Limits and Possibilities of US Energy Policy

Malcolm Keay sees déjà vu all over again

Introduction

For those of us who are old enough and have been following the energy scene for long enough, the current energy debate in the USA is producing a strong sense of déjà vu. The background is the same as in the 1970s – soaring oil prices, the prospect of stagflation, concerns about security of supply from 'unstable regions and unfriendly regimes'. The diagnosis is the same – the problem is that 'domestic production has been dropping steadily' while demand has grown; as a result 'much of the oil consumed in America comes from abroad – that's what's changed dramatically over the last couple of decades.' The high level of rhetoric is the same – the aim is to increase US 'energy independence' – as are the specific objectives. America must 'end our addiction to oil' by reducing demand for oil and 'promoting alternative energy technologies', which will also enable the USA to 'become better stewards of the environment'. The supporting measures are also similar – increased production of US oil (though the scope was/is recognised to be limited); clean coal – 'making the most of our abundant resources of coal … while taking care of the environment'; developing 'new, unconventional sources'; promoting renewables; raising 'fuel efficiency standards to ambitious new levels'.

The quotations in the above paragraph are taken more or less randomly from President Carter's energy policy speech of 1977 (when he described the challenge as the 'moral equivalent of war') and President Bush's energy speech of June 2008. It would be difficult for even the most assiduous Washington analyst to ascribe the various references to the correct president, so similar were the overall themes – for instance, it was President Bush, not Carter, who thought that US oil imports are a development of the last two decades (although, of course, they had also worried President Carter 30 years before) and who talked of ambitious new fuel efficiency standards; President Carter who called for a switch to clean coal – but it could equally have been the other way round. The similarity of rhetoric is informative in many ways – although there are differences of emphasis, the politics of the issue are largely bi-partisan (President Carter was picking up the baton from President Nixon's 'Project Independence'). The perception of the issue within the USA also remains rather different in tone from the European debate, being based around themes of morality and independence (Bush's 'end our addiction to oil' is very much like Carter's moral crusade).

> "Despite being a nuclear engineer, President Carter was cautious about nuclear power"

One change, of course, is the increased emphasis on the environment, but even that is not entirely new – one of President Carter's ten principles was protection of the environment, which he thought could go along with improved security (as did President Bush in his call for 'alternative technologies' to help solve both problems and, to continue the bipartisan theme, Speaker Nancy Pelosi when she set up the Congressional Select Committee on Energy Independence and Global Warming. The two current presidential candidates also put considerable stress on the environment, unlike the Administration supporting cap-and-trade schemes for CO_2.)

But perhaps most striking is that the policy responses of the 2000s remain essentially the same as in the 1970s (with the interesting exception of nuclear; see below) – despite, or because of, the fact that the problem also remains essentially unchanged (this has apparently not led anyone to consider whether the policies actually achieved anything). Is this because, like the Bourbons, US presidents 'forget nothing and learn nothing'; or is it that the right policies were always available but were not pursued consistently enough? This article looks at some of the differences and similarities between the approach of 30 years ago and that of today.

The Policy Response: 1970s

The main planks of President Carter's programme were contained in a National Energy Plan. Much of it was concerned with the regulation of oil and gas prices (now of mainly historic interest) but many of the key policy elements would still be familiar today:

*Energy Efficiency***.** One of Carter's lasting moves was to create a Department of Energy (USDOE – at that time most OECD countries had, or were in the process of creating, a government department specifically devoted to the issue; now interestingly the USA is virtually alone in retaining one.) Energy conservation was identified as the core of the Carter Plan and USDOE introduced a number of programmes including the Weatherisation Assistance Programme which over the past 30 years has provided insulation and other services to more than 5.5 million low income families, and the Energy Star programme, which promotes greater appliance efficiency. Encouragement was also provided for utility demand side management programmes, tighter building codes and a range of other energy conservation measures.

Promotion of Renewables. President Carter had some difficulty in getting his National Energy Plan translated into legislation and the National Energy Act of 1978 only implemented about half of it. The Act was essentially a piece of umbrella legislation with a number of separate components of which the best known (at least to

those in the electricity industry) is the Public Utility Regulatory Policies Act (PURPA). This was designed to promote greater use of renewable energy by forcing utilities to buy power from outside producers at so-called 'avoided cost'; it also exempts developers of such projects from various levels of regulatory scrutiny. Much of the implementation was left to individual states. In practice, PURPA proved more effective in promoting co-generation schemes (generally gas-fired, but included on the basis that they saved energy by using steam which would otherwise be wasted). PURPA contracts have now largely expired and deregulation of electricity has removed much of their logic but support for renewables remains central to the new approach.

Synthetic Fuels. The Carter plan included funding for a range of alternative fuel projects including a variety of synfuels, mostly based on coal. The vehicle for this initiative was the Synthetic Fuels Corporation which had the huge (for the time) budget of $15 billion. It aimed to enable the USA to produce the equivalent of 2 million barrels of synthetic crude a day by 1992 (about half of expected imports). In the end, only one plant was completed – the Great Plains project in North Dakota, and the initiative was wound up in the mid 1980s.

*Nuclear***.** Despite being a nuclear engineer, President Carter was cautious about nuclear power – he called for a pause to re-examine the programme in view of the danger of proliferation. In practice, because of cost overruns and delays, nuclear power development in the USA had already stalled – between 1974 and 1976, US utilities cancelled 23 reactor orders and deferred 143 more. Whether there might have been a return to nuclear after the 1979 oil price increases became a moot point after the accident at Three Mile Island (also in 1979). It remains the case that no new nuclear order has been placed in the USA since 1975.

*CAFE Standards***.** CAFE (Corporate Average Fuel Economy) standards were first set under President Ford in 1975. They were designed to improve the fuel economy of cars, light trucks and so on, by setting limits for the average consumption of a manufacturer's fleet, with fines for those who fall below the standard. Their effectiveness is discussed below.

The Policy Response: 2000s

In many ways the response to the more recent crisis has been on similar lines. The emphasis is still on the demand side rather than oil supply. There has been pressure from the Administration to ease restrictions on drilling offshore and in the Arctic National Wildlife Refuge, but it is recognised that these moves would make only a limited difference and the two presidential candidates are not very keen (although Senator McCain has recently moved in favour of offshore drilling). Instead, emphasis is being given to the old favourites.

Energy Efficiency. The Energy Policy Act of 2005 (the 2005 Act) and the Energy Independence and Security Act of 2007 (the 2007 Act) continue and extend the energy efficiency measures of the 1970s, promoting residential and appliance efficiency, including funding for improved building codes, phasing out incandescent light bulbs and the like. Both presidential candidates support further action on energy efficiency.

Promotion of Renewables. The 2005 Act extends the renewable electricity production credit (though at some $2.7 billion, the amount is less than many had called for – further tax breaks are in the pipeline) and authorises subsidies for renewables. As in the 1970s, much of the policy initiative is left with the individual states, 27 of which have introduced renewable portfolio standards (i.e. an obligation to produce a certain proportion of electricity from renewables). Senator Obama is in favour of stronger renewable requirements; Senator McCain puts less stress on the issue (the inverse of their positions on clean coal and nuclear).

Synthetic Fuels. Although the coal route remains of interest, the emphasis now is of course on biofuels. The 2007 Act sets a mandatory Renewable Fuel Standard requiring fuel producers to use at least 36 billion gallons of biofuels in 2022. Interestingly (and worryingly) this is almost exactly the same as the target adopted by the Synthetic Fuels Corporation, and on a similar timescale. This is one of the key differences between the candidates though it does not follow party lines so much as geographical affiliation. Senator McCain (of Arizona – not an agricultural state) wants to eliminate subsidies for corn ethanol (and remove tariffs on imports of Brazilian sugar-cane ethanol) while Senator Obama (from the agricultural state of Illinois) supports the subsidies and the tariff (in the name of 'energy independence').

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Nuclear. There is also some difference between the candidates on the issue of nuclear. The Bush Administration is of course keen on nuclear and has offered significant subsidies and regulatory streamlining in the 2005 Act. A production tax credit of 1.8c per kWh can be provided for the first eight years of operation of new nuclear plant. The support is designed to be comparable with that for renewables and, to encourage early build, the credits are limited to the first 6GW of plant to be built before 2021. Senator McCain is strongly in favour of nuclear – he has called for 45 new reactors to be built by 2030 as part of the drive towards energy independence, with the ultimate goal of 100 new plants. Senator Obama is not fundamentally opposed but does not stress the role of nuclear. However, it is not clear whether private investors will be prepared to take the risk of new nuclear, in view of the chastening experience of the 1970s (and despite the fact that the 2005 Act

also provides financial support in the case of cost overruns). The problems of the 1970s may not have gone away. Recently the *Wall Street Journal* reported that:

> A new generation of nuclear power plants is on the drawing boards in the U.S., but the projected cost is causing some sticker shock: $5 billion to $12 billion a plant, double to quadruple earlier rough estimates.

Clean Coal. As in the Carter Plan, the present US approach aims to increase the use of clean coal and the 2005 Act contains provisions for regulatory simplification and funding for clean coal initiatives. However, as discussed below, the main project in this area (Futuregen) has now stalled.

CAFE Standards. The standards were tightened under the 2007 Act. The main change is to tighten the limits on heavier vehicles (SUVs) – previously they had faced much lower standards and, as consumer preferences shifted to these vehicles, the impact of the tighter standards for smaller vehicles was negated. Both candidates support further strengthening.

The Results

All in all, the recent package has been on very similar lines to that of the 1970s and, with differences of emphasis, both candidates support its general thrust towards energy independence. But does this reflect a judgement that the 1970s package was a success? It is admittedly a complex question and the following brief analysis does not aim to be definitive – rather to make the simple point that, whatever the uncertainty about the details, it is clear that the measures adopted in the 1970s were simply not up to the scale of the task as originally defined – to halve, and eventually eliminate, US oil imports. The current 'independence' rhetoric has similar long-term objectives, and there must be a question as to whether the existing approach will be any more effective than its predecessor.

*Energy Efficiency***.** As always in this area, it is difficult to measure what would have happened in the absence of government programmes, given all the confounding variables, but US primary energy consumption has grown by about 40 percent since 1975 and the rate of growth seems more tied to energy prices than to conservation efforts. The increase has been in line with other major economies and, while slower than the rate of US economic growth (over 100 percent), it still leaves the USA as one of the most energy-intensive countries in the OECD whether measured in terms of energy consumption per unit of GDP (0.21 tonnes of oil equivalent per $1000 of GDP as compared with the UK's 0.14) or per capita (8 tonnes compared with 4 for the UK). At best, the effects of US energy efficiency programmes have been marginal.

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Promotion of Renewables in Electricity. The past three decades have certainly seen rapid growth in new renewables – wind power has for instance risen by several orders of magnitude above its level of the 1970s, when it was virtually non-existent; biomass-produced electricity has similarly risen about one hundredfold. Solar power (the centre-piece of the Carter approach) has however risen more slowly and hydro power has remained virtually unchanged. The net result is that the contribution of renewables as a source of electric power has in fact *fallen*, not increased – from 16 percent in 1975 to 10 percent today.

*CAFE Standards and Oil Consumption***.** As with energy efficiency it is difficult to determine a counterfactual. A 2002 study by the National Academy of Sciences suggested that in the absence of the CAFE standards and with no other fuel economy measure (e.g. gasoline taxes like those in Europe) vehicle fuel consumption might have been 14 percent higher. But even this looks uncertain. As noted above, CAFE standards as originally set largely failed to limit the efficiency of light trucks (as SUVs are classified). Consumer preference, possibly encouraged by the standards themselves, moved strongly in favour of these heavier vehicles (over 50 percent of the fleet by 2004). In fact, fuel economy for the US fleet of cars and light trucks reached its highest level in the late 1980s – since then it has deteriorated somewhat. (It seems to be rising again, in response to higher fuel prices, but remains far below that of European countries.) The overall result in the USA was that oil consumption in transport fell slightly in 1973–4 and again in 1979–82 (probably due to price rises and speed limits) but since then has resumed its inexorable ascent. Consumption today is over 50 percent above that of 1975 and alternative fuels have made very minor inroads.

*Synfuels***.** It is not clear whether the USA has learnt its lesson from what was probably the biggest failure of the 1970s Plan – the Synthetic Fuels Corporation. On the one hand, the rush into biofuels may seem to threaten similar risks (indeed, in view of current concern about the impact on food prices, the problem may be even worse than that of creating expensive white elephants). On the other hand, it is noticeable that a relatively cautious approach has been taken with the main current synfuel venture, Futuregen. This is similar in many ways to the ill-fated Great Plains project, which involved a coal gasification plant in Beulah, North Dakota (taken over by the US Department of Energy when its commercial sponsors pulled out). The plant was not originally designed to incorporate carbon sequestration but, in an interesting example of unintended consequences, has recently found a new lease of life as the provider of CO_2 for the Weyburn enhanced oil recovery project in Canada. Futuregen looks very much like Great Plains Mark II (and seems to be suffering a similar fate). It is also a coal gasification project

in northern mid-America (Illinois), designed to produce hydrogen (for vehicle use) and electricity, while capturing and storing CO_2. Recently it seems to have collapsed in a stand-off between the corporate sponsors and the government, though this time it was the DOE which withdrew from the project, because of higher than expected costs.

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More Unintended Consequences. Although it was not part of the original Carter package, the major achievement of the USA in reducing oil consumption since the 1970s has been in power generation, and can be ascribed primarily to the growth of nuclear power (plus not-very-clean coal generation). Nuclear power has risen some fourfold since 1975 (though all this development, as noted above, was initiated before the Carter plan) and coal-fired generation has roughly doubled. The main loser has been oil; oil consumption in power generation peaked in 1978. The reduction since then has been significant – equivalent to about 20 percent of transport oil consumption in the mid 1970s. President Carter set a goal to reduce gasoline consumption by 10 percent between 1977 and 1985; he did not achieve this (consumption had by then returned to its 1977 level) but power sector oil consumption fell by a greater absolute amount over that period and the reduction has persisted to this day. It is not however repeatable – because oil consumption in power generation has now fallen to negligible levels, a new nuclear programme would have no real impact on oil consumption (at least until electric vehicles are in wide use). In short, the easy oil savings (though they were not identified as such at the time) have already been made and future reductions will be more difficult (this is probably a worldwide phenomenon, evidenced in the apparently falling price elasticity of oil demand).

Conclusion

Overall, it is difficult to see that the Carter Energy Plan had any significant lasting consequences apart from the creation of the USDOE (and the reader can decide whether this has been a benefit or burden on the US energy scene). Much of the Plan was abandoned within a few years in the easier oil price climate of the 1980s; the rest seems to have had a marginal impact at best. Does a similar fate await the latest (and very similar) energy proposals? In the short term, abandonment seems unlikely – given that both candidates support the main elements of the programme (and indeed want to go further, on the environment in particular). But neither has a fully worked out energy policy and in both cases the key question is likely to be whether their proposals can get through Congress and withstand the pressure of events (the twin forces which derailed the Carter Plan). Energy is a long-term business; investment cycles are measured in decades or more. President Carter's plan was largely dismantled or bypassed within a decade as the emphasis moved to energy deregulation. It is therefore ironic to consider one of his original ten principles for energy policy: 'government policies must be predictable and certain. Both consumers and producers need policies they can count on so they can plan ahead.'

The key question may not be so much what policies will the US introduce but how long will they last? And if they only last while oil prices are high will they really add much to what markets are doing already? The experience of the 1970s does not offer much reason for optimism.

Jérôme E. Roos suggests a set of policy proposals to cure America's addiction to oil

A little over two years ago, in his 2006 State of the Union address to the U.S. Congress, President George W. Bush took the world by surprise with five simple words: 'America is addicted to oil.' The president went on to warn that this oil 'is often imported from unstable parts in the world,' and that the USA must 'move beyond a petroleum-based economy and make [its] dependence on Middle Eastern oil a thing of the past'.

A look at the 2006 Advanced Energy Initiative (AEI) illustrates the speech's practical implications. The AEI calls for a 22 percent increase in research funding at the Department of Energy, with a two-pronged strategy: (a) to change the way cars are fuelled by increasing research in hybrid and electric car batteries, hydrogen fuel-cells and new methods of ethanol production, from switchgrass, stalks and wood chips; and (b) to 'revolutionize' electricity production through research in clean-coal, solar, wind and nuclear energy.

The Initiative calls for a 75 percent reduction of Middle Eastern oil imports by 2025, still a far cry from overcoming the actual oil addiction. Indeed, general US energy policy seems to further feed the nation's thirst for oil by focusing on improving national production capacity. This means the ANWR (Arctic National Wildlife Reserve), Continental Shelf drilling, and refineries. It also means securing supplies from elsewhere, like the Gulf of Guinea.

For these reasons the AEI is still extremely limited in scope. Although Bush linked the initiative to the 'move beyond a petroleum-based economy', more radical policy rearrangements will be necessary to live up to these words and truly kick the American oil habit. Given that only 3 percent of

US oil consumption goes to electrification, the principal focus should be on transport, which accounts for two-thirds of the 20 million barrels consumed in the USA every day. Moreover, policies should be based on a two-tier strategy: firstly, vast investment in R&D of state-of-the-art technologies (hydrogen, cellulosic biofuel and plug-in batteries) that would help to replace gasoline as a fuel altogether. Secondly, since such technologies still have a long lead-time and the commercial viability of hydrogen fuel-cell cars is estimated to be reached at best in 2020, there is a strong need to employ existing technologies to *conserve* present oil resources, pushing back the prospect of dwindling oil reserves, reducing both demand and prices, as well as foreign dependency and carbon dioxide emissions in the short term, while developing more sustainable solutions for the long term.

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Fuel Efficiency: Saving Oil

America's addiction to oil surely starts at the gas station. 97 percent of all American transport relies on oil for fuel, and transportation accounts for two-thirds of total oil consumption. To make matters worse, US vehicles are among the least fuel efficient in the world. Under the AEI, CAFE standards for light trucks and SUVs were raised from 20.7 to 22.2 miles per gallon (mpg), the first increase in over a decade. In December 2007, Congress passed its first fuel efficiency bill for cars since 1975, increasing mileage standards 40 percent, up to 35 mpg, to be reached by 2020. The problem, however, is that there are already cars on the US market that run up to 48 mpg and SUVs that achieve an astonishing 30 to 34 mpg. According to the UK Vehicle Certification Agency, there are three cars that currently exceed 70 mpg in Europe: the Mini Cooper Hatchback, the SEAT Ibiza and the Volkswagen Polo, and dozens of models that run over 60 mpg.

The point of mileage standards should be to challenge the automobile industry to develop radically new approaches to fuel efficiency, and indeed, to promote the sustained switch to hybrid vehicles. Current CAFE standards are still far too low, and are dwarfed by fuel standards in Japan, the European Union and even China. California, along with ten other states, the cities of New York and Washington, D.C., and four environmental groups, took the federal government to court in 2007 arguing that federal standards were much too low. According to State Attorney General Jerry Brown of California, 'they didn't look at hybrids. They didn't look at available technologies, [the standard] has the hand of lobbying, not the mind of science.'

An authoritative independent research by the Rocky Mountain Institute in 2005, co-funded by the Pentagon, states that an oil saving strategy can be profitable and that significant saving technologies are already available. The group of researchers hold that the 'full use of cost-effective, established technologies can wring twice as much work from each barrel by 2025 […] Most of the savings, like most of the use, is in light trucks, heavy trucks, cars and airplanes.' Such cost-effective and established technologies include:

- Hybrid technology (which could further benefit from a new generation of improved batteries and flexible-fuel technologies, switching from gasoline cars to gas, diesel and/or ethanol hybrids);
- Plug-in technology (as demonstrated by the California Cars Initiative for Plug-in Hybrids, or CalCars, making cars run their first 30–40 miles on an electric battery before switching to hybrid mode);
- Light-weighting (which is possible without reducing safety through the use of carbon fibres, hailed by the Rocky Mountain Institute as the 'emerging revolution' in the automotive industry);
- Reducing drag and rolling resistance (through shaping, better tyres, and so on).

The main point is that such technologies are already available. Therefore, rather than merely looking forward, the objective should be to make them commercially viable at present. Economies of scale can do the trick, provided that enough capital investment flows into the business. In order for investments to take off, the federal government could (1) implement 'smart government procurement and targeted technology acquisition' through the Departments of Defense and Energy; (2) further extend the federal loan guarantee program to include a solicitations round for gasoline-saving technologies in transport; and (3) provide state subsidies, in the form of tax incentives for producers. The latter could be financed by phasing out oil subsidies, removing $15 billion in tax breaks for oil companies (as proposed by Democratic legislators but blocked by the White House).

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Another way to promote fuel efficient cars on the market is through so-called 'feebates' (revenue-neutral by design), which punish inefficient buyers (and thus producers) by charging additional fees for low mileage cars, using the revenues of these fees for efficient car buyer rebates. Such 'feebates' are already employed in Canada. Combining these with subsidies and tax incentives would both reduce demand and promote supplies, and has the potential to quickly propel efficient technologies into the mainstream.

When it comes to fuel efficiency, the current policies of the Bush administration will hardly make a dent. Research investment is too insignificant and the plan lacks an integrative

vision applying the different policy tools on both the demand and supply side. The AEI puts a lot of trust in substitution fuels (hydrogen and cellulosic biofuels), but largely neglects the need for short-term energy efficiency to successfully bridge the lead-time in making cellulosic biofuels, electric cars and hydrogen fuel cells commercially viable.

Fuel Production: Substituting for Oil

Substituting for oil altogether is a much more daunting task than increasing fuel efficiency alone. Current technologies cannot realistically replace gasoline as number one car fuel – let alone kerosene for air transport. The US government and experts hold that it will take at least until 2020 before alternative technologies, such as more efficient batteries and improved hydrogen production and storage, become commercially viable. However, many arguments can be made to start moving along the path towards such substitution technologies today, rather than tomorrow.

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According to Amory B. Lovins in the Rocky Mountain Institute report, 'it will cost *less* to displace all of the oil that the United States now uses than it will cost to *buy* that oil,'(p. ix) under the presumption that by 2025 (second generation) biofuels can make up for 25 percent of current oil consumption levels. In order to prevent interference with the food market, incentives should promote R&D of (ligno)-cellulosic ethanol from switchgrass and wood chips. Moreover, although there is still significant debate over what will be the silver bullet (hydrogen fuel cells, electric cars or biofuel hybrids), the Bush administration seems to have firmly set its eyes on hydrogen.

In 2003, Bush announced the $1.2 billion Hydrogen Fuel Initiative, with the goals of bringing hydrogen production costs down to the oil range by 2010, making fuel-cell cars enter the mass market by 2020, and replacing all fossil-fuel powered cars in the inventory by 2040. The 2006 Advanced Energy Initiative further expanded hydrogen research funding.

In his 2002 bestseller, *The Hydrogen Economy*, Jeremy Rifkin provides unremitting support for a transformation to hydrogen-fuelled cars. He states that hydrogen is abundant, has the highest energy content per unit of weight of any known fuel, is safe to store and can decentralise fuel production, greatly democratising its distribution.

However, some experts worry that the USA is betting its money on the wrong horse. Joseph J. Romm, former DoE official during the Clinton administration and author of *The Hype about Hydrogen* (2004), shows that there are significant hurdles in hydrogen development for automobiles, hurdles that are not fully acknowledged by either Rifkin or the Bush administration. For starters, the production process (hydrogen from water through electrolysis) is highly energy inefficient. 96 percent of hydrogen is still generated from fossil fuels, oil accounting for 30 percent, with nuclear and renewable electrolysis only accounting for 4 percent of the total. According to Romm, 'to replace all the gasoline sold in the United States today with hydrogen from electrolysis would require more electricity than is sold in the United States today' (p76). Secondly, storage and shipping are problematic, with hydrogen having a tendency to disperse even through solid materials, and laying down appropriate pipe infrastructure will prove to be a costly endeavour. An IEA energy technology analysis argues that 'a transition to hydrogen would require infrastructure investment in the range of several hundred billion to a few trillion dollars'. Thirdly and lastly, fuel-cells are still very expensive (over 10,000 euros for a medium-sized sedan) and excessively big.

Most importantly, however, like electricity, hydrogen is but a means of energy *storage*: it is not a fuel in itself. Hydrogen, therefore, is only as clean, cheap and abundant as the energy by which it is produced. When produced through electrolysis (using renewable sources), a large share of energy (around 30 percent) is lost – energy that could otherwise have been fed directly into the grid, using plug-in cars with improved batteries to take up the energy at relatively small loss. Fuel-cell vehicles have a total energy efficiency of 19–23 percent, whereas a plug-in electric vehicle recovers 69 percent of renewable energy production. For this very reason, conversion into hydrogen makes no logical sense from an energy economy perspective.

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Ulf Bossel, chairman of the European Fuel Cell Forum, made a surprising announcement at the 2006 meeting, stating the EFCF would no longer occupy itself researching hydrogen. He said that 'the energy problem cannot be solved by creating artificial fuels. The laws of physics speak against a hydrogen economy, and physics cannot be changed by wishful thinking, political initiatives, research programs, or venture capital.'

For these reasons, the US government should not bet all its money on a physically disadvantaged horse. Rather, it could support competing technologies in a similar fashion as it supported hydrogen R&D, and then let the market select the most cost-efficient product: plug-in electric cars, cars driving on pure cellulosic ethanol,

or hydrogen fuel-cell cars.

Recent developments in lithium-ion battery technology could offer an interesting perspective for plug-in electric cars, and have even led General Motors to reconsider its strong research focus on hydrogen fuel-cells. According to Bob Lutz, GM Vice Chairman, electric cars might soon run up to 300 miles before needing to recharge. In his words, 'if we get lithium-ion to 300 miles, then you need to ask yourself, "Why do we need fuel cells?"' In light of these recent developments and the problems associated with hydrogen, improving car batteries should become a research subsidy priority.

As for biofuels, relevant ethanol requires cars with internal combustion engines that can run on 100 percent cellulosic ethanol (as opposed to corn-based ethanol, which is used as a fuel additive). In 2003, VW introduced the first flexible-fuel vehicles in Brazil, which can run either on pure ethanol or on E25 (Brazil's fuel mix comprising one unit of ethanol for every three units of gasoline). Such vehicles could be introduced in the USA in the very near future through a set of tax incentives and the proactive promotion of an ethanol infrastructure, by obliging every filling station to offer at least one ethanol pump. Moreover, kick starting cellulosic biofuels requires additional research funding in production methods of switchgrass ethanol, next to government allocation of barren lands where switchgrass can be grown, ensuring protection of arable and forested land.

In addition to promoting these technologies, the government should create an overall climate which is reassuring to innovative producers. In 2006, the Brookings Institute suggested a $60 oil price floor (perhaps at this point a $100–125 floor would be more appropriate), setting a minimum price for oil, thus ensuring endured competitivity and reducing entrepreneurial risks for oil-substituting technologies. In addition, the negative externalities of burning oil (carbon dioxide emissions) should be internalised into the market to reflect the real price of oil combustion – either through a carbon tax or through a cap-and-trade mechanism. This would instantly make electric, hydrogen and biofuel powered cars more competitive on the market.

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Most importantly of all, however, the next US president should seek to halt the very price distortions that currently undermine the Advanced Energy Initiative. In short, he should remove tariffs on Brazilian sugarcane ethanol, and sign the Congress' Ending Subsidies for Big Oil Act of 2007. With an annual $15.69 billion in tax breaks and subsidies for oil companies, the US is the world's biggest 'aider' of oil. In the words of the *Washington Post* in February 2006, 'few administrations have done more to feed America's oil addiction than this one.'

In the end, however, we have to realise that it is not oil or the internal combustion engine that Americans are addicted to, but rather the freedom and autonomy that come with driving an automobile. There are ample economic and technological opportunities for the USA to move beyond the hydrocarbon economy without necessitating a change in lifestyle. But in order to get there, the administration will first of all have to cease being the dealer of the nation's oil; only then can it start presiding over the peaceful divorce of oil and the automobile by finding a suitable new partner for the latter.

Jim Arrowsmith assesses the current fall in US oil demand

In the past eight months US oil demand has fallen by an average 300,000 b/d, only a fraction of the increase in the previous seven years, and a small decline by previous historical standards. Of course, this partly reflects the structural changes in demand in recent decades. In 1978–83, a US consumption decline of 3.6 million b/d (mb/d), much of it in heavy products, was the major contributor to the 5.4 mb/d drop in world demand which weakened oil markets for several years. With heavy fuel oil consumption in the USA below 1 mb/d since 1996, a comparable drop in US demand is now practically inconceivable, except in extreme economic or political scenarios resulting in huge cuts in demand for light and middle products.

Such 'outlier' scenarios include a severe US recession lasting several years, as might result from price spikes triggered by a war with Iran. Barring such cases, no decline in US consumption through the next year or two can provide a significant offset to the exuberant demand growth in Asia and the Middle East. Nonetheless, in today's markets, US demand trends can have an impact on prices out of proportion to their actual share of world consumption. In particular, if US demand, especially for highway fuels, is seen as on a relentless upward trajectory, market players may underestimate the price-calming potential of future supply increases.

For several years, it seemed that the USA was exacerbating the continuing boom in world oil markets, with demand rising from 19.6 mb/d in January–September 2000 to 20.7 mb/d seven years later despite increases in the West Texas Intermediate crude oil price from an average of $31.61/bbl in third-quarter 2000 to $75.46 in third-quarter 2007. Gasoline demand climbed by nearly 980,000 b/d (1.6 percent annually) despite an increase in retail gasoline prices from $1.56 to $2.78/gallon, while distillate usage

grew by 570,000 b/d (2.1 percent annually) despite a rise in diesel pump prices from $1.51 to $2.89/gallon.

Consumption of other products did fall, partly offsetting gasoline and distillate trends. Even as airline traffic recovered strongly post-9/11, fuel consumption fell by 60,000 b/d. Due to the rise in fuel prices from $0.93/gallon in 2000 to $2.20 in 2007 and intense competition between the incumbent higher-cost airlines and lower-cost new entrants, available seat miles (ASM) per gallon of jet fuel rose by 2.7 percent annually. Heavy fuel oil consumption continued its downward trend, falling by over 270,000 b/d, albeit with year-to-year fluctuations due to factors such as the changing competitiveness of natural gas. Meanwhile, demand for the heterogeneous group of other petroleum products, including liquefied petroleum gases such as propane, fell by 300,000 b/d.

"in today's markets, US demand trends can have an impact on prices out of proportion to their actual share of world consumption"

Fears that demand for gasoline and distillate had become totally unresponsive to price increases confused nominal and real prices. As late as the summer of 2007, crude oil and product prices in real terms were still below their peaks of the early 1980s. Crude oil did not reach that peak until its October 2007 average of $85/bbl, gasoline until its $3.10/gallon average in January 2008, diesel until its March 2007 average of $1.96/gallon, and jet fuel until its $2.32/gallon in September 2007. Although conventional economic theory casts little light on this, it appears that in the USA, at least, only after prices passed these peaks were consumers convinced that price increases were likely to persist and willing to take serious steps to adjust to higher prices. After all, there had been several episodes of price fluctuation in the 1990s and it was not irrational to believe that the upward movement would be halted or even reversed, especially in light of both media and analysts' predilection for explaining price increases in terms of unique events – Nigerian strikes, diplomatic spats over Iran – which could be terminated or resolved, holding out the possibility that markets would then soften.

Meanwhile, higher GDP was helping offset rising prices. Following the shallow recession of 2001, real growth averaged 2.4 percent annually into 2006 and was strong through September 2007 when the US economy was almost 17 percent larger than in the first quarter of 2002. In this environment, the share of household expenditures on petroleum fuels for transportation remained very low. At their peak in 1981 such expenditures equated to only 5 percent of consumer spending, falling as low as 2 percent in 1998. By the third quarter of 2007, the ratio had risen only to 3.5 percent, and by the first quarter of 2008 to 3.8 percent.

Moreover, in the case of gasoline, the overwhelmingly dominant fuel for cars and other light passenger vehicles, persistent demand growth into 2007 also reflected the impact of the declining average fuel efficiency of new vehicle sales from 22 mpg in model year 1987 to 19.3 mpg in model year 2004. Federal corporate average fuel economy (CAFE) standards for cars and light trucks (including vans and SUVs) had boosted the average fuel efficiency of the light passenger vehicle fleet from 13.1 mpg in 1975 to 22 in 1987. However, political opposition froze mandated standards for several decades while the less stringent standards for light trucks meant that effective mpg mandates declined as light truck sales outpaced car sales.

But in the fourth quarter of 2007, demand for gasoline fell significantly below year-earlier levels, while demand for jet fuel, heavy fuel oil and the other products category continued to decline. In the eight-month period from October into May 2008, total petroleum consumption fell from 20.7 to 20.4 mb/d, with declines in all the major products, including almost 60,000 b/d for gasoline, and a similar volume for distillate. Jet fuel usage, residual fuel oil and other products were also down. Preliminary data for the first four weeks of June show these trends continuing for all the major products.

Weakening demand had two parents. Economic growth in the fourth quarter of 2007 slowed to only 0.6 percent (seasonally-adjusted annual rate), and was only 1 percent in the first quarter of 2008. Meanwhile, crude oil and product price increases have accelerated. Spot WTI has risen from a September average of $80/bbl to nearly $140 in early June. Average retail gasoline prices have increased from $2.85/gallon in September to over $4 in early June. Highway diesel has climbed from $2.95/gallon to $4.65 while jet fuel prices have also soared from $2.32/gallon to as high as $4 by early June.

"As late as the summer of 2007, crude oil and product prices in real terms were still below their peaks of the early 1980s"

Vehicle miles travelled (VMT) nationwide fell by 2.2 percent year-on-year for the six months through April 2008. With 90 percent of VMT generated by light passenger vehicles, spiking prices and lower growth weakened gasoline demand by cutting travel. Survey data likewise show Americans cutting back their driving through cancelling vacations, vacationing closer to home, carpooling, telecommuting, combining routine trips to stores into one rather than several journeys, and in those places where it is possible, taking public transport to work.

In the 56 percent of American households with two or more vehicles, cutting gasoline consumption may involve only minor reductions in VMT. Family members can favour more over less fuel-efficient vehicles within the household, reducing

gasoline usage per mile travelled. Some consumers are also switching from less to more fuel-efficient vehicles, with passenger car sales in the first five months of 2008 accounting for 52 percent of light vehicle sales, and light trucks only 48 percent. This compares with the car share of only 47 percent and the light truck share of 53 percent in the comparable period in 2007. Moreover, sales of small cars have been far stronger than those of large ones and sales of large SUVs and trucks far worse than those of small vehicles in the light truck category. Increased market penetration by gasoline hybrid-electric cars like Toyota's Prius is part of this process, aided to a limited extent by federal tax credits. Other ways of boosting fuel efficiency include modifying driving habits – avoiding speeding, rapid acceleration, sudden braking and idling – and improved maintenance.

The outlook of US gasoline demand over the next year or eighteen months – further shrinkage, stabilisation, a return to further growth – cannot be accurately foreseen without stipulating the broad contours of the outlook for the economy and world oil prices, even though defining a precise scenario is far beyond the scope of the present discussion. Nonetheless, a lowest common denominator can surely be set. US GDP growth at best will remain sluggish for several quarters. World oil prices may rise, stabilise or fall, but if the latter, will likely still average well above 2000 prices in real terms. In this fairly austere environment, significant fuel-saving adjustments seem likely to continue, and indeed intensify. In particular, consumers' shift to smaller vehicles seems likely to be ongoing. US gasoline demand seems likely to move down further in the next several quarters, albeit at the kind of pace seen since October 2007.

The same will likely be true for distillates. On-highway diesel accounts for over 60 percent of distillate demand with nearly 90 percent of this utilised in freight transportation. The key industry indicator of trucking activity fell in recent months and is now below its December 2007 level. Moreover, even where traffic volumes have held up, many firms have changed business and operating practices to boost fuel economy, for instance, dialing back the speed governors on trucks so that engines run at a maximum of 62 miles per hour versus 65 mph previously and switching to wide-base tyres. Other major diesel users such as the railroads and especially construction are also suffering demand losses now. The residential/commercial sector probably experienced some price and income induced conservation in winter 2007–2008, offsetting the slightly cooler weather in the heating oil-dependent northern East Coast states.

> "This recent fall in US oil demand owes practically nothing to federal policy"

In the six months through March 2008, airline travel rose by 3.3 percent year-on-year. Even as capacity grew, jet fuel demand fell as fuel efficiency was boosted further, for example, by flying aircraft at lower speeds. Further operational gains in fuel efficiency are harder to achieve. However, most major airlines now believe that potential travellers are reacting to rising ticket prices and slower growth and consequently plan to cut flights in many markets. These substantial reductions in ASM are likely to cut jet fuel demand in coming quarters. Moreover, since the companies will likely take out of service their least fuel-efficient aircraft, fuel consumption per ASM will probably fall, enlarging the drop in consumption.

This recent fall in US oil demand owes practically nothing to federal policy. Washington did not even debate repeating the 1974 imposition of a nationwide 55 mph speed limit. The opportunity to use post-9/11 national security concerns to enact a serious reform of fuel-efficiency standards was thrown away. The comprehensive tightening of CAFE standards was delayed until passage of the Energy Security and Independence Act (ESIA) last December. ESIA mandates a 35 mpg standard for light vehicles by 2020, with increases beginning in model year 2011. However, if enacted in December 2001, tightened standards beginning in model year 2005 could have helped cut gasoline demand growth sooner and in larger volumes.

A waiver of emissions standards post-9/11 could have also helped, encouraging the dieselisation of the light vehicle fleet by accelerating European manufacturers' plans to market in the USA. Stringent controls on emissions of nitrogen oxide and particulates and US consumers' disastrous experience with diesels a quarter century ago have kept the diesel share of car sales well below 1 percent and light truck sales below 4 percent over the past 20 years.

The US Energy Information Administration defines gasoline to include ethanol blended into gasoline. The mandates and subsidies in the 2005 Energy Policy Act did bring a modest increase in this type of fuel ethanol usage, thereby reducing the US call on the world's actual petroleum supply, albeit at an economic and environmental cost. Fuel ethanol consumption rose from 420,000 b/d in October 2006–February 2007 to 510, 000 b/d in October 2007–February 2008. With the mandate raised in 2007, 75,000 b/d of additional petroleum could be backed out of gasoline this year.

Even including this ethanol effect, reduced US oil demand since the fall of 2007 has eased the world petroleum balance but modestly. Further falls in consumption in the next year or two will likewise be relatively inconsequential. Longer-term however, the new ESIA mandates and possible serious US efforts to limit global warming should generate sustained oil demand reductions cumulating in meaningful multi-year volumes. While possible through incremental improvement of existing vehicle technologies, the process will be much easier with economically viable and commercially attractive new technologies. Those may or may not include currently widely touted vehicles such as plug-in hybrids, battery-powered electric cars, and fuel cell or other hydrogen powered cars.