and social interdependencies (Gavrilova et al. 2005).¹⁵³ Although the two reports gathered information partly from the same published scholarship, their judgements diverged radically (see also Gavrilova et al. 2006). Both reports were requested to be presented to the Committee on Industry, Research and Energy of the European Parliament, although the invitations were generated through different channels.¹⁵⁴ According to one author of the EASAC study, the Committee wanted to replace whole paragraphs of their report with the more critical 'LCA' study; a request that was furiously refused by the authors (Veiderma 2009). The subsequent debate in Brussels disclosed the possibility of different perspectives on oil shale, which influenced subsequent EU definitions of the resource. Furthermore, it demonstrated publicly the lack of consensus amongst national experts and raised a question of *who* actually has the right to speak for or against the industry in front of international audiences.¹⁵⁵

¹⁵³ The report was requested by the Estonian MEP Andres Tarand and prepared by scientists associated with the TUT Institute of Chemistry and the TUT Institute of Geology in cooperation with the Estonian Fund for Nature.

¹⁵⁴ It has been speculated that the Parliament committee ordered EASAC to prepare their analysis because they were already familiar with the 'LCA' study which was completed two years earlier.

¹⁵⁵ Although neither of the reports was widely disseminated in Estonia, there were serious repercussions within academic circles, which strongly dominate the memories of the involved actors today. Interviews, 18 June, 18 August, 24 August 2010.

Parallel to the decline in technical expertise has been a rise of another set of expertise, the managerially educated experts who have taken lead in restructuring the post-Soviet sector (cf. Dunn 2004; Wengle 2012). Today, the key executives of oil shale companies are all young professionals, who have received their degrees in economics, law, and policy, with very few exceptions.¹⁵⁶ The Ministry of Economic Affairs (hereafter, the Ministry) is similarly staffed with young people who despite having mostly graduated in engineering have spent their careers in management, and who are overall greatly outnumbered by the industry staff. In comparison to the older generation, these managers tend to value and instrumentalize the legacies of the energy sector in different ways and for different purposes, notwithstanding any disagreements between the industry and the Ministry. As further explained in Chapter 8, Eesti Energia's current work in technical innovation has little to do with academic research at all. The Ministry, meanwhile, has replaced the expertise of ageing academics with independent consultancy firms and, above all, Eesti Energia's in-house data and knowledge. For example, the Ministry recently disbanded an informal council of energy academics who had advised the officials for years (Veiderma 2009) and outsourced the last planning process instead of ordering the documents directly from TUT institutions. If the differentiation between science and politics results from ongoing framing and boundary-drawing (e.g. Callon 2009), then the older tradition of academic oil shale research is becoming increasingly replaced by professional management and business-led research.

¹⁵⁶ For example, the executive management of Eesti Energia comprises five men, all but one of them educated in economics, business management and law. The only exception has both a PhD in engineering and an MBA.

6.5 A monopoly of truth

If oil shale has previously been depoliticized in Estonia as an exclusively expert sphere, then today the erosion of national expertise is demonstrated at all fronts, with the potential to rework traditional sites and forms of energy governance. At the time of the EU energy policy negotiations in 2008, the Ministry undertook an unprecedented step to draw wider support behind its 'Energy 2020' and 'Electricity 2018' plans. Within the space of ten months, between March and October, the Ministry organized four open debates titled 'Energy Forums' in parallel to the regular 'public participation' procedures associated with strategic environmental impact assessments by professional consultancy firms. In his keynote address to the first forum, Minister Parts asked everybody to be open-minded and come up with their honest opinions of Estonia's prospects under the EU energy market and climate policies. A key state official then stepped forward to open the Pandora's box of national energy policy with three provocative questions: *Is the export of oil shale electricity justified? To what extent could Estonia depend on imported electricity? How could the government guide people to improve the state's high energy intensity?*¹⁵⁷ The stage was not limited to eminent ministry officials and technical experts, but presentations were also requested from a number of maverick professors, opposition leaders, and younger generations, before handing the floor over to "specialists" at the second forum. Some of them raised even more heretical questions and articulated visions that were radical by an order of magnitude. Others, meanwhile, called for engineers to restore oil shale-based technocratic governance and not let the politicians embark on any radical

¹⁵⁷ Einari Kisel (11 March 2008) "Kolm keerulist küsimust" [Three difficult questions], <http://energiafoorum.blogspot.com/2008/03/einari-kisel-kolm-keerulist-ksimust.html> (accessed 11 March 2013).

changes.¹⁵⁸ The debates were broadcasted through an online blog, which invited comments from the wider public with regular video feed and text summaries of the gatherings (<http://energiafoorum.blogspot.co.uk/>).

As these events paralleled my reading of Callon's famous book on technical democracy (Callon et al. 2009), they came across as the most genuine 'hybrid forums' in the sense that Energy Forums were both open to people from different professions, backgrounds and generations, and that they addressed complex, multifaceted issues in the face of radical uncertainty, reaching from geo-technical and market calculations to political and ethical 'matters-of-concern'. In this light, the greater was my disappointment when interviews disclosed a year later that behind the veil of such forums, planning documents were compiled by a single person, a leading official of the Ministry. For him, the forums were intended to facilitate communication with media and prevent uncontrollable lobbying of politicians by industry representatives, rather than provide any significant input to state policy.¹⁵⁹ The final texts took no account of actual debates and the blog was soon forgotten, even if it still remains online. The real-life governance of the sector, meanwhile, partly adjusted to the reality of the market, but mostly maintained the 'conservative and even regressive' approach that has arguably dominated Estonia's energy policy for nearly two decades (Hamburg 2001).

There are two possible readings of the fate of Energy Forums, the second of which is given in the next section. The first would simply condemn them as a failed participatory exercise orchestrated by ruling elites in a postsocialist society which is not well immersed in even the more established procedures of delegative democracy.

¹⁵⁸ Ain Tomson (1 April 2008) "Poliitikute asemel peaksid Eesti energeetika arengut suunama insenerid" [Estonia's energy developments should be led by engineers instead of politicians] <http://energiafoorum.blogspot.co.uk/2008/04/ain-tomson-poliitikute-ase-mel-peaksid.html> (accessed 27 February 2013).

¹⁵⁹ Interviews, 16 March, 20 September 2010. The same position is also reflected in the state's official website on participatory politics, <https://www.osale.ee/?id=124> (accessed 14 March 2013).

In a way, the forums functioned like any other ‘public engagement’, where participants simply assumed the role of stakeholders without putting their previous knowledge and identities ‘at risk’ (Stengers 2005) or ‘suspending judgement’ for the sake of collective futures (Callon et al. 2009). At a closer look it becomes evident that the spokespersons were for the most part well-known proponents or opponents of the industry, whose statements no longer surprised anybody in the ageing audience. The magnitude of uncertainty and complexity of issues at stake limited the space of disagreement and the formation of new expertise. Even though the planning documents were more broad-based than antecedent policies, and perhaps created some ownership in the Parliament and amongst the “general public”, the outcome cannot be mistaken for the politically and epistemologically generative events of collective learning imagined by Callon, Stengers and others. The notion of ‘hybrid forums’ does not afford for this deficiency because it “tends to synchronize the event of controversies and the emergence of new publics”, as Whatmore and Landström argue, but indeed “neither the multiplication of political actors nor the amplification of the matter of politics were in evidence” (2011: 592), or at least not initially.

This impression was confirmed by another exercise composed of three separate workshops that I was able to witness first hand during the preparations of the National Renewable Energy Action Plan, a document required by the EU law. In a format similar to Energy Forums, a number of key stakeholders gathered around a roundtable in the Ministry, some of them formally invited, others not.¹⁶⁰ Although this plan was structured around *renewables*, while the framework of scenarios, prognoses and other anticipatory knowledge techniques was prescribed by the European Commission, the local actors made the supreme issue – the burning of oil shale –

¹⁶⁰ Field notes, 14 April 2010, 4 June 2010.

acutely present and thereby disputed the rationale of the entire process. Most remarkably, two representatives of wind energy companies, themselves educated engineers, presented calculations titled “Wind vs. Oil Shale”, which refuted the widely accepted claim that oil shale is much cheaper and more reliable source of electricity than renewables, if all subsidies and CO₂ costs are taken into account.¹⁶¹ Along with several others in the audience, they refused to focus narrowly on the question of how to achieve the 25% national target, as was expected, but disputed the main conventions of Estonia’s energy economy. Notwithstanding the significance of such ‘rival calculations’ (Mitchell 2008), the final document took no account of these debates. In a remarkable contrast to the first roundtables, during the third workshop chairs were lined up in front of a Ministry official who dryly introduced a text to be sent to Brussels, because time was pressing. Again, these meetings seemed to offer a ‘mere tool of legitimization’ for energy elites (Callon et al. 2009: 154). Moreover, there appeared to be very little interest in producing any new knowledge or understanding. For state officials, the prognoses made and the scenarios mapped out were not expected to actually take place or even inform decision-making to any significant extent, but instead identified the maximum level of contribution required to meet the EU criteria through simple top-down calculations.¹⁶² The possibility that Estonia may be able to produce more electricity from renewables was put aside without preparing an alternative strategy that could reveal the actual potential.¹⁶³

The fate of the few extra-parliamentary initiatives that have articulated low-carbon visions has been similar. These include the analyses of environmental NGOs,

¹⁶¹ Estonian Wind Energy Association, “Tuul vs põlevkivi” [Wind vs Oil shale], available at <http://www.tuuleenergia.ee/wp-content/uploads/Tuul-vs-polevkivi.ppt> (accessed 5 March 2013).

¹⁶² My impressions were confirmed in later interviews with other participants – 14 June, 16 June, 25 August, 20 September 2010.

¹⁶³ In the past, national experts have actually prepared an alternative strategy for renewable energy, but this was shelved by the Ministry.

such as the *Energy Plan for Green Estonia* (Nõlvak 2006) and the *Baltic Sustainable Energy Strategy* (SEI-Tallinn 2008), energy workshops organized during the nation-scale ‘My Estonia’ brainstorming campaign in 2009,¹⁶⁴ and even a movie titled *Report: Green Estonia* (Siimets 2007). All of these initiatives have received little publicity and been remarkably short-lived. Other alternative visions are not objectified in textual artefacts or even clearly articulated, because of a lack of designated forums. Media outlets are often identified as one of the potential sites for public discussion, but tend to act as a public relations instrument for competing businesses. Although journalists have begun to report more on energy issues, the number of more detailed analyses and dissenting opinions published remains strikingly small.

In a way, managerial expertise appears to have displaced broader debates – either expert or non-expert, public or non-public. In 2010-2012, the Eesti Energia company decided to follow up earlier debates and made ‘Energy Forums’ into their regular publicity events on the eve of “market opening”. Although their forums initially retained their tone of openness, for example invited presentations from some ‘off-the-grid’ opponents of the monopoly,¹⁶⁵ they were quickly transformed into elite gatherings, where industry executives took the podium alongside state officials and ‘opinion leaders’, whilst participants were limited to a few established experts and journalists, whereas others learnt about the event in the evening news. The state-industry allies successfully seduced the public sphere – not just laypersons, but the academia and media alike – into an illusion of consensual agreement that the event of marketization will eventually solve any problems, if carefully engineered around Estonia’s needs. In effect, however, the indeterminacy resulting from market liberalization was deemed so prevalent that uncertainty has become a normal state of

¹⁶⁴ See <http://www.minueesti.ee/>

¹⁶⁵ Peeter Jalakas at Eesti Energia’s forum, 17 May 2010.

affairs, partly justifying indecisiveness and partly depoliticizing the sector once again. *There is no debate*, the elites nod together with the Minister, *the market will decide*.

For many local actors, the fate of Energy Forums concluded that Estonia's energy politics is conducted by a handful of industry executives through the voice of Ministry officials. Even if these energy elites themselves no longer know where the sector will be heading in the free market, they have successfully created a "monopoly of truth", as one of my informants called it.¹⁶⁶ Eesti Energia, in particular, has monopolized expertise by assuming highly ambiguous political roles. The company has lobbied as one of the affected 'stakeholders' before the Parliament when critical changes are made in legal acts at the same time as it has provided essential policy advice for the Ministry in drafting the very same legislation, thus shadowing other sources of expertise, including academia and independent consultancies.¹⁶⁷ In what some actors summarize in a satirical equation "Eesti energia = Eesti Energia" (translation: Estonian energy equals Eesti Energia), the managers have sewed up both the production of specialist knowledge on the matter-of-concern and its political representation.¹⁶⁸ The convergence of the state, industry and expertise is further furnished in the ongoing turnover of top managers between the Ministry and Eesti Energia, as well as their joint public statements made on behalf of the World Energy Council whose national office is led by the same people. Notwithstanding occasional disagreements between the company and the ministry (and even *within* the company), they can be portrayed as a surprisingly homogeneous group, which is not so much challenged by an inherent diversity of opinions, than the emergence of other bodies of

¹⁶⁶ Interview, 14 June 2010.

¹⁶⁷ For example, Eesti Energia provided the calculations of economic performance and carbon-intensity for 'Electricity 2018' scenarios. Similarly, there was no due diligence conducted in the 'IPO' case but the government relied solely on the company's calculations of its investment needs.

¹⁶⁸ Interviews, 14 June, 16 June, 20 September, 12 November 2010.

expertise. Notably, as explained below, there are more recent currents where new experts have stood up against the monopoly of truth and begun to dismantle the discourse of energy security tied to oil shale.

6.6 Shifting accounts of energy security

Another reading of the fate of Energy Forums is due here. This would be to acknowledge that the failure of public debates does not mean that there is no debate whatsoever. If such gatherings are 'situated achievements that are neither automatic nor guaranteed' (Whatmore and Landström 2011: 604), then controversies may be politically productive even in the absence of designated spaces for open debate. Whereas national security arguments have helped restrict the scope of politics, the continued securitization of oil shale at times of market liberalization simultaneously opens up potential for alternative forms and channels of contestation which infiltrate existing bodies of expertise without necessarily constellating into discreet political sites or new publics (Barry 2001; Marres and Lezaun 2011). Despite the elimination of non-expert groups and other initiatives of 'public-ity', something seems to have changed within the 'monopoly of expertise' itself in conceptualizing energy security and oil shale (cf. Mitchell 2002; Barry and Slater 2005b).

If oil shale continues to enjoy a monolithic presence in the energy mix, then the question becomes: how can anybody disassociate the resource from the assembly of socio-technical networks and national security conceptions that are claimed to be objectively given? Even though the immediate effect of Energy Forums was to limit the potential for controversy, these and other recent events have also disclosed the fragmentation of expertise, the wide range of positions available on the subject, and the emerging state of uncertainty, especially in relation to the process of marketization. In short, the forums opened up the possibility for further dissensus in

the future. The unavoidable reality of 'the market' has not just requested laypeople to become more informed about energy pricing and prepared the ground for further contestation of issues such as technology exports (see Chapter 8), but resonated with changes in the formal bodies of power and knowledge. First, the few rival calculations and extra-parliamentary initiatives have been revived in the gatherings of the actual parliament. Second, they have overflowed, generating 'hot debates' in more specialist circles and reformed the monopoly of expertise along the way (cf. Callon 1998)

The events of publicity discussed above coincided, and possibly were partly fuelled by a reactivation in party politics, especially in association with the Green Party that managed for the first time ever to gain a minor representation in the Parliament during 2007-2011. Before that, the Parliament was considered just a 'rubber stamp' for energy policy documents prepared by the Ministry-industry allies, but the active campaign of Greens made energy issues visible to the extent that they became present in the programmes of *all* parties and even in the coalition agreement.¹⁶⁹ Although the direct impact of green politics was limited in terms of representation and time since they lost their seats again in 2011, the issues they raised have been slow to leave the public stage. If nothing else, then the Greens made the unspoken a matter of public inquiry by arguing that "this Janus-faced official policy in which we groping either way – one way we are trying to meet EU requirements, but actually still want to burn oil shale – does not lead anywhere."¹⁷⁰

Energy supply issues have since acquired major significance in political competition, with the conservatives led by Minister Parts being increasingly

¹⁶⁹ Interviews 8 March, 4 May, 14 June, 16 June, 18 August 2010.

¹⁷⁰ MP Toomas Trapido at the second reading of Electricity Market Act, 13 January 2010 (Parliament's online scenogram). Trapido uses the untranslatable word "rehepaplus", which refers to a pragmatic 'the end justifies the means' attitude with elements of lying, theft and duplicity. The term is widely popularized in Estonian political satiric after a fictional character "Rehepapp" [Old Barney] from a novel by Andrus Kivirähk.

challenged by the growing awareness of liberals and social democrats. The 'IPO' case in 2010 was one of the first instances where Eesti Energia's requests for new investments or favourable legislation did not simply get approved, but instead sparked a string of questions, for which the company suddenly had no adequate answers. Several of my informants see the 'IPO' failure as a crucial turning point in defeating the 'monopoly of truth' given that the company had invested a remarkable sum of money, time and expertise into preparing the deal.¹⁷¹ On the eve of "market opening", these debates have intensified remarkably across all political parties and institutions.

At the same time, as I have argued, the strong position of managerial expertise has made it possible for the ranks of 'energy elites' to be supplemented with new young professionals, whose experience is more diverse and often gained abroad. Several of those who first publicly spoke up around the time of Energy Forums have now become leading political advisors or industry spokespersons. Given the small numbers of experts overall, they are either associated with the businesses developing alternative energy resources, such as nuclear, wind and solar, or left oil shale companies for Elering, the TSO, after unbundling. Others have even entered the Parliament or established alternative political forums, such as the recent "100% Renewables" campaign that advocates transition to a fully carbon-free society.¹⁷² Sometimes, it takes a woman to intervene in the masculine world of energy elites by raising questions that are deemed inappropriate or even outrageous.¹⁷³ In this way, several 'experts' have gradually turned into 'diplomats' (Stengers 2005), who no

¹⁷¹ Interviews, 4 May 2010, 14 June 2010, 29 June 2010, 20 September 2010.

¹⁷² The campaign is launched by the Estonian Association for Renewable Energy created in 2011 in cooperation with environmental NGOs. See <http://www.taastuvenergeetika.ee/>

¹⁷³ Ms Kaja Kallas was the first expert to publish a series of articles in 2009-10 that disputed the subsidization of the new power plant in light of EU policies. She was then a renowned lawyer who advised renewable energy companies, but has since become the head of the Economic Committee in the Parliament after joining the liberals and gaining a personal mandate in the 2011 elections.

longer specialize in a particular knowledge field, but instead work actively to bring matters of collective concern subject to more broad-based debates.

Most notably, the event of unbundling in 2010 did not just deliver transparency and equal access to market participants, but above all created an alternative network of competency and counter-expertise. In a race with Eesti Energia, the most popular employer in Estonia, the TSO now attracts a number of younger specialists, many of them educated in foreign universities, and several female. Their annual reports on security of supply have since become a primary source of alternative visions against the monopoly of truth (see Elering 2010; 2011; 2012). Characterized by a strong belief in the panacea of the free market to sort out energy security problems once sufficient physical infrastructure is in place, Elering has started to disintegrate the paradigmatic discourse by putting more emphasis on improved grid connections, diversification of supply sources, and fair market competition; also in the supply of natural gas.¹⁷⁴ Moreover, since publishing their first report in 2010, Elering has quickly moved to challenge self-sufficiency overall. In their view, security of supply is no longer state-based but a regional issue, since its cornerstone is physical integration with the EU network, rather than maintaining independent capacity. Taavi Veskimägi, the CEO of Elering, has put it straight in his public blog: “Oil shale is ...an important part of the picture, but should not be the starting point for weighing other solutions.”¹⁷⁵

Echoing Elering’s positions, the National Audit Office recently published its first ‘overview audit’ on the industry after years of futile attempts (cf. Chapter 3). In the report *Alternatives for Electricity Production* (NAO-Estonia 2012), the office laments the fact that the state still sees oil shale as the main source of supply security,

¹⁷⁴ Interview, 18 June 2010.

¹⁷⁵ My translation from <http://www.taaviveskimagi.ee> (13 December 2011), “EL kliimapoliitika pärast Durbani konverentsi” [EU climate policy after Durban conference].

lacks any vision on the sector's future beyond the year 2023, and withdraws from options that would lead to carbon-free production. The NAO's recipe for energy security lists diversification, connectedness to Western infrastructure, and overall compliance with the EU policies. The NAO also makes public the open secret that there will not be enough feedstock to produce *both* electricity and shale oil within the annual extraction limit, and predicts that resources will run out in the next 15 years (whereas Elering opts for 50 years). The report brings the horizon of radical uncertainty much closer again and demands immediate action from the government, although Minister Parts has since strongly disputed its authority.¹⁷⁶

Energy security ['the state']	Energy security ['the market']
Self-sufficiency	Grid connections
State ownership	Diversification: gas, renewables, nuclear
Subsidies	Open competition
Resistance to market liberalization	Privatization
Export	Import

Table 8 Contending elements of energy security in Estonia.

Nevertheless, these recent shifts in conceptualizing security are more than merely a reflection of the opposition between state and market in energy governance. Although one can probably identify a few dichotomous conceptions based on either state regulation or complete neoliberalization (Table 8), the ongoing debate reflects a *continuum* between these two extremes, where different aspects of the problem of security become intermingled and change positions over time. In practice, physical connectedness to Western markets is not considered an alternative to Narva power plants, but rather an independent element that supplements existing strengths.¹⁷⁷

¹⁷⁶ Ministry press release (12 October 2012) "Põlevkivielektrijaam on Eestile vajalik" [Estonia needs an oil shale power station], <http://valitsus.ee/et/uudised/pressiteated/majandus-ja-kommunikatsiooniministeerium/73298/p%C3%B5levkivielektrijaam-on-eestile-vajalik>

¹⁷⁷ Interview, 18 June 2010.

With few exceptions, oil shale is still central to any scenario, accompanied by disputes of whether the EU climate policy will prove viable in the longer term.¹⁷⁸ The construction of security varies over time and across changing subjectivities within the expert body, whereby several elements can be advanced simultaneously, with some of them being objectified as accurate and others portrayed as misinformed or outright dangerous. What the case indicates is not a replacement of one security concept with another, but rather a merger of different, potentially conflicting components, alongside alternative enactments of the resource patrimony.

Notably, market liberalization is expected to generate an impulse for *shale oil* development, which has so far stayed outside the domain of state planning. It is now anticipated that more and more resources will be diverted from power generation to the oil industry (e.g. Parts 2009), although the exact share between these two pathways is again seen as determined by ‘the market’. Moreover, the strategic adoption of market-based vocabularies also implies that Estonia’s ‘post-peak politics’ is now being carefully rearranged with the possibility that state-imposed limits to mining will not be lowered from 2015, as decided in the Oil Shale Development Plan, but instead abolished altogether for the purposes of commercial oil production,¹⁷⁹ which in turn is claimed to guarantee Estonia’s future energy security. However, these developments are subject to further political negotiations over the EU Fuel Quality Directive, as noted in Chapter 7.

An extreme end at this continuum is indicated by a possibility of discarding the convention of energy security as independence from Russian supplies. If “Russia is no

¹⁷⁸ This has been continuously voiced by the Ministry-Eesti Energia allies. By contrast, the CEO of Elering argues in his blog article cited above that Estonia cannot continue to act contra to the EU climate policy regardless of uncertainty over the policy’s future.

¹⁷⁹ *Postimees* (6 March 2013), “Põlevkivi uus arengukava võib jääda koostamata” [The new oil shale development plan may never be prepared], available at <http://www.e24.ee/1159962/polevkivi-uus-arengukava-voib-jaada-koostamata/> (accessed 6 March 2013).

longer an omnipresent threat” (Lehti 2005: 98) in light of the ongoing EU-Russia energy dialogue and the creation of a ‘single Euro-Asian energy market’ (see Bielecki 2002; Aalto 2008), then strong infrastructural connectedness to the Eastern neighbour becomes against all odds the guarantor of security of supply for the Baltic states, since they are now positioned as a strategic corridor linking the two imperial networks (Elering 2012).¹⁸⁰

6.7 Multiple transformations, contending futures

As a result, the debate abounds. Anticipatory energy politics in Estonia does not just display several political actors or ‘publics’ who decide over a set of ‘possible worlds’ (cf. Marres and Rogers 2005; Callon et al. 2009; Marres and Lezaun 2011), but an entire ‘political situation’ (Barry 2012). This situation revolves around oil shale as the central ‘matter-of-concern’, but through the resonance of many independent issues and controversies; from long-running national debates over the resource patrimony, to the conflicting political logics of the EU in establishing energy and carbon markets, to international dilemmas over the mechanisms of neoliberal energy governance and ‘post-oil’ futures. The effects of such a situation cannot be added up as a straightforward ‘transition’ from state-regulated to competition-based energy policy, or from a high-carbon economy to a lower-carbon future. Instead of an energy transition based on marketization and decarbonisation, there is a mixture of transformations simultaneously at play with contending implications for the organization of the regional market (cf. Bridge et al. 2012).

¹⁸⁰ Andres Reimer, *Eesti Päevaleht* (23 January 2013) “Venemaa pürgib Eesti energiajulgeoleku tagajaks” [Russia aspires to become the guarantor of Estonia’s energy security] <http://www.epl.ee/news/majandus/taismahus-venemaa-purgib-eesti-energiajulgeoleku-tagajaks.d?id=65567474> (accessed 6 June 2013).

Further, the ‘matter’ of these controversies is not given, but future economic and political realities are made together with the materiality of the resource and associated technological systems. Although there is some consensus that oil shale will maintain a central position in the short term, the debate continues over what exactly is classified as a resource, how it should be valued and used, and who is entitled to formulate the realities at stake. In a situation where uncertainty remains over technical solutions, market trajectories and political agreements, both the definition of energy security and the material conditions that are supposed to guarantee security remain open to collective experimentation. It is no longer clear whether oil shale actually secures energy supply, or simply continues to supply security. It is no longer clear whether it is a ‘resource of the future’ or a ‘resource of the past’.

Such multiple energy transformations are defined by an ongoing negotiation of who will decide the industry’s future. It is certainly not the EU authorities alone, since Estonia’s relationship with Brussels is indeed ‘two-way’, whereby international knowledge of oil shale and energy security issues is largely informed by national experts (Kuus 2004, 2007). However, the national body of expertise is increasingly fragmented as a result of conflicts between those who acclaim expertise and their changing subjectivities. The self-sufficiency paradigm embodied in technical expertise has begun to recede in favour of market-based convictions and a new generation of managerial ‘energy elites’, who debate and influence both the design of EU requirements and their translation into practice. Anticipatory energy politics takes place within this transforming space, where the emergence of new knowledges, issues and publics affirms that “energy security is not and should not be a matter primarily regulated by national governments” (Bouzarovski 2010: 179), although it is *not* conducted outside the domain of expertise as such. As the limited significance of Energy Forums and extra-parliamentary initiatives has demonstrated, energy still falls

under an oligarchy of professional knowledge, where most laypersons cannot have a say apart from carefully orchestrated ‘public participation’ exercises. What the Estonian case unveils are not so much shifting relations between experts and non-experts, but shifting conceptualizations of patrimony and security between and within different sets of expertise. Instead of a ‘redistribution of expertise’ (Whatmore 2009), possible energy futures are made through a *reconfiguration of expertise*.

With the gradual, yet highly selective adjustment of neoliberal ideas and vocabularies to the Estonian context, the concern of energy elites is not whether to open the oil shale sector up to competition, but how to maintain the industry’s competitiveness by negotiating the boundaries between market and non-market forms of energy governance and, even more importantly, changing the way ‘the market’ is organized. In a remarkable twist, the market argument now helps to depoliticize oil shale in a manner similar to security considerations, albeit with the difference that uncertainty is no longer resisted, but rendered into a normal state of affairs where options are located everywhere and business opportunities are up for grabs.

In this way, the process of marketization opens up novel configurations of the resource and energy sector, as well as new spaces of politics. One can identify here two major developments, which are intersecting and partly conflicting. First, the state energy policy headed by Minister Parts continues developing shale-based power industry “in the anticipation of an apocalypse, because the EU climate policy does not show any signs of blowing over and little Estonia has no power to change it”.¹⁸¹ Second, there are growing political, economic and moral dilemmas over whether

¹⁸¹ My translation from *Postimees* (29 December 2012), “12 tegijat aastast 2012” [12 key actors in 2012], <http://arvamus.postimees.ee/1088048/12-tegijat-aastast-2012> (accessed 2 January 2013).

Estonia should become the proving ground for commercial shale oil production. The remaining two empirical chapters address these developments in turn.

Chapter 7. On the Borders of the Market: Negotiating Energy and Climate Security

The problem is that the frame or border of the economy is not a line on a map, but a horizon that at every point opens up into other territories (Mitchell 2002: 292).

7.1 The threat of carbon pricing

The year 2013 marks the beginning of the most uncertain time for oil shale production in Estonia, with fundamental changes anticipated to take place within the market logics that have enabled the post-socialist complex to withstand the capitalist system to date. While Estonia's energy economy has so far existed largely 'outside the market', on 1st of January 2013 it became the last EU member state to open up its electricity system for competition, after having received a number of derogations from the *acquis communautaire* following repeated promises to restructure the oil shale sector. A key question for the country's policy-makers is the extent to which local companies will be able to compete with other suppliers in open market conditions, where any measures of State aid are prohibited. Moreover, the new rules of the EU climate change policy that were enforced on the same day imply that the industry needs to pay for the release of greenhouse gas emissions instead of continuing to receive all quotas free of charge. Local experts claim that carbon prices will become the most important driver for electricity pricing, challenging the investments made into the development of new oil shale-fuelled power plants and determining the extent to which Estonia may come to rely on imported electricity, rather than continuing to export (Mäe 2009; Maigre 2010; Elering 2011). Likewise, carbon pricing is considered to seriously affect the competitiveness of shale oil production within the EU borders, and hence outweigh the benefits of rising prices of oil in the global markets (Francu et al. 2007).

The onset of ‘marketization’ that for years has been considered a paramount threat to the future viability of oil shale production has nevertheless turned out less significant than anticipated. This chapter discloses that the rules of carbon trading have become carefully adjusted in order to accommodate concerns about Estonia’s energy security, which the state government has mobilized in tandem with wider assertions of national sovereignty articulated by other Baltic and East European member states. The spotlight of this chapter is on a recent shift in the EU carbon trading regime, which can best be witnessed in a Communication published by the European Commission in May 2010. The Communication explores the possibility of moving beyond the objective to cut 20% of EU emissions by 2020 in light of the economic crisis and analyses the potential side-effect of outsourcing carbon-intensive production to non-EU countries. This is known in the economics literature as the risk of ‘carbon leakage’. In this document, the Commission accepts for the first time that attempting to tackle climate change with a market-based policy instrument, the EU Emissions Trading Scheme (EU ETS), generates legitimate security concerns. While stating that the greatest potential for further emissions reduction lies in the electricity sector, the Commission concedes that carbon leakage may also affect the functioning of the internal energy market:

There are cases where carbon leakage can have effects other than loss of competitiveness. For some Member States at the periphery of the EU with easy interconnection to countries outside the EU, there could be an impact on energy security. For example, this is the case for the Baltic States, given the unique situation of the Baltic electricity markets. This is one of the reasons why the ETS already provides for an optional and partial exemption from full auctioning for these countries. Investments in the transmission grid can help reduce the risk to electricity security. In addition, the Commission will closely monitor developments and will, if appropriate, take further measures with a view to enhancing energy security and providing a level playing field for competition on the electricity markets (Commission 2010b: 11).

The Communication not only reveals that the EU scheme accommodates certain compromises between climate policy and energy security concerns beyond the

Kyoto commitment period ending in 2012, but highlights the spatial envisioning of the EU common market as a 'territory' (Mitchell 2002) and the effects of technological systems on the delimitation of the market space. Specifically, it leads us to ask about the implications of transnational electricity infrastructure networks for the enclosure of carbon exchange within the borders of Europe.

In order to analyse this situation, I draw upon a series of recent articles by Donald MacKenzie, in which he argues that social science research has paid very little attention to how the evolution of markets for emissions trading involves both political decisions and specific technical matters, or what he terms the 'technopolitics' of carbon market construction (MacKenzie 2009b, 2009a, 2010). Beyond MacKenzie's contribution, however, the socio-technically distributed constituents of 'new carbon economies' remain little studied (Boykoff et al. 2009; Newell et al. 2012). Yet the exercise of setting up an EU carbon market is firmly rooted in the formation of what has been called a European 'technological zone' through wider processes of market integration and technological harmonization (Barry 2001). For Barry, a technological zone represents a standardized regime that is formed to facilitate the circulation of goods, people and information; "a space within which differences between technical practices, procedures or forms have been reduced, or common standards have been established" (see also Dunn 2005; 2006: 239). One could say that the EU ETS provides an exemplary case of a Europe-wide techno-zone in the making, the failure of which may reveal the incapacity of the Union to operate a common political space (cf. Callon 2004). The admission of a risk to 'electricity security' therefore calls into question the possibility of a fully integrated and territorially bounded marketplace structured by national borders, which is a prerequisite of the EU economy and the neoliberal exercise of carbon valuation and exchange in regional markets more broadly (cf. Bumpus and Liverman 2008; Bailey and Maresh 2009; Knight 2011).

The chapter analyses how the contending processes of containing both emissions and electricity within the EU economy challenges the formation of a homogeneous market zone, drawing on a sub-field of economic sociology informed by the STS approach. In particular, I argue for the necessity of adding a spatial dimension to MacKenzie's analysis of technopolitics, contributing to the nascent studies of 'geographies of marketization' (Berndt and Boeckler 2012). As discussed in Chapter 2, the central tenet of this literature is that 'the market' does not represent a universal, pre-existing set of affairs, but is brought into being in diverse and open-ended forms through the interaction of human beings with various material and technical devices (Callon 1998; Callon et al. 2007; MacKenzie et al. 2007; Çalışkan and Callon 2010). Marketization refers to the constructed, composite and dynamic nature of concrete markets in the making, whereby things such as emissions become commodified and enter into the processes of economic calculation, valuation and exchange (Çalışkan and Callon 2010). While economic sociologists have mainly interrogated the performative functions of economic theory, their recent work nevertheless offers opportunities for exploring how marketization can also be technologically conditioned and politically contested, and a geographically variegated process. The geographical perspective that I propose in this chapter enables carbon marketization to be understood as a fundamentally territorial exercise, which needs to be continuously reproduced in relation to rival techno-political issues and economic knowledges concerned with different logics of security.

Despite the growing relevance of poststructuralist writing for geographical research on markets (see Berndt and Boeckler 2009, 2012), market-led approaches to emissions reduction have provoked little discussion between economic sociology and geography (with the exception of Powells 2009). To be clear, there is no lack of academic literature on emissions trading in general, especially regarding the EU

scheme. Since its launch as the world's largest carbon market in 2005, it has provided material for volumes of books that describe how carbon pricing has become the cornerstone of EU climate policy and document the lessons learned from the first years of trading. However, this scholarship is largely dominated by economists and lawyers, who have explained the specific features of the 'cap-and-trade' approach to allocating CO₂ allowances and the resulting effects of price fluctuations, over-allocation and limited abatement (e.g. Ellerman et al. 2007; Faure and Peeters 2008; Ellerman et al. 2010). Geographers, meanwhile, have joined ranks with political scientists (e.g. Skjærseth and Wettstad 2008) to explore the shifting relations between state and non-state actors at multiple levels and scales of governance, and their implications for the negotiation of the EU ETS reforms (Bailey 2007; Bailey and Maresh 2009). Although recent work on the scalar politics of neoliberal climate governance distinguishes between what Bailey and Maresh (2009) call the 'regulatory' and 'territorial' logics of the EU ETS, the latter are ascribed solely to the alliances formed between state authorities and the industry, without specifying the political rationales *and* technological and material structures that preclude the integration of the market space in practice.

The complex relationship between such territorial logics and specific technical and material predicaments is evident in the resistance to carbon pricing of the new member states that make up the margins of the internal market, especially in the Estonian case. Despite the extreme carbon-intensity of its energy economy the Estonian government has managed to subvert the demands of neoliberal climate policy by appealing to the country's geopolitical location between the European market and the former Soviet empire. Their arguments are further facilitated by the fact that the Baltic countries remain physically interconnected with the electricity transmission grid of the CIS. While the vision of a linear transition from state-led

energy governance into a market economy has largely failed, as documented in Chapter 6, the oil shale industry both challenges and transforms the constitution of the European economy. Representing a profoundly disturbing case for market integration, Estonia therefore provides a unique opportunity to learn about the socio-technical configuration of carbon markets and the spatial processes of ‘marketization’ more generally.

Based on an in-depth analysis of EU policy documents and interviews in Brussels, the following section both draws on and complements the performativity approach and MacKenzie’s conceptualization of ‘technopolitics’. It offers an empirically informed response based on the two constituents of this term and argues that both ‘the political’ and ‘the technical’ run deeper than previously described in the context of carbon trading. The conflict that has occurred between different energy security logics in EU border states suggests, along similar lines to a recent critique of MacKenzie, that ‘marketization *as such*’ is inherently political, opening up new sites of contestation beyond the mechanisms of allocation (Blok 2011). Likewise, the technical is not limited to the techniques and devices involved in allocation, but the politics of market design needs to embrace larger socio-technical systems, including infrastructure networks. As further elaborated in the next section, such technopolitical issues evidence the problem of drawing the boundaries of the market. Grounding these arguments in a detailed account of Estonia’s participation in the EU scheme, the subsequent section documents how a five-year controversy over the reduction of its emissions quota has highlighted a conflict between national energy policy and other security concerns in the spatial politics of carbon marketization. In the following section, the risk of ‘carbon leakage’ anticipated in economic literature is identified as a central matter of concern for market design from 2013 onwards. The actual meaning and implications of this concept, however, have been rendered open

for strategic interpretation. Associated with the leakage potential, cross-border electricity exchange with third countries is observed to challenge the constitution of a homogeneous space for carbon circulation, creating a wider 'frontier region' (Mitchell 2007) on the borders of the market. Moreover, similarly to the electricity sector, the unique material characteristics and technical specificities of *shale oil* production resist the standardization of carbon-intensive products and further challenge the territorialization of the market, as discussed in the penultimate section. The conclusion argues that carbon marketization can be understood as 'co-performance' (Callon 2007), where the territorial setup of the market has to be negotiated not only against a plurality of economic knowledges and logics of security, but also against the material qualities of commodities and wider technological infrastructures.

7.2 The evolving technopolitics of the EU ETS

It is widely recognized that the idea of emissions trading originates directly from certain economic theories concerned with attempts to correct market failure and 'internalize' negative externalities in economic calculation (e.g. Lohmann 2005; MacKenzie 2009b; Ellerman et al. 2010; Goodman and Boyd 2011). For leading STS writers in economic sociology, carbon markets thus provide an excellent example of the performative role of economic theory and economists in bringing 'the economy' into existence (Callon 1998; MacKenzie et al. 2007). Both Callon and MacKenzie have suggested, drawing on Muniesa and Callon (2007), that the EU ETS should be regarded as an ongoing 'economic experiment' in the collaboration between academic theorists and European policy-makers, or more specifically, as an '*in vivo* experiment' taking place in real life, outside laboratory space (Callon 2009; MacKenzie 2009a, 2009b). In designing the EU ETS, the experimenters are understood to be engaged in a continuous reflective activity that transforms the market, as the object of their

economic knowledge, through a series of trials and errors, which is particularly manifested in the changes made in trading rules between the scheme's different phases. This aligns with the general anti-essentialist stance of Callon and colleagues in arguing that markets are not ontologically pre-given spheres or 'quasi-natural realities'. Rather, markets emerge from mundane processes of 'marketization', understood as a dominant modality of the wider programme of 'economization', whereby things, actions and institutional arrangements are qualified as economic and entered into commercial transactions (Çalışkan and Callon 2009, 2010).

Given the decentralized system of EU decision-making, however, the role of academic economists and educated bureaucrats in "doing economy" is arguably limited. This recognition has led to attempts to expand the spectrum of performativity. Callon (2009) emphasizes that the construction and maintenance of the EU ETS also involves a diversity of other actors, not least 'economists in the wild', who all should be recognized as economic agents in their own right (see also Callon 2007). According to Callon, in a situation of uncertainty over the viability of the market, its magnitude, composition and potential effects, any analysis must take into account "all the assessments, points of view, projects and programmes developed by the actors who transform it in an on-going (open) experiment" (2009: 540). It is precisely the inclusion of alternative economic (and non-economic) agendas and new market elements with generative effects that this chapter seeks to address. Notably, the agencies involved in such experiments are not exclusively human (Callon and Muniesa 2005). Consideration of carbon trading schemes in the STS/ANT vein of thought as 'socio-technical assemblages' (*agencements*) of both humans and non-humans brings into focus the material and technical dimensions of marketization. In sum, the EU ETS should be regarded as a compromise between the (changing) standpoints of a wide range of economic agents and the socio-material realities they are engaged with.

This resonates with the growing, yet unexplored recognition that contestation, material recalcitrance, and potential failure do not refute, but are constitutive of performance (Callon 2007). In analysing how the EU ETS has diverged from the initial proposal of economists to sell CO₂ allowances to installations, MacKenzie has attempted to further the performativity thesis with an account of its politics. A key problem of designing an efficient market based on free allocation and historical emission levels ('grandfathering') is to avoid the tendency to hand out too many allowances. The struggle against over-allocation has been central to what MacKenzie, borrowing the concept of Mitchell (2002), calls the 'technopolitics' of carbon market construction. For MacKenzie, politics is primarily confined to choosing a feasible mechanism of allocation and thereby conditioned by specific technical matters, which define the success or failure of the economic experiment (MacKenzie 2009b, 2010).

This chapter provides evidence that technopolitics transfers from the problem of over-allocation endemic to 'grandfathering' to the post-2012 regime where auctioning abounds. The Estonian case suggests that both 'the political' and 'the technical' should be analytically extended to incorporate a wider range of disagreements and technical elements involved in carbon marketization. Firstly, as Anders Blok (2011) has recently argued in response to MacKenzie, drawing largely on Barry (2001, 2002), the act of rendering carbon internal to the market frame is overall politically productive because it generates new sites of contestation and collective identities (see also Barry and Slater 2002; Berndt and Boeckler 2011a). Blok himself interrogates grassroots resistance to market-based climate policy, engaging critically with Lohmann's (2005) analysis of technopolitics in the context of the North-South inequalities spurred by Kyoto project-based mechanisms. The conflicts that have occurred between energy and climate security concerns within an interstate marketization programme, however, are indicative of deeper tensions between

national articulations of territorial sovereignty and neoliberal modes of governing climate change (Oels 2005). The ‘politics of allocation’ is exacerbated by the incompatible modalities of security and wider shifts in European political rationality that accompany the single market project (Walters and Haahr 2005), which only amplify the difficulties in finding an acceptable mechanism for the calculation and distribution of allowances.

Secondly, the problem of electricity exchange suggests that ‘the technical’ is not limited to technical devices alone (cf. Barry 2001: 9). In general terms, this chapter supports the view that emissions trading systems, like any markets, may take diverse forms, for the processes of economizing carbon do not merely follow textbook models, but are conditioned by institutional and technical arrangements and the material properties of the new commodity alike. For Callon and colleagues, however, market diversity derives largely from ‘the infinite ways of configuring calculating equipment and material devices’ (Callon et al. 2007; Çalışkan and Callon 2010: 4). Likewise, MacKenzie’s analysis prioritizes specific calculative tools and formulas (2009b, 2010). But what about other technical arrangements that do not necessarily function as discreet devices but nevertheless affect calculation, especially if ‘calculation’ is understood in a wider sense as distinguishing between different states of the world and courses of action (Callon and Muniesa 2005)? Timothy Mitchell originally suggested that ‘technopolitics’ emerges from “a process of manufacture, whose ingredients are both human and non-human, both intentional and not, and in which the intentional or the human is always somewhat overrun by the unintended” (Mitchell 2002: 42-43). So, when markets are recognized to be ‘constellations of distributed agency’ (Berndt and Boeckler 2011a: 560), it should also be acknowledged that such agencies may exceed the more narrowly defined role of market devices. The path-dependent and socio-technically fixating attributes of a particular large-scale

infrastructural system, the transnational network for power transmission (Hughes 1983, 1987), presents a serious challenge to the formation of the EU ETS, having the potential to both invent and exceed the intentionality of calculation (cf. Mitchell 2008).

A further argument of this chapter addresses the shifting boundaries and borders of carbon markets. Drawing on Mitchell (2002) 'the market' is often envisioned and set up as *a territory* that is framed in exclusion from its constitutive outside, the non-market. In this sense, the potential for politics has been attributed to the sets of limits imposed on marketization: negotiating what goes inside and what remains outside the realm of valuation and exchange (Slater 2002; Barry 2006; Mitchell 2007; Callon 2009; Berndt and Boeckler 2011b, 2012). Since carbon markets are invented and objectified as 'variable products of expert knowledge and political practice', the boundaries of such economic objects remain always disputable and re-negotiable (cf. Barry and Slater 2005a: 6). As MacKenzie points out, the EU ETS is not a static construction, but its very existence helps transform the techno-political context of its functioning. Phases I and II can be seen as distinct stages of collective experimentation, whereas the third phase continues to be "shaped in part by the accumulating effects of the evolving process of market construction" (2009b: 167). Moreover, such struggles of boundary-drawing intersect with the territorial borders of Europe, since the single market operates on the idea of an idealized and abstract, yet regionally concentrated space. In this sense, carbon trading is also a spatially transforming experiment. The formation of an integrated 'technological zone' for emissions calculation and exchange is put at risk by its co-existence with other interstate networks and zones of circulation, both informational and infrastructural. The following sections interrogate the spatio-temporal dynamics of the EU ETS by observing how the question of transboundary energy exchange has been entered into

its technopolitics and challenged the territorialization of the market along national borders.

7.3 Energy security introduced: cap-setting in Estonia

7.3.1 The political: market efficiency vs. national security

As MacKenzie (2009b) has rightly noted, the shifting technopolitics of market construction is particularly evident in the assessment of National Allocation Plans (NAP) for Phase II trading (2008-2012); a process which was not completed until the last year of the period. Prior to the last reform the directive for emissions trading (2003/87/EC) laid out two criteria for determining the total quantity of allowances notified by member states in their NAPs. For the EU-15 countries, the plans had to be consistent with the commitments to reduce national emissions under the burden sharing agreement along with the overall goal to cut EU emissions by 8% compared to the Kyoto baseline. For the new member states of Eastern and Central Europe (ECE), which had no difficulty meeting their Kyoto targets after the post-socialist collapse of heavy industry, the directive applied an additional criteria that the national cap 'shall not be more than is likely to be needed', compared to business-as-usual emissions (*Official Journal* 2003: 43). The grandfathering approach therefore created the problem of projecting future emission trends on the basis of installation-level data, especially in the ECE countries (Ellerman and Buchner 2007). Consequently, as MacKenzie (2009b: 161) remarks, the application of these criteria became highly contested precisely because of the techno-political specificities involved in setting the caps. Moreover, the subsequent controversies over cap-setting made it possible to introduce rival matters of concern into market technopolitics, such as the security of electricity supply.

The Estonian case serves as an outstanding example of how carbon pricing has become challenged and contested due to path-dependent technological systems and security concerns. As the sector generates the majority of Estonia's greenhouse gas emissions, up to 87% (MoE-Estonia 2009), oil shale producing companies have been the main recipients of CO₂ allowances, amounting to roughly 80% of the national cap proposed by the government.¹⁸² Due to a generous Kyoto baseline, carbon trading has proven a lucrative business for the local industry. The state-owned energy monopoly Eesti Energia, in particular, was able to make remarkable profits from selling their excess quota in the scheme's early years. Although Estonia's emissions account for only a minority of the carbon traded in the European market, the centrality of oil shale exploitation to the national economy has given it a high profile during the EU negotiations (cf. Panke 2011), which has been overlooked in recent analyses of the EU ETS, considered as just one example of the many lessons to be learned from over-allocation. When the carbon price collapsed in 2006, after the publication of the 2005 verified measurements of actual emissions, the Commission requested that nearly all states reduce their second-period NAP totals compared with the allowances of the first phase. Little notice has been given to the fact that Estonia suffered the biggest proportional cut in its NAP2 allowances, receiving only 65% of its first-period annual quota (Ellerman et al. 2010: 55-57). The state had proposed that the annual quota were raised from 19 million tonnes to 24.4 million tonnes of average CO₂ equivalents, but the Commission was willing to approve a maximum of 12.7 million tonnes.¹⁸³ This

¹⁸² Ministry of the Environment, Estonian Institute for Sustainable Development (SEI-Tallinn) (2006), *National allocation plan of Estonia for greenhouse gas emission allowances trading for the years 2008-2012* [1st version]; Ministry of the Environment (2011), *Estonia's National Allocation Plan for 2008-2012* [2nd and 3rd versions proposed in 2011].

¹⁸³ "Commission decision of 4 May 2007 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by Estonia in accordance with Directive 2003/87/EC of the European Parliament and of the Council".

‘ceiling’ was only slightly more than Estonia’s 2005 emissions, 12.6 million tonnes, and less than the average emissions of the first period, 13.4 million tonnes.¹⁸⁴

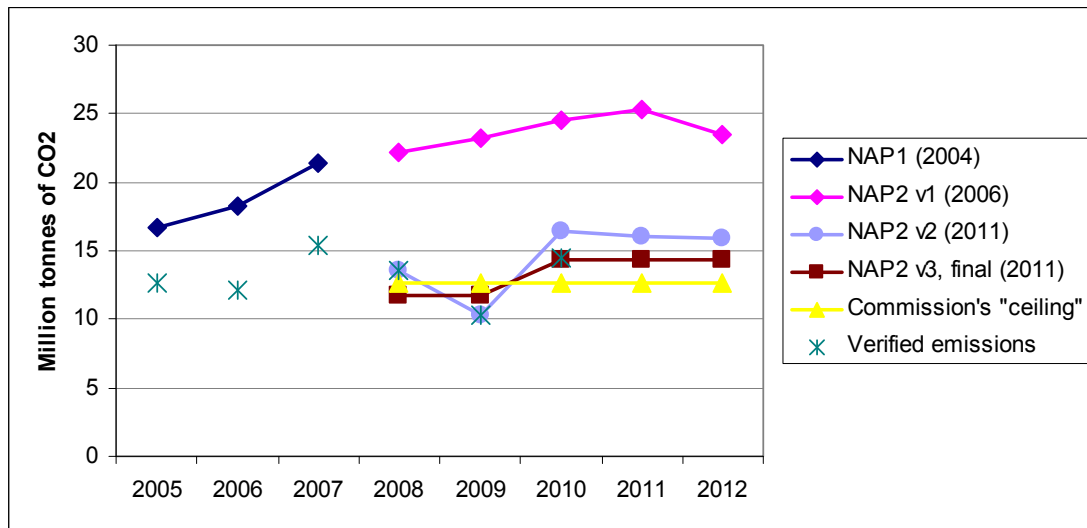


Figure 18 Allowance needs projected by Estonia (NAP) and the Commission, and actual verified emissions.

The Commission’s attempt to fix the market did not remain uncontested. As illustrated in Figure 18, for Estonia it took nearly five years and three NAP2 documents to settle the controversy, which eventually led to the inclusion of energy policy issues into the calculative frame of cap-setting. Amongst the nine member states that challenged the Commission in the Court of the First Instance, Estonia and Poland became the leading applicants seeking the annulment of the decisions to cut the emission limits proposed in their plans (by 47.8% and 26.7% respectively). Estonia and Poland not only disputed the assumptions and facts that had led the Commission to impose a smaller cap, but argued that overall the Commission had exceeded its authority in fixing a ‘ceiling’ for eligible allowances. Moreover, both countries argued that the Commission had intruded on their sovereign rights to decide over the structure of energy supply, as outlined in the Treaty of Rome, therefore threatening

¹⁸⁴ See also Commission’s press release (4 May 2007) “Emissions trading: Commission adopts decision on Estonia’s national allocation plan for 2008-2012”, <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/613> (accessed 20 December 2011).

their energy security (*Official Journal* 2007a, 2007b). On 23 September 2009, the court gave right to Estonia and Poland and indeed annulled the decisions (*Official Journal* 2009a). However, the Commission re-appealed and in the meantime continued to reject the plans, thus effectively continuing to implement the ‘ceiling’.¹⁸⁵ The prolonged court proceedings together with the “ping-pong game” between Tallinn and Brussels froze the cap-setting process for all other states still in court, and hence the EU as a whole.¹⁸⁶ It was only in November 2011 that the parties were announced to have finally reached an agreement, fixing the annual quota of 13.3 million tonnes.

What had been regarded as a scientific and technical issue of allocation became thereby reformulated as a wider problem of national energy policy and sovereignty. At large, these court cases evidence the occasional prevalence of ‘territorial logics’ in the EU ETS negotiations (Bailey and Maresh 2009). Yet, while appropriate, the term glosses over a variety of socio-material conditions that have grounded sovereignty and security claims, as opposed to neoliberal rationalities of government, as well as their historical contingency, and implications for subsequent market experiments. A more useful abstraction would be to consider these cases to indicate discrepancies between at least two ‘problematizations of security’ coded in the Treaty (Walters and Haahr 2005); while Estonia and Poland advocated geopolitical security, the Commission stood for the security of economic processes within the market territory. Territorial logics were not limited to state-bound strategies, but the setup of carbon marketization was equally territorial from the outset.

¹⁸⁵ Commission (2009) “Q&A in relation to the Commission's decision to appeal in Cases T-183/07 and T-263/07 (CFI rulings on Commission Decisions on the Polish and Estonian NAPs)” http://ec.europa.eu/commission_2010-2014/hedegaard/headlines/docs/qa_appeal_091203.pdf (accessed 5 October 2011).

¹⁸⁶ Poland's NAP was accepted by the Commission in 2010. As of end-2011, other pending cases concerned Lithuania, Czech Republic, Romania and Hungary.

7.3.2 The technical: Methodological disputes in projecting emissions and the problem of electricity exports

The Estonian example reveals that it was possible for state governments to bargain for a higher cap on the basis of sovereignty claims, but there is more to the case than that. Beyond the central political argument of energy security, the case added its own technical specificity to the organization of the market. According to the court materials, the disagreement over the NAP, which led to such a drastic reduction, centred on the expertise and authority to forecast future emissions (CFI 2009). More precisely, the controversy derived largely from antinomy between two different approaches to calculation, or two projective devices; estimates of what is 'likely to be needed' in the future and the 'actual' verified emissions of the past, both of which are characterized by inherent uncertainty. The conflicting outcomes of these calculations were most clearly articulated in relation to electricity supply and exports.

The Estonian approach to calculating its 'needs' is detailed in an extensive investigation carried out by the national audit office (NAO-Estonia 2009). The audit reports that any analyses of emission trends (both past and future) published by the government have been based on limited, distorted and insufficiently verified data, and prepared solely for the purpose of meeting international requirements. As in 2006 there were no reliable data of actual emissions and no sound evaluations of the impacts of possible measures for their reduction, the government was incapable of determining even the general direction of emission trends, i.e. whether they were increasing or decreasing. The first plan (NAP1) was based solely on the industry's ambitions, whereas the oil shale companies received the majority of allowances. For the initial NAP2 proposal, a growth rate was simply added to NAP1 quota resulting from an expected increase in electricity consumption and export. As the audit concludes, carbon trading has been regarded foremost as an opportunity to secure

local companies with short-term profits from selling “hot air” to other countries. In a situation where Kyoto commitments had been met before they were even introduced (see MoE-Estonia 2009), the government has showed no intention to further decarbonize the economy and provided no incentives to invest the profits into carbon-efficiency measures. In fact, the audit discloses that the revenues earned by Eesti Energia, the largest single trading body, were initially simply transferred to the state budget as dividends.

This ‘bottom-up’ approach to emissions projections was in no way unique in the ECE states (Ellerman et al. 2007: 252). By contrast, the Commission prioritized ‘top-down’ calculations based on the aggregate data of past emissions in combination with estimates of future economic growth measured in GDP, and the resulting index of carbon-intensity.¹⁸⁷ This approach was supported by the publication of 2005 emissions figures which, for the first time, were reported by individual installations and independently verified, and became subsequently chosen as the baseline for Commission’s own projections of eligible needs. The 2005 data were regarded as the most representative, and hence ‘harder facts’ than the states’ earlier estimates, notwithstanding high measurement uncertainty (MacKenzie 2009b: 172). Furthermore, the Commission employed a single method of evaluation based on the PRIMES model for energy systems. For Estonia, as local informants are quick to point out, the modelling expert assumed that oil shale electricity could be to a great extent replaced by generators running on natural gas. This option had indeed been considered in national policy documents but, at that point, was largely dismissed because of the prospect of relying solely on Russian supplies (Kasekamp 2006).

¹⁸⁷ “Commission decision of 11 December 2009 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by Estonia in accordance with Directive 2003/87/EC of the European Parliament and of the Council”, http://ec.europa.eu/clima/documentation/ets/docs/2008/et_decision_en.pdf (accessed 19 July 2011).

Although the court eventually declined to pass a judgement on any security related complaints, on the grounds that there were enough reasons to annul the Commission's decision anyway, it did acknowledge the relevance of this "geostrategic consideration" to Estonia's allocation methodology, and affirmed the state's right to refer to its energy policy when designing the NAP (p. 81-82 in CFI 2009).

The technical aspects of this controversy, however, were not limited to calculative techniques. Estonia's main contribution was that it introduced the problem of cross-border exchange of carbon-intensive electricity into the ongoing negotiation of market boundaries. Namely, disputes over energy policy gathered new momentum with the assessment of the modified NAP that Estonia submitted twice during 2011. The first revision proposed a smaller cap at 14.3 million tonnes, whereas for 2008-2009 the government adhered in retrospect to 'actual' emissions. Nevertheless, it still requested significantly higher rates for the remainder of the period – over 15 million tonnes – which in effect exceeded the 'ceiling'. The proposal now centred on the alleged shortage of allowances resulting from Eesti Energia's increased export of electricity to Finland and the Baltic market in 2010, following the closure of the Ignalina nuclear power plant in Lithuania.¹⁸⁸ Soon thereafter it turned out that Estonia's 2010 emissions had indeed soared compared to 2009, rising from 10.32 to 14.42 million tonnes. In consequence, the emissions exceeded the quota that the Commission had agreed to allocate to installations in the absence of a valid NAP, 11.85 million tonnes¹⁸⁹, as well as the government's earlier projections.¹⁹⁰

¹⁸⁸ Ministry of the Environment (2011), *Estonia's National Allocation Plan for 2008-2012* [2nd version]; "Commission decision of 29 April 2011 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by Estonia in accordance with Directive 2003/87/EC of the European Parliament and of the Council," http://ec.europa.eu/clima/documentation/ets/docs/2008/et_decision_2011_en.pdf.

¹⁸⁹ DG CLIMA press release (17 May 2011) "Emissions trading: EU ETS emissions increased in 2010, but remain well below pre-crisis level", http://ec.europa.eu/clima/news/articles/news_2011051702_en.htm (accessed 19 July 2011).

Despite the sudden restructuring of the Baltic market, the Commission was reluctant to accept the inclusion of electricity exports, arguing that any free allocation beyond domestic consumption may violate State aid rules and distort the level playing field of the energy market.¹⁹¹ Yet the situation was even more delicate. Contrary to Estonia, the NAP2 allowances had been raised for the other Baltic states because of their ‘needs’ to compensate for lacking power generation capacity; but instead of building their own stations, however, they had relied on imports. Aiming to maintain market efficiency, the Commission was careful not to over-allocate quotas to the Baltic region as a whole. Commissioner Hedegaard called for a political agreement between the states based on solidarity, insisting that the Commission must remain consistent and not create “special principles just for Estonia.”¹⁹² However, there seemed to be no legal instrument which could require Latvia and Lithuania to hand over their surplus allowances instead of selling them for profit.

Instead of being contained as a merely political issue of sovereignty or a merely technical issue of allocation, the Estonian case overflowed into a race against time; the release of the ‘harder facts’ of verified emissions. “The reality conforms [to] the approach of the Commission”, stressed one interviewed EU official, and indeed Brussels prevailed, armed with evidence of measurements that were much lower than Estonia’s projections. With the second phase drawing closer to its end, it was local industry that primarily suffered from the delay, as they risked paying a 1.5 billion EUR

¹⁹⁰ Ministry of the Environment (2011), *Estonia's National Allocation Plan for 2008-2012* [2nd version].

¹⁹¹ “Commission decision of 29 April 2011 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by Estonia in accordance with Directive 2003/87/EC of the European Parliament and of the Council”, http://ec.europa.eu/clima/documentation/ets/docs/2008/et_decision_2011_en.pdf (accessed 19 July 2011).

¹⁹² Commissioner Hedegaard in an interview with *ERR News* (26 January 2011), “Emissions Allowance Dispute Drags On”, <http://news.err.ee/Politics/7bc7d202-6056-4041-b28f-54f53ff97852> (includes a link to the Estonian site with a video, accessed 21 March 2013).

fine for not complying with the directive.¹⁹³ In July 2011 the government waived any further proceedings, admitting that a prolonged court case was no longer in the state's interests as it would not give the country an approved NAP and the opportunity to trade.¹⁹⁴ Nevertheless, although the government now dispensed with the projections of electricity exports, the existing increase in the 2010 emissions gave a new chance to challenge the 'ceiling'. With the approval of Estonia's third proposal, the Commission effectively lost the argument against exports and accepted the superiority of the 2010 data. The final document both legalized the quota that had already been handed out to companies and confirmed the needs for 2010-2012 on the basis of the real emissions increase associated with the closure of Ignalina.¹⁹⁵

The problem of transboundary electricity exchange exemplifies the emergence of unexpected 'matters-of-concern' in carbon markets, which, according to Callon (2009: 542), do not respect pre-defined boundaries between economy, politics and techno-science. Instead they only give way to such qualifications through the process of experimentation (see also Lis 2011). The inclusion of such complex techno-political issues in the cap-setting experiment did not just define power relations at any negotiations over future allocation, but made it necessary to employ novel conceptual and calculative tools. Moreover, such issues highlight the difficulties of settling the borders of the market territory, since each issue opens up other territorial imaginations and claims. Expanding MacKenzie's (2009b) observation that the experiment changes its context, the remainder of the chapter discusses how the

¹⁹³ *ERR News* (15 July 2011) "Companies May be Spared Fine for Skipping CO₂ Reports", <http://news.err.ee/Economy/5f89b754-8db6-430c-b36a-4287da6a5799> (accessed 21 March 2013).

¹⁹⁴ Transcript of the Government's press conference (19 May 2011).

¹⁹⁵ In the final NAP version, nearly all references to Ignalina were removed, but the methodology was swiftly adjusted to include the 2010 data, resulting in a cap that in effect adheres to the actual emissions increase.

integration of energy policy, competitiveness and security concerns generates unique market forms and spatialities in the third phase, beginning in 2013, under the banner of 'carbon leakage'.

7.4 The potential politics of 'carbon leakage'

Court cases and similar trials of strength provided the backdrop for the EU ETS reform undertaken in 2008, as a constitutive part of the EU energy and climate packages. The outcomes of these negotiations testify to the process of 'co-performance' (Callon 2007), in which economists' conceptions of market efficiency are diverted by alternative economic and non-economic knowledge, political agendas, and local materialities and technologies. The new directive (2009/29/EC) aims to overcome geographical and sector-specific differentiations by paving the way for a fully harmonized and centralized market based on a single EU-wide cap and auctioning of allowances. However, although the post-2012 mechanism was eventually accepted with a unanimous vote, it did not fully align with the positions of ECE countries, who would have preferred to proceed with free allocation (Skjærseth and Wettestad 2010a). The directive was therefore carefully adjusted to incorporate a series of exemptions for certain regions and industries deemed vulnerable to carbon pricing, including Estonia's energy sector. A central feature of this re-spatialized politics of marketization is the risk of 'carbon leakage', which serves to both mediate the political compromises between economic agents and simultaneously depoliticize the process.

The notion of 'carbon leakage' should be of particular interest for geographers, because it reinforces the implications of transboundary networks, flows and movements for the 're-territorialization' of national interests (cf. Newman 1998). In economic modelling studies the term refers to a potential future event involving two types of spatial effects resulting from the increased costs that a unilateral climate

policy imposes on manufacturing industries (e.g. Babiker 2005; Ellerman et al. 2010: , p. 194). On the one hand, it is anticipated that companies exposed to international trade competition may relocate production beyond the stringent policy regime, in this case beyond the EU borders, by either physically moving their factories abroad or changing investment strategies. On the other hand, carbon leakage indicates a competitive advantage for the exterior industry, forcing carbon-constrained companies to lose a share of the market to less expensive products. The directive primarily mobilizes the latter definition. Either way, however, the potential event is expected to result in the outsourcing of emissions to non-EU countries, yielding no environmental benefits at the global level.

Whereas ‘carbon leakage’ itself represents *a measure* of the emissions increase resulting from the production shift, the EU system calculates pre-emptively the extent to which energy-intensive industries are *at the risk* of leakage, called the ‘carbon leakage exposure factor’. For those sectors involved in extra-EU trade that are deemed to be at significant risk, the risk factor is used to complement the ‘transitional free allocation’ made available due to general competitiveness concerns (*Official Journal* 2009b).¹⁹⁶ By contrast, the differentiation instituted between power consuming and power producing sectors implies that electricity suppliers will need to buy all allowances, otherwise they could easily pass the costs to end-producers, leading to ‘windfall profits’ (Sijm et al. 2006). However, certain ECE governments managed to adjust this methodology by extending both free allocation and the ‘leakage’ risk to the electricity sector.

In practice there has been virtually no evidence of leakage since the introduction of EU carbon pricing (Reinaud 2008; Ellerman et al. 2010: Chapter 7). It

¹⁹⁶ Contrary to the previous ‘grandfathering’ approach, the Commission aims to harmonize free allocation with the help of ex-ante benchmarks.

has been suggested that the risk appears to be overestimated if other economic and political factors are taken into account, together with the positive effects of technology spillover to less-developed countries (Barker et al. 2007; Barker and Scricciu 2009). Critics have also argued that the application of leakage-related criteria represents a political compromise between the Commission and industrial lobbies rather than an economically sound solution, while extended grandfathering may not actually guarantee less leakage (Clo 2010). Moreover, the lower carbon price and unused free allowances which have recently become evident, resulting from the recession, have inclined the Commission itself to reconsider the risk (Commission 2010b).

In the context of the electricity sector, at least, we could think of carbon leakage as *a future threat* of an event which ‘has not happened and may never happen’, but nevertheless enables the reshaping of present market reality (cf. Anderson 2010a). If concerns about sovereignty loss in free-market competition have enabled ‘leakage’ to be employed as a rhetorical instrument rather than an economic matrix, then carbon market construction appears profoundly engaged with affective politics. The present is acted upon in the name of a potential threat, exhibiting similarities with Massumi’s ‘logic of preemption’ in the way that any action on future leakage cannot be derived from the knowability and measurability of its effects. Rather, the potential lies in radical uncertainty. As Massumi argues, “There is uncertainty, because the threat has not only not yet fully formed, but [...] it has *not yet even emerged*” (2007: 13, original emphasis). This means that in order to fight the threat one first needs to *produce* the threat. What Massumi calls ‘potential politics’ is particularly evident in Estonia’s contributions to marketization, as the economists’ concept of ‘leakage’ was ascribed a specific meaning and content, and hardwired into existing technological systems.

7.5 A 'frontier region' of the market

If we think of the EU ETS as a 'technological zone', then the affective politics of energy security can be seen to create diversity and complexity within this space, particularly when combined with the 'leakage' threat. As Barry notes, a technological zone is never a 'smooth space', but "marked by significant levels of differentiation and variation", the borders of which remain always uncertain, contested and negotiable (2001: 41). Following Mitchell's work on the properties of markets, however, the border-making exercise remains essential for the performativity of economics, enabling the capitalist regime to gain its identity and function through exclusion from non-market systems. Moreover, the exemptions made available to electricity generation in the EU ETS framework support Mitchell's argument that the boundary should not be conceived of as a thin line between market and non-market, capitalism and non-capitalism, but rather as a broader terrain of negotiations, or 'frontier region' (Mitchell 2007). The post-2012 market comes to have a distinct geography.

The Central European and Baltic countries are not only notorious for their resistance to liberalizing national energy sectors in the manner of neoclassical economies (von Hirschhausen and Wälde 2000; Ürge-Vorsatz et al. 2006; Bouzarovski 2010; World Bank 2010), but remain physically connected to a Soviet-era technological zone. Even if the variable outcomes of postsocialist energy reforms, coupled with attempts to lessen dependence on Russian hydrocarbon imports, have created new institutional networks and power relations within the region and beyond (Bouzarovski 2009), the 'technological momentum' created by the presence of energy infrastructure is hard to evade (cf. Hughes 1987). In Estonia, Latvia and Lithuania, concerns about energy security are more pronounced owing to the fact that their electricity networks are synchronously interconnected with the unified transmission system of Russia and Belarus, part of the IPS-UPS, which operates separately from the

interconnected system of Continental Europe coordinated by the ENTSO-E (Aalto 2008: 10; Maigre 2010).¹⁹⁷ Located at the interface of two techno-zones, the 'Baltic energy island' has become a particularly troubling site for the integration and re-territorialization of Europe. Although infrastructural interconnectivity has always been considered a central feature of the internal energy market (Matlary 1997), the building of grid connections under the Baltic Energy Market Interconnection Plan (BEMIP) has been delayed for various political and financial reasons. To date, the three countries remain isolated from the EU system, with the exception of a single link launched between Estonia and Finland in 2007, the 350MW Estlink1 submarine cable.

The establishment of geographically differentiated rules for carbon trading was grounded in the path-dependencies characteristic of post-Soviet 'techno-economic networks' (Callon 1991). In the revised directive, these differentiations take the form of two legal provisions; Article 10c, which extends 'transitional free allocation' exceptionally to the electricity sector, and an additional section in Article 10b, which transforms the whole idea of 'carbon leakage' by ascribing the potential threat to non-EU electricity imports. Achieved mostly by Poland's diplomacy the main instrument, Article 10c, offers member states the possibility of opting out of auctioning in case they wish to upgrade and diversify their power supply systems. In other words, this 'optional derogation' accepts windfall profits, but requires these profits to be used for the modernization of infrastructure (recital 40 in *Official Journal* 2011b). In order to be eligible, countries had to meet *one* of the following criteria, falling under two main categories. First, lack of interconnectivity, where the national grid was either not connected to the EU network in 2007, or was connected only through a single line with

¹⁹⁷ Finland also has a connection with Russia, but operates in a synchronized way with the Nordel system, which is interconnected with the EU network. For technical analyses, see <http://www.ucte-ipsups.org/> (accessed 12 February 2012).

a capacity of less than 400 MW. Second, fossil fuel dependency, where more than 30% of electricity was produced from a single source in 2006 and the national GDP did not exceed 50% of the EU average. Following these limitations all new member states were qualified to apply for the opt-out, with the exception of Slovenia and Slovakia.¹⁹⁸

The Estonian contribution to the directive, furthermore, linked energy policy considerations to the possibility of outsourcing power generation to non-EU suppliers. By default Article 10b applies to the non-electricity sector, obliging the Commission to take “measures to support certain energy-intensive industries in the event of carbon leakage” (*Official Journal* 2009b: 75). However, an additional provision in paragraph 1, letter (c) commits the Commission to also assess the leakage impact on energy security in any countries that have significant connections outside the market territory. The application of leakage potential to electricity supply is unique and deserves special attention. Notably, in theory, the power companies are not considered to be in competition with third party producers and thereby exposed to a significant risk because typically the transmission grid has no extensive connections to non-market regions (e.g. Droege 2009; Clo 2010).¹⁹⁹ In practice, however, a number of member states do have extra-EU connections (see Figure 19). The isolated Baltic market represents the most intriguing case, enabling the Estonian government to dispute the economists’ view. The Estonian argument, simply put, was that in an open market the Baltic industries may prefer to buy cheaper, and allegedly dirtier, Russian electricity, thus risking the competitiveness of the investments made by EU producers (Kisel 2009; Mäe 2009; Kisel 2011). In recent years, there have been no electricity sales between Russia and Estonia despite the inevitable mutual exchange of

¹⁹⁸ The Baltic countries were included by setting the threshold for connection capacity slightly higher than provided by Estlink1.

¹⁹⁹ An additional reason might be that electricity is still regarded as a state service rather than a global commodity.

electrons.²⁰⁰ Nevertheless, the future threat was ascribed a reality status at the disjuncture of these two markets and the oil shale country was identified as “a high risk leakage site”.²⁰¹ Regarded as a tailor-made provision for Estonia, Article 10b(1)(c) therefore combines the idea of carbon leakage with deeper concerns about the security of supply and fair competition in power markets. This nexus of security, competitiveness and leakage risks became fully acknowledged by the Commission in a subsequent report that served to further assess the impacts on any sectors at risk (see the Communication cited above) (Commission 2010a: section 7, 2010b).

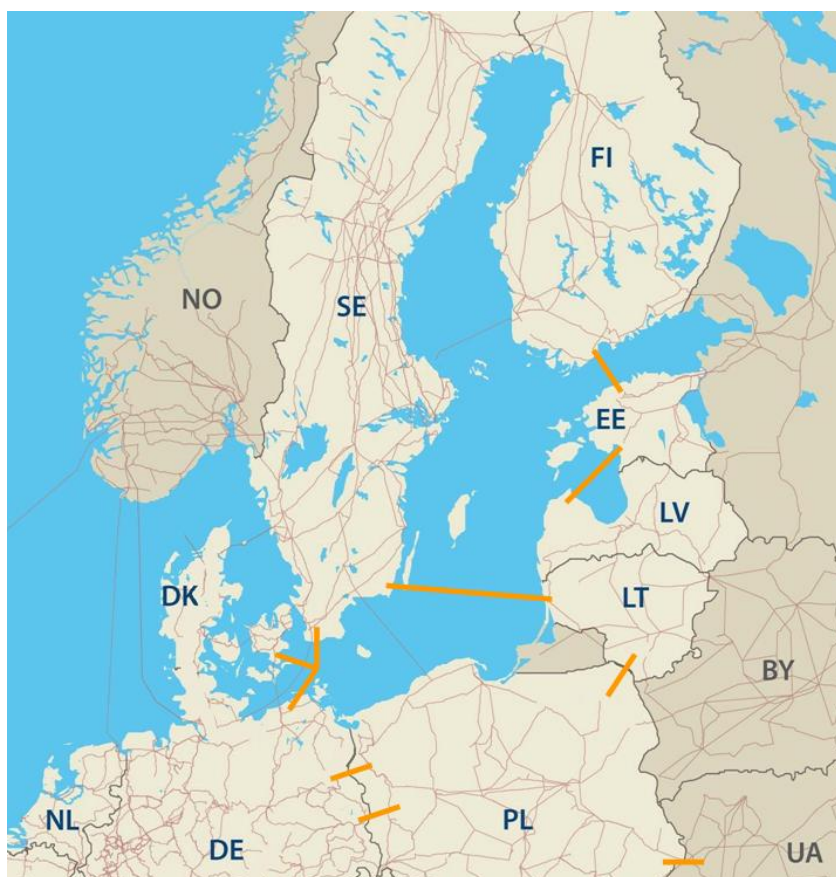


Figure 19 The electricity transmission networks of Northern Europe.

Note: These include the Estlink1 cable between Estonia and Finland and the yet-to-be-constructed BEMIP connections (in orange). © European Union, 2009.

²⁰⁰ Nonetheless, the networked grid allegedly enables Estonian lines to be used to transit Russian electricity to Latvia and Lithuania, and “back” to the Nord Pool. A real-time dashboard depicting the flows is available at <http://elering.ee/cross-border-physical-flows/> (accessed 12 February 2012).

²⁰¹ *ERR News* (18 January 2011) “Estonia a hotspot for carbon leakage”, <http://news.err.ee/Economy/72a17a3d-6ae5-47e7-b8a8-5dc287d94563> (accessed 21 March 2013).

Such a re-conceptualization of the economists' term indicates that the risk of shifting carbon-intensive production outside market boundaries becomes again framed as a threat to state sovereignty. Here, the potential politics reaches beyond the idea of a temporary economic and infrastructural "transition" as foreseen in Article 10c. As the directive is not designed to deal with energy security, the issues of interconnectivity helps carve out a special niche between the single market and its exterior. Borrowing Mitchell's (2007) term, this could be called a 'frontier region' of the EU ETS. Whilst for Mitchell the frontier denotes informal, non-market practices embedded across the entire space of the capitalist regime, here the economic horizon overlaps with the regional margins of Europe as actively constituted borderlands (cf. Berndt and Boeckler 2012). In a way, it becomes literally "a line on the map", which is nevertheless transformed by other territorial imaginations and claims (Mitchell 2002: 292). By integrating security into the post-2012 market rules the diplomats of ECE states have successfully created a spatially differentiated market, which comes to have complex, yet continuously disputable and shifting borders.

Overall, a concern with 'leakage' adds another layer to the geopolitical exercise in which Estonia is constructed as 'fundamentally insecure' owing to its borderland location (Kuus 2007).²⁰² This is not to say that energy (in)security represents an objective state of affairs defined by concrete circumstances, such as grid connections. In other Baltic countries, interconnectivity with third parties is not seen as a threat, rather the opposite (Grigas 2012). The 'leakage' case only confirms the argument of the previous chapter that Estonia's energy security, as security at large, represents "a malleable and fluid sphere that is constituted differently in different circumstances" (Kuus 2004: 203). As explained, there are multiple conceptions simultaneously at

²⁰² Estonia's geopolitics has been also discussed in several earlier writings (e.g. Aalto 2003; Kuus 2002; Berg and Oras 2000).

work – being a pendant of the Russian grid represents only one of the factors mobilized in local debates. Also, for the time being, Article 10b(1)(c) turns out to be solely a rhetorical achievement, which does not provide Estonia with any immediate benefits. New BEMIP connections may additionally not lead to disconnection from the CIS grid due to other geopolitical strategies, and may even culminate with the integration of the two techno-zones as a result of the EU-Russia energy dialogue (Kasekamp 2006; Aalto 2008; although disintegration is still pursued by the TSO, Elering 2011). In this situation, the only instrument currently available remains ‘transitional’ free allocation, while an alternative measure of border carbon adjustment has been waived by Brussels in light of WTO agreements (Commission 2010a; Droege 2011). Meanwhile, Estonia’s decision to use the opt-out results not from interconnectivity problems, but an earlier failure to get State aid approval for the subsidization of new generation capacity. The additional emissions quota received in late-2011 were quickly employed for the same purpose, as the government allowed Eesti Energia to transfer the assets into building the new shale-fuelled power station, if the prices of household electricity were kept unchanged until 2013.²⁰³

7.6 Making products the same: is shale oil really oil?

Similarly to the electricity sector, the unique features of Estonia’s *shale oil* industry and its central place in the national economy raise questions about the possibility of maintaining a territorially bounded and regionally integrated regime for emissions control and exchange. At the time of writing, the derogations that Estonia is granted for Phase III trading have still not received final approval from the EU authorities. However, the last years of negotiations over an extremely complex technical and

²⁰³ *ERR News* (22 December 2011) “Eesti Energia Withdraws Price-Rise Bid”, <http://news.err.ee/economy/02c9e013-141f-4eae-aab1-7083343cce29> (accessed 21 March 2013).

political issue illustrate the degree of standardization that is required for designing a transnational carbon market, or what MacKenzie (2009a) calls the problem of ‘making things the same’. This concerns both the EU ETS and more recent debates over the Fuel Quality Directive.

MacKenzie’s phrase originally indicated the need to account for emission rights in a standard way by translating various greenhouse gasses into CO₂ equivalents. Yet the inclusion of ‘carbon leakage’ and competitiveness concerns in the ‘post-2012’ rules for transitional free allocation gives a new dimension to the whole agenda of harmonization that is instrumental in forming a homogeneous ‘technological zone’ for carbon, especially in power-consuming sectors. According to economists’ convictions, any free allocation maintains the possibility of market distortions, because the quota given to individual installations differ remarkably. As Ellerman *et al.* explain, such differences derive from various issues “ranging from unavoidable random variation in the factors determining production to the explicitly purposeful in the different treatment that may be given to different countries and sectors within a country”, while they admit that “it seems at least possible that the heterogeneity among installations is such that no two are alike” (Ellerman *et al.* 2010: 120-121). Although Ellerman *et al.* doubt that such variations have significant financial effects, according to their view, full auctioning would avoid the problem of harmonization altogether. However, since the new directive institutes auctioning only gradually, the imperative of market efficiency has required free allocation to be implemented in the non-electricity sector through ‘harmonized Community-wide rules’ that would guarantee the commensurability of installations across the EU.

In this context, the problem of standardization reaches from the framing and qualification of goods that are being traded in the market, such as emissions allowance

units (Callon et al. 2005; Callon 2009: 540), to the technological processes that supply the carbon commodity in the first place. In order to create a fully harmonized and centralized cap-and-trade system, not only the emitted gases have to be ‘made the same’, but also the manufacturing processes which generate these emissions. Hence, the ‘post-2012’ system aims to calculate allowances in respect to the carbon-intensity of *products* rather than the energy inputs of production, which was the case under the ‘grandfathering’ approach. A central measure to achieve the equivalence of carbon-emitting industrial processes (and thereby avoid distortions in competition) has been the invention of ex-ante benchmarks. The benchmarking exercise was grounded in earlier attempts to render industries comparable across the EU, notably the NACE statistical classifications system for economic activities. Ideally, the ETS would establish one benchmark for each individual product given in the NACE 4-digit system according to the average performance of the top 10% installations across the EU based on efficiency, without making any differentiation “on the basis of geography or on the basis of technologies, raw materials or fuels used” (*Official Journal* 2011a: 1). For the non-electricity sectors covered by the scheme, the critical question that emerged was *how* their products were made commensurable with those of other emitters under the same NACE category, resulting in a specific benchmark category.

Given this background, the problem of ‘oil shale’ comes to embody a trinity composed of a unique raw material (and fuel), specific technologies of production, and a final product that resists standardization due to its specific material characteristics. Representing another marginal, yet profoundly disturbing techno-political issue for the Commission, shale oil does not fit easily into existing classification systems. It complicates the translation of the product’s distinct materiality into harmonized market rules, alongside associated technological processes. Moreover, it raises the question of what actually qualifies as an *individual* product.

Within the EU legal framework, the existence of oil shale as an indigenous fossil fuel unique to Estonia has deserved little notice beyond the Accession Treaty. It is only recently that oil shale has become explicitly addressed in the new legislation for industrial emissions (the IPPC directive, 2010/75/EU). The directive grants shale-based combustion an exceptionally lower rate of desulphurization due to the ‘specific characteristics’ of the feedstock, permitting in effect 25% higher SO₂ emissions than the limit values imposed on coal combustion (*Official Journal* 2010b).²⁰⁴ By contrast, the NACE classification underlying the ETS benchmarking exercise did not initially list oil shale individually but equalized the resource with lignite, whereas *shale oil* was merged with a separate category for crude oil refining, the ‘manufacture of refined petroleum products’ (NACE code 2320). Due to the latter code, shale oil production was automatically included in the list of industries exposed to a significant ‘carbon leakage’ risk along with 164 other sectors, which were calculated through modelling the sector’s extra-EU trade intensity and increases in production costs that were anticipated to result from carbon pricing (see *Official Journal* 2010a).

Notwithstanding the ‘carbon leakage’ bonus, this approach turned out heavily contested by the Estonian government and industry, giving way to an extended and extremely technically detailed dispute that centred on the specific characteristics of the resource and its manufacturing technology. Is shale oil like any other crude oil? Or, is it in fact a *separate product* that requires special treatment under the ETS? When the consequences of the NACE code for benchmarking became clear, the Estonian mission in Brussels was to convince the Commission that shale oil is substantially different. Again, Brussels’ knowledge of the industry was significantly transformed by Estonian

²⁰⁴ Interview in Brussels, 7 June 2011. Allegedly, the high content of ash resulting from oil shale combustion does not enable the use of the same abatement criteria for desulphurisation.

experts, or more precisely, by a single expert.²⁰⁵ The national technical specialist who consulted the EU bureaucrats highlighted shale oil's complex hydrocarbon composition and different density compared to crude oil, the technical specificities of the thermal treatment process, as well as the product's individual standing in other EU records, notably the REACH regulation on chemicals, EC 1907/2006 (Siirde 2010). As shale oil processing is approximately a hundred times (sic) more energy-intensive than petroleum refining, according to my interviewees in Brussels, benchmarking with other NACE 2320 products would have had fatal consequences for the industry: the values imposed by refining would have basically ruled out any free allocation for shale oil.²⁰⁶ The distinctiveness of shale oil was partly acknowledged by the Commission; for example, shale oil factories were excluded from the list of refineries (see Ecofys 2009). Even more importantly, a recent NACE revision lists 'the mining and extraction of oil from oil shale' as a separate activity, and moves it under a different category, 'extraction of crude oil and gas' (Eurostat 2008). Contrary to refining, there was no benchmark established for this category, because hydrocarbon extraction incorporates very diverse operations and locations, which consequently opened up the possibility of finding a specific benchmark for shale oil.²⁰⁷

Nevertheless, benchmarking shale oil alone turned out equally difficult. Even if the Commission would have accepted the fuel-specificity argument, the Estonian industry is so uniquely small with its three companies and two technologies (see Chapter 8) that the BAT 10% rule mentioned above could not be applied either.²⁰⁸ These problems concerned not just Estonia, but many countries raised their own

²⁰⁵ The majority of consultancy was provided by Prof. Andres Siirde, who is also one of the two Estonian professors who participated in the EASAC report discussed in Chapter 6.

²⁰⁶ Interview in Brussels, 7 June 2011.

²⁰⁷ Interview in Brussels, 7 June 2011.

²⁰⁸ Even this would have been politically accepted, creating a separate benchmark would have required level comparable data at installation and product level, which was not easily available.

issues in relation to their specific industries, with Poland taking the Commission to court again. Overall, it turned out far too overambitious to find product-based benchmarks for all EU industries, given the short time-frame allocated for the preparations, with only 54 product-specific benchmarks being identified as a result. Shale oil along with many other ‘non-benchmarked products’ subject to carbon leakage risk was included under the ‘fall-back’ method, according to which the degree of free allocation depends on only two EU-wide standard benchmarks for fuel and heat inputs, or if these cannot be measured, then the previously used ‘grandfathering’ approach based on historical emissions (Commission 2011).

As a result of this compromise, shale oil companies were initially calculated to gain approximately 63% of their quota for free, with the remainder to be obtained from the market.²⁰⁹ Nevertheless, the Estonian diplomats and experts continued to level any technical and legal argument possible even against the ‘fall-back’ method,²¹⁰ and eventually achieved the unprecedented 100% free allocation based on grandfathering. Similarly to security arguments, this dispute blurred the distinction between mere techno-scientific calculations and wider economic and political problems. The new trading rules were not simply imposed on Estonia, but carefully adjusted to the specific material and technical conditions of oil shale production. Moreover, the formation of Brussels’ knowledge about the industry was again a ‘two-way’ process (Kuus 2007), whereas national expertise was still formed within very small circles, and remains open to further contestation.

²⁰⁹ Interviews 7-8 June 2011, 18 June 2010.

²¹⁰ The Estonian expert convinced the Commission that ‘grandfathering’ should be applied to the whole production process without dividing shale oil plants into “sub-installations” by separating fuel consumption. Arguably, the problem is not only that heat inputs cannot be measured in the process of oil shale thermal treatment (i.e. pyrolysis), but the EU-wide fuel benchmark based on natural gas as the least carbon-intensive fuel is also inappropriate, because oil shale simultaneously provides a fuel for the process, not just a raw material. Transition to gas or any other external fuel was claimed to be technically, economically and environmentally unfeasible in the Estonian conditions, causing oil shale’s energy potential to be wasted (Siirde 2010).

A further example of the significance of resource materiality to marketization concerns ongoing debates over the revision of the Fuel Quality Directive, which is aimed to set a 'default value' to different types of carbon-heavy fuels that can be sold in the European market, based on life-cycle emissions (Sperling and Yeh 2010; Brandt 2011). In this case, shale oil along with the crudes produced from tar sands are expected to become inferior fuels due their higher carbon content in comparison with conventional liquid fuels, and precluded from market competition. At the time of writing, there is still no resolution to these debates, but it is clear that the Commission has once again been unable to impose the new market rules on unconventional energy development, but has had to take into account the specific material and technical characteristics of the industries and their entanglements with other sectors. In the Estonian case, this pertains to the close integration of oil and other by-products, including electricity, whereas the Commission has come to rely on national information about the industry's total carbon footprint, rather than on international expertise (see Brandt 2010; Siirde et al. 2013). Again, this debate has turned from simple technical calculations to an extremely complex techno-political debate involving dilemmas about national economic stability and energy security, the outcomes of which are not yet fully known.²¹¹

7.7 Uneven geographies of marketization

Discussed in light of recent sociological studies of carbon marketization, the case of oil shale production leads to several conclusions. Most importantly, the chapter highlights the limitations of the performativity thesis and draws attention to wider political and

²¹¹ See *ERR News* (23 May 2013), "New EU Energy Directive Threatens Estonia's Fuel Industry", <http://news.err.ee/politics/e719631c-7cda-4b48-8eb8-16130c2e9d05>, and (24 May 2013) "EU Fuel Quality Directive Should Make Exception for Estonia, Says Industry", <http://news.err.ee/politics/06d52590-ccd2-4379-9ffa-8443ed159ebd> (accessed 1 July 2013).

technical constituents of marketization as an indeterminate process that can assume different courses in time and space. Rather than representing a strong case of the performativity of economic theory, the post-2012 rules of the EU ETS remain grounded in earlier trials of strength in debating market efficiency and rival matters of concern, such as national energy policy. The potential politics of ‘carbon leakage’ exercised by state governments further involved the strategic deployment of geopolitical security arguments as generative discursive practices that have helped reshape present market reality before any threats have fully emerged. Although the Commission is said to have taken ‘epistemic leadership’ in designing the scheme (Skjærseth and Wettstad 2010b), the re-conceptualization of ‘carbon leakage’ was possible due to the activity of ‘economists in the wild’, in particular government and industry specialists, thereby lending support to the idea that carbon markets are ‘co-performed’ (Callon 2007), involving economic as well as non-economic expertise.

MacKenzie’s ‘technopolitics’ provides a useful starting point for rethinking the politics of performativity. However, his focus on the ‘politics of allocation’ tends to overlook wider forms and sites of contestation over the economization of carbon in its material forms of both emissions and energy. Re-reading MacKenzie’s work geographically directs attention to wider tensions between different modes of political rationality based on territorial sovereignty and market-led governance. The new member states’ resistance to carbon pricing can be interpreted as ‘territorial logics’ (Bailey and Maresh 2009), except that these logics are not exclusively bound to the strategies of national governments, but rather coded into the EU market experiment from the outset, as the enclosure of emissions within the EU economic territory brings neoliberal rationalities of government continuously into conflict with state sovereignty and other modalities of security.

Moreover, such territorial logics may take very specific forms and dynamics in relation to distinct socio-technical and material contexts. If markets are taken to be ‘socio-technical agencements’, then the post-2012 adjustments should be understood to also account for the effects of non-humans on marketization. While Callon and MacKenzie explain market diversity primarily with the relational effects of human interaction with the devices that directly mediate calculation, here the evidence suggests that techno-politics may also span other technicalities and materialities, in this case both the specific properties of the oil shale resource, and the infrastructures of oil production and electricity transmission. Such path-dependent technological complexes do not act as market devices, but nevertheless affect calculation. Being made central to national energy policy and integrated into market technopolitics, they come to perform as a ‘rival calculative regime’ (Mitchell 2008) that cannot be ignored in the ongoing reconfiguration of the European carbon economy. Furthermore, the presence of such material and technical structures renders visible the difficulties of singling out a clearly-bounded market territory. The routine realities of transboundary carbon exchange challenge the distinction between market and non-market domains and effectively create a wider ‘frontier region’ on the borders of the market, which is not reducible to “transition”, notwithstanding the agenda of harmonization.

By demonstrating how the process of carbon marketization can take spatially divergent courses and generate uneven market geographies, the chapter contributes to the nascent field of ‘geographies of marketization’ (Berndt and Boeckler 2012) and highlight further avenues of collaboration between this field and the growing body of research on energy geographies. It leaves open the question of the extent to which agency should be ascribed to the non-human components of calculation, such as the electric grid (cf. Bennett 2005, 2010). A detailed discussion of distributive agency in energy assemblages is beyond the scope of this thesis, but it would certainly be a

mistake to explain the case in terms of technological determinism, especially if infrastructure is regarded as a relational concept embedded in other forms of human organization and technological structures (Star 1999). For example, the “electricity leakage” risk was skilfully orchestrated by the Estonian government, who mobilized a narrow definition of security as independence from Russian supplies, which in turn was rooted in earlier geopolitical discourses and prolonged resistance to energy market liberalization in the region. This definition was only partially facilitated by the socio-technical networks inherited from the Communist era and the strategic presence of oil shale resources. Market configuration could therefore be regarded as interplay between human and non-human agencies, which may have unpredictable consequences.

Chapter 8. 'When Unconventional Becomes Conventional': A Shale Oil Technology in the Making

Unfortunately, to harvest the oil in oil shale you have to do what Mother Nature didn't do: heat the rocks to 700 degrees [°F]. For a century, men have periodically mined and crushed shale, then shaken and baked it in giant kilns. But the rocks have proved stubborn, promising much, delivering little (Udall and Andrews 2008).

In Estonia, oil shale production is something conventional, something proven.²¹²

Enefit – A Reality.²¹³

8.1 Technology in translation

In March 2011, news of an unexpected deal between two companies rocked the small circles of oil shale experts around the globe. The Estonian state energy company had paid 29 million euros and acquired 100% of the shares of the Oil Shale Exploration Company (OSEC) registered in the United States, following approval from government authorities of both sides. In what was regarded as a “surprise move to many”, Eesti Energia – and in principle the entire Estonian nation – overnight became the owner of the largest privately owned oil shale resources in the state of Utah, which together with leased land stretch across 30.000 acres (124km²) of barren landscape on Utah's eastern border, close to the town of Vernal (NOSA 2011). As icing on the cake, the deal included a smaller federally owned property subject to one of the six RD&D leases issued by the Bureau of Land Management, which is, in fact, the only such lease to date in Utah (Leverette 2011). The takeover of OSEC assets and leases shadowed another deal signed a year earlier with the government of Jordan, which made Eesti Energia the second company after Shell to enter into a concession agreement with Jordan. Building on several memoranda of understanding that had been signed earlier, the Estonian managers have since pursued a clear strategy to reserve resources overseas

²¹² Rikki Hrenko, CEO of Enefit American Oil, in her presentation at the 31st Oil Shale Symposium, 18th October 2011, Golden, CO.

²¹³ This slogan has consistently appeared on Enefit's presentation slides and corporate pamphlets distributed at international meetings during my field research.

and develop projects on their own, in addition to the consultancy provided to Morocco, Syria, Egypt and, most recently, Serbia aimed at studying the conditions under which their deposits could be also put into use.²¹⁴

Within only a few years Eesti Energia has undergone a rapid transformation, turning from a national power monopoly to an international energy company, and has attempted to become ‘the undisputed world leader’ in oil shale development by selling Estonian technological expertise to other countries under its new international brand ‘Enefit’.²¹⁵ In a keynote address opening the annual international oil shale symposium in Colorado in October 2010, the Estonian Minister of Economic Affairs boasted that his country is now “going through a phase, which we call the rebirth of our oil shale industry”.²¹⁶ Yet the news of Enefit’s entrance into the United States gave rise to heated debates about the company’s ambitions, the suitability of its Soviet-era technology for the exploitation of different deposits, and its prospects for further innovation. “Estonians don’t fail us!” adjured the Lieutenant Governor of Utah in a keynote speech at the 2011 Colorado symposium, while expressing his confidence that with the help of their technology the dream of American energy independence may eventually come true.²¹⁷ The ‘rebirth’ of the industry was greeted with high hopes and deep doubts, both at home and abroad.

What is at stake when a technological system previously considered underdeveloped, unable to compete with traditional energy economies, or unacceptable for socio-political reasons is subsequently claimed to be viable under all these criteria, based on the example of a “real” industry existing in another geographical location?

²¹⁴ In addition, Enefit has been negotiating technology sales to China.

²¹⁵ Eesti Energia, *Creating New Energy!*; a corporate information pack distributed in 2010.

²¹⁶ Field notes, 18 October 2010.

²¹⁷ Field notes, 17 October 2011.

While recent critical literature on ‘post-peak’ energy futures has attended only to the novel invention of turning the oil shale deposit into a vast underground retort (Mitchell 2011; Klare 2012b), here I interrogate the technologies which have long been used for retorting shale oil on the ground, after the mineral has been mined through conventional methods. In shifting focus to exterior markets located outside the climate policy regime of the Kyoto Protocol the Estonian company seems to have harnessed the perfect moment, which has been opened up by the increasingly uncertain future of the domestic industry, on the one hand, and the continued failure of multinational corporations to develop a commercial ‘in-situ’ conversion process, on the other. This window of opportunity has allowed for a radical reorientation not just in Eesti Energia’s business, but in Estonia’s energy economy at large. Rather than being simply transported to other sites, the displacement of the technology necessitates a ‘translation’, whereby the domestic system is transformed alongside the context of the recipient country; a two-way process that summons and globalizes the entire industry (cf. Callon and Latour 1981; Latour 1987, 1999; Callon et al. 2009).

The central observation made in this chapter is that in order to be ‘translated’ into other locations, the ‘eventful place’ of the Estonian oil shale industry needs to be made conventional, or indeed, *conventionalized*.²¹⁸ This process should not be reduced solely to the rhetorical skills and practices of marketing. Rather, shale oil is rendered technologically possible, economically viable, and politically desirable to extract by building up credibility overseas with the help of locally developed technological solutions and know-how, whereas ‘the local’ is subjected to change on both sides. These interventions entail geographically contingent and often contradictory

²¹⁸ According to the *Oxford English Dictionary* (1989), to ‘conventionalize’ means either to ‘make conventional’ or ‘bring under conventional rules’ (also: to ‘treat in a conventional manner’). I prefer to use the term in the former sense in order to emphasize the active process of *making* and transforming conventions, rather than take any rules as given and static. The verb has been used since late 19th century.

practices, which assume multiple spatialities and temporalities. As explained throughout the thesis, the Estonian ‘rebirth’ is far from being decided, but is subject to remarkable uncertainty and ongoing disputes. To the same degree, as long noted in STS literature, the success or failure of ‘technology transfer’ depends on the industry’s ability to be adopted at other sites, wherein the established properties of the machinery and its intended use may become compromised by unfamiliar social, economic, and ecological entanglements (Akrich 1992; de Laet and Mol 2000; Law and Mol 2001). Namely, apart from uncertainty and contestation, the main problem with transferring existing retorting solutions is that they represent a ‘site-specific technology’ (cf. Hughes 1983: 47). The Estonian methods for oil shale exploitation, particularly for shale oil extraction, have evolved in relation to the depositional and compositional characteristics of the kukersite resource, thereby rendering it potentially difficult to adjust the technology to other deposits. Moreover, the regime in which oil shale has been maintained as an ‘economic’ and socio-politically favoured energy resource does not travel well either, being entangled in particular local conditions inherited from the planned economy and backed up by the nation’s ongoing pursuit of energy independence. Hence, the following inquiry is driven by three key questions. First, what does it mean for oil shale to be ‘conventional’ or ‘unconventional’? Second, how is it possible to translate specific technological systems that are deemed ‘proven’ and ‘economic’ in one place into different settings? And third, how can one account for the role of resource materiality in the politics of technology transfer and development? At stake here is the relationship between three processes: the technical innovation required for commercial-scale production, the creation of markets for both venture capital investments and actual oil processing, and the public inquiries through which these developments continue to be called into question. The

outcomes of ‘conventionalization’ are decided at the intersection of innovation, economization, and political contestation.

The chapter seeks answers to these questions by tracing the changing relations between human experts, technical systems and the resource, which may enable (or disable) the commercialization of the ‘Enefit’ technology. It takes inspiration from two bodies of social theory literature informed by the STS approach, which help move beyond the simplistic, yet widespread assumption that shale oil becomes economically feasible to extract once crude prices are sufficiently high. The first theoretical starting point here is again the thesis that things enter into economic valuation and exchange through the dynamic and diverse, yet path-dependent processes of ‘economization’ and ‘marketization’ resulting from the relational effects of hybrid collectives (Callon 1998; MacKenzie 2009b; Çalışkan and Callon 2010). Departing from the argument made in the previous chapter, however, I will pay little attention here to the performativity of economic theories and devices in the configuration of markets as ‘socio-technical agencements’ (Callon 2007; Callon et al. 2007). Instead, the focus of this chapter is on the process of something ‘becoming conventional’ and, in this way, opening up the possibility of creating new forms and subjects of market exchange in the future. Rather than mobilizing the *specificities* of Estonia’s energy sector, as was the case in the design of the EU carbon market, here the prospects of economization require the local industry to ‘universalize itself spatially and temporally’ (cf. Bowker 1994: 50). It attempts to be applicable everywhere in the foreseeable future by imitating and adjusting to the market and political logics of other localities, whilst simultaneously transforming these logics.

The second field of literature relates to the developments in STS studies of technological change and innovation over the last two decades, to which actor

network theory has made a critical contribution (e.g. Bijker et al. 1987; Law 1991; Bijker and Law 1992; MacKenzie 1996).²¹⁹ A key concept in this field is Callon's (1991) 'techno-economic network', which contrary to sociological studies emphasizes the active capacities of technical objects and materialities in the innovation process. In parallel to the idea of 'eventful spaces' introduced in Chapter 4, Callon's term serves here to conceptualize the increasingly globalized oil shale industry as a series of 'highly heterogeneous, yet coordinated sets' of resource materials, locally situated knowledge and techniques of extraction, and nation-specific regimes of political and economic rationality grounded in distinctive metrological and calculative practices (see also Callon 1992). When expanded internationally, these networks define the relationships between the spaces of past, present and future exploitation. The distinct identities of such networks are particularly manifested in the discrepancy between in-situ and ex-situ approaches to extraction, but also between the different paths to commercialization taken within the industry associated with above-ground retorting.

Despite Callon's groundbreaking contributions to both fields and his early attempts to explain how technological innovation and market-making are interwoven processes (Callon 1987), the co-production of technological and economic systems has rarely been taken up in recent work in geography (see Barry and Slater 2005b). Timothy Mitchell provides an exception in a recent article, where he argues that the design of large technological systems has always formed an integral part of the invention of 'the economy':

The economic is not a calculus that exists in advance, which then determines the success or failure of different technologies. The economy was not a pre-existing sphere, into which technological innovation introduces changes. Rather, there are different attempts to introduce calculations and persuade others that they are superior to rival models and calculations (2008: 1118).

²¹⁹ This turn remains in contrast to the earlier 'social constructivist' and 'social shaping' approaches to explaining technological change exclusively through social dynamics.

Although Mitchell (2011) has more recently interrogated the critical importance of the idea of unlimited oil supplies for modern economic thought, he overlooks the potential of alternative fossil fuel industries for reconfiguring the economy of oil, considering them to only sustain the present order. The practices through which non-traditional approaches to hydrocarbon extraction are conventionalized remain to be studied. The chapter addresses this gap by empirically studying *how* this is being achieved. Combining these literatures, the following analysis has three underlying themes. One concerns the *co-evolution* of innovation and economization in the oil shale industry. The other concerns the *materiality* of the resource itself that is made subject to standardization and economic valuation (cf. Mitchell 2002; MacKenzie 2009b; Braun and Whatmore 2010). The third and related theme concerns the exchange and translation of technology between different *spaces* of past and future production, in Estonia, Jordan and the United States. The question of the difference between regionally specific forms of exploitation lies at the heart of the problem of oil shale becoming conventional.

Building on the concept of ‘techno-economic network’ (Callon 1991), the next section traces the evolution of the ‘Enefit’ technology by detailing the arrangements under which a particular method of retorting has emerged and survived since the Soviet era. The ‘Galoter’ process that was invented during this period has not only been continuously in operation, but also retained ‘economic’ status under the veil of the state-run electricity sector. In order to be elevated from an isolated local case to a more universal solution suitable for technology exports, however, Eesti Energia’s sole remaining Galoter-based oil factory needs to be gradually disentangled from the post-Soviet institutional and infrastructural complex, rendered into a distinct techno-economic object so that it can be treated as a form of intellectual property, and upgraded for industrial-scale production. Refuting the linear vision of innovation that

sees technologies cumulatively improving over time and space, this upgrading process has been sidetracked by competing attempts to build up alternative techno-economic networks at home and a redistribution of innovative and inventive capabilities between the state monopoly and its foreign partners for commercializing the business elsewhere.

‘Becoming conventional’ is, in this way, a geographical process. It entails both the translation of technology across disparate spaces of shale oil extraction and refining and the reconfiguration of the relation between resource materials and markets. In the next two sections, I focus on the critical role of Enefit’s technology in bringing into reality the longstanding hopes for commercial exploitation in Jordan and Utah. Here, the process of ‘conventionalization’ does not just hinge on the achievement of ‘economies of scale’ (David 1985), but more broadly on the constitution of above-ground retorting as the new norm. In Jordan, the Estonian company attempts to institute its model of power and oil co-production by reworking local conventions of energy provision, while still being required to prove both technologies in radically different socio-ecological circumstances. By contrast, in Utah, the evidence of rapidly growing oil production in Estonia serves a somewhat different purpose when combined with the material legacies exhibited by the former OSEC property: to ensure access to the speculative capital required for the largely virtual industry to be materialized. What I describe as the programme of *conventionalizing* shale oil thus comes near to a ‘rival calculative regime’ (Mitchell 2008), which generates contending conceptualizations of what it is to ‘be economic’ in relation to making visible selected instances of technical possibility and political acceptability, whilst concealing other matters of concern. As discussed in the following section, however, this process is compromised by growing disputes over Enefit’s global ambitions in Estonia due to concerns about the publicly owned company becoming ‘bigger than the nation itself’.

Confronted by many academic and political leaders on technical, financial and moral grounds, the Jordan and Utah deals have remarkably intensified the proliferation of issues and publics that interrogate the place of oil shale in the national energy economy. The contestation of technology development and displacement, which is the third dimension of the ‘conventionalization’ process, in turn further complicates the actualization of the industry elsewhere.

In conclusion, the three components of ‘conventionalization’ are revisited in light of the material and spatial heterogeneity of world resources detailed in Chapter 4. This heterogeneity has become increasingly acknowledged by developers as a major obstacle to inventing a universally applicable technology, both for surface and in-situ extraction. I argue that the materiality of oil shale is therefore not only emerging through historically and geographically contingent practices of measurement, but once fixated in relation to liquid fuel also presents a serious challenge for the industry to standardize production and establish itself in conventional oil markets.

8.2 Innovation and economization: the Estonian techno-economic network

To produce merchandise from things that are not yet completely economized one has to use what exists, edge one’s way in, articulate (Callon 2007: 327).

8.2.1 Innovation: from Kiviter and Galoter processes to the Enefit technology

According to Enefit’s presentations at international conferences, the Estonian industry can be regarded as ‘something conventional, something proven’. Beyond the simple marketing rhetoric one cannot deny the central place that *oil shale* has occupied in the industrial history of the state. However, this is not the same as to say that *shale oil* production is conventional, economic, or even unquestionably proven in Estonia. The direct burning of shale for electricity generation has indeed become part of the nation-wide conviction of what constitutes energy security, even if this

convention is now increasingly called into question. But squeezing liquid fuel out of the stone recalls a different story of technological development. Although the solid fuel was introduced in the same year for both electricity generation and oil production, in 1924, the oil industry has always struggled to survive in a troublesome relationship with the power sector. Having been used for the manufacturing of a wide range of chemical products, heat oil, and initially also low octane motor fuel, the oil factories have often found it hard to keep functioning *and* find markets for their products, although they now appear to be a major constituent of the industry (Aarna 1989; Holmberg 2008). Focusing on shale oil, the following documents how technical innovation and economization are interrelated practices, which remain deeply embedded in local socio-technical arrangements.

The two methods of above-ground retorting that are currently used in Estonia, called 'Kiviter' and 'Galoter' processes, have grown out of intense work with testing, modifying and improving different pyrolysis devices that were originally invented for brown coal and other solid fuels. This includes experiments with tunnel and chamber furnaces, vertical, horizontal and rotating retorts, and even a short, but environmentally disastrous episode of in-situ retorting combined with underground mining (Aarna 1989; Kattai 2003; Veiderma 2003; Oja 2007). The main obstacle to all these experiments has been a material characteristic specific to the Estonian shale, namely its 'thermo-bituminous' properties. As the pyrolysis process requires the shale to be heated in the absence of air up to 550 degrees, it involves a short phase at 300–400°C, during which the crushed rock turns into a soluble bitumen-like substance, before gradually decomposing into shale oil, gas vapours and residue char. This bituminous material tends to stick together and clog up the retort shortly after the process has been started (Aarna 1989; Kattai 2003: 49). The 90 year history of shale oil production can be summarized as an ongoing struggle to overcome this 'stubborn'

quality of the rock, with continuous attempts to reduce technical problems in order to extend operating hours (cf. Udall and Andrews 2008). Today, the Kiviter- and Galoter-based oil plants assemble two distinct technologies, which have emerged, gradually expanded and co-existed with each other, whereas both have been variably claimed to be technically and economically appropriate to the Estonian conditions.

Both Estonian retort types are considered to have come closest to commercial-scale use in comparison with other retorting processes tested around the world, as depicted in Figure 20.²²⁰ The development of these retorts, however, has not always presented such a unilinear path of technological evolution, which remains the popular depiction of innovation, overlooking its socio-technical content (Pinch and Bijker 1987). Rather than being predetermined by some intrinsic qualities of the machinery or, on the contrary, solely by the dynamics of social relationships, the progress made with some retorts at the expense of other solutions reflects an ongoing negotiation of what “actually works”, or what “works best” on a given resource at a particular moment in time, during which the categories of ‘the social’ and ‘the technical’ themselves transform.²²¹ Although both ‘Kiviter’ and ‘Galoter’ techniques are now well established, it continues to be disputed even by the most experienced international engineers whether shale oil production in Estonia has in fact ever reached a ‘commercial phase’, given the low capacity of the units, the inferior quality of the crude and the monopolistic position of Eesti Energia in mining and processing the feedstock, which is primarily still used for power production (Schmidt 2012).

²²⁰ The other three technologies in the ‘demo plants’ category include the Chinese (Fushun) and Brazilian (Petrosix) industries, and the ‘Unocal’ shale oil plant in Parachute, Colorado, which was the last one to survive the 1980s collapse of oil shale development in the States, producing synthetic crude oil until 1991, after which it has remained closed.

²²¹ For critiques of the a priori dualism underlying both technological determinism and social constructivism, see e.g. Bingham (1996) and MacKenzie (1996).

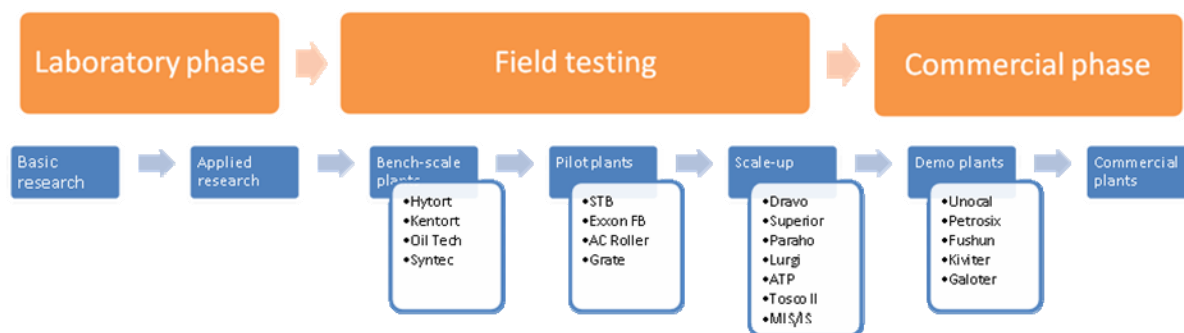


Figure 20 A linear depiction of the evolution of major technologies for surface retorting of shale oil.

Source: adjusted from Lukens 2004 (copy published in Dammer 2007).

The ‘Kiviter’ process is today used by the descendants of the historical Estonian *shale oil* industry, the two privately owned petrochemical companies called Viru Keemia Grupp (VKG Oil) and Kiviõli Keemiatööstus (KKT) (Figure 21). It represents a series of robust vertical retorts (or distillation generators), which bear a family resemblance to several other pyrolysis devices invented in other countries. The ‘Galoter’ process used by Eesti Energia, on the other hand, is somewhat more unique, recent and sophisticated solution based on the solid-heat-carrier process (SHC) built into a rotary drum reactor (see, *inter alia*, Francu et al. 2007).²²² Apart from a number of technical differences between the two retort types, both are particular local achievements. In either case, innovation has involved the painstaking process of gradually setting every retort in tune with the obdurate materiality of the kukersite resource, thus overcoming its susceptibility to bituminization. Further, the present-day distribution of these two technologies between the privatized sector and the electricity monopoly that has been left under government control reflects the institutional and infrastructural legacies of the planned economy. Namely, the companies and their property rights originate in, first, the Soviet techno-economic rationale of the ‘territorial-production complex’ comprising of closely integrated

²²² The technology is variously called the SHC, UTT and TSK process, reflecting the English, Russian and Estonian abbreviations for ‘solid-heat-carrier’ respectively.

industrial enterprises, and second, the ‘complex utilization’ approach to efficient use of raw materials and by-products, which is akin to the modern industrial ecology ideas of industrial symbiosis and waste-free production (e.g. Lonsdale 1965; Sathre and Grdzelišvili 2006; Salmi and Toppinen 2007).

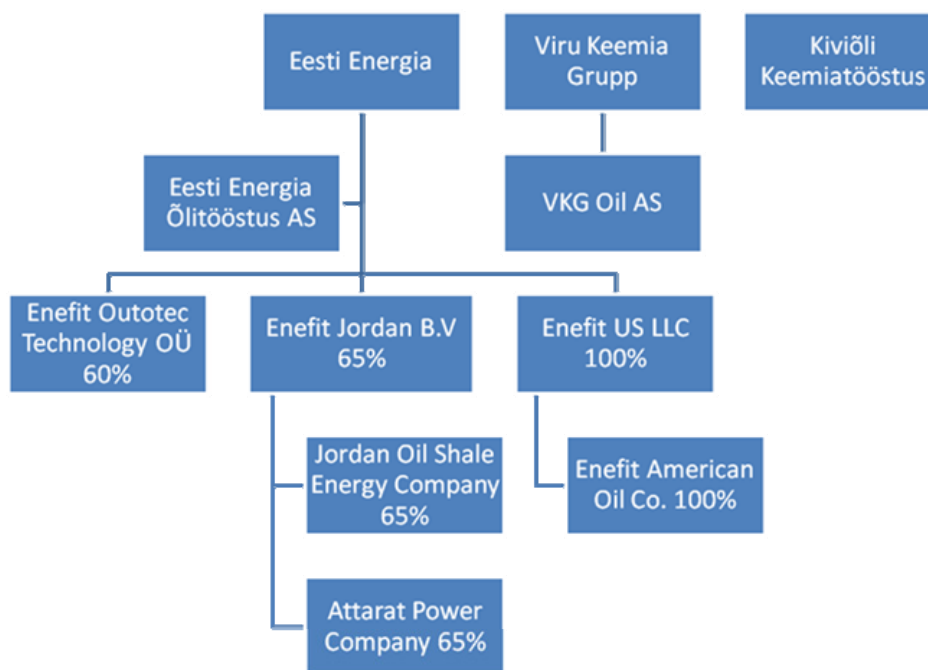


Figure 21 The corporate structure of Estonian shale oil producing companies.

As Holmberg describes in his thesis on the industry’s evolution, the ‘Galoter’ process can be regarded as the most original Soviet-era invention rooted in the ‘complex utilization’ approach (2008: 164). Other technical features aside, the most crucial difference between ‘Kiviter’ and ‘Galoter’ retort types concerns the ability of the SHC-based device to process fine-grained oil shale of lower calorific value, in contrast to the bigger pieces of enriched material (lump shale) needed for vertical retorts (Kattai 2003: 68; Siirde et al. 2013). Due to the high porosity of world oil shales, the so-called ‘fines’ may account for more than half of the feedstock gained via mining and enrichment, but most retorting technologies are able to process only larger pieces of crushed shale. The ‘Galoter’ process and the Canadian-developed ‘Alberta-Taciuk Process’ (ATP) are said to be the only exceptions based on the SHC

method, which are currently subject to further development and testing on various shales (and consequently, these two technologies are seen as main competitors in above-ground extraction) (Francu et al. 2007).²²³ Other existing solutions, many of which are analogous to the ‘Kiviter’ retort based on gas as the heat carrier, result in a loss of kerogen-rich material, including the ‘Petrosix’ technology that has been developed out of experiments with Brazilian oil shale and the ‘Fushun’ process typical to China (see e.g. Russell 1990).²²⁴ Another distinct feature of the ‘Galoter’ method is that the Soviet patent for the SHC process makes use of hot oil shale ashes, the by-product of direct burning, as the internal heat carrier, unlike similar Western inventions of the same period which use either ceramic balls or sand and ash mixture, respectively the ‘TOSCO II’ retort developed in the USA and the ‘Lurgi’ process in Germany (Volkov and Stelmakh 1999).²²⁵

The processing of ‘fines’ together with the ashes of spent shale can be seen as the core economic rationale driving the Soviet-era invention of the ‘Galoter’ process, allowing for a significant reduction in the handling of the resource and wastes. In parallel, the ‘territorial-production complex’ approach to spatial planning implied that processing plants were built into the vicinity of supply lines and consuming industry. As a result of this agglomeration, the sole existing demonstration plant with two SHC-3000²²⁶ production units, known simply as “the oil factory”, was erected in the 1980s on the site of the ‘Eesti’ power plant in Auvere, near Narva city and subsequently

²²³ The ATP method was initially proposed for the processing of tar sand bitumen, and only later transferred to shale oil retorting. It is being developed by UMATAC Industrial Processes located in Calgary, Alberta; a company which now owned by Polysius, a subsidiary of Thyssen Krupp in Germany. See <http://umatac.ca/about/> (accessed 20 July 2012).

²²⁴ According to Kattai (2003: 74), the Kiviter process loses 50% of the organic matter in oil shale.

²²⁵ Aarna (1989: 78) mentions a further SHC device developed by Chevron around the same time, where the pyrolysis process also utilizes hot oil shale ashes, but takes place in fluidized bed.

²²⁶ The numbers reflect the projected capacity to process shale (tonnes/day). Thus, the UTT-3000 units were expected to process 3000 tonnes of shale per day; a capacity they have never achieved.

remained in the possession of Eesti Energia (Figure 22). Although the produced fuel oil and gas were originally intended for internal use in power generation, today exports prevail, while the factory is put in the limelight as “the world’s most efficient technology for oil shale”.²²⁷



Figure 22 Eesti Energia’s shale oil factory in Auvere, Narva.

Note: This plant consists of two SHC-3000 ‘third-generation’ units (now called Enefit-140), which were commissioned in 1980 and 1984, after a series of experiments with smaller pilot and bench-scale units based on the ‘Galoter’ process, followed by SHC-200 (1953-1963) and SHC-500 industrial units (1963-1981) in Kiviõli, which by now have been all dismantled (Volkov and Stelmakh 1999).²²⁸ The smokestacks of the ‘Eesti’ power plant are visible in the background.

In order to make sense of recent disputes over *what* constitutes the ‘Enefit’ technology today, *how* it should be valued and *where* it should be employed, it is necessary to say a few more words about the intellectual and institutional

²²⁷ Eesti Energia’s brochure, *Creating New Energy!*

²²⁸ These units were also tested with oil shale samples from 20 world deposits. Analogous pilot plants were also built in the Ukraine for testing samples from other Soviet regions and Israel, and later also for Jordanian oil shale (Volkov and Stelmakh 1999).

environment in which the Galoter process eventually became installed in Auvere and retained in the collective ownership of the nation. In the early years, 1947-1956, the development of this technology indeed evolved more or less linearly from academic research to the first pilot retorts raised in post-war conditions in Kiviõli, Estonia. Invented at a laboratory scale in the G. M. Krzhizhanovski Power Engineering Institute in Russia, the SHC method was advanced in collaboration with other research centres in Estonia and Russia, while design and construction works were later carried out by AtomEnergoproekt, a nuclear engineering institute still active in St. Petersburg (Aarna 1989; Volkov and Stelmakh 1999).²²⁹ Although the contributions of Estonian engineers to the invention of the process may have been initially limited, its implementation was nevertheless facilitated by the local academic community. According to Holmberg, in the 1950-60s Estonian academics strived towards building up a large-scale industry for various petrochemical products (i.e. no longer motor fuel), which was seen by some as an alternative to the rapidly expanding electricity generation and exports, and simultaneously “expected to become something more than an uncompetitive provider of gas and oil”, given the abundant supplies of hydrocarbons in Russia (2008: 188). At the same time, the ‘Galoter’ technology was also greeted with scepticism and suspicion by others due to its complex design and untested performance in comparison with the older and more reliable ‘Kiviter’ retorts. As Holmberg reports, this culminated in a surprisingly open public debate over the industry’s future in 1968, clearly fostered by the first international oil shale symposium that took place in Tallinn the same year. Later, the dispute was probably also fuelled by the technology’s close association with the power monopoly, following the move of the demonstration plant from Kiviõli to Auvere. In light of the more recent debates about the value of the Soviet-era oil factory, it is vital to understand that the

²²⁹ The same company built the oil shale-fired power plants in Estonia.

birth of the technology was marked with questions of what should be rendered internal to the frame of ‘the economic’, how to retain a *national* industrial science under an oppressive political regime, and how to deliver long-cherished hopes of supplying future technological needs for the Western world. The invention was controversial from the very beginning.

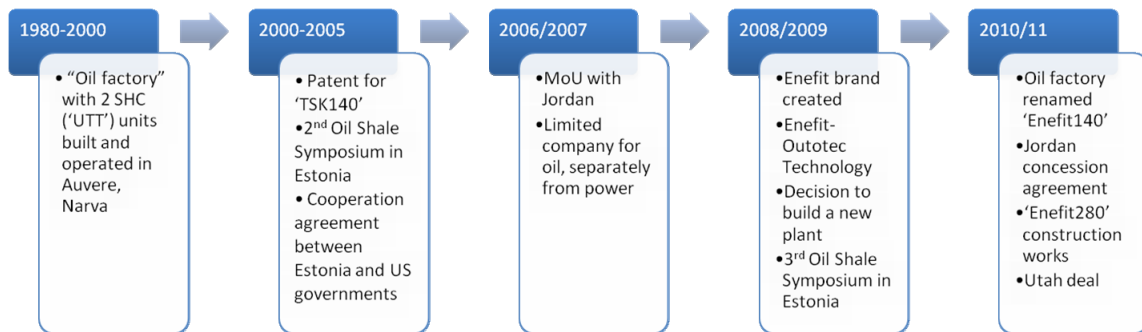


Figure 23 The creation of the ‘Enefit’ technology and company in 1980–2011.

In spite of continued disputes amidst the restructuring and privatization of the industry after re-independence, the sole oil factory based on the ‘Galoter’ process survived as a sort of collective property under the auspices of the state-owned electricity industry. Over the last 30 years, it has been operated by a group of local mechanics, allegedly with little input from the Russian designers after their immediate disappointment with the performance of the plant.²³⁰ The company staff has maintained and tuned the pyrolysis process in collaboration with university-based engineers despite periods of mounting difficulties, resulting in frequent outages. If the processing units were initially reported to have stood idle for most of the time, by now the operators claim to have reached a 75% availability time, yielding up to 90% of the Fisher Assay laboratory scale (Öpik et al. 2001; Aarna 2009).

²³⁰ Interview, 10 June 2010.

Having represented until very recently the sole example of the ‘Galoter’ process, the Auvere oil complex needs to be transformed in both institutional and physical senses before it is possible to lease and replicate it as a commercial technology in other places. As Barry explains, any intellectual property requires the creation of a technical *object* in connection with a social *subject* who can claim ownership of the invention, whereas both of these categorisations remain prone to contestation (Barry 2001: 106, 204). In order to create a full-fledged oil technology, the Auvere facilities were at first *made into an Enefit oil plant* and then subjected to competing claims over Eesti Energia’s actual contributions to the knowledge and skills needed for the plant to “work” (and what this actually means). While the plant was nearly sold as scrap metal by Eesti Energia’s management in the context of the record low crude prices of 1998–1999 and the subsequent bankruptcy of the privatized industry at Kiviõli and Kohtla-Järve (the predecessor of VKG and KKT companies),²³¹ the resurgence in market prices for crude oil and growing international interest in unconventional resources caused a turn-around in the monopoly.²³² After deciding to launch its own shale oil business in early 2000s, Eesti Energia at first ‘estonized’ the name of the technology into ‘TSK-140’ (Estonian for ‘solid-heat-carrier’) and then moved on to patent all modifications that its operators had allegedly made in the process over the previous two decades.²³³ In 2010, the technology was further re-branded as ‘Enefit-140’ without any significant improvements (Figure 23).

However, the question of how much has been in fact changed in the ‘Enefit’ technology as compared to the original installation, and moreover, whether it *actually works*, remains at the centre of heated debates amongst the three local companies and

²³¹ Field notes, 17 October 2010 (see also Rooks 2004: discussed in Holmberg 2008, p. 217–218).

²³² It seems quite probable that this sudden change was also facilitated by the second international oil shale symposium that was hosted in Tallinn in 2002.

²³³ Interview, 10 June 2010. In contrast to the earlier Russian name, ‘UTT-3000’, the number 140 reflects the tonnes of oil shale approximately processed *per hour*, not per day.

the wider community of energy specialists. Whereas Eesti Energia claims that over 70% of the equipment has been either improved or replaced,²³⁴ and will be further modified for the next-generation ‘Enefit280’ retort (see below), other interviewed engineers doubted if there is any innovation beyond some changes made in the ‘knots’ connecting different sections of the process.²³⁵ One engineer formerly associated with Eesti Energia even affirmed that the company has given just a “facelift” to the Soviet-era technology, rather than created a new retort model.

8.2.2 Economization: the marriage between state energy services and shale oil production

The paradox arising from the framing of Enefit’s plant as an individual technical object is that it also remains of vital importance to keep it both physically and institutionally integrated in the electricity sector in order to dispel any questions of *economic* production. Two examples serve here to explain such entanglements with state energy services. First, being incorporated in the power monopoly, the local operators have had relative freedom to keep the units running and improve the process throughout their lifetime, having been insulated from any demands of corporate profit-making or academic research. This remains in stark contrast to the businesses operating under Western standards.²³⁶ The second example concerns the fact that electricity and oil production share the same infrastructures and economies of material supply and waste handling. Most importantly, the fine-grained shale fed to the retorts is mined by Eesti Energia for power generation, whereas the more valuable lump shale is subsequently sold to its private competitors operating the ‘Kiviter’

²³⁴ See <https://www.enefit.com/en/retorting-enefit140> (accessed 10 September 2012).

²³⁵ Interviews, 26 April 2010, 4 May 2010, 19 September 2010, 20 September 10.

²³⁶ For example, Shell has admitted to having limited patience and funding to test its in-situ technology in Jordan. Field notes in Colorado, 18 October 2011.

retorts.²³⁷ Sharing the facilities for feedstock transport and storage and ash handling with the neighbouring power plant helps cutting costs further. In turn, the produced oil is periodically used in firing the power units in order to balance peak loads, alongside the regular use of retort gas for the same purpose.²³⁸ Composed of closely integrated people, technology, and material flows, the oil-electricity complex of Eesti Energia can be seen as a ‘short’, yet tightly knit and persistent ‘techno-economic network’ in its own right (Callon 1991).

Being part of the power industry, the Auvere oil plant continues to enjoy the large-scale subsidies that the government has provided for the security of electricity supply, paying no royalties to the state and very low charges for resource extraction and environmental pollution (Gavrilova et al. 2005; NAO-Estonia 2012).²³⁹ In turn, the revenues made from the sales of oil, electricity and EU carbon allowances are used to compensate for the lack of capital in other parts of the sector – depending on which article is the most profitable at a given point in time – as well as transferred to the state budget as dividends. Since oil revenues have come to provide the companies with substantive income, the government has only very recently started to discuss whether a specific royalty should be introduced for shale oil production, which would be bound to the volatility of global crude markets.²⁴⁰

The ‘Enefit’ technology therefore exhibits no clear-cut boundaries between the infrastructural facilities and material flows of the industry’s different sectors, between

²³⁷ In earlier times, all lump shale was “subsidized” under the veil of the electricity sector, but more recently Eesti Energia has significantly raised the prices of the feedstock. Interview 26 April 2010.

²³⁸ Eesti Energia, *Creating New Energy!*

²³⁹ The Stockholm Environmental Institute in Tallinn has calculated that the state pays the oil shale industry 814 million EUR every year through various subsidization schemes. *ERR News* (15 May 2012) “Sustainability Institute Accuses Government of Greenwashing Oil Shale”, <http://news.err.ee/Politics/49515303-e629-46e8-a9f3-91e7ba449336> (accessed 28 May 2012).

²⁴⁰ *ERR Uudised* (2 May 2012) “Ansip: kaalume ressursitasude tõstmist” [Ansip: we are considering to raise resource taxes], <http://uudised.err.ee/index.php?06251895> (accessed 28 May 2012).

the contributions of its original inventors and subsequent operators to the proper functioning of the retorts, and between economic and non-economic modes of production. In a sense, it operates as a relatively 'fluid technology' (de Laet and Mol 2000), although this term refers here to its inter-dependencies with the power sector and the Kiviter-based complex, and not so much to substitutable pieces of equipment. The same local qualities of 'fluidity', however, may hinder the technology to travel beyond the national borders, or even to continue thriving within these borders when the rationales of economic valuation change. Whilst today's Eesti Energia has immensely benefited from the planned economy approach to industrial symbiosis, these legacies also convey more negative repercussions under new trends of 'economization' in the sector, most notably in terms of carbon emissions. The relationship between the carbon that gets released in the atmosphere to the carbon that remains in spent shale represents a crucial drawback of the 'Enefit' process in comparison with the older 'Kiviter' retorts, largely due to the burning of spent shale in the former for energy savings. As carbon-intensity and resource-efficiency represent different aspects of what can be valued as 'economic' or 'environmentally sustainable', in this case these indicators work against each other and, as local experts have explained to me, make it difficult to establish which one is the 'best available technology' required for the EU exercise of technological harmonization.²⁴¹ This has led to a situation where the need to reduce carbon-intensity favours the older 'Kiviter' technology, but would result in a more extensive pollution and waste of the declining resource (Siirde et al. 2013).²⁴²

²⁴¹ Interviews, 18 June 2010, 19 September 2010.

²⁴² Another drawback of Kiviter is the disposal of huge amounts of hazardous semi-coke, as opposed to the black, nearly organic-free ashes resulting from the SCH process.

A further note to be made here is that the co-existence of electricity and oil production makes it immensely difficult for independent researchers to access the company data and evaluate the economics of shale oil production, as well as its environmental performance, particularly emissions. As a result, there are currently no academic studies available that would give insights into the carbon-intensity of the Estonian oil product separately from the power industry (Brandt 2010). The only publicly available studies of life-cycle emissions, EROEI and other crucial indicators have been conducted and distributed on behalf of the industry itself, whereas these calculations include the co-product of retort gas used in electricity generation (Aarna and Lauringson 2011, 2012; Siirde et al. 2013).²⁴³

8.2.3 The re-distribution of innovative expertise: the Enefit-Outotec joint venture

As Callon (2007: 327) suggests, to trade with things yet to be fully economized, the existing system has to be articulated and put into use in a particular way. For the Estonian expertise to be capitalized upon and deemed suitable for technology exports, it is not sufficient to simply attribute Eesti Energia's oil factory with the qualities of a stand-alone technical object, while in fact maintaining it as an inextricable part of the power complex. The translation of the technology into other locations also requires the Estonian techno-economic network to be reconfigured. For this, the plant has to be transformed from an isolated, locally embedded case into something that is not just distinct from similar pyrolysis solutions, but can be potentially copied, improved and implemented by others. In other words, the technology is disentangled, reframed and objectified further by rendering it a subject of competing knowledge claims and intellectual property disputes.

²⁴³ Even though Enefit has publicly presented some of the results of these studies, the original calculations remain in the company's sole possession. The paper by Siirde *et al.* is a very late publication, which compares the old 'Kiviter' and new 'Petroter' technologies of VKG Oil.

Having narrowly escaped a closure ten years ago and currently serving a limited, but relatively stable regional market for heating oil and bunker fuel, the Auvere plant has only recently been exposed to calls for increased production rates, improved efficiency, and readiness to produce higher quality crude under more stringent environmental measures. The apparent motivation behind upgraded production is to reap lucrative revenues from the sales of shale oil while prices are high. However, its more hidden strategy is to build up credibility in surface retorting at a larger scale worldwide, before any possible decline in the domestic business. In effect, these agendas are mutually reinforcing. The reconfiguration of people, things and knowledge required for the creation of exterior markets has simultaneously yielded a new set of subjects and objects in the internal business. To put it differently, the translation process has implied a new ordering of 'the inside' and 'the outside', 'the social' and 'the technical', and 'real' and 'unreal' components of the industry (cf. Callon and Latour 1981; Akrich 1992; Bowker 1994; Latour 1999: Ch. 6). In consequence, innovation and economization have not been linear processes, especially since Eesti Energia entered into cooperation with the Finnish-German metallurgy and engineering consortium Outotec.

Established in 2009, the Enefit-Outotec Technology joint venture (60% Eesti Energia, 40% Outotec) has taken over the task of improving the retorting process and selling the licences designed for the use of Enefit technology to third parties, whereas the financial risks associated with overseas projects are borne by Eesti Energia. It represents a strategic, but uneasy marriage between what the Estonians consider their long-term knowledge of operating a "real" shale oil plant and what is offered by Outotec as Western-style rapid progress, optimizing novel technical solutions for ore processing and bringing them on stream at a commercially-suited scale. Over the last couple of years, the German branch of Outotec, a descendant of the Lurgi Metallurgie

company formerly involved in oil shale development, has become an inseparable partner for Estonians and helped raise their engineering credibility, global business networks, and corporate visibility to an entirely new level.

The first brainchild of this union is the new 'Enefit280' retort; a process that the company claims to be significantly upgraded in comparison with the 'Enefit140' plant, soon to be implemented in Jordan and Utah, and potentially also sold to China and other countries. The key hurdle for creating a saleable product, however, is to constitute this technology as distinct and more efficient in comparison with any alternatives and even the original 'Galoter' process for which any Soviet-time patents are long outdated. Instead of simply copying existing retorts, the German engineers advised Eesti Energia to opt for further innovation by scaling up the process to higher unit capacity and replacing the spent shale combustion process with the fluidized bed method, the key expertise of Outotec.²⁴⁴ The 'new-generation' plant constructed by Outotec next to the old one is designed to double the size of the latter with an installed capacity of 280 tonnes processed per hour (hence 'Enefit280') and more than 90% of availability time.²⁴⁵ Being integrated with the new electricity plant (see Chapter 6), these facilities continue to act out the industrial symbiosis of the Auvere site. According to their website, the Enefit-Outotec team finished the construction in 2012, to be followed by two more 'Enefit280' plants in 2013–2016 if the commissioning of the first one proves successful.²⁴⁶ The first plant alone is expected to triple Eesti Energia's outputs, but for the company this is only a start (Figure 24). Of course, the

²⁴⁴ Interview, 10 June 2010.

²⁴⁵ *Enefit Oil & Gas: Unlocking the Potential of Oil Shale*, a corporate brochure distributed during international oil shale symposiums 2010–2012.

²⁴⁶ See <https://www.enefit.com/en/enefit280-building> (accessed 23 March 2013). As of early 2013, Enefit's plans to start oil production have been delayed for at least half a year, as reported in Estonian media. See also *Bloomberg* (28 Nov 2012), <http://www.bloomberg.com/news/2012-11-28/eesti-energia-shale-oil-plant-delayed-to-next-year-ceo-says.html>.

expansion of domestic production will also depend on the government's willingness to continue supporting the sector, the company's ability to raise additional capital in international finance markets, and not least, the continued availability of high-quality resources in parallel to the feedstock required for electricity generation.

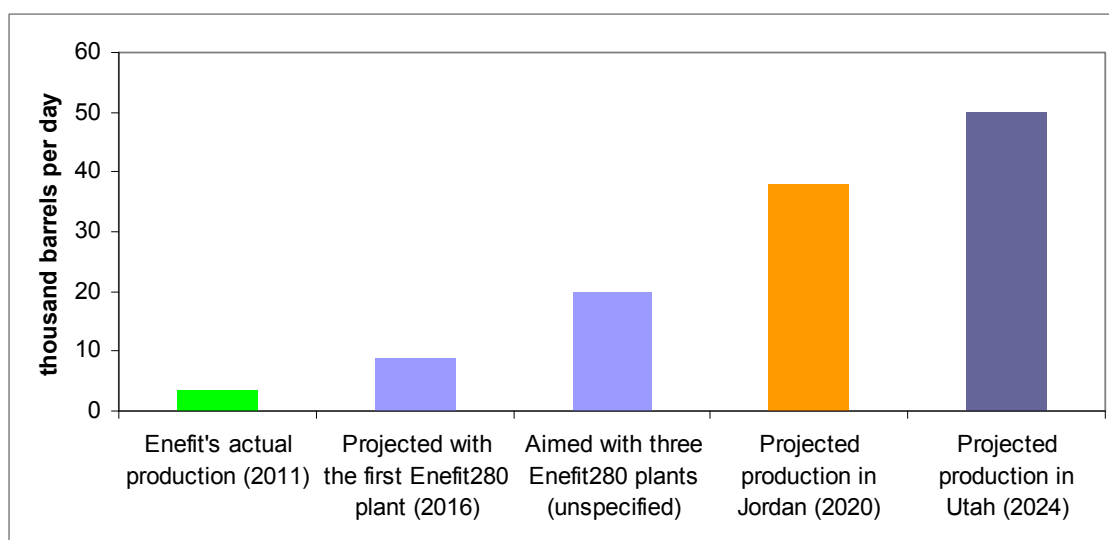


Figure 24 Enefit's actual and projected outputs of shale oil.

Source: company's public statements.

The commercialization of the Enefit technology has entailed not only accelerated progress in achieving 'economies of scale', but a redistribution of innovative and inventive capacities between the Estonians and Germans. The division of labour between the two parties has led to a situation, in which the majority of expertise needed for design and construction is now supplied by Outotec's experienced team of engineers.²⁴⁷ Eesti Energia's role is based on foregoing "operational experience", which has become detached from the scientific research conducted in Estonian universities. Apart from the practical lessons learned from day-to-day maintenance, however, the local knowledge is of little use for Outotec, particularly the knowledge accumulated in academia. Thus, the 'industrial science' is gradually overtaken by Outotec (cf. Bowker 1994). This is not to say that Eesti Energia

²⁴⁷ Amongst other things, the German engineers had to re-draft plans for the old factory because the original project by AtomEnergoprojekt had gone missing. Field notes, 17 October 2010.

no longer participates in the invention of the technology: the outsourcing of technical *innovation* does not preclude *inventive* action on behalf of the Estonian managers, politically or otherwise (Barry 2001, 2005b). Quite the contrary, the Estonians have taken a leading role in ‘conventionalizing’ the industry in Jordan and Utah by rearranging, articulating and mobilizing existing bits and pieces of the techno-economic system in novel ways, rather than relying on the development of an entirely unique retort model.

At the same time, the nature and significance of this ‘operational experience’ provides an entry point into wider disputes over Eesti Energia’s ownership of the invention. Notably, the disentanglement and re-framing of the techno-economic system has yielded overflows, which are hard to control (cf. Callon 1998). As mentioned earlier, in order to become respected as an international technology provider, the company needs to maintain the promise that the ‘new-generation plant’ is a distinct, knowledge-intensive technology unparalleled by any other retort. While the technology is yet to be detached from the local context to the extent that it can be deemed universal enough to work on other shales, paradoxically it also needs to remain attached to its point of origin in order to defend claims to intellectual property (cf. Barry 2001). These claims continue to be contested, however, especially since other companies attempt to build up alternative techno-economic networks in opposition to the close affinity between power and oil production that is symptomatic of Eesti Energia’s business.

The collective efforts of the Enefit-Outotec team have become challenged foremost by one of the descendants of the Estonian *shale oil* industry, the privately owned Viru Keemia Grupp. Although VKG Oil has so far relied on the older ‘Kiviter’ retorts, it seeks opportunities to expand production with the help of alternative

technologies due to tightening environmental restrictions and declining resource base (while being more silent about its own international ambitions²⁴⁸). Having given up the idea to adopt the Canadian 'ATP' process, VKG has also opted for 'Galoter' as a tested, if not proven domestic technology. As a result of ongoing quarrels over VKG's access to the feedstock, specifically to the adequate supplies of enriched lump shale required for 'Kiviter' retorts, the company is now building up an independent supply system.²⁴⁹ In 2012, VKG opened a new mine, which will supply both lump and fine-grained oil shale. In parallel, the company is in the process of commissioning its own first SHC-based oil plant, with a second one in planning, having refused to pay for Enefit's patents and being able to instead acquire the original design from the 1980s from the same AtomEnergoproekt that built the Auvere plant. The adoption of the 'Galoter' process is not just expected to help VKG cut costs and increase production outputs. Having coined a new name 'Petroter' for this retorting process, the company has established its technology process as distinct from 'Enefit', while continuing to dispute Eesti Energia's ownership of the invention, considering operational history insignificant for intellectual property rights.²⁵⁰

Central to this race of technology development is a certain politics of visibility, accompanied by mutual accusations of intellectual property theft. Both companies

²⁴⁸ VKG holds an exploration licence for oil shale in Ukraine, which was recently renewed.

²⁴⁹ Priit Rohumaa (27 November 2010), "Me ei taha tegeleda poliitikaga, vaid äri ajada" [We don't want to deal with politics, but business]. A column by the CEO of VKG oil published by Delfi.ee, <http://www.delfi.ee/news/paevauudised/arvamus/priit-rohumaa-me-ei-taha-tegeleda-poliitikaga-vaid-ari-ajada.d?id=35662149> (accessed 2 July 2012).

²⁵⁰ It is interesting to note that VKG's actions are further paralleled by AtomEnergoproekt, the designer of the 'Enefit140' and 'Petroter' plants. The Russian institute is now also seeking ways to capitalize internationally on their original project of the 'Galoter' process, having established a private company called TTU Ltd. for the distribution of their own patent and teamed up with the Sultani International Oil company, a Saudi Arabian group applying for one of the concession agreements in Jordan. As it becomes clear from their recent presentations (Salikhov 2012), their proposal to achieve commercialization is simply to recycle the 'complex utilization' model from the past: in a way to revive the historical socio-technical complex that emerged in the uneasy cooperation of the Soviet Estonian and Soviet Russian engineers.

have now restricted public access to their facilities, with no photos allowed to be taken even in the ‘Enefit140’ plant.²⁵¹ Secrecy operates here as one of the means to establish the technology. In 2009, such disputes shortly overflowed into criminal proceedings, after VKG complained about having caught Outotec engineers spying at its ‘Petroter’ plant.²⁵² These conflicts have led to a gradual disintegration of the Soviet-era ‘territorial-production complex’ and the emergence of at least two distinct ‘techno-economic networks’ comprising independent mining operations and the production of both oil and electricity. The latest addition to these disagreements is the inability of the companies to build a joint refinery, even though both lack sufficient production volumes and still need to demonstrate that it is possible to upgrade shale oil into synthetic crude for high-quality motor fuels, which to date remains largely untested.²⁵³

Meanwhile, the rescaling of the ‘Enefit’ retort has not proven straightforward either. The difficulties in marrying the cumulative tacit knowledge of operating a real plant to Western-style progress are indicated by the telling fact that Outotec decided to return to “earlier” stages of innovation, building a bench-scale plant at its Frankfurt research centre. Commissioned in late-2010, the plant is designed specifically for testing the ‘Enefit280’ process with oil shales from Estonia, Jordan and China, with a pilot plant to be constructed later (Sieger 2011). These plants are being built in spite of earlier experiments in Outotec’s pyrolysis device in Frankfurt, which is also used for other ores, and the ongoing efforts towards scaling-up in Estonia. As the development

²⁵¹ Field notes 3 May 2010, 1 September 2010.

²⁵² See *Äripäev* (3 September 2009) “Riigifirmat süüditatakse spionaazis” [State firm accused in espionage], http://www.ap3.ee/article/2009/09/03/Riigifirmat_suudistatakse_spionaazis, and “Tants ümber põlevkiviõlikatla” [Dance around the shale oil cauldron] <http://www.ap3.ee/?PublicationId=a3a26da9-e168-4d38-915d-4ea5a7f03495> (accessed 20 July 2012).

²⁵³ Interview 10 June 2010. See also *ERR News* (8 September 2012), “VKG to Build Fuel Production Terminal”, <http://news.err.ee/economy/796aec6c-ccca-4179-8997-cc059a4504ab>, and a recent interview with VKG’s CEO in *Postimees* (3 March 2013) “VKG ehitab kütuseimpeeriumi” [VKG builds a fuel empire] <http://www.e24.ee/1148858/viru-keemia-grupp-ehitab-kutuseimpeeriumi/> (accessed 6 March 2013).

director of VKG sarcastically asked an Outotec representative in public at the 2011 Colorado symposium, why build a new demo plant after a fully commercial one is already in operation in Narva? Outotec's answer did not concede any problems with Estonian operations, but emphasized the material differences between world resources that do not enable Estonian solutions to be simply taken over.²⁵⁴

For the Enefit-Outotec team, today the Auvere complex provides a useful, tangible "reference", which is mobilized to reassure international audiences that the technology is indeed working.²⁵⁵ The industry, of course, does not use the term 'reference' in the Latourian sense to denote a whole series of transformations which connect 'the thing' with different sites, but it is nevertheless worthwhile to revive this vocabulary here (cf. Chapter 5). Consideration of the entirety of such a chain of translations enables us to understand why the Estonian industry has not remained a fixed and stable point of comparison in space and time, but must be subjected to constant transformations in response to the technology's travels to other geographical sites. As Latour puts it, "every change in even *one* element of the series will make for a change in the reference" (1999: 150).

Before turning to Jordan and Utah, it can be summarized that to conventionalize the Estonian method the Enefit-Outotec team needs to undertake both 'infrastructural work' for rendering the site-specific technological system universally applicable across space and time and 'rhetorical work' for maintaining its retort as sufficiently unique, yet potentially replicable by others (Bowker 1994). Whilst simultaneously designing a new retort model, constructing plants of various sizes and producing oil, the joint venture is faced with a three-fold problem: what counts as technology, what counts as *working* technology, and what counts as *oil*? The first

²⁵⁴ Field notes in Colorado, 19 October 2011.

²⁵⁵ Field notes in Colorado, 19 October 2010; Jordan, 8 May 2012.

requires the disentanglement of the post-Soviet institutional-infrastructural complex, with the Estonian case being rendered into a reference point that links together disparate sites and modes of future extraction. The second involves the difficulty of demonstrating that Enefit's domestic facilities can be scaled up and remain on-stream as expected by "commercial" standards. The third relates to the problem of *shale oil* materiality, which can be traced back to the heterogeneity and recalcitrance of the resource, as discussed in the concluding section of this chapter.

8.3 Jordan: Reworking conventions

At a time when the 'Enefit' retort is yet to prove itself as a nationally appropriate technology, it has nonetheless become praised as a major invention suitable for exports, the next "Estonian Nokia" after inventing Skype.²⁵⁶ The export of local expertise, however, requires the Enefit company to not just adjust its technical solutions to distinct environments of oil shale exploitation, but *translate* the Estonian conventions of energy provision into other locations together with the machinery.

At first sight, Estonia seems to hold very little in common with the Kingdom of Jordan. By and large, the ecological conditions, political and religious histories, and business cultures of the countries are very different. Yet, they share a mentality of national self-determination based on the exploitation of oil shale as a major indigenous fossil fuel resource. Compared to its Gulf neighbours, Jordan has virtually no conventional hydrocarbon reserves, with more than 95% of its energy needs being met with imported fuels (Jaber et al. 1997; Jeffreys 2011). For decades, the country's leaders have cherished hopes that the vast deposits of organic-rich rock underlying

²⁵⁶ The search for an "Estonian Nokia" was called forth by the late President Lennart Meri in 1999 (Frucht 2005: 107). There have been many candidates for this title, but in relation to oil shale it has been employed by several proponents of the monetization of Estonian expertise, including VKG Oil. More recently, the term has been attributed to the Enefit technology specifically.

two thirds of Jordan's land mass could be put to use, and thereby create a rupture to its colonial past, lessen energy dependence, and provide for future economic prosperity and stability (see Jaber and Probert 1997; Bsieso 2003).²⁵⁷ Following several attempts at exploration and feasibility studies carried out in 1968, 1979 and 1982 (Russell 1990: 307) and continued laboratory tests, the revived interest in unconvensionals at the turn of the millennium have encouraged Jordan to volunteer as the test case for modern oil shale exploitation. Having given Shell the right to survey more than a quarter of its entire territory in order to study the potential use of in-situ conversion, with all the geological data to be shared with the Natural Resources Authority (NRA), today Jordan is at the frontline of extensive resource assessment and efforts to demonstrate the possibility of commercial-scale shale oil extraction – a 'concessionary economy' of sorts (Boal et al. 2006: 56).²⁵⁸

Except for ongoing political turmoil, with further instability added by the uprisings of the Arab Spring, Jordan's recent governments have tended to be in favour of oil shale development.²⁵⁹ However, the NRA has attempted to manage the risks associated with the immature in-situ technology, which still requires a long timeline of experiments with no guarantee of success, by opening doors to all potential investors, including those associated with existing methods of above-ground extraction. In addition to the deal with Shell, the government has subsequently signed agreements for much smaller concessions with two other companies developing alternative surface retorts, who have promised more realistic and timely solutions to the energy deficiency problem. Moreover, the desire to diversify the energy mix and the need to

²⁵⁷ See also the interviews with government officials published in an earlier report of the Oxford Business Group (Jeffreys 2008).

²⁵⁸ The Shell concession area is 22,270 km², in which it is trying to locate the best 1000km² for a commercial project.

²⁵⁹ However, the government's consent to support oil shale is far from unanimous. There are also interests in utilizing local uranium resources for nuclear power development (Jeffreys 2011).

mitigate risks has led the government to support not only a variety of in-situ and ex-situ technologies, but also shale-based electricity generation. The Jordan Oil Shale Energy (JOSE) company, a subsidiary of Eesti Energia, is now in charge of the construction of the first shale-fired power plant in addition to implementing the 'Enefit' oil technology in the Attarat Um Ghudran deposit. Another company called Karak International Oil, which is associated with the UK-registered Jordan Energy and Mining Ltd (JEML), aims to adjust the ATP process to the El Lajjun resource, building on the expertise of the Canadian technology developer UMATAC with a smaller demonstration plant in China and the failed Stuart project in Australia.²⁶⁰ In addition, the government has signed memorandums of understanding with several other potential developers and is currently in the process of negotiating concession rights with up to eight companies, including big players like Total, ExxonMobil and Petrobras (Al-Ramini 2011). The government's goal is to gain 11% of its primary energy from oil shale by 2015, reaching up to 14% by 2020 (Jeffreys 2011: 85), with a further aim to cover roughly half of the country's liquid fuel needs from the rock.²⁶¹

The Estonian solutions can be considered attractive to Jordan for two reasons. The first relates to Enefit's promise of efficient resource use and minimized environmental burden associated with the 'complex utilization' approach. The abundance of fine-grained material may be a critical issue due to the lack of depositional compression that has taken place at Northern latitudes during ice ages.²⁶² Likewise, Enefit's claim for having minimum water needs in comparison with competing technologies certainly makes it attractive in the arid desert environment (Aarna and Lauringson 2011). The second and more important reason, however, is the

²⁶⁰ In fact, the ATP technology was at first considered for use in Jordan by Suncor in the 1990s (see Bsieso 2003), but this company later surrendered its plans.

²⁶¹ Interview, 15 March 2011.

²⁶² Field notes, 7 May 2012.

undeniable existence of Estonia's energy system. Having been posited as the world's only nation whose energy independence is achieved via oil shale exploitation, Estonia works as an example of *reality* which many Jordanian leaders are eager to not simply copy but take forward to the level of global leadership.²⁶³



Figure 25 The entrance to Enefit's concession at the Attarat Um Ghudran deposit in Jordan.
Note: the concession is located close to the town of Al Qatrana in central Jordan.

The reality claim reaches beyond the mere reference point of an existing industry. With regard to their project, Enefit's offer is basically to institute the Estonian 'techno-economic network' with only limited adjustments: "we do in Jordan what we already do in Estonia now".²⁶⁴ Seen in this light, the question is not whether

²⁶³ Such thoughts were expressed at the signing of the concession agreement. Dr Maher Hijazin, the director of NRA, promised that "one of the first commercial oil plants in the world will be in Jordan. Jordan will be the leading country in the World in exploiting its reserves of oil shale". Eesti Energia's press release from 12 May 2010, "Enefit signs concession agreement with the Jordanian government".

²⁶⁴ Enefit's representative during his presentation at the Jordan International Oil Shale Symposium. Field notes, 8 May 2012.

the ‘Enefit280’ technology is the best or even appropriate to the Jordanian context. Rather, the company’s success depends on how it stabilizes, naturalizes and black-boxes its entire socio-technical model of oil shale extraction, processing and marketing in the Middle East. This implies, above all, a close association between power and oil production, in terms of both shared physical infrastructure and the institutional arrangements required for a profitable business. In parallel to the explorations and test works carried out for future oil production, Enefit is preparing the construction of a 474MW power station with the potential to triple the capacity if the government agrees to long-term purchase at guaranteed prices (Anijalg 2012).²⁶⁵ The oil and power plants will be raised right next to each other and share both mining and ash disposal facilities – to some extent mirroring the Auvere site in Estonia (Figure 26).²⁶⁶

But only to *some* extent. Even though Enefit relies on its established techniques of resource assessment, mining and power generation for as much as possible, the Estonian model has not proven to be an instant solution that can be “airdropped” in the Jordanian desert (cf. Sloterdijk and Mueller von der Haegen 2005). This applies equally to technical systems and the social relations embedded in the use of technology. The environmental hardships of the desert landscape, the inferior qualities of the Jordanian shale, and different institutional and legal arrangements have all required the Estonians to adjust their model accordingly. Whereas Shell has imported its own cutting-edge knowledge, laboratory equipment and finances to survey the deeply situated resources beneath its concession,²⁶⁷ the implementation of

²⁶⁵ The power project was added to the deal only two years after Enefit’s first visit to Jordan, in 2008, when a separate agreement was signed (Anijalg 2010).

See also Oxford Business Group (13 May 2013) “High hopes for oil shale potential”, http://www.oxfordbusinessgroup.com/economic_updates/jordan-high-hopes-oil-shale-potential (accessed 6 July 2012).

²⁶⁶ Field notes, 6 May 2012.

²⁶⁷ This was repeatedly stressed by the executives of JOSCO, the Shell subsidiary, during the Jordan Oil Shale International Symposium, as well as by other participants. Field notes, 6–7 May 2012.

surface retorting depends on whether smaller companies manage to build up capital and negotiate local realities under stricter timelines and higher expectations, whilst navigating between the limits of their own expert capacity and the demands of the local workforce that has intricate relations with the nomadic tribes who populate the concession territories (Figure 27).



Figure 26 Enefit's concession close to the future site of the power and oil plants.

Hence, I suggest, the success or failure of technology transfer will depend on *how* 'fluid' the Estonian techno-economic system proves to be when instituted in Jordan. The fact that its boundaries have remained relatively flexible and blurred within the borders of the Estonian state does not necessarily guarantee survival in other places. The 'fluidity' of the technology, or its variable qualities, resilience and adaptability – or indeed what counts as a *working* technology at all – may not remain the same outside the national regime (de Laet and Mol 2000: fn. 33). Rather than remaining a constant in networked time and space (an 'immutable mobile' in the ANT

terminology), the technology – or in fact not just a piece of machinery but the entire socio-technical aggregate of oil and power co-production – has to become a ‘mutable mobile’ that is gradually disintegrated, altered and reintegrated when transported from one site to another (Law and Mol 2001).

Looking more closely, one discovers that the technical systems for extraction, processing and waste disposal will go through remarkable transformations on their travels from Estonia to Jordan. Contrary to open-pit mining with draglines the company now intends to use the truck-and-shovel technique. The exhausted landscape is intended to be refilled with mining waste, but also with the ashes of spent shale, which is considered hazardous waste in the EU. The most serious challenge in Jordan, however, is imposed by the scarcity of water (Jaber et al. 1997). Water availability is particularly critical in power production due to the vast amounts consumed in the cooling of turbines and ash handling.²⁶⁸ Concerns about possible impacts on groundwater used by the population caused Enefit to swap resources with JEML before entering into the concession agreement, in exchange for lower-quality shale. Although geological studies have indicated no aquifers that are used for potable water beneath Enefit’s current concession, the poor quality and high temperature of groundwater limits its use for the company’s own sake. Whereas in Estonia the company uses river water for cooling and ash removal (called ‘hydro pulp’ transportation), here it intends to test dry disposal as a less water-intense solution (Aarna and Lauringson 2011; Puura and Andersen 2012). However, some water will still be needed to prevent dust pollution from ashes, which only adds to the pollution that occurs in surface mining, especially considering that it takes many years from striking the ground to the exhaustion of area sufficient for permanent back-filling.

²⁶⁸ The dryness of the deposit may in turn incur smaller costs for mining and feedstock preparation.



Figure 27 Nomad camps share Enefit's concession territory with exploration shafts and drilling.



Figure 28 Test drilling of groundwater in Jordan.

Note: Although the aquifer is not used for potable water, the temperature of the water is 60°C, making it potentially difficult to use the water for cooling systems.

Likewise, it is unclear how the prospects for commercial production will be affected by the material conditions interior to retorting and combustion that differ largely from the Estonian context. The most striking issue is the low quality of the Attarat Um Ghudran shale. It represents only half of the calorific value of what has been deemed economic to process; on average 4.5 MJ/kg in contrast to the blend of 8.4-11.6 MJ/kg used in Estonian power plants (Aarna and Lauringson 2012). Even though new plants based on the fluidized bed (FBC) technique are supposed to handle lower-quality feedstock, the technology suppliers²⁶⁹ need to tackle the distinct and widely varied composition of Jordanian shales, which, in fact, comprise various geological sediments yet to be properly classified, including their high content of ash and sulphur, and the abundance of carbonate minerals mixed with silica (Jaber and Probert 1997; Bsieso 2003; Al-Otoom et al. 2005; Puura et al. 2012).²⁷⁰ The additional energy needed for lowering the temperature of cooling water or air-cooling can be expected to reduce the efficiency of the process even further. Nevertheless, burning the rock is still claimed to be possible and even competitive in Jordan, especially since disrupted gas supplies from Egypt following pipeline attacks during the recent unrest in the region have pushed the electricity price to unprecedented levels (Jeffreys 2011; Anijalg 2012). It is interesting to see that what falls far behind the Estonian criteria can potentially become 'economic' in another geotechnical and geopolitical context after marketing is decided. Whereas at home Enefit enjoys a monopolistic position, here it still needs to reach an agreement with the national generation and transmission utility NEPCO concerning the criteria, price and availability of infrastructure which determines the delivery of power to customers.

²⁶⁹ The FBC technology is not supplied by Enefit, but purchased from major design and engineering companies that build power plants such as Alstom/Daewoo, Foster Wheeler, and others.

²⁷⁰ Field notes, 7 May 2012. The presence of CaCO₃, however, is expected to help bind sulphur emissions.

This brings us to the second component involved in oil shale becoming conventional: the process of economization. While shale-based electricity rides the wave of scarcity-induced investment decisions, shale oil development does not depend directly on current market prices. With the help of British consultants, the Jordanian government has set up a novel calculative regime, which is designed exclusively to facilitate commercialization at times of political instability, without taking unnecessary financial risks and discriminating between different types of extraction technology. Apart from environmental fines, this pertains to royalties and taxes and the lack of restrictions imposed on emissions. Specifically, the fiscal regime establishes an *independent* tax system comprising only a pre-fixed royalty which is loosely linked to the Brent crude price and a 'petroleum tax' based on the revenue/costs ratio, thus avoiding fluctuations in national lawmaking over the next 40 years (Al-Ramini 2012).²⁷¹ Moreover, following from the concession agreements, Jordan is not expected to join any international schemes for emissions reduction and pricing. In this regard, the industry acquires a significant power to determine the measures that guarantee a viable business, since every concession agreement is instituted as a special law in Jordan, which supersedes the national legislation in case of any conflicts. Any future international commitments or environmental regulations instituted by the government can be considered a 'material adverse change' for developers, which will be tax deductible.²⁷²

The impending prospect of shale oil production has thereby instigated a particular economy of expectations and appearances (Tsing 2000; Wieszkalnys 2011), which allows foreign finance and knowledge to flow into Jordan, whereas the

²⁷¹ The royalty tax rate is 1% in case crude prices stay at the level of \$0-60/bbl and increases incrementally up to 5% within the price range of \$60-120, and above. The petroleum tax ranges from 15-65% in relation to an increase from 1.25 R/C to 5 R/C (Al-Ramini 2012).

²⁷² Dr Maher Hijazin, personal communication, 28 December 2010.

implementation is still bound to local political and ecological constraints. By now the government's energy strategy has clearly turned out to be overambitious, while all projects have become delayed due to constant changes in the cabinet and worse-than-expected circumstances afield. During the Jordan International Oil Shale Symposium in May 2012, the expert panel concluded that Enefit's power plant will not be functional before 2017, while oil production is not expected before 2018-2020, with a further ten years needed for the 'in-situ' oil to come on stream.²⁷³ With no sight of actual oil in the next several years, Jordan remains the litmus test for commercial development – not only in terms of technology demonstration, but also in terms of state regulation of the industry's environmental and economic performance, since there were no previous examples available for the government to study before entering into the concession agreements (Al-Ramini 2011).

At a time when Jordan exhibits an 'oil shale economy without oil' (to paraphrase Weszkalnys 2011), Enefit concentrates efforts on the geological works, licences and contracts required for commencing the first power unit, with the oil plant delayed for a few years (Anijalg 2012).²⁷⁴ The prioritization of power production serves a vital case for the conventionalization of oil shale, as it would offer a highly visible and palpable proof that Jordanian rocks are indeed a valuable resource, even if used for generating a different source of energy than traditionally envisioned. In parallel, the 'Enefit280' plant commissioned in Estonia performs as another case of 'reality' which is mobilized to render the industry's elusive future more tangible. Combined, these forms of 'infrastructural' and 'rhetorical work' will help Enefit raise further capital for its original agenda in Jordan – shale oil extraction (cf. Bowker

²⁷³ Field notes, 7 May 2012.

²⁷⁴ In answering a question asked at the Jordan oil shale symposium, an Enefit director promised to have the oil plant operating by 2019. Field notes, 7 May 2012.

1994). Yet, even if this ‘politics of visibility’ turns out to be successful, it remains to be seen whether Enefit will manage to produce any synthetic crude for transport fuels or merely heating oil, which could potentially be fed into power stations, given high prices and the fact that most Jordanian stations are fuelled by heavy oil.

Another dimension of the virtuality-reality interface pertains to the circuits of capital that accompany possible changes in company ownership. The sale of shares to third parties before implementing the projects is something that the Jordanians apparently intended to avoid when preparing the legal regime for concession agreements. Nonetheless, Eesti Energia sold a third of the JOSE company to the YTL Power International Berhad of Malaysia before the concession agreement was even ratified by the Jordanian parliament, earning a price ten times higher than it had invested by then. Even though the Malaysian expertise is claimed to play an active part in the power project, there have been some concerns as to whether Enefit will eventually retain responsibility for delivering the projects.²⁷⁵

In any way, shale-based power serves as a major constituent in the making and establishment of ‘Enefit’ technology as a realistic and viable solution for Jordan, even though it will deliver no oil as such. Although Enefit appears to have meticulously published its exploration data and other lessons learned from the project, there is a significant absence of clarity as to how the company intends to produce, process, and market shale oil. This double politics of ‘visible invisibility’ simultaneously obscures other critical issues, most importantly the high carbon emissions associated with both combustion and the ‘Galoter’ process (cf. Barry 2009).

²⁷⁵ Interview, 15 March 2010.

8.4 Utah: The promise of reality

Meanwhile, in Utah, the issues at stake are substantially different. The idea of squeezing liquid fuel out of the rock is neither novel, nor previously untried in this continent. Following the takeover of OSEC, Eesti Energia faces the legacies of not only the firm itself, but the two previous boom and bust cycles that have occurred in the American oil shale history (Gulliford 1989; Hanson and Limerick 2009). After signing the RD&D lease in 2007, OSEC was assisted at first by the Canadian UMATAC company and then Brazil's Petrobras for the use of ATP and Petrosix ex-situ processes respectively. In 2008, it entered into a joint venture with Petrobras and Mitsui, but was neglected abruptly after they had invested 40 million dollars into resource exploration, environmental and feasibility studies (Crawford et al. 2012).²⁷⁶ The history of the development site, however, reaches back to the previous rush for energy independence when these resources were first allocated for exploitation in the aftermath of the 1973 OPEC crisis. The failure of these earlier projects opens up a peculiar set of expectations and challenges. Amongst local advocates and the state's conservative government, Estonians are anticipated to bring along the long-awaited 'paradigm shift' in oil shale exploitation. Welcoming their help to unlock 'millions of barrels' of shale resources, the Governor of Utah is quoted saying: "In Enefit, we have a company which has the technology, commitment, history, and financing to try and

²⁷⁶ In a brochure distributed at the 2010 Colorado oil shale symposium, *American Energy Independence through Global Innovation: Oil Shale*, and in their presentation made at the symposium, OSEC opted exclusively for the Petrobras technology with no mention of ATP. Around the same time, Petrobras and Mitsui pulled out and the company was shortly thereafter sold to Eesti Energia. The sum invested by Petrobras and Mitsui has been published in Estonian media, see Sulev Vedler and Tarmo Vahter, *Eesti Ekspress* (13 May 2011) "Eesti Energia riskibisnis Ameerikas" [Eesti Energia's risk business in America], <http://www.ekspress.ee/news/paevauudised/majandus/eesti-energia-riskibisnis-ameerikas.d?id=45857615> (accessed 18 July 2012).

bring that oil shale to market”.²⁷⁷ For others, by contrast, the birth of Enefit American Oil stirs up a hornet’s nest of disputes over an unfulfilled technological promise, being envisaged to fail like all its predecessors.²⁷⁸ For example, one of the most eminent local sceptics, the leading peak oil theorist Randy Udall quoted in the opening of this chapter has confessed to an Estonian journalist that he doubts if Enefit’s know-how, technology and government’s support will make any difference:

What is interesting to me about Enefit coming is that no-one in America has ever produced oil shale conventionally as a liquid, for long periods of time... Well, lots of people are trying different technologies here in the U.S., but Enefit has a proven technology. You guys have a retorting process that works at least with Estonian oil shale. Our oil shale is different... I’m curious to see whether Enefit can make it work here... Everybody has claimed that but nobody has demonstrated yet. So it’s a question of whether we should believe Enefit’s claims or not. They haven’t built anything, they haven’t produced a single barrel here in the U.S.²⁷⁹

Here in the U.S. Here again the reality of the Estonian case operates as a *promise* of the possibility of marketization in the not so distant future. Yet the spatio-temporal disjuncture between the places of present and future exploitation and the material heterogeneity of the resource also emerge as substantive constraints to the transportation of the technology from one continent to another. To conventionalize surface retorting in Utah, especially as a viable alternative to the in-situ experiments under way in neighbouring Colorado, Enefit attempts to mobilize this promise of reality, while it still needs to ‘translate’ the technology in order to overcome the latter difficulties. The key difference in this case is that the company lacks a critical

²⁷⁷ Utah Business in March 2011, “Governor and Economic Development Office Welcome Estonian Oil Shale Company to Utah”, available at <http://www.utahbusiness.com/issues/articles/10787/2011/03/> (accessed 12 April 2012).

²⁷⁸ Scott Diel, *ERR News* (8 November 2011) “Enefit in America: Hot Topics”, <http://news.err.ee/economy/cc106d34-adbb-433d-9ec5-b5a22ee97858> (accessed 30 August 2012).

²⁷⁹ The text in this quote is transcribed by the author from a tape made available by Mart Zirnask, the journalist who interviewed Randy Udall. The interview formed a basis for an article in Estonian, which was published by the weekly newspaper *Eesti Ekspress* (4 August 2011), <http://www.ekspress.ee/news/paevauudised/eestiudised/usa-polevkiviskeptik-teie-plaanid-siin-ameerikas-kolavad-veidi-spekulatiivselt.d?id=50638885> (accessed 16 July 2012).

component in rendering the industry conventional: electricity production. All America is interested in is oil.



Figure 29 Enefit's (former OSEC) White River Mine site in Utah.

Note: Established on the former Utah Lease Tracks U-a and U-b, the White River Mine site was developed in 1972–1985, while the infrastructure was subsequently maintained under a BLM research programme, including the open mine shaft seen behind the fence which was constructed in 1984 and abandoned a year later (Russell 1990: 131; Crawford et al. 2012). Together with the presence of a former employee and oil shale advocate Gary Aho (Figure 31, left), now working for Enefit, these infrastructures provide continuity with the previous boom, enlivening both negative and positive connotations. The Estonian phone number on the plaque further links the geographies of extraction across different continents.

As in Jordan, the company is in the process of transferring its techniques of resource measurement, mining and ore processing along with Estonian staff to the country's hinterlands. As in Jordan, it struggles to accommodate these techniques to the high-desert environment and the depositional and compositional heterogeneity of oil shale, intending to replace some of its present practices in favour of dry disposal of ashes, backfilling of mines with spent shale, combined open-pit and underground mining, and so on; not to mention the need to upgrade the oil product in the future

(Aarna and Lauringson 2011; Hrenko 2012). The approach is similar, but the crucial missing element is power. Whereas elsewhere direct burning helps dissolve oil production in terms of shared infrastructure, economies of production and environmental liabilities, but also render the industry more actual rhetorically, in Utah the company is in need of different allies. In addition to the “reference” of the new ‘Enefit280’ plant erected in Estonia, which may require a further scale-up for Utah, Enefit mobilizes local material legacies for the same purpose. These are available in the form of the land, infrastructure, and people inherited with the concession, particularly those associated with the former White River Mine (Figure 29). Unlike the majority of U.S. resources that lie under federal lands, OSEC’s resource acquisition strategy concentrated primarily on privately owned oil shale with no royalties, forming the Skyline property (Figure 30), and to a lesser extent, state leases.²⁸⁰ This land is largely mineable with conventional open-pit techniques well known to Enefit. For oil shale exploitation to be rendered conventional on a grand scale, however, the federal resources of the White River mine site, which is covered by the RD&D lease and will possibly be expanded once commercial viability can be demonstrated, is thought to be of more critical importance.²⁸¹ Yet these resources are accessible only via underground mining at depths which have never been penetrated in Estonia, 300 metres.²⁸² The White River mine has been under development from the 1970s onwards, but abandoned in 1985, and thereafter maintained under the responsibility

²⁸⁰ OSEC’s brochure *American Energy Independence Through Global Innovation: Oil Shale*. The previous owner of the majority of these resources was a company called Cleveland Cliffs.

²⁸¹ In terms of size, the White River mine is a minor resource, covering only 160 acres with estimated 17.7 million bbl of in-place oil, as opposed the Skyline property and other leases with more than 2 billion bbl in-in place oil (Hrenko 2012).

²⁸² Vahter & Vedler, *Eesti Ekspress* (13 May 2011) “Eesti Energia riskibisnis Ameerikas” [Eesti Energia’s risk business in America].

of a BLM research programme.²⁸³ Although no oil retorts were actually put into operation during the last boom, the project has left behind a number of infrastructural monuments, which are now utilized by Enefit for both marketing purposes and the preparation of actual exploitation. These landmarks include roads, buildings, and most importantly an underground mine complex, which is inaccessible today however due to a methane explosion that occurred in 1995 and the subsequent flooding in the mine.



Figure 30 Enefit's (former OSEC) Skyline property in Utah.

Note: The Skyline property makes up the majority of the concession. Unlike the White River Mine, the resource is located on private land owned by Enefit and accessible with above-ground mining.

The hole in the ground that marks access to the flooded mine carries both material and discursive connotations. It creates a linkage between the geological space and time that have so far remained beyond human control, on the one end, and the

²⁸³ Field notes, 21 October 2011. According to Russell (1990: 131), the project owners were Sohio Shale Oil Company, Phillips Petroleum Company and Sun Company.

social world of unlimited technological potential and capital exchange ‘freed from geological fixity’, on the other end (Bridge 2009a). Having acquired material as well as immaterial existence, the hole appears to testify that the American rocks which have ‘promised much, delivered little’ (Udall and Andrews 2008) are nonetheless easily at hand to be entered into the circulation of technology, knowledge and money. In a similar manner, the weather station that has been installed at the site for the collection of environmental baseline data via monitoring meteorological indicators and a range of ambient air pollutants and emissions, as required by the EPA, has double effects. Inevitably, the physical object creates trust in the form of a visible image of environmentally conscious planning. Indeed, Enefit has emphasized the presence of the station and its contribution to regional air quality studies in every public presentation of the project, alongside its claims that the domestic industry meets the most stringent EU requirements.²⁸⁴ Moreover, extending from lithosphere to atmosphere, such measurements also help to make actual the potential future of oil shale exploitation in the face of its present absence (cf. Latham et al. 2009: 118-121). By fixing the status quo the data makes visible a possibility of difference, wherein these qualities, albeit strictly observed and generative of liabilities, will *not* remain the same.²⁸⁵

²⁸⁴ See also, *ERR News* (17 February 2012) “Eesti Energia Assisting in Utah Air Quality Study” <http://news.err.ee/economy/02cb0db7-19e9-4227-990e-b1705f7dc0bf> (accessed 30 August 2012).

²⁸⁵ It is interesting to note that, in turn, the Utah project has inspired Enefit to rework its techno-economic network with respect to other sites, in Jordan and potentially even in Estonia. The collection of environmental baseline data required under EPA rules has been recently instituted in Jordan, too. Both sites now exhibit a weather station, which is used for measuring a range of ambient air qualities, with some variation between the sites. Likewise, Enefit has more recently started adjusting its Estonian-specific methods for resource measurement, which is also used in Jordan in accordance with international standards for mineral reserves assessment (cf. Chapter 5). Again, the translation of the technology necessitates a transformation in the entire network. Field notes in Jordan, 7 May 2012.



Figure 31 An open mine shaft at the White River Mine site.

The presence of such material objects and bodies has ambiguous effects. The prepared landscape certainly helps Enefit to settle in, but equally to make the project tangible for potential investors. A key prerequisite for ‘conjuring up’ the investment finance that is needed for small mining ventures to be successful, as Tsing notes however, is that it resonates with national and regional aspirations (Tsing 2000). Although Utah’s political leaders have indicated strong support to Enefit, the memories of the 1980s collapse are hard to evade. During the 2011 Colorado symposium, several experts and representatives of local authorities asserted that the main problem with shale oil lies in the question of whether local facilities would be ready to meet another boom.²⁸⁶ The long-term scarcity of water in the Colorado river

²⁸⁶ These following problems were raised during the final panel of the symposium and by some participants of the following field trip to Utah. Field notes 19-21 October 2011.

catchment area is well known, but even more limited appears the capacity of pipelines, transport routes, refineries, local workforce, and residential facilities, taking into account the large-scale exploitation of conventional oil and gas that already takes place in the area.²⁸⁷ As for the moment, Enefit claims to tackle all these issues and bring shale oil into pipeline by 2020, meaning literally a pipeline for transporting the crude to Salt Lake refineries, which would necessitate the company accumulating further licences, capital and time (Hrenko 2012).²⁸⁸ In addition, the facility is promised to produce 50.000 barrels daily by 2024, which is seventeen times more than the present output of the Estonian plant (Figure 24).²⁸⁹ The company's managers think big, yet they make no secret that they still need large amounts of capital and welcome further investors.²⁹⁰ Furthermore, like other developers in the States, Enefit is faced with a myriad of environmental restrictions and potential public opposition to its plans; something which has been of little concern in Jordan and Estonia. In addition to the federal licences to be negotiated with the BLM and the EPA, energy companies active in Utah have to overcome a series of obstacles related to state-specific legislation, private property, as well as the exclusive rights of the First Nations who are located close to the concession.²⁹¹ The regulatory gauntlet to be run by any new energy project in the Uintah basin is considered to be a nightmare, "a patchwork of

²⁸⁷ See also articles by Scott Diel in *ERR News* (28 October 2011) "Dodgy Man Camps", <http://news.err.ee/Economy/62fed124-822a-4bc6-b7c3-3b6b70c4da8e>, and (8 November 2011) "Enefit in America: Hot Topics", <http://news.err.ee/economy/cc106d34-adbb-433d-9ec5-b5a22ee97858> (accessed 30 August 2012).

²⁸⁸ This was raised by Thomas Sladek in a question to Rikki Hrenko, the CEO of Enefit American Oil during her presentation at the Jordan International Oil Shale Symposium. Field notes, 8 May 2012.

²⁸⁹ This is thought to generate roughly 70.000 tonnes of spent shale ashes per day, which needs to be processed and disposed at the same time. Field notes at Enefit site, 21 October 2011.

²⁹⁰ The company executives have confirmed this in Estonian media, see e.g. *Äripäev* (9 March 2011) "Eesti Energia ostis USA ettevõtte" [Eesti Energia bought an US enterprise], <http://www.ap3.ee/article/2011/3/9/eesti-energia-ostis-usa-ettevotte> (accessed 19 July 2012).

²⁹¹ The tribal lands are located close to the mine area. There used to be a reservation on the site, but this is no longer the case. Field notes, 20 October 2012.

overlapping agencies”.²⁹² Needless to say, the appropriation of the resource does not guarantee that Enefit American Oil will be able to gain the ‘social licence’ for any operations to start.

Considering the centrality of conventional hydrocarbon extraction to the Utah economy, the creation of a ‘rival calculative regime’ (Mitchell 2008) might currently be a task too great for a single oil shale company. Although some tax incentives or lower royalty fees might be well under way and environmental concerns here are less pronounced than in Colorado, there is still a long way to go until full-scale production can be launched.²⁹³ In light of the above and more recent problems,²⁹⁴ it becomes evident that Enefit’s efforts are more concentrated on strategically engineering the *promise* of a techno-economically viable industry in order to raise the profile of the business and attract investors, rather than immediately producing any oil on its own. In orchestrating a careful interplay of local materialities and untested technological possibilities, the company cultivates an ‘economy of appearances’, as Tsing defines it, “the self-conscious making of a spectacle that is a necessary aid to gathering investment funds” (2000: 118). Tsing proposes this for frontier-style resource appropriation, but the same applies to technological development in a frontier field, where the question is not whether the mineral resource really is there, but whether it can be turned into something useful and brought to markets. The ‘economization’ of

²⁹² *Utah Business* in August 2011, “Energy Development in Utah: Weighing Costs and Benefits”, <http://dev.utahbusiness.com/articles/view/energy-development-in-utah-weighing-the-costs-and/?pg=1> (accessed 6 July 2012).

²⁹³ See *Salt Lake Tribune* (9 July 2011) “Utah officials fired up about oil shale after Estonia visit”, <http://www.sltrib.com/sltrib/politics/52156050-90/oil-shale-county-company.html.csp> (accessed 31 August 2012).

²⁹⁴ The Estonian media has repeatedly reported that Enefit’s tests with Utah oil shale in Frankfurt have not been promising. The company is said to be in a desperate need of additional capital, while researching alternative technologies. *Eesti Ekspress* (17 January 2013), “Eesti Energia kardab Ameerikas kaotada 100 miljonit dollarit” [Eesti Energia afraid of losing 100 million dollars in America], <http://www.ekspress.ee/news/paevauudised/eestiudised/eesti-energia-kardab-ameerikas-kaotada-100-miljonit-dollarit.d?id=65540092> (accessed 17 January 2013).

oil shale requires the Estonian technology to be showcased through infrastructural and rhetorical work, so that it can be deemed sufficiently “working” across otherwise disparate sites. Furthermore, it requires the mobilization of existing materialities for the purpose of rendering the virtual technology internal to global circulations of speculative capital. From a purely business perspective, Enefit seems to have a valid strategy, as justified by the lucrative revenues earned from the sale of its Jordanian shares to Malaysian investors. In doing so, however, Enefit does not assume responsibility for large-scale production of synthetic crude or even unrefined shale oil.²⁹⁵ Economization in this case is not underpinned by access to oil markets, but above all to venture capital markets.²⁹⁶

It should be added, however, that although Enefit’s recent actions certainly convey a strong element of opportunism, this is not a uniform strategy employed on behalf of the company as a whole. Rather, the company’s executives and employees seem to have multiple motivations, which despite being in synergy cannot be aligned under a single agenda.²⁹⁷ Whilst some have joined forces with international advocates of oil shale to convince the world’s financial community that the unconventional industry is worthy of investment, others are desperate to get the retort properly working in a race to launch the first commercial industry in Jordan and America. Yet others are simply doing their jobs or embarking on a stable career.²⁹⁸ It is hard to tell

²⁹⁵ In a sense, however, OSEC and Enefit have employed somewhat different strategies. OSEC was not very interested in R&D but claimed that it will establish a commercial oil production complex right away. Enefit seems to have taken a more cautious approach by emphasizing the research-intensive work of Outotec in Frankfurt. Field notes 20 October 2010.

²⁹⁶ I owe this idea to Gavin Bridge, who expressed similar thoughts at the “Geographies of Extractive Industries and Development: Institutions, Territory, Justice” panel discussion during the AAG Annual Meeting in New York, February 2012.

²⁹⁷ Kesküla (2012) has observed similar processes taking place in oil shale mining.

²⁹⁸ An anthropologist in my place would not overlook the fact that Enefit was able to appoint an American woman as the first CEO of Enefit American Oil, who had previously worked for several years for Eesti Energia in Estonia. It is not my task to assess her personal stake in the Utah business, but it is clear that Enefit would not have been so confident to proceed with OSEC’s takeover without

these strategies apart. However, the public contestation of the industry, both at home and abroad, focuses primarily on oil production, as if it will take place in reality. The following section turns to such contestation and clashes of values back in Estonia.

8.5 'A company bigger than the nation itself'

Since Eesti Energia abruptly ventured into international business, the energy sector of Estonia has undergone profound transformations following its integration with EU energy and carbon markets. The radical shift in the company's identity and production profile has not just been caused by these transformations, but equally affected the place of oil shale in national conceptions of security and self-determination, the closely related question of the monopoly's ownership structure, and the relationship of these processes to wider aspirations of a 'knowledge-based society' (cf. Lehti 2005). The socio-technical controversies documented in Chapter 6 thus require a further reflection in this context. For although the country's energy elites seek to fend off controversy by rendering the domestic business even more self-evident and irreversible, their attempts to rework and globalize the local techno-economic network under 'market-oriented' principles have simultaneously opened up a new space of contestation.

In light of heated debates over the fate of oil shale, it is hardly surprising that the industry's 'rebirth' has not been applauded by all, but met with disbelief, suspicion and frustration across a whole breadth of social groups. The main supplier of state energy services is now feared to be becoming "a company bigger than the nation itself", according to journalist's statement that neatly summarizes the wide range

her existence as a potential middlewoman between the two nations. See also <https://www.enefit.com/en/success-stories> (accessed 4 October 2012).

concerns expressed over the manner and pace in which the publicly-owned company goes commercial.²⁹⁹ Broadly speaking, Eesti Energia's actions are interrogated at two levels: the company turning, first, from a production and service-oriented enterprise into a technology developer, and second, from a national power monopoly into an international energy consortium. The Jordan and Utah deals in particular have been met with disapproval in various circles, extending from countless commentaries made anonymously on the internet and in private conversations to a growing number of open remarks from academic and political opinion leaders. In opposition, some government officials and businessmen have expressed their support for the company, especially those involved in its leadership.³⁰⁰ Overall, the dispute has greatly facilitated the proliferation of new 'issues' and 'publics' that are preoccupied with different aspects of the industry's restructuring under the tenets of the free market (cf. Marres 2005b; Callon et al. 2009). Tentatively, this mobilization can be divided into two streams: contestation of Enefit's technology in more specialist circles and contestation of its foreign business at large.

As mentioned above, the disputes over the value and ownership of the 'Galoter' invention originate in the 1960s, but have now intensified dramatically. There is growing dissensus regarding whether the old technology should be monetized, how to rate its performance, and above all, what the oil can be used for. Is it technically possible and economically reasonable to start producing higher-quality synthetic crude? Subsequently, it is also questioned whether oil production can be allowed

²⁹⁹ This title is borrowed from Scott Diel's interview with Sandor Liive, the CEO of Enefit, *ERR News* (9 May 2011) "A Company Bigger than the Nation Itself", <http://news.err.ee/Economy/954325b3-8d36-4c7a-957c-2e5a1e1b7bb9> (accessed 28 October 2011).

³⁰⁰ The OSEC takeover in particular was initially considered a good deal by some Estonian economists and politicians, including the Prime Minister Ansip who commented that "who is overall afraid of making investments, will not earn any profit either". Apparently the deal has been celebrated in association with the failure to sell a part of Eesti Energia to the US-registered NRG Energy a decade earlier. See Tarmo Vahter and Sulev Vedler, *Eesti Ekspress* (13 May 2011) "Eesti Energia riskibisnis Ameerikas" [Eesti Energia's risk business in America].

limited growth, given high prices and needs for technology demonstration, or even increased at the expense of electricity generation until it covers domestic needs for transport fuel (e.g. Parts 2009). Such questions evade distinctions between technical, business and political strategies, and hence overspill inter-industry competition. One of the crucial implications of Enefit-Outotec cooperation is that this has further degraded the importance of academic oil shale science. The disintegration of the former techno-economic network has led to a point at which there are barely any university-based experts involved in the development of Enefit's technology.³⁰¹ As my interviewees revealed, the ageing community of academics is able to offer only limited, one-off solutions to practical problems in operating the retort, according to their credentials, which on Eesti Energia's side legitimizes the decision to outsource their entire R&D to Outotec and foreign consultancy groups. This has resonances with the general concern in technical universities that they are tasked to produce only the workforce for the industry, since there is little demand and funding for oil shale research, which only deepens the overall generational gap in the local knowledge base.³⁰²

Such frustrations may provide a partial explanation as to why diverging views about the technology's value have culminated in a situation where Enefit's ambitions are considered a potential source of embarrassment for the entire nation. Since the news of the Utah deal, some of the most renowned members of the academic community have voiced doubts whether the technology would be working on different

³⁰¹ Except for a few university-educated scientists who are now employed directly by the company.

³⁰² Interviews, 10 June, 18 June 2010, 9 September 2010, 20 September 2010; field notes 17 October 2010. This tendency is also evidenced by the fact that very few Estonian academics are able to independently participate at international oil shale conferences, being totally outnumbered by Eesti Energia's delegation. The majority of presentations are being made about the company's progress.

shales and in different environmental and socio-political conditions.³⁰³ Others have gone even further and disputed the company's assurance that no money coming from Estonian customers and taxpayers is used to pay for such "utopian" and "irresponsible" plans and thereby extended the debate to questions of national security and reputation more broadly, as contrasted with market-oriented business strategies.³⁰⁴ One can witness here again a clash between the worldviews of Eesti Energia's top management comprising a relatively young team of men educated in finance and law and an older generation specialized in engineering, chemistry and geology – the 'managers versus engineers' conflict that seems to be a general feature of post-Soviet energy sector reforms (Wengle 2012).³⁰⁵

Further, these technocratic concerns have come to resonate with growing anxiety over the security of electricity provision following "market opening". While there is less awareness about Enefit's technological and business strategies in the public sphere, the millions invested into resource acquisition and exploration in Jordan and America are seen to be at striking odds with the company's apparent inability to continue delivering adequate and affordable electricity to the Estonian population. As it is still the main power supplier despite market liberalization and partial unbundling, Eesti Energia is accused of neglecting its duties at home, such as

³⁰³ See, *inter alia*, *ERR News* (10 March 2011) "Scientists Raise Doubts about Eesti Energia's US Success" <http://news.err.ee/Economy/dcca35cf-398e-497a-aed6-a230d800e984>; (24 January 2013) "Eesti Energia CEO Defends Utah Project", <http://news.err.ee/politics/5e9c9dad-8e79-47f2-a8cc-c089d30f6cde> (accessed 24 January 2013).

³⁰⁴ Anto Raukas, *Eesti Päevaleht* (18 March 2011) "Eesti Energia mõtleb liiga palju suurele äridele" [Eesti Energia thinks too much about big business], <http://www.epl.ee/news/arvamus/eesti-energia-motleb-liiga-palju-suurele-arile.d?id=51293772>; Mati Pallasma, *E24 News* (30 March 2011) "Kas põhjendatud optimism või kontrollimatu avantürism?" [Justified optimism or uncontrollable adventurism?], <http://www.e24.ee/410933/mati-pallasma-kas-pohjendatud-optimism-voi-kontrollimatu-avanturism>. Likewise, experts like Jüri Žirjakov have called "utopian" the plans to produce synthetic crude from Estonian shale, <http://www.e24.ee/1051050/ekspert-eestis-polevkivioliist-korgkvaliteetse-mootorkutuse-tootmine-on-utoopia/> (all accessed 12 October 2012). Similar issues have been raised during the sessions of the Parliament.

³⁰⁵ These tensions have parallels in the mining sector, where an increasing divergence has emerged between the 'meritocratic ideology' of the capital-based managers and the values of the historical dynasties of Russian-speaking miners inhabiting the eastern regions of the country (Kesküla 2012).

the maintenance and upgrading of distribution networks required for ensuring a good quality supply even in more remote areas, which have repeatedly been affected by adverse weather conditions.³⁰⁶ This frustration is perhaps most eloquently articulated in the words of the country's President:

A company owned by the Estonian state invests in the deserts of the Middle East and the US Great Basin, but the storms that strike us with seeming clockwork precision in August and January leave tens of thousands without power, because investing in buried cable instead of overhead lines is said to be prohibitively expensive.³⁰⁷

Moreover, on the eve of market opening, Eesti Energia's investment plans have been subjected to intense scrutiny in both the public sphere and more private political debates, which in turn have been picked up as a counter-argument to oil shale development in international media.³⁰⁸ To the dismay of Enefit managers, critics have established a direct connection between their ability to raise capital for activities on other continents and rising electricity prices at home.³⁰⁹ The profit-oriented risk business of a state company is thereby considered not only imprudent, but *immoral* by critics at home. In this situation, the questions of possible energy futures are revisited yet again. While the 'monopoly of truth' of chief government and industry executives struggles to demonstrate a clear distinction between domestic and foreign

³⁰⁶ Eesti Energia's subsidiary Elektrilevi is responsible for the majority of electricity distribution in Estonia, while transmission networks have moved under the responsibility of Elering, the TSO.

³⁰⁷ Toomas Hendrik Ilves (22 August 2011) "Let's make Estonia greater", <http://www.president.ee/en/media/interviews/6422-lets-make-estonia-greater/index.html> (accessed 24 May 2012).

³⁰⁸ See articles in *Salt Lake Tribune* (25 January 2013) "Utah oil shale becomes political bunching bag in Estonia," <http://www.sltrib.com/sltrib/money/55701459-79/utah-shale-oil-estonian.html>; and (14 July 2011) "Blowing smoke" <http://www.sltrib.com/sltrib/opinion/52183351-82/estonia-oil-utah-rocks.html>. See also a series of analyses and overview of media published by U.S. oil shale opponents, "Eyes on Enefit", <http://checksandbalancesproject.org/category/eyes-on-enefit/> (all accessed 8 April 2013).

³⁰⁹ Several journalists and members of the Parliament have interrogated whether Eesti Energia is able to use the domestic electricity infrastructure as a warranty for international bond issues, while refraining from returning the benefits reaped from relatively high network charges and/or free CO₂ quota to offer lower prices for household customers. The Competition Authority has recently launched an investigation into Eesti Energia's pricing mechanisms.

investments, and between power and oil production,³¹⁰ the interdependencies of regulated economy and commercial affairs – and further, their relationship with shifting conceptualizations of security, opportunities to realize competitive advantages, and patriotic demands of pride and morality – all become conflated in the formation of public politics. The already bleak prospect for a productive dialogue is exacerbated by the perceived arrogance of energy elites and their unwillingness to respond to any critique, or as Enefit's CEO has put it straight: “we are not discussing it; we are just doing it”.³¹¹

8.6 The smell of oil: resource materiality and marketization

A few months before the Utah deal became public and shortly before the Jordanian parliament ratified their concession agreement, I was lucky enough to accompany an exclusive fieldtrip arranged to Enefit's Estonian facilities for the delegation of the Jordanian government, led by the former Minister of Energy, HE Khaled Irani. “When unconventional becomes conventional...” was the phrase that had launched a long day of presentations and sightseeing to convince Jordanians about the Estonian case of energy independence through oil shale exploitation. Everybody was exhausted after having walked through the entire ‘Eesti’ power plant, and our trip was reaching its final stop, the oil factory next-door. Cameras had been put away and we slowly walked upstairs to the retorting floor... Yet a moment later all Jordanians filled the room

³¹⁰ Again, Minister Parts has been a chief spokesperson for the company, as revealed by his Estonian interviews. See *Delfi.ee* (12 July 2011) “Parts: Eesti Energia tegeleb teadmiste ekspordiga” [Parts: Eesti Energia is exporting knowledge] <http://www.delfi.ee/news/paevauudised/eesti/parts-eesti-energia-tegeleb-teadmiste-ekspordiga.d?id=49394313>; and *Eesti Päevaleht* (15 January 2013) “Juhan Parts: häda algas Bombardieride ostuga” [Juhan Parts: The trouble started with the purchase of Bombardiers] <http://www.epl.ee/news/majandus/taismahus-juhan-parts-hada-algas-bombardieride-ostuga.d?id=65530422> (accessed 13 February 2013).

³¹¹ Scott Diel, *ERR News*, (9 May 2011) “A Company Bigger than the Nation Itself”. See also *ERR News* (10 April 2013), “Ansip scolds Eesti Energia excs”, <http://news.err.ee/politics/6302c064-9706-43fb-9f2b-d22103e5702e> (accessed 10 April 2013).

excited, awake, chatting and smiling. It *smelled*. One of the two ‘Enefit140’ retorts was rotating with a loud sound, milling a content that nobody could really see, but could otherwise sense. It smelled of *oil*.³¹²

The smell of oil continues to invigorate the promise of a commercial and self-sustainable oil shale economy for prospective developers and resource-holding governments alike. Month by month, there are more frequent tours made to the Enefit territory, as well as to the factories of VKG Oil. In June 2011, praising the Estonian industry in the international media, a group of Utah officials made no efforts to hide their enthusiasm upon visiting the Auvere site.³¹³ After all, the Estonian companies do produce some oil. Mobilizing the entire industrial landscape behind the “reference”, the tangibility of the Estonian case cultivates an affective atmosphere, wherein the largely virtual industry is rendered present and politically operational in a precognitive manner (cf. Massumi 2002; McCormack 2003; Massumi 2005a; Anderson 2006, 2007; Latham et al. 2009: 118-121). In the affective space where shale oil is actualized, it is of little importance *what* is there beyond the smell. What comes to matter is not what exactly the Estonians are able to wrest out of the rock, but the fact that they do process something, that this stuff is indeed sold and consumed outside the industry itself, *and* that there is apparently more to come in the next years.

As documented throughout the thesis, the Estonian industry can be conceived of as a ‘short’, albeit historically strong techno-economic network (Callon 1991), which is organized around a resource-sensitive technology, a limited market niche,

³¹² Field notes, 1 September 2010.

³¹³ The four members of this delegation praised the Estonian industry in several articles published in the *Salt Lake Tribune*, a central forum of disputes on Utah’s developments. E.g. “Utah officials fired about oil shale after Estonia visit” (9 July 2011) <http://www.sltrib.com/sltrib/politics/52156050-90/oil-shale-county-company.html.csp>. Also, Scott Diel interviewed them for Estonian media, see “Investing Abroad: Meet Uintah County” (1 July 2011), <http://news.err.ee/Economy/4bfae220-564e-4f73-a14b-7f1587af1327> (accessed 31 August 2012).

and a supportive state apparatus; however little it is facilitated by independent scientific research. Technically speaking, the *modus operandi* of Eesti Energia centres on an affinity between electricity and oil production inherited from Soviet-era resource and spatial planning rationales, which makes it possible to fully utilize both lump and fine-grained shale, to reuse part of the by-products of combustion and pyrolysis, and most importantly, to periodically exchange the materials, equipment, capital or environmental externalities accumulated in one section in favour of the other. Enefit's success hinges on its ability to establish this model as "conventional" and "proven" elsewhere, whereas the 'fluidity' of the technology implies that it is not just modified where appropriate, but reworks the domestic industry accordingly. Beyond the 'reciprocal adjustment' between the technology and its new environments (Akrich 1992), the entire techno-economic networks of the involved countries need to be aligned, converged and concurrently adjusted. In Jordan, Eesti Energia implements what it has best mastered, namely power generation, at the same time as it rearranges and mobilizes the domestic industry to continuously enliven the promise of liquid fuel production. In Utah, the anticipated production increase in Estonia works further to compensate for the lack of need for electric power sources and, combined with local aspirations and materialities, helps realize the future beyond a mere resource speculation strategy. However, even if the commissioning of the 'Enefit280' plant turns out successful, the marketization of its products remains undecided. For the time being, Estonians are not producing "flowing honey", as one industry representative mused in private, but heavy bitumen-like stuff, which is used as heat oil in local boiler houses or shipped to Rotterdam and other European ports and sold there for marine transport after it has been blended with other crudes, but not refined.³¹⁴ To date, it has

³¹⁴ According to Statistics Estonia, nearly 80% of shale oil production is currently exported. In 2012, over a third of shipments went to the Netherlands, and more than a fifth to Belgium,

not qualified for synthetic crude production, except for a few laboratory samples displayed for marketing purposes. What continues to be debatable is whether the evidence of continuous extraction guarantees commercial-scale production of high-quality motor fuels, although in pursuit of the “reference” Eesti Energia now promises to cover the entirety of Estonia’s needs for diesel by 2020.³¹⁵

If the literature on ‘techno-economic networks’ stands out because of the emphasis on the configuration of people, knowledge, technical objects and *things* (Green et al. 1999), then what about the active capacities of oil shale itself in the constitution of future energy economies? Recent work in political ecology has observed that the biophysical and geospatial qualities of resources, embedded in geographically and historically specific socio-technical realities, may show remarkable resistance to the creation of standardized goods and exchangeable market commodities (Le Billon 2001, 2004; Bakker 2005, 2010; Bumpus 2011). Besides economic and political uncertainty the major challenge to shale oil commercialization is indeed exposed by the material and spatial heterogeneity of world deposits, which precludes a universally applicable retorting technology to be designed for both ex-situ and in-situ extraction. As oil shale companies are well aware, every shale oil plant needs to be *tailor-made* by “matching” the technology with the given resource (Schmidt 2011). Since the technology is so sensitive to the ore, the achievement of ‘economies of scale’ is also bound to local factors, as the Canadian inventors of the ‘ATP’ retort have admitted by reference to their continued failure to translate pilot experiments into a large industrial plant in China (Odut and Mohr 2011).

<http://www.stat.ee/57642> (accessed 7 June 2013).

³¹⁵ <https://www.energia.ee/et/polevkivioli-tootmine> (accessed 4 September 2012).

However disturbing such geophysical and geochemical heterogeneity of the resource is for technology exchange, it is not helpful to focus exclusively on the ‘ore vs. machinery’ interaction, because this would resort to a form of ‘bedrock naturalism’ (Bakker and Bridge 2006) without explaining how the materiality of the resource is enacted in the first place and with what consequences. Furthermore, following Braun (2008), neither the socio-technical realm nor ‘the economy’ amount to pre-given structural units against which a recalcitrant nonhuman world can be projected and assessed. Rather, as I have argued earlier, the material qualities of the resource that are valorized as ‘good’ or ‘bad’ originate in the geoscientific and economic knowledge practices through which oil shale is valued, measured, utilized and brought to the market; the ‘ontological politics’ of the resource-in-the-making (Mol 1999). Indeed, if the resource would be enacted otherwise, then these qualities would not necessarily matter (cf. Lepawsky 2012).³¹⁶ Understood as relational and processual, rather than a ‘geological fixity’, materiality helps here to think through the ways in which the geographically dispersed, physically varied, and inherently dynamic properties of hydrocarbons shape their utilization, without falling into the trap of commodity determinism or nature-society binarism (cf. Bakker and Bridge 2006; Bridge 2011b).

In effect, the ambiguous materiality of ‘oil shale’ profoundly affects the prospects of commercial production when transposed from solid mineral formations to liquid fuel resources. The purification of one material state at the expense of the other is highly problematic. As a result of the obdurate qualities of the resource, not only are the deposits of *oil shale* highly heterogeneous, but so are the products of *shale oil*. The variation of products reflects not just the specific properties of the feedstock, but also the socio-technical specificities expressed in the used technology, such as the

³¹⁶ For example, as a raw material for cement production or a medical remedy.

latter's ability to process fine-grained material and the mineral components of host rocks.³¹⁷ In particular, the retorts based on lump shale processing and those adapted to 'fines' yield different oil products (Oja and Elenurm 2011; Schmidt 2012). The extent to which oil shale may exceed the status of mere resource and become a standardized commodity subject to market exchange – or more specifically, *an oil commodity* – is thus inevitably a local achievement.

Furthermore, the materiality of oil shale, once stabilized, may constrain its access to conventional oil markets. Among other practicalities, the possibility of marketization hinges on the willingness of refineries to accept the stuff for hydrogenation and distillation. The main problem here is again imposed by 'fines', which resist leaving their solid state and contaminate the liquid fractions. The solid particle residue renders the upgrading of shale oil an expensive and time-consuming process, if not impossible (Knaus et al. 2010). As refining is a highly concentrated, technology- and capital-intensive business (see Bridge and Le Billon 2013) the unconventional industry may fail to enter global oil markets unless it undertakes further 'infrastructural work' in the form of independent refineries built exclusively for shale oil processing, such as those underway in Estonia. The invention of a standard retorting technology and a more homogenized product also requires vast amounts of material to traverse distant sites of physical transformation, from the experimental mines of host countries to research facilities located far overseas. For instance, the 'ATP' developers have shipped huge samples of Jordanian shale to its pilot plant in Calgary and the new demonstration plant in China (Morgan 2011; Odut and Mohr 2011). Enefit, meanwhile, has put hundreds of tonnes of Jordanian and Utah rocks under testing in Outotec's centre in Frankfurt (Sieger 2011; Hrenko 2012). Both

³¹⁷ Accordingly, so are the by-products and wastes of oil shale retorting.

have tested upgrading in US refineries. Such ‘non-linear, multidirectional travels’ of the material further expand the geographies of knowledge exchange and circuits of capital (cf. Lepawsky and Mather 2011).

To conclude, ‘becoming conventional’ requires a reconfiguration of the relation of such materialities to market affairs. Conventionalization works to erase disparity between present and future sites of shale oil extraction, processing and consumption. Aligning these nodes into a series of singularized global networks, the ‘translation’ of ex-situ techniques necessitates the adjustment of both technical equipment and economic-political norms. Innovation and economization are therefore mutually reinforcing processes, whereby the retorting process is rendered sufficiently working given a favourable regulatory environment or, alternatively, opportunities for consultancy, speculative resource appropriation or mergers and acquisitions. Lacking sufficient capital to open initial commercial mines and oil plants, developers are only beginning to think about the product’s ultimate access to established oil markets.³¹⁸

The co-construction of resource materiality and markets is further tested through public inquiries into these processes. For the ‘conventionalization’ of the Estonian industry to take place *vis-à-vis* widespread mistrust and disappointed hopes, national energy elites follow two agendas. First, the domestic energy system is maintained as a self-evident, objectively determined situation, and subsequently rendered even more irreversible in the face of mounting uncertainty and tightened scrutiny. Second, the former techno-economic network is partially reformed in response to growing needs for investment, knowledge and credibility. The disintegration of the network, in turn, denaturalizes and destabilizes local conventions by rendering the already ‘leaky black boxes’ wide open (Callon and Latour 1981). Thus

³¹⁸ The issues related to financialization and marketization gradually gained prevalence throughout the international oil shale symposiums I attended in Colorado (2010, 2011) and Jordan (2011).

obscuring the boundaries between legitimate business strategies and the normative ideologies of nation-building, the industry's expansion generates new issues and publics amidst ongoing energy sector transformations. Ultimately, this may have repercussions for the bankability of the projects, given the high level of speculation associated with the virtual technology, and hence undermine the actualization of the industry elsewhere.

The interactions between innovation, economization and contestation are thus multi-sited and multi-directional. Techniques for commercial-scale extraction are invented and re-invented at the same time as they travel between variable socio-ecological, regulatory, and economic contexts that are geographically contingent and path-dependent. Although the literature instigated by Callon and colleagues attends to the co-production of technologies and economies by foregrounding non-human agencies, it pays little attention to how such agencies transform through and within networks when traversing otherwise disparate sites; that is the spatial displacement aspect of 'translation' and its politics. Geographical insights help to understand the dynamics in which locations become converged through such translations and techno-economic events are acted out not just in time, but in space too. How to make sense of these processes at the interface of the actual and the virtual in frontier-style resource development poses a question for future research.

Chapter 9. Conclusions: Unconventional Futures

This thesis has followed the birth of an alternative fossil fuel resource called in English with a single name ‘oil shale’. Focusing on oil shale’s persistent status as an ever-promising “resource of the future” the preceding chapters documented and analysed how the resource is assembled from heterogeneous sedimentary rocks that are found all over the globe, constituted as ‘unconventional’ oil, and subsequently made to ‘become conventional’. As I have shown, this dual movement of becoming both ‘unconventional’ and ‘conventional’ takes place through specific abstractive practices in the geo-sciences, rival economic calculations, political negotiations, corporate rhetoric, and mundane ‘infrastructural work’ in the field. This analysis was based on a meticulous study of technical reports, policy documents and media sources. At the same time, I carried out ethnographic fieldwork across a number of geographical sites with varying degrees of engagement: from five months of interviews and participant observation in the world’s leading oil shale producing country of Estonia, to short-term conference ethnographies and site visits in Colorado, Utah and Jordan, to day-trips of interviewing in London and Brussels. In this way, the thesis traces recent transformations in the oil shale industry, interrogates the politics of anticipation in the creation of an alternative resource economy, highlights the underlying practices of geoscientific, economic and political calculation, and explores the geographies of knowledge and technology exchange that characterize these transformations.

There are two possible ways to summarize the key findings of this thesis. For some readers, the storyline of the chapters might give an impression that this thesis is simply concerned with the Estonian case, of an energy economy ‘in transition’. This way of reading the thesis follows a particular post-socialist country with a peculiar history in exploiting an ‘inferior’, carbon-rich resource (Holmberg 2008); a country

which since being admitted to the European Union has encountered severe challenges, and now struggles to extend the industry's lifetime at the same time as it takes advantage of opportunities to capitalize on its legacies at overseas markets, outside the climate policy regime of the Kyoto Protocol. In this reading, these challenges derive from the conjunction of three conditions: a declining resource base; the demands of EU environmental and climate policy; and the impact of open competition following the integration of the state energy sector with the EU internal market for both electricity and emissions trading.

The thesis can certainly be read in this way. First, Estonia as the leading producer of oil shale in the past has now entered a 'post-peak' situation, in which the future of its energy economy is defined by the declining quality and quantity of its domestic resource base. This has both generated a struggle between the industry and government to control resource access and led to the redefinition of the resource itself in specialist circles. At the same time, any public concerns about imminent scarcity tend to be denounced as misinformed. Second, the continuing existence of an industry that generates the majority of Estonia's hazardous wastes and greenhouse gas emissions has become increasingly challenged both by growing environmental awareness in Estonia and by the external demands of EU environmental policy, especially since the EU introduced carbon pricing. Third, having so far existed 'outside the market', the former state-regulated and subsidized sector is expected to undergo major changes once companies have to be subject to fair competition in the context of the European single market. Approaching the end of the 'transitional period' afforded by the accession treaty, the nation's energy futures have become increasingly governed by the need to anticipate the closure of a substantial quantity of power generation capacity due to a combination of carbon pricing, constraints on other emissions, and the strategies of other market participants. Although the government

has managed to defer the date at which many EU requirements come into force, fears for the industry's dissolution have opened up a space of intense political contestation, leading both to calls for a lower-carbon energy economy and, in a remarkable twist, to demands for increased levels of shale oil production. In the face of mounting controversy, local energy elites have begun to extol the virtues of the market, enabling them not just to shift the domestic industry away from the 'shale-to-power' towards the 'shale-to-liquids' pathway, but to take up the opportunity to commercialize Soviet-era expertise by taking a leading role in technology development and project management overseas. In turn, the success of the Estonian government and industry in resisting the demands of the EU has made it possible to promote the development of oil shale elsewhere. Indeed, the success of the Estonian industry in its relations to the EU has contributed to a sense of its economic viability and political acceptability in other locations, including Jordan and Utah.

However, while this reading provides a helpful starting point, the linear narrative it proposes has two major pitfalls. I address these first, before going on to provide an alternative reading of the thesis. The first problem is that it explains the future likelihood of oil shale extraction as the result of a set of given conditions. According to this view, which is popular amongst industry professionals and government officials, the value of oil shale for Estonia as well as for other national economies is largely determined by the material qualities and energy content of their resources, as well as the technological readiness of the industry, its access to infrastructure and markets, regulatory constraints, and perhaps most importantly, the dynamics of pricing and state of competition in the global market in relation to alternative energy products. However accurate this list may be, it tends to descend into a sort of energy or resource determinism. Estonia's strong position in the business of oil shale extraction cannot be simply explained by the fact that its

resources are said to be among the highest-quality deposits in the world and can therefore compete with conventional hydrocarbons. Nor can it be attributed solely to the legacies of the planned economy, although the logics and programmes of Soviet authorities certainly played an important part in the industry's expansion to this scale, considering the large-scale electrification programme of the 1950s and 1960s. The same is true for the industry's future – it is not exclusively determined by 'material limits', EU policies, or the merciless rules of the market. Instead, oil shale continues to be exploited in Estonia due to the manner and extent to which a particular section of the country's subsoil has been enacted and stabilized as a resource historically. Moreover, this constitution of oil shale as a resource has become inextricably tied to the promise of an independent nation-state, the future autonomy of which depends on a successful economy and liberal business climate, backed up by relevant cutting-edge scientific research. Estonia's resource decline or admission to the EU does not determine whether it will follow other member states towards a 'low-carbon transition' in practice. Rather, the maintenance of oil shale as a strategic resource is a historically and geographically contingent process, which from the very start has been challenged by internal differences as well as external forces, but has nevertheless been sustained to date.

The second weakness of the narrative presented earlier is that it does not convey a sense of the indeterminacy and openness of the future. All of the causes that this narrative identified are open to disputation and negotiation, and their significance is uncertain. After all, there may be no immediate resource depletion if technological innovation or business opportunities facilitate the use of lower-grade deposits or, even more dramatically, if the 'shale-to-liquids' discourse displaces the 'shale-to-power' discourse. Moreover, the introduction of the EU regulatory regime, which was initially considered to bring the industry to a halt, has instead turned out a flexible

process of policy formation, whereby the alliance between the industry and the state has assumed an increasingly proactive role through the mobilization of national sovereignty and energy security arguments, undermining EU attempts to build the single market into a homogeneous ‘technological zone’ (cf. Barry 2001; Callon 2004). Consequently, the exact organization of the internal market for both energy and carbon cannot be known in advance. Their constitution depends in part on the success of the Estonian energy elites in their efforts to draw on the industry’s existing capacities and convince others of its continued importance for the national economy and social security, as well as offering a solution to regional energy supply and global energy security problems.

As a result, this study of the ‘Estonian case’ is not a case study of a given phenomenon. This is not just because there is no similar oil shale industry in the world, nor because Estonia differs significantly from other post-socialist “transition economies”. Rather, it is because oil shale itself is a peculiar ‘resource of the future’, which has repeatedly failed to be developed at a larger scale, particularly for oil production, but nevertheless continues to be revived as a resource in parallel to other conventional and unconventional hydrocarbons. This is why I have tried to avoid using concepts like ‘neoliberalization’ that are commonplace in the existing political ecology literature on natural resources (cf. Peluso and Watts 2001; Castree 2003; Bakker 2005; Heynen 2007). Instead, I have focused on the processes of ‘resource-making’ more broadly in relation to the shifting and continuously reproduced politics of the future and struggled to find out ‘*what* is this case a case of’ (Flyvbjerg 2006: 238). Through these struggles, the field of my research has gradually turned out to be more global than initially envisaged, although the relationship between ‘the global’ and ‘the local’ have never been clear-cut and settled. These categories, along with others, are not given, but result from an intricate process through which Estonia not simply

participates, but becomes the starting point or ‘eventful place’ (Massey 2005) for dreaming, narrating and creating alternative, *unconventional futures*. This is a study, in part, of how ‘Estonia’ has become global.

The remainder of this chapter offers another reading of the thesis. In this reading, I argue that uncertainty about scientific, economic and political developments has been central to the constitution of the ‘resource of the future’ with the potential to reshape our carbon-based energy economies. This reading takes an ‘object-oriented’ approach (Latour 2005a) and analyses the undetermined and multiple processes through which *oil shale* is objectified, universalized, and subsequently rendered into a more global energy resource, drawing upon the long-standing conviction in geography that resources do not exist in nature, conceived of as external to society, but rather ‘become’ resources at certain times and places (Bridge 2009b). Indeed, I have argued that the ‘below-ground’ material world and the ‘above-ground’ sphere of social relations are simultaneously co-produced through the collective politics of making the future (cf. Bridge and Wood 2010; Mitchell 2011). These categories are not given, but rather outcomes of an ongoing process of stabilizing reality (see also Latour 1993; Mitchell 2002; Latour 2004, 2005b). In this way, the thesis develops existing geographical accounts of resources as dynamic and relational by drawing on STS-informed accounts in critical geography and economic sociology. In particular, it complements the ‘above-ground’ research interests of peak oil geographies with an account of the practices of measurement and calculation that constitute ‘below-ground’ resource realities, and documents how these realities in turn facilitate the ‘cultural, economic and political work’ (Bridge 2011c) that goes into the constitution of extractive economies. Developing from this view, the materiality of fossil fuel resources, as well as the associated institutional and socio-technical systems through which they are rendered technologically malleable and distributed, can be seen as part

and parcel of the making of economic and political regimes; a process that is locally and temporally specific (Mitchell 2002; Braun 2008; Mitchell 2008; Braun and Whatmore 2010). Hence, what is taken to be technologically possible, politically acceptable and 'economic' to produce, and therefore exists as a resource, results from the interplay of various techniques and practices with non-human agencies. The future status of oil shale as an energy resource therefore depends on the extent to which the industry manages to reconfigure existing social conventions and techno-economic arrangements around the specific qualities of the resource and its geographical distribution by relying upon dilemmas surrounding national energy security, economic stability and international climate policy.

The research carried out for this thesis therefore brings together geographers' interests in the histories and politics of resource development in particular locations with theoretical insights from those strands of research in STS that make the concern with materiality or non-human agency central to their argument and invite us to study the making of material realities ethnographically through a series of knowledge practices. As noted earlier, however, the STS approach to materiality has largely been dominated by general theoretical debates, and to date insufficiently informed by analyses of the history and politics of particular materials. Extending the methodological guidelines of Latour, Mol and Stengers to a particular case of 'thing-politics', my research project aimed to 'study up' the richness of empirical data, whereby conventional theoretical constructs, as well as normative statements related to my own citizenship in Estonia, were 'put at risk' in a productive way. By learning meticulously from various sources, the thesis has let empirical data inform conceptual thinking, whilst simultaneously borrowing from and advancing existing theorizations of anticipation, materiality and economic processes. As a result, in this way of reading, the story of oil shale follows 'the engagement of a certain type of world in a certain

type of collective' (Latour 1997) in which objectivity has been achieved through extended subjective encounters with the various 'spokespersons' of the resource (cf. Stengers 2010).

The empirical chapters began with taking up Mitchell's (2010, 2011) recent observation that the integration of hardly accessible, immobile mineral deposits such as oil shale into the economy of oil necessitates a 'new politics of nature'. Although the possibility of developing such unconventional resources has widely served to refute claims about 'peak oil', in Mitchell's account, this no longer provides a source of certitude, but has rendered the future of the carbon economy uncertain and prone to contestation, challenging the dualistic understanding of nature and society. In this regard, the story of oil shale enables Mitchell's remarks to be complemented with three observations. First, the new politics of nature indicates a 'politics of the future', which is indeed uncertain and subject to collective exploration, but nonetheless not exclusively "new" or radically uncertain. Rather, the industry's future is formed in conjunction of past successes and failures, present controversies, and more virtual promises. Second, what counts as the below-ground 'nature' or, more specifically, a resource, is the product of abstractive knowledge practices and technical and economic interventions, the result of which are particular, multiple and potentially conflicting material realities that are enacted in parallel (cf. Mol 2003; Law 2004; Law and Urry 2004). Third, the viability of unconventional energy development cannot be judged against existing regulatory constraints or market arrangements. Rather, it is likely that such 'above-ground' realities are equally transformed through this new politics of nature, specifically concerning energy and emissions pricing, which however need to be negotiated against rival political and economic programmes. The empirical chapters of the thesis worked to support these arguments in different ways.

Chapter 4 recounted how the ‘resource of the future’ is assembled from a range of sedimentary rocks distributed widely in the Earth’s crust through specific techniques of abstraction, systematization and calculation in the geosciences. The extent to which oil shale can be counted towards world energy resources appears to depend on whether it can supplement traditional hydrocarbon supplies. However, the likelihood of oil shale development is linked to the evidence of global oil availability only rhetorically, since estimates of conventional and unconventional crude supply project future recoverability in different ways. Moreover, oil shale needs to be first translated into a source of liquid fuel in order to be commensurable with conventional resources. Complementing geographical understanding of natural resources as dynamic and relational (Bakker and Bridge 2006; Bridge 2009b, 2009c) with STS reflections on materiality (Law and Mol 1995; Mol 2003; Barry 2005b; Anderson and Wylie 2009), the chapter argued for a relational theorization of resource materiality, since oil shale acquires multiple, contending modes of material existence when brought into being through both local practices of measurement and the promissory rhetoric of global viability that is facilitated by the ‘peak oil’ narrative. It was further noted that the spatial and material heterogeneity of the resource cannot be fully stabilized with a single name, definition, and calculative framework, particularly as an ‘unconventional’ oil resource. Instead, the singularized resource assemblage acquires the potential to jeopardize actual exploitation when developers become interested in a particular deposit. Moreover, it challenges the standardization of technology, the exchange of knowledge, and the building of markets required for commercial-scale production. The extent to which oil shale becomes acknowledged as a resource therefore results from a series of localized achievements, which hinge on the techniques of resource appraisal, production and circulation, and related political conventions and economic arrangements. The eventful politics of negotiating the

future importance of oil shale in these locations and the forms of resource materiality that are enacted thereby may lead to the creation of an alternative carbon economy at the global level.

Chapter 5 took the relational account of resources and materiality further by documenting in detail the processes through which oil shale is conceived, framed and assessed as a resource in Estonia. Since oil shale deposits are hidden in spatially and geochemically variegated bedrock formations, the resource does not exist apart from the practices of abstraction, measurement and calculation in the geo-sciences and mining economics, which are tasked to make sense of these messy subsoil realities and render them into ‘reserves’ that can be allocated for future use. This analysis revealed that resource-making is a nationally specific, historically shifting, and technologically and materially conditioned process, whereby ‘below-ground’ realities and ‘above-ground’ social arrangements are created in tandem. First, discrepancies between local resource assessment methodologies and ‘centres of calculation’ (Latour 1987) or a departure from established ‘metrological zones’ (Barry 2006) may bring forth distinct framings of resources with contending modes of material existence. Second, resources exhibit further multiplicity and instability when translated into reserves that are deemed ‘economic’ to exploit. In a situation of resource decline following peak production, or what I termed ‘post-peak politics’, both the quantities of resources and the their materiality may undergo further revisions in conjunction with technical or politico-economic change, as evidenced by the possibility that Estonia may lower the standards for feedstock in the electricity sector or shift from solid to liquid fuel production. In this way, resource assessment has both a political and an anti-political function, because the framing of ‘reserves’ makes it possible to reduce radical uncertainty and controversy, yet simultaneously explore alternative modes of reality.

Chapter 6 proceeded to investigate further interventions that have been designed to prolong the ‘future of the resource’, following Estonia’s admission to the European Union. Focusing on Estonia’s anticipatory energy politics, I interrogated how the importance of oil shale to the national economy has been renegotiated in the light of EU demands for energy sector deregulation and decarbonisation. I argued that the industry’s future is not so much foreclosed by the imperatives to effect an ‘energy transition’, than underpinned by multiple transformations that hinge on the extent to which oil shale as an Estonian patrimony continues to be tied to dominant national views on the importance of ‘energy security’ and state sovereignty. In turn, these derive from the country’s complicated historical and geopolitical relations with its Eastern neighbour. Rather than being exclusively dictated from Brussels, energy sector reforms are only made possible through a reconfiguration of national expertise, leading to the emergence of a new generation of managerial elites that has enabled the paradigmatic discourse of self-sufficiency based on domestic fossil fuel production to be called into question, and gradually redefined. In these circumstances, oil shale has become a central political issue or ‘matter of concern’ that mediates inconsistent conceptualizations of security, through which the boundaries between market and non-market forms of energy governance are renegotiated and carefully adjusted to the local context. In this way, the politics of anticipation has rendered open novel possibilities of reconfiguring both state-market relations and the ‘ontological politics’ (Mol 1999) of the resource itself along with the socio-technological systems through which these categories are materialized. Moreover, the future of the resource is made in a situation where the onset of ‘marketization’ not only disintegrates former conventions and thereby politicizes the domain of expert decision-making, but conversely helps to de-politicize and securitize oil shale development once again, as uncertainty over future market trajectories appears to legitimize the strategy of the

industry that grabs at every political and business opportunity in order to continue exploitation and allegedly foster national security and economic growth.

Chapter 7 studied the process of ‘marketization’ more closely in the context of one of the most important conditions for oil shale’s future viability, the pricing of carbon emissions. I argued that the extent to which it is ‘economic’ for the post-socialist industry to continue production in Europe is not simply decided by the imperatives of capitalist economy or the ‘rules of the market’, but subject to the ongoing efforts by the EU to establish regionally concentrated and closely integrated markets for both energy and emissions trading. Drawing upon MacKenzie’s (2009b) analysis of ‘techno-politics’ in the design of the EU ETS, I investigated a particular compromise made between climate and energy policies in the post-2012 rules for the electricity sector: the nexus created between the risks of energy insecurity, competitive disadvantage, and ‘carbon leakage’. The resistance of EU border states to carbon pricing has enabled ‘carbon leakage’ to be re-defined as potentially shifting electricity generation to non-market suppliers, thereby reinforcing state-bound production strategies of high-carbon indigenous fossil fuels. As the single market for energy and emissions functions through the vision of a closely integrated, yet nationally aligned territory, the question of the boundaries between market and non-market practices extends to the ‘borders of the market’. More specifically, the five-year controversy between Tallinn and Brussels over setting a limit to Estonia’s eligible emissions has effectively led to the inclusion of state sovereignty and energy security concerns into the design of the carbon market. In turn, the derogations that Estonia will receive from 2013 onwards have been facilitated by both oil shale’s unique material qualities and associated socio-technical systems, notably the geographical distribution of Soviet-era electricity transmission networks as well as the specific process of shale oil retorting, which resist technological standardization and market integration. The extent to which the

materiality of oil shale has become bound up with questions of Estonia's political and economic stability was therefore observed to significantly delay, if not undermine the harmonization of carbon exchange altogether. Instead of an economic and energy "transition", the continued extraction of oil shale and other high-carbon resources in Central European and Baltic states has led to spatially differentiated trading rules, creating a 'frontier region' (Mitchell 2007) on the territorial borders of the European market.

Chapter 8 studied the problem of 'economization' in a different context, the development of a commercially viable shale oil extraction business and the 'translation' of extractive operations between the sites of past and future development. Existing global oil shale industries were conceptualized as 'techno-economic networks', which are rooted in heterogeneous resource materials, national regimes of resource regulation, and path-dependent arrangements of exploitation and economization. Focusing on the evolution of a particular surface retorting technology in Estonia and the state monopoly's recent attempts to capitalize on its expertise in Jordan and Utah, I argued that the extent to which the industry could be replicated in other parts of the world is neither simply a matter of 'technology transfer' nor determined solely by economies of scale. Rather, the success of the post-socialist industry to act as a "reference" to other developers depends on whether the Enefit company manages to rearrange its technological and business practices both abroad *and* at home. This requires the company to adjust not only to different social conventions, but also to the varying materialities of the resource itself, whilst participating in the creation of these 'above-ground' and 'below-ground' realities at the same time. In this process, or what I termed 'conventionalization', the industry's prospects of 'economic' production are not just guaranteed by successful technical innovation. Rather, economization and innovation take place in tandem, whereas their

success hinges on novel configurations of knowledge, people, and things, as much as it requires evidence of their existing alliances, for example, the building of power plants in Jordan or the material legacies of the American shale oil business. Both the industry's present realities and its possible futures, however, continue to be multiple and heavily contested, particularly in Estonia, which complicate the prospects of materializing the almost virtual industry elsewhere. Moreover, the possibility of rendering shale oil subject to marketization depends also on the extent to which the industry is able to join the global economies of conventional oil retorting and consumption. It is in relation to conventional liquid fuels that the materiality of oil shale is increasingly stabilized and, in doing so, may come to hinder its entrance to other socio-material assemblages.

The process of 'conventionalization' therefore opens up a question of the 'politics of the future' in unconventional energy development more broadly, and its relations with both the 'below-ground' resource realities and the 'above-ground' dynamics of markets. In this way, the findings of the thesis contribute to three areas of emerging geographical literature on the knowledge and politics of anticipation (Anderson 2010a), resource materiality (Bakker and Bridge 2006), and 'geographies of marketization' (Berndt and Boeckler 2012).

One conclusion of the thesis is that 'anticipation' is not necessarily underpinned by a single orientation towards the future that replaces earlier orientations (Adam and Groves 2007), but rather an interplay of various logics, mechanisms and materialities, which can be identified only through contextual empirical research. Although the development of unconventional resources is akin to other areas of prospective techno-science, which in their uncertainty continue to be both managed and contested (Brown et al. 2000), it is not a radically 'open future' that

becomes detached from present trends and material predicaments. Nor are the industry's prospects opened up solely by a 'latent future' (Adam and Groves 2007) that is coded in the inevitable decline of conventional hydrocarbon resources and the move towards 'post-oil' worlds which appears to be already unfolding and materializing in the present (cf. Farrell and Brandt 2006; Bridge and Le Billon 2013). Rather, the future of what I initially called 'unconventional worlds' is indeed open to a certain degree. However, this future needs to be continuously reproduced, negotiated and adjusted in relation to many other energy futures in the making. Moreover, the promise of the resource is actualized in the present through carefully selected evidence, thereby grounding projections of the future in existing material realities. What is figured as 'the unconventional' is therefore simultaneously assembled together and 'conventionalized' through a careful interplay of: (i) the historical legacies and path-dependencies of existing oil shale economies, as well as our carbon-intensive lifestyles more broadly, which seem to legitimate certain trajectories, but nonetheless always conceal alternative possibilities of reality; (ii) affectively charged promises of a technically possible, economically viable and politically acceptable future; (iii) the material evidence of the industry's ongoing technical and economic progress, which continues to be challenged and contested. Such 'unconventional futures' are therefore not 'possible worlds' that can be established in advance as a range of identifiable scenarios of what is likely to happen, and traced across a discreet set of political actors and sites (Callon 1998; Callon et al. 2009). Rather, they could be called 'impossible worlds' in the sense that such promises have repeatedly failed to be realized historically and have survived only in limited contexts and largely through different material enactments of the resource (i.e. electricity vs. oil). Nonetheless, such unconventional futures continue to inform the industry's viability, as they help to forge new political attachments and carbon economies even in the absence of actual

production. As documented in the contexts of Jordan and Utah, one can find no clear boundaries between what counts as legitimate evidence of past success (or failure) and what are simply virtual promises, but rather the distinction between the material and immaterial, and the real and unreal is subject to testing when 'translated' across otherwise disparate geographies of oil shale development, with distinct and unpredictable outcomes.

In this sense, the material form of unconventional resources cannot be established *a priori*, but is itself the product of both historical legacies and the politics of the future exercised through rival calculations. By drawing together the STS-informed accounts of relational materiality with recent geographical scholarship on resources and other materials, my analysis affirmed that natural resources do not exist independently of our knowledge practices and specific forms of scientific, economic and infrastructural work (Bowker 1994; Mitchell 2008; Bridge 2011c). Nor are they merely the product of 'above-ground' social conventions and economic interactions. Rather, the materiality of resources is conceived, stabilized and objectified through specific practices of abstraction, measurement and calculation. Such practices are in turn related to both nationally specific and historically contingent forms of resource governance and technological development. Moreover, such practices may result in multiple, potentially conflicting forms of material reality – not just in history, but in the present too, as evidenced in oil shale's parallel material existence as solid mineral resources and potential stocks of liquid fuel. This develops from the apparently paradoxical argument first proposed by Bakker and Bridge (2006) that resources are both historically and geographically specific constructions, yet their 'biophysical' properties are nonetheless able to obstruct their production and circulation. Indeed, once oil shale has become stabilized as an 'unconventional' liquid fuel resource, its materiality acquires the capacity to resist certain modes of geoscientific abstraction,

technical standardization, and subsequent marketization. It is in this way that the materiality of the resource assumes the capacity to 'make a difference' in social life or, in other words, to become an agent.

This observation opens up the further question of how the materiality of commodities, as well as the associated technological systems within which they are produced and circulated, relate to the process of 'marketization', or the formation of what Callon has termed 'socio-technical agencements'. As argued throughout the thesis, the form taken by commercial-scale oil shale development is not solely decided by existing arrangements of pricing and exchange. Rather, the full economization of oil shale production hinges on the organization of future markets in concrete situations. As demonstrated by the struggles with establishing a territorially bounded EU internal market for energy and emissions trading, marketization depends not just on the power relations between a variety of human actors, who are equipped with different forms of economic (and non-economic) knowledge and devices of calculation; it also hinges on the extent to which such markets can be integrated with wider technological systems and networks, as well as adjusted to the materiality of commodities which are circulated through such networks. The process of 'marketization' is therefore always prone to challenges from both rival calculations and material realities, being subject to wider disputes over the borders of the market. I argued that there is a need to complement the work of MacKenzie and Callon in economic sociology with the recognition that markets are spatialized and territorialized in relation to other spatially distributed socio-technical systems. In other words, we need to develop an account of the spatially differentiated and uneven 'geographies of marketization' (Berndt and Boeckler 2012).

The case of oil shale raises further questions for the study of alternative carbon economies more broadly. First, there is a need for more empirical research concerning how carbon futures are figured, tested, and negotiated through the politics of anticipation, securitization and 're-territorialization' of energy supply in particular countries that are in the process of considering the development of their indigenous fossil fuels, most notably shale gas. Again, one may be unable to find here a straightforward distinction between lower- and higher-carbon pathways or evidence of an 'energy transition', but rather a variety of contending futures or realities that are simultaneously in the making through the same socio-material assemblages and economies of energy production (cf. Bridge et al. 2012). The logics, mechanisms and dynamics of such future-making processes could be studied, for example, by focusing on the 'anticipatory knowledge techniques' (Anderson 2007) that are used in energy sector planning and market regulation, including scenario-building and other exercises; a topic that was not fully addressed in this thesis due to lack of space. Second, the case of oil shale also opens up the scope for more theoretical work that would seek to conceptualize how exactly the materiality of carbon resources becomes an agent in the anticipatory programmes of nation-building, market-making, and technological standardization across disparate sites of development, while avoiding resource determinism. Both the uneven geographies of marketization and the difficulties of technology exchange discussed earlier indeed result from the specific materiality of oil shale, but not exclusively and only when resource materiality has become stabilized in particular ways and entangled in other local socio-technical systems and political programmes. Third, since sociological studies have mostly concentrated on markets that are either existing or soon to be established, unconventional energy development also demonstrates the need for more research on those economic systems that still in the making, not only in terms of alternative

platforms of pricing and circulation, but also in terms of the ‘techno-economic networks’ that enable the creation of new markets in the first place. This brings attention to processes in ‘the supply world’ through which carbon resources are standardized and commodified, rendered fully ‘economic’, and subsequently secure themselves a market niche or create new ones, before they can be subjected to further ‘qualification’ (Callon et al. 2005) as tradable goods. As discussed particularly in Chapters 5 and 8, *what* is to be conventionalized is created at the same time as it is ‘economized’ through specific intellectual, economic and political attachments as well as infrastructural work in setting up new techno-economic networks.

Finally, the case of oil shale also highlights a need for more conceptual work on what one might call the affective engineering of future energy economies and markets. As discussed earlier, the tenacious promise of ‘the resource of the future’ relies on the idea of an uncertain and largely virtual future, yet it remains grounded in present material evidence and in fact surprisingly conventional arrangements, although these arrangements are locally contingent and challenged by other possibilities of reality. Future research should therefore keep in mind that the ‘unconventional’ worlds that are being rendered more globally applicable are neither fully distinct nor uniform, but indeed are created and transformed at the same time as they are ‘conventionalized’.

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