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The Copenhagen Summit on Climate Change is probably the most important environmental event of recent years. The potential impact on energy would have been very significant had a good accord been reached.

Not surprisingly, Copenhagen elicited very different reactions. A senior oil minister of an exporting country recently assessed it as a huge waste of time and missed opportunities. The authors of the two articles in this issue of *Forum* hold different opinions. Benito Müller argues that the final verdict 'will depend on what happens next'. It was 'the lack of political will and leadership' in the period leading to the Conference that prevented the relevant parties from engaging in meaningful negotiations. The positive feature is that its failure may serve as a wake-up call inducing leaders to realise that nothing will be achieved unless they exercise collective leadership.

A more upbeat assessment is provided by Marianne Haug. Recognising that she holds a minority position, Haug argues that Copenhagen is a positive milestone, a condition for sustainable progress on the complex climate change issues. Like Müller, however, she sees it as a wake-up call. Copenhagen was a reality check, bringing to an end a long period of 'wishful thinking'. She wonders whether the UN, despite invaluable features of its work, is the right forum for climate change decision-making. She sees European leadership as absolutely vital, and does not agree with commentators who saw a failure of that leadership.

In previous issues of *Forum* we had debates on wind and solar power. But the most significant potential threat to oil in the long run is the development and wide penetration of the electric car. The second theme in this issue of *Forum* is therefore the electric vehicle.

David Robinson addressing the future of the electric car puts his faith in the need to de-carbonise the transport sector, a need that is bound to arise in 10 or 20 years time if carbon targets are to be satisfied. There are problems and challenges however. Robinson recalls that the first cars were electric. Their demise was due to high costs and 'limited appeal' to customers. These are the very problems that affect the future of the electric car today. The benefits of these vehicles

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as regards carbon emissions are obvious although the problem will shift from the transport to the power generation sector. However, this will make it easier to control emissions. One challenge is that the fixed costs of these new cars may not be smaller than the potential fuel savings accruing through the life of the car and discounted to the present. And consumers may prefer the internal combustion car for its flexibility and other performance features and be prepared to pay for these qualities. The electric car will need political support in the form of fiscal incentives, as well as agreement between OECD and developing countries to help its penetration in the third world, where the growth of car ownership will be faster.

Another, more technical, study is presented by François Badin. It shows that the electrification of the vehicle engine provides a number of functions that can reduce energy consumption. Today's cars involve several functions related to comfort, safety and communication. These lead to an increase in the number of actuators and in the power of the on-board network. The idea developed in some detail is to use for these functions the electrical energy in the vehicles' propulsion system.

Three articles address each an important energy issue. Bassam Fattouh examines the vexed issue of oil demand dynamics; Robert Mabro revisits the oil peak argument; and Edgar Jones assesses the implications for investments of oil prices moving through the animal spirits of traders.

Fattouh is challenging a widely accepted view about global demand continuing to rise on a high growth path. The implication is that the world oil market will become increasingly tight, and this expectation pulls current oil prices up. In a futures market expectations about prices rising in the future influence the determination of current prices. Fattouh argues that the relevant economic agents should factor into their views the possibility of 'events' that may cause a different demand development. Will a demand peak emerge before the dreaded supply peak?

This issue of peak oil is discussed once again by Robert Mabro. He proposes a conceptual distinction between an ultimate peak that is irreversible, and oil production peaks that arise because of temporary factors such as an investment deficiency, failure to use available techniques to increase oil recovery rates from producing fields, or political factors that deny access of oil companies to countries holding undiscovered or badly developed reserves. His view is that we may face a sequence of such reversible temporary peaks. Yet, because of response lags these may have costly consequences until remedies are found and implemented.

Finally, Edgar Jones notes that oil is no longer a straightforward commodity but is increasingly behaving like a financial asset. The risk is increased volatility and the emergence of instances of 'irrational exuberance'. Predicting price movements in the short term is almost impossible because of this volatility. Investment decisions must focus on the long run and ignore short-term price movements, since oil and gas projects take years to be completed. What matters is the state of long-term supply and demand fundamentals. The difficulty, however, is that the uncertainties are so significant that the vision is always blurred.

Contributors to this issue

François Badin is at the Institut Français du Pétrole (IFP) Direction Technique d'Applications Energetiques in Lyon

Bassam Fattouh is the Director of the Oil and Middle East projects and Schlumberger Fellow at OIES

Marianne Haug is Chair of the Advisory Group on Energy at the European Commission and teaches at the University of Hohenheim

Edgar Jones is Financial Comptroler in Statoil-Norks Hydro in Houston

Robert Mabro is Emeritus Fellow of St Antony's College, University of Oxford

Benito Müller is Director of Energy and Environment at OIES

David Robinson is Senior Research Fellow at OIES and Principal of the Brattle Group

Copenhagen: A Partial or a Significant Success?

Benito Müller argues that the lack of world leadership was the single most important reason for the way events turned out

I used to say that summits are either 'successful' or 'very successful'. The time has come to face the facts: I was wrong! That is not to say that Copenhagen was a failure, but merely that it could have done better but probably passed. The final verdict will depend on what happens next.

Copenhagen and the Accord

The main outcome of the summit, which was held in parallel to the Copenhagen Climate Change Conference and attended by over 110 heads of government and state, was the 'Copenhagen Accord.' It was drafted in the final 24 hours of the conference by 25 leaders convened by the Danish Prime Minister as 'Friends of the Chair.' The Accord contains twelve paragraphs in just over two pages. Its key provisions are:

- a recognition of the objective to reduce global emissions so as to hold the increase in global temperature below 2 degrees Celsius, and a commitment to take action to meet this objective consistent with science and on the basis of equity;
- the commitment by developed countries – Annex I Parties to the Convention – to implement individually or jointly the quantified economy-wide emissions targets for 2020, to be submitted to the UNFCCC for inclusion in the first of the Appendices by 31 January 2010;
- the fact that developing countries – non-Annex I Parties to the Convention – will implement mitigation actions, including those to be submitted to the UNFCCC for inclusion in the second of the Appendices by 31 January 2010;
- collective commitments by developed countries to (i) provide new and additional quick-start resources, approaching US$30 billion for the period 2010–12, and (ii) jointly mobilise US$100 billion dollars per annum by 2020.
- the establishment of (i) a High Level Panel to study the contribution of the potential sources of revenue, including alternative sources of finance, towards meeting this goal, (ii) a Copenhagen Green Climate Fund as an operating entity of the financial mechanism of the Convention, and (iii) a Technology Mechanism to accelerate technology development and transfer.

The drafting of these couple of pages was unorthodox, both on account of who drafted and the drafting procedure. Leaders rarely engage in drafting text. In fact, they rarely meet even bilaterally – let alone at a UN summit – without the certainty that an agreement has already been agreed for them to sign. To return home empty-handed is simply unthinkable. This is why there must have been a degree of panic when they arrived towards the end of the Conference, with no sign of an agreed outcome ready to be signed. The process of trying to avoid the unthinkable was frantic. Time was in very short supply – and unfortunately these constraints did leave their marks.

The text of the accord, for one, is poorly drafted. This is at least in part explicable by the time pressures and the fact that the key people involved were largely novices in drafting UN decisions. Time constraints also did not allow for establishing consensus outside the Friends of the Chair group, a fact which ultimately sealed the fate of the Accord: instead of being adopted by the Conference, it was merely 'taken note of.'

The 'Accord Process'

After the refusal of the Conference to adopt the Accord, two things began almost instantaneously: a mutual blame game, and attempts at portraying the Accord as the cornerstone of a new improved process outside the UN negotiations.

While it may help to vent frustrations and soothe bruised egos, the blame game that ensued – either between Parties or directed at the UN system in general – is singularly unhelpful, particularly if it is played out at the political level. What would be more fruitful is a modicum of self-critical reflection on what actually brought us to the absurd situation where world leaders found themselves drafting a text to avoid a failed summit. Why was there no agreed outcome by the time the leaders arrived?

> "leaders should recognise that in the months to come, they must give much higher political priority to the continuing UN negotiations"

It is all too tempting to blame negotiators and UN procedures. Yet the single most important reason for the events in Copenhagen is what happened before – namely, the lack of political will and leadership during the months leading up to the Conference to engage in real negotiations. The lesson that all attending leaders should take to heart after the Copenhagen Summit is that it is impossible – even for world leaders – to make up for months and months of wasted time in 24 hours, no matter how frantic they may be.

More importantly, the leaders should recognise that in the months to come, they must give much higher political priority to the continuing UN negotiations, if the inevitable endgame in December is to have at least a moderate chance of genuine success. The

world simply cannot afford another leader drafting exercise.

What of the Accord itself? There is no doubt that it could prove a stimulus to the UN negotiations. However, as mentioned earlier, there have also been fears that it might be used to form a 'coalition-of-the-willing' process in order to sideline the official UN negotiations. This would prove to be disastrous, particularly in light of the constant demand by developing countries for inclusiveness and transparency.

As it happens, the Joint Statement issued recently by the 'BASIC group' (Brazil, South Africa, India, China) after their meeting in New Delhi seems to have put an end to such aspirations. The Statement unequivocally endorses the primacy of the UN negotiations, and of the two-track negotiations under the Bali Action Plan in particular. As there is no (mitigation) regime without these four key countries, the idea of an independent 'Copenhagen Accord process' has been put to rest, at least as far as mitigation is concerned.

"it would be wise for everybody to follow the BASIC countries in recognising the primacy of the UN negotiations"

The situation may not be as clear-cut in the context of climate finance. The Accord's commitment to establishing a Copenhagen Green Climate Fund, for one, could – and should – be read as a political endorsement of the Climate Fund/Facility envisaged in the UN negotiations.

Yet, there may be a temptation to interpret it as a call for establishing a new fund with an existing financial institution such as the IMF or the World Bank. There are also worries that the High-level Panel of the Accord will be used to sideline the UN negotiations, particularly if its remit were to such a new fund under the aegis of one of the traditional 'existing institutions'. There must be no doubt that any such moves to undermine proposals established in the UN negotiations would lead to a widening of the existing chasm of distrust between developing and developed countries, something which would truly be counterproductive.

The Way Forward

The key to bringing the Copenhagen saga to a happy ending after all is first and foremost for the world's leaders to provide the leadership required to ensure that the UN negotiations proceed at a pace that will make the desired outcome in the December session in Mexico feasible. They need to give their negotiators the political guidance and mandate to actually negotiate, rather than procrastinate.

"Copenhagen will have redeemed itself if it has served as the final wake-up call for our collective leadership"

With respect to mitigation, it would be wise for everybody to follow the BASIC countries in recognising the primacy of the UN negotiations, and of the clear goalposts already agreed under the Bali Action Plan two years ago. Renewed attempts to change these goalposts are not productive. Compromises will have to be made by everybody, but in good faith they should not involve the fundamentals agreed by consensus (*sic!*) in Bali, such as the continuation of the Kyoto Protocol and the Bali Action Plan.

As concerns finance, it is important to separate the issue of quick-start funding and mid-term finance, particularly with respect to institutional arrangements. Undoubtedly, quick-start funding will have to be managed through existing entities. Equally, there can be little doubt that there are more 'existing entities' than just the Bretton Woods institutions. To avoid a further erosion of trust, it is crucial that a really significant share of the quick-start funds be channelled through the existing UN climate funds, in particular the Adaptation Fund and the Least Developed Country Fund.

At the same time, it has to be made crystal clear that the quick-start arrangements are without prejudice to the outcome of the UN negotiations, which must determine the post-2012 institutional arrangements for climate finance. Indeed, it should be made clear that the call for a Copenhagen Green Climate Fund is nothing more and nothing less than a high-level declaration of political support for the idea of a Climate Fund/Facility envisaged in the UN draft finance text.

The overarching lesson of what happened in Copenhagen, however, remains the need for real political leadership on the road to Mexico in December. Copenhagen will have redeemed itself if it has served as the final wake-up call for our collective leadership.

Marianne Haug is optimistic that Copenhagen will act as a wake-up call

I belong to the very few who see the outcome of the Copenhagen Climate Conference 2009 as a positive milestone – a conditio sine qua non for sustainable progress towards climate stabilisation.

Of course, it would have been wonderful to have an agreement with legally binding targets both from the present Annex I Parties to the Kyoto Protocol, the USA and the emerging

economies. The opposition of Cuba, Venezuela, Nigeria, Sudan, Bolivia and Tuvalu to even a watered down Copenhagen Accord and the mere 'taking note' of the Accord by 194 countries is a disappointment. This is hardly the end of the matter. The international community will continue talks on targets whether legally binding or not during the upcoming COP 16 in Mexico and, thereafter. Options to broaden the carbon market will be developed, including coordinated regional or national markets and additional sectoral approaches and technology transfer mechanisms will be explored.

"Copenhagen is a wake-up call. It brought an end to 'wishful thinking'"

Copenhagen is a wake-up call. It brought an end to 'wishful thinking'. The Conference presented us with a reality check. Visionary goals and stretch targets are wonderful tools for business, governments and community efforts to focus attention, prepare options and provide the necessary environment for policy making. But, do we have the luxury of mobilising the global community around inflated expectations and unattainable dreams? Should we fine-tune year after year structures, instruments or policy directions that lack agreement among crucial countries or are ineffective to tackle the immense climate challenge?

Dream Number One: The UN negotiating process is the appropriate decision making forum for effective climate mitigation and adaptation agreements and actions.

I admire the work of the UN, the IPCC and the many UN agencies active in the area of climate change. Without their relentless effort to gather together several times a year all stakeholders – from policy makers in small and large UN-member countries, to representatives from indigenous communities, NGOs and the private sector, the present broad-based climate consensus and call to action would have been unthinkable. The UNFCCC and the participants of annual COP and Preparatory Meetings have done their utmost to implement the Kyoto Protocol; to innovate and reach out and develop, inter alia, new mechanisms to reduce emissions from deforestation and forest degradation in developing countries such as the REDD and REDD plus, or new governance structures for climate financing in developing countries such as the Copenhagen Green Climate Fund. The give and take of these talks, the technical discussions of feasible options and priorities involving a wide range of stakeholders is invaluable. But, can we afford to allow procedural UN rules, customs and sensitivities to take precedence over effective problem solving and decision-making?

Dream Number Two: The basic tools and governance structure of the Kyoto Protocol will be carried over in a post-Kyoto agreement with increased Annex I country commitments including the USA and some meaningful commitments from the large GHG emitters among the emerging economies.

The Kyoto Protocol mechanisms together with the EU-ETS created a flourishing carbon market, a market price for CO_2. It encouraged sizable private sector investments in GHG reduction projects in developing countries. In 2008 alone, the project-based Clean Development Mechanism (CDM) and Joint Implementation (JI) transactions were valued at close to US$7 billion and will reduce 409 $MtCo_2eq$ per year.

The Kyoto Protocol architecture of GHG emission reduction requires a globally agreed emissions accounting framework with quantified constraints that are to be enforced under international law. Among the 187 countries that ratified the Kyoto Protocol, 38 accepted some GHG reductions targets, but only nine countries need to meet targets of more than 1 percent GHG reduction for the 1990–2012 period. Agreement was possible because so many countries needed to do nothing or very little – and, the enforceability remains elusive as the blatant example of Canada shows.

Nevertheless, the increased investment in developing countries, and the sheer putting in place and continuous improvement of the Kyoto Protocol mechanisms (CDM, JI, certificate trading) were immensely valuable. It has been an important learning experience for future carbon market developments.

Ideally, a Kyoto II Agreement needed both more ambitious targets and legally binding reduction commitments from the major GHG emitting countries. Neither the USA, nor China, nor India – countries that account together for about 50 percent of GHG emissions – have signalled any willingness to enter into legally binding reduction targets under a Kyoto type agreement. Does it make sense to remain fixated on a mechanism that will not be adopted by countries that matter? Is it time to explore other forms of commitments and focus more on GHG reducing technologies and investments?

"can we afford to allow procedural UN rules, customs and sensitivities to take precedence over effective problem solving and decision-making?"

Dream Number Three: Europe's leadership, its substantial GHG reduction targets, its functioning emission trading system, and its monetary commitments to climate financing for developing countries will catalyse a global agreement and convince the world to follow Europe's lead.

Europe's leadership has been and will be in the future, absolutely vital. The European policy makers, businesses, media and academic communities are pace setters in this race. Europe's consistent and sizable climate financing offers for developing countries resulted in the US$30 billion financing commitment for 2010–2012 and the Copenhagen Accord goal of mobilising US$100 billion per year by 2010. But, Europe accounts for

slightly less than 15 percent of global GHG emissions, at present. After the implementation of the 20-20-20 EU targets by 2020, its share will have dropped further. The major GHG emitting countries, in particular the United States and China, are keen to learn from Europe's experience with emissions trading and investments in clean technology. At the same time, they are intent on shaping new, global and regional agreements in light of their own domestic priorities.

"I would not be surprised, if Copenhagen goes down in the annals of history as the beginning of effective, global climate actions"

Thus, I do not agree with the many commentators who labelled Copenhagen 'a failure of European leadership'. The figures speak for themselves. If we are serious about climate stabilisation, building consensus among countries responsible for 80–90 percent of GHG emissions between now and 2050 must be our priority.

The Copenhagen Accord is a turning point. It provides a realistic basis for a new coalition on GHG mitigation and adaptation action. It is a big tent that invites, acknowledges and monitors actions from all participating countries. It includes a promise of substantial adaptation financing with priority given to the most vulnerable and affected countries – a long overdue refocusing of climate aid.

I would not be surprised, if Copenhagen goes down in the annals of history as the beginning of effective, global climate actions.

Global Oil Demand Dynamics: Rebalancing the Debate

Bassam Fattouh

The future fundamentals of the oil market cannot be more uncertain. On the one hand, many analysts claim that the world faces an energy crisis and that oil prices 'did not remain high enough for long enough to generate a solution to the energy problem, which has not gone away'. On the other hand, others argue that rather than just focusing on supply shortages and peak oil, the debate after the crisis should take into the account the possibility that oil demand may be peaking before oil supply. This (not widely held) view points to the convergence of three main drivers that would put downward pressure on oil demand in the long term: the new environment of high and volatile oil prices, higher efficiency gains in the transport sector, and government policies driven by concerns of energy security and climate change.

A major challenge in forecasting 'medium-term' or 'long-term' fundamentals is that there are too many unknown variables such as developments in technology in the transport sector and in oil extraction, change in consumer behaviour, and the impact of energy and climate change policies, among others that can play an important role in shaping these future fundamentals. The wide uncertainty surrounding the oil market, especially in the aftermath of the financial crisis, however did not prevent many analysts from making predictions that market fundamentals are likely to tighten in the future. These predictions are based on three main pillars: (1) a very limited growth in non-OPEC supply due to peak oil and/or over-ground constraints such as geopolitical factors and hardening fiscal terms; (2) a slowdown in investment in OPEC countries due to a variety of factors such as geopolitical and the incapability and/or unwillingness of these countries to invest in the oil sector in the presence of large spare capacity and large demand uncertainty; and (3) a rapid growth in global oil demand fuelled mainly by non-OECD countries.

The effects of these predictions are far from neutral. They can shape market outcomes, influence investment decisions, and filter directly and indirectly into market participants' expectations. Changes in expectations can in turn impact short-term and long-term prices and more importantly the interaction between the front part and the back end of the futures price curve.

In this article, I will focus on one element of those predictions: global oil demand, analysing some key relationships that are important to the understanding of oil demand dynamics.

Oil Demand and Income Effects

The demand for oil equation is often modelled as a function of a wide range of variables such as world economic activity and the structure and distribution of that activity, global demographical factors, demand-side technology, oil prices, the relative prices of competing energies and taxation policies. Despite this wide range of factors, the literature has persistently found that one of the main determinants of oil demand is economic activity. Yet while oil demand is strongly linked to economic activity, this relationship is far from being linear.

OECD Demand

It has been widely shown that oil demand increases faster than GDP below some income threshold but slows down beyond this threshold. In other words, the income elasticity is not constant and varies with the level of income. This observation is important for understanding oil dynamics in the USA (and the rest of the OECD). The US income elasticity has been in decline over the years and since the 1979 oil price shock income elasticity has fallen to below unity. With declining income elasticity, total expenditure on oil as a percentage of household income tends to decline, other things being equal. This implies higher resistance

of households to changes in the oil price over time, as the expenditure on oil will constitute a small share of household income. However, other things are not equal and one needs to take into account the price effect. Given the short-run price elasticity of demand, a large percentage increase in the oil price will induce a smaller percentage change in the quantity of oil demanded and as a result the expenditure share on oil out of total budget will increase as prices increase.

These dynamics can explain oil demand behaviour in the USA and OECD in the latest price cycle. At the beginning of the boom, the share of oil expenditure of households' budgets was relatively small due to a general decline in income elasticity and a relatively low oil price environment for most of the 1990s. Thus, in the early phase of the boom, households could afford to ignore the rise in oil prices as this did not hit hard their budgets. However, as prices continued on their upward path, the oil expenditure share out of households' budgets became substantial. This eventually induced consumers to react and adjust their consumption patterns. Concerning OECD demand, one can therefore draw the following two important lessons:

- Despite the decline in income elasticity or in the oil intensity of GDP, there is a threshold price above which a change in oil price can induce a substantial reduction in oil demand in OECD;
- Unlike the latest price boom, the price that could alter consumer behaviour in the case of a sharp recovery will be reached much faster this time round The share of oil expenditure in a household's budget is higher today than at the beginning of the previous price boom and household incomes are likely to grow at a slower rate. Thus, in the future, we might witness a faster reaction of OECD demand to oil price rises.

Oil Demand in Non-OECD

The above analysis is also useful for studying the dynamics of oil demand in emerging economies. This is vital as most of the future growth in oil demand is likely to originate from economies outside the OECD, mainly in Asia and the Middle East. Evidence suggests that the oil income elasticity in non-OECD is higher than that in OECD. Based on the experience of developed economies, the income elasticity is bound to rise before it falls, due to a variety of factors. One explanation focuses on the changing nature of economic structure during economic development.

Various theoretical and empirical studies have suggested the existence of a fuel continuum that varies with the level of income or economic development. As incomes rise, households tend not only to consume more of the same fuel but also to move up the energy ladder towards higher quality fuels. For instance, some analysts suggest the existence of an energy ladder in cooking and lighting, which are the dominant energy-using activities for households in developing economies. The energy ladder ranges from traditional biomass or solid fuels (dung cake, crop waste, charcoal, coal) to liquid fuels (kerosene) to gaseous fuels (LPG, gas) then to electricity. There is some evidence that a similar ladder also exists for transport. The ladder ranges from no mode of transport to bicycles to public transport to small and then to large vehicles.

One of the key factors determining the transition is the level of income per capita. However, the relationship is not linear. At a low level of income, car ownership rates (number of cars per 1000 people) are very low. As income per capita reaches a certain higher threshold the ownership rate increases very rapidly. This is because owning a car is costly and constitutes a lumpy investment, which households can only afford after their income has increased significantly. In fact, this stylised fact applies within countries over time and across countries of different levels of economic development. Household survey data from Asia also tend to support the existence of threshold effects. Such data show that ownership rates rise rapidly with increasing income per capita. Naturally this increase in vehicle ownership is associated with an increase in the share of expenditure on transport and transport fuels out of household budgets.

The above features suggest the following lessons concerning non-OECD demand:

- As income reaches a certain threshold, a group of new consumers will enter the market, inducing additional demand for liquid fuels;
- The share of expenditure on energy out of the total budget tends to rise at early levels of economic development before declining at later stages. This implies that in non-OECD the percentage growth in income is likely to be associated with larger percentage growth in oil demand;
- This last observation implies that an increase in petroleum product prices will have a significant impact on demand as there are two effects working in the same direction. On the one hand, the share of energy expenditure out of household budget is increasing as product prices increase. On the other hand, rising oil prices imply that financing this share becomes more costly. Due to these two effects, non-OECD demand response to changes in oil prices is expected to be much faster and stronger if there is another oil price boom. In the latest price cycle, fuel subsidies in many non-OECD economies weakened this price effect. However, looking into the future, non-OECD countries are likely to abolish, or reduce, fuel subsidies and some may even impose various forms of fuel taxes.

Oil Demand and Price Effects

There is more than one concept of price to consider when analysing the price determinants of demand. These include the price level, relative prices of various fuels in the energy mix, volatility and swings. Prices affect demand either directly through the usual demand-price channel or indirectly through changing the importance of oil in the energy mix and/or through their impact on growth.

Oil Prices and Economic Growth

The traditional view that dominated the thinking about oil market dynamics was based on the premise that oil price shocks (or more accurately rapid rises in prices) adversely affect economic growth and hence oil demand. While this

view recognises that the origins of the current financial crisis could be attributed to problems in the credit market, the impact of the crisis could not have been so profound if it were not for the high oil prices. Although the channel from oil prices to inflation and then to counter-inflationary measures is important, oil price shocks can induce recessions through different channels. Price shocks act as a tax that hits household incomes, affects key industries such as the motor industry, as well as consumer sentiment and spending, and can make some capital stock redundant.

This traditional view however was challenged in the upward phase of the cycle. According to the alternative view, oil price shocks are not special: they are just like many other shocks that hit the economy. In effect, the impact of an oil price shock is similar to that of an indirect tax. It involves a transfer of income from importers to exporters and by doing so lowers real disposable income and real consumption generating a deflationary effect in oil-importing countries. The ultimate impact on the global economy however would depend on how oil exporters use the oil revenues and whether these revenues are being saved or spent. Furthermore, since oil price shocks have a deflationary effect, fiscal and monetary authorities can engage in offsetting policy responses. For instance, if there is no change in inflationary expectations, monetary policy can lower interest rates to counteract the impact of an oil price shock.

In fact, one of the most interesting features of the recent oil boom is the limited impact it had on inflationary expectations. Compared to previous oil shocks, the impact of the oil price rise on the consumer price index in OECD has been muted. While the increase in the oil price generated first round effects and led to an immediate rise in consumer price inflation, the second round effects on wage inflation have been muted. This has been attributed to the decline in the power of trade unions in the OECD countries; the fact that the pool of labour supply became much bigger through the greater integration of India and China into the global economy; and the wide adoption of inflation targeting by central banks which helped stabilise inflation expectations. Regardless of the causes, the absence of expectations of wage-inflation meant that monetary authorities did not have to pursue a contraction monetary policy to combat inflation caused by higher food and energy prices.

The main implication of the above view was that the global economy could continue to grow even with persistent sharp rises in oil prices. Alternatively, oil prices have to rise to very high levels before they induce recessionary pressures that will impact global oil demand. During the boom, this belief was reinforced by many international organisations and financial institutions that were predicting high growth rates despite the sharp rise in commodity prices. This perception of the limited impact of oil prices on growth affected the behaviour of key market players.

While the view that oil price shocks are not special has gained some credence in recent years, it is premature to argue that the links from oil prices to economic growth have weakened to such an extent that the market could ignore this feedback mechanism in the medium to long term. High oil prices would eventually have an impact on growth and global oil demand. There is however uncertainty about the time lags and about the price at which one would see a meaningful response from global economic growth. In other words, there is a large uncertainty as to how far oil prices would have to rise before they endanger the growth prospects of the world economy.

Oil Demand and the Relative Price of Oil in the Energy Mix

Relative fuel prices affect the energy mix by substitution at the margin. When the relative price of a certain fuel goes down, its relative share in the fuel mix tends to rise. But relative prices of particular fuels can stay low only if increased demand can be satisfied by an elastic supply response. This has a number of implications. First, carbon taxes or subsidies, by changing relative prices, can affect the relative shares of oil in the energy mix. In the case of ethanol (especially the first generation), the supply response is likely to be muted in the long term as there are concerns that first generation bio-fuels are affecting the food supply. So, while the decrease in the relative price of ethanol would initially increase demand, the limited supply response will eventually cause its price to rise. To maintain its competitiveness, consuming governments will have to resort to subsidies.

Although coal and gas are not direct competitors for oil, they can no longer be ignored in the transport sector with the entry of the electric vehicle and compressed natural gas (CNG) cars. Unlike ethanol, the supplies of coal and natural gas fuels are much more elastic and an increase in demand for these two energy sources will not necessarily change much their relative prices in the energy mix and hence are likely to remain competitive without government support. If a carbon tax is imposed, the relative attractiveness of natural gas in the transport sector will increase while that of coal will decrease (in the absence of Carbon Capture and Sequestration, CCS).

Factors outside the Oil Market: Recessions, Step-Down in GDP and Oil Demand

The events of 2008–2009 have revealed quite clearly that shocks external to the oil market can have an enduring impact on the oil market in general and oil demand in particular. Regardless of its shape, recession often involves a 'step down' in GDP or output loss. The size of the step-down or the level effect of the recession can prove to be substantial. The loss in output occurs through various channels. For instance, financial crises may reduce participation in the *labour force* by discouraging jobseekers and prompting employed workers to retire. Crises can also lead to an increase in the underlying ('structural') unemployment rate. Finally, a financial crisis may depress investment and slow down capital accumulation especially if credit market conditions tighten and access to credit becomes more restricted and costly.

Based on the history of previous crises, the IMF in 2009 found that the path of output tends to be substantially and persistently lower following banking crises. On average, the IMF finds that there is no rebound to the pre-crisis trend over the medium term. On the positive side though, it finds that in most economies, growth returns to its pre-crisis rate.

Since oil demand is linked to GDP, financial crisis also

results in oil demand loss. In fact a series of shocks originating from outside the oil market can result in substantial oil demand losses, which may take a few years to recover from. In the current crisis, the magnitude of the step down is still unclear but it appears to be quite substantial. In its 2009 World Oil Outlook, OPEC estimates that just before the crisis in 2008, the average consumption of OPEC oil reached a peak of 31mb/d and that it could be as late as 2013 before this level is reached again. Reaching the pre-crisis peak level will be helped by the speed of the global economy recovery and affected by the efficiency measures pursued, and the growth of non-OPEC supply and alternative energy sources.

Policy Factors

There are two key non-price factors that are believed to have a large impact on oil demand. These are government policy and technological innovations. While in theory it is possible to distinguish between policy and technological innovations, in practice they are highly interrelated. There is great uncertainty regarding the impact of these policies on oil demand. However, it is possible to make the following observations:

- The drive for improved fuel efficiency in the transport sector is likely to continue unabated thanks to technological innovations which would improve the vehicle characteristics and due to government policy which favours more efficient, greener and smaller cars;
- The trend for improved efficiency is already set in motion and is unlikely to be reversed by oil price declines. On the other hand, an increase in oil price or its volatility and concerns about the future availability of oil can accelerate the growth in efficiency. In other words, the pace in growth of efficiency is asymmetric to price changes;
- Technological innovation and government policy are not exogenous and are affected by developments inside and outside the oil market;
- Countries' pursuit of improved efficiency will occur both in developed and developing economies perhaps with greater vigour in the latter;
- Potential cooperation at the international level on key areas such as advancement of electric car technology will consolidate over time;
- Although oil will continue to be the dominant fuel in the transportation sector for years to come, other sources of energy such as coal, gas, and ethanol have started to compete at the margin. This competition will only intensify over time;
- Despite the fact that these technological innovations and government policies will only impact the oil market at the margin, the effects on oil demand are both cumulative and potentially irreversible and hence cannot be ignored in the long term.

Conclusions

The above analysis suggests that the evolution of global demand dynamics is affected by a large number of interrelated factors. Expectations that global oil demand will continue on a robust and high-growth trajectory may materialise, but this is not a foregone conclusion. Oil exporters, companies, and market analysts should somehow factor into their expectations the possibility of policy reversals, development setbacks, shocks originating from outside the oil market, and should explore the role of price and income effects on long-term oil demand which can perhaps produce more balanced views. Unfortunately, this has not been done so far and an expectation of robust growth in oil demand, which is essential for the story that market fundamentals will tighten, is accepted uncritically. Stories that China's and India's thirst for oil is impossible to quench are now widely believed. This should come as no surprise because for stories to have an effect on market psychology they must sensationalise events surrounding oil market dynamics (peak oil supply, peak oil demand, future energy crisis, return to oil shortages, the end of cheap oil, just to mention a few examples). While in the past such sensational stories had limited impact on the functioning of the oil market, this is no longer true. In their recent book titled *Animal Spirits*, George Akerlof and Robert Shiller ask 'But what if stories themselves move markets? … What if they themselves are a real part of how the economy functions? … The stories no longer merely explain the facts; they are the facts.'

On Oil Peak or Peaks?

Robert Mabro

The oil peak theory first advanced by Colin Campbell more than 25 years ago is influencing market expectations about the medium-term supply/demand balance in the world petroleum market. In the same vein, Matt Simmons has focused on the scarcity issue, arguing in his book – *Oil Twilight in the Desert* – that Saudi Arabia has much less oil than generally thought, and that its super-giant field, *Ghawar,* is seriously suffering from natural decline. These theories and views provide additional ammunition to those who have been consistently arguing that this supply/demand balance will increasingly become tighter because of oil consumption growth in China, India and in oil-exporting countries, and the failure of OPEC member countries and the international oil companies to invest as much as may be required in the exploration, development and production of crude oil.

The peak oil theory has its promoters, some of whom seem

to be driven by missionary zeal, and detractors who usually fail to convince those who have espoused the theory, stock and barrel, on the ground that it is self evident.

The proposition taken as self-evident is that the *growth* in oil production cannot be sustained forever. A peak is bound to be reached for the simple reason that oil is an exhaustible resource. This is self evident.

One critical question is about dating the emergence of the peak. The promoters of the peak oil theory did not do much good to their cause by predicting early occurrences – in the 1980s, then 1990s, then in 2005 for example. All these dates are behind us and oil production is continuing to grow. Although a few still believe that the peak was attained in 2005 (really!), the most common view today is that we shall face it in 2020 or much more optimistically in 2030.

The question 'When?' is of fundamental importance. I referred once to the classic syllogism:

> All men are mortals
> Socrates is a man
> *Ergo* Socrates is mortal.

This is not a prediction but a self-evident inference. And Socrates is not interested in being told that he is mortal; he knows that in any case. He may like to know however when he is going to die. Similarly, we know that we cannot enjoy forever growing production from an exhaustible resource. We need to know the date at which a peak will be attained.

The second important question relates to the nature of production peaks. It is useful to distinguish between an *absolute* peak and *temporary* peaks. An absolute peak is one that is irreversible. Once such a peak is attained oil production will never grow again.

The impression given by those who argue in favour of peak oil is that the one that will emerge pretty soon is an absolute peak, an irreversible state of affairs. Yet such an absolute peak can only occur when a number of the following drastic conditions are satisfied:

1. All existing oil resources in our globe have been discovered, developed, and produced with maximum efficiency.
2. The technologies that maximise the recovery rate are used in all those fields where the geology allows their application.
3. Technological progress in exploration, development, production and recovery enhancement has reached an absolute constraint and cannot therefore proceed any further.

Those who predicted an emergence of the production peak at a date that is behind us seem to have ignored, among many things, the existence of vast discovered reserves in Iraq that were not developed at the time of their prediction. How can we then reconcile the presumed early emergence of a peak with a later entry of the vast Iraqi oil potential in the supply equation?

Some authors also seem to have ignored, or played down, the phenomenon of future reserve growth. Our knowledge of existing reserves in a field increases as production proceeds. The extraction of oil from a field generates new data about its boundaries and size, and other critical variables relevant to the estimation of its reserves. Thomas S. Ahlbrandt of the US Geological Survey stated that there is 'a multiplier of the original reserve estimate (of a field) and it is generally in the 4 to 9 times range'. True, most reserve growth occurs in the earlier years of a field production. But there are recent fields where the reserve growth potential is yet to be realised.

Furthermore, the estimates of global oil reserves fall within a very wide bracket. Low estimates put the ultimate recoverable endowment of a petroleum commodity (oil or gas) at less than or equal to 2 trillion barrels of oil equivalent (tboe); moderate estimates are those between 2 and 4 tboe; and high estimates are those greater than 4 tboe. The high estimates are wildly optimistic and should be discarded. Still the 2–4 tboe range that may be retained is extremely wide. Clearly, the view taken about the likely date at which a peak would emerge crucially depends on the choice of a particular estimate within this wide range. The point is that uncertainties are at the heart of the matter and they are too significant to be ignored in the interpretation of the results.

Let us now assume that a production peak occurs at a time when one or several of the conditions listed above to identify it as irreversible are not satisfied. In this case, production growth would be able to resume when new fields are discovered and developed and/or technology takes a leap ahead.

I believe therefore that the likely scenario is one in which we may face in the years to come more than one oil production peak that will prove to be temporary in nature and will be reversed. Of course, oil prices will rise, perhaps significantly, if such a production peak occurs when *ex ante* demand then exceeds available production. At this point the issue of adjustments arises. These are neither immediate (there are always response lags, some of which can be long). Adjustments can be imperfect. They rarely bring the situation affected by the price shock to its previous state. Still, adjustments do obtain.

Higher oil prices will reduce demand. They are likely to induce greater investments in the oil upstream sector and in technological R&D. Policies may be introduced to curb demand, provide subsidies for relevant investments, to accelerate the search for liquid fuel substitutes for oil. In any case one may recall that necessity is the mother of invention.

The economists err in their belief that adjustments fix problems. The promoters of peak oil err in the opposite direction by attributing little importance to the possibility of adjustments taking place. Furthermore, they seem to have little faith in technical progress. Yet the history of the modern world is one in which life has been transformed in many ways and in many fields by remarkable inventions and technical changes. Why then profess a total pessimism in the possibility of progress in the energy field?

All this does not mean that temporary peaks will not cause economic difficulties. They will surely cause them over an initial period of time. If the peak attained is followed by negative production growth at a time when *ex ante* demand is exceeding the achievable production level the world will inevitably face an oil price shock. The larger is the production deficit relative to *ex ante* demand, the greater will be the

initial oil price increase. A significant price shock will affect seriously the state of the world economy, and in extreme cases will cause social tensions and conflicts. Yet a price shock does not endure forever. The economic situation after a time lag will begin to improve.

We also should recall that the transport sector even in the absence of a revolution in the design of vehicles' engines does not need conventional oil but liquid fuels. A fall in conventional oil supplies can be compensated for by an increase in the output of unconventional oil from Venezuela, Canada and other places. It can be compensated for by a number of other substitutes such as ethanol, GTLs (gas to liquids) or CTL (coal to liquids), CNG (compressed natural gas) and so on. In all these cases, there are production difficulties yet real opportunities. It is legitimate to worry about the problems that would arise after the emergence of a temporary peak in conventional oil production. It is wrong to believe that such a peak would cause a final eschatological catastrophe.

A message of the peak oil theory is that the era of cheap oil is ending. Both supply costs and prices are bound to rise for a while. This is more than plausible. We would then need to ask about the implications of such a development. To say that temporary peaks are not without negative impacts is certainly correct. And my preferred scenario is one in which a temporary peak is likely to emerge again and again in some sequence in which the heights of the successive peaks tend to become lower and lower.

Given that the adjustment lags tend to be long the wise policy recommendation is to keep a watch on the development of oil production and on the progress being achieved in relevant R&D, upstream investments, technological changes in motorised vehicles, supplies of alternative liquid fuels. The questions to ask then are: first, about the forthcoming (realistic) date of a temporary production peak, and secondly, whether the time is approaching when precautionary measures need to be taken.

Media hysteria is of no use on this issue. The peak oil theorists are distracting attention from what needs to be done at an appropriate time to solve a problem should it arise. Hype is not the friend of wise counsel. Unfortunately hype is not a stranger in the current oil discourse. It only serves particular vested interests rather than helping the solution of real problems.

Oil Price and the Animal Spirits: Implications for the Oil Industry Leadership

Edgar Jones

Oil price behaviour in recent years has made it very clear to all industry participants that oil is no longer a classical commodity but rather behaves as a financial asset subject to the influence of the same *animal spirits* responsible for the 'irrational exuberance' that characterises the financial markets, making it impossible to predict in the short term. Crucially, it has become more difficult to seize short-term investment decisions under such price volatility. Regulation might or might not come and in any case its efficiency against 'over speculation' remains to be seen. If structured wrongly, regulation could also harm small and midsize companies' ability to hedge and hence their financial flexibility, forcing them to focus on increasing capital requirements for hedging. In any case short oil price volatility has created a confusing environment for investment decision-making.

In this article, we argue that the leadership of the oil industry should learn to feel comfortable with high volatility and with animal spirits in prices while maintaining the long-term focus on supply and demand. In other words, business decisions in the oil industry should continue to be analytical but increasingly intuitive to understand in which part of the oil price cycle the industry stands.

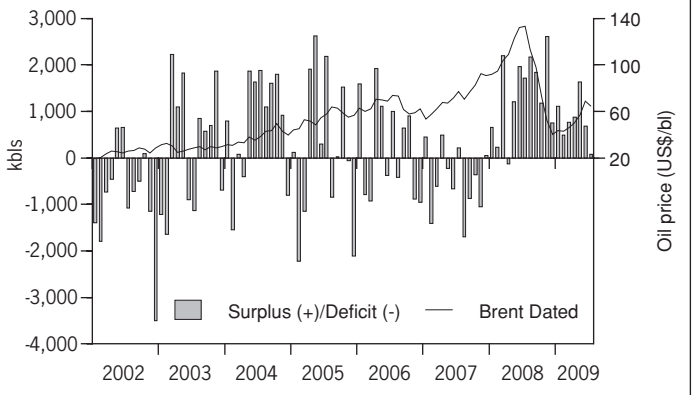
Oil as a Financial Asset and the Role of Animal Spirits

Commodity is conventionally defined as product traded on a commodity exchange through a futures contract and which spot prices will move in reaction to short-term demand and supply conditions. The existence of futures and options contracts should in principle reduce the volatility in prices as it allows market participants to have certainty in their pricing. Until the year 2000 oil tended to fit quite well according to these assumptions. Nevertheless, the last few years have brought substantial evidence that increased participation from the financial sector has become a major source of instability reflected in the intraday volatility as well as large and sustained price swings such as the one seen in the last 12 months, when the crude price path was not consistent with many fundamental indicators such as the change in stocks. (Figure 1)

One of the key reasons for these changes is that commodities in general have proven to be a good element for portfolio diversification, particularly due to their negative correlation with equities. In the case of derivatives, the amount of capital committed is less than the financial market alternatives (bonds, equities…) as only the margin call should be covered or the position cancelled. This has permitted speculators and black box investors to enter or leave the paper abruptly and create sharp movements in the future prices, which are subsequently re-transmitted to the spot market by driving expectations in the physical market transactions.

Oil has become too variable to predict in the short term, and thus has proved to behave more as a financial asset governed by the animal spirits, as conceived by Keynes, where

Figure 1: Oil Supply/Demand Balance with Respect to Oil Price



the prices sometimes reflect the fact that individuals in the economy take decisions and allocate resources influenced by emotions, feelings or perceptions and not by strictly rational behaviour as assumed in neoclassical economics. Recent paths among crude oil and financial implied volatility trends seem to confirm the increasingly similar behaviour (Figure 2).

Oil Industry Reaction during the Downturn

How can any industry player or government allocate resources and make investment decisions under such a price scenario so heavily influenced by the animal spirits? Oil price not only constitutes the main profit indicator for the industry but it is also the main psychological driver underlying the investment decisions undertaken by the oil companies. Investment in the oil industry tends to follow cycles, increasing substantially when prices are high and decreasing when oil prices drop. The price escalade between 2003 until mid 2008 drove the spare capacity build-up in OPEC and the billions of dollars invested in 'difficult oil' projects. In fact, overall industry capex also increased continuously through that period, along with oil prices, to reach record highs in real terms.

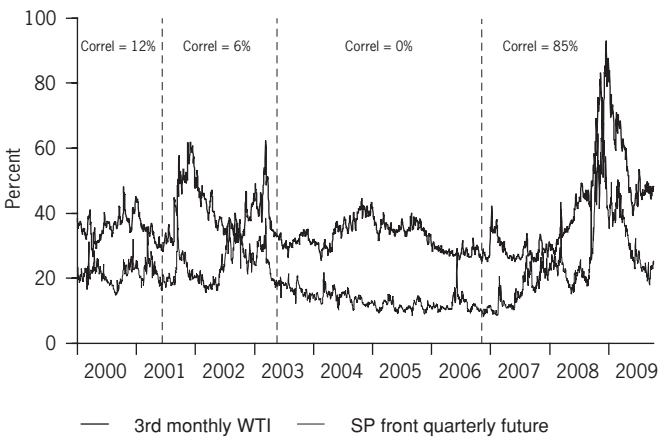
Oil is a long-term business where projects increasingly take years to go through their exploration, design, development and production phases. Can the oil industry really afford to leave its capex decisions at the expense of the animal spirits as happens in other industries, often with much shorter capital projects? The recent economic downturn has brought some evidence of what the industry's reaction to the sharp oil price swings has been. Some companies opted for a cash flow management strategy based on borrowing and/or cutting expenditure to maintain dividends or in some cases survive through the downturn (e.g. BP and Conoco); other groups of companies considered it was a good moment to restructure their business (e.g. the Suncor and Petrocanada merger); and some others decided to invest through the cycle and even scale up the growth rate (e.g. Exxon and BG). How did the investors react? The market seems to have rewarded the strategies that remained focused on growth. While the oil price went from 125 to 30 USD/bl and back to the 70 USD/bl in the last 12 months, Exxon's share price oscillated softly around 73 USD despite the steep oil price fall. At the same time Conoco, which announced cash flow management measures (incl. capex reductions), lost more than half of its share value at some points. Was the market not so irrationally exuberant after all and actually rewarded long-term focus on growth despite short-term price volatility?

Solid oil industry investors know that this is a business where you have to look at the big picture. The industry oil supply challenge is far from over. Current production capacity declines at a rate between 5–7 percent and at the same time demand is set to increase by 1.5 percent per year despite the slump. This leaves a 30–45 MMBD gap to cover by 2015 and an even bigger one of 70–100 MMBD by 2030. As economic theory would predict, this new oil supply can only come to the market via higher oil prices. Jeroen Van der Veer, former CEO of Royal Dutch Shell, was recently interviewed by Mckinsey and said:

> Even if you are in the middle of a short-term crisis, I think it is very good to keep your eyes on the long term… If the economy comes out of recession – and that will happen, I don't know when – you will see energy demand goes up again… then we expect quite robust pricing environment for energy because there are no longer cheap solutions left for oil, left to easy gas.

Yet, although hedging has been the source of the problem, by allowing speculators in, it could also be a part of the solution if companies could hedge more intensively to secure the price levels to provide the necessary cash flows for their projects to work. Recently Mexico earned an $8bn windfall from financial contracts it bought last summer when it locked in an average price of $70 a barrel for all its oil exports in 2009. However, discussions on tighter OTC derivatives markets regulation are still ongoing and moving towards more transparency oversight but also to higher margin calls that could potentially harm the investment capabilities of those small and midsize oil and gas producers which are also active

Figure 2: WTI vs. S&P Index implied Volatility



Source: Merryl Lynch

hedgers. They might have to allocate more capital in their hedging operations and less in their direct investment or shift to long-term agreements with fixed prices. Both measures could result in less production in the long term.

Conclusions

Overall, and keeping a long-term perspective, few would argue against the view that the price of oil and gas has been driven mainly by the animal spirits only in recent periods; it remains to be seen whether the dynamics have structurally changed or are an intermittent causality relation between oil price and speculation or price and fundamentals. Nevertheless, some lessons can be derived from the large price up-swing between the end of 2007 and July 2008:

1. Oil industry leadership should keep its focus on the long-term fundamentals and avoid being misled in their investment decisions by the animal spirits influencing the price behaviour in the short term (e.g. intra-day volatility).
2. Oil company leadership has to assume that the impact of speculation on the oil price is a short-term phenomenon while prices in the long run will still be governed by fundamentals.
3. Oil companies should probably intensify their use of hedging and consider longer maturities to secure future cash flows and keep developing the projects despite temporary low prices.

Access to and development of new oil resources continue; they never stop. We must not forget the key lessons from the fathers of the oil industry: Edwin Drake, Edward L Doheny, John D. Rockefeller and Weetman Pearson; they all provided solid examples that in the oil business you have to learn to live with risk and uncertainty. The first can be measured and controlled while the latter will remain but will eventually pay off.

Does the Electric Car have a Future?

David Robinson believes that the long-term prospects are favourable but there are many struggles ahead

This article on the global prospects for the electric vehicle (EV) makes three points. First, the long-term prospects are favourable, if only because we eventually need to de-carbonise the transport sector to meet greenhouse gas emission targets. However, in the next ten to twenty years, the EV will struggle with the same problems that stopped its growth a century ago – namely high cost and limited appeal to most customers. Third, to reach its potential, the EV will need sustained political support, whose justification will depend heavily on the de-carbonisation of the electricity sector. Nowhere is the potential greater than in the large and fast-growing developing countries.

The Case for Electric Vehicles

The first cars were electric. By 1900, 38 percent of US vehicles ran on electricity, 40 percent on steam, and only 22 percent on gasoline. However, the fleet of EVs in the USA peaked in 1912, after which internal combustion engine (ICE) cars running on gasoline became more popular. By 1930, the EVs were no longer important in the USA or Europe.

The EV has recently made a comeback, with hybrid electric vehicles (HEVs) in vogue, and plug-in electric vehicles (PHEVs) about to hit the market. The proponents of EVs see them as game changers, mainly due to the potential to lower greenhouse gas emissions and reliance on oil imports.

*Reduced GHG emissions***.** First, EVs emit significantly less greenhouse gas (GHG) than a car with a conventional ICE running on gasoline. The latter has an energy efficiency of about 20 percent. The electric motor is much more efficient and battery EVs using renewable electricity can lower life-time GHG emissions by 80 percent. But, in practice, GHG emissions will depend on the local conditions, in particular the electricity generation mix and the driving patterns. Assuming EU conditions, for instance, the life-time GHG emissions for battery EV light vehicles are about 40 percent lower than for conventional vehicles.

Second, by replacing conventional vehicles, EVs shift the burden of controlling CO_2 emissions to the electric sector and thereby facilitate the control of CO_2 emissions. There are fewer than 5000 large fossil-fuel power stations in the world responsible for the bulk of CO_2 emissions from electricity. Cutting or simply monitoring the emissions from a relatively small number of stations is significantly easier than cutting or monitoring the emissions from hundreds of millions of cars running on fossil fuels.

Third, in order to meet GHG targets from 2030 and beyond, it seems likely that we will need to de-carbonise transportation. EVs will become increasingly attractive, unless some other better zero-carbon alternatives emerge for the transport sector.

*Security of supply and reducing oil import dependence***.** Concerns over energy supply security refer primarily to reliance on the imports of oil products from potentially hostile countries. In particular, political enthusiasm in the USA for EVs reflects a perception that they would reduce the cost of oil imports and reliance on potentially unfriendly nations. This argument has more or less influence depending on the international and domestic political context, as well as perceptions about the future price of oil.

Rising gasoline and CO_2 prices. The prospect of rising gasoline prices (due to rising CO_2 prices and tighter hydrocarbon markets) may lead consumers to change their buying

and driving habits, moving towards more efficient and smaller cars and, possibly, EVs. If oil prices stay high enough for long enough, this may encourage customers to overcome their reluctance to pay the higher initial cost of the EV.

The Challenges

The future of EVs will depend on four key factors: the importance of the fixed cost of the EV relative to the potential fuel savings, the turnover of car fleets, the attraction of EVs to customers, and the sustainability of political support for them. The first three factors do not currently augur well for the EV, at least in the short run.

*Fixed cost of electric vehicles in relation to potential fuel savings***.** When consumers buy new vehicles, the initial fixed cost is a key choice determinant. According to the International Energy Agency (IEA), the extra cost of an HEV is about $5000, of which $3000 is for the battery. The additional costs are higher for a PHEV and they rise with the distance the car can travel between recharging. A recent US National Research Council (NRC) report estimated that the additional costs for a PHEV-10 (10-mile limit) would be $6300 in 2011.

Will the saved fuel costs compensate for the higher fixed costs? The studies I have seen suggest that for this to happen very high oil prices would be required, very low electricity prices and very low discount rates (for customers). Apparently, most customers are not willing to pay much, if any, additional fixed cost when they buy a new car.

Might the economics change? One possibility is that the cost of batteries will fall enough to make a difference. However, battery technology is quite mature. The US NRC study has a 'probable' scenario in which the additional cost of a PHEV-10 would only fall from $6300 in 2011 to $4100 by 2030; most of that additional cost is for the battery.

One proposed development that would favour PHEVs is to enable owners to sell ancillary services (e.g. electricity reserves that can be tapped at short notice) from their batteries back to the electric system. This will require the development of smart grids that allow for two-way communication between the customer and the electricity networks (the so-called Vehicle-to-Grid technology, or V2G). However, it is important also to recognise that a massive increase in PHEVs will require new generation capacity. The current costs of V2G technology do not seem to justify its deployment today, and some trusted experts are convinced this is really a dead end.

"by replacing conventional vehicles, EVs shift the burden of controlling CO_2 emissions to the electric sector and thereby facilitate the control of CO_2 emissions"

Are there ways to overcome the problem of the high initial fixed cost of EVs, short of subsidies? Certainly, there will be commercial strategies that aim to overcome a customer's reluctance to make the initial investment. For instance, the company Better Place proposes to lease car batteries to EV buyers (lowering the customer's initial outlay) and to provide replacements through a network of 'fast charging' stations. Better Place is also offering a second alternative in which they charge subscribers a fee per-kilometer driven, just like a mobile phone operator charges its subscribers for minutes used.

*Turnover of fleets***.** In wealthy countries, two other factors militate against an early, rapid growth of EVs. First, car penetration is already high; in the USA, for instance, the average household has more than two cars. Second, vehicles are kept on the road for many years, even though they may be resold. The 'cash for clunkers' policies have probably postponed the period when EVs might have expected to grow, since many consumers have locked themselves into a new conventional vehicle for a number of years.

There is, however, a greater potential for rapid EV growth in large and rapidly developing countries in the next few decades. There, car penetration is very low and the prospects are good for dramatic growth. It is also possible to imagine that mass production of EVs in India and China would drive down the costs. Already, the largest producer of EVs is a company based in Bangalore, India. If the Indians can produce a conventional car for $2000, what is stopping them from producing a relatively low cost EV for their domestic market and for export?

Customer preferences. When it is time to choose a new car, will the consumer choose an EV? There is some research that indicates that, even if the price was the same as a conventional vehicle, customers still see pure EVs as being insufficiently versatile. The limited autonomy of EVs will restrict the market for non-hybrid vehicles.

On the other hand, an even more important question is whether customers actually like EVs. Do the styling, image and performance appeal? If not, then it is very unlikely that the EV will ever take off. This is a major challenge for the industry.

The challenges summarised above are all largely short-term problems. There is no reason for them to stop the EV from becoming an important transport mode in the longer term.

Political Support

Significant growth in EV fleets is likely to depend on sustained political support. In the OECD countries, this will involve subsidies, tax and other benefits to buy and run electric vehicles; additional taxes on fossil fuels, ICE cars, road use, and CO_2 emissions; and regulatory and fiscal support for the development of smart grids, PHEV plug-in networks and battery RD&D.

But will the political support be sustainable and sufficient enough to make the EV a game changer? Many countries are now promoting EVs as a way of reducing their reliance on

imported oil, meeting CO_2 emission reduction targets, supporting local car manufacturing industries and even as a way of soaking up excess supply of electricity and integrating renewable energy. However, the costs of supporting these policies will come under increasing pressure due to the cost of overcoming customer reluctance to pay more for EVs, and of developing an electricity infrastructure to support them. The IEA has estimated a huge deployment cost between 2005 and 2050 to achieve a 15–25 percent share of new car sales by the end of that period in the main markets. It is certainly questionable whether political support will be adequate.

"in order to meet GHG targets from 2030 and beyond, it seems likely that we will need to de-carbonise transportation"

It would be easier to provide sustained, global, political support for the EV if its growth would lead to a substantial reduction in CO_2 emissions. An IEA scenario estimated that EVs could save 2 $GtCO_2$ in 2050 (energy-related emissions in 2008 were about 28 $GtCO_2$). However, EV technologies are among the most expensive forms of CO_2 abatement. In that IEA scenario, EVs constitute only 17 percent of the potential abatement in the transport sector, with improved fuel efficiency from conventional cars accounting for over 50 percent. In a more conservative scenario, the IEA forecasts savings of only 0.5 $GtCO_2$ in 2050 from EVs, which is less than 1 percent of the projected (business as usual) energy related CO_2 emissions in that year. Hardly a game changer.

If there is a public policy case to be made to support EVs, it will be in the largest developing countries that currently depend on coal-based electricity. In China and India, the GHG savings from EVs would be relatively minor while electricity is fuelled mainly by fossil fuels. If, on the other hand, these countries substantially de-carbonised their electricity systems and simultaneously promoted EV penetration, this would have a double effect: lowering emissions in the power and transport sectors. The IEA estimates that China's CO_2 emissions from coal-fired generation and transport will account for about 19 percent of global energy-related emissions in 2030. India's electricity and transport sectors will account for at least an additional 5–10 percent of global energy related CO_2 emissions in 2030. Therefore, de-carbonisation of electricity and aggressive expansion of the EV fleet in these countries would make a big contribution to global efforts to reduce greenhouse gas emissions. But, this comes with an important incremental cost.

Is this an opportunity to forge a deal with China, India and other fast growing developing countries that rely on fossil fuels? They would agree to facilitate investment to shift to low carbon electricity and a rapid growth of EVs, and the rest of the world would agree to share with them the incremental costs of this transformation. We would all be winners to the extent that this significantly lowered CO_2 emissions. The main developing countries would gain to the extent that they enjoyed low-carbon electricity and transport, partly financed by the rest of the world. Investors from around the world would benefit to the extent that they participated in the transformation. Developing countries would become major exporters of low cost EVs, making it easier for the rest of the world to adopt them. If this also lowered oil prices, it would benefit oil-importing countries. Who would be the losers? Mainly the manufacturers of conventional automobiles, oil-exporting countries, the oil and gas companies that had not moved into electrification and, of course, everyone who helped to pay for the transformation! As always, agreement on the sharing of the burden would be difficult, and it would be necessary first to demonstrate that the benefits outweighed the cost.

Who Will Lead this Charge?

Is there global political will to make this sort of vision come true, or at least to get the EV off to a good start in developing countries? I doubt it. In the aftermath of the Copenhagen Climate Change Conference, geopolitics seem to be moving more in the direction of multiple 'bottom up' deals, including sector-wide agreements and national or regional commitments to lower CO_2 emissions, with a clear eye on commercial advantage to be gained. The way forward for the EV probably lies in defining more clearly the strategic commercial proposition for a group of countries or sectors.

"If the Indians can produce a conventional car for $2000, what is stopping them from producing a relatively low cost EV for their domestic market and for export?"

If we were looking for white knights with a commercial interest in realising this vision, one would be the electricity sector itself (with a second being the automobile sector). The OECD electricity sector organisations recognise climate change legislation as a threat and an opportunity. They expect increasing demands for investment in zero carbon electricity generation and in massive new transmission networks to connect renewable sources of power that are often far from the market. At the same time, the sector faces a declining demand for their product from traditional customers, as prices rise to reflect CO_2 costs and scarce fossil fuels, and as governments introduce measures aimed at encouraging energy efficiency and savings. On a business as usual basis, electricity demand forecasts in the OECD countries are flat or growing at less than 1 percent per annum. With climate legislation, demand for conventional electricity uses could well begin to fall.

The response by the OECD electricity sector organisations to this threat has been to accept, in principle, the

need to de-carbonise the generation of electricity by 2050 and to promote (and here is the opportunity) a switch from fossil fuels to electricity, especially in transport and heating. EVs provide a new source of demand and might also help the electricity network operators to better manage the electricity systems, especially if the vehicles are charged during periods of off-peak demand.

It is ironic that the OECD electricity sector organisations have adopted this strategic vision, whereas the electricity sectors that really matter in this debate are in the large non-OECD countries. I think it is time they talked to one another, if they are not already doing so. If they did, they might well find that their collective futures were tied to the de-carbonisation of the sector, the development of smart grids and the growth of the EV.

François Badin believes that electrification is destined to play a key role in the optimisation of future vehicles

Electrifying the propulsion systems of vehicles provides a number of functions that can help reduce energy consumption. This is achieved by optimising the operating conditions of the heat engine and by recovering a variable fraction of the available energy during braking in hybrids that we will hereinafter call 'discrete'. The simplest systems, which make it possible to eliminate idling, yield fuel savings of 5 to 7 percent in the standardised European cycle. The most complex systems, which provide more functions, lead to savings of up to 40 percent.

Electrification also allows the creation of additional functions, of benefit to the users of the vehicle or to the community, such as all-electric range and connection to the grid. Implementation of these functions will require the addition of electric motors that will be coupled to the engine in various architectures – series, parallel, series-parallel, and all-electric – and will be more or less compatible with the existing components (transmission or wheel).

The announcements of the various automakers and equipment suppliers suggest that vehicle electrification may accelerate in the future, and constitute an opportunity in today's difficult economic and environmental context. The penetration of electrification among vehicles sold will then depend on the successes achieved in mastering energy storage, costs, and industrial production.

Situation of Vehicles with Conventional Propulsion Systems

This can be illustrated through the three examples described below.

Electricity on Board

The primary function of a vehicle's propulsion system is to move it, but the following remarks may be made:

- the increasing number of functions performed on board, for comfort, safety, and communication, has led to an increase of the number of electrical actuators and in consequence of the power of the on-board network. This power passed the 1000 W mark in the 1980s, doubled by 2000, and may reach nearly 5000 W in 2010;
- the mean power needed to move a vehicle is less than 10 kW for urban trips on level ground, and so of the same order of magnitude as the power of the on-board electrical network.

This convergence of power levels indicates that, for some types of use, it may be worthwhile to use electrical energy in the vehicle's propulsion system.

The Energies Involved

If we consider the flows of energy involved when a vehicle travels on a level road, we find that they depend on three forces: aerodynamic drag, rolling resistance, and inertia. The energy associated with the first two forces is dissipative and is lost as heat. The third force is a potential that can be recovered each time the vehicle decelerates. Analysis of these flows shows that the potential for energy recovery under urban conditions is very large and that it quickly falls off when traffic conditions become more fluid.[1]

Conditions of the Use of the Internal Combustion Engine

Analysis of engine operating conditions shows that they are very sensitive to the use made of the vehicle. Engine speeds and loads are low under urban conditions, leading to rather low efficiencies, whereas under open road and motorway conditions the zones of operation are close to the peak efficiencies of the engine.

If we consider the use of the vehicle itself, it becomes apparent that many trips are too short for the engine and exhaust gas treatment system to reach their optimal temperatures.

As we shall see below, electrification of the propulsion system can significantly improve the conditions of use of internal combustion engines and thereby reduce their harmful effects.

Functions Provided by Electrification

The various functions listed below are implemented in the vehicle primarily for the purpose of reducing fuel consumption. The vehicles concerned, which can be called 'discrete hybrids', provide no other new functions.

1 *Le génie électrique automobile: La traction électrique:* Alleau T., Badin F., Beretta J., Bleijs C., Bonal J. (2005). Hermès Science, Traité EGEM – Série Génie électrique. Paris: Lavoisier.

Optimised Management of Electrical Energy on Board

Electricity is produced on board conventional vehicles by a belt-driven alternator that delivers power via a diode rectifier bridge to the on-board 12-V network. Until recently, such a system was optimised mainly in terms of cost, to the detriment of global efficiency, limited to between 50 and 60 percent. The increasing power of the on-board network and the search for minimum consumption has led equipment suppliers to improve the system, its electronics, and its control.

"electrification of the propulsion system can significantly improve the conditions of use of internal combustion engines and thereby reduce their harmful effects"

In an optimised system, the energy delivered by the alternator is not determined solely by the consumption on the on-board network, but can be coordinated with the use of the vehicle. Recharging the battery is for example favoured during decelerations, when the engine is driven by the wheels, for the purpose of reducing fuel consumption by recovering a fraction – even if it is still a very small one – of the energy of deceleration.

While it is true that this approach has limited effects, it is very inexpensive and could come into widespread use in the short term.

Stop–Start System

The function implemented in this system, also called 'micro hybrid', is stopping the engine when it is not producing motive power for the vehicle, in other words essentially eliminating idling. The fuel savings, and the reduction of CO_2 emissions, will therefore be greater to the extent that idling accounts for a significant share of running conditions: for a mid-sized car, if the measured saving is 5 to 7 percent in the standardised European MVEG cycle, it can reach 10 to 15 percent in an urban type cycle but will be negligible in motorway type use.

The implementation of this function depends on the possibility of engine starts that are dependable, clean (in terms of regulated pollutants), rapid (a few tenths of a second), quiet, vibration-free and automatic (in response to driver action on the pedals). The engine is started by a motor that is more powerful than a starter (2 to 4 kW), can be linked by belt to the engine, and can also be used as a generator.

Such systems retain energy storage using optimised 12-V lead-acid batteries and add only a few hundred Euros to a vehicle's cost. They are currently implemented in vehicles that are primarily urban, in which the potential fuel savings are largest.

Stop–Start System with Regenerative Braking

These other systems are derived from those just described but use a more powerful motor (4 to 6 kW, belt-driven) and a storage system combining a lead-acid battery and supercapacitors. This configuration recovers a fraction of the energy available during braking and can start larger gasoline and diesel engines, and so be used in more vehicles. Highly satisfactory preliminary results have been obtained.

Regenerative braking increases the fuel savings, which could then reach, in a passenger car, 10 to 12 percent in the standardised cycle. The presence of the supercapacitors makes it possible to run the motor at a higher voltage (42 Volts), but requires the use of a DC/DC converter to supply the 12-V on-board auxiliaries network.

The use of a more powerful motor and new components (supercapacitors, converter) adds to the cost of this system (of the order of 500 to 900 Euros), so it will not spread as rapidly as the previous one.

Engine Assistance

In this configuration (called 'mild hybrid'), a more powerful electric motor (10 to 20 kW) is used, making it possible, in addition to the functions already mentioned, to assist the engine by providing additional torque during driving phases ('boost' mode). The torque curve obtained by combining the heat engine and electric motor preserves good performance at low engine speeds, like a turbocharged diesel engine, while using a severely downsized gasoline engine.

The automaker Honda markets this configuration with its IMA system implemented on the Insight and the Civic. The electric motor, characterised by a very high ratio of diameter to length, is fitted on the end of the crankshaft, in place of the flywheel, between the engine and the transmission. For this power level, the storage voltage is generally 120 to 150 V, with a total energy of less than 1 kWh. In this vehicle, compared to its gasoline equivalent, the fuel savings are of the order of 30 percent under urban conditions, 15 to 25 percent in the standardised European MVEG cycle, and very low under extra-urban conditions. The added cost of this system will be higher, in the range of 1000 to 2200 Euros.

All-electric Mode

This function allows the vehicle to run using its electric propulsion system alone; in other words, the engine can be isolated from the transmission and stopped during these phases. This 'full hybrid' configuration provides many more ways to optimise the operation of the engine, since most of the low-efficiency situations can be offloaded to the all-electric mode. The electric propulsion system will be larger here, with a 20 to 50 kW motor, storage at a voltage of 200 to 300 V, and a total energy of 1 to 2 kWh.

The very high level of optimisation that will be possible in the use of the engine will lead to extremely high fuel savings, up to 40 percent in urban conditions, where conventional propulsion systems are least efficient. These relative savings fall off, to between 10 and 20 percent under open-road conditions and become nearly negligible on motorways. The complexity of this system and

the dimensioning of its components induce however a large added cost, currently estimated at between 2500 and 5000 Euros. The most widely used hybrid to date, the Toyota Prius, implements all of these functions.

Optimised Management

These various operating modes must be used in a dynamic manner, changing in the course of use of the vehicle, and make allowance for the state of the various components, in particular the state of charge of the energy storage system. This complex management cannot be entrusted to the driver, so automakers, equipment suppliers, and research laboratories have developed complex software specific to the management of hybrid propulsion systems.

The objective is to ensure optimal management and control of the components in order to minimise the energy consumption of the vehicle while preserving its performance and if possible enhancing its drivability. In the near future, the management laws might make allowance for the parameters of the vehicle's environment, such as traffic conditions and relief, and for fleet operating parameters.

Complementary Functions

The functions listed below will enable a hybrid vehicle, one that might be called a 'functional hybrid', to provide one or more advantages for the driver, the passengers, or the local or global environment. Such additional functions should help justify the added cost of the vehicle by extending its uses (entering a downtown area closed to polluting vehicles) or by reducing its energy cost (use of another energy vector).

Electric Mode with Range

This complements the electric mode presented above, from which it is distinguished by the fact that the driver, or possibly an external infrastructure, will be able to stop the engine and keep it off for a specified distance (the 'all-electric range' or 'AER', of the order of 5 to 20 km in Europe, up to 60 km planned in the United States). This operation without local harmful effects makes it possible to consider special uses of the vehicles, such as night deliveries in city centres.

Connection to the Grid

Grid recharging: In a discrete hybrid, the battery's 'state of charge' (SoC, conventionally 100 percent in the fully charged state and 0 percent in the discharged state) is constantly kept close to an intermediate value (generally 50 to 60 percent; this is the 'charge sustaining' mode); in the grid recharging case the energy management system lets the SoC drift (this is the 'charge depleting' mode) down to a lower limit generally determined as a function of aging and performance (of the order of 20 percent). The battery can then be recharged from the grid ('plug-in' hybrid).

"cooperation with local and national authorities will have to be reinforced so that progress can be made in the areas of standards, incentives, and energy infrastructure"

This function will make it possible to shift consumption from a hydrocarbon to another primary source of energy, using electricity as vector. Because of the size of the battery, the added cost of the all-electric range and grid recharging solutions will be very high; the price range estimated using current data is 5000 to 20,000 Euros.

Exchange of energy with the grid: This is derived from the one just described, but in this case the system will be capable of providing energy compatible with that of the distribution grid:

- to a home network
- to the distribution grid, for the purpose of facilitating regulation by the operators, in particular with respect to supply at consumption peaks
- to the vehicle itself, from 110 or 220 V AC outlets serving to supply auxiliaries for comfort or for work.

The first two will require the use of two-way power grids capable of managing safety functions, operation, and metering in all of these cases, which may require large investments ('smart grid' concept).

Distributed Propulsion

The use of electric motors for propulsion makes it possible to consider innovative architectures, for example propulsion of the rear wheels in a FWD hybrid. The quasi-instantaneous activation of the rear electric motor makes it possible to have a vehicle that is 4WD only when necessary, in other words to enhance safety and drivability while helping to reduce energy consumption through the optimisation of regenerative braking on all four wheels.

Propulsion Architectures

The implementation of the functions described will require the introduction of electric drive motors that can be coupled to the propulsion system in several different ways:

- series coupling, similar to electric propulsion, with a heat engine that is not connected to the driving wheels but powers a generator. The advantages of this solution are that the engine is completely isolated from variations of the power and torque demand of the vehicle, full performance is available in the electric mode, and the solution is simple to control. On the other hand, this coupling requires two electric drive motors, and the efficiency of transmission from the engine to the wheels is low.
- parallel coupling, close to a conventional propulsion system in which an electric motor is mechanically coupled to the transmission. This configuration provides a large number of possible variants as regards the position of the motor (on the drive shaft or not) and its coupling to the transmission (before or after the gearbox, on

the engine and so on). Parallel coupling requires only one electric motor, the power of which can vary according to the functions provided, and allows efficient use of the engine. On the other hand, its performance in the electric mode is more limited, and controlling it is more complex.

- series-parallel coupling or power split, developed for the purpose of maximising savings by combining the advantages of the two possible configurations.
- All-electric architecture, the ultimate step in electrification of the propulsion system, with an all-electric vehicle comprising one or more electric drive motors and an on-board electrical energy storage system. There have already been attempts to manufacture electric vehicles industrially in the past, notably in France and the United States, which were not followed up. However, advances not only in electrochemistry and battery management, but also in the electrical engineering of the motors and in communication (locations of charging stations, and so on) and services (battery exchange), have encouraged manufacturers to propose new products. These latest-generation electric vehicles have ranges of 100 to 200 km and could replace conventional vehicles in a non-negligible share of uses, in particular semi-urban and urban uses. Several automakers, among them Renault-Nissan and Mitsubishi, along with Chinese automakers, have for example announced the marketing of electric vehicles between 2010 and 2012. The prices of these vehicles, equipped with 20 to 30 kWh of lithium batteries, are still very high, with added costs of the order of 10,000 to 20,000 Euros, but progress is expected with the arrival of mass production.

Problems and Prospects

Electrification is destined to play a key role in the optimisation of future vehicles, facilitated by the possibility of implementing it at more or less high levels, making its introduction gradual and thereby facilitating the adaptation of industrial infrastructures. This will make it possible to reduce the fuel consumption of vehicles, to levels that will depend on the degree of complexity chosen and the use of the vehicle, and also to implement such new functions as all-electric range or grid recharging. For these last cases, using electricity as vector will serve to reduce greenhouse gas emissions, dependency on oil and gas, and local harmful effects.

The automakers have already developed, and some of them have brought to market, various hybrid or electric propulsion system concepts. However, it would seem that massive penetration, which is necessary for a real impact on the greenhouse effect, depends on the handling of a number of factors, among them:

- energy storage, in particular the management and safety of lithium battery packs large enough for vehicles, their packaging, aging conditions, costs, new materials.
- the electric propulsion system and auxiliaries, in particular reduction of the volume and cost, improvement of performance in use and of reliability, and better integration;
- recharging infrastructure, in particular accessibility, safety, communication, metering, cost;
- life cycle analysis methodologies. These are necessary in order to determine the true footprint of the vehicle and of its components, from manufacture to recycling, and any problems concerning the availability of materials.
- the sensitivity of the fuel savings to the conditions of use of the vehicle and to the propulsion system technologies (gasoline, diesel), which will require judicious choices for the various types of application.

There are many research programmes under way aimed at progress on these various points. Concurrently, many automakers are planning to put models on the market as early as 2010–2012, after validation in test fleets. For hybrid vehicles, all technologies combined, world market forecasts suggest sales ranging from 3.5 to 8 million units by 2015, or more than 10 percent of all sales on the high assumption.

In a difficult economic context, such a change calls for setting up many collaborative ventures between partners, which already exist between automakers and storage system suppliers and between automakers and suppliers of electric power. At the same time, cooperation with local and national authorities will have to be reinforced so that progress can be made in the areas of standards, incentives, and energy infrastructure.

The determination of the various participants and the developments that have already taken place allow one to think that the electrification of vehicles could be an asset for manufacturers in the sector in the difficult economic and environmental context we are experiencing. The level of electrification of the vehicles sold will depend on success in mastering energy storage, costs, and industrial production.

Asinus Muses

Hope → Nope

One year ago Asinus predicted that 2009 would be the geopolitical year of the carrot: with Obama at the helm, I suggested, the stick would diminish in relative importance in diplomatic circles. This prediction was not itself refuted by events. Less robust has been the optimistic corollary that it would usher in a new age of international cooperation. This hope did, indeed, receive a decisive kicking in Copenhagen.

That's right: Hopenhagen ended as Nopenhagen. It started badly: reports of a draft agreement known as the 'Danish text', allegedly drawn up in secret by an exclusive group of developed countries, drew condemnation from NGOs who declared it a conspiracy of the rich. From bad to worse: the involvement of China did not save a later document from denunciation by the Sudanese Ambassador to the G-77, Lumumba Stanislaus Di-Aping, as 'a solution based on the very same values, in our opinion, that channelled six million people in Europe into furnaces'. This opinion was denounced in its turn by Sweden's chief negotiator, Anders Turesson, as 'absolutely despicable'. From worse to *keine wurst*: after two weeks of denunciation and rejection, no agreement was signed, no commitments made.

Treaties and Tongue Twisters

Instead of an actual agreement, the collective resolved to 'take note' of a non-binding 'accord'. Regular readers of Asinus will recall that the device to 'take note' was used last year to defuse a fight between China and France, and is a curious form of acknowledgement that does not imply endorsement. Thus I suppose I may 'take note' of the fact that a robber has entered my house without thereby offering my acquiescence.

This is one of several linguistic conundrums thrown up by the conference. For instance, can a document correctly be called an 'accord' when most of those involved have not actually agreed to, i.e. declared themselves in accordance with, said document?

In a further challenge to Asinus's understanding of the English language President Obama declared that the accord was 'a meaningful and unprecedented breakthrough—for the first time in history, all the major economies have come together to take action.' Asinus is struggling with two questions: is 'meaningful' consistent with inconsequential, and is 'to come together to take action' consistent with not, in fact, taking action? Asinus now understands why diplomats are required to have excellent language skills.

Wind, Gas and Hot Air

With Middle Eastern music playing in the background, Arabic script on a black screen melts into English: *Go back to sleep, America. The oil crisis is over*. Pause. An inimitable Texas drawl declares: "I don't think so!" Yes, T Boone Pickens is back on the offensive with a new TV advert. Having seen his wind plans drift away his current weapon of choice is natural gas, newly abundant in the US owing to recent technological advances, and a potential alternative to oil in domestic transportation. His primary motivation, he claims, is to reduce oil imports from the Middle East. His advert continues: 'Our economy is bleeding billions for foreign oil.' Other observers might have rephrased this as 'killing thousands,' but that would be another story.

Policing the Amazon

Asinus has just seen another enviro-thriller. *Crude* records the legal challenge of a group of Amazonian Ecuadoreans against Chevron-Texaco. The case is made with shots of black goo pulled up from the subsoil under the houses of the locals, babies with terrible skin rashes, and mothers and children with cancer of the liver. The case, ongoing since 1993, received a boost when it attracted the attention of rainforest-lovers Sting and his wife, Trudie Styler. In one of the film's several comic moments Ms Styler enthusiastically tells the Ecuadorian lawyer for the plaintiffs that The Police will be at a fund-raising concert – having to then quickly explain that she was referring to a pop group, not the repressive arm of the state.

But the big change in prospects was due to the election of Rafael Correa as President, a 'humanist and Christian of the left'. In such cases who is best friends with the government is often the deciding factor in any dispute. In one revealing moment Chevron-Texaco's lawyer declared in court that Texaco had operated in Ecuador since the 1960s with the full legitimation of the Ecuadorian government, 'a government that represents *all* Ecuadoreans'. He failed to point out that the government in question, and subsequent governments until 1979, were military dictatorships – not generally associated with universal representation.

Let There be Light

Madonna has been back to Malawi. She has already adopted two children from the southern African country, the second only after receiving the blessing of the country's Supreme Court. But she has returned on a different mission: speaking in the village of Mphandula, where she already funds a child-care centre, she announced: 'I know you work in darkness. I will bring you electricity.' As singer of the hit single and album 'Ray of Light,' the pop legend is clearly an expert on the subject.

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