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The articles published in this issue fit very well with *Forum's* main objective which is to elicit a debate. The topics addressed by our distinguished contributors raise questions, and involve views, that are widely open to discussion. Readers who would like to answer some of the questions raised, or to disagree with this or that view or opinion, are invited to write letters to the Editor. We would be more than happy to publish them in the next issue of *Forum*.

The first set of articles assesses the limits and possibilities of US energy policies. Malcolm Keay compares the energy policies proposed by President Carter in his 1977 speech and those by President Bush in his 2008 speech. The overall themes are similar, and so is the rhetoric. Carter was embarking on a moral crusade; and Bush's reference to the need 'to end our addiction to oil' has the same flavour. Did the Carter energy plan have any significant lasting consequences? The most relevant question is whether the Bush policies, so similar to what was proposed thirty years ago, have a chance of succeeding?

This is the issue addressed by Jérôme Roos who argues that appropriate policies may go a long way to cure America's addiction to oil. However his proposed policies are much more radical than those included in the 2006 Advanced Energy Initiative which, in his view, is extremely limited in scope. He advocates a vast increase in the investment in R&D for hydrogen, cellulosic bio-fuel, and plug-in batteries; but as these technologies have very long lead-in times, it is necessary to rely at first on existing technologies to enhance energy efficiency.

Since a major aim of US energy policy is to reduce the consumption of oil it is interesting to assess recent developments in petroleum demand. Jim Arrowsmith undertakes this task. The fall in US oil demand is likely to be greater in 2008 than the 300,000 barrels a day that occurred at the end of 2007 and early 2008, but this would still only represent a small amount relative to world oil consumption. Yet, what happens in the US petroleum scene, however small in world terms, tends to have a significant impact on oil prices. The reasons are, first, that US data are regularly available long before information from other parts of the world is published, and secondly, because the leading futures market where

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the WTI reference price is determined is a US exchange. So far the fall in US demand cannot be attributed to federal energy policies.

An article by Peter Fox-Penner and Matthew McCaffree of the Brattle Group, a Washington based consultancy, relates to the first set of papers as it includes an analysis of US oil demand. But the article has also a wider international scope. It is concerned with the needs of the developing world and seeks a solution to the climate change global problem, US security of supplies objectives and the legitimate desire of third world countries to use as much energy as required to fuel economic growth. The authors' proposal is for a bargain between these two parties – the USA on the one hand and the large emerging countries on the other – in which a significant US move to reduce its oil demand will induce the emerging countries to co-operate with other nations in international climate change agreements. Here again a debate may clarify many critical issues.

A different topic is the subject of Robert Mabro's article. The oil price issue is causing much ink to flow. The governments of OECD oil-importing countries, concerned by the inflationary and balance of payments effects of unprecedented increases in oil prices, and by the social discontent and fuel poverty caused, are naturally seeking solutions. Unfortunately, their diagnosis of the problem is not correct and this leads them to blame either OPEC for not responding to demands for a production increase, or developing countries for subsidising the domestic consumption of petroleum products and causing, or enhancing, the growth of oil demand. Yet the blame game leads nowhere.

The problem lies in a regime that seeks reference prices for crude oil in futures markets. These have an inherent tendency to overshoot and undershoot. The doubling of WTI and Brent prices over a short period is clearly due to overshooting. There is an urgent need to study and assess possible alternatives to the current oil price regime. Mabro outlines a possible scheme. To consider it requires political good will, a very rare commodity these days.

Forum includes an occasional column labelled Personal Commentary where a veteran of the energy world addresses a topic of her or his choice. We are very fortunate to have in this issue a contribution from Sir Mark Moody-Stuart, the former chair of the Committee of Managing Directors of Shell. Sir Mark focuses on the three main groups of oil industry players: the national oil corporations, the international companies and the services providers. He traces the main changes that have occurred in recent decades in the structure of the industry resulting from the greater dominance of the national corporations, the increased reliance on services providers, and on the challenges faced by all three sets of players. Technological developments have played and will continue to play a great role. The climate change issue 'adds to the challenge of meeting the world's energy needs and increases complexity'. All in all, important topics on which the author's personal experience sheds much light.

Contributors to this issue

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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').

"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)"

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.

"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"

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.

"there is a strong need to employ existing technologies to *conserve* present oil resources"

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).

"When it comes to fuel efficiency, the current policies of the Bush administration will hardly make a dent"

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.

"Substituting for oil altogether is a much more daunting task than increasing fuel efficiency alone"

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.

"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"

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.

"the government should create an overall climate which is reassuring to innovative producers"

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.

The Oil Price Conundrum

Robert Mabro

The governments of oil-importing countries are worried about the recent high oil prices. They worry about possible macro-economic effects: inflation, recession, balance-of-payments deficits. The consumers of energy in those countries where fuels are not subsidised are angry about the higher prices of oil, gas and electricity. Unfortunately these higher prices have coincided with increases in the cost of food and other items of vital expenditures. Those who use fuels in significant quantities, such as fishermen or truck drivers, are protesting through strikes or motorway blockades in some European countries.

Governments of importing countries could not remain indifferent to events too quickly labelled as the new oil price shock or the new oil crisis. Comparisons with the previous crises of the 1970s were hastily made but were more misleading than illuminating.

Is OPEC Responsible for High Oil Prices?

The focus in the 1970s was on OPEC. It is interesting to note that the response of OECD governments and their energy watchdog – the IEA – to the high oil prices of today followed the same line of thought: OPEC must be the guilty party in this new situation. The IEA asked OPEC to increase its production *illico subito.* President Bush asked Saudi Arabia, the only country with surplus productive capacity, to do exactly that. Prime Minister Gordon Brown made the same demands. President Sarkozy repeated the request. All that was backed up by a few unfortunate utterances such as 'OPEC's behaviour is scandalous' (the UK PM and 'We should apply the blowtorch on OPEC' (the Australian PM).

These governments did not seem to realise (or did not want to) that OPEC's role as the oil price administrator in international trade has ceased to be exercised since 1986. The 'cartel' label pinned on OPEC long ago is still there. And the simplistic view is that a rise in oil prices must mean that demand for physical oil *today* is greater than presently available supplies.

The reference prices for oil in international trade (WTI and Brent) are determined in futures oil markets in New York and London. OPEC adopts a production policy when oil prices are low and threatening to fall even lower. This happened in 1998 and early 1999; and even at that time the market response to OPEC's policy involved a very long time lag of 12 to 15 months. Prices continued to fall as output was being cut.

Another attempt was made in late 2006 when the oil price fell from about $75 per barrel (July 2006) to about $50 per barrel (January 2007). This was more successful in stopping the decline. When oil prices are high producers do not restrict output. They sell the quantities demanded by their customers, subject to capacity constraints.

It is important to realise that OPEC was established to defend the economic interests of its Member Countries. It is not well equipped to induce a fall in prices when these are considered to be too high. The reasons are twofold. First, Members are more likely to unanimously agree that some action is needed when prices are low or rapidly falling to low levels. When oil prices are high several Members would refuse to take any action as they are enjoying the higher revenues for so long as they continue to accrue. Secondly, announcing an increase in output when prices are high may cause a greater fall in price than intended. The responses of futures markets to an intended increase in oil production is impossible to predict. Oil prices cannot be steered smoothly toward a preferred level through the use of an OPEC production policy. Fine tuning is not the characteristic of this policy. OPEC Member Countries will be reluctant legitimately to introduce a policy which could induce a falling price spiral.

Those who in recent months requested OPEC, or more precisely Saudi Arabia, to produce more did not seem to realise that the current oil market was not short of crude oil. There was evidence that Iran was unable to sell the whole volume of its planned production and stored the excess in big tankers with the aim of selling this oil on a spot basis in the Mediterranean and elsewhere. Saudi Arabia noted that many Western oil companies were nominating smaller volumes than specified in their long-term evergreen contracts. Furthermore the term structure of futures oil prices displayed a contango, a phenomenon usually interpreted as a sign of excess supplies at the front end of the market.

To be sure, the supply/demand balances for different varieties of crude oil (for simplicity, say, heavy and light) is not uniform. There is excess supply for heavy varieties and excess demand for light/sweet crudes. But to ask OPEC to produce more oil is irrelevant when the output of the variety demanded by refiners cannot be increased.

Oil Subsidies in Developing Countries

Another approach favoured by some OECD governments was to advise developing countries to remove, or at least reduce, subsidies for petroleum products, gas and electricity in the domestic markets. Some countries have reduced, or indeed removed, all subsidies. Others are worried that such a move will have political implications for the stability of the regime. It is evident that the high oil prices are increasing the budgetary burden of subsidies. It is also evident that lower subsidies will reduce energy consumption after a time lag. Reducing subsidies may be achieved with a minimum of negative side effects if appropriate measures are introduced to alleviate energy poverty and distortions in the structure of the domestic fuel markets and industries are identified and at least partially removed. All that, however, may prove to be beyond the administrative capabilities of some developing countries. Furthermore, powerful vested interests may stand on the way to reforms.

The symmetrical policy to the reduction of subsidies in developing countries is increases in excise taxes on petroleum products in the USA. In international meetings held in Asia

on the subsidy issue nobody, to my knowledge (or perhaps this was not reported or publicised), has demanded that the quid pro quo was increased taxation in the USA. The USA would argue that this is politically difficult, nay impossible. Could we say that what is not good for the goose is not good for the gander?

The Blame Game

No solution to a serious problem can be found by playing the blame game. To blame OPEC or the subsidisation of energy in developing countries will not address the oil price problem where it really lies. Certainly, co-operation with OPEC will be necessary in the search for a solution and for implementing some non-conflictual policies. Co-operation between developed and developing countries will also prove to be essential. Yet, the first stage is to identify correctly the problems, freeing oneself from prejudices, simplistic notions that are more in the nature of buzz words than analytical concepts, and from the tenets of a conventional wisdom rarely subjected to tough critical evaluation.

The Current Oil Price Regime

It stands to reason that an investigation of the causes of a given price movement must begin where prices are actually formed.

In the current oil price regime reference prices for crude oil exports in the Western Hemisphere (referred to in the past as the West of Suez oil trade) are generated in the futures markets of New York (NYMEX) and London (ICE Futures). The reference crudes are respectively labelled WTI and Brent. Oil exports to Asia (East of Suez) are priced according to formulas that take reference prices from a Platts' assessment of Dubai and Oman prices. But the behaviour of these prices is influenced by movements in the Brent price.

Futures markets deal with a financial instrument which is a contract to buy or sell 1000 barrels at a future date (the date at which the contract expires). The NYMEX contract is physically deliverable at the expiry date in Cushing Oklahoma; the Brent contract is cash settled. The relevant question is: to which extent are these futures markets fundamentally oil markets?

Of course, oil news induces price responses. But much depends on how news is interpreted. Traders, and indeed nobody else, have exact information about the actual supply/demand situation at the moment of the bid. There are perceptions and expectations that move their 'animal spirits'. Some argue that spot markets, not the futures markets, are the locus of price determination. I believe, however, that spot and futures prices are co-determined for the simple reason that any entity wishing to bid in the spot market will look at the ruling futures price at that moment; and vice-versa anybody trading on a futures market will keep an eye on spot prices. And as there is a continual flow of futures prices data and on only intermittent spot transactions it stands to reason that futures lead. The claim made by the officers of the NYMEX that only the spot matters is not credible.

The futures markets where reference prices are determined are part of a wide set of other oil derivatives such as options of different types, contracts for differences etc. and commodity indices. All these are also financial instruments transacted over the counter (OTC) sometimes on the basis of contracts specifically negotiated for a particular deal. The difficult is in commodity indices and the futures prices that emerge on the NYMEX or the ICE Futures exchange. The objectives, behaviour of traders and the techniques used do differ depending on the nature of the transaction entered upon. And the question is whether all this can be neutral in its effect on the oil futures prices.

The oil futures markets are also part of a set of financial markets for other commodities, equities, bonds, foreign exchange, carbon, the weather and so on. Some of those who trade on the oil futures markets hold portfolios of contracts from other markets. A rational objective is to try to optimise the performance of this portfolio. This is not inconsistent with the fact that some Chinese walls are erected around every specific trading activity. Strategic objectives can still be set, deciding for example to lower (or increase) the allocation for a given market in order to increase (or lower) the allocation to oil. What matters then is the expected relative profitability of different financial markets. A non-oil factor can therefore influence oil price formation.

The futures oil market is not cartelised but there is effective leadership. And because it is essentially a financial market the leadership resides with financial institutions. Their views and especially forecasts expressed in newsletters, reports, interviews or conferences influence price behaviour particularly if the prediction track record turns out to be good. There is some feedback between a prediction that the market considered to be credible (on the grounds that it is uttered by an institution considered by a majority to have superior knowledge or that it is a recognised leader) and the price outcome. If a bullish (or bearish) mood prevails after a prediction prices will undoubtedly rise (or fall) accordingly.

But what are the motivations of perceived leaders?

The most important fact is that futures markets have a tendency to overshoot. This point was brilliantly made by the late Professor Rudiger Dornbush in an article on exchange rates 'Expectations and Exchange Rates Dynamics' *Journal of Political Economics,* December 1976. There is overshooting because the futures market reacts very quickly to news (that may be true or false) while the real world takes much longer to adjust (or to dismiss the wrong expectations).

Those who have tried to attribute the price rise to the futures market have not yet pinpointed where the problem lies. They talk loosely of 'speculation' a term that has different meanings and which is used without specifying its definition. Some use it as synonymous to manipulation. But why not simply use 'manipulation' if this is what is meant? Some seem to imply that speculation is an immoral activity; others that it is irrational. Speculation is also used as shorthand for the motivation of those who trade in financial markets. And there is a technical meaning to speculation, not often mentioned. The speculator is somebody who takes the other side of a deal sought by a hedger. Without it there is no market.

And those who want to distract attention away from a necessary look at the current oil price regime will tell us *ad*

nauseam that the fundamentals of supply and demand explain on their own the price behaviour. There is no speculation.

Of course, supply and demand are of fundamental importance. But they are not the only factor. The futures markets and its acolytes (options, OTCs, commodity indices) are not neutral mechanisms.

Alternatives to the Current Oil Price Regime

The issue is whether the current price regime for oil in international trade is an appropriate one. Nobody questions it because the vested interests in maintaining it are extremely powerful. Banks and hedge funds are wedded to it. Some of the major oil companies have trading arms that operate in these derivative markets like financial institutions. Their trading profits are substantial. OPEC accepted it because they thought that it would protect them from blame. It didn't.

And the question always asked is: What is the alternative?

I will simply say that no alternative will ever be found if nobody is looking for one.

Now the situation has changed. OECD governments have come to realise that oil price movements of the type recently witnessed have adverse macro- and micro-economic effects. Many oil-exporting countries are receiving happily the manna that is falling from heaven on their treasuries. But some of them, particularly Saudi Arabia, worry about the international political pressures put on them.

Oil is too important to the world economy for its international price to be left to financial markets that have an inherent tendency to over- or under-shoot. Ideally, every price should be set by markets where supply and demand directly interact. But all markets are not perfect; and those that have a significant impact on the national or the international economy are often regulated. Government intervention plays a role.

We do not have an appropriate oil market for the purpose of price determination. Spot markets are too narrow and some have acquired a bad reputation as the result of squeezes and manipulations. There is no market where auctions take place. There is no close interface between producers and users in the futures markets. There is no crude that has the properties required of a credible international marker or reference.

All of this involves a gap that needs to be bridged by governments.

If oil was a national commodity and its price specific to the national economy, like interest rates, an alternative regime could be designed on the same lines as exist in the UK (Bank of England), Europe or the Fed in the USA for the determination of interest rates. But oil is international. International co-operation is necessary.

A new oil price regime would involve an agreement between large importers and exporters to establish a system of price administration consisting of a Committee that considers data about supplies, demand, futures prices, prices emerging in an enlarged spot market, the world economy and investment costs and then define a reference price at regular intervals. This has to be backed up by a physical capacity to intervene in the market when excess supplies or excess demand undermine the reference price. The intervention mechanism will involve an agreement between importing countries that possess sizeable strategic stocks, such as the USA and Japan, and countries that hold surplus production capacity such as Saudi Arabia and hopefully other exporting countries. Procedures about the mode of intervention and the maximum length of time during which it could operate willl need to be agreed in advance.

Such a system does not involve the abolition of futures markets. It does not involve the abolition of spot markets but restricts their role in the determination of the reference prices.

A political vision and much goodwill are required. If governments are unwilling to rise to the challenge we shall have to live with the side effects suffered by economies subjected to the shocks of an oil market where prices are exceedingly volatile and thus fail to provide reliable and consistent signals for investments in energy producing capacities.

The Oil–Climate Bargain: How Fuel Economy Standards May Help Global Climate Policies

Peter Fox-Penner and Matthew McCaffree

We stand at a crossroads in global energy policy. The world's largest energy consumers recognise the threats of climate change and the end of cheap, easily extracted oil. They have all expressed their intention to act, but the small steps they have taken amount to a dangerously slow *pas de deux*. On one side, the United States has resisted global climate change policies because they do little to address the increasing greenhouse gas (GHG) emissions from emerging markets. On the other, emerging market countries argue that limiting the growth of their energy-intensive industries is misdirected punishment that does not afford them the same leeway given to developed states.

Faster progress towards world energy goals will be made only with US leadership, which must begin with a change in domestic energy policies. The policies and politics of today's energy proposals are often vastly different for the USA's climate and energy security objectives. Limits on carbon emissions are seen as economy-wide measures that primarily affect the electric power and renewable energy industries, with secondary impacts on oil and gas users. Oil security policies have little impact on power and renewables, but greatly affect the automobile and petroleum sectors.

The traditional divide between climate and oil security policies is obscuring an important link that oil demand

reduction policies can make between domestic and global action in both major policy arenas. In fact, stronger fuel economy policies have a positive feedback effect on global climate policies. Increasing fleet fuel economy, as well as advancing plug-in hybrids and biofuel development, will reduce pressure on the world's limited, increasingly expensive oil supplies. This will be a boon to the quickly-developing, increasingly oil-dependent economies of Asia who are extremely cautious about placing firm limits on their own GHG emissions.

The case for leveraging the impact of oil reduction policies on climate goals relies on four sequential facts. First, a carbon cap-and-trade system or carbon taxes will have very little impact on US oil use and therefore on oil demand or prices. Second, the developing economies that are most hesitant towards carbon limits are becoming more dependent on oil, and far more sensitive to oil prices, than the developed world. Third, US policies that substantively address oil dependence will impact world oil prices because the USA is such a large user. Fourth, emerging nations will not agree to greenhouse gas policies without leading actions by the developed world – especially the USA. Putting these together, a possible north–south grand bargain materialises: reduce domestic oil use, reduce world oil prices, promote economic growth in the emerging economies, and in exchange ask developing countries to join the rest of the world in setting carbon limits.

Oil Demand and US National Security

Despite 30 years of strong rhetoric and occasional action, oil use in the USA continues to rise and geopolitical security continues to decline. More than 50 percent of its oil today is imported and will head towards 68 percent by 2030 if current trends continue.

In the USA the fleet-wide fuel economy is 17.2 miles per gallon (mpg) which has increased by only 12 percent in the last 20 years. The energy bill passed last December will increase CAFE standards to 35 mpg by 2020 and is projected to reduce daily gasoline use by an estimated 1.2 million barrels per day (mb/d). Greater fuel economy may increase the cost of vehicles slightly, but this will be offset by lower prices at the pump. But even with these measures, US oil demand is predicted to rise 10 percent by 2030.

Recent data show that demand growth is slowing in the USA, but is quickly offset by increasing demand in the Middle East, India and China. The landscape of the market is changing as well. Oil 'supermajors' no longer dominate the industry. Of the ten leading companies in terms of proven reserves, only one, Lukoil, is privately held. National oil companies control over 80 percent of the world hydrocarbon reserves today.

The financial windfall from the recent, unprecedented climb in oil prices is having a dramatic effect on geopolitics. Oil revenues have emboldened regimes such as Iran and Venezuela; though the geopolitical gains for them may prove marginal in the long run, resource competition with China and oil dividends in Russia could strain US relations with these two countries vital to future economic and political stability.

The Developing World's Oil Needs

Developing countries use carbon fuels for two activities vital to their development – power generation and personal transport. In India, about 52 percent of all households do not have electric power. Even fewer have access to a car, but companies like Tata Motors are trying to change that with the introduction of inexpensive, accessible sub-compacts.

The demand for new energy supplies in the developing world is staggering. Energy demand is projected to grow by more than 5 percent a year across virtually all countries (a bit less in the Middle East). To meet this need, the world will add the equivalent of just over 3500 power plants between now and 2030. More than half of these will be in China and eight out of ten will be in the developing world.

Oil demand growth is no less prodigious. China is expected to nearly double its oil use over this period and in the rest of Asia and the Middle East it is also growing rapidly. By comparison, the IEA expects oil demand to grow by 0.8 percent a year in the USA and 0.2 percent a year in Europe through 2030. A number of developing countries are also heavily import-dependent. India imports 70 percent of its oil. According to the *Financial Time*s, China imports 40 percent, and car ownership is rising at 25 percent a year. Demand growth in these two countries will nearly double from 10 mb/d to 20 by the year 2030. Furthermore, the Center for American Progress points out that 38 of the world's poorest countries are net oil importers, 25 of which are wholly reliant on imports for supply.

This vulnerability has induced many emerging economies to adopt stronger domestic oil-reducing policies. China has already enacted auto fuel economy limits that are 30 percent more stringent than in the USA. They have also mandated renewable energy resources, enacted strict new building standards, and are considering a law that will ban inefficient sport utility vehicles altogether and raise fuel economy to 35 mpg by 2015, five years ahead of the new CAFE standards in the USA. Though not very helpful to climate goals, they are also mounting massive efforts to make oil from coal (see box).

US Demand, Oil Prices and Emerging Economies

The USA uses a little over 20 mb/d of oil, or approximately one-quarter of global petroleum consumption. If it were to decrease its oil consumption 30 percent, that *reduction* would equal the oil used in Central and South America combined, or the oil used by China's more than one billion citizens.

Oil- and, more specifically, gasoline-saving policies can have a very large and direct impact on prices. Of every 100 gallons of crude, about 47 end up as refined gasoline, making it by far the most widely used single petroleum product. There are two ways to decrease the price of gasoline: increase supply or decrease demand. It is unlikely that any large sources of petroleum will be discovered that will solve supply problems for the near and long term, which means the only other method of driving down the price is to decrease demand. The government's recent increase in CAFE standards is a step in the right direction, but bolder measures are needed to both demonstrate America's leadership and offset rising

Unconventional Oil and Greenhouse Gases

Energy security first collides with global climate policies in the realm of 'unconventional' oils. These include oil-bearing shales, tar sands, orimulsion, and several methods of making oil out of coal and have become feasible alternatives to some as oil prices creep higher.

The energy needed to make unconventional oils gives them a terrible emissions footprint. Most of the processes for creating unconventional oil are proprietary and energy use is a carefully controlled fact. Estimates indicate that the amount of energy required for processing ranges from 19 to 28 percent of the energy produced, versus about 6 percent for lifting and refining oil. These are very crude indicators of the increase in greenhouse gases associated with heavy oils, but they suggest two to four times as much heat-trapping gas is released per unit of energy used.

Harmonising sound energy security and climate policies in this area will require a careful evaluation of the tradeoffs between unconventional oils and other energy security and climate alternatives. It is possible that the energy security benefits are so large that the greenhouse gas increases from these sources should be accommodated by saving more GHGs elsewhere. It is more likely, though, that the converse is true: there are better alternatives for saving oil which do not contribute nearly as much to global climate threats.

demand for oil in emerging market economies.

Lower oil prices will carry even greater benefits for the economies of emerging nations. Their vulnerability to high oil prices is far larger than price-driven economic threats to the US economy. IEA Chief Economist Fatih Birol found that the negative growth impacts of higher oil prices are nearly three times as strong for Asian countries, and ten times as large for the countries of Southern Africa, as they are for the USA.

The recent oil price spike has created one of the largest barriers to development for countries that have no petroleum resources of their own. There are 28 African states – most designated as least developed countries (LDCs) by the United Nations – that spend more than 10 percent of their import budget on oil. That figure alone is striking, but is exclusive of the effect oil prices have on food, trade and necessary materials. Graeme Wheeler, Managing Director of the World Bank, recently pointed to the 'cruel irony' that connects oil and food prices. 'Higher energy prices have increased fertilizer and transport costs and stimulated bio-fuel production. Together, higher energy prices, drought, and rising demand have led to a 75 percent increase in the price of [food] staples since 2005.' Without a demand-side solution to higher oil prices, both production and output in oil-importing LDCs will drop, and those with the fewest resources will find it even harder to extract themselves from poverty.

Emerging Markets, Increasing Emissions

Turning from oil to climate, we immediately confront the fact that the emerging economies are rapidly becoming major sources of the heat-trapping gases responsible for global climate change. By some estimates, China has now passed the USA to become the world's largest GHG emitter. Within just five years, emissions from the entire developing world will become larger than those from the USA, Europe, and Japan combined. According to US government projections, the *change* in China's emissions from now to 2030 will equal nearly one-fourth of the world's emissions in that year – over 7 billion tonnes of CO_2 – with India contributing another 2 billion tonnes.

We will not stabilise the world's climate until all heat-trapping gas emissions are reduced. The importance of including all nations within global limits was emphasised in the UK Government's landmark study, the Stern Review. Stern posits that the industrialised world reduces its emissions to 60 percent below 1990 levels by 2050, requiring policies much stronger than have ever been seriously debated, much less adopted, in most of the world. The required reductions from developing countries get much larger if the stabilisation goal drops from 550ppm CO_2e to a much safer 500ppm. Developing countries will then have to reduce emissions by more than one-third of their 1990 levels.

The world must call on developing countries to reverse their fast-growing carbon emissions, yet among these are the nations of the world with the lowest levels of income, the least fiscal wherewithal, and the least-developed markets and policy institutions. Without their rapid cooperation and ultimate success, we cannot stop a global climate meltdown.

Developed Countries Go First?

Much of the international community, and certainly most developing countries, believes that the problem of climate change was largely brought on by advanced industrialised nations. Several calculations have estimated that over 66 percent of the accumulation of GHGs in the atmosphere since the 1800s were emitted by the developed countries. While developing countries are adding rapidly to the greenhouse gas burden, the West can fairly be seen as the originator of the problem.

At the same time, the sad fact is that climate change is expected to impact developing countries much more strongly than the rest of the world. The least developed nations have large populations that are poorly protected from natural disasters, often living at or near subsistence levels. When severe storms, drought, or rising sea levels hit these nations, the effects are deadly and tragic. Thus leaders of the developing world must choose between near-term growth with higher emissions and slower growth with greater long-term climate tragedies. The economic tradeoffs are not unique to developing countries, but the stakes in human life, health, and suffering are much higher for them. In any nation, it takes a courageous and secure leader to put long-term security over near-term economic gains. Yet this is precisely what it will take to get a domestic political mandate for substantive climate limits in a developing nation.

Recognising the sacrifices involved, many speakers have called for industrialised countries to adopt binding GHG limits first. They see this as a matter of equity in two senses.

First, since the industrialised countries are (so far) more responsible for the problem, it is fair that they act first to address it. Second, because the ability to emit greenhouse gases is so closely linked to development, it is equitable that the developed nations not use GHG limits to effectively foreclose economic advancement in the rest of the world.

The unwillingness of developing countries to agree to binding cuts has not been viewed favourably in the USA. The opponents of a binding US policy, including some industries operating in global markets, believe they will be placed at a competitive disadvantage if US firms must live within GHG limits (which indisputably raise energy prices) and firms in developing nations do not. In 1997, opposition to unilateral US climate action was so strong that the Senate enacted a resolution opposing it by a vote of 95 to zero.

This quasi-stalemate could substantially improve if the USA and other industrialised nations offered enough aid in traditional forms to gain the full participation of the developing world. However admirable an attempt this may be, it is unrealistic. The US government's balance sheet is in poor shape to become a major climate and development banker to the world. But there's a much better way to break the standoff – a mutually helpful strategy that starts with much more aggressive US policies to reduce its oil use. We call it the *oil–climate bargain.*

The Oil–Climate Bargain

If the developing world needs to 'go first' on reducing its emissions, one of the best areas for the USA is via its oil use. It would gain all the critical national security benefits of reduced oil dependence, benefits that are more than worth the political effort all by themselves. And if reductions in oil use induce the developing world to cooperate more strongly in the areas of climate change that are accessible and relatively cheap to address – especially coal-fired power – it is a worthwhile trade to leave their transport sectors out of the emissions debate.

In short, the bargain works like this. The USA adopts policies that reduce its oil use, lowering the future path of oil prices and taking pressure off the world's increasingly concentrated supplies. In turn, developing nations that will need oil more urgently agree to make stronger efforts to reduce overall emissions.

This bargain is a win–win arrangement among all participating countries. The USA reduces its outflow of wealth to oil producers and accelerates its transition to a post-oil economy. Its present oil-intensive transport sector is traded for a more efficient and exportable technology base. While the necessary policies will require a serious domestic effort, the true cost of achieving them – political as well as economic – is surprisingly small.

The rest of the world benefits as well. With an effective worldwide greenhouse effort, we can reduce the scope of natural catastrophes on the most vulnerable nations and populations. Developing countries will get their oil cheaper as demand slows in the United States. Lower prices will be a particular boon to economies that are dependent on oil for heating, electricity, or rapidly expanding transportation sectors.

The Geopolitical Gains

The geopolitical advantages of the oil–climate bargain go beyond the pure reductions in oil prices and greenhouse emissions. When implemented, this approach would create a new dimension of cooperation between the oil-consuming nations of the world. The bargain acts to jointly reduce their oil-related costs, reduce each of their national security threats, and improve their environment. It shifts the oil rivalry between the USA and emerging powers such as China and India on to a footing of mutual cooperation and support.

Conclusion

The United States needs an energy policy that:

- Draws consuming nations closer together rather than intensifying the rivalry for dwindling oil;
- Rapidly and assuredly reduces the threat of major climate disruptions;
- Strengthens national security by reducing oil use and reducing the geopolitical leverage and market power of oil producers; and
- Improves its economy and competitiveness, especially in the long run.

Only one strategy does all this – aggressive domestic oil reductions through higher fuel economy standards and other policies, coupled with a push for a strong global climate framework involving all nations. Climate policies alone will exacerbate US geopolitical vulnerability by increasing the rivalry between it and the developing world for ever more expensive oil and natural gas. It will be far more costly to induce the developing world's participation in a climate agreement by providing direct funding, raised from US taxpayers, for technology transfer. Funding will make the developing countries' economies more efficient, but it will do little for that of the United States.

The continuing energy policy debate surrounding legislation in the Congress needs to address more than CAFE standards. Biofuels promotion, research and development, and the encouragement of smart growth and transport alternatives are represented in the bills presently under consideration on Capitol Hill. These measures each have roles to play, but no oil-saving measure will come close to having the impact of aggressive fuel economy standards.

Oil plays a pivotal role at the intersection of North and South, climate and energy security, and energy market economics. Every barrel of oil we choose not to use reduces our own geostrategic and economic burden, but also helps the developing world afford its own critical reliance on oil for development. As we take pressure off the global supply and price of oil, the goodwill and growth potential conveyed to emerging countries can and should be used to address the greatest environmental challenge of our time: the global climate challenge.

The views in this article are those of the authors and do not represent the views of any other individuals or organisations.

Personal Commentary

Mark Moody-Stuart

In the many shocks and turning points in the upstream oil and gas industry over recent decades, the dominant teams, and the playing fields or leagues in which they compete, have changed. Technology has changed too – the equivalent of new racquets or clubs which give a temporary advantage to those who have them. Each change results in a market reaction, with sometimes unexpected consequences. The objective has remained the same throughout – finding and producing hydrocarbons in the most commercially competitive and environmentally sensitive way. Technology has always been central to this. The overlay of climate change concerns adds to the challenge of meeting the world's energy needs and increases complexity.

With 'participation' and sometimes '100 percent participation' of national governments in the seventies, the major oil companies saw their playing field severely reduced. Yet because of their technology, they retained a key role in most areas. It is only now, some thirty years later, that the development and application of sophisticated technology by the best National Oil Companies (NOCs) and the ability of others to access first rate technology through the Service Companies (SCs) is genuinely squeezing the majors out of some arenas. At the same time, the radically increased prices of the seventies, coupled with the closing off of outlets for the technology and capital of the majors, led to the growth of the frontier areas of the North Sea and Alaska. There is no doubt that projects in these areas were saved from the economic consequences of catastrophic project cost over-runs by the increased oil prices. It all sounds a bit familiar.

I have spent much of my life in a major oil company, and am currently working in the not dissimilar world of mining. I used to say that mining was a similar industry to oil and gas but with lower margins and smaller companies; that is less true now. I also have the honour of serving on the board of Saudi Aramco and my son has worked for Schlumberger for almost twenty years – never, I hasten to add, supplying services to Shell during my time. He is currently with Schlumberger bidding to Pemex for 'integrated projects'. So I have the pleasure of viewing the players in the industry from different angles and with multiple loyalties and interests, if not impartiality.

In the late eighties and early nineties, we had a concern in Shell that Schlumberger – our biggest service company supplier – would work with a financial institution to provide field development services to a NOC, thus dis-intermediating the International Oil Companies (IOCs). In discussions at the time Euan Baird of Schlumberger always insisted that there was a clear line of equity participation and risk bearing that they would not cross. In the mean time it has been remarkably successful in building a business in Russia. This is based on growing companies with Russian partners which deliver integrated services in ways that appear more acceptable than the traditional approaches of some of the majors. In Mexico, Schlumberger has a strong position delivering integrated services in a way that addresses Mexican constitutional sensitivities. Andrew Gould still states that there is a clear dividing line of equity and risk which will not be crossed. But ever since production sharing contracts were invented to address political sensitivities relating to 'ownership' of the oil, the IOCs have been pretty flexible about 'equity' and 'reserves' and the boundary has been blurring. Equally, it was blurred in the early nineties when a Shell/service company joint venture did deals with Russian/Soviet production units rewarded on the basis of incremental production from fraccing wells, and by Total and Shell field development contracts with NIOC in Iran. Why should we expect the boundaries not to blur? We are after all playing the same game.

So what are the current strengths and weaknesses of the players?

The IOCs have access to technology developed over the years, even though short-sighted cut backs in research and development spending has meant that the Service Companies have in some cases and some fields surpassed IOCs technologically. Second, the IOCs have access to masses of long-term field performance data and field analogue examples so that their reservoir models – one key to increasing recovery – are potentially better, always assuming that they have been prepared to put the necessary resources into their development. Third, the IOCs have access to current reserves and one important source of global reserve growth is increasing recovery factors through technology. For this reason it seems a strange strategy for majors to be shedding late life fields (and thus un-recovered hydrocarbons) to independents, on the grounds that these operations just need low cost stripping, too small for a major to be concerned with. But these are the very sources of potentially increased recovery. If the majors abandon a resource, it will be tapped by independents using best available Service Company technology. The learning from this will in turn only strengthen the SCs. I think the approach needs careful examination – after all they are not making this stuff anymore.

The SCs have excellent technology. In the early days much of this was developed in open collaboration with the majors, who bore the field costs of the experimentation. We have already seen majors taking a more commercial approach to the intellectual property of developments – for example in expandable casing – and this is likely to become more common. The open collaborative development is likely to continue between the SCs and the NOCs. The latter have much to gain from technology development and increased recovery, and little to fear from competition, as they are operating in what is often a reserved area. This will further strengthen the technological hand of the SCs (and the NOCs). The SCs do not have large capital resources.

But is this a disadvantage? Which company would not prefer a technology driven capital light model to a capital heavy one? Furthermore, any good idea will be able to attract capital (or a partner with capital) from somewhere else, so this merely requires a business model with appropriate remuneration for the technology input. The SCs have one further advantage – they are not perceived as a threat to the NOCs, and in many cases through long and continuous presence in countries have built up cadres of outstanding staff with sensitive relationships to their national clients. In the best cases they have distributed training centres and research centres in areas with the most important reserves, further strengthening relationships.

So what of the NOCs? They have the supreme advantage that many of them have privileged access to reserves. This means that their knowledge of their own resources is potentially unique. In the case of leaders such as Saudi Aramco, their reservoir models of these fields are probably more powerful and well populated than anything that the IOCs have. They have benefited from focus. And what of capital? At present oil prices, provided their own governments do not starve the goose laying the golden eggs, they have adequate access to capital. Unfortunately, starving your own goose is a very common habit of host governments, along with the mistake of treating its employees as government servants. Unlike government servants who have by definition only one possible employer, NOC staff are potentially highly mobile in a global and meritocratic industry with a shortage of skills. The NOC shortage of capital can be addressed by opening up the industry to the private sector, national and international. But I believe shortage of capital is not the only reason to do this. Although the best NOCs are now as good, or better, than some or even most IOCs, competition and benchmarking clearly sharpen up performance. No company leads in all areas, and the fastest way to address this is through benchmarking and competition. But if as a nation you let the private sector into your oil patch, it is only reasonable to let your NOC go overseas. This has been done successfully by Statoil and Petronas among others. This also contributes to motivation and retention (in country if not in the NOC).

So what conclusions can we draw?

Technology is a fundamental differentiator, and technology which increases recovery is crucial.

Technology is not the preserve of any one player – it is developed where effort is applied to the sources of learning available, whether these are your 'own' fields observed over years or through work you do for others. But equally demonstrable technical success in operation, including contracting the work of others, may be worth more than theoretical intellectual property.

Given the reserves that can be added through using technology to increase hydrocarbon recovery factors, the common abandonment by majors of their late stage fields to independents and service companies does not necessarily seem wise.

Access to capital is probably not a determining factor, for flexibility and performance capital can probably be acquired, through partnership or other means. We will see more different combinations of NOC/IOC/SC with or without external financing. Apart from technology, the ability to put together and staff appropriately deals which are crafted to take into account the sensitivities of resource holders or perhaps address a key recovery improvement challenge will be a second determinant.

We should probably all relax about who is moving onto whose pitch (or trying to keep people off our pitch). The boundaries will shift when there is a market reason for them to do so – in the mean time the key is technical and operational excellence.

I have not mentioned one other big difference between the players – the IOCs are generally integrated all the way to the market. This makes a difference and will probably also lead to differentiation in the response – technological and otherwise – to the challenge of climate change and energy supply. But it would need another article to explore this aspect, and discuss whether or not it is critical.

Asinus Muses

The multi-species university

Some places are now so liberal that members of different species study at the same universities as humans – a trend speeded up not only by the chronic skilled-labour shortage but also after both chimpanzees and crows were shown to be superior to humans in computer-related intelligence tests. I myself am now a graduate student in the Energy Studies faculty of the multi-species University of Higher California. Since you ask, my doctorate subject is 'Species difference and thermal over-compensation: a contribution to the study of species-specific contributions to global warming'. My supervisor happens to be a porpoise.

Thermal overcompensation:blowing hot and cold

Thermal compensation means using energy to change the temperature inside residences compared with outside. Residences of asses, polar bears or albatrosses are neither heated nor cooled so their level of thermal compensation is zero. Humans, however, especially the 'civilised' ones who have houses with windows and doors, use oodles of energy to counteract the natural temperature. As the outside temperature falls or rises central heating or air conditioning warms or cools interiors. Maintaining a constant indoor temperature is called 'neutral compensation'. My thesis emphasises cases when the indoor temperature in the summer is kept far below the outside temperature, and can be even lower than the indoor temperature in winter and vice versa (a situation known as 'absolute over-compensation').

STOP

Out of this concept comes the STOP (the Supress Thermal Overcompensation Proposal). This would work by fitting all houses with a 'fiscal thermostat', which automatically transfers money between your bank account and the tax authorities according to the rise and fall of the temperature of your house in relation to temperatures outside. Those who sweat it out on the hot days or sit huddled in llama wool blankets on cold days receive rebates and get richer while those who swan around in their scanties on cold days will pay tax and get poorer. The TCB (Thermal Compensation Board) will decide on the rates of tax and rebate, like the MPC of the BoE. Absolute overcompensation would be prohibitively taxed.

The dialectic of hot–cold and fat–thin

This relates to a new strand in the global warming debate. Two researchers at the all-human London School of Hygiene and Tropical Medicine recently claimed that fat people contribute to global warming, and so (from their website) 'fewer obese people … would reduce global demand for both fuel and food' (Wow, so would a nuclear war). This staggeringly thoughtless form of words was criticised by a distinguished obesity scholar, the director of (mono-species) Yale University's Rudd Center for Food Policy and Obesity: 'saying that obese people are contributing to climate change is highly stigmatizing and assigns blame to the individuals who are obese rather than the conditions driving the obesity in the first place' – what you might call soft on fat but tough on the causes of fat.

Maybe thin people cause global warming

All very well, but what's wrong is the original argument that it is fat people who are melting the glaciers. Fats, the experts say, consume 18 percent more calories than thins. Well, that depends on the time period. Doctors (including some from the illustrious School of Hygeine and Tropical Medicine) say that fat people live less than thin people. Well, they aren't eating calories when they are dead, are they? They may, it is true, give off, a little extra CO_2 at the crematorium or in the graveyard. But they may actually eat less calories over their lifetimes than thin people. Anyway, if they get thin and fail to die they will add to the consumption of the existing thins, won't they? In developed countries, at least, thin people tend to have diets (fillet steaks etc.) which are far more land- and other resource-intensive than those of fat people. So could it be not fat but thin people who are causing global warming?

Obesity, insulation and compensation

My thesis clinches the issue. Fats are more resistant to cold than thins because, like many animals, they are better insulated and they are less likely to overheat interiors in winter, which is the root of thermal overcompensation. In addition, it is not fats but thins who want to wander round the house in winter showing off expensive diaphanous negligées and designer boxer shorts. Fats shuffle around in ex-army sweaters, 5XL T-shirts and old jogging pants. So the warming effects of all the resources used to produce what thins consume must be considered when deciding scientifically who is causing more global warming.

Motto for our time

I am proud that my thesis has a role in settling an important scientific debate. My examiners, I hope, will see it as an expression of our Energy Faculty's motto, engraved above the entrance to one of its stable/laboratories: 'You can fuel all of the people some of the time; you can even fuel some of the people all of the time; but you can't fuel all of the people all of the time'.

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