Security of energy supply: a European perspective

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Abstract

Europe is finally engaging in a debate about the security of its energy supply and the appropriate policy response. Following a silence that lasted for far too long, the media, and politicians are clamouring for a European energy policy worthy of its name, capable of delivering a high security of supply and ensuring high environmental quality as well as competitive energy prices. While this renewed interest is highly welcome, one must note that this sudden commotion is the result of a conjunction of the most diverse structural facts, short-term events and motivations. In the short term, this makes the debate difficult to follow; in the long term, this heterogeneity impedes the formulation of policy recommendations that are economically efficient, politically sustainable and feasible from an energy point-of-view. The purpose of this article is to clarify the context and the background of the debate, to develop a conceptually coherent notion of energy supply security and to develop on that basis three general principles for energy policy-making as well as a number of concrete policy recommendations. Part 1 will trace the main contours of the current debate on the security of energy supplies in Europe. Part 2 will provide the main facts concerning Europe's current energy supply in the oil, gas and electricity sector. Part 3, finally, presents a more conceptual discussion of the notion of energy supply security and will conclude with a list of concrete measures the European Union can take now to improve the security of its energy supply.

1. The current debate on European energy supply security: contours and limits

During the last 18 months, concerns that European energy supply security might not be at desirable levels were nourished by the following facts:

1) a three-fold increase of the oil price in nominal dollar terms (corresponding to a doubling in real Euro terms) due to fast-growing Asian demand and the inability of producers to expand capacity in the short run;
2) short-term interruptions by Russia of gas supplies to Ukraine (December 2005) and oil supplies to Byelorussia (January 2007);
3) the creation of a new CO_2 permit market whose workings, impact and future are still uncertain;
4) tensions in European wholesale power markets with price increase of 30 % during three years accompanied by a series of blackouts due to declining reserve margins and insufficient investment in peak-load capacity;
5) a nuclear renaissance that has not yet fulfilled its initial promise despite new reactor constructions in Finland and France; renewable energies that remain stubbornly uncompetitive;
6) persistent political and geopolitical tensions in the Middle East (Iran, Iraq…), Venezuela and Nigeria;
7) intense investment activity by China in the energy sector of African countries with frequently fragile governance structures;
8) highly publicised discussions about a global "peak oil" and the future availability of physical oil supplies;
9) the rise of national oil and gas companies such as the "new seven sisters" (Saudi Aramco, Gazprom, NIOC, CNPC, PDVSA, Petronas and Petrobras) to the detriment of established majors;
10) technical difficulties in significantly expanding hydrocarbon extraction in hitherto un explored regions (deep-sea drilling, Arctic exploration, oil sands);
11) individual initiatives of EU member countries to construct gas pipelines (Germany, Italy, Hungary, Greece) outside of European coordination;
12) the increasing financial sophistication of energy markets which makes price formation les transparent and more difficult to understand for

non-financial players;

13) a re-organisation of the European energy industry with long accustomed to national monopolies giving way to a European oligopoly;
14) increasing European import dependency for both oil and gas given the decline of British and Dutch reserves;
15) finally, a European energy policy that has not yet decided upon how to organise the trade-offs between its multiple objectives; and the absence of a meaningful debate on energy prices.

It is obvious to the informed observer that only a few items on this list are actually security of supply issues in the proper sense. Higher prices due to resource scarcity, for instance cannot be combated by policy decisions, but require preparation, adaptation and the appropriate information and education of the public. Nevertheless, all of the above issues intervene in the current European discussion about the security of energy supply. One of the tasks of policy, however, is precisely to distinguish between those parameters over which Europe's policymaker do have leverage, for instance the organisation of electricity markets, and those that need to be accepted as unpleasant and inevitable facts such as resource scarcity and geopolitical tensions over which Europe has little leverage. Occasionally, European policymakers would be well-advised to adopt the fatalistic realism of Winston Churchill who stated as early as 1913 that "Safety and certainty in oil lie in variety and variety alone".

Fortunately, even if politics has little influence, certain facts seem far more dramatic in the short-term than in the long-term. Take the 1973 oil choc. First, the sudden price rise brutally affects consumers stuck in their behaviours; but then habits change, cars become smaller and more efficient, houses better insulated and new equilibria are found. Supply problems indeed look a lot worse in the short-run than in the long-run and what matters is not so much the absolute level of prices but the speed, magnitude and direction at which prices changes. Finally, the less energy per unit of value added a society consumes, the more flexible and adaptable it is when prices change. This is where governments do have a role to play. It is no coincidence that the recent tripling of oil prices had a very limited economic impact: fiscal and administrative measures have succeeded in rendering industrialised countries half as oil-intensive as thirty years earlier.

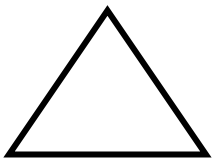
A different issue is raised by internal European policies whose consequences on security of supply have not always been fully thought through. The push for liberalisation of the electricity market favouring the use of natural gas and the hesitations on nuclear energy – in several cases European policymakers at DG COMP and DG TREN need to learn to incorporate security of supply issues in their decision-making matrix. Fortunately, there exists in this case an important example on how internal decision-making contributes to improving supply security. Europe's ambitious objective on reducing carbon emissions contributes to reducing the demand for CO_2-intensive hydrocarbons.

In addition, the inability of policymakers in the European Commission and national governments to decide between competing – and sometimes contradictory – objectives adds to the objective difficulties Europe is facing. Reducing greenhouse gas emissions, limiting subsidies, decreasing import dependence, phasing out nuclear power, augmenting the use of renewable energies, liberalizing energy markets, increasing economic competitiveness… the wish-list of energy policy objectives is very long indeed and not every addition is carefully considered in all its consequences. Crucially, European efforts to improve energy security are hampered by the lack of an internal consensus about the trade-offs between competing policy objectives (see the illustration of the unsolved European energy triangle below).

The unsolved triangle of European energy decision-making

1. Security of supply

(Stability of international trading system, short-term emergency storage)



2. Environmental objectives

(Kyoto Protocol, share of renewable energies)

3. Economic competitiveness

(Liberalization, nuclear power, Lisbon strategy)

As long as European policymakers have not made up their minds about the trade-offs between these different objectives, there are no easy solutions. Increased coal consumption, for instance, will improve security of supply but hamper the achievement of environmental objectives. Or more deployment of renewable energies will contribute to these environmental objectives but will harm economic competitiveness.

Finally, there are issues that seem important at first sight but actually constitute diversions from the true underlying problems. "Rising import dependency" is a headline-grabbing issue where breathless commentators forecast (correctly) EU oil dependency rising from 80 % to 90 %. True enough, however what these commentators fail to point out is that during the 1960s Europe's oil dependency was well 100 % without that this situation based on geological fact raised much concern. The real issue is, of course, the extent to which global energy markets are capable in smoothly allocating demand for scarce resources through the price mechanism according to the willingness to pay of different groups of consumers. In other words, the issue is the transparency, liquidity and flexibility of energy markets. The policy void concerning any multi-lateral approach to securing and strengthening global energy markets and their governance in terms of monitoring and arbitration is more of a threat to the security of European energy supplies than any quantitative import ratio.

Another example is the occasionally bizarre discussion about "peak oil" that seems to imply that this moment maximum oil production is reached, the world will slide inevitably towards a pre-petroleum stone-age.[2] The truth is that reaching the "peak oil" will be of little immediate consequence. For all that matters, we might have already passed it. Serious experts agree that the profile of global production will not be an inverted "V" but an "undulating plateau", where annual oil production no longer increases significantly but where new discoveries and better technologies balance declining production from mature fields. Of course, the question whether global production can be increased significantly remains important, in particular to the extent that it implies that increases in demand will require increases in price rather than in supply. However, changes will take place gradually over years and decade rather than in one crucial "peak oil" moment. Occasionally it is helpful to recall Maurice A. Adelman's insistence on the fact that the last barrel of oil will never be taken out of the ground. Oil (and gas, by the way) is not stored in a pool to which consumers have unlimited access and which quickly run dry once consumption has maximised but the product of complex inter-temporal investment decisions that shape an ongoing battle between increased ingenuity and rising supply costs.

Finally, there are the true issues which do not receive sufficient attention such as Europe's rising gas intensity, the levelling off of Russia's gas production in the face of rising European demand and the absence of any meaningful debate on energy prices (issues that shall be discussed in the following chapters). The first issue is directly linked to internal European policies on gas market liberalisation. In order to durably improve its security of supply, European policymakers need to do three things first:

- Decide on a clear trade-off between the priorities of environmental quality, security of supply and low energy prices; with many European companies operating in highly competitive global markets, any increase energy prices will have to be argued for very carefully. Without higher energy prices, however, limiting energy demand or improving energy efficiency will remain elusive;

[2] The « peak oil » hypothesis of the American geologist Hubbard predicted a bell-shaped oil production profile for the continental United States and predicted the peak of production, by and large correctly, for the early 1970s. Hubbard heuristic prediction based on US national assumptions has little implications for global oil supplies except as far as the obvious is concerned: production will have to decline some day.

- Reflect carefully on the interaction between internal policies such as electricity and gas market liberalisation or emissions trading and policies to improve energy supply security; by and large, the former has reduced and the latter improved security of supply;

- Pursue, wherever possible, multi-lateral rather than bilateral approaches; a commitment to an open and transparent energy market is crucial for Europe's security of supply; this includes downstream and upstream integration with supplier countries, currently still fraught with apprehensions on both sides, which needs to be gradually pursued putting in place appropriate safeguards in producer and consumer countries.

Most importantly, Europe needs a coherent strategy to safeguard its energy supplies based on openness, international cooperation and reciprocity. Europe does have some advantages in securing its energy supply. For instance, it is in "pipeline distance" (3000 km or less) of two thirds of global gas reserves and has overall well diversified oil and gas supplies. Its consumers are relatively energy efficient and catching up fast with best-in-class-Japan. Europe is the global leader in reducing greenhouse gas emissions and several European companies such as BP, Shell or Total are amongst the world leaders in the exploitation of hydrocarbons.

A careful look at European energy realities will reveal that Europe will have to rely on international markets to provide its citizens with heat, transport and electricity for decades to come. Renewable energies might become cheaper, nuclear might make a comeback, energy efficiency might rise dramatically – nothing will change the fact that even under the most optimistic circumstances, Europe will import at least 10 million barrels of oil and around 1 billion cubic metres of gas per day. Ensuring that the markets Europe relies on are as liquid, transparent and competitive as possible should be European policymakers' highest priority. Lately, European policymakers, not least in their tentative proposals to promote security of supplies, have been engaged in a number of "dialogues", "neighbourhood policies", "special relationships" etc. Of course, diplomacy frequently proceeds on a bilateral basis. It is crucial, however, to recognise that no single bilateral relationship can be more important than the working of global energy markets, in which each side is free to cater for its own advantage. Strengthening that market on a multilateral basis must become a European priority.

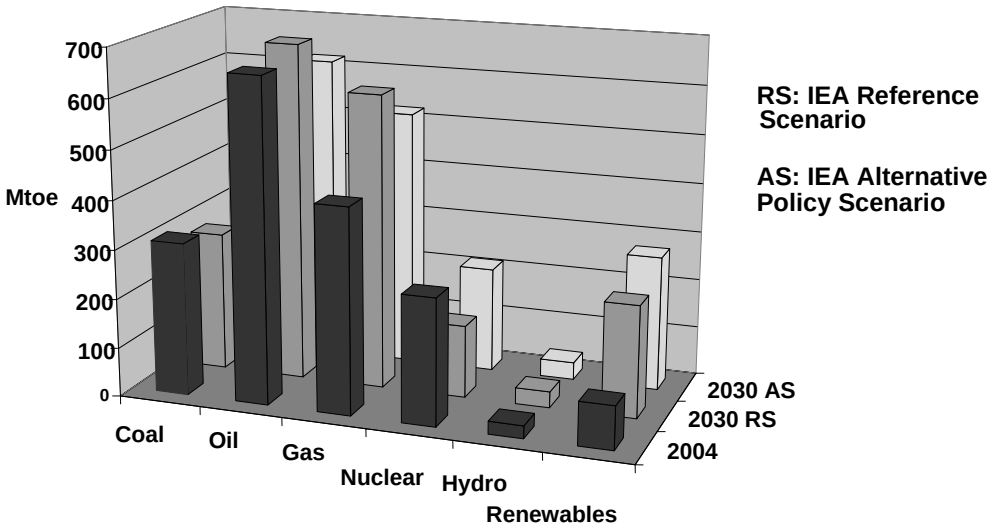
Last but not least, we would like to point out that nowhere is the old adage that "crisis spells opportunity" more applicable than in the case of European energy supply security. Policymakers, experts and the public are slowly preparing for difficult choices. The Commission's 2006 Green Paper on Energy Security *Towards a European Strategy for the Security of Energy Supply* has concentrated minds. Observers tend to point out, that energy matters played an important role at the birth of modern Europe. The first European institutions were indeed the European Coal and Steel Community (ECSC) and European Atomic Energy Community (Euratom), which preceded the European Union. Such hindsight underlines the importance of a common energy policy at the basis of European integration However, it must be clear that the way forward will not consist in inward-looking mutual subsidisation (as demanded by the realities of the post-war Europe) but in conscious outreach to global energy markets. Accepting and, of course, managing global energy interdependence will be a key pillar of any reinvigorated European Union. Confident about its own strengths and its intellectual position, outward-looking without abandoning policy priorities such as reducing greenhouse gas emissions, rightly addressed, Europe and the European Union have much to gain from the current debate about energy security.

2. The energy supply situation in Europe

While there are limits to the pertinence of the current debate on the security of supplies in Europe, which is fuelled by an amalgam of essential and peripheral issues, ephemeral and structural ones, there is no doubt that such a debate is necessary, given the very real challenges posed by the nature of its energy consumption. Europe's energy supply relies heavily on fossil fuels. In 2004, coal constituted roughly 18 % of total primary energy supply (TPES), oil 37 %, gas 24 %, while nuclear and renewable energies contributed only slightly more than 20 %. From a security of supply perspective, Europe's heavy reliance on oil and gas poses, of course, the most immediate challenge. However, as has been pointed out in the introduction, the issue is not so much the size of the dependency ratio of oil and gas but the stability of the markets that supply them. Europe currently imports roughly 80 % of the oil it consumes and about 60 % of the gas that it consumes. High growth rates in the use of renewable energies of almost 5 % per year will not fundamentally change that picture given that their base is too low.

It is instructive to briefly compare the values for 2030 in the Reference scenario of the International Energy Agency (see graph below) and the more proactive Alternative Policy scenario. Strikingly, there is little difference between the scenarios. Both agree that gas and renewables will continue to rise while coal and gas consumption will stay roughly stable in absolute terms. In addition, neither scenario paints a substantially different picture from the present, as if the evolution Europe's energy consumption was continuing on tracks whose direction can be changed only with great difficulty.

EU Total Primary Energy Supply 2004 and 2030



Source: IEA [2006]

There are three key reasons why the outlook for European energy does not look very different from the present:

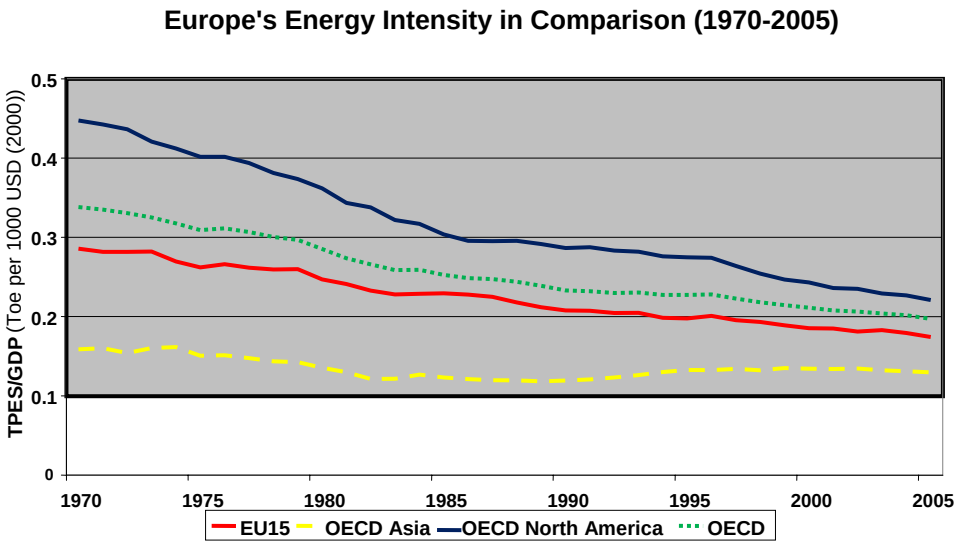
1. The intractable issue of private transport demand for oil, where modest technical improvements are unable to compensate for the rising use of ever-heavier personal vehicles.

2. The fast rise of gas around one % per year in both scenarios due to the attractive economics of gas-based CCGT technologies in liberalized (and fast-growing) electricity markets. This fact is linked to the decision of several European countries, to phase out nuclear power.

3. The inability of European policymakers to agree on an effective energy policy that would need to be built around two principles (1) a commitment to liquid and transparent global energy markets and (2) strengthening the commitment to energy efficiency and renewable energies with a pricing strategy that fully incorporates impacts on the environment as well as the economic effects of the risks of physical disruptions and excessive volatility.

Identifying only procrastination as the hallmark of the European energy situation, however, would be unfair. A picture of an essentially stable, or slightly increasing, *total* energy consumption, hides another picture in which economic growth constantly plays catch up with *relative* improvements in the efficiency of energy consumption. Per unit of GDP, Europe uses today only 60 %% of the energy that it used in 1970. Its energy intensity is still 10 % below that of the OECD average, although the distance to the high-intensity countries of North America has shrunk both in absolute and in relative terms.

Europe has made progress in the pas thirty years. However, can it do so in the future? The graph below invites to scepticism. At comparable levels of technology, the high-intensity (and low-price) countries of North America have made enormous progress, the low-intensity (and high-price countries) of OECD Asia have made little or no progress. There seems to be an intrinsic incompressible boundary to the effort to improve energy efficiency and lower energy intensity.



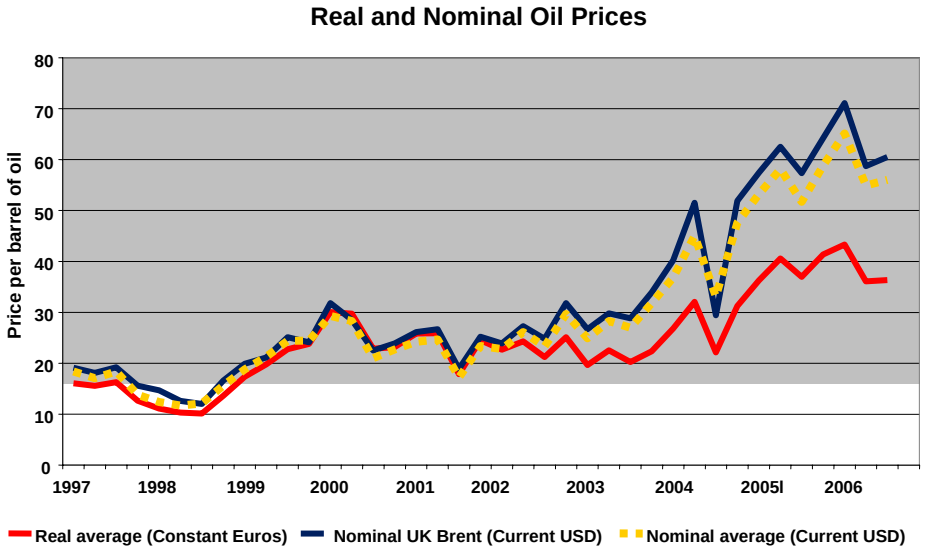
Source: OECD (2007), BP (2006).

It is up to the inventiveness of engineers and policymakers to prove such scepticism wrong. For the time being, however, Europe will have to contend with the fact that it will need to ensure the continuing supply of large amounts of hydrocarbons for many years. In the following we will briefly present key considerations in the oil, gas and power market.

2.1. The oil market

Massive increases in the oil prices have contributed to the feeling of insecurity of European consumers concerning energy supplies. This increases need, however, to be put into perspective:

1. The recent tripling of oil prices in nominal USD terms boils down to a doubling in constant Euro terms. Due to (modest) inflation and the substantial 50-%-increase in the value of the Euro against the dollar, Europeans were to some extent shielded of the most dramatic effects of the price increases. Even in constant dollar terms, oil prices have only reached the level of real prices in the early 1980s at their very peak in Spring 2006.



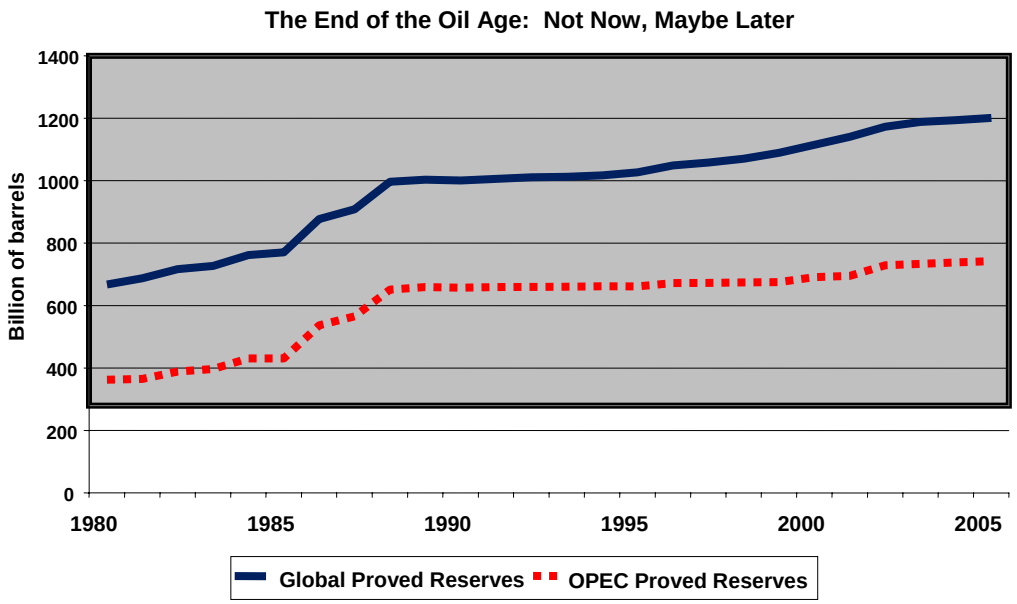
Source: DOE [2007], Eurostat [2007]

2. The widely quoted headline numbers are usually the prices for American West Texas Intermediate (WTI) or for British North Sea Brent. These are light, low sulphur qualities of oil, available only in relatively small quantities, commanding the highest prices of all oil qualities. More importantly, the gap between WTI and Brent and the rest of the market has recently been increasing, due to limited refining capacity for heavy, high sulphur oils.

3. Most importantly, the oil intensity of all industrialised nations, in particular in Europe and the United States, has declined strongly during the last three decades. Europe consumes now only half a barrel of oil per 1000 USD worth of economic production (in constant dollar terms) compared to one barrel in 1970. It was thus was much better equipped to pay for the price increases and to absorb the inflationary pressures that come with the price increase. Oil and its price are only half as important for the European economy as it was 30 years ago.

4. Talk of the end of the oil ago is premature. Proved supplies have increased, not declined in recent years, albeit at a pace slower than demand (see graph below). Of course, technological progress will not be always able to outpace the relentless drawing on geological stocks

that are inevitably finite and economic growth will thus provide continuing pressure on oil prices. However, the price mechanism does work in the oil sector in the long run, albeit with fits and bursts.



Source: BP [2006]

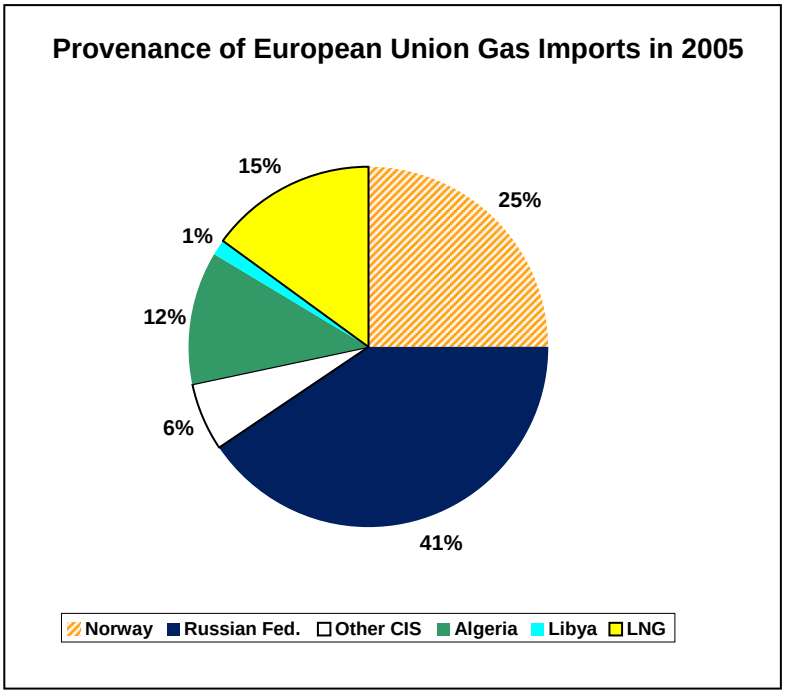
5. Increased supply and decreasing demand should bring prices down. Experts indicate that up to 4 million barrels per day of new or expanded capacity (5 % of the global total) are either under construction or already coming on-stream to participate in the bonanza of over 50 USD oil prices.

6. Markets for oil, once it has come out of the ground, are among the most liquid and flexible markets in the world, oil being easily transportable by pipeline, tanker or truck. Information is passed on immediately and tankers can be redirected for even minimal price differences. Logically, Russia's temporary interruption of the Drushba oil pipeline through Byelorussia (politically worrisome as it was) did not impact prices, which continued to decline from 54 USD to 52 USD per barrel during the three days of interruption.

These considerations imply that the situation in the oil market is perhaps slightly less dramatic than the media, always on the lookout for the next big story, might want to have it. None of them, however, implies that consuming countries can relax. In the long run, oil prices will stay high to balance increasing global demand with ever more difficult and more costly production conditions. An indicative number for marginal production costs at current demand levels might be 35 USD per barrel (average costs in countries such Saudi Arabia can be much lower). It is anybody's guess how high a geopolitical risk premium with its high speculative component needs to be, but it seems safe to say that the figures of early 2006 (i.e. roughly a doubling of cost of production) constitute somewhat of an upper bound. Factors to watch other than geopolitics are the weather, the energy and climate policies in key importing countries and, of course, the dollar exchange rate.

2.2. The gas market

The sector that has attracted most attention in recent debates about European energy security is the gas sector. This is due to its rapid rise in the European energy mix as an economically and environmentally attractive fuel. Gas-fired combined cycle turbines have become the technology of choice for private investors in liberalising European power markets. Together with a mature transport infrastructure and good security of supply record, its intrinsic attractiveness has contributed to an increasing intensity of gas consumption since the 1970s. Europeans today use more gas per unit of GDP than thirty years ago. Again, the issue can only be evaluated in the context of the commercial relations between Europe and its supplier countries. Total gas imports of the 27 member countries of the European Union from outside the EU area (i.e., net of intra-European trade-flows) amount to 317 billion cubic meters (bcm), roughly 60 % of total consumption. Main importing countries are Russia (41 %), Norway (25 %) and Algeria (12 %). The most dynamic section of the gas market is the global LNG trade globally diversified LNG trade, constitutes already 15 %%of imports and is rising fast. It is estimated that European LNG imports will rise by 7.5 % per year, compared to 5.1 % for imports through pipeline and 2.1 % for the growth of total demand (Suez [2006], p. 36). Global LNG trade will be fuelled by Qatar's massive "North field" of an estimated 900 trillion cubic meters, which constitutes by itself 14 % of proven global reserves.



Source: BP [2006]

The most importing trading partner for Europe in the gas market, however, remains Russia which supplies one quarter of total gas consumption. While Russia has been a reliable supplier of hydrocarbons for decades, two recent episodes made headlines. In winter 2005/06, the dispute between Ukraine and Russia over gas tariffs slightly reduced European supplies for several days. The event was unsettling on a symbolic rather than en economic level, leading only to a minor shortfall of 100 million tonnes, which corresponds to a difference in demand due to a temperature change of 2 degrees Celsius on a single day (Ladoucette [2006], p. 4). A similar dispute with Byelorussia concerning the Drushba oil pipeline one year later did nothing to arrange the situation. Other issues weighing on energy relations are the fast-developing international context, including the rise of LNG, the proposed coordination between Russia and other supplier nations, the uncertainties of Russia's potential to increase exports in the face of rising domestic demand, as well as the potential of the Asian market for Russian

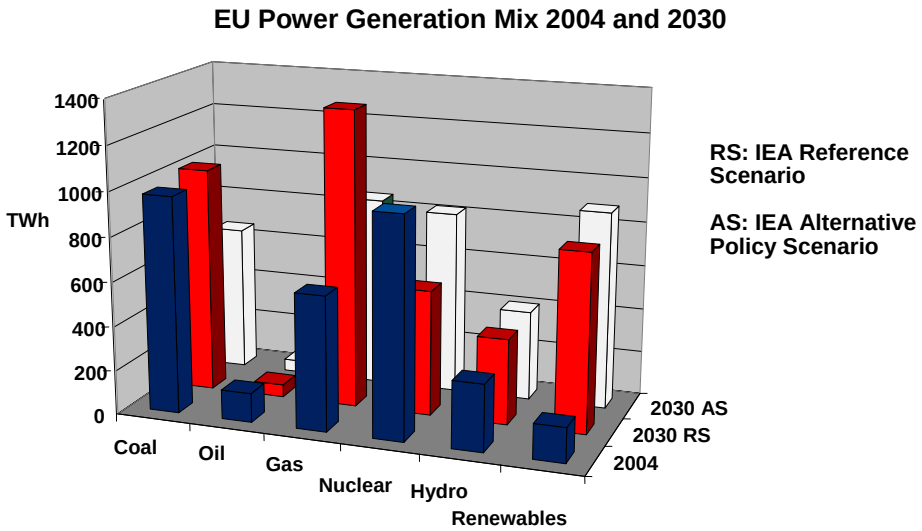
exports.[3] Despite a number of misunderstandings and a bilateral summit without major breakthroughs in May 2007, both, Europe and Russia, are making an effort to put their energy relations on a sound basis. Three new working groups on (a) Energy strategies, Forecasts and Scenarios, (b) Market Developments and (c) Energy efficiency are intended to foster a better understanding of the respective points of view. One issue demanding urgent attention is the role of long-term contracts in the liberalised European gas market.

In evaluating Europe's dependence from Russian gas imports, one should not overlook the fact that the 128 bcm that Russia exports each year to Europe constitute the bulk of Russia total exports of 151. In addition, it constitutes by far the most profitable part of Russia humongous annual production of 598 bcm fuelled by a domestic consumption subsidised with prices of around one quarter of world prices. In fact, gas exports to Europe are estimated to constitute 70 % of Gazprom's revenues (Finon and Locatelli [2006], p. 8). Nowhere is the old adage that dependence is mutual more true than currently in the gas trade between Russia and the European Union.

2.3. European power markets

Given the historic inelasticity of energy demand in the transport sector, any impulses for significant structural change in Europe's energy sector will have to come from the power generation sector. Coal and nuclear each represented 31 % of total electricity generation, gas 19 %, hydro 10 %, renewable energies 5 and oil 4 %. Expectations are that gas and renewable energies will grow fast (at three and six % per year respectively in a market growing at one % per year) to reach 32 and 19 % respectively of total electricity generation in 2030 in the "policy-as-usual" reference scenario. This will go hand in hand with the decline of the shares of coal and nuclear.

[3] Gas prices (including VAT) in Russia to both residential and non-residential consumers vary between 35 and 70 USD per 1 000 cubic metres depending on administrative zone. Compared to a world price of around 235 USD per 1 000 cubic metres this amounts to subsidisation rate between 70 and 85 %. Run-away domestic gas consumption is perhaps Russia's (and thus Europe's) biggest energy problem. Europe should help Russia in improving low domestic energy efficiency. Large recent supply contracts with Turkmenistan (more than 50 bcm per year), however, have somewhat eased the immediate pressure on Russia's export capacity.



Source: IEA [2006]

Coal fired-power generation, in particular *new* coal-plants, will be progressively priced out of the market by higher prices for CO_2-emissions. The share of nuclear energy might still increase beyond the forecasts. However, positive government pronouncements in countries such as the United Kingdom have yet to translate into firm orders beyond the two EPRs currently under construction in Finland and France (see below). In the absence of a nuclear revival and under the assumption that Germany and Sweden proceed with their phase-outs, gas remains the most likely option to fuel capacity increases. Higher gas prices, combined with much improved efficiency of power consumption and the competitiveness of renewable energies might still lead to lower growth in the electricity market in the Alternative scenario.

So far, however, demand shows no sign of abating and tensions in European power markets are increasing. The simplest indicator is the increasing number of blackouts that Europe has been experiencing in France (1999), London (2003), Denmark and Sweden (2003), Italy (2003), Greece (2004), Spain (2004) Germany (2004) and Western Europe (2006) (Ladoucette [2006], p. 5). This can be explained. In face of an insufficient increase in investments, electricity demand continued to outstrip supply in European markets. In some of the instances, technical issues also played a

role. Overall however, the average capacity margin in the UCTE region was 4.8 % in 2005, down from already low 5.8 % in 2004 (Capgemini [2006], p. 3). Partly, the factors explaining these imbalances are transitory such as the fall in French power production in early 2005 and in late 2005- early 2006 due to low hydropower reserves during two severe winters. It is unsurprising that under these conditions electricity prices have increased strongly in recent years (by about one-third each year since 2002), a tendency that was reinforced in January 2005 by the European system for CO_2-emissions trading the ETS (see graph below).

While internal European electricity trade has steadily progressed over the past five years (see graph on next page), it is still below the average level of 10 % of consumption advocated by the Commission. The initiative of the European Commission to press for adequate power infrastructures (EC [2007], p.9) is thus timely and highly welcome. Its key elements are:

(i) Fully linking the electricity grids of Germany, Poland and Lithuania;
(ii) Substantially expanding the interconnection between Spain and France;
(iii) Establishing a new Community mechanism for harmonising the technical standards of networks and their operation.

A key issue for the security of European energy supplies in the electricity sector is the question of nuclear energy. In a carbon-constrained world, in which the European countries are committed to reach their Kyoto targets (a reduction of %8 % below the level of 1990 emissions and a reduction of 20 % by 2020), an increase of generation based on hydrocarbon is not a viable option. Renewable energies are growing in importance but remain dependent on government hand-outs.[4] A number of factors encourage currently the use of nuclear energy:

- Rising gas prices, the high price of renewables make nuclear more competitive; carbon remains un environmentally unattractive option, while nuclear power currently saves more than 300 million tonnes of CO_2 (eight % of the EU total emissions);

[4] Renewable energy has some impressive success stories to tell, most notably the installation of about 20 GW of wind-power in Germany. However considering the cost (more than three billion Euros per year) and given the facts that other technologies are even more expensive and that large hydropower sites are exhausted, the proposal of the Commission to have 20 % of power generation based on renewable energies (up from 15 % today) sounds like a very expensive proposition for European tax payers.

- The decision of Finnish TVO to build new a reactor in Europe demonstrates economic competitiveness and demonstrates innovative management of economic risks; France also builds a new European Pressurised Reactors (EPR) with several European partners;

- Fast-growing Asian electricity demand creates demand for nuclear technology exports; while in the United States the 2005 Energy Bill provides insurance, subsidies (2.5 cents per kWh for new nuclear plants) and waste disposal (Yucca mountain);

- There is greater realism and less emotion in the European debate on nuclear energy.

However, the high fixed cost component heavily penalises nuclear energy in the eyes of risk-averse private investors who have to face the volatile price environment of liberalised electricity markets. The graph below captures the essential features of the economic competitiveness of nuclear energy. From left to right, the certainty of stable high prices for electricity decreases (here assumed to be 50 Euros per MWh). This implies the increased likelihood of a low-price scenario (here assumed to be 17 Euros per MWh equal to the marginal cost of nuclear power). Once the likelihood of a low-price scenario is higher than 25 %, gas becomes the fuel of choice for investors *even if* both technologies are still profitable and even if nuclear power is the cheaper option in terms of levelised average cost (equivalent to a certain high-price scenario).

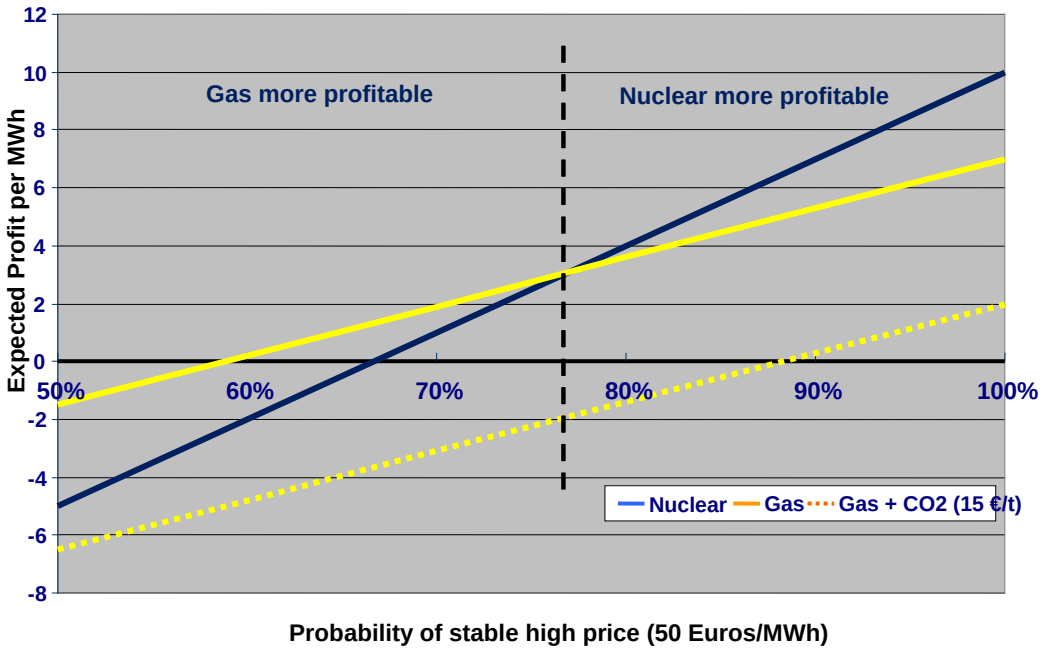
How can this be? It is crucial to understand that low fixed cost technologies such as gas, where investment costs are only about 30 % of total lifetime costs, come with an option for investors to exit the market if prices fall below a certain threshold. Nuclear power, where investment costs are 70 % of total lifetime costs, does not hold that option. If prices will fall, investors will be stuck and will continue producing even if they have no hope of ever recovering their money. Risk-averse investors will thus opt for gas in markets with uncertainty about the price for electricity.

The graph, however, also shows that a stable price for carbon (here assumed to be 15 Euros per tonne of CO_2), will make nuclear energy *always* the preferred option for private investors under all circumstances. The profitability of nuclear energy thus depends on two crucial conditions:

(a) The existence of long-term contracts or producer-consumer consortia (the option chosen in Finland and currently explored in France and Belgium) that mitigate or eliminate price risk;
(b) Credible long-term expectations about a significant price for carbon emissions.

In addition, the waste disposal issue must be solved on a European level. Collaboration with Russia that possesses the required geographic and geological conditions on this issue could be a win-win proposal for both parties.

The profitability of nuclear increases with decreased price uncertainty



Given that these conditions will not materialise immediately (even if second period carbon prices are now in their low twenties, there is still little visibility about their height over the lifetime of a nuclear power plant), the European electricity sector will continue to provide a serious challenge to

European policymakers. Wanting to improve security of supply and environmental performance will most likely mean higher prices, in particular if the structural underinvestment in new capacity is not addressed. One important point is that policymakers need to educate the European public that it will not be able to have it all. Inside the triangle of European energy-decision-making trade-offs need to be made, implemented and communicated. In short, Europe needs policy leadership.

3. Improving the security of energy supply today

In the first two parts we have argued that the organisation of the European energy sector currently suffers from unresolved contradictions between different objectives of European energy policymakers, namely environmental quality, security of supply and low prices in liberalised markets. To some extent the frontier of policymaking is thus firmly drawn and the only choice that is left is to decide where to situate oneself on this frontier. Part 3 tries to go one step further. Strategic choices still need to be made. However, there are a number of concrete and often fairly uncontroversial measures that can be made to improve European supply security – as long as we have a clear idea of what we mean by that.

Part 3 will thus begin by developing a coherent notion of what a policy to improve security of supply might mean. On that basis it will develop principles for the division of labour between private and public actors, which is to say between markets and governments. It will conclude with a catalogue of measures that can be implemented rather quickly and that would significantly enhance Europe's security of energy supplies.

First, it is useful to define an energy supply risk. The discussion in Part 1 showed that structural facts such as rising energy prices due to resource scarcity should not be part of such a definition. Once this line of thought is pursued, the following definition is obtained which allows identifying the specific nature of energy supply risks: **energy supply risks are constituted by unforeseeable events threatening the physical integrity of energy supplies or leading to sudden and discontinuous energy price rises independent of economic fundamentals**. What is important in this definition of an energy supply risk is its unforeseeable and disruptive nature. Each event is of a singular, incomparable nature.

In technical terms, it can be said that energy supply risks do not follow a well-known probability distribution function that would let private insurance markets take care of the issue.[5] Governments thus have a role to play in ensuring energy supply security precisely because the threats are of a stochastic nature. This is not to say that markets do not have a role to play. Liquid, transparent and competitive markets are an excellent mechanism for pooling and redistributing supply risks, as long as they are quantifiable. Improving commercial insurance and hedging strategies has greatly reduced supply risks for market participants. However, an incompressible residual of risks primarily linked to political events remains. In these cases, public action needs to complement private action and a framework for allocating risk efficiently between private players (quantifiable risk) and public players (non-quantifiable risk or uncertainty) must be created given that markets cover risk very well but uncertainty poorly.

From theses considerations follows almost by definition that energy supply risks are primarily short-term phenomena acting out in the space of weeks or months given that commercial risk management techniques can internalise longer term phenomena. This is an important distinction. For instance, high energy prices are frequently confused with energy supply risks. This is wrong as long as these high prices are stable and reflect economic fundamentals or reasonably stable policy choices such as gasoline taxation. High prices are not the problem (in the long run, economies can adapt with relative ease) but the speed and the magnitude of sudden price changes leading to economic disruptions are. Early warning systems and buffering mechanisms such as stockpiles are thus highly important. The causes for price rises also need investigation: high economic growth inevitably means higher energy prices. One may recall the spectacularly low energy prices of the late nineties. It should not be forgotten that they were due to the severe economic contraction of Asia countries and Russia and the subsequent slowdown in world economic growth.

Given that ignorance and lack of preparation make countries vulnerable to energy supply risks, policymakers need to manage expectations and perceptions as well as structural elements. Structural facts such as long-term high energy prices need to be put into perspective and agents need to

[5] To be precise, one would need to speak in the terminology introduced by Frank Knight (1922) about uncertainty rather than about risk. The important point is that the expected utility hypothesis brakes down in the case of uncertainty when probability functions are unknown. This means that insurance markets will not be able to cover the risks in question, which in turn motivates a role for governments in ensuring the security of energy supplies.

prepare for it. Short-term interruptions need to be anticipated. As soon as private economic agents are prepared for the issues of modern economic life, most importantly the fact to live in an interconnected world offering great advantages but also increased risk, they can begin to deal with them.

Finally, managing the security of energy supplies depends on the risk-adverseness of consumers that varies widely between countries. Other things being equal, American consumers prefer lower prices and relatively higher risk, whereas European customers prefer higher prices and relatively lower risk. The focus of security of energy supply is thus not the absolute level of energy prices but the size and impact of changes in energy prices. Obviously, such an approach implies managing the risk all along the supply chain in its different dimensions:

- Supply/production (geopolitical, regulatory and technical risk);
- Transport (safety and technical, risk);
- Distribution (regulatory risk);
- Consumption (price and environmental risk);
- Waste disposal (technical and regulatory risk).

Let it be said however, that no approach can completely prepare for all circumstances; "The unexpected happens." No policy is immune from natural disasters such as extreme weather events or political upheavals.

In the perspective of protecting risk-adverse energy consumers from unexpected changes, an energy system shall be judged by its ability to withstand shocks and to adapt; the resilience (flexibility, elasticity) of the system thus becomes key. More often than not, this flexibility and resilience are influenced by internal policies that have been formulated with scant regard to external security of supply. European examples are the liberalisation of European power markets, the EU's ambitious environmental objectives or the relatively high taxation of petroleum products. At this point, integration between internal and external policies is of high importance.
Concretely, three categories of policy instruments that can be useful to manage or mitigate supply risks over different time horizons can be enumerated:

1. In the short term, physical stockpiles and interruptible contracts for especially prepared consumers (that are rewarded by lower prices) are

useful. Technical and diplomatic cooperation to secure supply routes (including early warning systems) also fall into this category.

2. In the medium term, fiscal instruments can be useful to manage demand and to tip the terms of trade. However, there are tradeoffs. High energy taxes have a price in terms of economic efficiency (this becomes less important if other distorting taxes such as corporate taxes can be reduced due to higher energy taxes).

3. In the long term, only technological and geographical diversification can constitute a hedge against supply risks. This precludes derived policies that favour specific technologies that lead to imbalances (such as power market liberalisation). It includes policies that lower energy intensity and increase flexibility of consumers.

3.1. Two conditions and a list of concrete measures

Before proposing a number of concrete measures to improve the security of energy supply, the two most important pre-conditions for any successful policy in this area need to be recalled: (1) a forceful commitment to safeguard and enhance open and transparent global energy markets in a multilateral approach with key supplier and consumer countries and (2) a clear strategic choice between the orientations of supply security, environmental quality and liberalisation, where the role and the direction of energy prices must be clearly enunciated.

At all times, safeguarding and expanding liquid and transparent energy markets must be of primary concern to policymakers. As pointed out above, markets are excellent at managing quantifiable risk. They rely, however, on governments to provide insurance for non-quantifiable risk and for establishing the frameworks (e.g., physical safety and sanctity of contracts) in which they evolve. It is key, however, that concerns about the security of energy supplies do not endanger the gains from an international division of labour in energy matters. A mercantilist obsession with locking in resources through bilateral "special relationships" will have distinct drawbacks:

1. It will lock in suppliers and consumers in sub-optimal relationships when better deals are available; the commercial pressure by such alternative options adds a problem of credibility and uncertainty;

2. It will charge energy matters with an additional layer of political or even military considerations;

3. A generalised "race for resources" will create externalities that decrease rather than increase energy security for all concerned.

At the same time the need for risk management tools such as commercial long-term contract needs to be acknowledged and appropriately answered (see below on the issue of long-term contracts).

Nevertheless, there is no fundamental opposition between bilateral and multilateral approaches, or between "contract" and "competition". Bilateral contracts between individual parties are the essence of any functioning market.[6] Bilateral contracts (such as between China and certain African states, Europe and Russia, the United States and India…) do not need to be signs of a dysfunctional energy world as long as they inscribe themselves into a commercial, non-exclusionary logic. The important issue is that such as system of a myriad of bilateral contracts needs to be safe-guarded by a multilateral accord on the role of transparent and reliable global energy markets.

To some extent the energy world itself is changing and long-term relationships are dissolving themselves in the global marketplace. By the end of the decade, Russia will be able to export gas to East Asia and Europe will be able to import gas from Central Asia, Iran and Iraq. New centres of supply and demand emerge and demand to be integrated into world economy. The fast-rising share of LNG transported by tankers further transforms the gas market from a logic of long-term bilateral relationships to a logic of multilateral market relations. These are welcome developments.

Europe and the world, in fact, have everything to gain in moving towards

[6] Without taking a contribution to energy policy-making too far into the realm of economic theory, it might be worth recalling the two conditions identified more than a century ago by Edgeworth in his *Mathematical Psychics* allowing a system of bilateral contracts to develop into a competitive market: (1) contracts must be "divisible" and (2) it must be possible to "re-contract" them (Edgeworth [1881], p. 19). Technical features such as indivisibilities in the construction of large-scale projects might impede the first condition to be fully satisfied, although on a global scale project size alone might not impede competition. More importantly, governments can actively work towards overcoming the gaps in information, transaction costs and geopolitical concerns that currently still prevent the second condition, the possibility to re-contract at will, to be satisfied. It is here that policymakers need to create a multi-lateral framework ensuring as much as possible freedom to contract and re-contract.

open energy markets that inspire the confidence that they will be able to guarantee safe energy supplies on the basis of an international division of labour in the future as well. Elements of such a policy might be making the terms of contracts as transparent as possible (for instance, through international agreements on disclosure), working wherever possible with open tenders etc. They can become a threat to the working of the global energy system if they explicitly aim at excluding third parties and mix commercial logic with political logic.

Major importing nations such as the United States, China and India, as well as major producing countries such as Russia, the OPEC countries or the countries surrounding the Caspian Sea need to be part of this effort. Free global energy markets – in which each supplier has the right to look for the highest price, and each importer the right to ask for the best bargain – are the only way to avoid a global race for resources that would squander most or all of the rents contained in the natural resources nature has provided.

The key challenge in Europe, however, remains making the *political* choices between the competing objectives of security of supply, environmental considerations and cost minimisation. The current focus on improving energy efficiency is too much motivated by wishful thinking trying to avoid these choices. Energy efficiency is the result of an aggressive high-price energy policy; it cannot substitute for such a policy by itself. The EU Commission's *Green Paper* of March 2006 is an important document making a number of useful proposals. Its silence on energy prices, however, confines many of its pronouncements to the status of items on a wish-list rather than the status of objectives of a coherent strategy.

Before European energy policymakers proceed to formulating more proposals (even those contained in this paper), they must come to terms with the internal contradiction that is at the heart of the unease about the energy policy drift in Europe nowadays. They first need to state that wanting to save substantial amounts of energy requires higher energy prices. In a second step, they need to explain how to organise the importation of the large quantities of oil and gas that will be necessary for the foreseeable future even under the most optimistic assumptions.[7] In this context it is of

[7] The hope for a technological solution that will avoid hard choices is misplaced. What is most remarkable about energy markets is the fundamental stability of technologies and their inability to transform the energy sector. With the exception of the combined-cycle gas turbine, the energy technology world of fifty years ago is not fundamentally different from ours today.

great importance to educate the public about the necessity to make choices, about the inevitability of trade-offs and to build consensus around these choices. Once this consensus has been forged, a number of concrete options to improve the security of supply will be at their disposal.

Once these two conditions are fulfilled, there are indeed a number of concrete measures that can help to manage security of supply risk in Europe. They will, of course, not change the fundamental structural facts of the European energy equation but they do constitute useful elements in managing them. The following list is not exhaustive, nor is every point brand new. At this point, it is more important to let readers gain an intuition for the direction of the policy shift advocated rather than to insist on any specific proposal. Nevertheless, each single proposal constitutes in itself a carefully considered option for improving the security of European energy supplies:

(a) Europe should take the intellectual leadership in promoting an open international energy trading system and should organise to this purpose a large international conference in which the contours of the existing trading system are underlined and strengthened. Due to history, geography and political culture, Europe has the qualities to act as an honest broker in this context.

(b) Convince consumer and producer countries that price and ability to pay must be the only criteria for access to precious resources and that an open trading system is the best manner to realise the totality of resource rents. There is no escape from rising energy prices due to rising scarcity. Emphasise that rising global demand, the driving force behind higher price, is ultimately a good thing ensuring positive spillovers for everybody. Obviously, such an argument in no way precludes policies to assist the socially most vulnerable groups.

(c) Provide European actors, experts and decision-makers with the legal, technical, informational and economic infrastructure to participate fully in competitive global energy markets. The creation of a European energy information system is highly welcome in this respect.

(d) Limit the negative fallout from financial speculation by improving market transparency and the energy information infrastructure. While this does not constitute a hedge against permanently higher prices, it

can limit speculative bubbles.

(e) Engage other countries in efforts to improve transparency and disclosure of financial flows arising from energy transactions.

(f) Be forthright about the role of energy prices in promoting energy efficiency and the increase in renewable energy. Raising expectations that Europeans can have their energy cake and eat it too will necessarily end in disappointment.

(g) Build the credibility and enforcement capacity of international courts such as the Permanent Court of Arbitration, Geneva, or the International Court of Arbitration, London, in case of disputes in cooperation with other international partners.

(h) Strengthen the energy component of competent international organisations such as the International Energy Agency, the World Bank, the United Nations Framework Convention on Climate Change or the World Trade Organisation; energy conflicts should be solved in multilateral frameworks;

(i) Work on conditions and guarantees for investment in both supplier and consumer countries; in the long-run, close financial integration based on reciprocal investments is beneficial for security of supply;

(j) Continue implication in multilateral technical initiatives such as the Energy Charter Treaty (with an emphasis on investment rather than transit), the Global Gas Flaring Reduction Partnership, the Extractive Industries Transparency Initiative or the Equator Principles of the International Finance Corporation.

(k) Promote European energy champions capable of competing in world markets. Energy is a risky, capital-intensive industry that requires sizeable players on either side of the bargaining table. Resist, however, the demand for protection from competition that will come inevitably from those champions and persist with internal energy market liberalisation.

(l) Promote interruptible contracts in energy markets through fiscal incentives. They constitute a vital buffering mechanism in times of crisis – for all forms of energy.

(m) Take a non-dogmatic approach to long-term contracts, which are useful to finance large-scale projects such as oil and gas exploration or nuclear power plants. Standardising long-term contracts and insisting on disclosure enables them to be bought out which limits their role as a barrier to entry.

(n) Create a competent European agency for electricity and gas market regulation; coordination between national regulators is not enough; the added transaction costs are outweighing the gains from coordination.

(o) Continue a forceful policy of reducing CO_2-emissions and expand the European Emission Trading System to the transport sector. Independent of the environmental merits of this policy, it contributes to reduce the demand for carbon-intensive hydrocarbons. Such a policy demands creating links to other emerging trading systems, in particular the United States, and formulating as quickly as possible proposals for post-2012 policies.

(p) Create an emergency preparedness mechanism for physical interruptions of gas supplies such as it already exists for oil. In the same spirit, each Member State should implement minimum requirements for gas storage.

(q) Continue efforts to install early warning mechanisms, such as currently discussed with Russia, to improve mutual information in the case of physical supply interruptions.

(r) Appoint a European energy coordinator for negotiations on external energy infrastructures such as the oil and gas pipelines.

(s) Facilitate the construction of two or three new re-gasification terminals to take full advantage of the developing LNG markets.

(t) Facilitate also the construction of one more refinery to help remove the global bottleneck in processing heavy and ultra-heavy oils. Such investments are large and risky. They would benefit from European co-ordination as well as public-private cooperation.

(u) Expand intra-European power networks to improve interconnections and flexibility. Insist forcefully on the creation of adequate interconnection capacities between European countries. Promote also the interconnection with extra-European grids such as Russia.

(v) Promote a frank and wide-ranging debate on the merits and costs of new nuclear power plants in the European Union. Organise as speedily as possible a European solution to the disposal of nuclear waste.

(w) Continue to fund research in clean coal technologies, carbon storage and nuclear waste disposal. There are large positive spillovers associated with each one of these technologies warranting public involvement.

No single one of these measures will be able to guarantee energy supply security for the European Union for the foreseeable future. Together, however, they constitute a pattern for a style of energy policymaking that relies on the market wherever possible, but lets governments intervene wherever necessary. It is important that these government interventions are designed to work *with* the market rather than against it: overcome transaction costs and asymmetries of information, build trust and establish reliable rules that individual actors can follow. As argued at the beginning of this chapter, governments will always need to play a role in ensuring the security of energy supplies in the face of uninsurable uncertainty. Key, however, is to organise the division of labour between markets and governments as efficiently as possible. In some matters, certain structural elements – such as Europe's import dependency – leave little choice but adaptation. In other matters we do have a choice, such as opting for more intelligent energy policies.

4. Bibliography

BP [2006], BP Statistical Review of World Energy, June 2006 at www.bp.com

Capgemini [2006], Observatoire Européen des Marchés de l'Energie, Huitième édition, Octobre 2006, Paris

Chevalier, Jean Marie (2006), "Security of Energy Supply for the European Union", *European Review of Energy Markets* 1:3

Edgeworth, Francis Y. [1881], *Mathematical Psychics: An Essay in the Application of Mathematics to the Moral Sciences*, London: Kegan

European Commission [2007], An Energy Policy for Europe, Communication from the Commission to the European Council and the Parliament, SEC(2007) 12, Brussels

European Commission [2006a], An External Policy to Serve Europe's Energy Interests, Paper from Commission/SG/HR for the European Council, 15-16 June, S160/06, Brussels

European Commission [2006b], Towards a European Strategy for the Security of Energy Supply, Green Paper on Energy Security, Technical Document, Brussels at http://europa.eu.int/comm/energy_transport/doc-technique/doctechlv-en.pdf

Finon, Dominique and Catherine Locatelli [2006], "L'interdépendance gazière de la Russie et de l'Union européenne: Quel équilibre entre le marché et la géopolitique?", Cahier de recherche CIRED, Policy Paper 11-2006, Nogent-sur-Marne

IEA [2006], *World Energy Outlook 2006*, Paris: IEA/OECD

Keppler, Jan Horst (2007a), *International Relations and Security of Energy Supply: Risks to Continuity and Geopolitical Risks*, Report to the Foreign Affairs Commission of the European Parliament, Brussels

Keppler, Jan Horst (2007b), *La sécurité des approvisionnements énergétiques en Europe : principes et mesures*, Note de l'Ifri, Paris: Ifri

Keppler, Jan Horst [2006], *Le marché français de l'électricité : état des lieux, analyse, remèdes* avec Jean-Marie Chevalier, Research Paper, Direct Energie, Paris

Keppler, Jan Horst [2005a], *European Energy Supply: Facts and Figures*, Research report, Japanese External Trade Organisation (JETRO), Bruxelles, 2005, 28 p.

Keppler, Jan Horst [2005b], *D'un marché binational a un marché européen de l'électricité : Nouvelles régulations des réseaux et ouverture des marchés électriques en France et en Allemagne*, Research Report, Réseau Transport Electricité (RTE), Paris, 39 p.

Ladoucette, Vera (2006), *Energy Security in a Fragile World*, Special Report CERA Advisory Service, Presentation at Chatham House, 7 November 2006
OECD [2007], OECD Frequently Requested Statistics at www.oecd.org

Percebois, Jacques [2006], *Dépendance et vulnerabilité: Deux façons connexes mais différentes d'aborder les risques énergétiques*, CREDEN Cahier N° 06.03.64, 6 mars 2006, Montpellier

Suez [2005], "The State of European Electricity and Gas Market Liberalisation", SG CIB Paris Energy Conference, 25 January 2006, Paris