



The growth, regulation and environmental impact of green electricity tariffs

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Abstract:

In many retail electricity markets consumers are able to choose to purchase a green tariff, where the kWh consumed are matched by their retailer with electricity generated from renewable sources. These tariffs are sold to consumers as a way to reduce their own carbon footprints and as a way to help fight climate change. This thesis asks "what is the role of green electricity tariffs in reducing carbon emissions?" The question is answered by exploring the growth, regulation and environmental impact of markets for voluntary green electricity tariffs through four related areas:

- Chapter four undertakes an international comparison of markets for green electricity tariffs. Variation in enrolment levels is measured, which is then explained in reference to macro level variables including the regulatory environment, market competition and the types of supplier operating.
- Chapter five looks at one mechanism to increase consumer engagement with retail electricity markets, digital third-party intermediaries, and explores potential tradeoffs with the ability for consumers to discover and switch to green electricity tariffs.

- Chapter six uses a consumer survey to explore attitudes towards the environmental benefit of green electricity products. A census of the ‘additionality’ contributions made by retailers is undertaken to analyse whether the products available on the market meet consumers’ expectations.
- Chapter seven outlines the causal mechanisms whereby consumer demand for green tariffs translates into lowered carbon emissions, using a mixed methods approach.

The research highlights the importance of understanding the retail market context of green electricity tariffs, as enrolment is found to be affected by levels of competition in the market. It is also possible that increased use of intermediaries may present a challenge for the future green tariff market growth. An assessment of the environmental benefit finds that the green tariffs available in the UK have a negligible impact on lowering carbon emissions, with consumer research also suggesting that the tariffs currently on the market are not meeting customers’ expectations.

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Abbreviations:

BEIS	Department for Business Energy and Industrial Strategy
CFD	Contract for Difference
DECC	Department for Climate Change
EU	European Union
FIT	Feed in tariff
GB	Great Britain
GoO	Guarantee of origin
LEC	Levy Exemption Certificates
LCF	Levy Control Framework
NFPA	Non-Fossil Fuel Purchasing Agency
OFGEM	Office for Gas and Electricity Markets
PPA	Power Purchase Agreement
REGO	Renewable Energy Guarantee of Origin
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
UK	United Kingdom

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1. Introduction

In many jurisdictions consumers are able to choose to purchase a green electricity tariff, where the electricity their household uses is matched with generation from renewable sources. Consumers are sold these tariffs on the basis that they can help to lower their personal carbon footprints, support renewable energy and tackle climate change. Three tweets by some of the UK's most established green energy brands are included in figure 1-1, showing the claims that consumers are told when choosing to switch to a green electricity tariff. This research will determine the role of green electricity tariffs in reducing carbon emissions. The question is explored from two angles. The first angle concerns the factors which cause markets for green electricity to grow and to understand the ways in which green electricity tariffs can be discovered and switched to when purchasing decisions in electricity retail markets are becoming increasingly automated. The second angle concerns the environmental benefit of the tariffs themselves, from the perspective of consumer expectations and the environmental impact of the products currently on the UK market.

Figure 1-1 Tweets by three UK Green Electricity Suppliers



Good Energy @GoodEnergy · Aug 14

Great list! But forgets one of the easiest things to do — switch to clean energy.

The Conversation @ConversationUK

7 things we can all do to stop Hothouse Earth becoming a reality
bit.ly/2vVQPXs

Source: <https://twitter.com/GoodEnergy/status/1029295620874543104>



ecotricity @ecotricity · Aug 1

We have 24 operating windparks in the UK and the money from your bills helped us to build them. Over the next few months we'll share a series of our favourite windmill photos. [#WindmillWednesday](#)

...

Source: <https://twitter.com/ecotricity/status/1024673822157549569>



Bulb @bulbenergy · Jun 5

Happy [#WorldEnvironmentDay](#) to our members - by choosing a renewable energy supplier, you're saving 1.3 tonnes of CO2 from entering the atmosphere every year. That's like planting 655 trees 🌳🌳 Refer a friend today. Find your link: j.mp/2HkmkxO

Source: <https://twitter.com/bulbenergy/status/1003947891583586304>

Under the 2008 Climate Change Act the government of the United Kingdom is committed to reducing greenhouse gas emissions by at least 80% of 1990 levels by 2050 (Department for Energy and Climate Change, 2008). As per the European wide Renewable Energy Directive, member states must also meet 20% of their total energy needs from renewables by 2020 (EC, 2009b). If heat and transport are to be electrified it is also likely that the demand for renewable energy will only increase, with peak electricity load increasing by 93% and annual electricity consumption increasing by 35% (Baruah et al., 2014). Taken together, it is clear that there is a pressing need to decarbonise both the UK and the world's electricity system. What is less clear is who should be responsible

for paying for this renewable generation and what policy mechanisms should be put in place to facilitate the transition. Traditionally the construction of new renewables has been supported by price based mechanisms such as financial subsidies to generators, of which feed in tariffs would be a good example (Mendonca, Jacobs and Sovacool, 2009), or through quantity based mechanisms, such as the UK's Renewables Obligation (Woodman and Mitchell, 2011) or Renewable Portfolio Standards in the USA (Yi and Feiock, 2012). These policies, in combination with a rapid decrease in the cost of renewable technologies, have been successful increasing the supply of renewables in many developed countries. A particularly good example would be Germany, where the feed in tariff financing mechanism was pioneered (Mendonca, Jacobs and Sovacool, 2009). However, in most countries the subsidies are not paid through general taxation and are instead passed on to all billpayers, who are charged a levy on their bills in proportion to the amount of energy they use. As financial support for renewables increases, households in many countries are starting to express concern about the proportion of their electricity bills which go to fund renewables, and as a result many governments are cutting back these schemes. This is the experience of the UK, where the escalation of costs under the Levy Control Framework was blamed for the significant reduction in feed in tariffs in recent years (Lockwood, 2016). Under these centralised funding mechanisms the burden for supporting renewables is placed onto all consumers, regardless of the value they personally assign to receiving green electricity or reducing carbon emissions. Green electricity tariffs offer a decentralized mechanism to

support renewable energy, which takes advantage of the premium which consumers are willing to pay in order to increase the supply of renewable energy. If they are able to promote the development of new renewables, they could be a complement or even alternative to the conventional support mechanisms described above.

This research asks "what is the role of green electricity tariffs in reducing carbon emissions?" The question is answered through four sub-questions, which map onto the four research chapters. Chapter four asks how have markets for green electricity tariff grown and what has caused that growth? The largest ever study of markets for green electricity tariffs is undertaken, encompassing all jurisdictions where products are sold. The growth of the markets is measured and contrasted with the last international comparison from 2002 (Bird, Wüstenhagen and Aabakken, 2002). Data on macro level variables which explain the differing levels of enrolment are also collected in order to determine what regulatory environments and market structures are most conducive to growing markets for green tariffs. Chapter five builds on these findings, particularly in respect to competition and consumer engagement, and asks how consumers can purchase green electricity tariffs in a retail market which is increasingly automated?. The way in which consumers are interacting with energy markets is changing, with a growing number of consumers engaging with the market through intermediaries such as price comparison, group switching and automatic switching services. While these services have the potential to increase

consumer engagement, they may have the potential to focus too much on price savings and fail to incorporate green preferences. This tradeoff is analyzed using a content analysis of suppliers' platforms as well as elite interviews with representatives from the retailers.

Chapters six and seven are concerned with the question of environmental benefit, both from the perspective of the expectations which consumers have and of the environmental impact of the tariffs currently on the market. Chapter six explores what environmental benefit do consumers expect their tariffs to have and do products on the market meet their expectations? The chapter focuses on the specific issue of 'additionality contributions', which suppliers offering green tariffs in the GB electricity market are required to make. The research uses an innovative mobile-based polling platform to obtain a statistically significant and nationally representative sample of consumers. A census of the 'additionality contributions' made by suppliers was also undertaken to see if the measures to benefit the environment which the survey found that consumers expect are being delivered by the current tariffs on offer. Chapter seven determines what impact green electricity tariffs offered in the GB market have on reducing carbon emissions? The question is answered by outlining the causal mechanisms whereby demand for green electricity tariffs translates into lower carbon emissions, which have only been addressed in a piecemeal fashion in current research. The causal mechanisms are evaluated using a mixed methods approach which combines financial modelling, a survey

of renewable generators and a review of the currently available evidence. Taken together the four research chapters present a rounded analysis of the market for green electricity tariffs, providing an explanation of both the challenges associated with growing green tariff markets and a unique analysis of whether that market growth has any environmental impact. The four research chapters are followed by a discussion of whether a truly additional green tariff is possible and conclusions regarding the current state and future of the market for green electricity tariffs.

This is an important question to ask for several reasons. First is that markets for green electricity tariffs have been growing significantly with increased number of tariffs on the market and a growing number of subscribers. As the market becomes more mainstream it is important that the trend, and its environmental impact, is understood. Second, is because effective regulation of green electricity tariffs requires rigorous evidence in order to be effective, which has so far been lacking. For example, OFGEM's analysis of whether green electricity tariffs should be exempted from the upcoming default tariff cap does not cite any academic evidence on the subject (OFGEM, 2018c). Third, the imminent threat of climate change and the failure by governments to implement sufficient policy measures necessitates that all possible methods of mitigation are explored, as voluntary consumer action may provide an alternative. Fourth, retail electricity markets and the energy system more generally are undergoing a transformative change due to increasing amounts of decentralized and variable

generation. A greater understanding of how consumers interact with retail energy markets, and how green preferences are taken into account, is important for many new types of product such as demand side response enabled by smart meters or peer to peer energy traded using blockchain technology.

The research also expands the scope of the current literature on green electricity tariffs, explicitly addressing the concerns raised in previous studies that the environmental benefit of green tariffs sold to consumers may be lacking environmental benefit. This is an important shift in the literature, where the focus of research should not only look at how to increase enrolment or what consumers are willing to pay for a green electricity tariff. The research also expands upon the theoretical frameworks which exist in the literature, with chapter six building upon the model of consumer motivations for purchasing green tariffs outlined by Herbes and Ramme (2014). The extant literature is mainly composed of willingness to pay studies, perhaps because green electricity markets are a particularly good case study to view environmental preferences as the functional quality of the product remains constant regardless of the source. This research does not actively engage with this literature, aside from the insights it brings regarding demographic variations and consumer attitudes, and instead asks more conceptual questions around what value consumers expect green tariffs to have and the tariffs' actual carbon reduction potential.

While chapter four presents an international comparison of green electricity tariffs which includes all markets where the products are sold, chapters five, six and seven concentrate on the Great Britain (GB) retail market. There are several factors which explain why the GB market was chosen above others. The GB electricity market is a good example of a competitive retail market which has tended to be at the forefront of product development and regulation, and in fact was one of the main promoters of retail markets in the European Union, which has spread the GB model to other member states (Helm, 2004). GB was also a convenient market to analyse methodologically as all suppliers are required to supply the whole of the market, so one single search on a 'whole of market' comparison website can provide a near complete view of all the products available in the market. This would not have been the case in markets such as Germany where there are hundreds of suppliers and markets are differentiated by region (Herbes and Ramme, 2014). The final factor is convenience, as the researcher was located in the market and as such there were no geographic or language barriers which would have complicated the research.

2. Literature review

Any exploration of the growth or environmental impact of green electricity tariffs requires multidisciplinary analysis. Economists have measured the willingness to pay for green tariffs (Ma et al., 2015; Sundt and Rehdanz, 2015), behavioural economists have looked at the roles of nudges and 'green defaults' (Pichert and Katsikopoulos, 2008; Momsen and Stoerk, 2014), business scholars have analysed marketing strategies (Rundle-Thiele, Paladino and Apostol, 2008; Herbes and Ramme, 2014; Vecchiato and Tempesta, 2015) and political scientists have explored the most effective policies to encourage market growth (van Rooijen and van Wees, 2006; Wüstenhagen and Bilharz, 2006a). As such the literature presented in this review cuts across multiple disciplines in order to present a holistic picture of the current state of the discourse. This literature review is designed to complement the individual reviews present in each research chapter and will include areas which were not possible to cover in the published papers due to article length limits and more general topics which cut across all four chapters. As there is no single theoretical framework which is elaborated, the research questions arise from the gaps within the literature which are outlined at the summary in section 2.8.

The first two sections of the review provide context to the literature and research question, clarifying what exactly a green tariff is and the market context in which they exist. Section 2.1 defines and differentiates between different types of

green electricity tariff as identified in the current literature. In section 2.2 the review then examines the wider market context in which green electricity products exist, particularly focusing on the transition many markets have undergone over the past decades from state monopolies to competitive markets. This provides particularly helpful context for chapter four, which looks at the development of markets for green electricity across the world. Consumer motivations for purchasing green electricity tariffs will then be explored, looking at both the theoretical frameworks which have been used in the literature alongside specific analyses of the socio-demographic and attitudinal variables which have found to be significant indicators of enrolment. The role of eco-labels and self-regulation will then be considered, followed by other forms of state regulation and policies to encourage the growth of the market. Next, the topic of ‘additionality’, the extent to which green tariffs can benefit the environment, will be considered. Finally, green tariffs will be placed into the context of ‘political consumption’, the way in which consumers can express their political or ethical stances through selective consumption. In section 7.8 gaps in the literature are identified which form the basis of the four research chapters.

2.1 Defining green tariffs

The UK has a liberalised energy market, meaning that households are free to buy their energy from any one of over 60 retailers. Many consumers choose to purchase a green electricity tariff, these tariffs can be broadly defined as “any mechanism by which consumers can purchase green electricity from an

electricity retailer as part of their electricity tariff and in proportion to their electricity usage”, a definition which is outlined and expanded upon in chapter four. Under UK regulation the tariffs are also defined as those where the electricity sold to the consumer is matched with REGO certificates (OFGEM, 2014). These certificates, originally designed to facilitate fuel mix disclosure, are generated alongside the electricity itself as proof of origin.

Some previous literature has made a distinction between ‘contribution’ style tariffs, where the energy supplied is not matched with renewable generation but the supplier makes a contribution to an environmental cause in proportion to the usage of the customer, and ‘consumption’ tariffs, where the energy is matched with renewable generation through a tracking mechanism such as guarantee of origin certificates (Lipp, 2000; Boardman, Jardine and Lipp, 2006). While this may be an accurate reflection of some available tariffs in markets where the products are unregulated, in most countries where tariffs are defined by the regulator, they are always required to be ‘consumption’ based tariffs. In some regimes, as in the UK’s green source product regulations (OFGEM, 2014), there are also requirements to have an element of ‘contribution’ in order to ensure the products are benefiting the environment.

The market for voluntary green electricity in the UK has had three distinct phases to date. The first followed the initial liberalisation of the UK’s retail electricity market in 1999. Both small and large energy companies started offering green

electricity products for sale to both consumers and businesses. The “Future Energy” scheme was set up by the Energy Saving Trust and backed up by government (Lipp, 2000). The scheme aimed to accredit green electricity tariffs but was also subject to criticism that the standards were not rigorous enough. Friends of the Earth also set up their own more rigorous league tables, but by 2004 both schemes had shut due to lack of funding and interest, due primarily to the growth of the Renewables Obligation which meant that all consumers were supporting the development of new renewables. From 2001 green electricity could also be used by businesses to offset the Climate Change Levy, through the use of Levy Exemption Certificates. This made it more financially attractive to sell green electricity to businesses and has been blamed for restricting the growth of the residential market. In 2010 the Green Electricity Supply Certification Scheme was launched, based on the 2009 OFGEM Green Supply Guidelines (OFGEM, 2009) which were incorporated into an agreed Rulebook. In 2002 the market comprised of around 0.2% of households (Bird, Wüstenhagen and Aabakken, 2002) and by 2011 had increased slightly to 0.35% (Hast et al., 2015).

The second phase of the market followed OFGEM’s Retail Market Reforms in 2014 (OFGEM, 2013b). These restricted retailers to offering only four types of tariffs at any one time. This squeezed out the green electricity offerings from larger retailers and left the market dominated by small niche suppliers (Littlechild, 2018). This was then followed by OFGEM’s direct regulation of green

electricity products (OFGEM, 2014), which effectively made the Green Electricity Supply Certification Scheme redundant and prompted its closure. This period saw significant growth and by 2015 2% of consumers were purchasing green electricity, as chapter four finds. This was largely due to increased competition in the market as a whole and the particular success of retailers such as Ecotricity and Good Energy. The third phase has been a growth in new green electricity companies, many of whom charge rates closer to conventional electricity. These companies are able to offer prices similar to conventional suppliers as they purchase REGOs directly without also procuring green electricity through longer term PPAs. Following the announcement that OFGEM were considering that green electricity tariffs would be exempt from the default energy price cap, many more smaller suppliers have also recently started offering green electricity tariffs in a possible attempt to 'game' the regulations (OFGEM, 2018b).

2. Green tariffs in a market context

One prerequisite for a Green electricity tariff is that the end consumer has some control over the purchasing of their electricity. The most obvious way in which this is the case is in a privatized competitive market, where consumers can choose freely between different electricity tariffs. In cases where markets transition from monopolistic to competitive markets, the growth in market competition also corresponds to an increase in the number of green tariffs on the market, albeit with significant variation between countries (Bird, Wüstenhagen and Aabakken, 2002; Markard and Truffer, 2006). A more

substantial discussion of the relationship between market competition and the growth of markets for green electricity tariffs in an international context can be found in chapter four.

One particular aspect of retail markets which features commonly in the green tariff literature regards low consumer engagement and low switching rates. Among the 20 EU countries which have liberalized their electricity markets in the last 10 years, switching rates are less than 5%, based on data from 2013 to 2015, with more established competitive markets such as the UK, Germany and Sweden only seeing rates of around 10% per year (Schleich, Faure and Gassmann, 2018). In markets such as the UK this means that many consumers overpay for their electricity by staying with their current supplier on a 'Standard Variable Tariff' (CMA, 2016b). In other markets such as Spain, Romania, Poland and France, the apathy results in many consumers staying on regulated pricing and declining to participate in the competitive part of the market entirely (CEER, 2016). Yang et al. (Yang, Solgaard and Haider, 2015) point to households' unwillingness to switch supplier as one barrier to further uptake of green electricity tariffs, recommending marketing campaigns to increase engagement. Larsen (2013) describes the difficulty for marketers' to engage consumers with green electricity products, which are usually seen as homogenous and "low-involvement" products. However, some research suggests that consistent and repeated communication efforts can help to overcome the inertia and lack of interest most consumers have in their electricity supply (Litvine and

Wüstenhagen, 2009). Based on a study of consumers in Australia, Paladino and Baggiere (Paladino and Baggiere, 2008) argue that green electricity should be seen as a high involvement product, meaning that marketers should not shy away from using potentially more complex and detailed arguments to persuade potential customers.

It is also important to place green electricity tariffs in the context of the other policies which have been implemented to encourage the installation of renewables. At a global level there are multinational agreements such as the Paris Agreement which commits signatories to pursuing efforts to limit global temperature increases to 1.5°C compared to pre-industrial levels (UNFCCC. Conference of the Parties (COP), 2015). In all analyses of the pathways towards this target, renewable energy always plays a vital role (Cooper, 2016). Targets also exist at the multinational level, with the EU requiring its members to have a 20% share of their electricity generated by renewables by 2020 (EC, 2009b). At a national level the UK has legally binding carbon emission reduction targets, which by the end of the 5th Carbon Budget in 2032 aims to have reduced emissions by 57%, compared to 1990 levels (Department for Energy and Climate Change, 2008; Committee on Climate Change, 2018). Increasing the proportion of electricity generated from renewables forms a key part of the UK's decarbonization strategy, with a short-term target of meeting 30% of electricity consumption with renewables by 2020 (Energy and Climate Change Committee, 2016). Devolved governments also have ambitious targets, with the Scottish

Government aiming for renewables to generate 100% of their annual electricity usage by 2030 (Scottish Government, 2017). The Welsh Government has a comparably ambitious target of 70% by 2030 (The Welsh Assembly Government and Welsh Assembly Government, 2010).

In order to meet the above targets, a succession of policies have been implemented to increase the installed capacity of renewables in the UK, which now stands at over 30,000MW (BEIS, 2016). The first significant policy was the Renewables Obligation (RO), which was a quantity-based obligation on suppliers to procure a certain proportion of their electricity from renewables. As the obligation was placed on large electricity suppliers, the costs of implementing the policy were passed on to billpayers. The scheme was administered using 'Renewables Obligation Certificates' (ROCs), with the obligation increasing each year. In the 2017/2018 year the scheme supported 75TWH of generation (BEIS, 2018c), which was equivalent to three quarters of that period's total renewable generation (BEIS, 2018b). The scheme ran from 2002 and closed to new applicants in 2016. In 2010 the government announced a price-based Feed in Tariff (FiT) to provide support for small generators, (Energy Act, 2008) . The switch to a FiT was successful at encouraging independent generation such as domestic rooftop PV. In an attempt to ensure the level of costs which would be passed onto consumers, the Levy Control Framework (LCF) was introduced in 2011 (Lockwood, 2016). In part as a response to rising costs and an anticipated breach of the LCF, subsidies made available under the

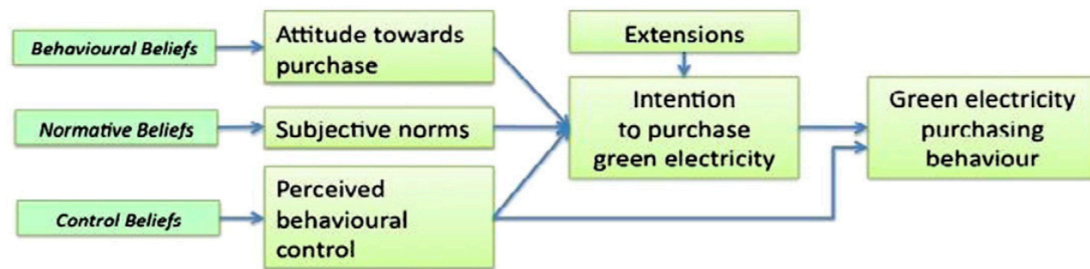
FiT were significantly reduced in 2015. The scheme is scheduled to be closed entirely by 2019. The main mechanism for the deployment of renewables currently and for the foreseeable future is the Contract for Difference (CfD) (Energy Act, 2013), which is a variable support mechanism awarded through competitive auctions. The mechanism is aimed to be a replacement for the Renewables Obligation, so therefore has tended to favour large generators.

2.3 Consumer motivations and willingness to pay for green tariffs

Much of the existing literature explores why consumers choose to purchase green electricity tariffs and at what price, mainly through willingness to pay studies. While most studies lack a theoretical model, which provide an understanding of the different factors which determine consumer motivations beyond a core idea of economic rationality, there have been a few notable exceptions. Litvine and Wustenhagen (2011) use the Theory of Planned Behavior (TPB) from Social Psychology to explain purchasing decisions relating to green electricity. The theory explains behavior through three concepts; attitudes toward the behavior, subjective norms and perceived behavioural control, as shown in figure 2-1. The authors then also add in three concepts from the green electricity literature which have been shown to be determinants of tariff uptake; personal environmental norms, perceived self-efficacy of the action (which is the belief in the effectiveness of the action to achieve its desired goal), and expected guilt or the feeling of regret for not having acted environmentally. Using this theory, the research finds that with the provision of information targeted at these

factors, primarily attitudes towards the purchase, social norms and perceived behavioral control, increases in enrolment can be possible.

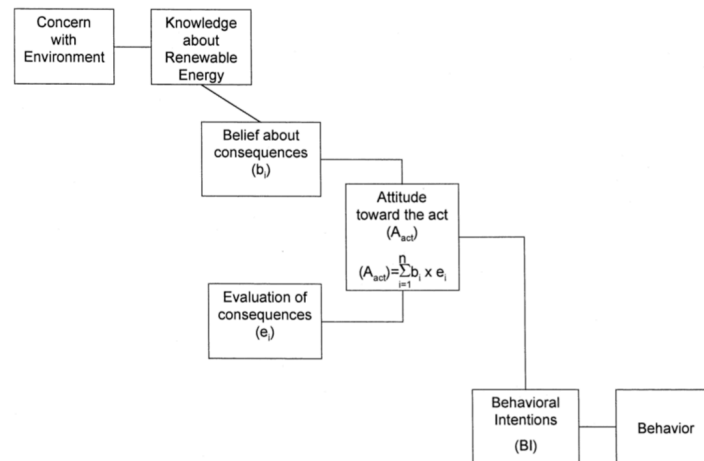
Figure 2-1 Theory of Planned Behaviour as applied to green tariffs



Source: Livtvine & Wustenhagen (2011)

Bang et al. (2000) use the Theory of Reasoned Action (TRA) to understand the relationship between four key variables; concern with the environment, knowledge about renewable energy, belief in salient consequences and consumer attitudes towards paying more for renewable energy. The relationship between these variables is outlined in figure 2-2. The research finds a positive relationship between beliefs regarding salient consequences and the willingness to pay more for renewable energy. This suggests that consumers are driven more by emotion and affect than by cognitive processes. They therefore conclude that marketers should make emotive arguments to consumers in order to promote their products successfully.

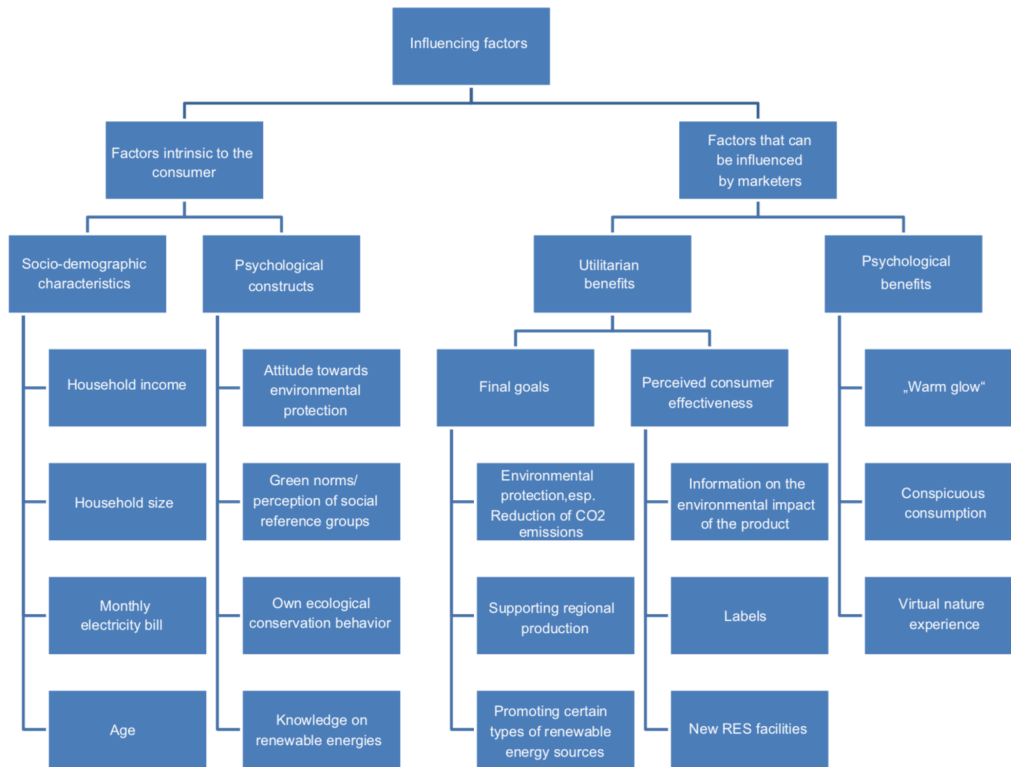
Figure 2-2 Theory of Reasoned Action as applied to green tariffs



Source: Bang et al. (2000)

Herbes & Ramme (2014) develop a framework, shown in figure 2-3, based on the work of Hartmann & Apaolaza-Ibanez (2012), which is specifically designed to help understand why consumers purchase green electricity and the ways in which marketers and retailers can tailor their products to maximise enrolment levels. The theory divides the factors which influence enrolment into two categories; factors intrinsic to the consumer and factors that can be influenced by marketers. The first refers to the attributes of the consumer including socio-demographic and psychological characteristics. The later refers to attributes of the tariff including utilitarian environmental benefits and psychological benefits to the individual. As this theory was designed specifically to be relevant to green electricity tariffs, unlike the TRA and TPB outlined above, this framework by Herbes & Ramme (2014) is drawn upon extensively and discussed in much greater detail in chapter six when exploring the expectations consumers have of the environmental benefit of green electricity tariffs.

Figure 2-3 Framework of consumer motivations for purchasing green tariffs



Source: (Herbes and Ramme, 2014)

2.3.1 Demographic variation

Many studies comment on the role of demographic factors on explaining willingness to pay for a green electricity tariff. Many studies find that willingness to pay correlates with higher levels of education (Conte and Jacobsen, 2014), income (Ek and Söderholm, 2005; Oliver, Volschenk and Smit, 2011; MacPherson and Lange, 2013; Krishnamurthy and Kriström, 2014), environmental knowledge (Paladino and Baggiere, 2008). Some evidence also suggests that younger consumers have higher willingness to pay for green electricity products (Zorić and Hrovatin, 2012). What debate exists regarding demographics focuses on two areas. The first concerns the reliability of the research contingent valuation methods used in willingness to pay studies, with

meta-analyses finding that the achieved result depends on the valuation method (Sundt and Rehdanz, 2015) and that the demographic variables influencing the result - such as income, energy use or technology type - are less important than the choice of methodology used (Ma et al., 2015). There also is always a difference between the stated willingness to pay found in the literature, partially due to respondents strategic behavior, however new methodologies such as neuropricing are helping to provide a more accurate measure of consumer willingness to pay (Herbes et al., 2015). The majority of the published literature also only examines developed economies (Oerlemans, Chan and Volschenk, 2016), with some evidence suggesting that consumers in emerging economies may have different perspectives (Zhang and Wu, 2012). The second aspect of the debate regards the importance of these demographic factors compared to other attitudinal factors which, as will be explored below, have been found to be more influential.

2.3.2 Attitudes and social norms

The Theory of Reasoned Action and Theory of Planned Behaviour discussed above both highlight the importance of attitudes and social norms in determining the likelihood of enrolment. Tabi et al. (2014) find that the types of socio-demographic factors outlined above only play a marginal role in explaining the likelihood of subscribing to a green tariff, with psychological and behavioural factors such as the perceived effectiveness of consumer action and belief in science being more influential. Consumers are also more likely to purchase a

green electricity tariff if they feel a sense of personal responsibility for the health of the environment (Ek and Söderholm, 2005). Positive attitudes towards the environment and climate change are also widely seen to be key determinants of enrolment, measured through membership of groups such as the green party (MacPherson and Lange, 2013), environmental knowledge and concern (Paladino and Baggiere, 2008). Altruism and liberalism are also found to often strongly correlate with higher willingness to pay for green electricity tariffs (Rowlands, Scott and Parker, 2003). The act of purchasing a green electricity tariff can also reinforce personal norms or attitudes towards the environment, such as through identity signaling (Hanimann, Vinterbäck and Mark-Herbert, 2015).

2.3.3 Price elasticity of demand

There is disagreement in the literature about the significance of the price premium for green electricity. Conte and Jacobsen (Conte and Jacobsen, 2014) find that higher enrolment is associated with more affordable tariffs, whereas Dagher et al. (2017) find that demand for green electricity is inelastic, meaning that consumers are relatively insensitive to price changes. Yang et al. (2015) also suggest that price premiums are not important for many households, evidenced by the fact that both 'green' and 'value seeking' consumers in Denmark are willing to pay extra to receive green electricity despite the country's high electricity prices.

2.3.4 Tariff attributes

There has also been research which attempts to understand the attributes which consumers find appealing in a tariff. Many studies find a variation between types of technology, with solar and wind consistently commanding higher willingness to pay than biomass and large hydro (Rowlands, Parker and Scott, 2002; Hansla et al., 2008; Vecchiato and Tempesta, 2015; Sauthoff, Danne and Mußhoff, 2017), with this showing up as a statistically significant result in a meta-analysis of willingness to pay studies across the world (Ma et al., 2015). Willingness to pay also varies depending on the type of generation that will be displaced by the renewables, with higher premiums to displace more carbon intensive generation (Sundt and Rehdanz, 2015). Evidence also suggests that consumers have an increased willingness to pay for energy which is generated closer to themselves geographically, on a national (Tabi, Hille and Wüstenhagen, 2014), regional (Kalkbrenner, Yonezawa and Roosen, 2017) and local (Ma and Burton, 2016) scale. There is also some differentiation by the organizational structure of the retailer, with willingness to pay approximately double when offered by co-operatives or municipally owned electricity utilities (Rommel, Sagebiel and Müller, 2016).

2.4 Eco-labels and self-regulation

It is common for environmental or ethical goods to have eco-labels attached (Boström, Klintman and Micheletti, 2008). These labels are common in markets for green electricity (Willstedt and Bürge, 2006; Burger, 2007; PWC, 2009) and

serve a number of purposes. They can be effective as a means of enabling 'identify signaling' Hanimann et al. (2015), whereby consumers can purchase goods which reinforce their own sense of identity as environmentally conscious individuals. Eco-labels can also act as a form of voluntary self-regulation, often working alongside certification schemes with requirements which are stricter than those required by government regulation (Berry et al., 2012). This was the form that the label on the UK's Green Electricity Certification Scheme took, which incorporated OFGEM's green supply guidelines (OFGEM, 2009). There have also been a growth in labels which certify electricity based on its geographical origin, as in the Netherlands, where a backlash against tariffs which are matched with imported Norwegian hydropower has prompted a demand for products backed by energy generated within the Netherlands (Mulder and Zomer, 2016a). Labels have also been found to be effective at promoting regional tariffs (Kalkbrenner, Yonezawa and Roosen, 2017). How labels are presented also is important, with some formats more appealing to consumers than others. Banerjee and Solomon (2003) find that the most successful programs are those which are backed up or run by the state. They also find that simpler 'seal of approval' style labels are more effective than detailed disclosure. Labels can also be an important tool transitioning green tariffs from a niche to a mainstream market, as found by Wüstenhagen, Markard and Truffer (2003).

2.5 Policy and regulation

A comprehensive review of the types of state and voluntary regulation which concern green electricity tariffs can be found in chapter four, but it may be useful to outline in a more general sense the different levels of regulation and state support which have been applied to markets. Types of policy are categorized into four types, which are shown in table 2-1. The form of policy with the least level of intervention is indirect regulation, where green tariffs are covered by regulations for consumer products in general, through general trading standards or consumer protection regulations (Ramsay, 2007), or electricity products of all types, such as through fuel mix disclosure (Lise et al., 2007). These types of regulation form a baseline and would generally aim to prohibit mis-selling and protect consumers. The next strongest form of policy are those which aim to directly regulate green tariffs, with provisions specifically aimed at the markets. Examples could include proof of origin requirements (OFGEM, 2014) or regulations to prevent 'double selling' (Boardman, Jardine and Lipp, 2006). Stronger still are policies which allow for green tariffs to derogate from the regulations which all other types of tariffs face. Examples could include exemption from caps such as the UK's default tariff price cap (OFGEM, 2018a) or four tariff regulations (Littlechild, 2014). The strongest possible form of policy are those which directly support green tariffs, such as through tax exemptions or public information campaigns. These types of policy can be implemented at a national level, such as in the Netherlands (van Rooijen and van Wees, 2006),

or on a local level, such as with community enrolment incentives (Kotchen, 2011).

Table 2-1: Policies related to green electricity tariffs

Type of policy	Level of intervention
Policies to directly support green tariffs • Tax exemption in the Netherlands • Recognition in carbon accounting frameworks	Strong ↑ Weak
Regulatory derogation • Exemption from the UK four tariff and default tariff caps	
Direct regulation • Proof of origin requirements • Regulation to prevent 'double selling'	
Indirect regulation • Fuel mix disclosure requirements • Trading standards	

There are also wider and more fundamental questions to be asked regarding the extent to which governments intervene in and regulate markets. Common justifications include; preventing monopolies, reducing windfall profits or ensuring social protection to name just a few (Baldwin, Cave and Lodge, 2012). Two rationales for regulation, which are often used as the justification for intervention in energy markets, are relevant in this case. The first are 'information inadequacies'. Under this principle markets should be regulated in order to inform consumers and to consider the limited time and resources consumers have to gather information in their purchasing decisions. This is certainly relevant for green electricity sales, where consumers have limited time and resources to understand the complex mechanisms which drive green electricity capacity and

to compare between the different types of green electricity products available on the market. Second is what Prosser would call a 'social' rationale for regulation (Prosser, 2010), that much regulation today does not merely seek to correct market failure, it seeks to further certain social objectives. In the case of green electricity markets, it could be argued that ensuring the market delivers environmental benefit is a suitable social objective which justifies intervention. There is also a large amount of precedent in UK consumer protection law which supports the idea that markets should be regulated in order to ensure the products and services that consumers purchase meet their expectations (Ramsay, 2012). This includes both mandatory regulation, in the form of trading standards, food safety and the accuracy of advertising, and voluntary regulation, in the form of certification schemes for products with environmental or ethical claims such as Fair Trade, MSC fish or FSC timber. It could also be argued that, seeing as governments provide the infrastructure to allow markets for green electricity to exist, and have previously supported their accreditation, there may be added justification for regulation to ensure these resources end up meeting the social goals which were intended.

For the most part the green electricity literature does not engage with these political science questions of when market intervention is justified. The literature tends to see regulation as a means to an end, with that end being increased enrolment rates. If a state backed label or direct regulation is introduced, as long as it increases adoption it is seen as a positive form of intervention. The one

context in which the justification for market intervention has been discussed is in the context of the debate between the ‘consumer sovereignty’ and ‘additionality’ (Menges, 2003). The substantive question of additionality will be explored in section 2.6, but the issue does raise the question of the extent to which the state should require green electricity products to meet consumer expectations, or whether a ‘caveat emptor’ approach that respects consumer sovereignty is most appropriate. Ultimately whether the market justifies regulation depends as much on the institutional world view of the regulator or policymaker (Hood, 1995; Lodge, Wegrich and McElroy, 2008) and the practical realities of governance and policy design (Mitchell, 2015) as it does on the actual experiences of consumers in the market .

2.6 Additionality

In the existing academic literature (Menges, 2003; Gillenwater, Lu and Fischlein, 2014) and regulation (OFGEM, 2014; OFGEM and Big Sofa, 2014) the benefit to the environment which green tariffs bring about is referred to as ‘additionality’. The term can be defined in a general sense as “the extent to which something happens as a result of an intervention that would not have occurred in the absence of the intervention” (English Partnerships, 2008). In the context of a green tariff, the something which happens is some form of environmental benefit such as lowered carbon emissions and the intervention can be characterized as either the action of a single consumer or the presence of the voluntary market as a whole, i.e. the impact of many aggregated consumer decisions. The

concept is sometimes also framed in reference to a baseline, with impacts above that given baseline counting as additional (Gillenwater 2012). The concept is key to understanding the variation between green electricity tariffs on the market, which deliver environmental benefit in different ways (Lipp, 2000). Measuring additionality is important for products with environmental, ethical or social benefits as consumers need to be assured that the environmental benefits they are paying for are legitimate and would not have been delivered otherwise. The debate has been most active in discussions regarding carbon offsets, where the environmental value of the offset rests on the fact that it is bringing about some reduction in carbon emissions that would not have otherwise occurred if the market didn't exist. A more specific discussion of the mechanisms which cause green electricity products to have 'additionality' is outlined in chapters six and seven, but it may be useful here to take a more general overview of the term and consider the debate which exists around it in related areas such as carbon offsetting.

In the current discourse additionality is referred to in two ways, as outlined with examples for each in table 2-2 below. The first refers to the additionality which occurs through the procurement of the green electricity itself. The second refers to additionality which is delivered by the supplier via some other means, usually through a contribution to an environmental cause but, as will be explored further in chapter six, there is substantial variation in the actions taken by suppliers. These two types of additionality broadly map to the two types of causal

mechanism outlined in chapter seven; with ‘green supply’ loosely matching with additionality in procurement and ‘supplier initiatives’ related to ‘additionality by contribution’.

Table 2-2: Two dimensions of additionality

Additionality in procurement
• Environmental benefit occurs through the procurement of the electricity itself, similar to what was formerly characterized as a ‘consumption’ based green electricity product. • Approach taken by discussions of additionality in markets including the USA (M. W. Gillenwater, 2013; CRS, 2016a) and EU (CEER, 2013). • Analyses looking at this form of additionality focus on the markets for the certificates and impact on generators.
Additionality by contribution
• Environmental benefit occurs through something else which suppliers do. • Similar to what was formerly known as ‘contribution’ based (Lipp, 2000) green electricity products, where tariffs were ‘greened’ by suppliers taking actions such as protecting and planting trees. • Approach taken in regulation by OFGEM, who are not prescriptive in order to allow suppliers to be innovative in the type of contribution they make. (OFGEM, 2014).

Analyzing the additionality of a green tariff is not merely just a practically difficult task, it is also problematic theoretically. Debates around the nature of causality and counterfactuals have existed at least since Hume’s work in the 18th century (Hume, 2012). His “problem of induction” explored the concept of causal efficacy and questioned traditional understandings of cause and effect. While these ideas have limited direct relevance today it is useful to bear in mind his skepticism. For example, in voluntary green electricity markets, even though one may be able to say that additionality may have been present for past projects there is no guarantee that future projects will exhibit the same characteristics given changing market conditions. One advantage of the concept is in the language of additionality evaluation (Hind, 2010), which focuses on the positive

outcomes of a given intervention and does imply causality between the two. This might be particularly useful for applying the term to a consumer context, as companies often stress the environmental benefit of individual purchasing decisions.

2.6.2 Additionality in carbon offset markets

The issue of additionality is most commonly discussed in reference to carbon offset markets. Carbon offsetting is where parties can pay to balance out their environmentally damaging actions by supporting environmentally beneficial actions elsewhere (Lovell, Bulkeley and Liverman, 2009). Additionality is therefore of the utmost importance, as without it the service fails to live up to its premise. The criteria of additionality are usually applied to the individual projects which are funded through offsetting payments, which 'must create reactions over and beyond a business-as-usual scenario, and there must be some assurance that the project would not occur without the funding provided by carbon credits' (Bayon, Hawn et al. 2012 p.25). Five criteria for additionality have been established jointly by the World Resources Institute and the World Business Council for Sustainable Development Greenhouse Gas Protocol for Project Accounting (WRI, 2008), which are outlined in table 2-3 below.

Table 2-3: Five Criteria for additionality

Investment	Also known as ‘financial additionality’. Developers should prove that the projected revenue from the sale of carbon credits is the decisive reason for implementing a project which would not have otherwise been undertaken
Technology	The primary benefit of the technology is to lower carbon emissions, i.e. lower emissions is not just a co-benefit
Regulation	The project must reduce emissions below the level required by law
Common practice	The project must prove that emissions are reduced below the level which would be ‘common practice’ for other similar projects
Timing	Related to when the project was planned and approved, can help to determine the contribution made by the voluntary scheme and whether there is financial additionality

The criteria outlined above seem to provide a clear and measurable way to calculate the additionality of carbon offsets. However, in practice it is difficult and sometimes impossible to implement these tests and be sure that additionality is present. There are also huge costs associated with certification at a project level, particularly when carbon offsetting programs can take place across the world with varying regulatory regimes and market circumstances (Trexler, 2006). There can also be difficulties associated with working out the counterfactual as even though developers may claim are carbon credits the main driver behind a project it is difficult to tell if this is really true. This has had the result that carbon offsetting has become somewhat less popular (Brohé, 2014) and has attracted a substantial amount of negative coverage in the media (Monbiot, 2006). There are also other concerns which exist regarding the moral justification of carbon offsetting (Hyams and Fawcett, 2013), even if the

additionality is found to occur, and whether the scale of voluntary demand is sufficient to make an impact on reducing global emissions (Kotchen, 2009).

2.6.3 Comparing green electricity certificates to carbon offsets

There is a debate over the extent to which green electricity certificates can be equivalent to, and should be counted as, carbon offsets. The debate mainly concerns whether the certificates are additional, as certificates are usually issued to generated green electricity without any of the additionality tests outlined in table 3 being applied. Harmon puts forward two possible ways to measure the additionality of renewable energy certificates (Harmon, 2008). The first is the 'project by project financial additionality test', which asks whether the project would have been built without the support of renewable energy certificates. This is a problematic test for a number of reasons. First is because finance for projects is often complex and shifting, and it might be easy for a developer to make it seem like the income from certificates was crucial. Second, this sets a very high bar for additionality and the current evidence suggests that the voluntary certificate market is not taken into account by developers for a variety of reasons. As will be explored further when looking at the interaction with other renewable energy subsidies, other forms of government support are likely to be far more important than the presence of voluntary markets for renewable energy certificates.

A second possible way of measuring additionality according to Harmon would be through 'performance-based additionality tests' (ibid). Under these types of tests, projects are considered additional if they meet certain criteria. The project must use a certain type of technology, it must be of a certain age and it must not have been mandated by law, regulators or courts. This is the measure of additionality used under the Green-e Energy and Climate certifications (Dagher, Bird and Heeter, 2017). This sets a much lower bar than the financial additionality test, as there is no requirement to show that the project would not have been developed without the support of the market for renewable energy certificates. One area which might be problematic however is the third criterion, that the project must not have been mandated to be built by law, regulators or courts. This does not make it clear whether publicly subsidised renewable generation, which the majority of renewable projects across the world receive, should be included. This type of criterion also leaves considerable scope for regulators to be lenient with what ages and technology choices they allow. One final problem with this type of criterion is that it somewhat abandons the notion of additionality altogether as there is no attempt to assess the extent to which the environmental benefit would have occurred if the extra revenue from the certificate market was not present.

Trexler (2009) would argue that RECs are rarely additional as they fail to satisfy the investment criteria of offsets. RECs should not be automatically considered to have environmental benefit as they simply represent the generation of

renewable energy, regardless of whether the REC market played any role at all in making that particular project happen. Gillenwater (2013) finds that in the US investors considering building a new renewable energy project require a minimum guaranteed revenue stream of between \$70 and \$80 per MWh. REC sales in the voluntary market usually fetch between \$1 and \$10, and the contracts are short, usually 1-5 years. This evidence seems to support Trexler's position, that RECs are not usually in the minds of developers, and therefore should not be considered automatically to have environmental benefit.

It is also worth noting that in the UK there has also been some debate as to whether green electricity sales should be counted the same as carbon offsets. In 2008 DEFRA announced that green electricity would be treated as equal to conventional electricity for the purposes of CO₂ reporting (DEFRA, 2008). In the past it had been classified as having no associated carbon emissions. In explaining this decision, the Environment Secretary Hilary Benn noted "It is increasingly difficult to demonstrate that buying a renewable electricity tariff is offering additional carbon emissions reductions compared with what suppliers are required to source to meet the Renewables Obligation" (DEFRA, 2008). In June 2008, Defra announced that with effect from the current financial year (2008/9), Green Electricity is to be treated the same as average grid electricity for CO₂ reporting purposes. Previously, it was treated as if there were no CO₂ emissions associated with it. There have been some changes to this approach however, with the revised scope 2 carbon accounting guidelines allowing a

green source tariff to be factored in to the calculation of the carbon impact of electricity usage (WRI, 2015).

2.7 Green tariffs in the context of political consumption

It may also be helpful to view green electricity tariffs in the wider context of what has been labelled as 'political consumption' (Boström, Klintman and Micheletti, 2008). This can take many forms and, while green consumerism is relatively new, these methods of political activism have been used successfully for centuries through both boycotting and buycotting (Lang and Gabriel, 2005). One needs only to look to the US non-importations movement of 1764-76 to see the power that consumer action can have to highlight issues of power and to manifest a political desire for change (Stolle, Hooghe and Micheletti, 2005). One study has found that consumers turn to political consumerism when they distrust political institutions and instead place their trust in other citizens (Jacobsen and Dulsrud, 2007). It also is worth acknowledging that consumers view their own responsibilities according to the product and context, and how the realities and complexities of day to day life may restrict the role of political consumerism (Lang and Gabriel, 2005). There have also been some concerns that political consumption may crowd out other forms of more direct activism, however there remains little evidence for this (Whiteley, 2011). This is especially relevant for climate change, where governments have mostly failed to undertake the radical policies necessary in order to reduce emissions to a sustainable level.

2.8 Summary

In reviewing the existing literature in the field there appeared to be a number of notable gaps, where assumptions regarding environmental benefit are not questioned and the experience and expectations of consumers is too often abstracted into willingness to pay values. The first clear gap is the lack of any recent international comparative case studies, the most recent of which was Bird et al (2002). This is addressed by chapter four, which undertakes the largest ever international comparison of markets for green electricity tariffs. The second gap, which has received no attention so far in the literature, concerns the interaction between green electricity tariffs and increased automation of green electricity markets, which is covered in chapter five. This is an important area to consider as it is important to both understand the green electricity tariffs themselves as well as the ways in which consumers discover, search and ultimately switch to them.

In the literature there is only one substantial attempt to reconcile the expectations of consumers with the green electricity products which are sold (Menges, 2003), and this is examined in an abstract sense without any direct reference to the policy and regulation which exists to protect consumers (OFGEM, 2014). Chapter six addresses this gap in the literature by combining analysis of consumer expectations with a census of the actual tariffs which exist on the market and are subject to government regulation. Chapter seven analyses the most notable gap in the literature, of understanding the causal link between consumer purchasing of green electricity and actual reductions in carbon

emissions. As explored in the section on additionality above, the environmental benefit of green electricity tariffs is rarely challenged and little evidence exists to support or refute retailers' claims.

3. Methodology

The research conducted in the four research chapters uses a variety of different methodologies, reflecting both the multidisciplinary nature of the research as well as the broad scope of the research question. The lack of a single theoretical framework or methodological approach is a conscious one, and is a result of the research questions emerging from gaps in the literature, as discussed in section 2.8, rather than from the extension or development of any overarching theoretical perspective. While each of the research chapters go into the methods in detail, a number of central themes and challenges will be addressed below. The topic is approached from a number of angles in the current literature, as table 3-1 shows, perhaps reflecting the variety of disciplines which take an interest. Even though only a few contingent valuation surveys measuring consumer willingness to pay are included in the table, these types of studies make up the majority of the published literature on the topic. This is likely due to the fact that green electricity tariffs are a particularly good case study for analysis of the premiums which consumers are willing to pay for an environmental good, as the functional quality remains the same regardless of the source. This would not be true for other environmental or ethical goods, such as electric vehicles, organic produce or fair-trade goods, where the environmental premium is difficult to distinguish from perceived changes in quality or function which are also valued by the consumer.

Table 3-1: A selection of research methods used in green tariffs literature

Methodology	Use	Examples
Contingent valuation surveys	Measure willingness to pay	(Roe et al., 2001; Borchers, Duke and Parsons, 2007; Zhang and Wu, 2012; Akcura, 2013)
Meta analyses	Aggregate results of papers using contingent valuation surveys	(Ma et al., 2015; Sundt and Rehdanz, 2015)
Neuropricing	More accurately measure willingness to pay	(Herbes et al., 2015)
Content analysis	Study how tariffs are branded and presented to consumers	(Herbes and Ramme, 2014)
Literature reviews	Review state of current literature and compare multiple case studies	(Bird, Wüstenhagen and Aabakken, 2002; Hast et al., 2015)
Interviews	Explain interaction between markets and policy	(Salmela and Varho, 2006)
Policy analysis	Understand the development of regulation and policy	(van Rooijen and van Wees, 2006)

3.1. Going beyond willingness to pay

As mentioned above, the majority of papers published on the topic of green electricity consist of attempts to accurately determine how much consumers would be willing to pay to receive green instead of grey electricity. This is often measured through contingent valuation studies, but more innovative methods such as neuropricing (Herbes et al., 2015) or meta-analyses (Ma et al., 2015; Sundt and Rehdanz, 2015) have been used to try and obtain more accurate figures. This research chooses to avoid this type of methodology for two main reasons. First is because the results, even from the most sophisticated studies, fail to reflect the observed actions of consumers in the marketplace. Second is due to the fact that the studies often do not attempt to take more conceptual looks at how consumers understand green electricity tariffs, as chapter six presented in this thesis aims to do.

3.2 Formulating durable conclusions in the context of changing markets

Dynamic markets such as energy retail present a challenge for researchers if their research is to produce durable conclusions which continue to be relevant as the markets change over time. The most effective forms of this inquiry make conclusions which can shed light on both the observed phenomena but also have prescient insights which can be applied to markets as they develop. In a subject area such as electricity retail, which is facing disruption by distributed generation, new technologies, regulatory changes and innovative business models, making durable conclusions from the observed phenomena can be difficult. For example, a conclusion in 2017 that green electricity tariffs are expensive and therefore the diffusion of the innovation is unlikely, would be invalidated by the market trend just one year later that saw companies able to ‘greenwash’ their tariffs by purchasing REGOs for negligible cost. Because of this it is also important that the methodologies used are able to provide results on a fast timescale, so the publications will be relevant for as long a period as possible.

One way to ensure that the research undertaken in this thesis is worthwhile is consider Pasteur’s quadrant, as shown in table 3-2 below. The majority of green tariffs literature falls into the lower right section, being purely applied with little additional contribution to a fundamental understanding of the subject area. This thesis will attempt to stay in the upper right section, with methods intended to

both be useful to understanding markets and enabling more effective regulation but also to improve the fundamental understanding of what drives market growth, how green preferences can be incorporated into automated purchasing decisions, how consumers perceive the environmental value of green tariffs and what causal mechanisms can translate consumer demand into lowered carbon emissions.

Table 3-2: Four types of energy research, applied to green tariffs literature

		Usefulness	
		No	Yes
Fundamental understanding	Yes	Pure basic research e.g. understanding consumers' environmental preferences	Use-inspired basic research e.g. model of consumer expectations so regulations can protect consumers
	No	Advocacy which selectively draws on academic evidence e.g. analysis by certification bodies	Purely applied academic research e.g. how to market green products more effectively

Pasteur's quadrant applied to green tariffs, adapted from Sovacool et al. (2015) and Stokes (2011)

3.3 Use of technology

One common theme across all the methodologies used in the research in the thesis is the use of digital technologies to provide robust and practical research methods, beyond more conventional methods such as online surveying. One innovative research method used is the mobile-based online survey platform, Pollfish, used in chapter six. To conduct a random sample consumer survey with a statistically significant sample size would normally be expensive and time consuming, even if an online survey platform was used. As a result, many social

science energy researchers are forced to use sample sizes which are insufficient to be statistically rigorous or rely on qualitative methods which are difficult to replicate. There has also been recently increasing scrutiny regarding the replicability of social science research. (Huebner et al., 2017) which picks up on similar themes. Methods which use new technologies such as mobile surveying have the potential to empower social science researchers to generate statistically significant sample sizes at an affordable cost. The data is also high quality, with results comparable to more established survey methods such as mail or telephone based surveying (Goel, Obeng and Rothschild, 2015). Similar styles of innovative survey are starting to be used increasingly in energy research (Pritoni et al., 2015).

3.4 Mixed methodologies

The research presented in this thesis uses a variety of research methods, in recognition of the varied nature of the research and the need for social science to engage with multiple disciplinary approaches (Sovacool, 2014). A summary of the methods used can be found in table 3-3. Using a combination of research methods, most notably in chapter seven where a diverse set of methodologies are used, allows the research to incorporate multiple perspectives so that causal mechanisms can be evaluated from both quantitative and qualitative angles.

Table 3-3: Methods used for each research chapter

Chapter	Qualitative methods	Quantitative methods
4. International comparison	Review of published literature	Regression analysis of macro level market variables
5. Digital third-party intermediaries	Elite interviews with decision makers from DTPIs	Content analysis of DTPIs websites
6. Consumer expectations	Representative online survey conducted using Pollfish.	Census of supplier additionality contributions.
7. Environmental benefit	Online survey with project developers, literature review	Financial modelling of renewable energy projects

4. An international review of markets for voluntary green electricity tariffs

4.1 Preface

The most recent comprehensive international study of green electricity tariffs was undertaken in 2002 (Bird, Wüstenhagen and Aabakken, 2002), it is likely that markets have changed significantly in the intervening years. Chapter four sets out to measure the size of markets for green electricity tariffs and explain the variation by reference to macro level factors including the level of market competition, average price premiums and, the regulatory frameworks in place. Alongside the published paper, a working paper was also completed which provides a more detailed overview of each completed case study, which has been included in appendix i.

This paper has been accepted for publication in the journal Renewable and Sustainable Energy Reviews on 14th March 2018.

4.2 Abstract:

As many countries reduce or abolish centralised government support mechanisms for renewables, such as feed-in-tariffs, it is critical that researchers and policy makers examine other ways of supporting their development. Green electricity tariffs are one possible alternative, using the power of consumer

demand to stimulate green electricity supply. This review is the largest ever study of markets for green electricity tariffs, covering 25 jurisdictions including many which have not been examined previously. The research finds that markets have grown significantly in recent years and, compared to the last comprehensive international study in 2002, the products are now available in many more countries. Those countries where green electricity tariffs have been on sale for longer periods of time have also seen significantly increased consumer uptake. A mixed methods approach is used to explore why some markets have seen more growth than others, as there is clear variation across the countries studied. High competition in energy markets is found to be a key driver of green tariff success, with the countries where consumers switched regularly more likely to have high enrolment. This factor has not been previously identified in the literature and highlights the importance of viewing green electricity tariffs in their wider regulatory context. Green tariffs are also found to be almost always more expensive than conventional electricity. While this may seem obvious, it highlights a weakness in some previous research which counterintuitively found that in many cases green electricity is cheaper than conventional electricity. The difference is explained by a change in methodology to one which recognizes that most consumers switching to green electricity are likely to be comparing against the cheapest conventional electricity supplier rather than simply the market average.

4.3. Introduction

This review is the largest ever study of international markets for green electricity tariffs, covering twenty five jurisdictions where the products are now sold. The findings provide a major update to the literature as markets have changed significantly since the last thorough international review by Bird et al. in 2002 (Bird, Wüstenhagen and Aabakken, 2002). Voluntary green tariffs, where the electricity supplied is generated from renewable sources, are worthy of examination as they are a decentralised consumer focused mechanism to support renewables and are beginning to be purchased by increasing numbers of consumers. The first aim of the chapter is to review the growth of international markets for green electricity tariffs, both in terms of the number of enrolled customers and the number of countries where green products are sold. This will also include several jurisdictions which have not been previously included in international comparisons, such in Eastern Europe where green electricity tariffs have only just become available. The second part of the study uses a mixed methods approach to explain the variance in enrolment levels across the regions studied. No previous work has taken this approach, which is made possible by the large number of case studies included. Several of the factors explored as drivers of green tariff enrolment have also not been substantially addressed in the literature before, such as the impact of market competition or interaction effects with other green electricity support schemes. The chapter also sets out a number of methodological improvements for the calculation of price

premiums, which help to ensure that estimated premiums are accurate and consistent with consumer experiences.

Voluntary green electricity tariffs come in a wide variety of formats, some of which are new and some of which have been established and studied for decades. For the purposes of this study green electricity tariffs only include those where the electricity is generated from renewables, not including nuclear. 'Grey' tariffs will be defined as those where the household receives electricity which is sold with no green claims, and may be from any source, though sometimes clearly this may be from renewables. Green electricity tariffs are not a new phenomenon, Germany has had green electricity tariffs since the mid 1990s (Wüstenhagen and Bilharz, 2006b) whereas other countries such as Latvia have only just introduced schemes. The research in this chapter is a significant addition to the body of academic literature on this topic due to its scope, encompassing 25 regions where green electricity products are now sold. The majority of the data has been gathered from new sources, which is important as any older literature can become quickly outdated. Even relatively recent research on this subject, such as Hast et al. (2015), is now out of date due to changing markets and regulations. This chapter also focuses only on household purchasing of green electricity. There is an interesting body of work around non-domestic purchasing of green electricity, but it is beyond the scope of this research. While the findings will still be relevant, particularly for SMEs who engage with the retail market in a similar way to households, decision making

processes and motivations for purchasing green electricity are likely to be different in larger businesses (Wiser, Fowlie and Holt, 2001).

The existing literature on green electricity tariffs suggests a number of factors can explain the variance in enrolment levels seen across the world. As there have not been many previous international studies, many of these concepts come from consumer research which analyse the barriers to individuals signing up to green tariffs. The areas to be explored include; competition and switching, price premium levels, interaction effects with other renewable energy policies, regulation and labelling, and policies to directly support green electricity sales. These areas, along with the key historical developments, will be outlined more thoroughly in the theoretical framework. The data gathered to investigate these areas is outlined in the methods section.

This is an important area of research as voluntary green electricity tariffs are currently helping to reduce carbon emissions and promote sustainable development across the world. For example, green electricity certified under the EKOEnergy label helps to fund the construction of renewables in developing countries and finances the protection and preservation of waterways affected by hydropower development (EKOEnergy, 2015). As the price of renewable electricity generation decreases (Bloomberg, 2017), the price differential between green electricity and electricity from conventional sources will fall. This process is already beginning in many jurisdictions and is leading to governments

seeking to reduce subsidies such as feed in tariffs (Muhammad-Sukki et al., 2013). Under these conditions, the importance of this research is increased, as it becomes possible that the gap between grid parity and the cost of renewables could be met through the voluntary market for green electricity tariffs. Of course, from a generator perspective, feed-in tariffs have the advantage of long term price certainty, which a voluntary market is unlikely to replicate (Holt, Sumner and Bird, 2011; Gillenwater, Lu and Fischlein, 2014). Some research has also suggested that the voluntary sale of green electricity, and the associated Renewable Energy Certificate (REC) market, has a negligible influence on decisions to invest in renewable energy or on the economic feasibility of these facilities (M. W. Gillenwater, 2013; Gillenwater, Lu and Fischlein, 2014). Furthermore, the experience of the Netherlands has reinforced this view, with 64% of consumers purchasing green electricity and only around 10% of electricity generated from renewables (ACM, 2015). It is because of this uncertainty of the impact of green electricity sales on the wider market that many tariffs also include additional elements such as a contribution to a renewable energy fund. Due to this, the extent to which voluntary tariffs can replace mandated support mechanisms completely is uncertain and merits further research. It is therefore important that attention is paid to the mechanisms which drive the success of markets for green electricity in both the short and the long term.

4.4. Green electricity tariffs

Before exploring the relevant literature, it may be useful to briefly define exactly what ‘green electricity tariffs’ are for the purpose of this research. The academic literature has inconsistent definitions, perhaps indicative of the variation in types of product available to customers. In order to capture the wide variety of products available in the markets studied, green tariffs will be defined to be any mechanism by which consumers can purchase green electricity from an electricity retailer as part of their electricity tariff and in proportion to their electricity usage. The element of proportionality is important to differentiate green tariffs from other forms of carbon offsetting which can be purchased separately in any quantity regardless of electricity usage. For example, a monthly set contribution to a carbon offsetting scheme that does not vary by energy consumption would not be classified as a green tariff, even if it was sold as a way to balance out the impact of the consumer’s energy usage. In a country where a very high proportion of electricity in the general mix is green, such as Norway or Iceland, it would be misleading to term these as “green electricity tariffs” as there is no grey alternative.

Some previous work has differentiated between consumption based green tariffs, where electricity usage is matched with certified green supply, and contribution based green tariffs, where the retailer pays into a fund for environmental projects (Lipp, 2000; Boardman, Jardine and Lipp, 2006; Burger, 2007 p.15). Given the definition above, only consumption based tariffs are

included in this study. This also excludes other types of 'ethical' electricity tariffs not related to green energy, such as the Woodland Trust energy supplier in the UK. This definition and approach is not universal, but is consistent with most regulators' thinking when defining a green tariff and the form green characteristics should take. This research also defines 'green' electricity sources to include all renewables and exclude nuclear, which is the usual practice in green electricity tariffs. A third type of tariff, which will be looked at briefly in this chapter in the section on market structures, is a 'decoupled' type of green electricity product such as Bullfrog energy in Canada. With these types of product consumers continue to purchase energy from their usual supplier, but pay a certain amount, proportional to their usage, in order to offset the carbon emissions. These types of tariff are one way in which consumers can purchase green electricity, despite not being able to do so in conventional ways due to the monopolistic model of their electricity market. Similar types of tariff also exist in Australia under the GreenPower scheme (ISF, 2015). While these schemes are similar to other forms of carbon offsetting, it is the fact that they are purchased in proportion to electricity usage which qualifies them as green electricity tariffs under the definition used in this research.

Table 4-1: Conclusions made by Bird et al. 2002 (pp.18-22) regarding the state of the green electricity market

1	Successful market penetration rates have typically been about 1%, more successful markets have achieved penetration rates of between 5% and 15%.
2	Consumer education and aggressive marketing is necessary.
3	Green power marketers have offered a range of products to appeal to consumers with varying price sensitivities and resource preferences.
4	The impact of green power marketing on new renewables development has been limited so far.
5	While price is not the only important driver of demand, companies offering lower priced products have generally obtained more customers.
6	Retail competition can stimulate green power marketing activity.
7	Many customers have purchased green power without switching suppliers.
8	Certification and labelling programs can play an important role in shaping products.
9	Government support can be an important facilitator of green power market development.
10	The impact of purchase obligations and similar policies designed to support renewables is still unclear, but uncertainty in policy development can stifle markets.

There have been few previous studies which have attempted international comparisons of green electricity tariffs. The most comprehensive, and among the oldest, is Bird et al. (Bird, Wüstenhagen and Aabakken, 2002) which reviews the development of green electricity tariffs across a wide number of countries. They found that most markets had penetration rates of around 1%, but that successful markets achieved around 5% to 15%. The research also made nine further conclusions regarding the state of the market, as shown in table 4-1, which will be referenced throughout this chapter to assess how the markets have progressed. A more recent study by Hast et al. (Hast et al., 2015) reviews green electricity products in the United Kingdom, Germany and Finland. The study

particularly focuses on interaction effects with other renewable energy policies, and finds that markets face particular problems to do with double-selling and ensuring that tariffs are providing an environmental benefit. This will be explored in further detail when looking at the interaction between green tariffs and other support mechanisms.

In order to make meaningful comparisons between the jurisdictions studied it is also important to look for evidence of possible variance at a consumer level. One recent meta-analysis of consumers' willingness to pay, looking across many jurisdictions, found preferences to be largely homogenous, though there can be variation depending on the source of electricity the green source is replacing (Sundt and Rehdanz, 2015). One notable exception in the willingness to pay literature is the case of China, where some consumers who may be attracted to the idea of 'premium' electricity and are willing to pay more (Zhang and Wu, 2012). There is some evidence however that consumers in some countries may be skeptical of particular types of renewables and consequently express a lower willingness to pay (Borchers, Duke and Parsons, 2007; Krishnamurthy and Kriström, 2014). This may be particularly true for countries with large amounts of hydroelectric power, where studies have found consumers to be less receptive to green electricity that is generated from hydro due to ecological concerns such as the impact on waterways (Larsen, 2013).

It is also important to place green electricity tariffs into the context of the wider literature on support mechanisms for renewable electricity. Policies implemented to promote renewables are complex and involve research and development, prioritised grid access, product standards and economic measures such as subsidies or obligations. Most relevant to this research is the last group, economic measures which aim to reduce the price differential between green and grey electricity. Currently many countries choose to support green electricity development by increasing the price which project developers receive for the electricity they generate. Conventionally this would be done either through a feed-in-tariff, which provides a fixed-price subsidy per unit generated (Mendonca, Jacobs and Sovacool, 2009), or through an obligation on suppliers to purchase a certain proportion of green electricity through a renewables portfolio standard (Barbose et al., 2016; Ritzenhofen, Birge and Spinler, 2016). Ultimately these costs are passed onto all consumers through taxes or, more commonly, levies placed on electricity bills. There is evidence that these subsidies are becoming less popular, particularly as governments are under fiscal pressure (Mahalingam D, 2016) and as levies grow with rising levels of renewable electricity generation. Voluntary green electricity markets provide an alternative support mechanism, they make green electricity projects more viable by using consumer demand to increase the price which developers receive for their electricity. Many green electricity tariffs around the world also contribute to funds for technological development, which have added benefits over and above the price signal sent to developers. For example, the UK electricity supplier

Npower previously offered a green electricity product which, through a partnership with Imperial College London, funded research into wind and tidal technology (Gross P, 2011).

4.5 Materials and methods

There is considerable variation in the types of green electricity products available across the world, and in the types of markets in which they exist. This section outlines five factors which emerge from the discourse to explain this variation. These are the role of market liberalization, price premiums, interaction with other government support for renewables, the presence of eco-labels and direct support for green electricity markets. As the selection of variables reflects, a particular emphasis is placed on the regulatory environments of the electricity markets studied, which has not been covered to a great extent in the existing literature. Once these variables are discussed, the data collection methodology is outlined.

4.5.1. Methods used

This research uses a mixed methods approach, combining statistical analysis of macro level data on markets and regulation with evidence from written case studies. The statistical analysis quantifies the extent to which different variables are significant in determining enrolment levels, with a level of confidence which would be not possible with purely qualitative analysis. Written case studies can

provide a more nuanced form of analysis, able to capture variation and complexity which may be lost when simply looking at macro level data. Below

4.5.2. Variables included

The first area to explore relates to market structure and competition, a factor which has not received much previous attention in the literature on green electricity tariffs. It is important to view green electricity products in their market context as there is considerable variation in the types of electricity markets in the developed world. Since the 1990s many European countries have been following the British model of retail energy market liberalisation, breaking up state or private monopolies and encouraging consumers to be active in the electricity retail market (Helm, 2004). In the USA there is a mixed picture, with electricity markets regulated on a state level. Some states, such as Texas, have competitive and liberalised markets whereas others maintain public or private monopolies. In Australia a similar variety exists, with only some states liberalised. Consumer research suggests that individuals are generally skeptical of electricity market competition and see the hassle of switching as one reason why they may not wish to purchase green electricity (Ozaki, 2011; Larsen, 2013). It is therefore likely that consumers in liberalised markets with high levels of engagement and switching would be more likely to purchase a green electricity tariff. This is touched upon in Bird et al.'s study (2002), where the authors note

that “retail competition can stimulate green power marketing activity”, but this research investigates the claim systematically.

One further variable considered is the role of price premiums; how much green electricity costs compared to grey electricity. There is an ongoing debate in the literature regarding the extent to which the cost of green electricity explains enrolment levels. Bird et al’s (2002) review found that “while price is not the only important driver of demand, companies offering lower priced products have generally obtained more customers”. This makes intuitive sense, particularly given the substantial number of willingness to pay studies which find that higher household incomes are associated with higher willingness to pay for green electricity (Oliver, Volschenk and Smit, 2011; MacPherson and Lange, 2013; Krishnamurthy and Kriström, 2014). However, one recent analysis of willingness to pay for green electricity in the USA finds that green electricity products are relatively price inelastic (Dagher, Bird and Heeter, 2017), so enrolment levels would not be substantially affected by increases in price. One meta-analysis of willingness to pay studies also finds that variables such as income are less important than the choice of methodology in determining willingness to pay. Given the above, it is possible that the price premium of green electricity plays a role in determining enrolment levels, but there may be reasons to doubt the strength of the relationship compared to other factors.

The third area to explore relates to the relationship of enrolment levels to other support mechanisms for green electricity. Mendonca, Jacobs & Sovacool suggest that “given the absence of national government support for a renewable portfolio standard or FiT, green power programmes have become especially popular in the US” (Mendonca, Jacobs and Sovacool, 2009 p.161). This is also argued in Australia, where there have traditionally been limited government subsidies for green electricity. Similarly research at a consumer level has found that, in countries where there are strong state subsidies for green electricity for which all households pay, consumers may feel less of a need to provide additional support themselves (Andor, Frondel and Vance, 2017). If this argument were to hold true, one would expect to see that the countries where green electricity receives less public subsidy, specifically where installed capacity is lower as a result, are also the ones where consumers take action themselves and purchase green electricity. While often cited, no previous research has attempted to examine if this claim is valid or not at a macro level.

Many studies have highlighted the role that voluntary eco-labels and regulation can have in developing markets for ethical products (Rex and Baumann, 2007; Roe, Teisl and Deans, 2014), and green electricity is no exception (Burger, 2007). Eco-labels can allow customers to signal their environmentally progressive attitudes (Hanimann, Vinterbäck and Mark-Herbert, 2015), can be effective at helping the transition from niche products to mass market appeal (Wüstenhagen, Markard and Truffer, 2003), and can boost sales by almost 30%.

There are also several different types of eco-label and it is important to ensure that the type of labelling scheme implemented matches the state of development of the market (Truffer, Markard and Wüstenhagen, 2001). Several common eco-labels are shown in figure 4-1. The labels also often come alongside certification schemes which should help to ensure that products provide environmental benefit. In some countries there is also specific regulation relating to green electricity products, to ensure that the tariffs meet minimum standards. Both of these types of governance, voluntary and mandatory, should be effective tools for marketing green tariffs and building up consumer trust. Because of this, it is likely that jurisdictions where there are eco-labels or specific regulation are more likely to have higher enrolment levels.

Figure 4-1: A selection of eco-labels for green electricity from across the world



One final area to consider relates to policies which can be implemented by government to encourage consumers to sign up to green electricity tariffs. There is evidence on both small and large scales that these policies can be effective at increasing enrolment in green electricity tariffs. At a national level the best policy examples come from the Netherlands, where the government prioritised the uptake of voluntary tariffs through a number of policy measures (Kroon, 2002). This included a tax exemption that lowered the cost for green electricity

tariffs. In Switzerland Litvine & Wustenhagen (Litvine and Wüstenhagen, 2009) find that providing information to households about green electricity can result in a significant increase in the market share of green electricity products. Research also suggests that a policy of 'green defaults' can be effective in increasing the number of consumers on green tariffs (Pichert and Katsikopoulos, 2008). Evidence from Australia finds that government marketing campaigns can provide a good return on investment, and may represent a good 'no regret' policy for government (Mewton and Cacho, 2011). This is also backed up by research at a local and community level, such as the provision of symbolic incentives in Connecticut (Kotchen, 2011). This body of evidence seems to suggest that the presence of policies to support green tariffs should have an impact on the number of consumers that purchase green electricity tariffs.

4.5.3. Data collection

Macro level data was collected in order to measure the growth of markets for green electricity tariffs. The data collected consists of two broad categories, related to the two aims of the review. The first aim was to measure the scope of jurisdictions with green tariffs and the size of their markets. To find out which countries have green tariffs for sale, a census of all developed countries was conducted, using a combination of online search and communication with regulators. This data formed the basis of the sample for this review. One unique aspect of this research is the size of the sample, which is larger than any study currently published. A complete list of included jurisdictions is included in the

results, table 4-2. The sample includes all countries in the developed world where it is possible to purchase a green electricity tariff at a price premium. These are mainly in the EU, but several cases from North America, Australia and New Zealand were also included. Data were collected at the jurisdictional level at which electricity market regulations are set, so in the case of the USA and Australia these were states rather than countries as a whole. Jurisdictions where the tariffs have been established for several years and those where they are relatively new were both examined. Countries where the majority of consumers purchase green electricity by default were not included, such as Austria, Norway and Iceland. In these cases there is always no consumer participation involved in the decision to purchase green energy. Several of the other factors such as price premiums or government support for renewables are also not applicable.

Table 4-2: Data collected from each jurisdiction

Country	Enrolment	Small or large suppliers	Number of retailers	Average price premium in EUR/kWh	Switching Rates	Percentage of energy generated from renewables	Average domestic electricity price (2014) EUR/kWh	Time available	Specific regulation	Eco-label
Australia - SA	6.9%	Mixed	Many	0.040	17.0%	36.0%	0.2	1990s	Yes	Yes
Australia - Victoria	6.0%	Mixed	Many	0.040	14.0%	12.0%	0.2	1990s	Yes	Yes
Australia - NSW	4.7%	Mixed	Many	0.040	17.0%	7.0%	0.2	1990s	Yes	Yes
Australia - Queensland	11.1%	Mixed	Many	0.040	15.5%	6.0%	0.2	1990s	Yes	Yes
Belgium	37.0%	Large	Many	0.014	25.3%	12.3%	0.2	1990s	Yes	No
Czech Republic	0.1%	Small	Few	0.009	15.6%	12.8%	0.1	2014	No	No
Denmark	6.0%	Mixed	Many	0.000	7.2%	43.1%	0.3	1990s	Yes	Yes
Estonia	0.3%	Large	Few	0.001	5.3%	13.0%	0.1	2013	No	No
Finland	2.0%	Small	Many	0.018	12.9%	31.1%	0.2	1990s	Yes	Yes
France	1.0%	Large	Some	0.007	1.0%	16.9%	0.2	2000s	Yes	No
Germany	17.0%	Large	Many	0.025	4.5%	25.6%	0.3	1990s	No	Yes
Ireland	1.2%	Large	Few	0.013	12.2%	20.9%	0.2	2000	Yes	No
Netherlands	63.0%	Mixed	Many	0.000	15.7%	10.1%	0.2	1999	Yes	Yes
New Zealand	26.0%	Large	Few	0.000	19.0%	74.0%	0.2	2000s	No	No
Poland	0.0%	Small	Few	0.025	2.9%	10.7%	0.1	2010s	No	No
Portugal	0.1%	Large	Few	0.005	9.8%	49.2%	0.2	2010s	No	No
Slovenia	0.2%	Large	Some	0.004	8.9%	32.8%	0.2	2010s	Yes	Yes
Spain	4.4%	Mixed	Some	0.008	7.6%	36.4%	0.2	2000s	No	No
Sweden	5.0%	Mixed	Many	0.003	11.2%	61.8%	0.2	1996	Yes	Yes
United Kingdom	2.0%	Small	Some	0.030	11.7%	13.9%	0.2	1989	Yes	No
United States - Connecticut	2.1%	Small	Many	0.008	10.0%	3.5%	0.2	1990s	No	Yes
United States - New York	2.3%	Small	Many	0.008	5.6%	23.5%	0.2	1990s	No	Yes
United States - Oregon	8.1%	Large	Many	0.008	0.0%	73.4%	0.9	1990s	Yes	Yes
United States - Texas	11.9%	Mixed	Many	0.008	17.0%	9.6%	0.1	1990s	Yes	Yes
United States - Utah	3.7%	Large	Some	0.008	0.0%	4.3%	0.1	1990s	No	Yes

Notes:

- Enrolment figures for Ireland and France are unknown. The figures included in the data table are based on the market share of each different supplier and the likely percentage of customers on a green tariff. The percentage is estimated using data from similar sized suppliers in other jurisdictions.

- One country, Switzerland, does have green electricity tariffs but no data was available regarding enrolment rates. In this case it was also not possible to estimate the percentage of customers on green electricity tariffs. Due to these two factors, Switzerland was not included in the sample.
- In the variable for the number of green tariff retailers, small is less than 5, some is 5 to 15 and many is 15 and ab

Once a database was constructed of all the countries where green electricity tariffs are sold, the next step was to obtain data on the enrolment levels in those jurisdictions. The figures on enrolment levels were obtained from a variety of sources including electricity regulators, suppliers themselves, press releases, and news reports. The majority of these data sources were publicly available online. Where figures were obtained from suppliers themselves, the numbers were cross-referenced with other sources where possible to ensure they were accurate. While the retailers may be liable to overestimate the number of customers they have, this is unlikely to happen to such an extent that the data is invalidated. In the few cases where data was not available for a particular retailer, the number of household consumers was estimated. The methodology used for each of these estimations is explained in the notes on table 2. Data was also collected on the number of suppliers, size of suppliers and length they have been operating. Again, this was collected using a combination sourced including, electricity regulators, suppliers themselves, press releases, and news reports.

The second phase of data collection involved obtaining macro level data based on the themes discussed in the literature review; competition and switching, role of price premiums, interaction effects with other renewable energy policies, labelling and regulation and policies to support green electricity sales. The proxy used for market competition was switching rates, the number of households who switched between suppliers on an annual basis, as a proportion of the total

number of households. It is very likely that electricity markets with high levels of competition and liberalised structures will also have high switching rates, so the data should be a good proxy (Defeuilley, 2009). Where available, the data was corroborated by surveys looking at perceptions of the ease of switching (EC, 2013) and retail electricity market Herfindahl index (HHI) measures. One flaw with this data is that it only accounts for consumers who switch between suppliers. Consumers who switch between tariffs offered by the same supplier are not counted in the switching data. This is particularly relevant in markets with low levels of competition but where green tariffs are offered by the monopolistic supplier, such as in Oregon or Utah.

The price premiums were defined to be the difference between the cheapest grey and cheapest green tariffs, based on a census of all products available in each market. This particular methodological approach is explored further below. The percentage of energy generated from renewables was used to measure the interaction effect between green electricity and other renewable energy policies. Higher percentages of energy generated from renewables are taken as a proxy of strong policy support for renewables. This was based on figures provided by regulators, which were cross-checked where possible with data from international organisations. The presence of specific regulation, eco-labels and policies to support green electricity sales was determined by a combination of online searching, news reports and communication with regulators and suppliers.

While the data collected above was mostly unproblematic, one particular issue arose concerning the calculation of price premiums. It became clear when looking at previous research that practices for calculating price premiums leave significant room for improvement. There are a number of issues which make the calculation of the price premium complex. The first issue concerns the calculation of the 'green' and 'grey' prices which need to be compared. There are two ways that this calculation can be done. The first is to simulate the behavior of a consumer looking to switch, to use a price comparison tool perhaps, and to compare the cheapest green tariff with the cheapest grey tariff. The second way would be to look simply at the difference between the cheapest green tariff price and a typical household price. The difficulty is that many electricity suppliers effectively overcharge consumers who do not actively switch to a cheaper tariff. In the UK, a recent CMA report found that "for all dual customers of the Six Large Energy Firms, average potential gains from switching externally to any tariff offered were equivalent to 14% of the average bill" (CMA, 2015). Furthermore, some categories of customer could save more than 20%. This experience is replicated in many other jurisdictions, especially in hybrid marketplaces where consumers can opt out of regulated pricing. This would mean that the second method for comparing prices, looking at the cheapest green and the typical retail price, makes green tariffs look much cheaper than if they are compared against the cheapest grey tariff. Using this second methodology, it is often cheaper for households to switch to green electricity

from their current supplier. The first way of comparing prices, by looking at the cheapest green and cheapest grey when signing a new contract on both and actively looking on a price comparison website, is likely to yield a very different result with green tariffs being almost always more expensive than grey tariffs. There is also difficulty in factoring in the 'greenness' of different tariffs when calculating and comparing the price premiums. For the purpose of this study, only the cheapest 100% green tariffs were considered, as any other option would need a much more sophisticated measure of comparison to take into account the different environmental impacts of the different types of tariff. There is also an issue over whether the prices should be differentiated by source, as consumers may have a different willingness to pay for some technologies over others (Borchers, Duke and Parsons, 2007). This may be particularly true in countries with high proportions of hydropower, which is often blamed for having adverse effects on waterways and ecosystems (Larsen, 2013).

Across the jurisdictions studied there is also a large number of different types of tariff available. For the purpose of consistency a standard set of criteria were used, which can be found in appendix A. These ensured that a consistent set of results were obtained. It could potentially obscure some of the nuance if, for example, green tariffs happened to be particularly cheap on a pay as you go tariff. However, there is no reason to expect that this would be the case. Rather than calculating a minimum, mean and maximum price as Hast et al (2015) do, this research has concentrated on only the minimum. This decision is based on

both theoretical and practical considerations. In terms of theory, assuming consumers are economically rational, one would expect the sensible choice would be between the cheapest green versus the cheapest grey options available on the market. Practically, to calculate a mean would require finding all electricity products on sale in a particular jurisdiction and a consumer survey or data on the number of subscribers to each tariff. There is also an issue about the extent to which the measure should be a fixed amount or as a percentage of the total bill. To ensure transparency and to allow both metrics to be analysed, data on average national electricity costs was collected alongside the price premium. Given that energy sold by renewable energy co-operatives, such as Ecopower in Belgium, is not available to all consumers and may require an initial membership fee, these types of tariffs are not included in the calculation of price premiums.

The third phase of the research consisted of longer in-depth case studies for each particular jurisdiction. It was important to do this in order to capture the complexity of the markets and regulations in each particular jurisdiction. These used a wide range of sources including pre-existing literature, reports from NGOs, and direct communications with stakeholders. The longer case studies were also compiled and published in the working paper entitled “The Global Status of Green Electricity Tariffs” (MacDonald, 2016).

The data was processed both quantitatively and qualitatively. The quantitative analysis consisted of a multivariate regression, performed using the SPSS software package (IBM, 2016). This looked for associations between the independent variables, such as the number of retailers or price premium of green electricity, and the dependent variable, the percentage of households who have purchased green tariffs. This indicates if any of the variables considered are statistically significant determinants of enrolment in voluntary tariffs. More qualitative analysis was also conducted, drawing on the country case studies in the associated working paper. These two methods combined provided an accurate explanation of the variance in enrolment levels seen across the jurisdictions studied.

4.6 Results and discussion

The results from this review provide a major update to the literature on markets for green electricity tariffs. The data was first analysed using a multivariate regression. Table 4-3 summarises the descriptive statistics and regression analysis results. The only variable which is found to be statistically significant at a 0.1 level is the switching rate, which has a p-value of 0.051. This variable was positively correlated to rates of enrolment in green electricity products, suggesting that jurisdictions with higher switching rates tend to have greater enrolment rates for green electricity products. Beyond this, no other factors were significant, probably due to the relatively small sample and the number of unidentified factors unique to each particular case study. This is indicative of the

variance between jurisdictions, where cases differ based on local circumstances and market development. The country case studies were used to explore further the complexity in each jurisdiction and to expand on the areas where statistical significance was not found.

Table 4-3: Descriptive statistics, correlations and regression analysis results

Variable	Mean	Std. Deviation	Correlation with enrollment rates	Multiple regression weights	
				b	β
Enrolment rates (%)	8.8840	14.25999			
Number of retailers	1.3200	.85245	.134	9.886	.591
Price premium (€/kWh)	1.4454	1.38044	.347	-2.411	-.233
Type of supplier	1.1600	.80000	.235	4.339	.243
Switching rate (%)	10.6760	6.44304	.051*	1.111	.502
Energy generated from renewables (%)	25.5956	20.83913	.573	-.102	-.149
Average domestic price premium (€/kWh)	21.9052	15.76969	.583	.134	.149
Presence of specific regulation	.6000	.50000	.582	-3.602	-.126
Presence of eco-label	.6000	.50000	.666	-3.958	-.139
Time available on the market (years)	1.6400	.75719	.184	-6.035	-.320

* $p < 0.1$

Model summary:

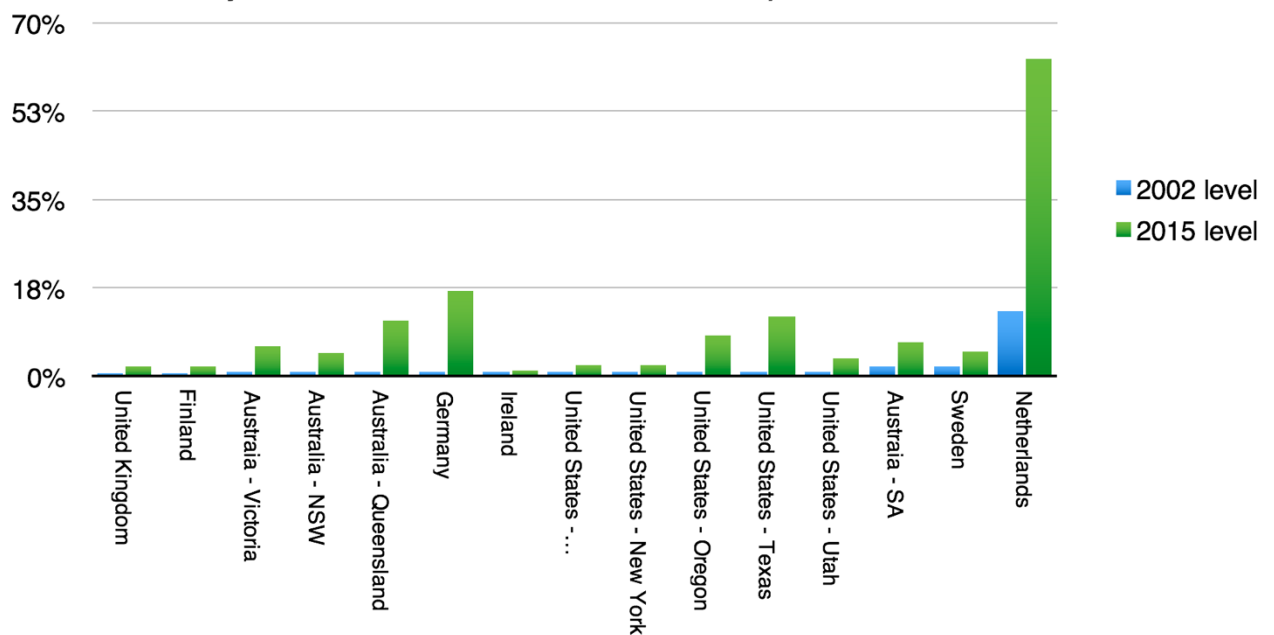
$R = .740$, $R^2 = .548$, Adjusted R Square = .276, Std. error of the estimate = 12.12966

4.6.1 Market development

The first aim of the review was to assess the development of the scope and size of markets for green electricity. Compared to the study by Bird et al (2002),

markets are significantly more developed, as shown in figure 4-2. Many jurisdictions now see enrolment levels of 5-10%. In the 2002 study only the Netherlands was above 5% (at 13%), with all the others around 1-2%. This is clearly a significant development and there are no countries where there has not been an increase. Among all the countries studied in this chapter, the Netherlands (63%), Belgium (37%) New Zealand (26%) and Germany (14%) stand out as having particularly advanced green electricity markets. Perhaps the biggest difference is the increased number of jurisdictions which now have green tariffs available in the market, particularly in Eastern and Central Europe.

Figure 4-2: Growth of markets for green electricity between 2002-2015 (for jurisdictions examined in both studies)



4.6.2 Role of competition and switching

Looking both at the quantitative data collected and the written case studies of each jurisdiction, it is clear that market structure and competition play an important role in determining enrolment in voluntary green electricity tariffs. In the statistical analysis that was undertaken, the only significant association was between the switching rates and the enrolment rates, which had a positive relationship. Furthermore, of the top ten countries with the highest enrolment, 6 had switching rates of above 15%. In the bottom ten only one was above 15%. The structure of the market is an important factor in two different ways. First, it is central in explaining the presence of a market for green electricity at all. In simple terms, there needs to be consumer choice in order to enable consumers to choose renewable energy. In markets where retail competition is low or non-existent, the uptake of other forms of usage linked offsetting, such as 'uncoupled' green electricity products such as Bullfrog energy in Canada, is very low. The importance of retail competition is shown particularly in the countries of central and Eastern Europe. In these countries it is the EU legislation encouraging liberalization, open and fair retail markets and price deregulation (EC, 2009a) that is allowing green products to be available on the market. It is therefore important for policymakers to recognize that one of the key benefits of energy market liberalization can be the promotion of innovative energy products such as green electricity.

Second, where there is retail competition, the level of that competition is key. It is not simply enough to be technically liberalized and allow consumers to be able to switch, it needs to be encouraged and facilitated by regulators and governments. Examples such as Belgium, Texas (USA) and New Zealand have very high switching levels, and are also some of the jurisdictions with higher enrolment in voluntary tariffs. Most consumers are not particularly engaged with their energy use, and rarely consider the quantity and source of the energy that they use every day. One of the rare occasions when this may occur however, is when switching suppliers and looking at the different types of tariffs available. This engagement is likely to be something that green energy retailers can take advantage of and may mean higher enrolment if switching rates are higher. One case does go against this conclusion however. In Australia the number of consumers purchasing green electricity has been declining over the past five years. One of the factors cited is that, amid the proliferation of suppliers and price comparison sites, the marketing for the GreenPower scheme gets 'lost in the noise' (ISF, 2015). Despite this recent experience in Australia, increased competition and choice for consumers was one of the original factors which facilitated the growth of green electricity sales until its peak in 2009.

Market structure can not only affect the number of consumers enrolled, but also the type of retailers that operate. In the United Kingdom the market for green electricity currently consists entirely of small niche suppliers who specialise in green electricity. This is due to the recent retail market reforms (OFGEM, 2013b)

which require all retailers to only sell four electricity tariffs. Also relevant is a general reluctance on the part of the 'big six' suppliers to sell green electricity to residential consumers, where in the past there has been a greater profit to be made selling to businesses. This is not the case in other countries such as New Zealand, Germany or Belgium where green electricity is mainly sold by the large electricity companies, whose main customer base still opts for grey energy. Some jurisdictions such as the Netherlands and Texas have both large and small suppliers in the market. It is interesting that differentiation has taken place in this way. The literature on innovation systems and technological diffusion (Rogers and Shoemaker, 1971) would suggest that green tariffs would be offered primarily as a niche product, become more mainstream and then be offered by larger suppliers (Wüstenhagen, Markard and Truffer, 2003). In most of the cases mentioned above, this sort of technological diffusion is not observed as there are too many factors which may block the acceptance of a green tariff such as; perceived low consumer demand, regulatory restrictions on number of tariffs offered, or the finite amount of green electricity available.

The extant literature on green electricity tariffs does not focus on the role of market structure and competition. This is perhaps because international comparisons are usually limited in scope to a handful of examples where market liberalisation has taken place. The finding of this study does echo the conclusion of Bird et al., (2002) who found in 2002 that "retail competition can stimulate green power marketing activity". However, in this case it seems likely that retail

competition does more than stimulate green power marketing, it creates the space for that green power to be sold and determines the number of customers who will actively engage with electricity markets. It also may be somewhat frustrating for policy makers and marketers of green electricity, but one of the main limitations on the growth of green power markets lies in the regulatory economics of the system as a whole rather than anything more specific to green electricity. This is an important finding as it highlights the importance of viewing green tariff enrolment not in isolation, but in the wider context of the liberalised market.

4.6.3 Role of price premiums

There are two contrasting views on the role of price premiums in green electricity markets. The first suggests that, as consumers have limited willingness to pay, the size of the price premium should be an important factor in determining the number of consumers who choose to pay extra to buy green electricity. The contrasting view is that price premiums are be less important compared to other factors such as a general lack of trust and understanding of green electricity (Wüstenhagen, Markard and Truffer, 2003). The findings of this chapter seem to support the later perspective. This may reflect the fact that there are other factors which are affecting the success of green electricity tariffs, such as market structure as discussed previously, or factors more specific to green electricity such as poor consumer understanding, trust and a general lack of awareness. It

is also worth noting that even with a high price premium, an average household using 3000kWh a year would only pay a price premium of around £7.25 (around €8.50) per month in the UK. This is not a particularly large cost compared to the total household electricity bill and is far less than many consumers pay to purchase other ethical goods. This suggests that much of the focus on price premiums may be due to the preponderance of willingness to pay studies, rather than because it is one of the most important factors.

Previous studies also do not recognise the significant methodological decisions which need to go in to the analysis of price premiums. As a result, this research shows considerable differences with studies such as Hast et al. (Hast et al., 2015) which did not take into account these issues. For example, Hast et al. find that the minimum price premium for a low usage household in the UK is -7%, something that is certainly not reflected in the data collected in this research. The only way this figure could have been obtained would be if the cheapest green tariff was compared against a typical grey tariff, which is not an accurate reflection of how most consumers choose their electricity. A similar issue is encountered by Diaz-Rainey & Ashton (Diaz-Rainey and Ashton, 2008) who only use the price comparison for the green electricity and therefore conclude that a negative minimum price premium and a small average price premium both exist. The data in this research suggests that, unlike the findings in the aforementioned studies, green electricity is almost always more expensive than grey electricity when using a price comparison tool and excluding co-operatives.

This is not true however for two countries, the Netherlands and New Zealand. In these two countries green electricity is available at the same price as grey electricity. The two countries also have the largest proportion of consumers purchasing green electricity. In New Zealand this is likely because a very large percentage of the energy mix is generated from renewables so an increasing number of companies are selling their energy as 'green'. In the Netherlands the story is slightly more complicated, not least because the majority of their green tariffs are backed up by cheap imported Norwegian guarantees of origin. This has caused a subset of tariffs to emerge which promote domestic green energy. This may be a case of greenwashing, where even though the percentage numbers are particularly high there may be little actual environmental benefit.

4.6.4 Interaction effects with other renewable energy policies

It is often argued that that green electricity tariffs may be a consumer and market response to a government's failure to invest sufficiently in renewable energy (van Rooijen and van Wees, 2006; Hofman, 2008; Mewton and Cacho, 2011) [38, 39, 42]. Bird et al (2002) also reach a similar conclusion, arguing that purchase obligations and other policies designed to support renewables may 'stifle markets' (p.18-22). This research seeks to test this idea, which had not previously been supported by academic evidence. In the data this hypothesis was explored by examining the relationship between the percentage of energy generated from renewables and enrolment rates. From examining the case

studies, and in light of the lack of statistical significance, it appears that the relationship between green tariff enrolment and other renewable energy policies is complex and multi-directional. While it may be true that consumer demand can be increased by a perceived lack of action on the part of the government, the presence of government support for renewables is necessary to provide the low cost renewables for those consumers to purchase. Future studies may benefit from developing more complex indicators of government support for renewables, as looking at the percentage of energy generated from renewables may not capture variation which exists between markets and natural resources, which may determine the level of renewables but would not be related to government support.

As mentioned above, it is commonly said that green electricity products are a consumer response to a perceived lack of action by government. Based on this logic one would suggest that jurisdictions with higher enrolment rates would be those where the government has less support for renewable energy and consequently less renewables are generated. The main case study supporting this theory would be Texas (USA), where there has been relatively little government support for renewables but a high take-up of green electricity products. Similarly, some have suggested that relative success of green electricity products in several Australian territories is a response to a lack of government support for renewables. However, this does not seem to hold true when looking across all the cases studied in the dataset. Countries such as

Germany and New Zealand have supported renewables yet also have among the highest rates of enrolment. Other countries have equally mixed experiences, so it would be impossible to find a consistent pattern.

An alternative explanation may be that there can be some symbiosis between support for renewables, which may be supported among the population, and a desire among consumers to purchase green electricity. It also may be that government supported generation allows electricity to be produced more cheaply, so can be sold to consumers at a lower price. This to some extent also depends on the regulation of green electricity sales and how government supported generation is counted towards the accreditation of green electricity tariffs. The macro level factors examined in this chapter may be unable to answer this question further. This is one area therefore which would benefit from further research to understand why consumers choose to purchase green electricity and if their decisions are affected by the extent to which the government also supports renewables.

From the case studies and data collected it appears that the interaction effects between sales of green electricity and other support mechanisms are complex and multi-directional. The GreenPower program and the Australian Renewable Energy Target (RET) is a good case study to demonstrate this point. When the GreenPower Program first started in 1997 there was little government support for renewables and consequently the scheme had some success in gaining

customers. When the government implemented the RET and mandated retailers to source a certain proportion of their electricity from renewable sources it had a mixed effect on the GreenPower scheme. On the one hand it created a system by which large scale generation could be easily accredited and sold to consumers, but it also increased energy prices and made it more difficult for retailers to explain to consumers where the additional environmental benefit in their tariffs was to be found. These negative interaction effects, along with several other factors, have led to a decrease in the number of consumers purchasing green electricity since 2009.

The Netherlands also provides an interesting case study for the interaction effects between policy types. The Dutch government supported sales of green electricity through tax exemptions between 1996 and 2005. During this time there were few other government support mechanisms for supporting renewable energy. The Ministry of Economic Affairs argued against introducing a renewable quota for retailers as it may undermine the market for green electricity sold to consumers (van Rooijen and van Wees, 2006). In the end this did not happen, sales of green electricity have grown by 20% since then, but it does show that the regulators did not view the two policies as complementary.

4.6.5. Regulation and labelling

Previous consumer research suggests that the presence of an eco-label and the regulation of tariffs can encourage consumer uptake of green electricity tariffs (Roe et al., 2001; Wüstenhagen, Markard and Truffer, 2003; Diaz-Rainey and Ashton, 2008; Hanimann, Vinterbäck and Mark-Herbert, 2015). These mechanisms are designed to build trust among consumers and provide easily recognisable brands that consumers will value. There is no statistically significant relationship between enrolment rates and the presence of an eco-label. However, despite the lack of statistical significance, many of the countries with high levels of enrolment do have an eco-label. When ranked by enrolment rates, eight of the top ten jurisdictions had eco-labels, compared to just three of the bottom ten. The lack of strength of this relationship is perhaps not unsurprising. It is relatively easy for eco-labels to be implemented, particularly when incorporating an international standard such as the Ekoenergy label, which now certifies over 1 TWh of electricity across 16 countries including most of Western Europe (EKOenergy, 2016). There is also uncertainty over the direction of causality, whether the presence of an eco label is responsible for higher enrolment or a product of it. Furthermore, it is clear from cases such as the UK which has had two green electricity labels which are now no longer in operation, the most recent certification scheme was retired after regulation was implemented to do a similar function, that having an eco-label is no guarantee of success. The GreenPower label in Australia has also had some success, but

has struggled to establish a brand and relationship with consumers. Since 2009 the number of providers offering green tariffs has dropped off and the number of customers has declined. The recent review of its progress cited the poor marketing of the eco-label as one of the reasons for this (ISF, 2015). What may be more relevant are the specifics of a particular label, such as levels of industry support, tightness of regulations or government backing. This corroborates the findings of Truffer et al (2001), and highlight that it is important to ensure that the correct type of eco-label is implemented for the stage of the market's development.

In recent years there has been an increase in the number of regulators which have proposed specific requirements for green electricity products. This is a relatively recent phenomenon and seems to have been mainly prompted by concerns around consumer protection. In the data collected it does appear that jurisdictions with higher levels of enrolment are more likely to have regulation specific to green tariffs. It is unclear however, what direction the causality is here. It may either be that regulation encourages suppliers to offer green tariffs and builds trust in consumers, or it may be that regulators react to the growth of the new market by implementing regulations to protect consumers. While further discussions with regulators across each of the samples would be required to answer this question definitively, it seems like the latter direction of causality is most likely. This was certainly the case in the UK and Ireland, where the

regulatory body was primarily motivated by consumer protection (OFGEM, 2014).

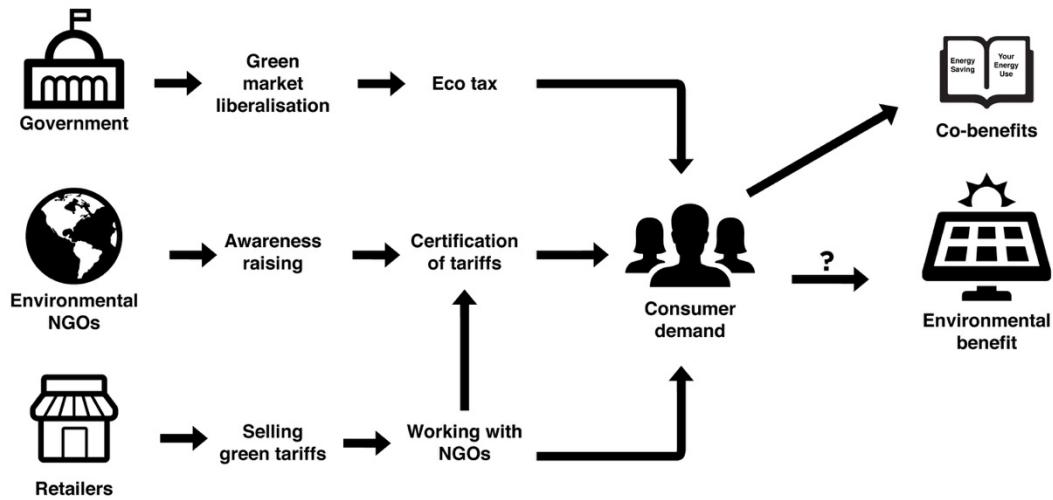
4.6.6. Policies to support green electricity sales

While policies to support green electricity sales are often sold as a ‘no regret’ policy option for supporting renewables (Pichert and Katsikopoulos, 2008) this review finds that in reality these types of intervention are rare and the majority of national governments have tended to concentrate on subsidies or obligations. In all but one case, which will be explored further below, national governments have not identified the positive role that consumer demand for green electricity sales may have. This may be a missed opportunity as, in theory, it is a good policy option to encourage consumers to purchase green electricity themselves, as it is cheap for governments to implement and ensures that fewer costs are placed onto those consumers who are not willing to pay for green electricity. It also means that consumers are more engaged with their energy supply and see some private benefit through the ‘warm glow’ satisfaction that arises from knowing that their energy is sourced ethically (Jacobsen, Kotchen and Vandenberg, 2012).

While most governments have not chosen to implement policies to support the development of markets for voluntary green electricity tariffs, the Netherlands has. Between 1996 and 2003 the Dutch government pursued a policy to support

renewable energy through increasing consumer demand, particularly from households and small businesses. While the government was instrumental in the policy, the co-operation of retailers and environmental NGOs was also key. The interaction between these different stakeholders is visualised in figure 4-3. In 1996 an energy tax was introduced for small and medium scale energy users, the 'Ecotax'. This was a levy that was placed on all electricity usage and had the effect of increasing all energy prices for consumers. Green electricity purchased by consumers was exempt from the tax, which made green electricity comparable to, or sometimes cheaper than, grey electricity. This was especially true after 2001 when the tax increased from 2-3 to over 6 euro cents per kWh. The market for green electricity was also liberalised before the market for grey electricity, with many retailers opting to compete for customers on the basis of electricity source. Some retailers also partnered with NGOs such as the World Wide Fund for Nature (WWF) who also ran campaigns encouraging enrolment in green tariffs. The set of policies above was very successful in increasing demand and engaging consumers, but as demand increased supply did not. The extra demand was met by increasing imports from Norway, which had little environmental benefit. The Ecotax was phased out in 2005 and was replaced by a new feed in tariff, a more conventional demand-pull policy. There have also been smaller scale policies at the city level in Portland, and community level in Connecticut (Kotchen, 2011) and Memphis (Jacobsen, Kotchen and Vandenberg, 2012).

Figure 4-3: Policies to support green electricity sales in the Netherlands



4.7 Conclusions

This review is the largest ever study of markets for green electricity products, covering all jurisdictions in the developed world where green tariffs are sold at a price premium. The research is significant update on the previous literature and provides a detailed analysis on the state of markets for these products. It is found that both the number of countries where green electricity tariffs are sold and the number of households purchasing tariffs have increased noticeably. Established markets such as the Netherlands, Germany and New Zealand have seen significant growth since the previous largest study in 2002. New markets have also recently opened, such as in Eastern Europe, substantially increasing the number of consumers who have the choice to purchase green electricity tariffs. This has an important impact for energy policy as a whole as it signals that these tariffs may not be necessarily be a niche market, and have the potential to be a viable alternative, or complement, to Government subsidies or

obligations. This could be especially relevant once the price of renewables approaches grid parity, where the additional revenue provided by consumer demand may become more important.

The chapter has also developed methodological improvements in the calculation of price premiums for green electricity, recognizing that consumers are likely to be shopping around and comparing the cheapest green tariffs with the cheapest conventional tariffs. Previous studies use inconsistent and flawed methods for calculating the price premium, often finding that green electricity can be purchased for less than standard grey tariffs. Using the methodology of this study, green electricity tariffs are almost always more expensive than grey tariffs. Despite the fact that the two countries with zero price premium are also the two with the highest enrolment, in the other cases the level of the price premium does not appear to be one of the most important determinants of enrolment. In the future it is hoped that more studies will elaborate how their premiums are calculated and understand that the method chosen will determine the level of the price premium found.

This research also establishes the importance of competitive markets in driving the adoption green electricity tariffs, an area which has not been previously explored in the literature. It is found to be a significant factor in determining the uptake of green electricity tariffs and highlights the importance of viewing green electricity products in their regulatory context. This suggests that as consumer

engagement with electricity markets increases across the world, particularly in Europe, there may be further opportunity for green electricity products to become widespread. More generally this may indicate the importance of competitive retail electricity markets in enabling new innovative products to thrive. Often the debate around energy market regulation focuses on delivering price reductions to consumers, perhaps ignoring other benefits in terms of innovative products which deliver other forms of value to customers.

The review also finds that, while green electricity tariffs are portrayed as a “no regret” cost effective means to support the development of renewables, most governments have not implemented policies to support their development. In the Netherlands, where government has taken the steps to encourage the growth of the market, enrolment has increased significantly, albeit with little impact on the amount of installed renewable energy. The relationship between consumer demand for green electricity products and other support mechanisms for renewable energy is also found to be complex and multi-directional. This makes it possible to question the assumption which is present in much of the literature, that green tariff enrolment is a response to perceived government inaction. In reality strong government support for renewables can be important in subsidising the electricity which ends up being sold to consumers through the voluntary market.

While this study has shown that green electricity products have significant potential, there are several possible limitations which may be important to bear in mind. The first is that electricity markets are expected to be transformed over the coming years as technologies such as smart meters and microgeneration become widespread. These technologies have the ability to fundamentally change the ways that consumers interact with energy usage and in the future the strict distinction between retailer and consumer upon which this research is based may not be so applicable. This is already starting to be observed in Australia, where consumer preferences are switching away from purchasing green tariffs and towards more visible and local support measures for renewable energy. This will present both a challenge for marketers of green electricity, who have to compete with these new more local ways of supporting renewables, and regulators, who have to consider how these new technologies and practices should be incorporated into the grid and markets.

4.8 Appendix A: Calculation of price premiums for green electricity

The price premium is defined as the difference in price between the cheapest 100% green and cheapest grey electricity product on the market. Prices were found using a price comparison tool where available, which was the majority of cases. Where price comparison tools were not available, quotations were obtained from all possible suppliers. The following criteria were used for each of the quotations:

- The electricity supply address was a typical household in the largest city/region in the jurisdiction, this was usually the capital city.
- The figures are based on an annual consumption of 3000kWh. There is also no reason to believe that in any of the markets there would be a significant difference between the price premiums for low or high users of electricity.
- The household was assumed to have a single rate meter with no time of use pricing.
- The comparison was made usually between fixed rate tariffs, but where only variable green tariffs were available a like for like comparison was made.

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5. Buying green in the age of digital automation: analysing the interaction between digital third-party intermediaries and green energy products

5.1 Preface

The key finding from chapter four which informed the research conducted in chapter five regards the role of consumer engagement, which was measured in chapter four through switching rates. The extant literature also picks up on this, with poor customer engagement with energy markets in general blamed for a lack of interest in green tariffs (Yang, Solgaard and Haider, 2015). Simultaneously, a growing proportion of consumers engage with the market through intermediaries, who have been the main actors driving switching rates over the past decade yet have been the subject of little academic research. Chapter five therefore aims to understand if the increased automation of engagement with retail energy markets through intermediaries has any tradeoff with the ability to discover and switch to green electricity products.

This paper is currently under review in the journal Energy Research and Social Science.

5.2 Abstract

The lack of competition in many retail energy markets is often attributed to poor consumer engagement. To remedy this, behavioural economists point to

evidence which shows that regulators need to make the engagement ‘easy’, implementing policies to reduce the amount of time and effort required for consumers to switch suppliers. One such method to do this in energy retail markets are Digital Third Party Intermediaries, which can help consumers switch supplier more easily by automating some steps of the process. However, discussions about these technologies are usually focused on potential cost savings for households and rarely consider how environmental preferences can be incorporated into automated decisions. This chapter analyses how these intermediaries interact with green electricity products, where consumers can choose to pay a premium to receive electricity from renewable sources. Three forms of intermediary are included: price comparison, group switching, and automatic switching. The relationship is explored using a mixed methods approach, combining an analysis of intermediary platforms with in depth stakeholder interviews. The research finds that there is considerable variation in the ways in which green electricity products are incorporated into intermediary platforms. In many cases green products are not clearly marked and, in some cases, as in some group and automatic switching services, they are not included at all. A tradeoff is also found between increased automation and the ability to incorporate environmental values into platforms. As the amount of information presented to consumers decreases, from whole of market, to auction winners, to only the cheapest, there is a decrease in the ability to both learn about, and consequently switch to, green electricity products. This tradeoff has both technical and market explanations. Many operators see the market for green

products as too small, there is a lack of knowledge on the part of the most operators, there are technical difficulties in system design and greater long term uncertainty exists regarding the role of intermediaries in the retail energy market. This case demonstrates the limits of the 'make it easy' approach, especially as there is a growing recognition that greater consumer awareness of how energy is used will be important in the future energy system. Despite these concerns however, in cases where intermediaries are informed and engaged with the products, they can be a useful tool to educate and evangelize the value of green energy to consumers.

5.3 Introduction

In competitive retail electricity markets, increasing numbers of consumers are choosing to engage with the market via digital third-party intermediaries (DTPIs), which make the process of searching for tariffs and switching supplier easier (Energy Committee, 2015). These intermediaries can be classified into two broad types; those which assist, such as price comparison or group switching, and those which fully automate, such as automatic switching. There is also an increasing range of electricity tariffs available to consumers, with varying environmental attributes. This research chapter aims to find out what happens at the intersection of these two trends, whether the ease which DTPIs bring to switching may have tradeoffs in terms of limiting consumers' ability to discover and switch to green electricity tariffs. The Great Britain retail electricity market is

used as the case study, but the results will be relevant for other competitive markets which suffer from similarly low levels of consumer engagement. A theoretical framework drawing from behavioural economics underpins the analysis, providing insight into the biases which consumers display when making purchasing decisions. This is an important area to explore as, while there has been research which looks at consumer inertia and switching from a behavioural economics perspective, the role of intermediaries in the process remains relatively understudied. Furthermore, while the tariff attribute of interest in this chapter is whether the electricity is green, the results will have implications for other types of tariff such as dynamic (Fell et al., 2015; Dutta and Mitra, 2017; Nicolson, Huebner and Shipworth, 2017) and regional (Kalkbrenner, Yonezawa and Roosen, 2017) tariffs. This research has three broad aims. The first is to understand how DTPIs in the retail energy market currently incorporate green electricity products. The second is to determine if there is any trade-off between assistance or automation and the ability to incorporate green electricity products. The final aim is to identify what challenges must be overcome in order to allow green electricity products to be better incorporated into the intermediaries' platforms.

The automation which prompted this research is not confined to retail energy markets. Many tasks which were previously performed by humans will start to be carried out by intelligent software and hardware, with an estimated 47% of jobs at risk of computerisation (Frey and Osborne, 2017). While the impacts on

labour markets may be most commonly discussed (Frey et al., 2016), increased automation also has the capacity to transform fields as diverse as care for the elderly (Broekens, Heerink and Rosendal, 2009), health (Poulymenopoulou, Malamateniou and Vassilacopoulos, 2012) and transport (Parent, 2007). This chapter is interested in the disruptive technologies which have the capacity to transform consumer engagement with retail energy markets. However, while they are usually presented as both beneficial for consumers and competition, their increased ease of use and simplicity may come with some trade-offs. For example, given that utility functions of automatic switching services are likely to be constructed to minimise price, there is no clear mechanism for environmental preferences to be taken into account. It is unclear how these difficulties can be overcome and how green consumers can make ethical purchasing decisions in an increasingly automated world.

The recent Competition and Markets Authority (CMA) report (CMA, 2015) into competitiveness in retail energy markets came to the conclusion that a widespread of lack of consumer engagement with the market was responsible for the lack of competition, resulting in excess profits for the large ‘big six’ suppliers. This has the result that many households pay more than they should for energy, particularly those on out of contract tariffs. One of the remedies the CMA proposed was to empower DTPIs to actively reach out to unengaged consumers through a national register of unengaged consumers. Similarly OFGEM has promoted the use of DTPIs through its campaign encouraging

consumers to switch. There has also been financial support for group switching services under the Cheaper Energy Together fund, which launched in 2012 and funded 31 group switches with a £5 million budget (DECC, 2013). Group switching services have also benefitted from a partial exemption from the four tariff cap imposed under OFGEM's retail market reforms (OFGEM, 2013a). The rationale for this government support for DTPIs seems clear, they can provide information to consumers and reduce the costs associated with searching between, and switching to, electricity tariffs. This chapter will analyse three types of intermediary; price comparison, group switching and automatic switching. While the former two types have been covered to a small extent in the current academic literature, this will be the first research to also consider automatic switching services. The market leader, Flipper, only launched its product in 2016, but it is possible to draw a number of interesting conclusions even at this early stage. Previous research, if it does cover DTPIs, tends to only focus on one particular model at a time. This research, by looking across three different types of intermediary, is able gain unique insights by highlighting the differences and similarities between the business model types

Alongside the growth of a more competitive energy market has been a growth in green electricity products, with increasing numbers of consumers choosing to voluntarily pay more to receive their electricity from renewable sources (MacDonald and Eyre, 2018). While this remains a niche market there is still potential for it to expand in the future, especially as the price gap between

renewables and conventional electricity shrinks. It is common for research on green electricity products to highlight the role of education and awareness of green products as something which can determine enrolment (Salmela and Varho, 2006; Bird et al., 2010). Given that increasing numbers of consumers are interacting with the energy market through intermediaries, it is important to take into consideration the extent to which the platforms facilitate or reduce the awareness of green electricity products. This study will explore that conflict and examine the interaction between green electricity products and different DTPI platforms. This is a unique contribution to the literature as currently no research has examined the interaction between these two different aspects of retail electricity markets.

This study employs a mixed methods approach incorporating evidence from two sources. The first is an analysis of intermediaries' platforms, which were coded by how green electricity products were presented to potential customers. The sample covered most major DTPIs operating in the GB marketplace, along with many smaller niche DTPIs aimed at specific market sectors. To provide further insight a number of semi-structured elite interviews were undertaken with managers of intermediary platforms and consumer groups. These included interviews with operators of DTPIs from all three different types of intermediary. A particular effort was made to ensure group and automatic switching platforms were well represented, as these types of platforms are fewer in number and relatively less studied.

The first step for this research chapter is to provide background on the role of DTPIs in the UK retail energy market. Second, a theoretical framework will be outlined which uses concepts from behavioural economics to break down the process of choosing an electricity supplier into ‘searching’ and ‘switching’ phases. Next the methodology is presented, followed by results and a discussion based on the research questions outlined above. Finally, some conclusions will be made on the role of intermediaries in the current landscape and what the future may hold for increased automation in retail electricity markets.

5.4 Background

Analysis of the competitiveness of markets usually involves examining their structure, concentration and the behavior of firms within them. However, in areas such as energy retail, it has become increasingly clear that markets can be rendered uncompetitive by the action, or inaction to be more accurate, of consumers within those markets (CMA, 2015). Most consumers do not switch supplier and consequently remain on expensive standard variable tariffs, ignoring possible cost savings of hundreds of pounds a year. Consequently policymakers are constantly (OFGEM, 2017) looking at ways to reduce the amount of time and effort required by consumers to engage with the market, and encouraging the choices preferred by the policy makers. In energy retail

markets one solution to do exactly that are digital third-party intermediaries (DTPIs), businesses who use digital technologies to assist or automate tariff decision making. By reducing the amount of time and effort required to search between and switch to electricity tariffs, these technologies should increase consumer engagement, facilitate better decision making and in the long run should lead to a more competitive energy market and lower prices for households. DTIPs act as an interface between retail electricity companies and consumers, providing information, assisting in switching, or automating the process entirely. The majority of intermediaries rely on commission payments from energy retailers for their revenue. These commission payments can be significant, up to £100 per customer. The services can also provide good value for consumers, especially if the alternative is an expensive standard variable tariff (CMA, 2015). Increasing numbers of consumers are using intermediaries to find out about the deals offered when last compared or switched, 51% of consumers used online price comparison services in 2016 compared to just 39% in 2014 (OFGEM, 2016). This ranks far higher than the two next most popular information gathering methods, ringing their current supplier (16%) and checking their current supplier's website (10%). However, the same research found that the penetration of group switching services was low, with only 1% of respondents having found out about the deals offered this way.

It may be useful to also attempt a definition of what a digital third-party intermediary is in the context of retail energy markets. Given there are no pre-

existing definitions in the academic literature that cover all the three types of platform included in this research, they will be defined as any interface between consumers and energy retailers, where some of the costs of switching and searching are transferred from the consumer and to the intermediary. While this chapter refers to these intermediary platforms as 'digital third- party intermediaries', others have used different terms to describe them. The recent CMA investigation refers to them as 'Digital Comparison Tools' (CMA, 2015), and includes all switching services covered in this research under that heading. This does not seem to be the most accurate term to describe the platforms, as it overstates the value of the 'comparison'. One could argue that a group or automated switch is designed to eliminate the act of comparison, so shouldn't be covered under that term. The term Digital Third Party Intermediary is broad enough to cover all types of switching service and makes clear that these are a new actor which is acting as an intermediary between consumers and retailers, through comparison, auctions or automated decision making. This chapter also refers to group switching instead of the more common 'collective' switching. The term 'collective' has connotations of the group as a cooperative, communal and shared enterprise. In reality this is no longer the case, as 'groups' for the purpose of switching are increasingly just segmented consumers whose value isn't in their co-operation but just the intermediaries' increased bargaining power.

DTPIs are not confined to the retail energy sector. They are common in markets which are complex and where customer knowledge and interest is low.

Intermediaries have the power to take markets which are dull and unappealing to consumers and substantially increase engagement. One good example of this may be Payment Protection Insurance (PPI), which was mis-sold for over a decade to millions of consumers who took out credit cards or loans. Consumers are now able to reclaim this money from their bank or lender. Given that few consumers were aware that they were eligible to make a claim, but that the payouts could be significant, a number of intermediaries emerged which made a profit by finding eligible consumers and submitting claims on their behalf. To date intermediaries have been responsible for around three quarters of PPI claims made (Financial Ombudsman, 2016). Similarly, brokers are common in markets for mortgages and insurance, both complex areas where comparing directly between retailers directly is time consuming and can be difficult to understand. Intermediary models, leveraging the power of more open data, are now becoming prevalent in markets such as flights, holidays, consumer electronics, and live event ticketing to name but a few.

It may also be worth bearing in mind some possible downsides of a reliance on intermediaries, aside from any concerns about tradeoffs with the ability to incorporate green electricity products. Group switching for example can have negative outcomes for some consumers, in Sweden the least satisfied customers in the energy market are those who left their choice of supplier to an intermediary, based on data from 2013 (GEODE, 2016). Some intermediaries have also had negative press coverage regarding the practices of intermediaries,

and there has been a Competition and Markets Authority investigation into Digital Comparison Tools (CMA, 2016a), although it did not specifically cover energy markets in the list of case studies being examined.

5.4.1 Price comparison

Of the three types of DTPI included in this research, price comparison platforms are the most mainstream. 51% of consumers have used price comparison tools to find out what deals are available on the market, compared to just 1% for group switching (OFGEM, 2016). The platforms are primarily online, but many also use telephone and in-person sales channels. Consumers are able to use the platforms to compare electricity tariffs, usually after inputting some basic information about their usage, meter type and location. The results are displayed on a list, ranked from cheapest to most expensive by an annual cost estimate calculated from the information supplied by the consumer. Alongside the price of the tariff is usually the supplier, payment method, and contract length.

Price comparison websites are subject to voluntary regulation through an opt-in confidence code published by the energy regulator OFGEM (OFGEM, 2015). The code is voluntary and as such only a relatively small number of participants have enrolled. Only one of the large players has signed and most of the most popular platforms have not. The code sets out nine requirements for participants, all of which need to be satisfied to be accredited. The regulations are designed to

increase transparency, through a requirement to have the option for a ‘whole of market’ comparison, impartiality of tariff presentation, and accuracy of the pricing and usage estimates. The requirement to be ‘whole of market’ is particularly relevant, as platforms which show a limited view can hide potentially cheaper tariffs from consumers. A recent report by the House of Commons Energy and Climate Change Committee made a number of recommendations on how to make price comparison websites more transparent (Committee, 2015). In order to ensure all platforms are whole of market they recommend regulating price comparison websites directly, or by amending license conditions of energy retailers so they are only permitted to work with accredited intermediaries. The report also goes as far as to suggest that compensation should be provided to customers who were encouraged to switch to a tariff that is not cheapest or most appropriate for their needs, as well as more transparency on commissions.

The academic literature relating to the price comparison platforms is limited, which is interesting given the crucial part they play in British energy markets and their role in engaging with customers. One economic analysis of the impact of price comparison websites on consumer prices found that their benefit was far from clear, and that in an unregulated market “if consumers only check one of the sites each, it is no better than if there were monopoly” (Ronayne, 2015). Consumer focus group panel research conducted on behalf of OFGEM found that participants were skeptical of the motivations of price comparison websites

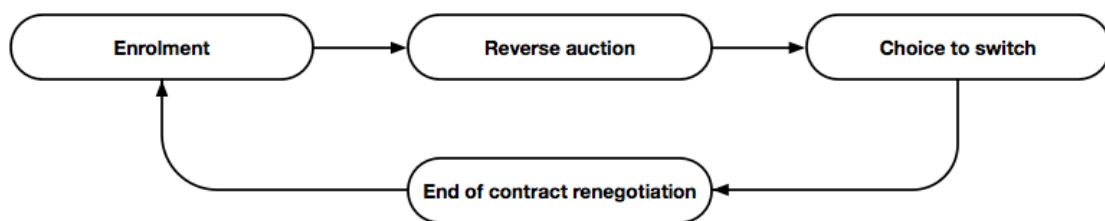
and questioned their impartiality (Ipsos MORI, 2012). Gamper (Gamper, 2012) also backs up these findings and also suggests that price comparison websites should focus more on the quality of service aspects of suppliers' offerings and less on price.

5.4.2 Group switching

Group switching platforms use the purchasing power of large groups of consumers to negotiate good prices for those participating in the switch. Participating in a group switch is usually a three-phase process, as shown in figure 5-1 below. The first phase is enrolment, where participants must actively opt-in to the scheme and provide some basic information on their electricity usage and type of meter. The second step is that the platform operator takes this list of participants and approaches electricity retailers, trying to source the best possible deal in terms of price. This typically take place in the form of a reverse auction, where the supplier who 'bids' in the lowest contract price is awarded the opportunity. The third stage is that the winning bid is communicated back to the participants who then have the opportunity to switch to that supplier or back out. There are some variations between the different platforms on the market in terms of the number of bids which are presented to participants in the final stage, the types of customers which are targeted and the ways in which participants are re-engaged once their contract has elapsed. There is no specific regulation for group switching services. However, there have

been a number of policies implemented to support their development. Group switching services were exempt from the retail market reform 4 tariff cap, so electricity retailers were able to offer an additional tariff to group switches (OFGEM, 2013b). Having been championed by the then Secretary of State for Energy Ed Davey, local authorities were also funded to run group switching campaigns under the Cheaper Energy Together fund launched in 2012 (DECC, 2013).

Figure 5-1: The three stages of a group switch



There has been some previous research which has looked at group switching, particularly in terms of the potential gains to those on low incomes. An analysis of group switches run by local government and funded through the 'Cheaper Energy Together' fund found that 29% of the general population and 25% of low income groups would be interested in participating in group switching (Consumer Futures, 2014). Focus group research conducted as part of the same project found that participants were skeptical of the motivations of the intermediaries and valued the presence of a trusted organisation such as a local authority. One characterisation of group switches is that they usually consist of two organisations, one providing the trusted front face and another supplying

the back-end technology (EESC, 2015). Some focus group participants with low incomes also expressed the concern that participating in a group switch might mean they lose their Warm Home Discount, a discount given to fuel poor households which is only available from some suppliers, or experience possible price rises.

Group switching schemes can have a difficulty in ensuring that participants follow through and do eventually switch, especially as the total switching process from registration to changing supplier can take months. One study found that only one third of participants followed through (Waddams et al., 2014). There have also been some international experiences with group switching, in fact one of GB's largest players has been operating in the Netherlands and Belgium since 2008. In the USA several states have experimented with municipal aggregation, which have been successful in states such as California where it is estimated that the PG&E may lose half of its customers to the schemes by 2027 ('Promising Local Control, Green Energy, California CCAs Snatching Away Investor-Owned Utilities' Customers', 2017). Other states however have had more mixed experiences, where opt-in schemes have struggled to attract sufficient interest and some opt-out schemes have had difficulty in negotiating prices below the standard tariffs available to all consumers (Littlechild, 2008).

One view of group switching which has been discussed in the academic literature and elsewhere but has not yet manifested itself in any product offerings, concerns the possibility of groups forming around certain attributes. Hirsch (Hirsch, 2013) argues that group switching could allow groupings to form around common preferences, such as those on lower incomes who might have stability over price. A project from the field of computer science also looked at a technology to group consumers around similar load profiles and form group discounts based on these groupings (Ramchurn et al., 2013). Robu, Vinyals et al. (Robu et al., 2014) explore a similar idea relating to prediction-of-use electricity tariffs. One similar application of this principle to healthcare in the Netherlands does find however that group contracts formulated in this way can lead to increased variation in premiums across the population as preferential contracts are offered to ‘good’ customers [56]. In the energy context one could imagine this having equity implications, perhaps as middle class households who are able to engage in load shifting are offered preferential rates, though the same criticism could also be made of time of use tariffs more generally.

2.3 Automatic switching

Automatic switching services are relatively new to the GB marketplace. Flipper, the market leader, was launched in mid-2016. These services offer the most automated switching process out of the three studied in this chapter. Customers are required to sign up to the service and pay an annual fee. The platform then

acts as the customers' agent, as defined under the services' terms and conditions of use. This gives the platform the ability to select an energy provider, apply for services and take out contracts and access the customers' information held by third parties. The platform is therefore able to automatically deal with searching and switching, automating the entire process and requiring no further involvement on behalf of the customer. Customers are notified by email each time a supplier is changed, which also gives them access to the standard 14 day cooling off period if they do not wish to continue. These services are not currently regulated, aside from general consumer protection and energy market regulation. There is also no academic work which relates to this type of platform, something that this research will seek to address.

2.4 Green electricity tariffs

Energy markets in Great Britain (GB) are primarily designed to promote competition and reduce prices for consumers, but are also expected to meet a wider number of goals, including promoting energy efficiency, reducing fuel poverty and increasing the supply of renewables [6]. One of the mechanisms to promote this final objective, increasing the supply of renewables, is voluntary green electricity tariffs, where the electricity sold to households is generated from renewable sources. In the UK 100% of the green energy sold to consumers is required to be sourced from renewables accredited under the Renewable Energy Guarantee of Origin scheme (OFGEM, 2014). While many consumers

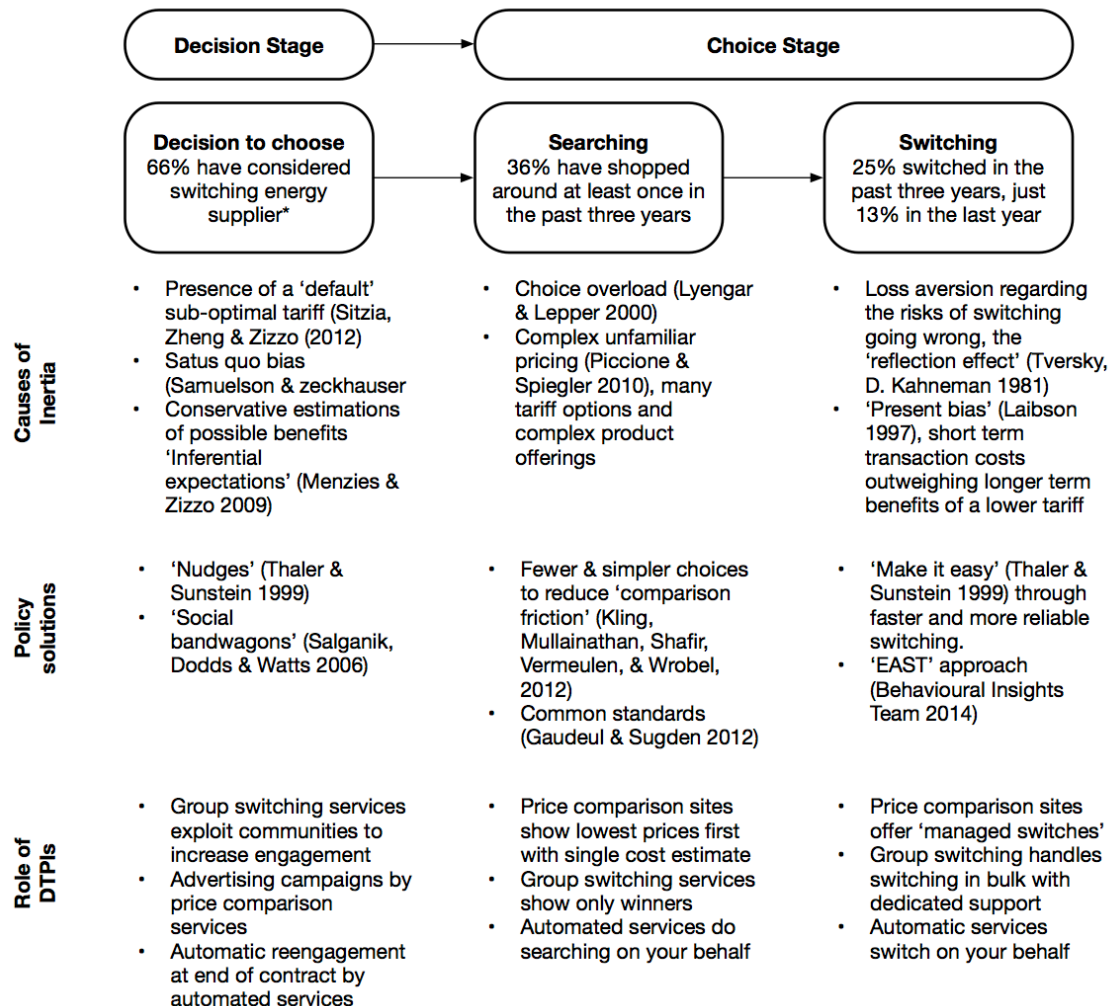
would like to purchase these tariffs, it is always conditional on the level of the price premium that consumers are willing to pay (Borchers, Duke and Parsons, 2007; Akcura, 2013). These types of tariff are growing in the UK, and across the world (MacDonald and Eyre, 2018). The growth in the UK market has been attributed to a number of factors including increased supply of renewables, increased switching in the retail market and the success of some key niche players such as Good Energy and Ecotricity. Most recently a new wave of price focused green electricity companies have launched, such as Bulb Energy. These suppliers will help the market to expand to more price-sensitive consumers who would have been previously put off by the higher prices of the incumbent green electricity companies mentioned above

5.5 Theoretical Framework

This chapter uses behavioural economics to analyse consumer engagement with retail energy markets, which is increasingly being used in energy research and policy (Hampton and Adams, 2018). Behavioral economics focuses on understanding the ways that consumers make decisions in practice in specific social and behavioural contexts, rather than assuming utility maximisation. Classical economic analysis struggles to explain the apparent irrationality with which most consumers act in the market, where savings of hundreds of pounds a year are ignored by the vast majority of consumers (Flores and Price, 2013). The literature on behavioural economics in energy markets is substantial (Pollitt and Shaorshadze, 2011; Mehta, 2013), and as such this literature review will only include the elements most relevant for this particular case study. Behavioural

economics has also started to offer some policy solutions to correct for these biases, with influential concepts such as ‘nudges’ (Thaler and Sunstein, 1999) now extensively used by policymakers. The framework adopts the distinction between ‘search’ and ‘switching’ which exists in work on retail energy markets such as Flores and Price (2013), Honcka (2010) and Wilson (2012). Given that many consumers do not even get as far as searching, as recognized by Hortaçsu et al (Hortaçsu, Madanizadeh and Puller, 2012), a separate ‘decision stage’ is added before the search and switching stages.

Figure 5-2: Inertia, policy solutions and the role of DTPIs in the three stages of consumer retail energy market switching



* Refers to switching between suppliers and does not include those who have changed tariff with their existing supplier
 (Data source: CMA domestic consumer survey results 2016)

Figure 5-2 shows how consumer engagement drops off as progression through the three stages takes place, as well as a selection of concepts from behavioural economics which help to explain the inertia which consumers experience. These three stages are useful to include as DTPIs are targeted at increasing engagement at all of these stages, each of which presents particular challenges in terms of consumer engagement. The following sections will go outline how

the behavioural economics literature can inform the ways in which DTPIs are used by consumers.

5.5.1 Decision to choose

The first stage of the switching process is the decision stage, where consumers make the decision to choose a new electricity tariff. As figure 2 shows, over half of GB consumers have considered switching energy supplier (CMA, 2016b). There are many sources of inertia which limit engagement at this stage. First is the presence of a 'default' sub-optimal tariff, usually the standard variable tariff from the 'big six' supplier, which is direct commercial descendent of the regulated private monopoly that inherited the customer at the point of privatization. Work such as Sitzia, Zheng & Zizzo (Sitzia, Zheng and Zizzo, 2012) shows that the impact of defaults can be considerable, with consumers not feeling the need to engage with the market unless prompted to do so. Automatic switching services shift the 'default' inaction to be yearly switching, with the automated service switching supplier when a contract ends or when cheaper tariffs become available. Samuelson and Zeckhauser (Samuelson and Zeckhauser, 1988) also find that individuals exhibit 'status quo bias', leading to incumbent advantage for the 'big 6' suppliers with large established customer bases. The idea of 'inferential expectations' also suggests that consumers have conservative estimations of possible benefits, leading to lower switching rates than would be expected if estimations were calculated rationally (Menzies and

Zizzo, 2009). Price comparison services move consumers towards the decision stage mainly through extensive advertising campaigns, highlighting potential cost savings. One of the key principles of behavioural economics is that social groups are important, and that 'social bandwagons' (Salganik, Dodds and Watts, 2006) can be a powerful tool with which to engage consumers. Group switching services exploit this by leveraging pre-existing networks of consumers and encouraging whole neighborhoods to sign up.

5.5.2 Searching

The second stage of a consumers' switching journey is the process of searching for tariffs and learning about the types of tariff on offer. The complexity of this stage has been blamed by both consumers and regulators for the low switching rates. Behavioural economics can help to explain why this complexity is problematic for consumers. Evidence suggests that the more complex the price structure, the less likely consumers are to make the optimal choices (Piccione and Spiegler, 2012). A key concept here is 'choice overload' (Iyengar and Lepper, 2000), where the presence of a large number of options to choose from may lead to poorer choices rather than better ones. This contrasts with what classical economics suggests, which is that greater choice would promote greater competition and consequently lower prices. To reduce the effect of this, behavioral economists recommend structuring markets to involve fewer and simpler choices to reduce 'comparison friction' (Kling et al., 2012) and to

implement common standards (Gaudeul and Sugden, 2012) to facilitate easier comparisons. All three of the intermediaries included in this study limit choice overload, to different extents. Price comparison sites usually show the lowest prices first, though many more tariffs would be viewable if one scrolls through the whole list of options. Group switching services limit the choice of tariffs to just one or two, and automatic switching services eliminate the choice component altogether. An experiment conducted using a large group switch found that participants were less likely to switch if they saw two offers rather than one (Waddams et al., 2014). In this research a control group of participants was only offered the winning bid from the group's reverse auction. An intervention group were offered two different choices, the winning bid from the group auction and the cheapest tariff available via a comparison website.

5.5.3 Switching

Once a consumer has gone through the process of deciding to switch, then explored all the available options, the final stage is to actually select a tariff and make the switch. As figure 2 shows, only 25% of consumers switched in the last three years with around 13% switching annually (CMA, 2016b). Two concepts from behavioural economics may suggest a reason for this. The first is the 'reflection effect', originating from prospect theory (Tversky and Kahneman, 1981). This suggests that consumers place a higher value on losses than gains so that the risks of something 'going wrong' during the switch are over-valued.

Second is 'present bias' (Laibson, 1997), where short term transaction costs of switching will outweigh the longer term benefits of a lower tariff. Behavioural economists offer solutions to these issues, which while unable to correct for the psychological biases themselves, minimize their effect. Thaler and Sunstein label the essence of the approach as 'make it easy' (Thaler and Sunstein, 1999), where the process of switching supplier should be as easy for consumers as possible. A variation of this also appears within the Behavioural Insight Team's (Behavioural Insights Team, 2014) EAST principle, that actions should be easy, attractive, social and timely. Although the process of switching is usually the responsibility of the chosen supplier, so outside the scope of the intermediary's duties, it is common for them to remain involved. Some price comparison services offer 'managed switches' where the process is monitored by the comparison website. Group switches also will only usually work with suppliers who are able to onboard consumers reliably, which should make the process easy in theory. Automatic switching services make the decision as easy as possible and take all of the control and responsibility away from the consumer.

5.6 Methodology

The research in this chapter is based on two complementary methodologies. The first is an analysis of suppliers' platforms. This provides a good insight into the variation in customer experiences and quantitative data on how green electricity products are presented. Similar content analyses have been effective in understanding how green electricity products are presented on supplier's own websites (Herbes and Ramme, 2014). The second methodology consists of 12

elite interviews with stakeholders. These provide a deeper insight into how those who run or interact with third party intermediary platforms see their role and how they view green electricity products. This mixed methods approach provides a thorough account of the interactions between markets for green electricity products and third-party intermediaries.

As mentioned above, the first stage of the research was to analyse the platforms. The first step was to construct a database of all DTPIs active in the marketplace. The researcher then registered on each of these platforms to experience the customer journeys. These journeys were coded according to a pre-determined coding frame, which is laid out in full in the footnotes to table 1. This included noting what information customers were presented with regarding the environmental attributes of the green electricity products, particularly in terms of how prominently these were displayed compared to other product attributes. This was most easily done for the price comparison and automatic switching platforms, which are all available online and are constantly open to new customers. This was more challenging for group switches, which operate intermittently. Where it was not possible to register for a platform's group switch, details of past switches were obtained from either the platforms themselves or from other reporting.

As a further supplement to the coding of the platforms, more analysis was undertaken regarding the Price Comparison platforms. These deserve a greater

depth of analysis due to the number on the market and the large number of consumers who use these services. These platforms were scored on three factors, which were used to give each platforms a score out of ten, with ten being the platform which best displayed green products. The first factor was the number of 'clicks' required to see whether a tariff was green from the main comparison list. Second was the presence of a green filter so that the user can choose to only view green tariffs. Third was whether the comparison was whole of market by default, the highest score, or up to user choice or partial by default, the lowest score. These three factors were used to rank price comparison platforms by how well green products were displayed.

In order to develop a more nuanced understanding of the issues at hand elite interviews were also conducted with stakeholders from the industry. A total of 12 participants were interviewed, who were senior individuals from the intermediary platforms. The individuals held positions including CEO, CTO and senior policy researchers, so would be in a position to comment both on the operation of their platforms and the market as a whole. Care was taken to ensure that all three types of intermediary were represented. As the size of the market for automatic switching services is small with few suppliers, the sample size for this group is the smallest. These interviews were semi-structured and revolved around four themes; target customers, varying business models, the role of green products, and barriers to further growth of intermediaries. All of the

interviews were conducted by phone or VOIP and lasted between fifteen minutes to an hour. The interviews were coded and organized thematically.

5.7 Results and discussion

5.7.1 Platform analysis

The results of the platform analysis are presented in table 5-1, showing price comparison sites, and table 5-2, for automatic and group switching sites. There is clear variation in the ways in which green electricity products are framed between platforms. This is particularly true between different price comparison platforms. Seven of the eighteen platforms displayed whether a tariff was green in the main product list, however the websites did not offer any detailed explanations regarding which tariffs would be classified as green. One site displayed a green leaf whereas all others had a subheading indicating the tariff in question was a green tariff. There was some variation in the language used to describe green electricity products which ranged from “100% green energy” to just “renewable”. Ten platforms did indicate which tariffs were green, but this information was only available after users had clicked on the ‘more details’ page. One platform offered no explanation as to which tariffs were green and which were not. This was also the platform which was linked to most prominently by the government’s own switching campaign. Ten of the eighteen price comparison websites surveyed included a ‘green filter’ option, where users can

choose to only see green electricity tariffs. While this may be a good mechanism to encourage comparison between green electricity tariffs, in several cases these tools were broken or filtered out some tariffs which were green. This seemed to be most common for newer green electricity companies which do not market themselves specifically as 'green electricity companies', such as Bulb, Octopus and Fischer energy.

There was also some variation in the presentation of green electricity products on the group switching platforms surveyed. The main difference was whether, at the auction stage, a separate auction was held for the cheapest 'green' product. Where this was true participants would be given a choice whether to sign up for a standard or green tariff. In other auctions there was no separate bidding process for green electricity, so participants are just offered a single standard tariff. One group switching service also has previously run exclusively green switches where only a green tariff is presented, but this is not a mainstream offering and was only done in conjunction with an environmental campaigning organisation as a partner. The automatic switching platform included in the study did not give its users an option to select a green tariff. As only one automatic switching service existed in the market when the research was undertaken, it is difficult to tell whether other automatic switching services could frame green electricity products in clearer ways.

Table 5-1: Ranking of how green products are displayed on selected price comparison platforms (as of April 2017)

	Ranking ¹	Confidence Code Accreditation	Consumer Reach ²	Clicks to view green tariffs ³	Green filter	Market coverage
MSE Cheap Energy Club	10	Yes	High	0	Yes	Full by default
Switch Gas and Electric	9	Yes	Low	0	Yes	Choice at registration
The Energy Shop	9	Yes	Low	0	Yes	Choice at registration
Runpath	9	Yes	Low	0	Yes	Choice at registration
Quote Zone	9	Yes	Low	0	Yes	Choice at registration
Energy Helpline	8	Yes	Low	1	Yes	Choice at registration
My Utility Genius	8	Yes	Low	0	No	Full by default - option for partial in list
Simply Switch	8	Yes	Low	1	Yes	Choice at registration
Unravel.It	7	Yes	Low	0	Yes	Partial by default - option for full at registration
Which	7	Yes	High	1	No	Only full
U Switch	7	Yes	High	0	Yes	Partial by default - option for full in list
Go Compare (Runpath)	7	No	High	0	Yes	Partial by default - option for full in list
Compare The Market	7	No	High	1	No	Full by default - option for partial in list
Energy Linx	6	Yes	Low	1	No	Choice at registration
UK Power	6	Yes	Low	1	No	Choice at registration
Confused	6	No	High	2	No	Full by default - option for partial in list
Money Supermarket	5	Yes	High	2	No	Choice at registration
Citizen's Advice	3	No ⁴	Low	-	No	Only full

Ranking methodology, explanations of variables included and footnotes are included in appendix A.

Table 5-2: How green products are incorporated into automatic and collective switching services (as of April 2017)

Platform Name	Platform Type	Consumer Reach	Green Options?
Flipper	Automatic	Low	No
The Mail Finance Switch	Group	Low	No
Telegraph Big Energy Switch	Group	Low	No
iChoosr	Group	High	No
Money Saving Expert Big Switch	Group	High	Yes ¹
The Big Deal	Group	High	Yes ²

Footnotes are included in appendix B.

From the analysis of DTPI platforms it appears that there is a tradeoff between increased ease of switching and searching and the ability to incorporate environmental preferences, which is summarised in table 5-3. As the difficulty of searching is reduced the ability to also display information about green electricity products also appears to decrease. Price comparison platforms, where a wide variety of tariffs were presented to consumers, seemed to incorporate green electricity products most easily. All price comparison platforms analysed included green electricity products and all but one labeled them in some way. Many also provided a filter so that consumers could choose to only view green electricity products. Group switching platforms restrict searching to a narrow choice between just one or two options, one of which may or may not be green. This reduction in search difficulty can be seen as reducing these services' ability to incorporate green products. Automatic switching services, as they eliminate the process of searching entirely, necessarily also reduce the potential for the discovery of green electricity products if they do not happen to be the cheapest on the market.

Table 5-3: Summary of switching effort, search effort, and the inclusion of green electricity products for three types of intermediary

	Searching effort	Switching effort	Inclusion of green products
Price comparison	High A large number of tariffs shown, can be whole of market	Variable Some tariffs can be switched to easily, many not	Information presented inconsistently across platforms. Always an option if a 'whole of market' view is available.
Group switching	Medium Only one or two tariffs shown, selected by the switch operator	Medium Process handled through operator, minimal involvement	Green products available in some group switches. Some switches aimed explicitly at green consumers.
Automatic switching	Low Tariffs selected automatically, no search costs	Low Tariffs switched to automatically, no switching costs	Not currently possible via the one service on the market.

Easier switching also comes alongside a tradeoff in the platforms' ability to incorporate green products. For price comparison websites this is because managed switching, where the price comparison platform can manage switch without having to go to the supplier's website, depends on system and financial co-operation between the intermediary and the retailer, which is not always in place for all green electricity products. For group and automatic switching services the issues are essentially the same as those created by easier searching, that often participants won't ever have the option to view green electricity products as an option, let alone switch to them.

5.7.2 Interviews with stakeholders

Elite interviews were conducted with stakeholders to gain a further insight into the interaction between green products and DTPIs. This was a useful addition to the results above, particularly as only one automatic switching site was included so it was not possible to make any comparisons between different types of automatic switching service. The interviews were coded into four themes which emerged during the course of the interviews - importance of the target market of DTPIs, platform operator's understanding of green products, technical challenges, and long-term uncertainty.

5.7.2.1 Target market of DTPIs

Only one of the participants interviewed saw green customers as an important target demographic for their platforms. This was true across all three types of intermediary. Many referred to the market for green products as a “niche market” whose demand was not sufficient to justify catering to. DTPIs viewed two other demographics as more important; cost sensitive consumers, in the case of price comparison websites, or the previously unengaged, in the case of automatic and group switching platforms. One participant commented regarding an automatic switching service that their “market is time poor consumers who have a perception that energy markets are too complicated”. Markets for green tariffs were repeatedly characterised as being “too small” to justify being incorporated into DTPIs platforms, with little demand. One participant from a start up DTPI commented that “not a lot of customers ask for green electricity products” and that “it isn’t efficient to target niche markets”. The one DTPI who did view green customers as an important target market was a collective switching service who had previously run a green electricity group switch.

The belief that green products are “niche” and not the target market for most intermediaries has important implications for the future incorporation of green electricity products into these digital services. They are unlikely to be seen as an important source of revenue and therefore it is unlikely that any attempts will be made to incorporate green electricity products into increasingly automated

systems. This is especially true for automatic switching services where it would be an extra technical challenge to incorporate green products, as will be explored below, so many system operators may not feel this to be a justifiable expense given their perceptions of the market size. This reluctance could be overcome if the requirement to include green electricity products were incorporated into the code of practice for intermediaries, but recent trends seems to be away from further regulation of intermediaries so this may be unlikely, in the short term at least.

5.7.2.2 Understanding of green products

There was some variation in the levels of understanding regarding green products and DTPI operators seemed to fall into two distinct categories. The first expressed a lack of understanding about the products and consequently wanted more communication from industry or a form of certification to make it easier to incorporate green electricity products. One participant found the variety of products on the market to be a source of complexity, saying that “green electricity products also come in a variety of different ‘strengths’”. One other participant commented that “there were too many different types of green electricity product on the market and it became impossible to compare or rank them in any meaningful way”. The second group was already informed about green electricity products and was using this expertise as a way to guide consumers through the process of buying green electricity. This was particularly

true for the platform operators of group switches which have been responsible for selecting a winning bid from green electricity companies. Two platform operators described the process by which a winning green bid was selected and included not only sourcing of green electricity but also looked at other forms of 'additionality' undertaken by the suppliers. One group switch operator who has had a separate green electricity auction commented that "ideally we would push it beyond just the minimum of having 100% renewable electricity". Where DTPI operators do understand the products available on the market, they can be a useful tool for educating consumers and differentiating between the types of green tariff available on the market.

It perhaps isn't a coincidence that the platform operators with the greatest level of knowledge around green products were from group switching services. These types of platforms are already responsible for recommending tariffs and incorporating several different factors into their decision making, such as customer service and their track record of switching. Well informed DTPI operators have the opportunity to both make searching for tariffs less effort and also to ensure that green products continue to be presented, an outcome which may be more appealing to time poor consumers who would otherwise not consider buying green electricity. This is markedly different to the approach taken by comparison websites, where price is the main differentiator and poor customer service or questionable green credentials is not sufficient to no longer be listed on the comparison page.

5.7.2.3 Technical challenges

As well as the market based obstacles mentioned above, there are also technical obstacles to the incorporation of green products. This was particularly true for the automatic switching service studied, where price is the most important factor, and the service is committed to saving its customers money above all else. An interviewee from an automatic switching service explained that one supplier was “offering a 50% and a 100% green electricity tariff” and that “this would be difficult to incorporate into the platform and might be difficult for our customers.” Conceptually it is difficult to imagine how other preferences could be taken into account, particularly environmental preferences which are values-based rather than quality-based. This is a challenge for human decision making, with solutions such as multi-criteria decision analysis providing useful tools, but for an automated system it becomes more complex still. One possible solution to this problem are ‘smart contracts’ enabled under a Transactive Energy system (Atamturk and Zafar, 2014). These smart contracts, enabled through distributed ledger blockchain technologies, would allow two parties to agree to purchase renewable electricity when certain conditions such as price are met. This would theoretically allow consumers to automate their energy purchasing, either directly or through an intermediary, and buy renewable or local energy when the price meets their willingness to pay. However, this technology requires significant further research and development before it is viable to be offered to consumers.

5.7.2.4 Long term uncertainty

One final aspect to consider, aside from the obstacles mentioned above, is that there are challenges to further adoption of DTPIs in general. This is particularly true for automatic and group switching services, which many interviewees from price comparison platforms were keen to point out. Regarding automatic switching services it is unclear how sustainable this business model is, and it was common to hear that the higher costs of onboarding consumers for shorter periods of time may make suppliers reluctant to co-operate with these platforms. There were also frequent criticisms aimed towards group switching services regarding the length of time it takes to switch and that the potential cost savings for consumers are lower than if consumers themselves went direct to a price comparison website. There is also widespread skepticism of the ability of the government and its data processing partners to implement switching, with one participant commenting that “currently the industry doesn’t support automated switching”. This may be rectified somewhat by smart metering, but as one participant responded “only time will tell”.

5.8 Conclusions

This research set out to explore the interaction between green electricity products and third-party intermediaries, with three central research aims. The first aim of the research was to explore how green electricity products are incorporated into DTPI platforms. The platform analysis found substantial

variation, particularly among price comparison websites. There was inconsistency in how green electricity products were labelled and what steps users needed to take in order to find out if a product was green. There was also diversity in group switching services, which varied depending on the target market of the particular collective switch. The one automatic switching service included in the study did not allow green electricity products to be selected. The second aim of the research was to identify whether there is a tradeoff between making the process of searching and switching 'easy' and the ability to incorporate green electricity products. The platform analysis, backed up by comments from the elite interviews, suggests that this tradeoff is present. As switching and searching became more automated it also became more difficult to discover and then switch to green electricity products. However, it is worth noting that among group switches, if aimed at green consumers specifically, this trade off does not occur as all options presented are green. Since the data collection was undertaken one group switching campaign called the 'big clean switch' has had success only offering green products.

The final research question was to identify challenges that must be overcome in order to better incorporate green electricity products into DTPI platforms. Four areas emerged from the elite interviews as relevant to this question. Markets for green electricity products were seen by many platform operators to be too small to be worthwhile investing in, and most platforms aimed at engaging consumers on the basis of price rather than environmental concerns. While many platforms

expressed a lack of understanding regarding green products, those that were familiar with the market used their expertise to guide their customers towards the green products on the market with the greatest environmental benefit. Some participants with limited understanding indicated they would like to see a scheme of certification or clearer communication from the regulator about the differences between green electricity products on the market. There were also technical challenges to incorporating green electricity products. It remains an ongoing challenge to ensure that increasingly automated services are able to incorporate multiple preferences beyond simply price. A final set of challenges identified related to the sustainability of new business models such as automatic and group switching. Interviewees from price comparison websites pointed out that these two new models may be not in the best interests of electricity suppliers or customers in the long run.

The theoretical framework based on behavioural economics provided a useful explanation of the inertia which some consumers exhibit when switching supplier and provided a rationale for the benefits which DTPIs can bring. However, the results do suggest some limitations of the kinds of policy solutions advocated by behavioral economists. Given the need for energy policy to go further than it does at present, it may be desirable for individuals to pay more attention to how they use energy and where it comes from. Policies which 'make it easy' or take decisions away from consumers entirely may run counter to this. Furthermore, as the time at which energy is used becomes increasingly

important due to the variability of key renewables, more tariff complexity may be necessary in order for the energy system to operate efficiently. Unless energy use can be automated, then greater levels of consumer knowledge would be necessary so that consumers are aware when electricity is, or is not, scarce.

The findings above have a number of other implications. First is that the growth of intermediary services may be further evidence of the inadequacy of the 'supplier hub model', where retailers are the main point of contact between consumers and the energy market. If the point of contact switches to an intermediary then this has implications for the delivery of other services such as energy efficiency or alleviating fuel poverty. One interviewee referred to the role of the supplier being limited to the "name on the bill", suggesting that there would not be a strong relationship between retailers and customers in the future. It may also create difficulties to energy service based business models, which wouldn't fit into the narrow price per unit criteria used by intermediaries. More generally, if digital intermediaries want to offer a wider variety of electricity products, the basis of competition between those products cannot only be the commodity price of the electricity. There must be a shift away from measuring the 'price' of the electricity and towards the 'value' of the electricity both to the individual and the environment

Changing regulations are also likely to impact on the ways in which green electricity products are incorporated into intermediary platforms. The energy

regulator, on the recommendation of the Competition and Markets Authority, has removed the 'whole of market' requirement for price comparison websites. This may have the result that, if price comparison sites do not receive commission from green electricity companies, these products will be presented less prominently. However, this is not likely to have a significantly detrimental effect to green products, as many retailers do offer commission payments to intermediaries and are thus likely to continue to be represented on comparison platforms. Furthermore, it may actually provide intermediaries with a greater ability to make judgements on certain products on behalf of their consumers, perhaps excluding products with poor customer service or green products with questionable environmental attributes. However, if this is to be the case then the level of understanding of platform operators must be increased, the responsibility for which must inevitably fall on the industry given the lack of external regulation.

The opportunities for intermediaries in the GB retail electricity market are clear, particularly given the trend towards increasing automation of homes. Some research has already looked at the potential benefits of group switching among groups of households with similar usage patterns, and this could be a potentially important market in the future. Relating to green electricity, it may even be possible for consumers to buy green electricity on a summer sunny day, but switch to a conventional supplier for evenings, mornings and winters. While the technology to allow this is far off, technologies such as blockchain enabled

smart contracts could make this possible. This research has been based on the assumption that better framing of green electricity products on intermediary platforms is something that would increase enrolment. Based on the current literature, which has found that increased consumer awareness is correlated with increased willingness to pay for green electricity, this is likely to be a valid assumption. However, further research is needed to quantify what possible increase in enrolment could be achieved by more effective incorporation of green electricity products into more or less automated switching systems.

5.9 Appendix A: Footnotes to table 5-1

¹ Ranking methodology:

Each supplier starts with a score of ten and points are deducted based on their performance in three areas Points are deducted based on:

- Display of green tariffs on main comparison grid. 0=indicated directly on list, 1=1 click, 2=2 clicks, 5=not indicated at all
- Green filter - ability to filter tariffs to only show green tariffs 0=green filter, 2=no green filter
- Market coverage 0=full by default, 1=choice at registration, 3=default to partial display

² Consumer reach is based on a combination of publicly available data on customer base and marketing spend. In the case of the MSE Cheap Energy Club, which isn't a commercial platform in the same sense as the others, this was based on the size of the MSE mailing list.

³ Represents the number of 'mouse clicks' required to determine if a tariff was green from the initial list of potential tariffs. For example: 0 would be where green tariffs are displayed on the list itself, 1 would be where the user would need to click once on a 'more details' link, 2 would be where a user must click on a 'more details' and then click again on an 'about this tariff' link for example.

⁴ While the Citizen's Advice comparison tool is not regulated under OFGEM's confidence code it is promoted by OFGEM on their switching guide, and is featured much more highly on the guides than the other price comparison tools accredited under the confidence code.

5.10 Appendix B: Footnotes to table 5-2

¹ The Money Saving Expert Big Switch has previously offered a green electricity product in the winners of their collective switch, but according to their own reports the tariff was “surprisingly unpopular” and attracted only 0.36% of consumers despite being only slightly more expensive than the non-green winner (Money Saving Expert 2014)

² The big deal has previously partnered on a collective switch with the socially conscious campaigning website ‘38 degrees’

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6. Consumer expectations of the environmental benefit of green electricity tariffs

6.1 Preface

In conducting the interviews for chapter five, one common theme expressed by intermediaries was the difficulty in differentiating or ranking the different types of green electricity tariff available on the market. Many intermediaries also faced a lack of understanding regarding the differences between the types of green tariff on offer. It also became clear when looking at how consumer preferences can be incorporated into intermediaries, that a more nuanced understanding of consumers' expectations regarding green electricity products may be useful. Chapter six addresses these issues with two complementary research methodologies, using a consumer survey to understand consumers' expectations and a census of the market to capture the variation which exists between the tariffs.

This paper is currently under review in the journal Energy Policy.

6.2 Abstract:

Increasing numbers of consumers are switching to green electricity tariffs. With the growth of the market has come greater scrutiny of the environmental benefit of the tariffs, which are now subject to regulation in Great Britain. As the supply of green electricity certificates is determined by public subsidies rather than

consumer demand, it is possible that merely matching household usage with certificates is not sufficient to support the development of new renewables. Because of this, suppliers in the UK are required to take extra steps to show their products have environmental benefit. Using a large-scale survey on the innovative Pollfish platform, this research finds that a majority of consumers expect their tariffs to have environmental benefit, and many also expect this to take the form of supporting renewable electricity. A census of green electricity tariffs in the GB market was also conducted and finds that many products are not meeting consumer expectations. The additional environmental benefit undertaken by suppliers can be small, lacking transparency, unrelated to the generation or development of renewable energy, or not present at all. This research therefore concludes that there is a strong argument for the revision of the current regulations for green electricity tariffs.

6.3 Introduction

Consumers, both in the UK and around the world, are able to voluntarily pay more to receive green electricity for their home. It is possible that, as other government support mechanisms for green electricity are scaled back, this consumer demand could contribute towards decarbonizing the electricity system. Similar voluntary consumer action, often labelled political consumption (Micheletti, 2003), has been successful in other areas including promoting sustainable development through Fair Trade products and protecting ocean biodiversity through MSC fishing standards (Boström, Klintman and Micheletti, 2008). However, there is variation in the green electricity products available on

the market in the UK, with tariffs offering environmental benefit in different ways. Through a representative consumer survey this research seeks to understand what environmental benefit consumers believe green electricity products should have, whether the benefit should be related to increasing the supply of renewable energy, and whether these preferences vary by attitudes to the environment and socio-economic characteristics. The analysis will build on the model of consumer motivations for purchasing green electricity outlined by Herbes et. al. (2014) which differentiates between factors intrinsic to the consumer, socio-demographic characteristics and psychological constructions, and factors which relate to the products themselves, utilitarian benefits and psychological benefits. A census of the green electricity products available in the UK will also explore whether the green electricity products available to consumers meet their preferences.

This is an important area to explore for three reasons. The first is that the environmental benefit of simply procuring green electricity certificates, used to show that the green electricity used by consumers is matched with green electricity generated, is now starting to be questioned (Gillenwater, Lu and Fischlein, 2014; Will, Jochem and Fichtner, 2017). This is because green electricity markets are complex and supply, of both the energy and associated certificates, has historically been driven by government subsidies rather than consumer market demand. Second, in recognition of the aforementioned fact, green tariffs in the UK are required by regulation to demonstrate some form of

‘additional’ environmental benefit (OFGEM, 2014), yet what form this should take is not set. The regulation was purposely non-prescriptive in order to allow suppliers to be innovative in the ways in which they bring about that benefit, but it does leave open the possibility that the steps taken by suppliers are not in line with consumer expectations. The approach to additionality is the primary form of variation between tariffs in the UK, so this ‘additional’ element of the tariff will form the focus of this study. As green electricity products are currently regulated by OFGEM, this research also has clear policy implications if the products are found to be inconsistent with consumer expectations. Third, markets in the UK are growing steadily and are in the process of transitioning from a niche market to a more mainstream product (MacDonald, 2016). Evidence from around the world suggests that markets can continue to develop, with over 60% of consumers in the Netherlands purchasing green electricity tariffs (MacDonald and Eyre, 2018), though the environmental benefit of those tariffs is starting to be questioned (BEUC, 2016).

In the literature on green electricity tariffs, environmental benefit is referred to as ‘additionality’ (Gillenwater, 2012) - the extent to which environmental benefit occurs as a result of purchasing a green electricity tariff in comparison to a counterfactual baseline where no purchase had occurred. This concept, originating in public policy analysis, has been traditionally used to assess the ‘value for money’ of public initiatives (English Partnerships, 2008). It has also been commonly used in the evaluation of the environmental impact of

carbon offsetting programs, where it is necessary to make a link between investment and outcomes in order to justify the worthiness of offsetting (Gillenwater, 2012). For the purpose of clarity, the term ‘additionality’ is used sparingly and replaced by the term ‘environmental benefit’ wherever possible. This change in language makes it more clear that additionally is a utilitarian ‘final goal’ (Herbes and Ramme, 2014), with that goal being environmental benefit. Similarly, the term ‘additionality’ was not used when these issues were presented to survey respondents. Given that the term requires some explaining if presented to a lay audience, it is possible that the way the concept is explained may bias the responses consumers give.

The research in this study takes a mixed-methods approach. The first data source is a consumer survey of 1002 participants, conducted using the mobile-based Pollfish platform. This choice of methodology allowed a large, statistically significant sample to be obtained, minimizing the pro-environment selection bias, which can be an issue for other opt-in survey methodologies. The nature of the survey, being online and with questions limited in number and length, did present challenges. A great amount of care was taken to translate the complex issues being discussed into simple and short survey questions. As a result, the data obtained was of a high quality and has allowed a number of unique findings to be made. A census of green electricity products was also undertaken, focusing on the environmental benefit of green tariffs available on the market.

Data was collected on the type of additionality contribution each product had as well as how transparent the suppliers are in revealing this to their customers.

6.4 Background

The environmental benefit of green electricity is a public good that cannot be captured by a single consumer (Kotchen and Moore, 2007; Mitra and Moore, 2017). In countries with liberalised electricity markets the provision of this public good is met by a combination of government subsidies to increase supply, through financial instruments such as the feed in tariff or contract for difference, and voluntary consumer demand, through the market for green electricity sold to consumers and businesses. This creates issues when starting to look at the question of 'additionality', as it is often not clear whether the voluntary market is of a sufficient size to be responsible for the generation of new renewables. In the UK context each kWh of electricity sold to consumers as a green tariff is accredited by a Renewable Energy Guarantee of Origin (REGO) certificate. Originally introduced by the EU to facilitate fuel mix disclosure, these tradeable certificates prove the 'greenness' of generated electricity, separate to the commodity value. However, the electricity sold will also have received a separate subsidy paid by all electricity consumers. This subsidy may have been through a certificate-based scheme such as the Renewables Obligation, in which case the same kWh the consumer received would have also produced a Renewables Obligation Certificate which could be sold separately to a retailer to meet their Renewables Obligation. The subsidy could also have been through a feed in tariff

or contract for difference, where the generator would have been paid additional income for each kWh of electricity generated.

Most markets for consumer goods and services follow the regular laws of supply and demand, that as consumer demand increases there should also be a corresponding increase in the supply of that good. One could look to markets for goods such as ethically farmed eggs as evidence for this, where consumer demand has led a shift in the market towards ethical free range eggs, mostly independent of government regulation (Happy Eggs, 2016). However, in the case of green electricity the normal relationship between supply and demand is distorted by the subsidies which the vast majority of new green electricity generators receive. These bill-payer funded instruments make up a far more significant proportion of generators' income than the REGO certificates sold to the voluntary market. While there has been no research which has substantially investigated the difference between these two revenue sources. For the sake of comparison the feed in tariff rates in the UK from October to December 2018, depending on the size of the installation, was between 3.86p/kWh and 1.75p/kWh for solar receiving the higher rate and between 8.31 p/kWh and 0.52 p/kWh for wind (OFGEM, 2018d)m while the value of one REGO certificate is estimated by the supplier Good Energy to be just 0.015p/kWh(Good Energy, 2017b). The subsidy, which is backed up by a long-term government backed contract, is substantially higher in value and less subject to market fluctuation than the revenue from the voluntary certificate. As a result, it is possible that

merely retiring Guarantee of Origin certificates is not sufficient to ensure the green electricity products have environmental benefit, as other factors are more influential in determining whether new renewables will be built. While no research has currently been undertaken to explore this relationship in the UK, evidence from the USA suggests that the voluntary market for green electricity certificates is too small and unreliable to be taken into account by project developers (M. W. Gillenwater, 2013). This fact is recognized by OFGEM who require retailers to take extra steps, above and beyond procuring green electricity certificates, to show their products have environmental benefit (OFGEM, 2014).

As mentioned above, green electricity tariffs are currently regulated in the UK by OFGEM (OFGEM, 2014). The regulation has three components: additionality, transparency and evidence of supply. The latter two ensure that retailers purchase sufficient REGOs for the electricity they supply and that this is transparently communicated to consumers. The aspect that is most relevant for this research are the regulations which require green electricity products to have additionality. OFGEM acknowledge that when consumers purchase green electricity they expect to be benefiting the environment by supporting renewable generation so require suppliers to make additionality contributions, over and above the effect of the additional demand for green electricity certificates. This means that, for OFGEM, merely procuring green electricity is not a sufficient level of additionality, due to the negligible value of REGO certificates compared to other revenue streams for generators. At the time when the regulations were

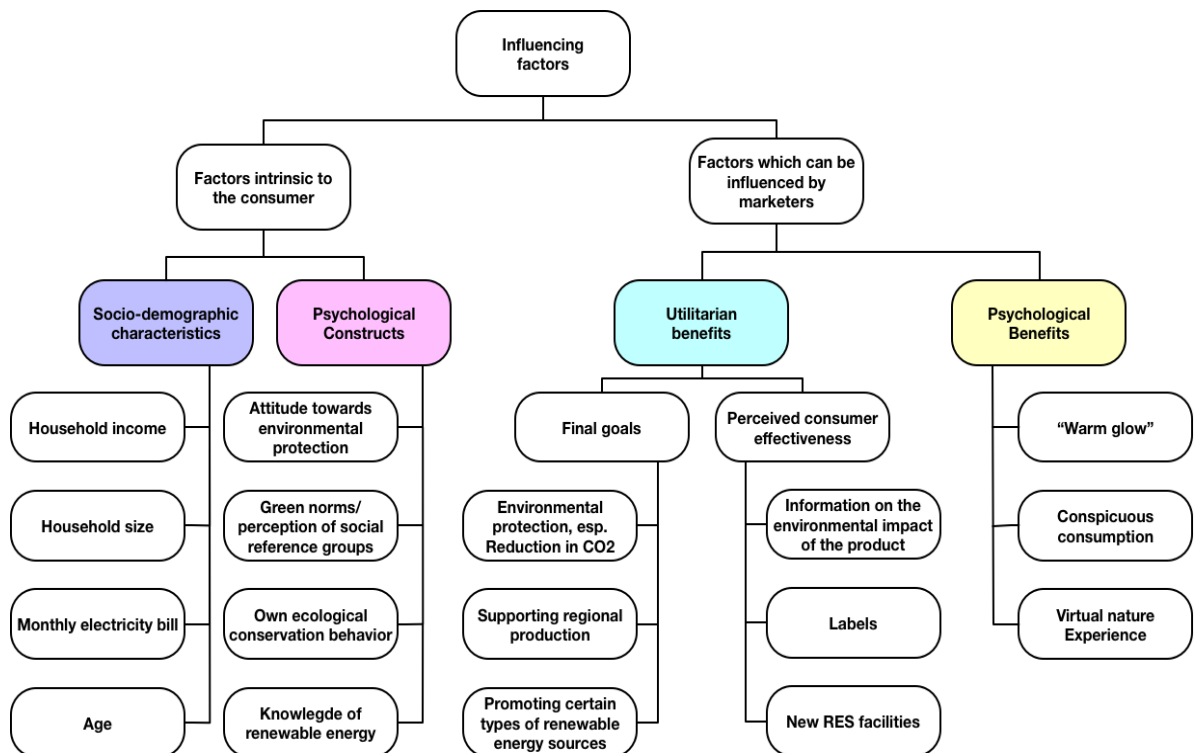
being formulated, this was controversial, with many retailers arguing that this is view of the market is not correct and that procurement of REGO certificates was sufficient. Suppliers believed that demand for REGO certificates was sufficient to increase the supply of renewables, and that consumers cared more about their own electricity to be green irrespective of the wider impact. The regulation is not prescriptive regarding what the additionality contribution should be, theoretically designed to allow suppliers to be innovative in the ways in which they bring about environmental benefit. The findings of this research will have clear relevance for these regulations, which should shape the products offered in the market so they align with consumer expectations.

6.5 Literature review

This research builds on the literature exploring the marketing of green electricity products. This body of work attempts to both understand who is likely to purchase green electricity and, most relevant for this research, what type of green electricity products they are most likely to purchase. The theoretical framework used is the model of factors which influence green electricity purchasing decisions put forward by Herbes et al., (2014), which builds on the work by Hartmann (2012). The model, as shown in figure 6-1, splits motivations into two categories, factors intrinsic to the consumer and factors that can be influenced by marketers, i.e. those to do with tariff design which retailers and regulators are able to shape. The model then branches into four sub-categories which will be discussed in turn below, with hypotheses to be tested also

outlined. The selection of this framework over other theories of decision making, such as the Theory of Planned Behaviour (TPB) (Ajzen, 1991) as used by Litvine and Wüstenhagen (2011), or the Theory of Reasoned Action (TRA) (Fishbein, M. & Ajzen, 1975), as used by Hae-Kyong et al. (2000), is due to its previous use in the referenced literature and its specific applicability to the subject matter. Furthermore, both the TPB and TRA do not easily handle altruistic motivations and require extensive supplementation to be relevant.

Figure 6-1: Factors influencing consumers' purchasing of green electricity products



Source: Herbes et al., (2014), highlighting added to emphasize relevant areas

6.5.1 Utilitarian benefits (pure altruism)

As mentioned above, economists view the renewable characteristic of green electricity and the consequent carbon reductions as a public good. Given that classical economics views individuals as rational and self-interested, public goods should be inefficiently supplied as individuals following the Nash assumption have no motivation to provide for them. In order to reconcile the fact that some individuals do choose to voluntarily supply public goods, the assumption is made that these decisions are driven by pure altruism, where consumers value the increased provision of the public good regardless of the actions of and impacts on others (Bergstrom, Blume and Varian, 1986; Roberts, 1987). Consequently, a pure altruist would be most interested in the 'final goal' of purchasing a green electricity tariff - reductions in carbon emissions. Herbes et al., go into further detail and divide between supporting regional production, and supporting certain types of renewables as well as factors which impact perceived consumer effectiveness (Herbes and Ramme, 2014). In the literature on green electricity tariffs this utilitarian benefit is referred to as the 'additionality' of a tariff, the impact that a consumer's purchase has on funding new renewable energy generation and subsequent carbon emission reductions. There is debate around the extent to which consumers value this additionality (Goett, Hudson and Train, 2000; Roe et al., 2001; Menges, Schroeder and Traub, 2005), and consequently the extent to which it should be required to protect consumers even if that may reduce or eliminate the market (Menges, 2003). The first

hypothesis therefore seeks to understand whether consumers act altruistically and value the environmental benefit of green electricity products. If this hypothesis is not supported then other possible motivations may play a role, such as 'impure altruism' or personal environmental norms.

H1: When purchasing a green electricity tariff, consumers act altruistically and value environmental benefit

A supplementary hypothesis also concerns exactly what form that consumers believe the environmental benefit should take. This is an important question to ask as the forms of benefit offered by retailers in the UK under the 'additionality' regulation vary widely. While some retailers invest in new renewables, support community generation or invest in research and development others plant trees, fund community facilities or clean waterways affected by hydropower development. This is an important issue to highlight as it touches on a contradiction in the existing UK regulations. The final proposals for the existing regulations state that "consumer research shows that when customers buy these tariffs they expect they are benefitting the environment by supporting renewable generation" (OFGEM, 2013a p.5). However, in the regulations additionality merely needs "to show that environmental benefits happen", with no reference to supporting renewables. This is an area which has not previously been considered by the academic literature but is key to understanding what additionality means in practice for consumers. In order to explore this,

respondents were asked ‘if buying green electricity didn't lead to any new renewable generation being built, would this make you more or less likely to buy a green electricity tariff?’.

H2: Consumers expect environmental benefit to take the form of increasing the amount of renewable generation that is built

6.5.2 Psychological benefits (impure altruism)

In recent decades there has been a growing understanding that decisions to engage in pro-environmental behavior are likely to be influenced as much by the private psychological benefits of increasing public goods, as the increase in the public good itself. Altruism of this kind is known as impure altruism, with the ‘warm glow’ effect being the most common example (Andreoni, 1989, 1990). As well as the warm glow Hartmann also includes ‘conspicuous consumption’ and ‘virtual nature experiences’ as private benefits derived from purchasing green electricity (Hartmann and Apaolaza-Ibáñez, 2012). This perspective argues that individuals purchase green electricity in order to feel better about themselves and their decisions, rather than because they are concerned about the environmental impact their decision will have (Wüstenhagen and Bilharz, 2006b). Previous studies have shown the value of the private benefit to be significant (Hartmann et al., 2017). It is therefore possible to form hypothesis that consumers value the impurely altruistic psychological benefits of green

electricity. This is not strictly opposed to H1 as it is likely that consumers act based on a combination of motives.

H1b: When purchasing a green electricity tariff, consumers act impurely altruistically and value psychological benefits

6.5.3 Socio-demographic characteristics

Socio-demographic characteristics play an important role in determining which customers choose to purchase green electricity tariffs, four of which are highlighted as being significant by Herbes et al. (2014). This is a common focus of research in the willingness to pay literature, with a large number of analyses and meta-analyses exploring the demographic characteristics of consumers who are more likely to purchase green electricity tariffs (e.g. meta analyses of willingness to pay studies (Ma et al., 2015; Oerlemans et al., 2016; Sundt and Rehdanz, 2015) and OECD cross section study (Krishnamurthy and Kriström, 2014)). Most studies find that that willingness to pay is higher for consumers who have higher incomes and higher levels of education (Diaz-Rainey and Ashton, 2008; MacPherson and Lange, 2013), . A useful summary of correlations between willingness to pay and socio-economic factors is found in Kowalska-Pyzalska (2015), a version of which is presented in table 6-1. However, it is worth noting that one meta-analysis of the contingent valuation methodology used by most studies in the field found that these demographic variations are less

important than the choice of methodology used in the study itself when actually trying to quantify willingness to pay (Ma et al., 2015). This research will build on this literature to determine whether socio-economic factors determine not only the likelihood of purchasing a green electricity product, but also whether they determine the type of green electricity products one might purchase.

H3: Attitudes towards environmental benefit will vary according to socio-economic factors

Table 6-1: Correlations between willingness to pay for green electricity and socio-economic factors

Correlated positively with:	Correlated negatively with:
Positive attitudes towards green energy or energy conservation	Non-voluntary programs
Self-transcendence values	Self-enhancement values
Income level	Electricity cost
Educational level	Household size
Knowledge about energy issues and awareness of the climate issues	Extra cost of supporting technologies (smart meters, in home displays) in case of dynamic tariffs
Concern about environmental problems	Age
Experience in investing in green energy	Rural population
Urban population	

(Source: Kowalska-Pyzalska, 2015)

6.5.4 Psychological constructs

Attitudes and norms also play a significant role in determining the likelihood of purchasing a green electricity tariff. In the words of Ozaki “when people decide

to adopt an innovation, such as green electricity they consider not only functionality, usability costs and intended outcomes, but also what the innovation means to them, for example, the way it reflects their identity image, memberships, values and norms” (Ozaki, 2011). Unsurprisingly many studies find a positive correlation between pro-environmental norms and higher willingness to pay for green electricity (Rowlands, Scott and Parker, 2003; Paladino and Baggiere, 2008; Gerpott and Mahmudova, 2010; MacPherson and Lange, 2013; Krishnamurthy and Kriström, 2014). Litvine and Wüstenhagen (2011) describe these norms as ‘personal norms’ which induce feelings of moral obligation to act pro-environmentally. Ozaki finds that, as well as green values, strong social norms are necessary to encourage adoption (Ozaki, 2011) as they can indicate whether purchasing a green electricity tariff is socially accepted or expected. Ek & Söderholm (2005) find that these social norms are more important than perceptions of others behavior, i.e. that it’s more important to feel that what one is doing is socially accepted than to believe that others are likely to do the same (2005). Emerging from the TRA and TPB are also several studies which incorporate norms regarding ‘perceived self-efficacy’ (Litvine and Wüstenhagen, 2011). There is also evidence that effective green tariff marketing should take advantage of these attitudes in the way green electricity tariffs are sold to consumers, with the presence of an ‘ecological message’ (Ayadi and Lapeyre, 2016) or ‘fear arousal’ (Hartmann et al., 2016) around the issue of climate change both being effective at increasing purchase intention.

The fourth hypothesis to be explored relates to environmental norms and attitudes and seeks to explain whether perceptions of environmental benefit vary along these lines. Wüstenhagen (2000) makes a link between environmental attitudes of consumers and the forms of altruism by which they are motivated. He argues that 'dark green' consumers, those with the most strongly held environmental attitudes, are early adopters and make decisions altruistically for the public benefit. Conversely the most 'light green' customers, who have the most loosely held environmental attitudes, are motivated by impure altruism and are only likely to subscribe once they perceive there to be sufficient private benefit. From this it is possible to hypothesize that consumers with strongly held environmental attitudes are those who are most likely to be motivated by pure altruism, favoring environmental benefit the most.

H4: Consumers with the most strongly held environmental attitudes are most likely to value utilitarian altruistic outcomes

6.6 Methodology

A consumer survey is used as the basis for this research. The survey was conducted using Pollfish, an innovative mobile based research platform. This methodology was chosen for several reasons. First was value, in this study use of the Pollfish platform was provided free of charge, but for future studies building on this methodology a similar quantity of responses could be obtained for around \$2000. This is significantly more cost effective than alternative means

of sampling large numbers of consumers. The platform was also fast, gaining the full sample in less than two days. This was useful for practical reasons, though the rapid rate at which responses were received did mean that it was important to ensure that the survey was thoroughly tested before it was activated. A third reason was sample size, due to the low cost of Pollfish it is possible to easily obtain a statistically significant size. A similar sized sample would be either time consuming or prohibitively expensive using other means. The platform also allowed demographic targeting and as such responses were limited to consumers in the UK over the age of 18. This was helpful as it would have been difficult to draw conclusions if there were responses from other countries with other electricity market structures, and it may have been problematic ethically if younger participants were permitted to respond. A final advantage of the platform was the ability to use a screening question to only recruit respondents who were decision makers regarding their household's electricity supply. This ensured that all the respondents were in a position to be informed about the issues at hand and would have had direct experience of selecting an energy provider. There is a risk that this screening question would exclude certain groups of consumers who would not be decision makers or who didn't realize that there were decisions to be made, as research has shown that 5% of households didn't know it was possible to switch suppliers(Ipsos MORI, 2012). However, this potential bias was outweighed by the value of having a greater number of respondents who were familiar with the issues at hand and had previously made decisions relating to their energy supply.

It is important to address the issue of sampling bias, and possible issues arising from conducting an opt-in mobile survey. Participants opted-in to the surveys voluntarily, through other third party mobile applications where the surveys were embedded. The participants were rewarded for their participation through those third-party applications, usually in the form of non-monetary rewards such as 'virtual coins' or in-game advantages. As a further incentive for participants to complete surveys, Pollfish randomly awards some users with added rewards. While there have been no academic studies to use Pollfish previously, one piece of research has compared the platform to surveys conducted in-person by the 2012 General Social Survey and random digit dialing phone surveys by the Pew Research Center, both well regarded polling organisations. That study finds that the platform is "surprisingly well-aligned with surveys that are generally regarded as the best available" (Goel, Obeng and Rothschild, 2015). The platform pre-weights by demographic factors to minimise selection and non-response bias, which is a common technique applied to online surveys (Scherpenzeel, Bethlehem and Amsterdam, 2011) and applies a greater weight to responses from demographics which are under-represented. The platform also uses automated techniques to ensure that only legitimate responses are included, as randomly completed responses have reduced the effectiveness of other opt-in surveys such as those conducted on the Amazon Mechanical Turk platform (Downs et al., 2010; Pritoni et al., 2015). The automated techniques take into account multiple factors including device ID, IP, device type and location. While

it was possible that the sample may be skewed towards younger and more technologically literate respondents, this does not appear to be an issue with this particular study. By definition a segment of consumers would be excluded who do not own smartphones, but as there is no reason to expect a significant correlation between attitudes to green electricity products and smartphone ownership this is unlikely to be a substantial source of bias for this survey.

The mobile survey platform also placed constraints on the format of the survey, which was limited by question number and length. The questions were recommended to be below 140 characters. This meant that considerable care and attention was necessary to capture the meaning of complex ideas such as ‘additionality’ in the relatively short question format. As a researcher this was a useful limitation, as the necessity to have short questions was beneficial in ensuring the survey as a whole was clear and engaging for respondents. The questions were also limited in number. As a result of this many questions were formatted as scored matrixes, allowing several responses to be captured within a single question. The platform also has data on participants’ demographics already, as users have a consistent profile across multiple surveys. This meant that it was not necessary to ask the standard demographic questions, something which may have increased levels of engagement and attention in the rest of the survey questions. This data included the respondents’ age, location, education, income, career, marital status, number of children, and race. The survey also included one final open-ended question which was used to gain insights which

may not have been captured in the previous questions. Once the data was downloaded it was coded and analysed using the SPSS software package (IBM, 2016). Where tests for significance were carried out, results were required to be significant at the 0.05 level. Based on the areas covered in the theoretical framework, three hypotheses outlined above were tested for correlation.

In order to assess whether consumer expectations are being met by the products currently on the market a census of all green electricity tariffs available in the UK was undertaken. This data collection focused on the 'additionality' contributions, as required by OFGEM under the green supply regulations. Data was collected on the type of contribution that suppliers made as well as the level of transparency regarding that information. All green electricity products available to households in the UK as of February 2017 were included in the census. Where data was not available on suppliers' websites or other marketing materials direct contact was made with customer service agents working on behalf of the green electricity companies.

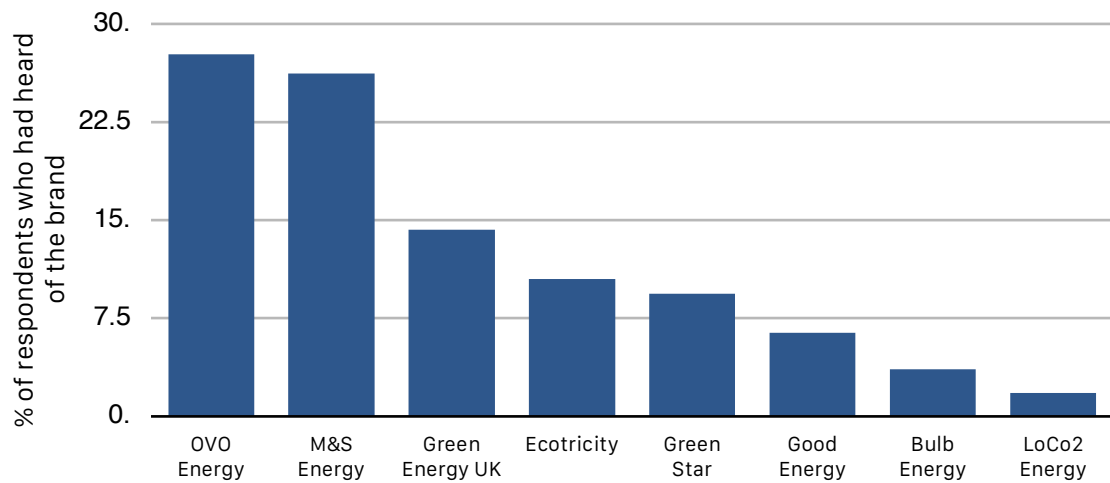
6.7 Results and discussion

6.7.1 Awareness and uptake of green tariffs

The survey produced a wealth of data for analysis and provides a valuable insight into how consumers perceive the value of green electricity tariffs. Awareness of green electricity products was found to be high, with 52.5% of

consumers aware that it was possible to switch to a green electricity tariff. As the sample was limited only to respondents who were decision makers regarding their household's energy use, this figure may be higher than in the UK population as a whole. 52.4% of consumers responded that they may purchase a green electricity tariff in the future, despite being informed prior that it costs on average 10% more than a standard tariff. This suggests that green electricity may not always be a niche product, though there is evidence to suggest that translating knowledge and intention to actions can be challenging (Frederiks, Stenner and Hobman, 2015). 12.3% of respondents say they have previously switched to a green electricity tariff. This is a higher number than expected considering there are around 3% of households in the UK who currently purchase green electricity. This difference may be explained by a number of factors. First is that some respondents may have previously purchased green electricity tariffs and have since switched back to a grey tariff. However, even if this was the case the figure of 12.3% still seems high given the historically small size of the market. An alternative explanation is that some consumers may have thought they receive green electricity but have not purchased a tariff explicitly sold as a green tariff. For example, many companies who procure green electricity as part of their regular purchasing will claim this percentage of their electricity to be green or may use 'green' or 'low carbon' terms in marketing material.

Figure 6-2: Awareness of green electricity brands



As figure 6-2 shows, brand awareness of the established green electricity companies is relatively low, with the market leaders Good Energy (6.39%) and Ecotricity (10.52%) falling well behind more well-known consumer brands such as Marks & Spencer's energy (26.23%) and OVO energy (27.69%). This reflects the niche position of green electricity retailers, and the automatic advantage that larger well-known names have in offering green electricity products. The newest entrants to the market, Bulb Energy (3.58%) along with the small supplier LoCo2 Energy (1.81%), were the least well known by respondents.

6.7.2 Attitudes towards of environmental benefit

H1 seeks to understand whether consumers act altruistically and expect their green electricity tariffs to have environmental benefit. Respondents were asked, if they were to purchase green electricity, what factors would be important to

them. Five factors were presented in a single selection matrix question. Three referred to forms of pure altruistic motivation; helping the environment, helping to generate more green electricity and sending a message to government. One referred to an impurely altruistic motivation; reducing guilty feelings about energy use. The final referred to a norms-based motivation, knowing the electricity they use is green. The responses were ranked on a five-point scale ranging from ‘extremely important’ to ‘not at all important’.

Figure 6-3: Consumer motivations for purchasing green electricity % (n=1002)

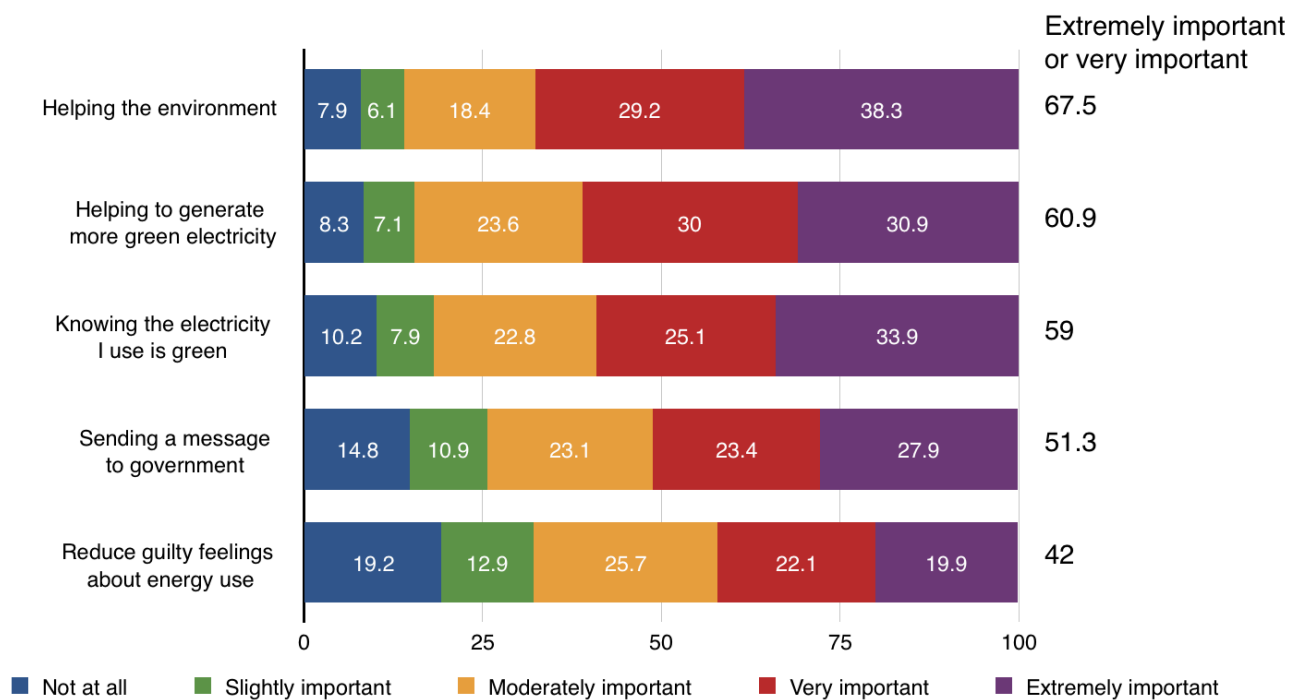


Figure 6-3 shows how the respondents valued various factors. When looking at the factors ranked ‘very important’ and ‘extremely important’ the two most commonly expressed motivations were related to pure altruistic motivation; helping the environment (67.5%) and helping to generate more green electricity

(60.9%). In these two cases, a clear majority of consumers expected that the green electricity tariffs they are purchasing should have environmental benefit, this therefore supports H1 and suggests that consumers to value the environmental benefit of green electricity tariffs. This corroborates OFGEM consumer research which also came to similar conclusions (OFGEM and Big Sofa, 2014). The least important factor was found to be reducing guilty feelings about energy use. This is a notable finding as this was designed to represent the impure altruistic motivation, which has previously found to be significant in the literature. This does not necessarily preclude H1b from also being supported, as 42% of respondents did also rank reductions in 'guilty feelings' as being very or extremely important. Interestingly the data also shows that all factors are somewhat important for consumers, suggesting that consumers are likely to have a mix of motivations.

6.7.3 Importance of increasing renewables

H2 explores whether consumers expect environmental benefit to specifically take the form of increased renewable energy capacity. This is an important area to analyse as there are many forms that environmental benefit can take, ranging from investing in community renewables to planting trees in primary schools. In the survey this question was approached from two angles. First, the factor "helping to generate more green electricity" was included in the selection matrix of factors that would be important when deciding whether to purchase a green

electricity tariff. As is mentioned above, a total of 60.9% of respondents said that “helping to generate more green electricity” would be an “important” or “extremely important” factor if they were to buy green electricity. While this provides strong evidence that consumers do expect renewable energy to be increased, it does not necessarily mean that consumers would be that much less inclined to purchase green electricity if it had no impact on renewable generation, particularly as several other factors were also said to be important, as figure 6-3 shows.

In order to provide another perspective, and to give an indication of how consumers would feel if a product was found to have no impact on increasing renewables, the question was also asked in another format later in the survey. The question was phrased in a negative context, whether respondents would be any more or less likely to purchase green electricity if it didn’t lead to any more renewable generation being built. This negative phrasing builds on the way that the concept of additionality was discussed in OFGEM’s consumer research, where respondents rejected the concept of an un-additional green electricity tariff as not “proper” (OFGEM and Big Sofa, 2014). While almost half of consumers (47.4%) stated that it would make no difference, 39% did respond that knowing there would be no more renewable generation built would make them less likely to purchase a green electricity tariff. This provides evidence that many consumers do expect the environmental benefit to take the form of new renewables, supporting H2. The importance of increasing the supply of

renewables was also a common theme in the open-ended comments section at the end of the survey. The sentiment was best encapsulated by the comment “a portion of the green electricity supplement should be used to increase green energy generation facilities”, left by a dark green consumer who was somewhat likely to purchase a green electricity tariff in the future. This provides good evidence that increasing the supply of renewables does matter to a substantial proportion of consumers. As will be explored below, these results become more nuanced when also broken down by attitudes towards the environment.

6.7.4 Variation by socio-economic characteristics

There is considerable variation in willingness to pay for green energy, some of which is explained by socio-economic characteristics. H3 seeks to understand whether these characteristics similarly explain variation in attitudes towards environmental benefit. In order to test this hypothesis a linear regression was performed to determine whether demographic factors, several of which were automatically provided for each respondent by Pollfish, explain variations in the importance of green electricity tariffs generating more renewable energy. As table 6-2 shows, none of the socio-economic variables included in the regression are significant ($p < 0.1$) in explaining variation in attitudes towards environmental benefit. This suggests that while the existing literature suggests socio-economic characteristics explain some variation in the likelihood of

purchasing a green electricity tariff, they do not play a significant role in explaining attitudes towards the environmental benefit of the tariffs.

Table 6-2: Descriptive statistics, correlations and regression analysis results

Variable	Mean	Std. Deviation	Correlation with enrollment rates	Multiple regression weights	
				b	β
Help to generate more green electricity	2.750	16.479			
Age	-.058	.034	-.059	-1.700	.090
Household Income	.065	.032	.070	2.031	.043
London resident	.005	.123	.001	.038	.970
Responsibility for supply	-.011	.094	-.004	-.114	.909
Switching in past 5 years	-.030	.026	-.039	-1.146	.252

* $p < 0.1$

· 18-24, 25-34, 35-44, 45-54, over 54

· <12,500, 12500-18499, 18500-49999, 50000-62499, 62500-99999, 100000-124999, > 125,000

· 0 = non-London resident, 1 = London resident

· 0 = Joint responsibility, 1 = sole responsibility

· Not at all, once, twice, three to five times, more than five times

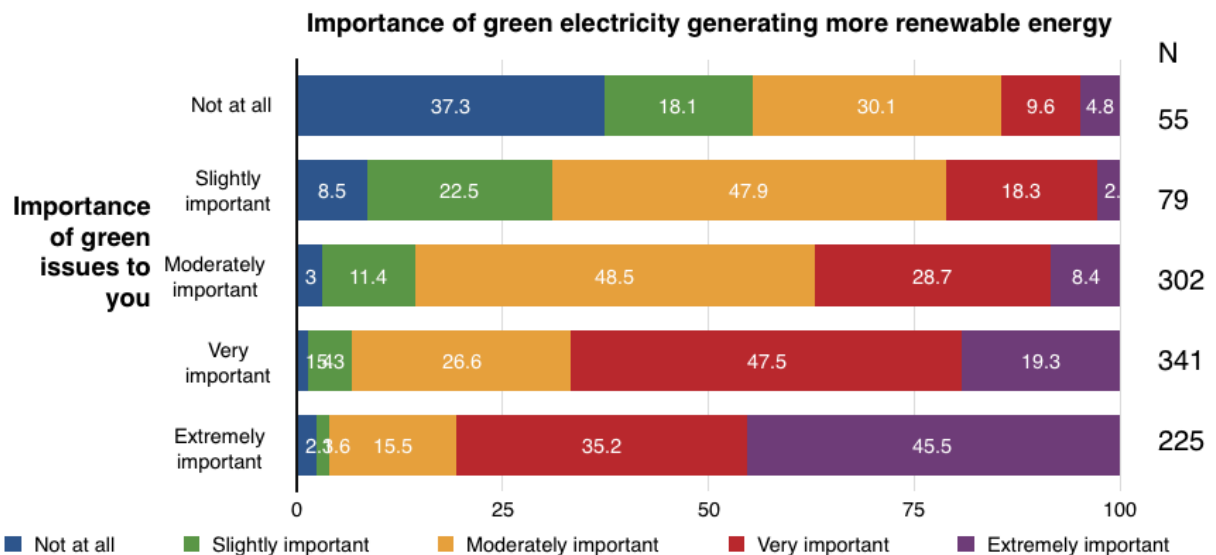
Model summary:

R = .103, R² = .011, Adjusted R Square = .005, Std. error of the estimate = 1.20170

6.7.5 Variation by psychological constructs

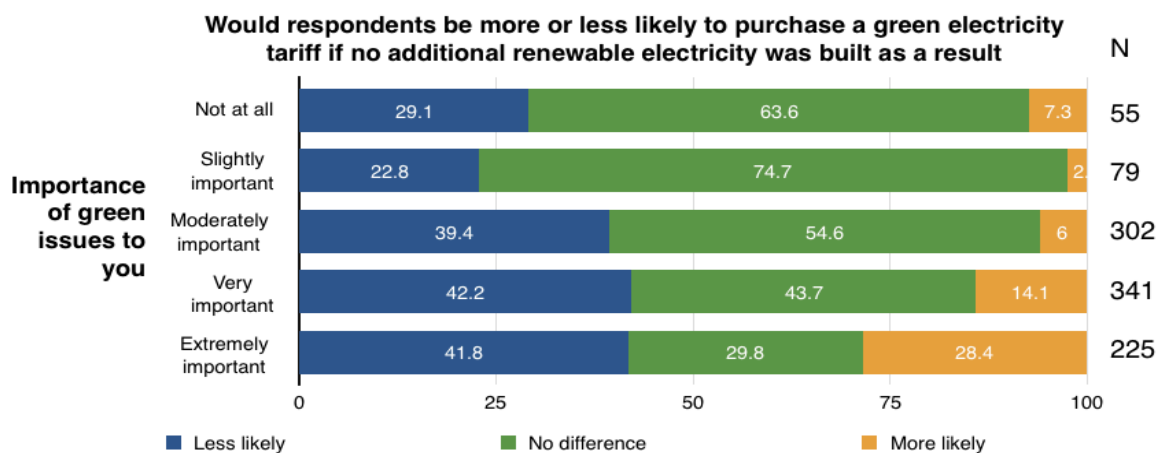
Previous consumer studies have found that willingness to pay for green electricity varies by environmental attitudes, and that ‘dark green’ consumers are more likely to act altruistically and value environmental benefit. H4 is designed to test this theory in the context of green electricity products in the UK. To determine their environmental attitudes participants were asked how important environmental issues, such as climate change, are to them, with answers on a five-point scale from ‘not at all’ to ‘extremely important’.

Figure 6-4: The relationship between generating more green electricity and environmental attitudes (%)



This relationship is statistically significant at the 0.05 level (.000) with a moderately strong correlation, 0.531. N=1002, single tailed correlation test

Figure 6-5: How failure to generate more electricity makes various environmental groups more or less likely to purchase green electricity (%)



This relationship is not statistically significant at the 0.05 level (.318) N=1002, single tailed correlation test.

The results of this consumer survey find that the relationship between environmental attitudes and environmental benefit is complex. When asked

whether it was important to help to generate more green electricity this was found to be significantly positively correlated with pro-environmental attitudes ($r=.531$, $n=1002$, $p<.000$), as shown in figure 6-4. This suggests that the more someone cares about the environment, the more likely they are to also want their purchase to support more renewable generation. However, respondents were also asked if they would be more or less likely to purchase green electricity if it led to no extra generation. Responses to this question were not significantly correlated to environmental attitudes ($r=.032$, $n=1002$, $p=.318$), as shown in figure 6-5. For all levels of environmental concern, including those who said green issues were extremely important, over 50% of respondents said it would make 'no difference' or even 'more likely' to purchase a green electricity tariff. In fact the 58% of the greenest consumers said it would make no difference or make them more likely to purchase a green electricity tariff. This suggests that this core group of environmental consumers are likely to purchase green electricity even if there is no new generation as a result. This suggests that personal environmental norms supersede concerns about utilitarian benefit for many consumers, including those with the most strongly held environmental beliefs. This complements the findings of Wustenhagen, though suggests that the motivations for the early adopting 'dark green' consumers may be more to do with psychological characteristics such as their attitudes towards environmental protection, green norms or perception of social reference groups than a more utilitarian altruistic mindset. This has implications for the market as it becomes more mainstream, and perhaps suggests that there will need to be a

greater focus on environmental outcomes as the products try to appeal to a wider audience, including those who are more skeptical of environmental claims. This may explain some of the experience of The Netherlands, as increasing scrutiny of the environmental benefit of the tariffs has come only as the market has become more mainstream. It does seem counterintuitive that a number of consumers, particularly those who are most environmentally conscious, should be 'more likely' to purchase a green electricity tariff knowing that leads to no extra generation. It could be possible that these consumers want the greenness to be 'exclusive' to themselves and not benefitting others, but more qualitative research would be helpful to understand this phenomenon further.

Table 6-3: Additionality' contributions for all UK green electricity suppliers

Supplier	Contribution		Transparency		
	Amount	Type of fund	Available on website	Available from customer service	Available per customer
Marks and Spencer Energy	£1 per customer per year	Community renewable energy fund	Yes	Yes	Yes
Good Energy	Unknown	Invests in new renewable generation and funds research and development of renewable technologies	Yes	Yes	No
Ecotricity	Unknown	Invests in new renewable generation and funds research and development of renewable technologies	Yes	Yes	No
LoCo2	'A share of the profits'	Invests into a fund to build their own new hydropower generation	Yes	Yes	No
Green Energy UK	None	None	No	No	No
OVO Energy	5 per customer	"I Dig Trees" fund to plant trees.	Yes	Yes	Yes
Green Star Energy UK	Unknown	Planting trees in the UK and protecting rainforest in the Amazon.	Yes	Yes	No
Bulb energy	£1.00 REGO purchasing plus £2.50 to the tree council per year per customer	Tree council plants and protects trees. REGOs are green electricity certificates.	No	Yes	Yes
Octopus Energy	30 trees	Tree plantation	No	Yes	No
Fischer Energy	None	None	No	No	No

Data correct as of February 2017. Where the information was available through supplier's websites it was assumed the same information would also be available from customer service agents.

6.8 Market census

The results above show that a substantial proportion of consumers, and particularly the consumers with light green environmental attitudes who would be important if products go mainstream, expect green electricity tariffs to have environmental benefit and to increase the amount of renewable electricity which is generated. This section will explore whether current products on the market match up to consumer expectations. In order to make this assessment a census of all products available in the UK market as of February 2017 was undertaken, shown in table 6-3.

As mentioned previously the market regulator OFGEM requires green electricity tariffs to demonstrate additionality above and beyond procuring REGO certificates, which they do not believe constitute additionality. From the market census the additionality offered by suppliers takes three forms; tree planting, investment in the company's own generation and other forms of renewable support such as community energy or research and development. This reflects the fact that OFGEM did not specify what form additionality should take to allow for innovation in product offerings. It seems clear that there is a difference between the types of additionality on offer, between those which directly support the construction of new renewables and those which do not. Offering additionality by planting trees does not help to support the generation of new renewables, something this research suggests is an important aspect of green

electricity tariffs for consumers. It also has a minimal long term, and carbon positive in the short term, impact on carbon in the atmosphere (Cannell, 1999). A second observation regards the amount of additionality offered. There is substantial variation, with contributions ranging from 30 trees across the entire customer base to a fixed amount per customer to community energy projects, £1 per customer per year in the case of Marks & Spencer Energy. This figure of £1 was also the level of contribution required under the now retired Green Electricity Supply Certification Scheme. These amounts are small compared to the price premium associated with green electricity, which can be around 10% (MacDonald and Eyre, 2018).

From gathering the data it also became clear that there was a persistent lack of transparency for consumers. Only two suppliers provided per customer figures on their websites, and all others required often lengthy conversations with customer service agents to determine what additionality contributions were made. Two suppliers' customer service agents even denied making any additionality contributions at all, putting them in violation of OFGEM's green supply regulations. Some suppliers also referred to the fact that they purchased carbon offsets for the green gas they sell as a form of additionality for their electricity. This perhaps indicates that at heart most green electricity retailers believe that the act of procuring green electricity is sufficient for additionality, though there is no available evidence to support this. It may be the case that in the future, as government subsidies for renewables are reduced and if consumer

demand approaches the level of existing supply, that this may be a stronger argument.

6.9 Conclusion and policy implications

Based on the analysis above there are three recommendations which can be made to better ensure that the green electricity products more closely match consumer expectations:

Increased transparency and enforcement - suppliers should be required to clearly state to their customers what their contributions are on a per-customer basis. This should be communicated to customers both directly on their bills and made available on their websites and marketing materials provided to potential customers. The implementation of this could be similar to license condition 21 of the OFGEM supply license regarding fuel mix disclosure and environmental impact (OFGEM, 2018f). This will increase consumer trust in green electricity suppliers. It would also encourage suppliers to compete more actively to offer the greatest amounts of environmental benefit, and it would be clear to consumers which tariffs offer more environmental benefit than others. There should also be greater enforcement of current regulations, as this appears to be poor at present.

Focus on renewables - suppliers should be required to ensure that their additionality contributions go towards the funding or development of new

renewable energy. This is in the spirit of the current regulations and is backed up by both this research and OFGEM's own consumer insights.

Accreditation or ranking - in the case that suggestions 1 or 2 fail to be adopted by OFGEM as conditions of sale for green electricity products, it would be beneficial for a neutral academic or third sector organization to accredit tariffs which do voluntarily meet suggestions 1 or 2 or to provide rankings regarding 'green-ness' of green electricity tariffs. This would require further research regarding the environmental benefit of the procurement of green electricity, through supply and demand mechanisms, to be most effective.

This research makes it clear that a substantial proportion of consumers expect that their purchasing of green electricity will lead to more renewable electricity being generated. This is consistent with the marketing language used by green electricity retailers, which often make the link between purchasing green electricity and helping to decarbonize the electricity system. The market census which was undertaken also shows that the additionality contributions required by OFGEM lack transparency, are often small and can be unrelated to decarbonisation and the development of more renewables. As such it is justified to conclude that the additionality requirements in regulation are in need of significant revision. The policy recommendations put forward above lay out three simple ways in which this could be done. Taken together these recommendations would make the additionality requirement more transparent

and more consistent with consumer expectations. This is especially important as a number of new suppliers have recently entered the green electricity market with cheaper offerings than the more established green electricity companies, and also with less historic commitment to building renewables themselves or supporting research.

The consumer research presented in this chapter also expands on the current literature to provide further insights into where consumers expect the benefit of green electricity tariffs to lie. Consumers are found to value environmental benefit and expect the tariffs they purchase to help increase the amount of renewable energy generated. Regarding the debate between altruism and impure altruism, and what it means for additionality, it is clear that consumers have a mix of motivations and expectations which encompass both public and private benefit. It is also possible that the existence of the private psychological benefit depends on the validity of the public environmental benefit, as presumably the 'warm glow' from a good deed would cool off if the deed was found to not actually be that virtuous. Therefore, it does not seem credible to suggest that impure altruism has sufficient value to justify regulators deciding not require products to have environmental benefit. It is also clear that the interplay between personal environmental norms and altruism needs further explanation, as evidence was not found that 'dark green' consumers are especially motivated by the latter. Focusing too heavily on the relationship between pure and impure altruism, while useful for framing an economic analysis

of consumer purchasing, also risks neglecting the potential roles of personal environmental norms, which may more accurately explain consumers' purchasing behavior. By focusing on environmental norms, it is possible to explain how some committed environmentalists may care less about actual environmental outcomes than simply doing the right thing. As a whole this research provides insights both for future work in this area and for green electricity retailers who are looking to improve their product offerings in line with consumer expectations.

6.10 Appendix A: Pollfish survey

This survey is conducted by researchers at the University of Oxford and will form part of published research. The research is anonymous, which means that in any publications, your name or any other identifying details will not be used. Your participation is voluntary and you can withdraw any time. The project has been reviewed and approved by the University's ethics committee.

Q1. In the past five years, how many times have you switched electricity supplier?

Once, Twice, Three to five times, More than five times, Not at all

Q3. Some electricity suppliers allow you to buy green electricity. This means the electricity you use is matched with energy from wind, sun or water. Were you aware of this?

Yes, No

Q4. How many of these brands have you heard of? (select the options below the images)

M&S Energy, OVO Energy, Good Energy, Ecotricity, LoCo2 Energy, Green Star Energy, Green Energy, Bulb Energy

Q5. Have you ever switched to a green electricity tariff?

Yes, No

Statement: When you choose a green tariff the actual electricity you receive won't change, and the reliability of your supply won't be affected. The prices are slightly more expensive, on average around 10% more than normal suppliers.

Q6. How likely are you to purchase a green electricity tariff in the future?

Not likely, Somewhat likely, Very likely

Q7. If you were to buy green electricity, what factors would be important to you?

Extremely important, Very important, Moderately important, Slightly important, Not important at all

Q7a. Knowing the electricity I use is green

Q7b. Helping the environment

Q7c. Help to generate more green electricity

Q7d. Sending a message to the government

Q7e. Reduce guilty feelings about energy use

Q8. Thinking about reasons why you might not buy green electricity, how important are the following?

Extremely important, Very important, Moderately important, Slightly important, Not important at all

Q8a. Don't trust my electricity retailer

Q8b. My bills are already too high

Q8c. I don't understand how green tariffs work

Q8d. Switching is too much hassle

Q8e. I like my current supplier

Q9. If you buying green energy meant that the electricity of everyone else in the UK becomes 'less green', because they are buying what is left, would you be more or less likely to buy green electricity?

More likely, No difference, Less likely

Q10. If buying green electricity didn't lead to any new renewable generation being built, would this make you more or less likely to buy a green electricity tariff?

More likely, No difference, Less likely

Q11. Government policy means that all households pay around £26 a year for green electricity in their bills. Does knowing this make you any more or less likely to buy a 100% green electricity tariff?

More likely, No difference, Less likely

Q12. Which of the following types of goods have you purchased in the last year?
(select all which apply)

Organic fruit or vegetables, Fair-trade goods such as coffee or chocolate, Ethically farmed eggs such as 'free range' or 'happy eggs', Efficient LED lightbulbs

Q13. How important would you say that green issues (such as climate change) are to you?

Extremely important, Very important, Moderately important, Slightly important, Not important at all

Q14. Is there anything you would want to add about buying green electricity that wasn't covered above?

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7. An evaluation of the potential of consumer green electricity tariffs to contribute towards the decarbonization of the electricity system

7.1 Preface

Chapter six only looks at one mechanism whereby green electricity tariffs can have environmental benefit, the additionality contribution which is required by legislation. When gathering data, several suppliers believed that the act of simply procuring green electricity through REGOs is sufficient to bring about additionality. Chapter seven takes this claim as a starting point and builds out a theoretical model of all the causal mechanisms whereby a green electricity tariff could have environmental benefit, which are then evaluated using a mixed methods approach.

This paper is currently under review in the journal Energy Policy.

7.2 Abstract

Many consumers choose to pay a premium to purchase a green electricity tariff, which are sold as a way for households to reduce their carbon emissions and tackle climate change. This research outlines a theoretical model which includes all mechanisms whereby green tariffs could reduce carbon emissions, which are evaluated using a mixed methods approach with the UK as a case study. The voluntary market for green electricity tariffs is found to have a negligible impact

on the profitability of new renewable energy investments, both through the value of REGO certificates and through increased competition in the PPA market. No empirical evidence is found that suppliers are able to bring more renewable energy projects to market by providing non-financial support to the independent generators they work with. While most green electricity retailers engage in some form of investment in new renewable energy technologies or business models, this is not causally related to the sale of green tariffs and is not different to the investment which many other suppliers undertake. Taken together, these findings suggest that consumer demand for green electricity tariffs does not translate into increased renewable energy capacity and claims regarding their potential to reduce carbon emissions are overstated.

7.3 Introduction

Many households in the United Kingdom and across the world voluntarily pay extra to purchase a green electricity tariff, so that the electricity they consume is matched with renewable generation. The marketing of these tariffs claims that doing so can help to reduce personal carbon footprints, support renewable energy generation and reduce carbon emissions, as demonstrated by the quotes in figure 7-1. In order for these ambitious claims to be true there must be a positive relationship between the consumer demand for green electricity tariffs and increases in the supply of renewable energy, which will displace carbon intensive energy sources and consequently lower carbon emissions. This

relationship has not been tested and often in academic research is assumed to be true, too frequently asking how to increase adoption of green electricity tariffs and ignoring whether it is a worthwhile objective in the first place (in the UK context examples include Diaz-Rainey and Ashton, 2008; Hast et al., 2015; Lange and MacPherson, 2012). Unlike most other consumer goods the relationship between supply and demand for green electricity is complex, as increases in supply rely on investors and developers undertaking significant capital investment to be paid back over many years (Krupa and Harvey, 2017). The market is also reliant on subsidies paid by all bill-payers, through a number of schemes such as the Feed in Tariff, Renewables Obligation and Contracts for Difference (Mitchell, Bauknecht and Connor, 2006; Mendonca, Jacobs and Sovacool, 2009; Muhammad-Sukki et al., 2013). A theoretical framework is outlined which includes all possible causal mechanisms whereby demand for green electricity tariffs can have environmental benefit, which is then evaluated using a mixed methods approach. While the United Kingdom¹ is used as the case study the results will be relevant to many other jurisdictions where green electricity products are sold, particularly in Europe.

Figure 7-1: Environmental claims made by green electricity retailers

“With so many new Bulb members, we are collectively having a BIG impact. Together, we’re saving 374 million kg of CO₂ from entering the atmosphere every year. That’s a lot of CO₂. In fact, it’s like planting 187 million trees.”-

Bulb Energy “Green Impact Report” (<https://bulb.co.uk/blog/our-2017-green-impact-report>, retrieved 27th July 2018)

¹ The case study only looks at the market in Great Britain, as the electricity market in Northern Ireland is structured differently.

“The average carbon content of our electricity is far below the UK average, giving you peace of mind that you are also doing your bit for the environment.”

Green Star Energy “Our Energy” (mygreenstarenergy.com/Our-Energy/Energy-Sources, retrieved 27th July 2018)

“When you switch to us, we [match all the electricity](#) you use over a year with electricity sourced purely from renewables. Making UK electricity cleaner and greener with every new customer we have”

Good Energy “Our Energy” (goodenergy.co.uk/our-energy, retrieved 27th July 2018)

This has become an important question to answer in light of the default tariff cap which is under consultation by the electricity market regulator OFGEM, which will limit the price which retailers can charge for default variable tariffs. While the ‘big six’ suppliers use these tariffs to charge higher rates to unengaged customers (CMA, 2015), they are often the only tariff type offered by green tariff retailers who do not offer fixed contracts. The regulator was directed by statute in 2018 (Domestic Gas and Electricity (Tariff Cap) Act, 2018) to explore whether green tariffs should be exempted from the tariff cap, which in turn prompted a discussion over whether which, if any, green tariffs should be allowed to charge more than the default price (OFGEM, 2018b). The proposal OFGEM has settled on is that tariffs can apply for a derogation from the cap if they meet three criteria (OFGEM, 2018b). First, they should have been actively chosen by the customer, and not rolled over after a fixed period has ends. Second, they should contribute towards the development of new renewables. Third, they should have ‘materially higher costs’ than a non-green tariff. This research will help to answer the last two of these questions.

There are three other reasons why this is a worthwhile area of research. First is because increasing numbers of electricity retailers in competitive energy markets, both in the UK and across the world, are marketing their tariffs as 'green', and subscriber numbers have been steadily increasing (MacDonald and Eyre, 2018). Second, consumer purchasing of green electricity tariffs may incur opportunity costs for other green or ethical products, as according to an OFGEM calculation "consumers can pay up to £300 more for their energy per year for an SVT (standard variable tariff) with a supplier who claims to invest in renewable technology innovation" (OFGEM, 2018a p.6). Some alternative investments may have more proven environmental benefits, such as making energy efficiency improvements. Third is the potential presence of psychological rebound effects, where consumers who purchase green electricity may no longer feel 'guilty' about their electricity consumption, so may consume more energy if they believe it comes from a 'guilt-free' green source (Santarius and Soland, 2018). Finally, there is also a consumer protection rationale for understanding how valid the claims made by green electricity retailers actually are. Three quotes from green electricity retailers are included in figure 7-1, all of which make the link between electricity purchasing and helping the environment by lowering carbon emissions. There is a principle of consumer protection law that consumers should be able to make informed choices about their purchasing (Ramsay, 2007:2) and claims from retailers should not include false or deceptive messages (Reich and Micklitz, 1980:41). This consumer protection angle has also

prompted loose regulation by the electricity market regulator (OFGEM, 2014), which will be explored further when outlining the theoretical framework.

A mixed methods approach is used to explore the impact of the voluntary market for green electricity tariffs. Both quantitative and qualitative methods are used, in recognition of the fact that no single methodology would provide both the rigor and nuance required to answer the questions at hand. While it may be unusual for such a wide variety of methodological instruments to be used within a single piece of research, it is suitable as each of the causal mechanisms listed in the theoretical framework requires different methods to be evaluated. For the quantitative analysis, financial modelling of renewable energy projects, measuring the impact of the market for REGOs on overall investment rates of return for renewable energy projects, will be undertaken. The data source is the 2015 Department for Climate Change feed-in-tariff impact assessment consultation response (DECC, 2015a), which combines government cost and revenue estimates with responses from project developers and industry analysts. Questions requiring a qualitative method will be answered using a survey conducted with renewable energy project developers. Where available, evidence from the published literature will also be used to evaluate the causal mechanisms.

7.4. Theoretical framework

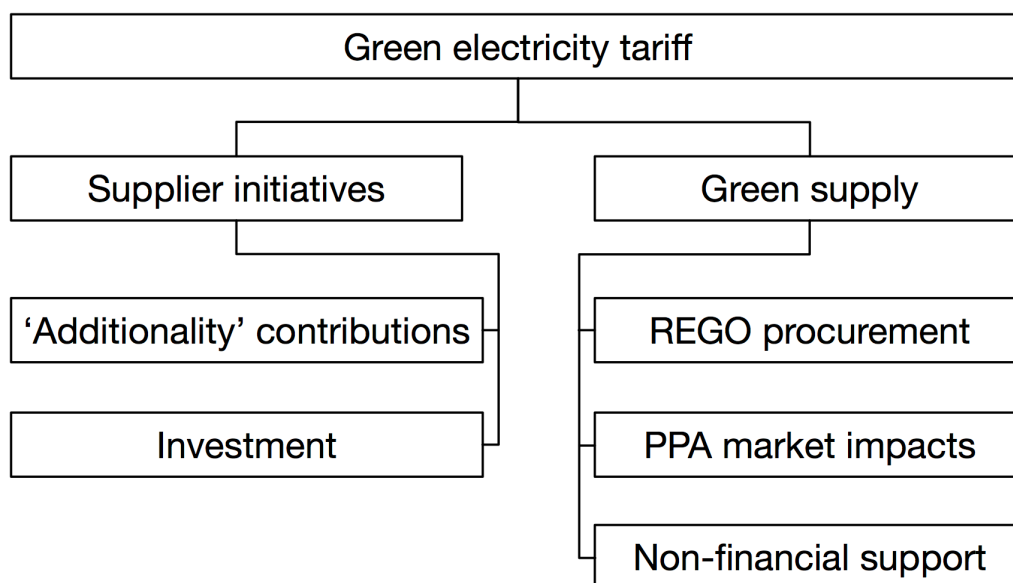
Despite an increasingly large body of work exploring why consumers purchase green electricity tariffs (Herz, 2013; Ma et al., 2015; Yang, Solgaard and Haider,

2015; Mulder and Zomer, 2016b) and what marketers can do to promote their products more effectively (Wüstenhagen and Bilharz, 2006b; Rex and Baumann, 2007; Herbes and Ramme, 2014), there have been no previous attempts to outline and explore the causal mechanisms whereby the increased consumer demand for green electricity tariffs translates into lower carbon emissions of the energy system as a whole. What debate there has been focuses on the issue of ‘additionality’ (Menges, 2003; OFGEM and Big Sofa, 2014), whether the tariffs benefit the environment. The framework developed in this research attempts to outline and evaluate the causal mechanisms which bring about the ‘additionality’ of green electricity tariffs. In a general sense the term can be broadly defined as “the extent to which something happens as a result of an intervention that would not have occurred in the absence of the intervention” (English Partnerships, 2008). The concept became popular primarily in the field of policy evaluation in the 1990s as governments became interested in measuring ‘additional’ outcomes (Pearce and Martin, 1996). Relating this to green electricity, the ‘something’ that happens is a reduction in the carbon intensity of the electricity system which happens as a result of an ‘intervention’ that is a consumer demand for green electricity tariffs. While the term will be used consistently in this chapter in line with the definition above, there remains no standardised meaning of the term and it is used (and misused) in many different contexts (Gillenwater, 2012). One issue which has preoccupied the academic discussion around additionality concerns causality and the difficulty of establishing a baseline or counterfactual scenario against which to measure the output of the intervention (Hind, 2010). It

can be particularly difficult to establish causality when the issues at hand are complex (Pawson and Tilley, 1997) and involve multiple government programs and regulations (Mayne, 2001).

As shown in figure 7-2 below, the theoretical framework developed splits the mechanisms into two types; supplier initiatives and green supply. The first of these refers to initiatives which the supplier undertakes which are not directly related to the procurement of green electricity, including ‘additionality’ contributions, and investment. The second mechanism relates to the ways in which carbon emissions can be lowered through the process of sourcing green electricity, either through the procurement of the capacity itself or the associated REGO certificates.

Figure 7-2: Mechanisms whereby green electricity tariffs could potentially lead to lower carbon emissions



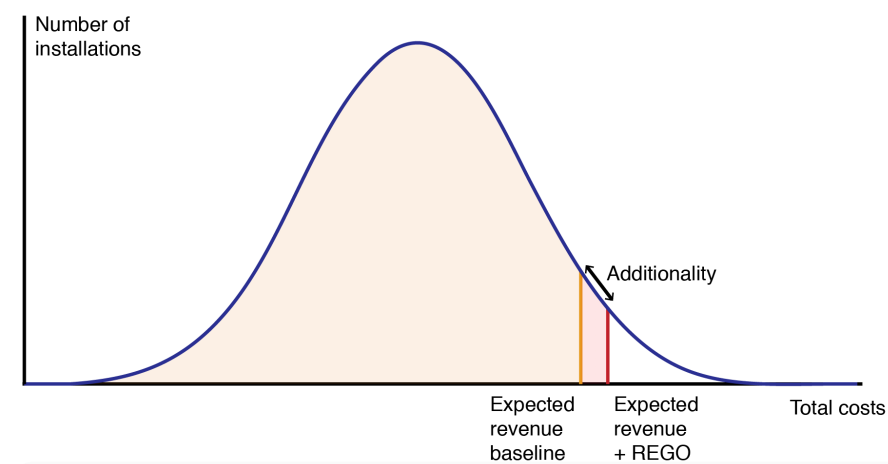
Before analyzing each mechanism, it may be useful to present a brief summary of the policy mechanisms which have been driving the uptake of renewables in the UK, as there are interaction effects between state policies and the voluntary market which be relevant to consider throughout. The first significant support mechanism for renewable energy was the Renewables Obligation (RO) (Utilities Act, 2000; Wood and Dow, 2011), a quantity-based mechanism which required large retailers to match a proportion of their electricity sales with Renewables Obligation Certificates. These certificates are generated by projects accredited under the RO, alongside REGO certificates. In order to provide greater support to smaller generators a price-based feed-in-tariff was launched in 2010 (Energy Act, 2008; OFGEM, 2018d), which was instrumental in increasing the penetration of small scale and microgeneration (Cherrington et al., 2013). Since 2015 the FiT has been decreased in value considerably (Muhammad-Sukki et al., 2013) and will be phased out entirely in 2019. Current projects can receive support under the Contract for Difference (Energy Act, 2013), a variable auction-based price mechanism which so far has provided support to large scale renewable energy projects.

7.4.1 Green supply – REGO procurement

In the GB retail electricity market, retailers are required to show that each unit of electricity sold to their customers is matched with equivalent REGO certificates (OFGEM, 2014). As green electricity tariffs are proven to be green by the presence of REGO certificates, the increased demand for the certificates, which

are also used by all suppliers for fuel mix disclosure, should be the mechanism by which the environmental benefit takes place. When a renewable generator produces one MWh of electricity, one REGO certificate is produced, separate to any renewable obligation certificate or other subsidy payments. In classical economics one would expect that when demand for some particular good rises there should either be an increase in price if supply remains constant, or an increase in supply keeping the price constant. This is the mechanism which underpins notions of 'ethical consumerism', that individuals are able to affect the supply of certain goods based on changing the underlying demand. Examples from the ethical purchasing literature include goods as varied as Fair-Trade coffee (Peattie, 2010), ethical fashion (Gibson and Stanes, 2011) and MSC certified fish (Kalshoven and Meijboom, 2013). In the context of markets for green electricity certificates, the only way that the supply can be increased is to build new generation as, with the exception of some biomass, the output of preexisting generation sites is fixed. Because of this it is necessary to look to the role of the voluntary market in the development of new projects.

Figure 7-3 : Cost benefit analysis performed by project developers with and without the revenue from REGO certificates



Across the whole market for new green energy investments there will be a spectrum of projects, ranging from the most profitable ones with favorable planning and topological characteristics to those which are not profitable at all, possibly due to local opposition or difficult site characteristics, as shown in figure 7-3. The horizontal axis shows the total project costs and the vertical axis indicates the number of installations which are viable at each cost level, the curve has been shown to follow a normal distribution (DECC, 2015b). Projects falling within the shaded area in the graph are assumed to be profitable investments, and as such should be developed. In theory markets for green electricity provide an additional revenue stream for project developers, so one would expect the cutoff point to shift right along the horizontal axis and a greater number of projects should become profitable. In the cases where investment into the green electricity project was marginally profitable, this small additional element of revenue should be the tipping point for the decision to invest to go

ahead. This shift, between the expected revenue baseline and the revenue with the value of REGOs added, represents the additionality of the market for REGOs. If markets behave this way then it is possible to say that consumer demand for green electricity, even though the price premium is small, will lead to an increase in the amount of green electricity which is generated. This is the view of the market put forward in working papers looking at the impact of Renewable Energy Certificates (RECs) in the USA (CRS, 2016a, 2016b; Jones, 2017) published by the US Center for Resource Solutions, which also administers the Green-e certification scheme. One such paper argues that “the more consumers who buy RECs, the more renewable electricity the market will create to meet that aggregate demand” (CRS, 2016b). Similar arguments are made by analysts in the US government, including both the EPA (EPA 2010) and NREL (Holt, Sumner et al. 2011). It is worth noting that while the general principle of increased demand for voluntary certificates manifesting as increased generation is similar, the existence of a Renewable Portfolio Standard in many US states makes the comparison with the UK imperfect.

7.4.2 Green supply – PPA market impacts

Many green electricity companies procure their energy through Power Purchase Agreements (PPAs) with renewable generators. Under these agreements the retailer enters into a contract with a generator to purchase energy at a set price and for a set period (Lam and Law, 2018). There is a huge amount of complexity in the different types of PPA which exist, which for the sake of simplicity can be

split into four categories. The first two are short term (1-3 year) and long term (above 3 year) bilateral contracts. The third type are Contract for Difference (CfD) PPAs, for generation supported under the CfD subsidy scheme. The fourth type are short term contracts awarded through auctions, where suppliers can bid to procure energy for a short period of time, usually 6-12 months. This fourth type is popular with small entrants to the retail market, who do not have access to the credit to secure a longer term PPA (Solar Trade Association, 2016). All of the contract types can vary by the agreed price and how the Embedded Benefits, REGOs and ROCs are shared between the two parties (Littlechild and Cornwall, 2008). In an uncompetitive PPA market there would be relatively few suppliers, or other PPA off-takers, looking to purchase power from generators in this way. In a more competitive market, a greater number of suppliers would be bidding for the same contracts and therefore the prices paid to generators should be higher or the contract terms should be more beneficial to the generator. Higher number of green electricity companies procuring energy through PPAs should therefore push up PPA prices and make renewable energy investments generally more profitable, and *ceteris paribus* the market should deliver more renewable projects. Importantly, unlike the market for REGO certificates, this premium to developers takes the form of increased revenue through higher export prices or more favorable contract terms rather than being tied to a particular certificate which is generated and sold on.

7.4.3 Green supply – non-financial generator support

Section 2.1 presents a model whereby there is a spectrum of projects which range from the most to least profitable ones, with all those which provide a good rate of return to developers being developed. However, in reality this is not the case as projects face both financial and non-financial barriers to project development (ECORYS, 2008). Larger developers for example may be limited by the rate at which projects can be developed or may choose to invest their capital into other types of more profitable or less risky projects. These non-financial barriers are also significant for small scale developers, such as private individuals or community groups. These developers may lack the expertise necessary to bring their projects to market, as they are likely to not be from personal backgrounds related to renewable energy. Green electricity retailers, if they contract directly with smaller generators through PPAs or FiTs, may also bring with them expertise in bringing projects through the development process. As such, a form of additionality could occur through green electricity companies helping to bring more projects to market, even if the export price those developers received was no higher than the standard market rate.

7.4.4 Supplier initiatives - additionality contributions

In the GB retail electricity market, suppliers are required to show that their tariffs have ‘environmental benefit’ above and beyond the procurement of REGO certificates (OFGEM, 2014). Why the regulator may be skeptical that the REGO market is insufficient will be outlined when discussing the impact of REGO

procurement. These additionality contributions are similar to the steps taken under what were formerly called ‘green fund’ tariffs, where suppliers didn’t actually need to procure green electricity but instead made per unit contributions to environmental projects (Lipp, 2000; Boardman, Jardine and Lipp, 2006). Examples of the types of measures taken include investing in community energy projects, clearing waterways affected by hydropower development or planting trees in schools (MacDonald, forthcoming).

7.4.5 Supplier initiatives – investment

The second form of supplier initiative which could contribute towards lowering carbon emissions concerns the investment undertaken by green electricity retailers, funded through the profits of their supply business. The first element of this concerns investment in innovative technologies and business models. The argument put forward by green electricity retailers is that in order to remain profitable they must be innovative and invest in where the market is heading, rather than where it is now. As a result of this suppliers invest in developing innovative business models in areas such as peer to peer energy, funding pilot projects or building out the infrastructure necessary to facilitate the transition to a low carbon economy, such as electric vehicle charging points. In these cases, the business logic, of innovating to stay profitable, and environmental logic, that new business models will be necessary in order to decarbonize the electricity system, are in alignment. Retailers would therefore argue that carbon emissions are lowered through the profit made by green electricity retailers being invested

into these new areas, regardless of the environmental attributes of the product itself.

Some suppliers also develop new renewable energy projects themselves, using the profits from the green tariff sales to fund the construction of new renewable energy projects. The retailer Ecotricity has pioneered this business model through its “bills into mills” strategy (Ecotricity, 2018b). In 2016, the last year for which the company has produced an environmental impact report, the company had an installed capacity of 81.49MW (Ecotricity, 2016), equivalent to 0.22% of the UK’s renewable installed capacity at the time (which stood at 35,690MW (BEIS, 2018b)). The retailer does not have enough self-generated capacity to cover the total number of homes they supply, so around half of their electricity is procured through PPAs with other generators (Ecotricity, 2018a). The retailer Good Energy formerly adopted a similar strategy, but no longer invests in generation due to reductions in the support tariffs for smaller generators and a change in business model towards a leaner operating structure (Good Energy, 2015).

7.5. Methodology

The theoretical framework has identified five possible ways in which consumer demand for green electricity tariffs can lower carbon emissions; REGO procurement, PPA market impact, non-financial support, ‘additionality’

contributions, and investment. This research will evaluate each of these causal mechanisms in terms of their empirical validity in the UK context, which will be tested through quantitative and qualitative methodologies as outlined in table 7-1, and whether they present logically valid causal mechanisms. This later form of evaluation is important as many of the arguments may be empirically true, for example if green electricity retailers do invest in new technologies, but logically flawed, if that investment was not directly related to the sale of their tariffs.

Table 7-1: Methods used to evaluate each causal mechanism

Mechanism	Methodology
REGO procurement	Financial model of renewable energy project investment showing impact of REGO revenue on project internal rates of return.
PPA market impact	Review of currently available evidence, alongside analysis of PPA auction results.
Non-financial support	Survey of generators who have export agreements with green electricity companies.
'Additionality' contributions	This will not be tested as a census of retailers' additionality contributions was recently undertaken by MacDonald (forthcoming).
Investment	A census of supplier investment initiatives.

7.5.1 REGO procurement

One mechanism by which green electricity tariffs can lower carbon emissions is by increasing the demand for REGO certificates in such a way that a greater number of renewable energy projects become profitable. In order to answer this question a financial model similar to those used both by project developers themselves to make investment decisions and by government to set renewable energy subsidy rates will be utilized. The model uses projected cash flows to calculate internal rates of return for a variety of renewable energy projects. As

the IRR only considers the internal factors relating to the project, external factors such as inflation and cost of capital are not taken into consideration. This methodological approach was chosen in order to keep the model lightweight given the resources available, and because the primary concern of the model is to establish comparative levels of support. The model uses project finance data obtained from the UK Department for Energy and Climate Change 2015 feed in tariff impact assessment (DECC, 2015a). The dataset is based on existing government data as well as consultation responses from project developers and industry experts. The data source provides rigorously calculated and scrutinized figures for a variety of technologies and sizes, and is still being used by government in 2018 to model the impact of varying levels of subsidy on the viability of small scale renewable generation (BEIS, 2018a). While payback time and projects' internal rates of return are not the only factors which determine decisions to invest in new renewable generation, they are arguably one of the most influential. Four scenarios are compared; a baseline with no REGO or subsidies, REGO revenue at the current level, REGO revenue at a level equal to the premium that consumers in the market pay currently and with a feed in tariff. A detailed overview of the model and all assumptions factored in can be found in appendix A.

7.5.2 PPA market impact

As outlined in the theoretical framework, one mechanism whereby demand for green electricity products can have environmental impact is by increasing the

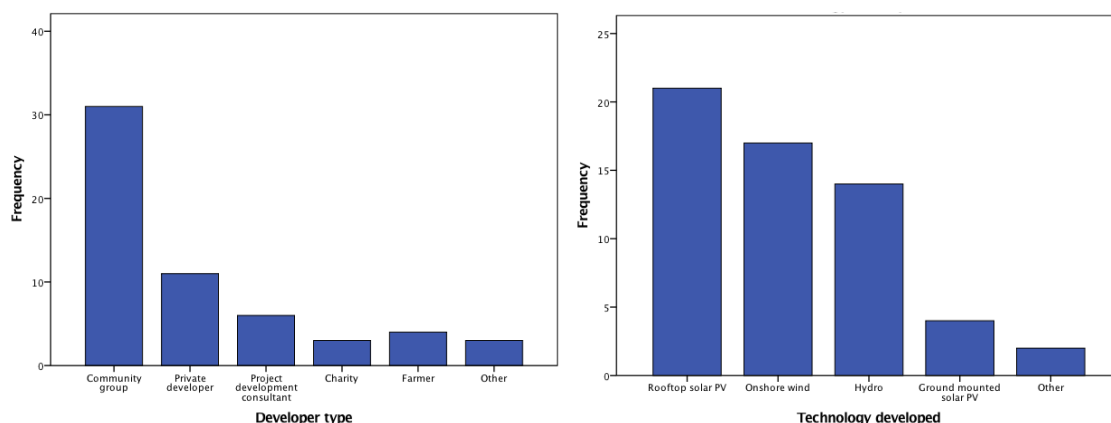
competitiveness of the PPA market, leading to higher export prices and more favourable distribution of associated benefits such as embedded benefits for developers. This is a difficult mechanism to evaluate, as PPA prices and terms are confidential between generators and retailers. There is also little data available publicly regarding changes in PPA market competition and liquidity. In order to provide some assessment a review of the current published evidence was undertaken. An analysis of trends in the Non-Fossil Purchasing Agency ePower PPA Auction was also conducted, which should provide insight into the impact of green tariffs on this particular type of PPA.

7.5.3 Non-financial support

Whether a project is developed not only depends on the financial viability of the project, it also requires the developer to have the capacity to see the project through to completion. Green electricity retailers can be useful agents in assisting smaller developers with the development of their project. In order to estimate the benefit of this mechanism a survey was conducted of renewable generators who supply electricity to green electricity companies. A list of generators was obtained from the Ofgem Renewables and CHP Register (OFGEM, 2018e), which is used to distribute and track REGO certificates. Online search engines were then used to obtain email addresses for the generators, which were entered into a database. An online survey was distributed to the mailing list and a total of 255 emails were sent out, a reminder was also sent out 3 days later to all participants who had not completed the survey. In total 58

responses were received, which represents a response rate of 22.7%, a result which is typical of online surveys distributed using this method with no added participant incentives (Lauber et al., 2005; Van Mol, 2017). The survey responses were coded and analysed using the IBM SPSS statistics package (IBM, 2016). A breakdown of the spread of respondents can be found in figure 4. The developer type is skewed towards community groups, as this population had up to date contact details which were available online and are the types of groups which are most likely to benefit from the additional project support compared professional developers.

Figure 7-4: Respondents broken down by technology and developer type



7.5.4 'Additionality contributions'

Suppliers selling tariffs labelled as 'green' in the GB market are required to show that they take extra steps, beyond the procurement of REGO certificates, to show that their tariffs have environmental benefit. As a recent comprehensive study which has data for all additionality contributions made by suppliers in the

GB market exists (MacDonald, forthcoming), and summary of the findings from that research provide suitable evidence for analysis.

7.5.5 Investment

Many retailers which offer green electricity products also invest in other renewable technologies and business models, many of which will be necessary to transition to a low carbon economy. As these investments are funded with the profits obtained from the sale of green electricity sales, the retailers argue that the environmental benefit of the new investments should be counted towards the environmental benefit of the tariffs themselves. In order to determine the likelihood that this is a valid argument a database was built of the different forms of investment undertaken by retailers, including the type and quantity where possible. This data was gathered both from press releases advertising recent activity as well as public financial reports. Due to the availability of commercially sensitive data, only publicly declared investments were included.

7.6 Results and Discussion

7.6.1 REGO Procurement

The results of the project finance modeling, table 7-2, indicate that the market for REGO certificates as it currently stands has a negligible impact on the profitability of renewable energy investments. The impact on the IRR of was

found to be less than 0.1% in all scenarios tested, even with the assumption that the value of the REGO would be present throughout the project's whole lifetime. This assumption is not likely to be true as the true value of the revenue stream to developers would decrease if the REGO's long term risk was considered. A more significant increase was seen in the REGO High scenario, where the revenue attributed to REGOs was equal to the lowest possible price premium for green electricity on the GB market, equivalent to £0.0263/kWh (MacDonald & Eyre 2018). Under these conditions the IRR increased by an average of 2.66% compared to the baseline scenarios. Both of these scenarios were substantially lower than the 20-year feed in tariff option, which had a substantially higher IRR across all technology types and sizes tested.

Table 7-2: Impact of REGO revenue on project viability in comparison to baseline, feed in tariff and high REGO scenarios

Project	Model output	Baseline	REGO	REGO High	Feed in tariff
30kW Rooftop Solar PV	IRR	2.6%	2.6%	4.5%	5.8%
	Baseline change	-	0.0%	1.9%	3.2%
2840kW Rooftop Solar PV	IRR	4.7%	4.7%	7.0%	11.8%
	Baseline change	-	0.0%	2.7%	7.1%
80kW Onshore Wind	IRR	0.0%	0.0%	2.3%	6.6%
	Baseline change	-	0.0%	2.3%	6.6%
482kW Onshore Wind	IRR	1.0%	1.0%	4.6%	7.9%
	Baseline change	-	0.0%	3.6%	6.9%
30kW Hydro	IRR	2.0%	2.0%	4.8%	10.1%
	Baseline change	-	0.0%	2.8%	8.1%

This modelling suggests that, at the level they currently exist, REGOs have no value to new project developers. To a large extent this reflects the fact that the

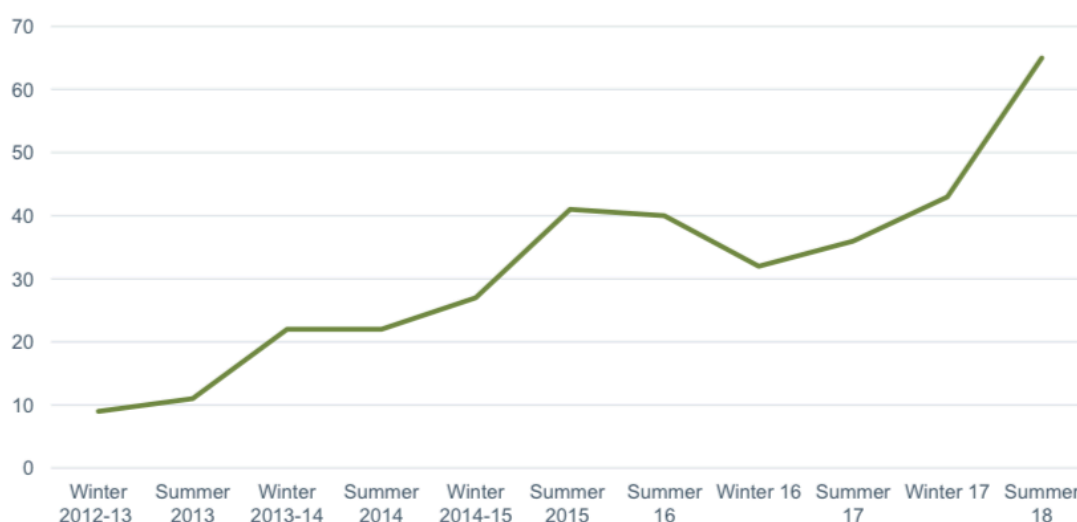
certificates were not designed to be tradeable goods but were instead primarily meant to facilitate tracking of fuel mix disclosure. It is knowing this, albeit without any of the modelling performed here, that brought about OFGEM's skepticism in the green source tariff regulations that REGO certificates alone would be sufficient to have environmental benefit. However, the results do show that if REGOs were able to command a significantly higher value that was closer to the actual premium that consumers pay to purchase renewable electricity which could be sustained throughout the lifetime of the project, the impact on IRR would be more significant.

7.6.2 PPA Market Impact

There is no previous published academic work which attempts to measure the impact of increasing numbers of PPA off-takers on achieved PPA prices. However, there are several pieces of evidence which may give some insight. Since 2012 there has been a six-fold increase in the number of contracts agreed in the Non-Fossil Purchasing Agency (NFPA) NFPA e-POWER Auction, for PPAs lasting between 6 months and a year, as shown in figure 7-5. In an analysis of the January 2018 auction an independent auditor noted "a rise in the number of suppliers entering the e-POWER auctions as a route to market for green power", adding that "this has created high levels of bidding and liquidity" (Dixon, 2018). These auctions are important for newer suppliers, as the credit score required to participate in the auction is much lower than for long term bankable PPAs which usually require the counterpart to have a credit rating of at least 'BBB'

(Baringa, 2013). Aside from a growing interest in corporate PPAs (BloombergNEF, 2018), there is no indication that competition for longer term PPAs has been increasing as a result of the growth in smaller suppliers. This is confirmed by recent analysis by the Department for Business Energy and Industrial Strategy which finds that “within the PPA market there appears to be a competitive short-term PPA market with 40 off-takers participating, however, availability of longer-term PPAs appears limited” (BEIS, 2018d p.27).

Figure 7-5: Trends in the number of contracts signed at the NFPA ePower Auctions 2012-2018



Source: Analysis of the e-POWER January 2018 auction (reproduced from Dixon, 2018)

The causal mechanism tested here is that increased demand for voluntary green tariffs increases competition in PPA markets, leading to higher agreed export rates and more favourable contract terms for generators. This has the effect of marking the market more attractive to new project developers and increasing the number of investments. The evidence presented suggests that while

competition may be increased in auctions, there is no impact on the market PPAs for longer term PPAs that most new renewable projects are looking to sign. There is no reason therefore to expect that the increased consumer demand for green tariffs will increase the number of renewable energy investments through this mechanism. There is also variation in the procurement methods of green electricity retailers, many of whom never sign PPA agreements and may simply 'greenwash' their tariff by purchasing REGOs. The viability of large utility scale projects, which are being increasingly common under the contract for difference, will also not be affected by marginal changes in PPA markets.

7.6.3 Non-financial support

A survey of renewable energy project developers was undertaken to assess the role of retailers' non-financial support in helping to bring projects to market. As table 7-3 shows, additional project support ranked lowest of all factors which were important when choosing a partner to sign an export agreement with. Furthermore, when asked in an open-ended question whether they received any additional support from their export partner, only 7.3% of respondents answered yes, with half specifying that the support was only to do with public relations. Interestingly all of the respondents who claimed that additional support was received, were individuals who acted as consultants with professional backgrounds in energy. This is not the group which would have been expected to need the additional support, suggesting that it was not likely to be an influential factor. There was no variation in the responses when split between

different developer types, suggesting that characterizations of smaller or community generators as lacking knowledge and capacity may be incorrect. Several comments were also left in the open ended 'any other comments' section regarding the importance of subsidies and the negative effects of the removal of the feed in tariff.

Table 7-3: When choosing a partner to sign an export agreement with, which of the following factors are most important to you? Responses measured on a five-point scale from not at all important (coded as 1) to extremely important (coded as 5)

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Export price	49	1	5	4.39	0.953
Customer service	48	1	5	3.29	0.988
Contract length	47	1	5	3.21	1.318
Shared values	48	1	5	3.15	1.288
Green revenue	44	1	5	3.07	1.404
Past experience	46	1	4	2.87	1.24
Additional project support	46	1	4	2.33	1.156

The survey also found that different motivations for embarking on the renewable energy projects also corresponded to different strategies for exporting electricity. Those who were motivated primarily by the environment rather than profit were less likely to care about the export price ($-.387$, 0.08 , $n=46$), more likely to look for a partner with shared environmental values ($.551$, 0.00 , $n=45$), signed longer contracts ($.506$, 0.00 , $n=47$) and were less likely to develop larger projects ($-.384$, 0.05 , $n=51$). However, despite this variation there was no association between the value assigned to additional project support, regardless

of the motivations of the developer or whether they had a professional background in energy.

The logic of the suppliers when arguing non-financial project support constitutes additionality is that their advice and support can be important to some developers. This survey finds no evidence that this is true, especially among the demographics who would be most likely to appreciate this support. There also remains a problem with the applicability of this argument across different retailers as there are no green electricity retailers who source their energy entirely from the smaller independent generators who should benefit from this kind of non-financial support. Even suppliers, such as Good Energy, who have traditionally had a strong focus on supporting independent generators now aim to procure a significant amount of their energy from large utility scale renewable energy projects such as offshore wind farms developed by DONG (Good Energy, 2017a) or tidal lagoons (Good Energy, 2017c). These arguments also wouldn't apply to any retailers who source their electricity from auctions or simply purchase REGO certificates.

7.6.4 'Additionality' contributions

No primary research was undertaken concerning the 'additionality' contributions made by suppliers as a recent comprehensive census was undertaken by MacDonald (forthcoming). The research finds that the measures taken by suppliers, where they do take measures at all, are often small and may be

completely unrelated to reductions in carbon emissions. Of the ten suppliers included in the census two did not make any additionality contributions. Of those who did, four suppliers planted trees and several others counted the sorts of investment included in section 4.5 as their contribution. The size of the contributions are also small, with one retailer putting just £1 per customer into an environmental fund. There was also found to be a lack of transparency in the market, with information not clearly presented to consumers. Four out of ten retailers did not state what steps were taken on their website and only three stated their contribution on a per customer basis. Based on the evidence above, this is not an effective mechanism for ensuring that green electricity products can help to lower carbon emissions or support new renewables in any substantial way.

7.6.5 Investment

Data was collected on the investment activity undertaken by different renewable energy suppliers, gathered both from press releases as well as public financial reports. As table 7-4 shows, all suppliers listed take part in some kind of investment in new technologies, products or business models. In their analysis of the green tariff price cap exemption OFGEM considered classifying a green tariff as having environmental benefit if the level of this investment was equivalent to ten percent of the total tariff cost (OFGEM, 2018a). As retailers' investment and detailed financial statements are confidential, it is difficult to say if any suppliers meet this level. However, the difficulty with this mechanism is as

much to do with the argument's logic, as it is to do with the empirical levels of supplier investment. The issue is that the investment undertaken by the retailer is only indirectly linked to the green electricity product, and that the same standards are not applied to other companies which also invest in renewable energy innovation. Many fossil fuel companies and large 'big six' energy companies, whose environmental credentials are questionable at best, invest equally if not more in renewable technologies. For example, Royal Dutch Shell recently purchased one of Europe's largest electric vehicle charging networks (Sheppard and Campbell, 2017), but it would be difficult to argue that this makes their fossil fuel extraction and sales any more environmentally ethical. Furthermore, the majority of green retailers are private companies who return much of the profit they generate back to their shareholders, with only a proportion invested in innovative projects. Furthermore, the suppliers have a fiduciary duty to return profits to their shareholders and investors, so would only undertake investment and innovation when it helps to bring about that goal. The investments undertaken also do not always relate to lowering carbon emissions, with one retailer investing in a loss-making football club (Ecotricity, 2018b).

Table 7-4: Supplier investment and innovation

Supplier	Investment activity undertaken i	Source: Investment activity All retrieved 31st July 2018
Marks and Spencer Energyii	None, though the white label provider (SSE) does undertake significant investment in new technologies and business models.	Supplier's own website.
Good Energy	Investment in many areas including electric vehicle infrastructure, smart billing and peer to peer energy trading.	2017 Annual Report
Ecotricity	Wide variety of investments ranging from development of new renewable energy sites, electric vehicle charging to a vegan football team.	'About us' section on website
Solarplicity (formerly LoCo2)	Investments in renewable energy development in social housing and EV charging pilots.	Press releases on website https://solarplicity.com/part-solar-powered-car-charging-system
Green Energy UK	Developed innovative time of use tariff, among the first to be on the market in the UK.	https://www.greenenergyuk.com/Tide
OVO Energy	Developed home battery storage offering and EV charging hardware as well as smart storage heating	https://www.ovoenery.com
Green Star Energy UK	Part of the Hudson Energy group which invests in new technologies and business models on a global scale.	https://www.mygreenstarenergy.com
Bulb energy	Exploring new business models through the experience of early adopters through the 'Bulb Labs' project	https://bulb.co.uk/blog/bulb-labs-designing-for-the-future-of-energy
Octopus Energy	Invests in electric vehicle technology and developed the 'agile octopus' time of use tariff.	https://octopus.energy/blog/agile-octopus-bigger-story/
Fischer Energy	Sister company 'Fisher Future Heat' invests in innovating smart heating systems.	Fisher future heat press release

All data is obtained from suppliers' websites, or publicly available company annual reports, retrieved on 31st July 2018.

· As of late 2018 Marks and Spencer Energy will switch from SSE to Octopus as their white label provider. The data provided concerns the offer provided through SSE.

The idea that green electricity companies provide additionality through directly developing new generation sites themselves is a more plausible argument, given one could argue that without the presence of Ecotricity, the turbines it has developed would not have been built. Their construction was dependent on the profits which the lucrative green electricity tariffs brought in. However, there are several caveats which make this argument less persuasive. The first is that on a macro-economic scale the presence or absence of one single developer is

unlikely to be influential in determining the levels of renewables which are built as a whole, especially considering the projects developed by Ecotricity accounted for only 0.22% of the UK's installed capacity of renewables and that overall installed capacity is a product of targets set at international, European and national levels. In a counter-factual scenario where one particular developer doesn't exist, the sites may be developed by other parties and the capital used to purchase green electricity tariffs by households may be directed towards other environmentally beneficial projects. Second, many conventional retailers including the 'big six' develop renewable energy projects, often at a larger scale. Third is that the driving force behind new development of renewables has been billpayer subsidies such as the Feed in Tariff and Renewables Obligation, and that when these are reduced, as was the experience of Good Energy, investment in new projects falls regardless of whether the developer also sells green tariffs. With these caveats in mind, the argument is less convincing, however it is still difficult to deny that this is the most direct form of environmental impact and of all the possible routes of procuring electricity this seems to be the most closely coupled to the consumer demand for green tariffs.

7.6.6 Variation between suppliers

While none of the tariffs available on the UK market are found to substantially increase the supply of renewable energy, there are some clear variations between suppliers, which are summarized in table 7-5. The main axis of variation

concerns how closely coupled the retailers are to their generators. The most loosely coupled are retailers who only purchase REGO certificates, which involves no change in business model or procurement strategy compared to a standard non-green tariff. Slightly more connected are retailers who procure their energy from competitive PPA auctions. Even though procurement by this strategy means that the retailer and generator have no direct contact, evidence from the recent auctions does suggest that increased demand from green retailers does increase competition in the auctions. The next closest type of supplier are those who source their energy from a mix of independent and larger generators through bilateral PPAs. These suppliers would claim it is this relationship which helps to benefit the environment, though this research has found no evidence that this is true. The most closely coupled type of retailer are those who are currently engaged in the development of new projects, funded through the growth of their supply business. It is problematic to add a scale of environmental benefit to the same ranking, as it is found that none of the suppliers, with the possible exception of those who actually invest directly in new generation, are helping to reduce carbon emissions in any meaningful way.

Table 7-5: Suppliers differentiated by procurement strategies

Type of supplier	Coupled to generation
Direct investment in generation Retailer actively develops their own renewable energy generation, reinvesting profits from sale of green tariffs.	Close  Distant
Mix of independent and large generators Direct relationship with both small and large generators, would argue that they are able to offer non-financial support or better terms.	
Short term PPA auctions No direct relationship with generators. Purchases from established large renewable generators through short term auctions	
Only purchases REGO certificates. Supplier is likely to have recently switched to becoming a 'green supplier' either for marketing advantage or to game future regulations	

7.7. Conclusions

This research has analysed the link between consumer demand for green electricity tariffs and lowered carbon emissions through five causal mechanisms. No empirical evidence has been found which supports the claims made by developers that their tariffs are lowering carbon emissions or tackling climate change in any meaningful way. The most convincing argument concerns suppliers who match a proportion of their sold electricity with generation they have built as a result of the green electricity tariffs which consumers purchase, but the extent to which this is sustainable without additional subsidy is unclear. No evidence is found that environmental benefit occurs through the procurement of REGOs, increased competition in the PPA market, non-financial support given to generators, or through investment unrelated to the construction of new

renewables. The existing literature finds variation in the types of ‘additionality contributions’ made by suppliers, with current regulation clearly failing to ensure that all suppliers undertake any substantial efforts to offer environmental benefit through this mechanism. While the UK market was tested, the results can be clearly applied to other markets across the world, where the fundamental difficulty of encouraging long term investment in energy infrastructure through the mechanism of variable consumer demand still exists.

The market for REGOs, as it exists today, is found to be not causally responsible for any increases in renewable energy generation. Even if the issue of revenue stream reliability is put aside, the fact that the value of REGOs is so low makes the possibility that they could drive new investment impossible. However, the financial modelling does show that if REGOs could achieve a higher price, closer to the amount that consumers actually pay to receive green electricity, then the voluntary market could potentially be a driver of new renewable energy investments. This would be predicated on a business model being developed whereby the value of the REGO could be structured in such a way that the revenue stream could be seen as reliable by the financial institutions which underwrite the projects. It is unlikely that this higher price could be achieved in the REGO market as it currently stands, but an alternative tracking and certification system which places limits on the eligibility of projects in order to keep supply of certificates closer to the consumer demand may be a possible alternative.

Based on the conclusions above, there seems to be no justification for exempting any green tariffs from the default tariff price cap. In order for tariffs to be exempted OFGEM believes they should support the generation of new renewable energy, which is not found to occur in any significant way apart from the developers which actively build new renewables. Second, green tariffs should have 'materially higher costs'. Given the negligible value of REGOs it seems unlikely that this is the case, with the cost associated with the procurement of green electricity far lower than the price premium which consumers pay for green tariffs. If green tariffs are not exempted from the default tariff cap the tariffs still do remain viable, but the structure of the tariffs may need to change so they would not be counted as 'standard variable tariffs' under OFGEM's rules. The findings also cast doubt on whether OFGEM's existing green source tariff regulations, designed to protect consumers, are meeting their objectives. There is also no evidence to support retailers' claims that purchasing green electricity can help to reduce carbon emissions or fight climate change, apart from those retailers which also are involved in the development of new renewable energy projects.

A wider question still exists around whether any of this actually matters to consumers, who may be satisfied to consume green electricity in order to maximize their own 'warm glow' (Menges, Schroeder and Traub, 2005; Mitra and Moore, 2017) and to feel less personally guilty for the impact of their electricity

consumption on climate change. However, recent research suggests that this may not be the case. Consumer research into consumer expectations of green electricity tariffs shows that consumers expect the products to lower carbon emissions (MacDonald, forthcoming) and that tariffs which did not would effectively be “a con” (OFGEM and Big Sofa, 2014). There may be an argument for continuing to allow green electricity to be sold, to satisfy any consumers who are not interested in the environmental benefit, but to limit the environmental claims that can be made by suppliers in regard to helping to mitigate climate change. However, if the tariffs do not help to lower carbon emissions, one could consider advising consumers that they may be better to spend their limited resources towards measures known to have a more measurable environmental benefit such as investing in more efficient appliances or an electric vehicle.

7.8 Appendix A: Financial model assumptions

An internal rate of return model was used to assess the comparative profitability of projects under different support mechanisms; a baseline with no support, REGOs at the current level, REGOs at a higher level and under a feed in tariff. Details of assumptions included within the model are outlined below:

Energy retail prices

Energy retail prices were based on the 2017 BEIS retail electricity price growth assumptions 2017. The baseline scenario was used. As the dataset only extended to 2035, the average of the growth up to this point was averaged and this rate was used to extrapolate the data out to 2045. This was necessary in

order to provide a forecast for the full length of the renewable energy installation, of 30 years. The energy price for <10kW solar PV uses residential average, all other figures use the Services/Industrial average.

Panel efficiency loss

The data source already accounts for losses of 0.5% per year into the load factors for solar PV.

End of life disposal

No costs are associated with end-of-life disposal.

Export rate:

As there is little data available on the PPA rates which larger installations receive, the export tariff set under the feed in tariff was applied to all projects.

Feed in tariff:

Feed in tariff rates were based on the 2016 Generation Tariffs for Jan 2016 (p/kWh, Nominal prices). Contracts are assumed to last for 20 years.

Consumer price premium:

The consumer price premium was calculated using the figure from MacDonald & Eyre (2018), converted from EUR to GBP at a rate of 1:0.89 (XE.com, 5th July 2018). This represents the difference between the cheapest grey supplier and

cheapest green supplier on the market. Using this figure does assume that the entire difference is passed onto project developers, however given that many consumers choose to pay a higher premium even than the rate used, e.g. those who choose to buy from a premium supplier such as Good Energy or Ecotricity, the value is not unrealistic.

REGO Value:

The figure used to estimate the value of a REGO certificate is obtained from the green electricity retailer Good Energy. The source states that the cost of REGO is £0.15 each (One REGO equals one MWh of green generation, £0.00015/kWh)

<https://www.goodenergy.co.uk/blog/2017/08/15/green-tariffs-and-regos/>

Inflation, costs of capital and external risks:

As the model calculates the projects' internal rate of return, inflation, costs of capital and other external risks are excluded.

Selection of installation sizes:

The installation sizes are calculated using the average size of installations within each given size band, as obtained from the data source. For example, within the 50-100kW Wind tariff band the average installation size was 80kW.

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8. Discussion: is an additional market for green tariffs possible?

The obvious question which arises from the thesis is whether a market for truly additional green electricity tariffs is possible. The question will be analysed from both a theoretical and practical perspective, drawing on evidence from all four preceding research chapters. Where recommendations are presented, they represent the types of steps which may make the market work more effectively in each jurisdiction but are not costed or modelled beyond the analysis performed in chapter seven.

8.1 Matching short-term consumer demand with long-term investments

One difficulty with the concept of a truly additional tariff is that after the initial investment decision, renewable energy projects generate electricity certificates and the associated tracking certificates for the lifetime of the project. For solar energy this could be 25 years, for others such as hydro it could be over a century (Waters and Aggidis, 2016). There is a difficulty in ensuring that the short-term consumer demand can be made valuable for the lifetime of the project, and that the consumers who purchase electricity generated from established renewable energy projects are contributing to 'new' additional generation. Taking a hypothetical example, a new retailer named the 'truly additional green electricity company' raises funds from investors to build a new solar farm, free from any subsidies or external support, with the expectation that the premium consumers are willing to pay for the energy it develops is sufficient to make the project

profitable. It is intuitive to understand that the energy from the few years of customers is perfectly additional, as the premium that consumers are willing to pay has translated into new renewables which would have not otherwise been built. However, if the company decides not to invest in further renewables, it is less obvious that the electricity sold to its customers each year in perpetuity would be equally additional, especially as chapter six found that consumers when they purchase a green tariff expect to be contributing to new generation. Because of this some regulators or labelling schemes place a limit on the age of renewables which can be sold to consumers, however this would have tradeoffs in reducing the value of the consumer price premium to only the first few years of a project. One further reason the example above seems problematic is due to the difficulty in differentiating between the individual retailer's actions and that of the market and the economy as a whole. By continuing to purchase green electricity at a premium, consumers are sending a signal to the market that persistent demand exists. Even if the retailer in the preceding example builds no more generation, that does not mean that others will not see the value of the market and consequently engage in more project development themselves.

8.2 Causal attribution of direct and indirect public subsidy

A second issue concerns the causal attribution of the generation in the presence of subsidies which are passed onto all billpayers. The first aspect which is problematic are direct subsidies which are received by generators, such as feed

in tariffs. The state backed support mechanisms have several key benefits over voluntary markets in the size, length and stability of the revenue stream they provide. It is therefore unlikely, especially given the evidence in chapter seven, that in a circumstance where a project receives revenue from both the voluntary market and a state subsidy, that the voluntary market revenue stream would have been an important factor in the decision whether to invest in the project. Furthermore, the extent to which some private individuals should be able to co-opt the environmental benefit which has been paid for by society at large is questionable ethically. The second mechanism, which will become increasingly important as the cost of renewables decreases, are the indirect subsidies renewables receive due to their variability. The growth of renewables has created an additional form of public subsidy through markets for demand side response and capacity, both of which come at the cost of all billpayers. If renewables reach grid parity, there may be a situation where consumers are able to choose to purchase green electricity for zero extra cost, and will receive the private 'warm glow', but the true system cost of that renewable energy will be paid for by all consumers. The effect that an individual renewable project has on the capacity and flexibility of the energy system is a function of both its own generation profile and the wider system, so it would even be difficult to imagine a scenario whereby the indirect costs of any given renewable project could be apportioned among generators. The regulatory response to these concerns about publicly supported generation being sold to customers as green has been to prohibit 'double selling', where electricity sold to consumers cannot have also

received a public subsidy. In Germany where this is the case, the end result is that consumers receive energy from older hydropower projects which were profitable without subsidy, or from electricity generated from countries where renewables are plentiful such as Norway.

8.3 Regulatory uncertainty

Retail electricity markets are subject to significant regulatory intervention, and as such there is no guarantee that any market for green tariffs which exists today will persist into the future. Changes in regulations which have, or will have, implications for green electricity tariffs are presented in table 8-1. A perfect example would be the 2013 retail market reforms which aimed to make the choices for consumers simpler by introducing a cap on the number of tariffs which retailers are able to offer (OFGEM, 2013a). As a result of this all the 'big six' suppliers withdrew their green electricity tariff offerings. If a renewable generator had premised the financing of their project on this demand, then there may be losses when the revenue stream disappeared. Similar concerns could be had regarding the 'chilling effect' on the market of the soon to be effective default tariff cap, or for future policy changes such as new municipal suppliers or even the renationalization of energy retail, for which there is widespread public support (Ipsos MORI, 2012). These regulatory changes affect the demand for green tariffs both by lowering consumer engagement with the market generally, or by threatening the very concept of a competitive liberalised retail energy market.

Table 8-1: Regulatory changes affecting the market for green tariffs

Year	Policy change	Impact
2013	Four tariff caps for retailers	Large suppliers no longer able to offer green electricity tariffs
2014	Green source product regulations	Limits on the types of product which can be labeled as green
2018	Default tariff cap	Cap on standard variable tariffs, surge of new 'green' suppliers aiming to be exempted. Possible reduction in switching and market engagement
Future	Municipal offerings and nationalization	Given the widespread public dissatisfaction with energy markets, it is possible that future governments may attempt to reshape the retail market in a more profound way.

8.4 Market uncertainty

Uncertainty also exists in the market for voluntary renewable energy certificates. In the financial modelling in chapter seven this is ignored in regards to REGOs, but it is certainly present in the PPA market impact and explains why the voluntary market is only having an impact on PPA markets in the shortest contracts. Evidence from the USA also suggests this is true, with wind power developers viewing voluntary markets as too unreliable to be a valuable revenue stream (Gillenwater, Lu and Fischlein, 2014). The reason for the price instability is threefold, as summarized in table 8-2. First is that the developer has no guarantee that the consumer demand will endure, as it may be subject to a reduction if there is a regulatory change or if consumer tastes change. Second is that the cost reductions currently occurring in renewable technologies may mean that the price cannot be sustained for the lifetime of the project. Third is the growth of new business models which may be preferable for consumers,

such as peer to peer energy (Zhang et al., 2017) or personal microgeneration and storage (Liu et al., 2017).

Table 8-2: Sources of market uncertainty

Source	Causes
Instability of consumer demand	Changing consumer tastes and attitudes Regulatory uncertainty
New business models	Market enabling technologies such as peer to peer trading Personal microgeneration and storage
Undercutting by future renewables	Price of renewables decreasing so new generation will not need subsidy

8.5 A role for REGOs?

Green electricity sold to consumers needs to be matched by REGO certificates, which are issued to all renewable generation regardless of the age of the technology or type of renewable technology. As chapter 7 concludes, REGOs as they currently stand are not a viable mechanism for bringing about additionality in the market. Their value is negligible and they were never intended to be a tradeable certificate which responds to supply and demand. The position of the REGO certificate in relation to European Guarantee of Origin certificates makes it unlikely that REGOs could themselves be regulated to provide a greater level of additionality.

However, could a parallel certification scheme have success where REGOs have failed? One way of envisaging such a scheme would be to limit the supply of

certificates, to increase their value, and to ensure that they were only issued to projects where the financial assistance is most needed. Certificates would be issued only to installations which have been built within a certain time period, are from within the UK and are of particular technology types. For example, this could exclude existing large hydropower or imported certificates from countries with high proportions of renewables such as Norway. The scheme would not be dissimilar to the accreditations of some eco-labels in the Netherlands and Germany. However, the increase in price is likely to be undermined by a diminishing of long-term value as the certificates would generate revenue for the generator for a short period of time. It is also unlikely that the scheme would be able to overcome the regulatory and market risks outlined above, so would not be considered by developers and therefore would not have any impact on whether projects are constructed or not. It seems unlikely therefore that a new certification scheme would be able to deliver additionality.

8.6 Could it be possible?

Given the above analysis it seems unlikely, given the evidence presented in the four research chapters, the discussion above and looking at the business models which are currently on the market, that a truly additional green tariff market could be possible. No developer of a large renewable energy project would be willing to take into account the premium which green tariffs currently command, given the substantial regulatory and market uncertainty which exists. Regulations which could be implemented to decrease the supply of tariffs or to

prevent double selling may have the side effect of limiting the value of revenue streams to project developers and do not address the underlying instability of the revenue stream. It is also important to note that the future of renewable generation looks to be in large utility scale generation, as supported by the CfD, rather than the small-scale independent generation which green tariff providers tend to promote. These large projects are backed up by financial institutions and investors such as pension funds, who have stringent requirements for the security and stability of their investments. It is also problematic to attribute the development of any publicly supported generation to the voluntary market, both practically and morally.

The obvious question which arises from the conclusion above, is the extent to which this actually matters for consumers, and whether further regulation is necessary. Chapter six concludes that consumers purchase green electricity for a mixture of reasons, both to do with the altruistic motivation of helping the environment and also for the private benefit of the 'warm glow' satisfaction. Because of this, it does matter that green electricity tariffs are not benefiting the environment, as the altruistic motivation is both important for many consumers and is the foundation of the private 'warm glow' benefit which consumers also value. The question for regulators, assuming regulation to make tariffs truly additional would not be effective as the discussion above suggests, is whether there is a way to ensure that consumers are accurately informed of the environmental credentials of the products available on the market so that they

are not being misled regarding the environmental impact of their purchasing decisions. One way to implement this would be to restrict the green claims that retailers can make, in the same way that health foods brands are not able to make claims regarding the health benefits of their products without research and evidence to back them up. However, there may be still an issue that simply just calling a tariff green and stating that it is matched with renewable energy, may give consumers the impression that some additionality will take place. There may also be concerns on the part of the regulator about harming innovation in the marketplace and reducing consumer motivations for switching if green tariff markets were heavily regulated. Ultimately the decision on this will fall with the market regulator, and how they view their consumer protection remit in this context.

Based on the findings of chapters six and seven, one could also have ethical concerns with the functioning of the market at present. Currently subsidies are paid by all bill payers to developers of renewable energy projects, as the associated reduction of carbon emissions is viewed as a public good. When households receive their annual summary of their energy costs, they would be able to see a proportion being spent on supporting renewable energy. Notably this subsidy is paid by all billpayers in proportion to their usage, even if they are fuel poor. There is something morally questionable about the ability of some consumers, who are likely to be on higher incomes, being able to capture a proportion of the public good, either in counting the reduction towards their own

carbon footprint calculation or through the ‘warm glow’ satisfaction they receive. This objection is sustained even when the renewables do not receive a public subsidy directly, as they will still need to receive indirect subsidies to allow the network cope with the variability of the renewable generation. However, it could be argued that these indirect costs are needed in order to make the network suitable for a low carbon future and that a lack of flexibility is not a problem solely with renewables.

There is also the issue of the relationship between the state commitments to the development of renewable energy and voluntary markets to consider. Historically the drivers of decarbonization have been international agreements which states sign up to and independently are charged with implementing. In the UK context, the responsibility under the Climate Change Act (Department for Energy and Climate Change, 2008) to decarbonize rests with the state rather than with citizens. Therefore, one can imagine that even if consumers voluntarily support more renewables, their actions could just be reducing the burden on government rather than substantively changing the quantity of renewables which will be developed in total. However, the presence of international targets alone is not enough to prove that voluntary markets are unnecessary or ineffective. Given current policy commitments, the UK may miss its climate targets, in which case the voluntary market could provide valuable support for renewables. Alternatively, if voluntary markets are not seen as reducing the burden on government, then targets could be exceeded. Under either of these scenarios,

the voluntary market aiding the development of renewables would still be desirable.

One implication of a lack of additionality, which exists under the status quo in the GB market, is that by purchasing green electricity consumers are essentially ‘pigeon holing’ their own green supply and making all other consumers’ electricity less green. The lack of additionality in the market means that when a customer purchases green electricity, as no new generation will occur, the only possible outcome is that other consumers’ electricity becomes less green. This is, on the face of it, a powerful argument against purchasing a green electricity tariff. However, this phenomenon should be seen as a symptom of the lack of additionality rather than its cause. If markets were to be more additional, then this would not need to be the case.

One further research question which this thesis throws up is, if consumers want to help fight climate change, what should they do instead of purchasing a green electricity tariff? While this research hasn’t conducted any comparative analysis between green electricity purchasing and other consumer actions, it may be possible to present one hypothesis for future research. Consumer demand is, by its nature, distributed and decentralised. It may therefore make sense for consumers, if they are looking to invest to help fight climate change, to support elements of the transition which are also distributed and decentralised. This is in comparison to the large renewables which are approaching grid parity and

encouraged by the CfD, which are relatively centralized. There may therefore be an argument that consumers should be encouraged instead to support investments such as energy efficiency, the distributed and decentralised nature of which has made it traditionally a difficult area for the state to intervene in.

9. Conclusions

9.1 An international comparison of markets for green tariffs

The aim of the international comparison was to understand how have markets for green electricity grown and what determines that growth? On the first element of the question, the research finds that markets have grown substantially since the last comprehensive international study in 2002, with tariffs available in many more countries. In the countries which have had green electricity tariffs for longer periods of time, particularly in the Netherlands, subscriber numbers have also increased significantly. The second aspect of the question was to understand this variation, and why some markets have seen greater enrolment levels than others. Greater retail competition is found to be a key driver of enrolment, with higher switching rates positively correlating to higher enrolment rates. Green tariffs are also found to be more expensive than conventional electricity, as demonstrated through an improvement on the existing methodology used to calculate price premiums.

9.2 Digital third-party intermediaries

Chapter five asked how can consumers purchase green electricity tariffs in a retail market which is increasingly automated? Digital third-party intermediaries are the primary point of contact for many consumers with the energy market. As such it is important that their operation is analysed, particularly if increased consumer engagement comes at the price of other goals of the energy market such as decarbonisation. Chapter five finds that there is substantial variation in the ways in which green electricity products are incorporated into intermediary platforms. Green electricity products are often not marked and, in some cases, they are excluded entirely. The research finds a tradeoff between increased ease of searching and switching for consumers and the ability to incorporate environmental values. The reasons for this are both technical and market based. Many operators of intermediary tariffs see the market as too niche and lack the knowledge to differentiate between green tariffs. There are also technical issues with system design that would need to be overcome, as well as some long-term uncertainty regarding the role of intermediaries in the retail market due to changing regulations. Taken together the findings highlight a tension between the aims of policymakers to make engagement with energy markets 'easy' and the sort of greater consumer empowerment that would be required if consumers are able to take a more active role in the energy system. A similar debate is ongoing in regards to demand side response concerning the level of involvement necessary on the part of the householder versus the level of acceptable automation.

9.3 Consumer expectations of environmental benefit

Chapter six explores what environmental benefit do consumers expect their tariffs to have and whether the products on the market meet their expectations. A representative consumer survey is used to understand the motivations for purchasing green electricity tariffs, focusing on the ways that consumers view their environmental benefit. The research finds that a majority of consumers expect their tariffs to benefit the environment, and many also expect this to take the form of supporting the development of more renewable electricity generation. A census of tariffs available on the GB market was also undertaken to measure whether the tariffs currently available matched consumer expectations. It was found that they often did not, with the tariffs lacking transparency and any additional steps that suppliers are required to take by OFGEM regulation were often small, unrelated to renewable energy or not present at all. What the research uncovers is a sharp disconnect between the ways in which they see their products as having environmental benefit, which are outlined and tested in chapter seven, and the way the regulator sees the situation. The result of this is a lack of compliance with the regulations and ultimately a lack of protection for consumers who care about the environmental impact of their electricity consumption.

9.4 An evaluation of environmental benefit

Chapter seven asks what impact green electricity tariffs offered in the GB market have on reducing carbon emissions? The question is answered by outlining and

evaluating the causal mechanisms whereby consumer voluntary green electricity tariffs can have environmental benefit through reducing carbon emissions. The claims of retailers that their tariffs are ‘helping to fight climate change’ or ‘lowering carbon emissions’ are found to be lacking in justification. No environmental benefit is found to be present through the procurement of green electricity, either through the market for Guarantee of Origin certificates, the procurement of electricity through PPAs or non-financial support given to generators. The arguments that suppliers are benefiting the environment through investment in new technologies and business models is argued to be causally problematic, with green suppliers undertaking no more investment than other non-green suppliers. The most plausible form of environmental benefit concerns the one supplier in the market who also invests directly in new renewables, but even this is questionable given that the new renewables are also supported by public subsidies.

9.5 Overall conclusions

The aim of this research was to understand the role of green electricity tariffs in reducing carbon emissions. The findings regarding the lack of additionality of green electricity tariffs suggest that green electricity tariffs have a limited role, at least in their current form, in reducing carbon emissions. This raises questions for both academics and policymakers concerning the future of the market and how it should be regulated. Within the academic discourse on green tariffs it would be beneficial for future research to examine not only how markets can be

grown but whether it is a worthwhile objective at all, given the difficulty in translating consumer demand for green electricity into reductions in carbon emissions. The discussion in section 8.5 touches on other forms of spending and investment which may have more proven environmental benefit, and future research would benefit from making clearer comparisons between the different actions that consumers can take.

The lack of additionality, combined with growing consumer interest in green electricity products, represents a complex dilemma for regulators. There is a clash between the need to protect consumers and the desire to respect consumer sovereignty. The situation is also complicated by the fact that green retailers are some of the most innovative and popular retail electricity brands. One of OFGEM's principal aims in retail markets has been to engage customers in order to increase competition, encourage supplier efficiency and reduce over-charging by the 'big six' retailers. In reality this aim may mean that all customer engagement is seen as desirable, and the regulator can choose to turn a blind eye to the lack of environmental benefit of green electricity tariffs if they help inspire switching. It is also important to consider the role of political ideology in government, which at the present time favours limited intervention in markets, and the worldview of the regulator, which has historically been an economic regulator and is struggling to adjust to its new environmental and social goals. However, what is essential is that regulators are aware of the lack of additionality and have sufficient evidence with which to assess the claims being made by

retailers. The work undertaken in this thesis provides some of the first evidence which could be used by regulators, and future research would benefit from more intensely questioning the environmental and ethical claims made by retailers both in electricity and other markets.

The energy system is also undergoing a radical change, with energy retail moving away from commodity sales of kWh and towards energy services. Simultaneously the structure of the system is changing, away from a linear network of generators, retailers and customers, towards a distributed and decentralized grid. New technologies such as distributed ledgers may enable energy to be traded peer-to-peer, with smart algorithms matching supply and demand across the system dynamically. In this context it is clear to see how green electricity markets could be transformed, into something where there is a far more direct link between the demand for green electricity and its supply. In this research green electricity is always sold as a 'product', which is assembled, branded and sold by a retailer. In a decentralized future this does not necessarily have to be the case, with consumers potentially being able to buy energy directly from the generator. As chapter five finds however, there may be tensions with this approach, given that the algorithms which usually would be responsible for acting on behalf of consumers are usually only responsive to price. It is difficult to imagine how a reward function for an automated buying algorithm could be designed to account for each individual's own willingness to pay for renewable energy. It is also difficult to predict how markets for green electricity products

will respond to reductions in the cost of renewables. As renewables approach grid parity, and the only downside for the system is the variability of the technology, the true cost of the renewables compared to their fossil fuel counterparts will be in the payments required to cover the flexibility needed to make sure demand and supply remain aligned. In this situation consumers could purchase green electricity at little to no extra cost, with the burden of paying for the system flexibility which enables those renewables to be built still resting with all remaining billpayers. As is discussed in 8.5 above, it is important to question whether it is ethically justifiable for some consumers to capture the 'green-ness' of the system even if the costs are passed on to all billpayers.

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11. Appendix i: The Global Status of Green Electricity Tariffs

Continued on following page.

The Global Status Of Green Electricity Tariffs

A Lower Carbon Futures Working Paper



Preface

This working paper looks at global markets for green electricity tariffs and encompasses all developed countries where the products are sold. The purpose of this paper is to provide a source of reference for those interested in taking a global view of markets for green electricity products. As well as the condition of markets in each country, any relevant state and non-state regulation is also outlined. Regions where the tariffs have been particularly popular are studied in greater depth than others where the tariffs may be more niche or newer to the market. This is not to suggest a bias towards certain case studies or countries, simply that there may be more of a story to tell in some rather than others. The paper is also limited to residential green source electricity products. There are some countries where businesses are able to purchase green electricity and residential consumers can't, such as Japan. Where relevant, any interaction effects between the two markets will be noted.

One theme which emerges from looking across all of the countries studied, is the lack of a consistent pattern between cases. There are considerable variations in regulation, consumer uptake and the type of retailers offering tariffs. Further analysis is needed in order to extrapolate what lessons can be learnt from these case studies, and to determine whether green electricity tariffs can be an effective way for consumers to support the development of renewable energy.

This working paper is written at a time of flux, where energy markets across the world are undergoing a transformation and are being disrupted by smart and distributed technologies. While the green electricity tariffs studied in this paper are primarily sold by retailers to consumers, there are a growing number of companies operating on a community and co-operative basis that may prove to be important in the future energy system. The case study looking at Australian experiences particularly reflects this, with some consumers choosing solar PV installations rather than a green electricity tariff.

I would like to thank the ESRC for generously funding my DPhil research as well as my supervisors, Dr Nick Eyre and Dr Sarah Darby at Lower Carbon Futures.

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Introduction

Green electricity tariffs remain a relatively understudied mechanism for increasing the supply of renewables in the electricity mix. This introduction will explain the concept of green electricity tariffs, and will introduce a couple of the main themes in the current literature.

Most mechanisms to increase the amount of renewable energy being generated focus on the supply side of the industry, either subsidising generation through feed-in-tariffs or obliging energy companies to purchase a certain proportion of green electricity. There is another mechanism however which might provide a more sustainable and equitable solution, and which focuses on the demand side of green electricity. That mechanism is green tariffs sold to consumers. These products can support green electricity in two ways, either by creating a market for green electricity which then incentivises investment in renewables or by contributing to an environmental fund. The tariffs also have other associated co-benefits for consumers such as greater engagement with electricity usage and increased energy literacy .

Arriving at a precise definition of Green Tariffs is problematic, as different countries have different types of products available. Sometimes this depends as much on the particular business models which happened to be successful as the regulatory regimes, which sometimes may encourage some types of product over others. The most broad way to categorise the products is between “green supply”, “green fund” (Lipp 2000) and “uncoupled carbon offset” types of products. Green supply products are where the electricity sold to consumers is matched to green electricity purchased by the retailer, usually averaged over a year to counter the problems of intermittency of some renewables. Green fund tariffs are those where the consumer may receive conventionally generated electricity, but a set amount per kWh goes to projects which support the development of renewables or help the environment more generally. The third type are uncoupled carbon offset products, this is where a company which is not the electricity retailer is paid to offset the carbon cost of the consumers’ electricity usage. This is different to other types of carbon offsetting as it is done in proportion to the consumers’ electricity usage, rather than in other arbitrary amounts. In practice, many products are a combination of the first two. This is partially because many jurisdictions, such as the UK and Ireland, only allow green supply products with an element of green fund to be classed as ‘green sourced tariffs’. In the author’s opinion a more important differentiation between product types is based on whether the retailer is vertically integrated and generates the energy they sell themselves or is just the retailer. It may be that retailers who also generate green electricity have greater levels of additionality, as the relationship between supply and demand of the green electricity are more closely coupled. In

this paper a broad definition is used, given the wide variety of products available in the different marketplaces around the world.

There is also an ongoing issue regarding the accreditation of green electricity tariffs; what types of electricity count as renewables, how that electricity should be tracked and certified, and how tradable the tracking certificates should be across borders. There are ongoing debates about whether green electricity certificates should be traceable across the European Single Market, given some countries have a large proportion of green electricity and in others it needs to be subsidised heavily by bill payers.

There is also a wider issue regarding the extent to which a voluntary electricity tariff could ever provide enough support for renewables (Akcura 2013) and whether the types of green source products available on the market really lead to any more green electricity being sold (Gillenwater 2014). This is also related to the issue of the interaction between voluntary and mandatory schemes, especially when the electricity sold to consumers is subsidised by all other bill payers.

Useful terms

Below are definitions of some terms which will be used frequently in this working paper.

Deregulated electricity markets

See: liberalised electricity market. The term may be slightly misleading as ‘deregulated’ markets are often highly regulated by the energy regulator.

Eco-label

A label which can be applied to a product to certify certain environmental credentials. In the context of green electricity this usually means the product has been certified by either the government or a non-governmental organisation. In other markets the “Fair Trade” label for coffee or “MSC Certified” label for fish would be good examples of successful eco-labels.

Green electricity tariff

Mechanisms by which consumers can purchase green electricity as part of their tariff and in proportion to their usage.

Guarantee of origin (GO)

An EU wide system for the tracking of the sources of green electricity. The certificates are used to prove that green electricity sold to consumers is matched to green electricity that is generated. Some countries also have their own certification schemes, with other certificates also being created when green electricity is generated.

Hybrid market

A market which contains both a free market element and a regulated element, such as a default government set tariff.

Liberalised electricity market

Markets which have transitioned from a state owned monopoly to a private competitive market model.

Non-governmental regulation

Systems of voluntary regulation which are independent of government. In the context of green tariffs this mainly refers to voluntary labels or certification schemes.

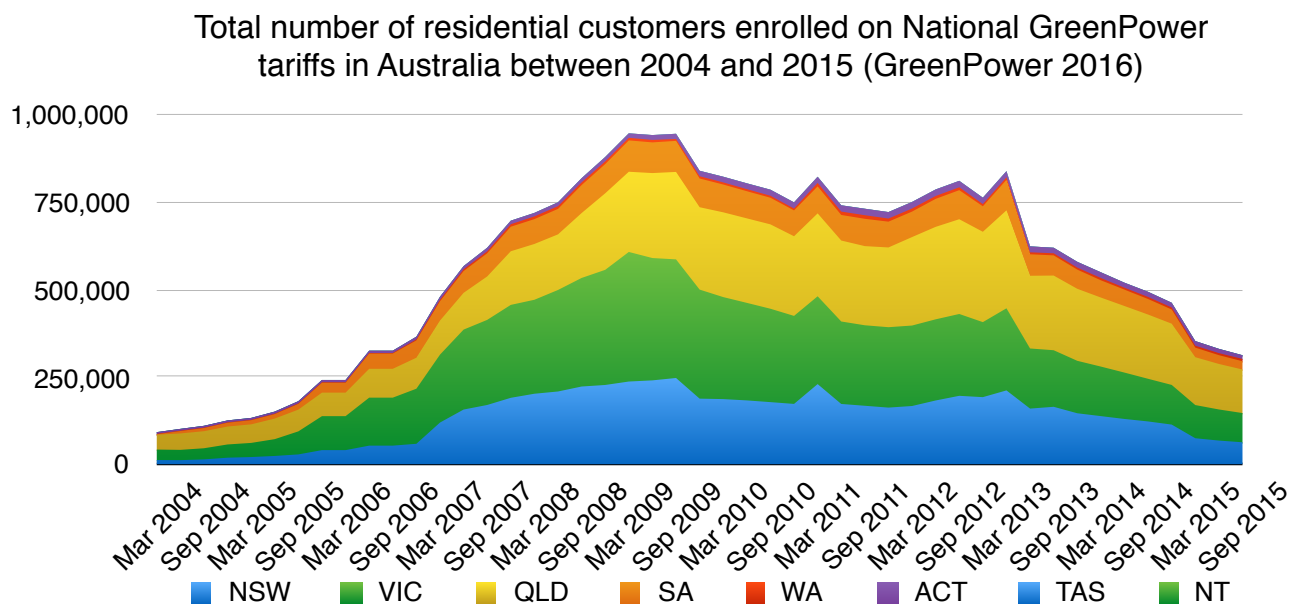
Specific regulation

This refers to regulation which is directly aimed at green tariffs, as opposed to general rules on disclosure or marketing which are applicable to the whole electricity market.

Australia

Retail Electricity Market Overview

As in other federal systems, retail markets in Australia are regulated at the state level. Since mid-2015 some states, Queensland, New South Wales, Australian Capital Territory, Tasmania and South Australia, have adopted the National Energy Customer Framework. These reforms were adopted to simplify the ways in which the state markets are regulated. In some states the government is partially responsible for controlling energy prices. In these states (Queensland, ACT and Tasmania) consumers are able to purchase a contract at a regulated electricity price that is set by the government. Switching rates are high across all states, but are noticeably higher in states that don't have government regulated pricing.



Green Electricity in Australia

Australia was one of the first countries to see significant amounts of renewable electricity sold to residential consumers on a voluntary basis. The primary mechanism encouraging this was the National Green Power Accreditation Program. The Program accredits renewable electricity generators and certifies green retail electricity products. Since its founding in 1997 the program has been credited with growing renewable electricity generation by 8.6% (ISF 2015). This was particularly important before the government's Renewable Energy Target, supporting investment in new small and large scale renewables, was implemented and when options for consumers to support renewable energy were limited. The scheme has been available to consumers in all the territories where retail competition allows switching between energy suppliers. At its peak the program had over 945,000 residential customers buying green electricity, over 10% of eligible households.

As the figure above shows, in recent years the program has suffered from falling customer numbers and a gradual decline in the number of generators accredited under the scheme. This fall in subscribers has been attributed to a number of factors including a failure to keep consumers engaged with the brand and the increased popularity of rooftop solar PV as a more visible way of supporting the environment. A study by Hobman et al (2015) undertakes consumer research that backs this hypothesis up, finding that consumers are less likely to subscribe for green tariffs if they are already engaging in other energy efficiency behaviour or renewable energy generation. Mewton and Cacho (2010) also find that while it is possible that advertising campaigns for GreenPower can be a cost effective measure to promote renewables, any other government policies such as tax breaks would be less efficient than if the government intervened at the supply end through direct purchasing of renewables.

Regulation

Apart from the National GreenPower accreditation scheme there is no other specific regulation. One continuing issue for the green electricity market is that as the GreenPower scheme is voluntary, there is nothing to stop other companies offering tariffs which claim environmental benefits that are not accredited under the program. A competing label called 'GoldPower', which was established by Climate Friendly and supported by the WWF, invests in renewable energy from countries with no Kyoto target. These tariffs are cheaper than GreenPower, which only includes generation from renewables within Australia. There are also other companies which claim environmental benefits for their tariffs, which are not accredited under any eco-label and are cheaper to purchase.

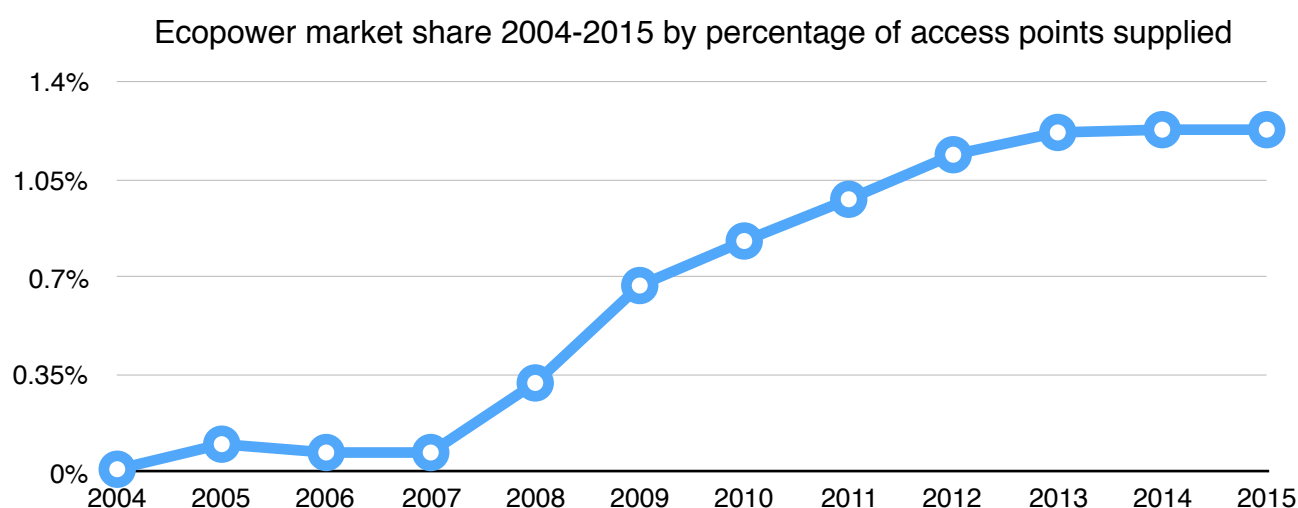
Belgium

Retail Electricity Market Overview

The Belgian electricity market is regulated at the regional level, but in practice there are broadly similar regimes in place across the Flemish, Brussels-Capital and Wallonia regions. Across the whole country switching is among the highest in the EU, and is ranked in the top five on the perception of the ease of switching (EC 2013). Since 2012 the market has become more competitive, with more switching taking place. This is due to several factors including: revision of the energy law to increase the ease of switching, a campaign organised jointly with local communes to promote energy comparison, and the promotion of collective and joint energy purchasing (ENER Belgium 2016).

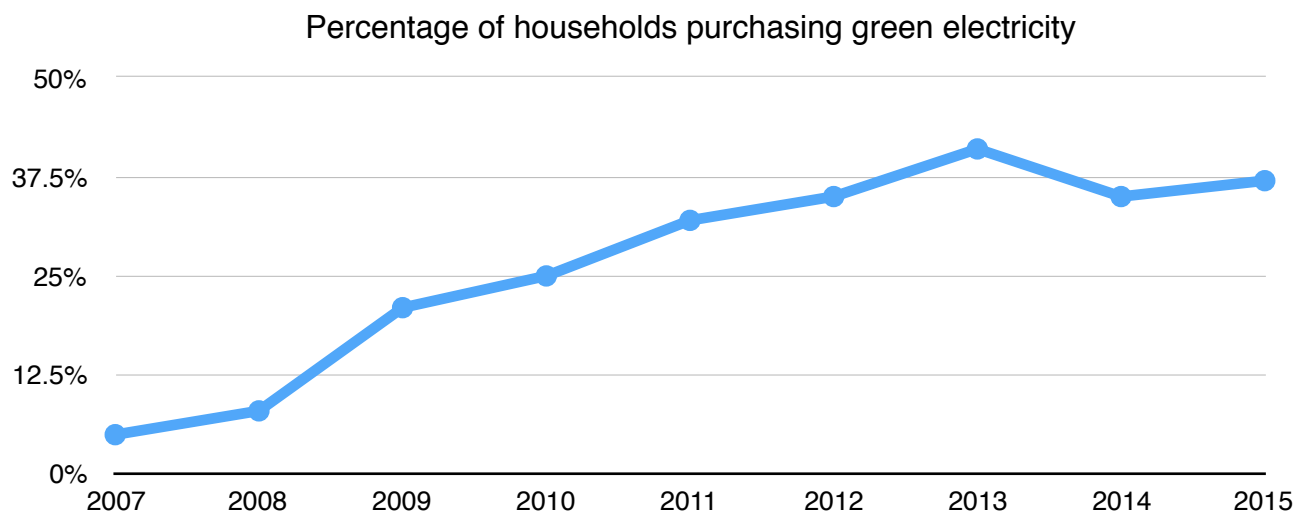
Green Tariffs in Belgium

There are two main way to purchase green electricity as a consumer. The first is to join and then purchase electricity from a co-operative such as Ecopower. The co-operative invests in renewable energy capacity, which is then provided at a cost to consumers which is cheaper than conventional suppliers. Each month Ecopower submits guarantees of origin (GOs) to the regulator to prove the source of their energy. As the graph below shows, even though Ecopower has grown significantly since 2007, its market share is currently still only at 1.23% (VREG 2016).



The second way is to purchase green power from a retailer who has purchased GOs for renewable energy. Suppliers are only able to label their electricity as 'green' if they have purchased enough corresponding GOs. It is unclear the extent to which there is environmental benefit in the second type of supplier, as there isn't any differentiation between different types of GO. Green tariffs are offered by each of the main suppliers, with products that include both 100% green and lesser amounts. As the graph below shows, the number of households purchasing green electricity currently stands at 37%.

The increase in 2013 is due to an anomalous result in the market research which produced these figures. The regulator estimates a more correct figure to be 35%, which is equal to the years before and after.



Regulation of tariffs

Green electricity tariffs are regulated in Belgium. Suppliers are only able to label their electricity as 'green' if they have purchased enough corresponding guarantees of origin (GOs). It is unclear the extent to which the green tariffs have an environmental benefit in this scenario as there is no differentiation between different types of GO. Co-operatives such as Ecopower are also required to submit GOs to the regulator in order to prove the source of their electricity.

Canada

Retail Electricity Market Overview

As in the USA and Australia, electricity markets are multi-jurisdictional. Provincial and territorial governments are responsible for the majority of market regulation including resource management within their boundaries and the generation and transmission of electrical energy (CEA 2013). Only Ontario and Alberta have deregulated markets, so only those two will be considered in detail here. Ontario has a hybrid retail electricity market. This means that consumers can choose to purchase electricity from their local distributor, this is usually at a price that is centrally regulated. Alternatively, it is also possible for consumers to sign separate contracts with electricity retailers and enter into the free market. Like Ontario, Alberta also has a hybrid market. 44% of consumers in Alberta have switched from the Regulated Rate Option onto a competitive contract (MSA 2015).

Green Tariffs in Canada

There are many companies in both Ontario and Alberta which sell green electricity tariffs, due to a lack of data it is unclear how many consumers subscribe to each of these tariffs. As well as traditional green electricity tariffs, there are also several suppliers which sell 'uncoupled' energy products. These types of product allows consumers to proportionally offset the carbon emissions of their electricity supply, but without changing their current electricity provider or tariff. The largest of these is Bullfrog energy, which now supplies 10,000 individuals and 1,200 business with green electricity (Bullfrog Energy 2015). These tariffs may be a unique solution to allow consumers in states where there is no competition in electricity markets to purchase green electricity. As markets become more competitive it will be interesting to see if there is a shift towards more conventional green electricity products, evidenced perhaps by the recent move by Bullfrog Power to apply for an electricity retailing license.

Regulation of tariffs

There are two predominant voluntary eco-labels for green electricity, the EcoLogo and Green-E. EcoLogo is native to Canada whereas Green-E originated in the US and has since expanded. There is no specific regulation implemented by central government. In order to gain credibility most green electricity suppliers also undertake external auditing to ensure that the energy sold is from a green supply. There is also an important issue of cross-border trade with the US, as some green electricity sold in the US may be backed up by hydropower from Canada.

Denmark

Retail Electricity Market Overview

Households have been able to choose their electricity suppliers since 2003 (Bird et al. 2002). Denmark's retail electricity market has a relatively low level of consumer engagement and a switching rate of 7.2% in 2015 (Energinet.dk 2016). In an attempt to solve this issue, from 1st October 2015 the electricity retail market has been changed to a supplier centric system and regulated prices were ceased (ENER, Denmark 2015). Regulated prices have previously been dominant in the market, with between 90% and 95% of consumers remaining on regulated tariffs in 2012.

Green Tariffs in Denmark

There are many different retailers offering a variety of different types of products. Details of the different types of products, and how they are regulated is below. Currently around 6% of households have subscribed to green tariffs. As of March 2016 there were fifteen green tariffs available on the market, some of which have price premiums as small as £25 (240 Danish Krone) a year.

Regulation of tariffs

There is specific and uniquely complex regulation for green tariffs in Denmark, with a regulator energinet.dk that administers and regulates the products (RE-DISS Denmark 2015). There are three possible types of product with six options in total (Bröckl 2011), see below. This does mean that there are several different types of products available on the market, and comparisons as a consumer looks to be difficult. One website does rank each of the products available by their environmental attributes (Ecological Council 2016). However, the methodology isn't fully explained and it is questionable how useful it would be to compare a product which only includes a monthly £1.70 contribution to a renewables fund to a product which is based on purchasing carbon offsets. There is no national eco-label for electricity. Instead each supplier has their own label, and even the Swedish Bra Miljöval label is in use to a minor extent.

Types of green electricity product available in the Danish market

1. CO2 reduction
 - a. *Cancellation of CO 2 allowances or credits*
 - b. *CO2 reduction from voluntary projects on a global scale*
2. Contribution to a renewable energy fund to promote further development
3. Guarantees of origin
 - a. *From maximum 2 years old renewable energy*
 - b. *From more than 10 year old renewable energy*
 - c. *From renewable energy without age restriction*

Retail Electricity Market Overview

Consumers in Finland are able to freely select their retail electricity supplier and there is no regulation of prices by government. Switching and consumer engagement is about average across the electricity market as a whole, with 9.8% of consumers switching in 2014 (ENER, Finland 2015). No single supplier dominates the market, with the market share of the three largest suppliers at around 35-40%. The vast majority of households have smart meters, over 97% since 2013.

Green Tariffs in Finland

All consumers have been able to buy green electricity since 1998 (Salmela & Varho 2006). The market is highly varied and fragmented, with many competing products and labels. Some products are sold without any certificates or labels and some only feature one resource such as wind power. There is also a co-operative called Lumituuli which develops wind farms and sells the energy back to its shareholders. Currently it only has around 1200 shareholders, so it is far more niche than its Belgian counterpart Ecopower (Hast et al. 2015). On average green electricity is around 0–2% more expensive than standard electricity. However the cheapest green tariffs can be cheaper than standard tariffs. In 2010 8% of consumers were on green tariffs. This dropped to 2% in 2011 due to a change of criteria of the labelling scheme EKOenergy and changes in the labelling of hydropower products of the large company Fortum. While more accurate subscriber numbers are not yet available, EKOenergy believes it currently supplies 2-4% of households in Finland in 2015.

The share of hydropower in the overall energy mix is very high, so often consumers are supplied with green energy without specifically opting in. There is also an ongoing debate about the extent to which hydropower should be sold as green electricity, due to its possible environmental impact and its higher profitability compared to other technologies such as solar and wind.

Regulation of tariffs

There is both state and non-state governance of green electricity tariffs in Finland. One of the largest non-state certification bodies is EKOenergy, a pan-european labelling scheme that originated in Finland. Since its launch in 2012 the scheme has grown to cover the majority of European countries and in 2015 it accredited over 1 TWh of electricity (EKOenergy 2016). It is managed by the Finnish Association for Nature Conservation and energy can be labelled if the production meets certain environmental criteria. The label can be used by producers, suppliers or companies that buy eco labeled energy. Suppliers have to pay a set amount per kWh of energy sold to the EKOenergy Climate

Fund. In Finland these funds are used for projects such as river restoration in order to reduce the harmful effects of hydropower. For more on EKOEnergy see appendix ii.

France

Retail Electricity Market Overview

Since July 2007 consumers are able to freely switch between suppliers in France, as the market is fully liberalised. Consumer perception of the ease of switching is relatively high, slightly above the UK. Consumers can choose to either sign up to regulated prices, set centrally by government, or to a market where the rates are freely set by suppliers. The regulated market continues to be dominant with, as of 2014, 90% of consumers and 93% of consumption (ENER, France 2015). EDF is the dominant electricity supplier, with only one other supplier having a market share of over 5%.

Green Tariffs in France

Households are able to purchase green electricity from a variety of suppliers. Current enrolment is estimated to stand at around 1%. As in several other European countries, it is possible to purchase green electricity as part of a cooperative through 'Enercoop'. As of mid-2014, Enercoop had 25,000 enrolled consumers (Enercoop 2016). This is significantly lower than its counterpart in Belgium, Ecopower, which has over double this amount in a much smaller market.

Regulation of tariffs

The regulator (CRE) has minimum standards for "green" products. Suppliers must hold sufficient guarantee of origin certificates to support the amount of renewables they sell to consumers. Only the original certification guarantees have value, they cannot be delivered separately from the electricity with which they are associated. While there was previously a domestic label, "Electricite Verte" (PWC 2009 p106), this now has been retired. The pan-european EKOenergy label has now launched in France, represented by Observ'ER.

Germany

Retail Electricity Market Overview

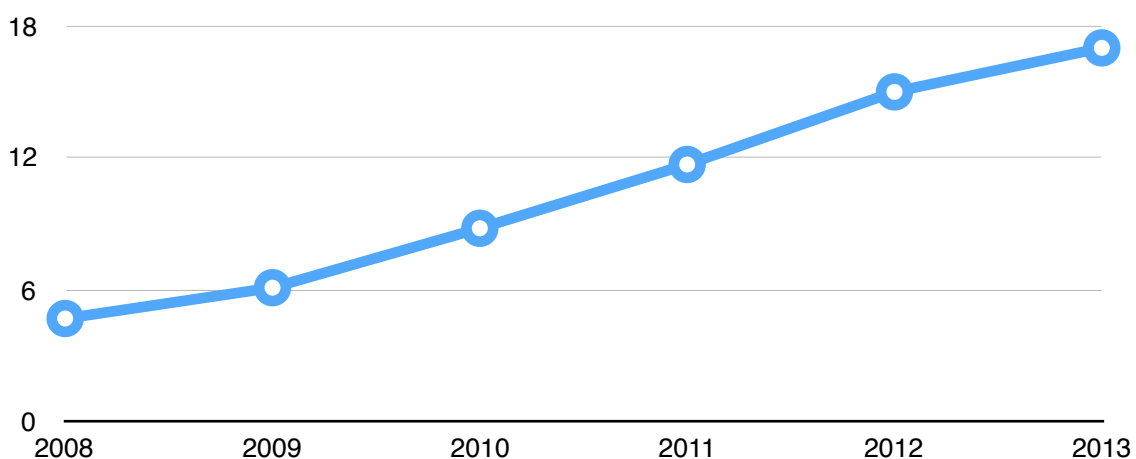
Germany has a competitive electricity market with over 1000 suppliers. Consumer prices are relatively high, due in part to the cost of supporting renewables and other taxes to support energy efficiency. In 2014 the volume-based supplier switching rate for households was 9% (Federal Network Agency 2015). Germany is notable for the large amount of renewables which have been installed in recent years. The cost of this has fallen mostly on consumers, with taxes, surcharges and levies accounting for 52% of electricity prices. While it has been previously suggested that this might limit the growth of the green electricity market (Bird et al., 2002), this doesn't seem to have been the case.

Green tariffs in Germany

A very large number of suppliers sell green energy. In 2013 17% of households purchased green electricity, with more recent data not being readily available due to an error in the regulator's data collection (Federal Network Agency 2015). The average price for green electricity, across 740 companies that provided data on tariffs, was €0.2875/kWh. This is €0.0738 per kWh more expensive than the alternative grey electricity supply. Though it is worth noting that the electricity price for green electricity has been decreasing. Other estimates place the size of the market at up to 21% (Gesternova 2015). There is a concern among some market commentators that the green electricity sold is obtained from Norwegian Hydropower rather than domestic generation, and hence that there may be little added environmental benefit.

Green electricity sales by number of household customers 2008 - 2013

(Source: Federal Network Agency 2015)



Regulation of Tariffs

While there isn't any specific regulation related to green products, they are covered by the general EU regulations concerning electricity labelling which require companies to disclose to end consumers the mix of their electricity supply. For more information on common EU labelling regulations, see the appropriate later section. There are several green electricity labels present in the market, one of which has been certified by the Europe wide EKOenergy label.

Republic of Ireland

Retail Electricity Market Overview

Households are able to switch electricity suppliers freely, with market regulations broadly similar to those in the UK. Electricity markets have been fully liberalised since 2011 and switching rates are 14% (CER Ireland 2015a). There appears to be very little competition in the market with only a handful of suppliers.

Green tariffs in Ireland

Currently there is only one residential green source product on the market, which is offered by the large retailer 'Electric Ireland'. In the third quarter of 2015 the company had 1.2 million customers and a 60.5% market share (CER Ireland 2016), though there is presently no data available regarding the number of subscribers to its green tariffs. It is estimated by the author¹ that around 2% of Electric Ireland's consumers have opted into its green tariff. This would mean that around 1.2% of consumers are subscribed to green tariffs.

Regulation of Tariffs

The Irish Commission for Electricity Regulation (CER) has recently announced plans to regulate Green Source products. This was mainly prompted by a need for increased consumer protection, as well as a likely response to similar changes in regulation made across Europe and in the UK in particular. The government has opted for a regulatory approach, with green Source Products now needing to be verified by the Single Market Electricity Operator (SEMO) (CER Ireland 2015b). The process will be overseen by the CER which will publish reports on the outcome of the verification process. Suppliers offering green source products will be required to allocate government (PSO) supported renewable generation equally amongst all their customers. It is unclear what impact this will have on the electricity sold by Electric Ireland. Though several months on from the decision paper they are still offering products, it is unclear whether this will continue in the future.

¹ Estimation is based on the market share of the supplier and the likely percentage of customers on the green tariff, based on similar suppliers in other jurisdictions.

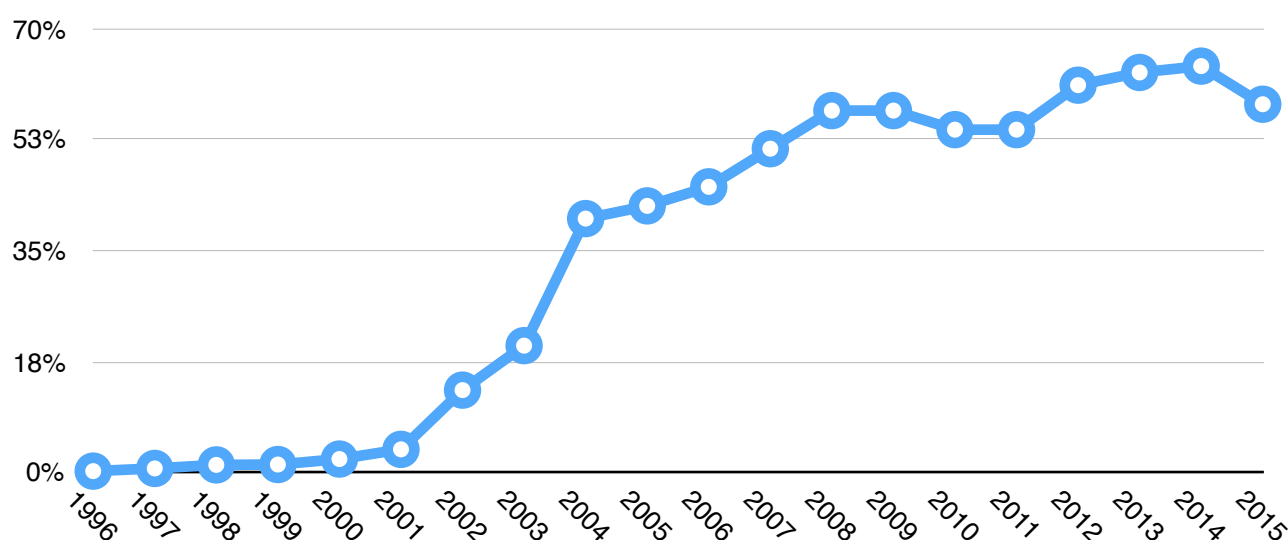
Netherlands

Retail Electricity Market Overview

The Netherlands has had liberalised electricity markets since 1998 and the process of liberalisation was designed specifically to encourage switching to green electricity tariffs (Van Rooijen 2006). Consumer switching rates are very high and in the past 10 years 55% of consumers have switched at least once (ACM 2014). A relatively low proportion of electricity generated is from renewables, only 10% in 2014 (Eurostat 2014), interesting given the very high proportion of households which have purchased green electricity tariffs.

Green Electricity Tariffs in the Netherlands

In the first half of 2015 58% of Dutch consumers had a green power contract for their electricity (ACM 2015). This is by far the highest recorded enrolment out of any country in the world, though it's six percent less than at the same time in 2014. The products are offered by many suppliers and are often sold at a very low price premium. There were a number of factors which have contributed to the success of the scheme in the Netherlands, which will be briefly outlined below.



*Percentage of households purchasing green electricity 1996-2015
(% of households, various data sources)*

The most important policy mechanism put in place to encourage the uptake of green electricity tariffs was the 1996 'ecotax'. This was a levy that was placed on all electricity usage and had the effect of increasing all energy prices for consumers (Linderhof et al 2003). Green electricity purchased by consumers was exempt from the tax, which made green electricity comparable to, or sometimes

cheaper than, grey electricity. This was especially true after 2001 when the price increased from 2-3 to over 6 euro cents per kWh. The tax was phased out in 2005 and was replaced by a new feed in tariff, a more conventional supply side policy. The tax was very successful in increasing demand and engaging consumers but, as will be explored later, its affect on installed capacity was far less clear.

The liberalisation of electricity markets helped to encourage the adoption of green electricity in two main ways. First, the market for green electricity was opened before the market for grey electricity. This meant that many consumers' first experience of switching between retailers was in order to purchase green electricity. Second, and perhaps most importantly, was that retailers saw green characteristics as the main way to differentiate their product in the face of oncoming liberalisation (Hofman 2008). Because of this many retailers engaged in aggressive marketing campaigns to sell green electricity. These suppliers also partnered with NGOs such as the WWF to certify their electricity. The WWF also launched a campaign aimed at encouraging switching entitled 'Don't Let the North Pole Melt, Go for Green Electricity'. The campaign was large and was launched at a public event attended by 3000 volunteers who rolled out a 300 km long green ribbon along the Dutch coast line. There were also co-ordinated TV programs, volunteers giving out 250,000 flyers at train stations, and advertisements in national newspapers. The organisers claim that 20,000 new households purchased green electricity in the first three weeks of the campaign (WWF 2000).

The case study of the Netherlands is a model example of well marketed green electricity, robust support from government, and record enrolment rates. However, the actual impact on the installed capacity of renewables in the Netherlands may be less clear, with slow growth in generation from renewable sources. It has also become increasingly common for guarantee of origin certificates to be purchased from abroad, primarily from Norway where green energy is plentiful. This led to a situation where the majority of the green electricity that was being subsidised by the Dutch government was in fact being generated elsewhere. It was partly for this reason that the Ecotax exemptions were phased out by 2005.

Regulation

Green tariffs in the Netherlands are regulated on a voluntary basis, with most suppliers partnering with NGOs to provide certification of the tariffs they are offering. The voluntary Milieukeur label covers green electricity, though it also covers a large number of other products (such as both open field and covered crop blackberries), and uses a system that is backed up by GOs. There are some restrictions on what types of imported GOs can be included. Competing certification schemes such as Heir "real green power" or the 100% green anti-"sjoemelstroom" campaign run by WISE promote green electricity generated domestically with stricter regulations on additionality. There have been some concerns that the proliferation may reduce consumer understanding (ACM 2016).

New Zealand

Retail Electricity Market Overview

New Zealand has been reforming its electricity market to promote a competitive and efficiency electricity market since the 1980s (Ndebele & Marsh 2014). The switching rate for households is very high, with 20.2% of consumers switching supplier in 2014 (Keall 2015). It has also been previously estimated by other sources to be as high as 26%, the highest globally (VaasaEET 2013). The market is broken up regionally, with the number of suppliers available ranging from 9 to 21 in 2014 (NZ Electricity Authority 2016). There has also been a recent growth in smaller suppliers offering innovative products such as rates specifically aimed at electric vehicle owners. Many suppliers source a large percentage of their electricity from renewable sources, primarily hydro. Because of this, many consumers may be receiving a large proportion of their electricity from green sources without ever needing to opt into a green tariff. The electricity market is also characterised by a high level of vertical integration between generation and retail, with most consumers being able to associate their retailer with the main energy sources used to generate their electricity (Ndebele & Marsh 2014).

Green tariffs in New Zealand

Two large suppliers source their electricity directly entirely from renewables; Meridian Energy and Trust power. Together these two suppliers have a combined market share of 26%. One supplier also claims to be the only supplier to use 100% renewables, Ecotricity (not to be confused with the British supplier under the same name). This supplier is in the process of gaining certification under the carbonZero scheme, which is a carbon neutral business and product certification rather than explicitly a green source certification.

Regulation of green tariffs

There is no voluntary or government regulation of green source products (Smith 2015). Unlike other green source retailers across the world, the websites of the main retailers in New Zealand don't seem to be concerned about addressing concerns of the reliability of their electricity sourcing. This may explain to some extent, if consumers haven't been misled in the past and generally trust the green electricity suppliers, why there is no additional regulation. Smith (2015) argues that the prevailing opinion is that electricity certification on a voluntary or compliance basis would not work in New Zealand given the high level of renewable electricity, the structure of the electricity industry, the dominance of wind in the future energy mix and the policy environment.

Portugal

Retail Electricity Market Overview

Due to the legacy of the previous monopolistic supply model and the only recent abolition of price regulation, the retail market continues to be concentrated and switching is relatively low (ERSE 2015). The three biggest companies in the liberalised market accounted for a total market share of 85% in 2013. In 2013 9.8% of consumers switched tariffs (EC 2013), a figure that has been steadily increasing over time since price regulation was abolished. Prices for consumers have also increased significantly in recent years, due to an increase in taxes and levies imposed by government to cover the costs of the liberalisation process and investment in renewables. Due to this government support, renewable energy represents a large percentage of generation in Portugal.

Green Electricity in Portugal

One large retailer, EDP, offers a green electricity tariff, which supplied 4000 households with green energy in 2015 (EDP 2015). This number has decreased since Q1 2011 when it was 5,664. The price premium is €0.0048/kWh.

Green Electricity regulation:

There is no specific regulation or labelling aimed specifically at green electricity sales. However, green tariffs are still included under the general disclosure regulations. All retailers are obligated to disclose the sources and environmental impacts of their electricity to customers. This is designed to facilitate consumer choice.

Slovenia

Retail Electricity Market Overview

Slovenia has had liberalised electricity markets since 2007, however it took a number of years before retail competition increased significantly. Unlike many other countries the market is dominated by many local suppliers, each of which is dominant in a specific area. This may have the effect that despite having a large number of suppliers, each with relatively small market shares, there is still little true competition. The switching rate is 9%, which has increased significantly since 2012 when GEN-I and Petrol entered into the household market segment and now have over 22% market share. Renewables make up a significant share of electricity generation, with 36% of the country's electricity generated from hydro power. Only 20% of electricity generation comes from thermoelectric power, with 37% coming from nuclear and the remaining 7% from other small scale renewables (Slovenian Energy Agency 2015).

Green Electricity Sales in Slovenia

All five regional incumbents offer their customers the possibility to buy green electricity (Zorić & Hrovatin 2012), however it is unclear the number of consumers which take up these tariffs. There is a brand of 'Blue Energy' started by the company HSE, which supplies electricity generated from hydro power. The blue energy offered by HSE has been certified by EKOenergy, the European eco-label founded in Finland. The price for 1 kWh of electricity from 'Blue Energy' programme is €0.00417 higher than the regular price. Part of the income from blue energy is collected in a fund for stimulation of R&D work and to fund new renewable capacity. Customers, under the blue energy scheme, are able to opt to have between 10% and 100% of their electricity from renewable sources (Buy Smart 2014). Households are also able to display the 'Blue Energy' stamp, however this seems to be more aimed at business users. Enrolment levels seem to be very low, with only 2000 subscribers across commercial and domestic subscribers.

Elektro Enerija, Slovenia's second biggest electricity supplier, also offers a green energy tariff under its 'Zelena Enerija' scheme (Elektro Energija 2016). This allows households to purchase 100% green electricity which is generated from small hydropower solar plants. There is a price premium of €0.001/kWh consumed. Some of the revenue also goes towards a fund which promotes renewables. The company does not disclose the number of consumers which have signed up to its green tariff.

Green Electricity regulation

There is specific government regulation concerning green tariffs. These primarily relate to disclosure and require retailers to disclose both the share and source of renewables in the standard electricity

package as well as in the green package. As mentioned above, the 'Blue Energy' tariff conforms to the EKOenergy standard. This requires a higher level of disclosure and also places additional requirements onto the type of electricity sourced.

Retail Electricity Market Overview

Electricity markets have been liberalised since 2003, with all households eligible to choose their electricity supplier. From 1st April 2014 regulated pricing for 'small consumers' ended, and was made only available to vulnerable consumers and those which have not yet entered into a free market supply contract (CNMC 2015). The majority of consumers are still supplied under regulated tariffs and haven't opted into the free market. Competition continues to rise and an increasing number of consumers are switching away from the regulated tariffs. Switching rates are relatively high, with 11.75% of domestic consumers switching in 2014 (ibid p.36). Despite this increase in competition prices for consumers have increased significantly in recent years. There is some controversy about the scale of renewable energy being installed in Spain and the effect that it is having on consumer electricity prices.

Green electricity tariffs in Spain

Despite the controversy over green electricity subsidies there are several companies which are selling green electricity products. The large retailer EDP Energy counts for the majority of the green labelled electricity sold, which is matched with guarantees of origin (EDP 2015). Several small regional co-operatives such as Som Energia and Goiener also offer green tariffs, which are much smaller than others in Europe but are growing (Ines 2014). Based on available data from green electricity retailers in Spain, 4.4% of households are enrolled on green tariffs.

Regulation

There is no specific government regulation regarding the sale or labelling of green electricity in Spain. Sales of green electricity are subject to the same standards of conventional electricity, with labelling backed up by guarantees of origin.

Retail Electricity Market Overview

Sweden has had a liberalised electricity market exposed to competition since 1996, with no price regulation (Olsen et al. 2006). It has relatively high levels of competition and consumer engagement, with 10.4% of customers switching electricity suppliers in 2014 (SEMI 2015). There is a very large number of suppliers, over 100. Consumers also benefit from an almost universal presence of smart meters, which may have the effect of increasing consumer interest and understanding of energy usage. The electricity generation mix is also predominantly low carbon. In 2014 8.7% was generated from conventional thermal sources, 41% from nuclear, 42% from hydro and 7.5% from wind (SCB 2015).

Green Electricity Market

Green electricity products are widely available in the marketplace, with around 50% of all suppliers offering green electricity tariffs. Green tariffs also make up the majority of product offerings, with 65% of the electricity tariffs registered with the electricity market regulator at the end of 2014 being green contracts (SEMI 2015). The latest consumer data available, from 2010, indicates that around 5% of households have signed up for green electricity tariffs and there doesn't seem to be much evidence that this has increased significantly (Bröckl et al 2011). While the Bra Miljöval scheme does not collect data on the number of consumers who purchase green power, in 2015 approximately 8TWh of electricity was sold under the label to domestic users, companies and government. This is equivalent to around 5% of total electricity consumption. This is relatively low compared to the number of green electricity products available. This may be explained by the low switching rates and consumers' reluctance to change electricity provider. There has also been no co-ordinated marketing campaigns aimed at promoting green energy labels.

Applicable Regulation

The main form of regulation for green tariffs in Sweden is voluntary, and based around the national Bra Miljöval eco-label. Only suppliers who provide a guarantee that their energy comes only from renewable sources are entitled by the Swedish Society for Nature conservation (SSNC) to market their electricity as eco-labeled electricity under the Bra Miljöval label. As well as requiring sufficient guarantees of origin, the label also has three types of additionality requirements. The tariffs must support energy efficiency improvements, fund environmental projects for hydro power and support investments into renewable energy.

Switzerland

Retail Electricity Market Overview

Electricity markets for households are still regulated. Initially liberalisation had been planned for 2014, but the date has been rescheduled several times. It is now expected to be in place by January 2018, though this may be subject to a referendum (Raemy 2015). Households currently purchase electricity from the local or regional supplier.

Green Electricity Market

Even though electricity markets are not yet liberalised, electricity retailers have been expecting it to take place for over a decade. One mechanism used by retailers to pre-empt the move to competitive markets has been to launch green electricity products (Hari, Karathanasis et al. 2008). This is perhaps similar to the experience in the Netherlands where companies competed on the basis of green supply rather than price. A large number of local and regional suppliers offer green electricity tariffs, some of which are certified under the Naturemade label . At most green electricity costs around 5 cents (€0.05) more per kilowatt than conventional electricity. In 2014 over 6.5% of the total volume of electricity sold in Switzerland was certified under the Naturemade 'basic' and 'star' labels (Naturemade 2014), however the percentage of this which is sold to domestic consumers is likely to be very small due to the lack of liberalisation in the marketplace and difficulty in signing up to the tariffs.

Applicable Regulation

The Naturemade label is the largest certification scheme for green electricity in Switzerland. It partners with both environmental NGOs such as the WWF and other external auditing bodies. Perhaps due to the large amount of hydropower installed, the scheme focuses on guaranteeing that renewables are sourced sustainably. Any additionality payments (the Ecological improvement fund) are aimed at ecology and the natural environment, rather than investing in more renewables. Only 45% of green source products are sold under the Naturemade label. There is also the TÜV SÜD standards and eco-label for green electricity which is available for consumers to purchase. While there is no specific government regulation for green tariffs, since 2005 there have been electricity disclosure rules backed up by a guarantee of origin system (FOE 2015).

Retail Electricity Market Overview

Sales of green electricity products in the UK were made possible in 1999, after markets had been liberalised and consumers were able to switch between electricity providers (Boardman et al. 2006). Switching rates in 2015 were 8.8% (DECC 2016). Electricity prices are often a controversial subject in the UK, with the 'big six' electricity retailers systematically overcharging consumers (CMA 2015). In an attempt to rectify this problem through market mechanisms, currently government policy is to focus on improving switching rates through measures such as 24 hour switching times.

Green Electricity Market

The green electricity market in the UK has seen two distinct phases. The first phase, following liberalisation in 1999, saw both small and large electricity companies offering green electricity tariffs. The second phase, prompted largely by OFGEM's simplified tariff rules coming into force in 2014, saw the larger suppliers no longer offering green electricity products and the market dominated by small suppliers. This is still true today, with green electricity products being sold exclusively by a small number of niche retailers. Together they have an estimated market share of around 2% of all households.

Applicable Regulation

There have been three broad stages to the regulation of green electricity products in the UK. The first stage followed the first wave of liberalisation in 1999 and consisted of a scheme called Future Energy, which was set up and regulated by the Energy Saving Trust and backed by government (Lipp 2000). While it did accredit green tariffs, there were criticisms that they weren't 'green' enough. This was then followed by Friends of the Earth setting up their own league tables, which were subsequently stopped in 2004 due to lack of funding.

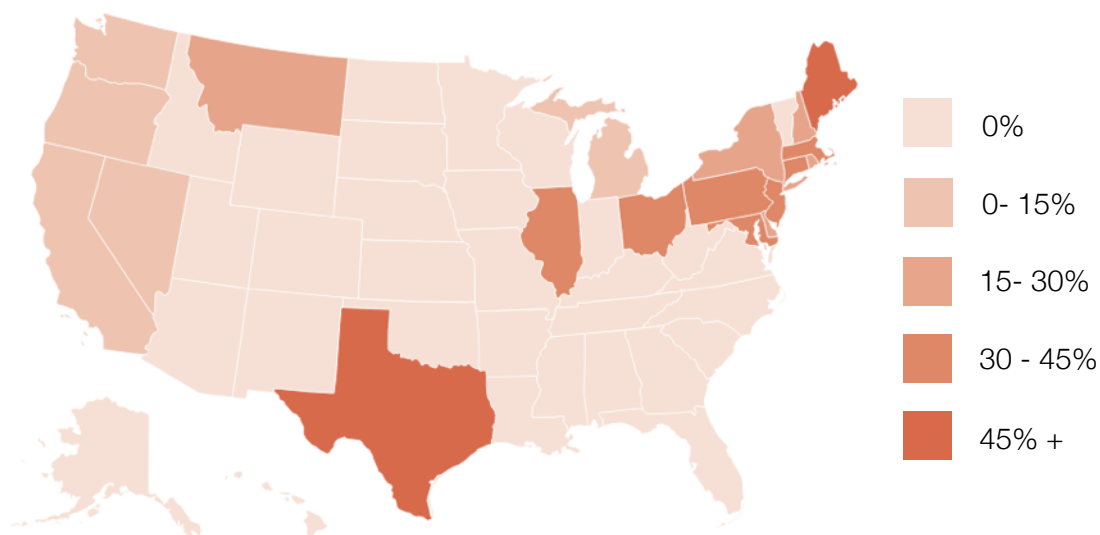
The second phase of regulation was another voluntary system called the Green Electricity Supply Certification Scheme. Under this system green electricity retailers were able to gain certification and were allowed to use the 'Certified Green Energy' label. The criteria were based on the 2009 OFGEM Green Supply Guidelines, which were incorporated into an agreed Rulebook. The scheme was closed in 2015 following the introduction of the third phase of regulation, OFGEM's direct regulation of Green Electricity products. The new regulations are compulsory for all retailers wishing to supply green source products to consumers in the UK. They set out a number of criteria relating to transparency, traceability and additionality (OFGEM 2014).

United States

Retail Electricity Market Overview

Given the large amount of variation between states in the USA, it is difficult to provide a simple overview of their electricity markets. This variation is outlined in the figure below which shows the proportion of consumers active in the market rather than on regulated pricing. It is clear to see that there is significant variation, with states such as Texas and Maine having reasonable levels of liberalisation, whereas others still have monopolistic models with no competition.

Share of Retail Sales from Retail Power Marketers
(Adapted from Borenstein and Bushnell 2015)



Texas has a competitive retail market for electricity and consumer switching rates are relatively high. It leads the nation in diversity of product offerings and number of providers, as well as in terms of facilitating consumer choice by promoting switching and simplifying consumer access to price information. As of September 2014, in the proportion of the state that permits competition, 90% of all customers had exercised their ability to switch providers (PUC Texas 2015).

Green Electricity Market

In Texas there were over 300 100% green source products available on the market. The most up to date data (EIA 2012) states that 11.86% of total consumers in Texas were purchasing renewable energy from a total of 34 utilities. In states where switching is lower, such as Connecticut, there are also schemes in place which allow consumers who are supplied by the monopolistic retailer to purchase green electricity through their current supplier (Kotchen 2011).

Applicable Regulation

As many be expected in this situation, there is no national system of government regulation for green tariffs. The most significant form of non-state regulation is the green-e scheme which has been operating since 1997, the accreditation badge for this is shown in appendix i. This scheme certifies green electricity tariffs and also provides marketing assistance. In 2014 over 836,000 customers purchased Green-e certified renewable energy, including 50,000 businesses (CRS 2014). In terms of volume of electricity purchased, residential Several states and cities also have their own green electricity switching campaigns, such as the Portland Bureau for Planning and Sustainability and the Connecticut Department of Energy and Environmental Protection.

Other countries with low enrolment

Czech Republic

Since the 1st of January 2006 all electricity customers have had the right to choose their supplier of electricity. A retailer called Nanoenergies seems to be the only retailer selling green electricity, with an estimated 0.07% of households enrolled. The brand builds trust with consumers by having itself audited annually by PWC to ensure that sufficient guarantees of origin are purchased to cover the amount of electricity they sell to consumers. This is perhaps similar to the Good Energy (UK) model. The company has a label that they allow consumers to use (shown in appendix i).

Estonia

The electricity market has been liberalised for all consumers since January 2013. All consumers pay a levy of around 10% of their electricity bills to support renewable energy. There is no specific government regulation regarding green electricity tariffs. It appears that only one supplier offers green electricity, Eesti Energy. The company also has an electricity label featuring a frog which consumers, particularly businesses, can use to show they purchase green electricity (shown in appendix i). The tariff appears to not be popular, out of a total of 583,991 households only 2042 had signed up under the scheme. Electricity prices for all consumers seem to be very low, so the difference in price between green and grey is not significant.

Italy

The electricity market in Italy is liberalised and consumers are able to freely switch suppliers. One supplier has a tariff certified by EKOenergy, but this is primarily aimed at businesses rather than domestic consumers. There are no specific minimum standards set out by government.

Poland

Consumers are able to choose their own electricity supplier. Switching rates have been increasing in recent years, particularly because of increased advertising activity by retailers. The market is split between a free unregulated market and a regulated market where prices are set by the Energy Regulatory Office. It is unclear if any retailers offer green electricity tariffs.

Common regulation across the EU

As well as the regulations in individual countries, there are also several elements which are common to all countries across the EU.

Guarantees of Origin and the European Energy Certificate System (EECS)

Guarantees of Origin are certificates awarded for every MWh of electricity generated. They can be used to track all types of electricity generation, but they are most commonly used to track the generation of renewables. The EECS is a harmonised Europe-wide system for handling and tracking the certificates, operated by the Association of Issuing Bodies (AIB) (EC 2009). As well as providing the mechanism for fuel mix disclosure (below), guarantee of origin certificates are also widely used as the tracking mechanism for national regulations on green tariffs. This is true in the UK for example, where enough guarantee of origin certificates must be presented to the regulator to show enough green electricity has been purchased to cover the total amount sold to consumers. Some countries also have other forms of certificates, the UK has both Renewables Obligation Certificates as well as Levy Exemption Certificates, which overlap with the Guarantees of Origin and can lead to double selling.

Fuel mix disclosure

The tracking of electricity also facilitates fuel-mix disclosure. Since 2004 it has been EU policy that all consumers must be provided with a fuel mix disclosure statement from their electricity supplier. This was introduced in Directive 2003/54/EC (EC 2003), though many of the details of implementation such as the label format and energy types which are included are left to member states to determine. These requirements also provide a mechanism which allows consumers to know if they are purchasing green electricity and provides a very base level of regulation in some markets where products are not widely available.

Market liberalisation

The EU is broadly also responsible for the wave of market liberalisation which has spread over Europe. It has been the policy of the EU since the 1990s to move away from monopolistic supplies to consumers, and towards more competitive markets where consumers are free to switch between suppliers. This was originally introduced in Directive 96/92/EC (EC 1997) and has been strengthened by the second and third phases in Directives 2003/54/EC (EC 2003) and 2009/72/EC (EC 2009). This liberalisation has been one of the main drivers of green tariffs in the EU and has been responsible for allowing products to be offered in many new markets, particularly in Eastern Europe.

Appendix i - Certification Stamps

A selection of certification stamps used by green electricity suppliers



Czech Republic



Estonia



EKO Energy



Blue Energy



Green-e

Appendix ii - The EKOenergy label

The EKOenergy Label



The EKOenergy label is the the fastest growing certification scheme for renewable energy in the world. Since its launch in 2012 the scheme has grown to cover the majority of European countries and in 2015 it accredited over 1 TW/h of electricity (EKOenergy 2015). From its inception the project has been pan-european and multi-lingual, all coordinated from its secretariat in Finland.

The scheme has a number of components:

Transparency - Retailers are required to inform consumers and potential consumers about the origin of their EKOenergy labelled electricity. They need to disclose at least the country of origin and the technology.

Electricity Sourcing - Energy sold must not be sourced from generating stations in protected nature areas. Hydropower can only be included if it comes from power plants which have been approved by the EKOenergy board, after consulting local NGOs.

Additionality - At least 10 euro cents must be contributed to the EKOenergy climate fund per MWh of EKOenergy sold. This money is used to finance further investments in renewables.

Tracking - Only electricity which is tracked can be sold as EKOenergy, in Europe via the Guarantees of Origin system.

Verification - The quantities of EKOenergy sold by an electricity supplier, it's origin and the associated contribution to the EKOenergy fund are verified by an external independent auditor.

Appendix iii - The Green-e label

The Green-e Label



The Green-e label is North America's leading voluntary certification scheme and eco-label for renewable electricity. It has been operating since 1997 and in 2014 it reached 38 million MWh of sales. The scheme currently certifies 1% of the total U.S. electricity mix, with the majority of that going to commercial rather than residential customers. Due to the varying regulation across the USA it sells energy through three mechanisms.

1. Green Pricing Programs
2. Competitive Renewable electricity
3. Renewable Energy Certificates (RECs)

The scheme requires that all green sourced products undergo independent annual audits to ensure compliance with Green-e's environmental and consumer protection standards (Green-e. 2016). As well as solar and wind the scheme also allows generation from hydropower, biomass, biodiesel and fuel cells, though these latter four have strict criteria attached. Importantly the scheme only certifies 'new renewables', with limits on the ages of the generating stations. The tariffs sold can be from 25% to 100% renewable, though if a supplier offers a product less than 50% they must also offer a 100% renewable option. There are also mechanisms to allow renewables to be sold in 100% green 'blocks' in a minimum size of 100kWh/month. In order to eliminate double counting, the products sold must be comprised of eligible renewable generation over and above anything required by state or federal RPS requirements, legislation or settlement agreements. Renewable energy which has obtained tax or financial incentive payments are eligible, so long as these do not also require that the electricity generated be used or counted towards a mandated obligation or other policy. For a more complete description of the relevant criteria refer to version 2.8 of the Green-e Energy National Standard (Green-e 2016).

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