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**THE NEW FACTORS AFFECTING
THE SUPPLY OF OIL**

by

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Overview

Romain Bonenfant and Laurent Kueny's dissertation entitled *De l'arme du pétrole aux armes pour le pétrole* (From oil as a weapon to weapons for oil) discusses the state of future oil supplies for the next thirty years. Paradoxically, while there is a problem associated with a shortage of hydrocarbons, there is also a problem associated with their superabundance which results in the release of carbon emissions into the atmosphere producing a dramatic impact on climate. Although the latter problem appears more important than the former, geopolitical crises, which may be generated by a shortage of hydrocarbons, appear to influence public opinion more than progressive climate change. Unless new energy fields can be found to prevent a disruption of supply, and as there is no alternative form of energy available in the near future, there is a risk of price increases in those hydrocarbons which are used, and which will cause increased carbon emissions. Major conflicts may arise between producer and consumer countries. In the consumer countries there may be conflict between those which are already industrialised and those which are on the path to industrialisation.

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TALK : Romain Bonenfant and Laurent Kueny

Romain Bonenfant : Our talk today is based on our dissertation which formed a part of our final year engineering examinations at the École des mines (Paris). This work was carried out over eight months and was based on interviews conducted with experts in the field. Our starting point was the depletion and exhaustion of fossil fuels. The Club of Rome's conclusions in 1976 – that owing to the limited availability of natural resources, economic growth could not grow indefinitely – are still relevant in the 21st century. Today, this is confounded by the paradoxical problem of the superabundance of carbon-derived energy whose use can, in turn, lead to potentially devastating effects on the world's climate.

A paradox

Laurent Kueny : All economic indicators confirm that oil consumption is currently increasing. According to IEA (International Energy Agency) forecasts, energy needs will grow by 52 % between 2003 and 2030. There are an increasing number of books on the bookstands with apocalyptic titles such as *The end of oil*, *The party's over* and *Life after oil*.

However, if one compares the reserves of hydrocarbons which are still available in the subsoil with the equivalent volume of carbon emissions, it is obvious that the consumption of these reserves would necessarily lead to important climate change. One might therefore conclude that we simply have to change our traditional consumption : if we do so, oil will not run out in the very near future. But is our situation one of shortage or superabundance ?

Debate about the volume of the oil reserves

Romain Bonenfant : Experts in the field do not agree on the quantity of oil reserves which remain. This prevents a consensus for predicting the future.

The curve provided by the ASPO (Association for the Study of Peak Oil and Gas) showing the growth in consumption is exactly the opposite of that of the IEA. Between these two, there are many other curves proposed by various forecasters. There are two reasons to explain these divergences.

Firstly, at the present time, proven reserves, ie. the quantity of oil which can be extracted from the subsoil under reasonable technical and economical conditions, represent an additional forty years of consumption if current consumption levels remain constant. Even if consumption increases, it has been estimated that there will not be an oil shortage before 2030. However, this prediction is based on data which should be treated with caution, since the figures provided by OPEC (Organisation of Petroleum Exporting Countries) oil-producing countries are the basis for calculating their production quotas and are therefore eminently strategic. A number of bodies, such as the ASPO, consider these figures to be significantly exaggerated.

The second reason concerns the dynamics of development. Even if oil reserves are indeed abundant, there is nothing to suggest that producer countries will be able to increase production sufficiently to match an increase in consumption. According to the ASPO, there will be no more important discoveries of oil, and the relatively small oil fields which are now being exploited will not be able to compensate for decrease in production.

As well as the lack of consensus between geologists, there is the economists' point of view. Generally speaking, economists think that oil reserves can be increased in response to the price of oil, in other words, the greater the price of oil, the more likely one is to resort to costly extraction techniques. However, geologists reply that there is a limit to the amount which can be extracted and we will soon be reaching saturation point.

Confronted with these contradictory forecasts based on discussions between experts and rather vague data, authorities appear to be paralysed. Many do nothing because they believe that alternative sources of energy will be developed.

Alternative sources of energy

Non-conventional oil, in other words, in its solid form, represents a considerable potential. The existing stock of solid oil is equivalent to the amount of all the liquid oil reserves in the Middle East. However, the IEA estimates that solid oil will only represent 6 % of world production in 2030 because its exploitation requires huge investments. For example, the IEA thinks that an investment of 92 billion dollars is necessary in order to exploit non-conventional oil in Canada.

Biocarbons are very fashionable, but if one wanted to use this form of energy, for example for the entire French transportation system using current technologies, at least three times the area of land currently cultivated in France would have to be transformed. However, the IEA estimates that even if one were to increase voluntarily the potential for the production of biocarbons, in 2020 they would still not account for more than 5 to 6 % of the consumption used by the transport system.

Carbon liquefaction was already used industrially during the Second World War when it accounted for 90 % of the German air force's energy consumption. However, this process produces a great deal of carbon dioxide and such emissions would have a significant impact on climate if one decided to use this method to create energy.

Laurent Kueny : All these solutions demand considerable investment and it is by no means certain that such investment can be made confidently in view of the variations in oil prices. Furthermore, the demand for oil is based on transport : 50 % of oil produced is consumed by the transport sector and 98 % of energy used in transport is oil-based. There is no other credible energy substitute for this sector, and we cannot afford to wait and hope for a miracle in the form of an alternative energy source.

The geopolitical 'peak oil' debate

Contrary to doubts regarding the reliability of estimates of oil reserves in OPEC countries, there are relatively reliable data for non-OPEC oil-producing countries, such as Norway. We know that these countries will reach production saturation levels between 2010 and 2015. The only countries which will then be in a position to respond to an increased demand for oil will be the OPEC countries. This will give them considerable power.

Romain Bonenfant : For several decades, the market ensured the supply of oil, as it acted as a regulating mechanism for supply and demand. However, this was not always the case : in the early days, when producer countries started developing their oil industry, the model adopted ensured the entire production chain from the exploitation of oil fields (generally in the colonies at that time) to the transportation of oil, its refining and its distribution.

The establishment of a large oil market guaranteed producers a long-term income, limiting the risk of crises which could weaken this sector by using new technologies. It also allowed oil-consumer countries to continue their programme of economic development because oil was available at a reasonable price.

Satisfying the interests of both producers and consumers is now being called into question : OPEC member countries now find themselves in a strong position because they are the only countries capable of increasing oil production and they know that there is no credible energy alternative in the immediate future. Such a situation can be referred to as a 'geopolitical peak oil' situation.

Increase in the number of bilateral agreements

Laurent Kueny : The first signs of this new power struggle have been apparent for some time.

In 1998, Hugo Chavez came to power in Venezuela. In 1999, he asked OPEC to study the idea of a 'reasonable price range' with a minimum price to ensure the profitability of investment, and a maximum price of approximately 20 Dollars a barrel. However, he soon realised that oil consumer countries are dependent on their supplies and have no alternatives and no power. This forces them to remain dependent on this resource, regardless of the price set. From 1999 onwards, Chavez tried to take state control of national oil reserves and in 2002, he nationalised the Venezuelan oil company PDVSA (Petroleos de Venezuela). Multinationals now have to be content with minority shares in mixed economy companies. Hugo Chavez has tried to export this strategy which is based on 'alter-globalisation' (where values of democracy, human rights and environmental protection are more important than purely economic concerns) and anti-American ideas, and in so doing, he has attempted to lay the foundations for a sort of international solidarity between countries in the Southern hemisphere.

He has also developed bilateral agreements which avoid the 'big basin' of the world oil market. With an initiative called the 'Bolivarian Alternative for the Americas', Venezuela supplies 53,000 barrels of oil per day at a preferential rate to Cuba, amounting to one third of its energy needs. In exchange for this, Havana supplies Caracas with 20,000 doctors who manage health centres in the shanty towns and far-flung villages of Venezuela. There are increasing numbers of bilateral agreements like this between Venezuela and fifteen or so other countries in the Caribbean. In Spring 2006, the Bolivian president, Evo Morales, nationalised hydrocarbons and has started to put in place bilateral agreements with African countries.

The fragmentation of the market

At the same time, some consumer countries are raising prices because they are starting to appreciate the difficulty they will encounter in the coming years to meet their growing energy needs. This applies to India and China who are trying to establish new sorts of bilateral contracts with certain producer countries.

China is currently investing heavily in regions where installation and development are particularly difficult, such as the Niger delta, Sudan and Libya. It is able to do this by using national companies and because of contractual proposals which are very different to those which Western multinationals can offer. There are rumours concerning the supply of arms and of corruption prevalent in Chinese national companies. Multinationals do not allow themselves to indulge in such practices. Moreover, the more important multinationals are under a great deal of pressure from their share-holders to be profitable, whereas Chinese companies benefit from huge cash contributions.

There is a risk that regional markets will develop and function according to the bilateral method and not the international method : this may eventually jeopardize the continuing supply of oil. An interpretation of the reasons for the war in Iraq is that it was an example of an attempt to impose democracy and a liberal economy so that Iraq could continue to 'supplement' the large international 'oil basin'. One can appreciate the limitations of a method which has to resort to violent means in order to maintain a liberal system by force.

Towards a troubled future

This change may stimulate a return to the previous situation when Western countries signed trade agreements with African or Middle Eastern countries. The difference now is that we are no longer the colonial master, and countries like China deliberately trade on the spirit of third world solidarity in order to get contracts, and are clearly opposed to post-colonial influences

which they denounce with increasing virulence, especially in Africa. Important international companies find it increasingly difficult to keep their market share in these countries.

With this volte-face in the balance of power, there are other sorts of risks, some of which are what one might expect. These include the temporary withdrawal from the market of a producer country for geopolitical reasons, stopping the supply as a result of terrorist action, and completely new reasons, such as natural climatic disaster. In the space of a few hours, Hurricane Katrina destroyed 8 % of the world's refining capacity.

Reactions to the geopolitical 'peak oil' debate

Romain Bonenfant : From 2015 onwards, in other words tomorrow, Western economies will be faced with this geopolitical peak oil situation. As engineers, we would like to believe that a technological miracle will take place, and that alternative energy sources will be developed, especially in the transport sector. We have seen that it is very unlikely at the present time.

The scenarios which are more likely to become reality are much more worrying. The first scenario is 'oil at any price' : consumer countries will force producer countries to continue to supply the international market, even at the price of armed conflict, as witnessed in Iraq. The second scenario would also see the development of armed conflict between powers attempting to form bilateral agreements, such as China, and those who want to keep an international market, such as the United States or European countries. A third scenario would see an oil shortage, encouraging consumer countries such as the United States and China which have considerable carbon resources, to develop carbon liquefaction on a grand scale without having a stockpile of carbon. This solution would jeopardize any hope of controlling climate change.

Laurent Kueny : Faced with two important issues – the shortage of oil and climate change – the solution appears to be simple : one should withdraw from the oil game altogether, make draconian savings on energy, and invest huge sums in alternative technologies. However, all these solutions are extremely expensive and no single Western economy – not to mention that of a developing country – wants to abandon the use of oil. There is a sort of opposite version of the Prisonner's dilemma where abandoning the game results in a huge cost : no-one is ready to agree to this sacrifice unless one's neighbour agrees as well. There is an increase in alarming signs of climate change, but it still does not encourage policies to reduce demand.

Over many years, countries were more or less uninterested in discussions about energy, because the liberalisation of the market seemed capable of ensuring a safe supply of oil. Today, we appear to have come to the end of this kind of thinking : the current situation requires a return to state power, either by individual countries or by groups of countries, in order to be able to put in place strong measures which will allow us to face up to these important issues in the coming years.

TALK : Olivier Appert

I agree with the analysis and almost all the conclusions which have just been presented. According to André Giraud, 'oil is a raw material which has a powerful diplomatic and military significance, is financially important and in addition has calorific value.'

The sponge and the shoe box

Politicians and journalists have a problem understanding what exactly is an oil deposit. They think it is a lake for canoeing or a bath which is gradually emptied. When I talk to non-experts in order to explain the problem, I wet a sponge with a drop of wine, I put it in a shoe box and I make holes in the box with two knitting needles with which I try to determine the quantity of wine soaked up by the sponge. This gives quite an accurate picture of the difficulty in assessing an oil deposit.

The ways in which reserve levels in an oil deposit are estimated include the physical size of the sponge (in other words, its surface area, its volume and its porosity) ; its technical dimension (in other words the ability to recover the oil in the deposit according to its quality and available technology) ; and finally its economic dimension (which depends on the sale price of the extracted oil). If one were to change each of these parameters by plus or minus 20%, it is easy to calculate that there is a two to three-fold uncertainty in the estimated amount of reserves according to the whether one proposes an optimistic or pessimistic hypothesis. It is therefore impossible to assess with certainty the volume of the available reserve.

An important turning point in the assessment of these reserves took place in 1985. Up to that time, more oil was discovered than was being produced. Since 1985, important oil discoveries have been made, such as the oil deposit of Kachagan in the Caspian Sea. However, annual production is now greater than the discoveries of new deposits

Nevertheless, estimates of world reserves remain at the same level. The geologists and bankers of important multinationals in particular are cautious. When they announce a discovery, they prefer to underestimate it in order to announce the good news to their shareholders, rather than having to present them with a downward re-evaluation. During the development of the deposit, it becomes easier to appreciate the size of the sponge and the quantity of the 'wine'. The shoe box becomes transparent and, since a certain amount of caution was exercised from the start, the reserves are generally revised upwards. In Africa, between 1999 and 2003, half of the increase of reserves came from new discoveries and the other half from the re-evaluation of discoveries which had already been made. The same phenomenon has been observed on a global scale for twenty years.

Technological innovations

Another reason why the reserves remain stable is that we are improving the way in which we 'squeeze the sponge'. This is where I differ from Romain Bonenfant and Laurent Kueny's conclusions : new technologies may strongly delay the moment of 'peak oil'.

Real reserves are very difficult to understand. We know precisely the total amount of oil produced from the start, but our estimate of discovered reserves is inaccurate : these reserves form only a part of global resources. In addition to these are resources which will be discovered in the future, as well as some reserves which cannot be currently developed, but will be later, due to new technologies. Today, only 30 to 35 % of the oil exists in a deposit is produced. If we were able to increase this to 50 %, we would almost double the amount of the available reserves.

The geopolitical challenges of hydrocarbons

The subject of peak oil is in fact less worrying than the extremely uneven distribution of oil in the world. Saudi Arabia alone possesses 25 % of the world's oil reserves and the entire membership of OPEC countries accounts for 70 % of these reserves. However, some of the countries are not geopolitically particularly stable and this is where the real danger lies, and not in determining the exact volume of reserves. As the English say, the real problem is not 'what you see', but 'what you can't see'.

Another geopolitical challenge concerning hydrocarbons is the concentration of the oil trade between the Middle East and the rest of the world. By 2030, one third of traded oil will be transported via the Strait of Ormuz, a zone where a little less than a year ago, the Iranians tested their ballistic missile which is capable of carrying a nuclear warhead.

The second challenge is the size of the investment necessary to increase oil production and even to keep it at its current level. During the past thirty years, most of the investments were made in OECD (Organisation for Economic Cooperation and Development) member countries. Over the coming thirty years, most investments will be made in countries situated outside the OECD, in other words, the Middle East, Africa and Russia. But will these countries agree to make the necessary investments in time ?

The third challenge is the loss of flexibility of the oil market. After the first two oil crises, the OPEC countries created an overproduction which could be used in times of crisis. This was the case, for example, during the Gulf War in 1990, when Iraq and Kuwait stopped supplying the market. But this overcapacity diminishes year on year : whereas in the beginning of the 1980s, it was 10 Mb/d (million barrels/day) for a global market of 70 Mb/d, today it is only 2 or 3 Mb/d for a market volume of 85 Mb/d.

Reactions

Faced with these challenges, the reactions of those involved are, to say the least, inadequate.

The UN (United Nations) is powerless to force countries to abide by the Kyoto Protocol. The most important outcome of the UN Nairobi Climate Change Conference which took place in October 2006, was to fix a date for another conference in 2007. And yet industrialists and governments are taking decisions right now which will have an impact over the next fifty years. During the next ten years, China will have to increase a power generation capacity equivalent to the entire production of Europe. The power stations which China is going to build will still be functioning in 2050 or 2060. Will it build power stations which are not carbon-based ?

OPEC has managed to recover a degree of control of the market which it had lost during the 1990s and the early years of this century. One of the consequences is the rise in power of the NOC (National oil companies) countries by comparison with the IOC (International oil companies) countries whose access to mining areas is being increasingly rejected.

The IEA has created oil stocks, but this is a 'one-shot' approach : what will happen when these stocks are exhausted ?

Europe appears to be very short, not only of energy sources but also diplomatic and military capacities. As explained in André Giraud's quotation, this is a key dimension. .

During this time, those involved in the market make use of the short-term price volatility which is very important in the oil sector because of its geopolitical context, and is even more attractive because colossal volumes are involved.

I shall finish with a remark from Sheikh Ahmed Zaki Yamani, the former Saudi minister for oil during the two oil crises. He said 'the Stone Age did not come to an end because there were no more stones left. The Oil Age will not come to an end for lack of oil.' This can undoubtedly be applied to the environmental challenge which I shall not discuss due to time constraints.

TALK : Hervé Juvin

The serious content of our discussion this evening is not completely new. Many episodes in the history of the 20th century started as a result of war over oil. There are numerous examples : the German army advancing towards the Bakou oil wells ; the 1956 Suez crisis ; and the overthrow of Mohammed Mossadegh, Iranian Prime Minister under the Shah in 1953, to name but a few. What is new is the recognition that the level of oil resources on which our economies are based is fragile. There are several reasons for this.

The world no longer belongs to us

The Industrial Revolution was only possible because, for a century and a half, almost all the natural resources of this planet were removed in an uncontrolled way by a very small number of Western countries. In the past, the entire world was at the disposal of the West ; now we are in competition with newcomers. The people who had been faced with queues for petrol in Indonesian or those who had witnessed Chinese factories ceasing production because of lack of electricity, know exactly what it was all about.

Too much trust in the market

After the second oil crisis, we became lethargic, lulled by the illusion of a perfect market, which in times of shortage would give us sufficient notice of price changes and would allow us to prepare ourselves for the medium and long term. We did not anticipate the necessary investments, both from a technical and training point of view. Today, oil companies, suppliers and important equipment manufacturers seriously lack the skills in areas where it takes many years to train experts. Those experts who are available are employed with huge starting salaries.

The end of liberalism

The confrontation between American and European interests in relation to Iran or the reconstruction of Iraq, made us realise that henceforth it would not be enough merely to win tenders in order to have access to the market. Twenty or twenty-five years ago, the important multinationals, which were all Western, were able to exploit nearly 80 % of world reserves. As a result of various nationalist movements previously mentioned, the important multinationals are now competing to obtain contracts to exploit just one quarter of all the oil fields.

I think there is an increasing number of rifts between a Europe, whose liberal politics and economic beliefs are no longer shared by anyone else in the world, and the United States, whose clearly defined objective is to preserve its supremacy. The United States made it very clear to the Chinese administration that it was out of the question for them to deploy their air force or their navy in order to guarantee oil supply routes, as such action would be interpreted as a threat to the domestic security of the United States.

I interpret these various phenomena as a sign that economic and political liberalism has come to an end, and that we are going to witness an important return to the nation state. It is striking that the important oil companies have hardly been mentioned in this talk. Ten years ago, their

names would have been cited all the time in such a discussion. French or European diplomatic pressures may result in a decision in which Total is asked to close an oil field.

Europe : moved to the sidelines ?

Countries in Europe are caught between a very strong cultural and political dislike of the nuclear situation, and have great difficulty in finding an agreement to combine a mixture of energies which would produce European energy independence. Our suppliers are aware of our weaknesses and the Russians, for example, are asking, that in return for supplying gas, they take control of our distribution networks, or have shares in certain high tech companies. A coordinated European response has still to be formulated.

The end of political and economic liberalism does not mean the end of the market. However, this institution conforms to rules which member states have always manipulated in one way or another. It is undoubtedly true that European states are no longer in a position to make the rules for a future energy market. It is likely that the rules will be written by both the United States and China. It is certain that in the years to come, we will become painfully aware, at least in this energy sector, that we are pygmies although we would like to be considered giants.

DISCUSSION

Caught between Scylla and Charybdis

Question : *The first speaker explained that we are going to be faced with both a problem of shortage and superabundance. He hinted that the more serious of the two was superabundance because of its likely consequences on the planet. However, as the talk continued, it was the oil shortage which dominated the talk.*

Laurent Kueny : Climate change is a more serious problem and will become even more important as time goes by. However, more importantly, one has to deal with the question of the supply of oil in view of its geopolitical repercussions. Curiously enough, the solution to both problems may be the same, in other words a return to political control of energy management.

Romain Bonenfant : The problem of oil shortage will be the first to be tackled but if we do not solve it correctly, we will be in an even worse position to control climate change.

Hervé Juvin : It is tragic to see a country like Madagascar caught up in a scissors effect (where revenues and expenses move in different directions). Oil is not expensive there and people use it as an energy source for cooking. But when prices increase, people walk for hours in order to find wood to burn, even from natural reserves. In this way, they destroy the remaining wood reserves of the country, and by creating such deforestation, they aggravate the greenhouse effect.

Olivier Appert : From a pragmatic point of view, if one examines the results of Hurricanes Rita and Katrina (after which the price of crude oil soared), one realises that the priority of French and politicians was not to strengthen a rational policy aimed at controlling energy with a sensible approach to climate change, but simply to reduce taxes on fuel so that people were able to continue to consume as much fuel as before.

H. J. : Both problems will result in a return to state control. For a long time, we thought that the market adequately regulated everything, and that differing individual attitudes would allow us to prepare for the future in the most efficient way possible. It is difficult for individuals and the market to respond to the issues of oil shortage and climate change. A return to state control can take various forms. An energy policy has more impact with a group

of countries rather than with a single state. It is likely that we will see a reorganisation in order to create blocks of 'sovereign' countries. If such a change takes place, it will clearly be against the tide of events which have followed the fall of the Berlin wall. On the other hand, we will probably see the construction of new walls, such as exist on the Mexican-United States border, the border between Pakistan and Afghanistan, and the one which separates Israel from the Palestinian territories.

Are there positive scenarios ?

Q. : *Apart from the catastrophic scenarios which have been mentioned, is there any possibility of any other scenarios which could provide the slightest glimpse of a solution ?*

O. A. : What is the probability in the next six months that George W. Bush will decide to attack Iran ? What would be the consequences be of an air attack on Iran by Israeli forces ? What are the chances that the United States will succeed in establishing peace in Iraq and restart its oil production ? What positive scenarios can possibly be envisaged given such uncertainty ?

Too much oil !

Q. : *The crucial question seems very clear to me. Are we, or are we not, threatened by a greenhouse effect with extremely serious consequences ? It seems that the answer is 'yes' and in this case, the issue of the shortage of oil is irrelevant. We are going to have to deprive ourselves of a fossil fuel even though it is available. There appear to be two solutions : firstly, stop the supply at its source, in other words where the oil, gas and carbon are supplied, or, secondly, stop it at its outlet, in other words, the consumers. It is the second choice which was adopted by the Kyoto Protocol. If it fails, which is unfortunately likely, the situation will become catastrophic in a very short space of time, and public opinion will eventually put pressure on producer countries to curb their sales of fossil fuels.*

L. K. : People are very slow to appreciate the effects of climate change. Who could have imagined that three years ago New Orleans would be wiped off the map one day by a hurricane ? But it happened, and we have to accept this and rebuild the city. Problems of oil supply will certainly have a much more decisive impact.

Q. : *The Kyoto Protocol itself is clearly not enough to solve the problem of climate change but at least it allowed us to see what international governance, based on economics, would be like. It also made us realise that some resources, which up until then had been free, now come at a cost, and that furthermore, there is no winner : we can only use these resources if we refuse to allow other consumers to use them.*

Investment in technologies

O. A. : Kyoto has been an important step. But it is a first step which will not solve the climate change challenge. I am concerned by the fact that when Europe is trying to adhere to the Kyoto Protocol, the United States is investing massively in research, and in 2020, it will flood the planet with its technologies.

L. K. : Even though Europe is unfortunately quite helpless to intervene from the point of view of defence or foreign affairs, it is nevertheless capable of starting research programmes and could decide to invest massively in alternative energy. Even though there is no chance of a miracle solution in the near future, a solution is absolutely essential for the future.

Q. : *Unfortunately, Europe does not need to wait for Kyoto to establish its research budget at a level which is significantly lower than that of the United States...*

Q. : *You seem to overlook the ability of those involved in the market to react, and in particular you considerably underestimate the billions which are being invested in alternative technologies. Japanese car manufacturers are fifteen years ahead of their European counterparts in terms of hybrid engines.*

R. B. : The problem is not only a question of investment, but also one of time in order to develop new fields. This timescale does not correspond to the foreseeable deadline of geopolitical peak oil.

Energy savings ?

Q. : *The European Commission recently put forward a plan for the next twenty years to reduce the use of fossil fuels by 30 % : 20 % would be reduced due to better energy efficiency and 10 % to alternative energy sources. This corresponds roughly to the savings made during the first oil crisis. Today, why does everyone think that such a reduction would be unrealistic ?*

O. A. : Today's situation is very different to that of 1973. Since 1973, oil intensity, in other words, the number of oil barrels per point of GDP (Gross Domestic Product) has been cut by one third, because of both technological progress and the transfer to poor countries of industries which consume a great deal of energy. The nuclear programme has also contributed significantly to the reduction of the consumption of fossil fuels. Our options are now much more limited.

L. K. : The United States, which represents 25 % of global oil consumption, has greater economic margins but its geography lends itself less well than that of European countries : its distances are very great and its cities were built for the car. By contrast, China's equipment needs are huge : there are still only 18 cars per 1,000 inhabitants, whereas there are 800 cars per 1,000 inhabitants in the United States ...

And gas ?

Q. : *I am surprised that you have not mentioned natural gas which has numerous advantages. The reusable reserves are much greater than those of oil, and natural gas can be used for transport. A large number of Parisian buses currently run on gas.*

O. A. : Gas reserves are also situated in a few countries : two-thirds are in Russia, Qatar and Iran. During the last few months, Russia has decided to exploit these gas fields itself, instead of calling on international companies. Because Russia was already in a state of under-investment, the situation has become very worrying. Qatar, which shares a very large oil deposit with Iran, decided to adopt a moratorium on new development projects. Finally, in the current climate of concerns about Iran's nuclear programme, it is unlikely that Iranian gas will be commercialised in Europe in the immediate future. These different elements presuppose large price increases which will not improve the competitiveness of gas : in terms of energy costs, it is less competitive than carbon, and with respect to climate change, it emits CO₂ and is therefore less competitive than nuclear energy.

A danger for democracy ?

Q. : *Will democracy be threatened by the major geopolitical risks which you have discussed ?*

H. J. : If everything which has been said tonight is true, in the near future we are going to be faced with shortages in areas where they were never envisaged, such as drinking water, breathable air and food resources. We will be entering into a new historical and political situation characterised by an end of the belief in progress, based on the fact that for a century and a half the entire world was at our disposal. The threat which you mention is very likely to

be a real one. The early stages might be characterised by a generational conflict with young people criticising us for being totally disinterested in the world which we will leave them.

O. A. : Questioning the democratic principle will tend to result in international migration which will almost certainly become more pronounced, and will put increasing pressure on rich countries, both because of the poverty linked to soaring energy prices, and climate change which will strike certain countries which are already very poor.

The personal role of managers

Q. : *You explained that the market was no longer able to play its role and that we would see a return to nation states. When one considers the personal role played by George W. Bush, Vladimir Putin and Mahmoud Ahmadinejad even though they lost public confidence, one could wonder whether the situation is going to deteriorate even more and turn to confrontation between statesmen.*

L. K. : Throughout history, there have always been statesmen such as Nikita Khrushchev or John Fitzgerald Kennedy who have played decisive roles. The difficulty which we encounter with the current leaders in China, Iran, or even in Venezuela, is that it is difficult for us to understand their psychology and their strategy. They do not follow a clear, coherent doctrine and because of this, their decisions can be very unpredictable.

Q. : *The apparent coincidence that regions which are rich in hydrocarbons are also particularly unstable is not really the result of chance. This phenomenon, which was widely studied and documented, is called 'the resource curse'. According to the theory of comparative advantages put forward by David Ricardo, when a country is more efficient in terms of a certain production than its neighbouring countries, its other activities are comparatively less profitable and so it tends to abandon them and concentrate on those activities which are efficient. This is a structural phenomenon which does not have a great deal to do with the personality of Mahmoud Ahmadinejad or Hugo Chavez. Every time one discovers important quantities of oil or gas in a country which does not yet have a well established democratic tradition, sooner or later the country will be plunged into chaos. The free game of the economy is then a factor which merely serves to aggravate the situation rather than to bring solutions.*

Presentation of the speakers :

Romain Bonenfant : engineer, Ecole des Mines ; national expert, on secondment to the Directorate General for competition, European Commission.

Laurent Kueny : engineer, Ecole des Mines ; in charge of the Marseilles division for the French Nuclear Safety Authority (ASN : *Autorité de sûreté nucléaire*).

Olivier Appert : president of the French Oil Institute (IFP) ; engineer, Ecole des Mines. He was the director for energy policy at the International Energy Agency (IEA). He occupied a number of positions in the Ministry of Industry and in the cabinet of the Prime Minister, including director for hydrocarbons in the Ministry of Industry.

Hervé Juvin : president of the Eurogroup Institute. He has published several articles and books about society in general. His latest book, entitled *La Production du Monde* (The Production of the World), will be published by Éditions Gallimard in September 2007.

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