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An initial assessment of policy options to reduce – and secure against – the costs of energy insecurity

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1. Introduction

Energy and climate change remain on top of the agenda of the European Union (EU). Rising oil prices, regional concentration of conventional oil and natural gas, increasing demand for energy of emerging economies together with decreasing stocks within the EU, the alleged use of energy as a "political weapon" by politically unstable regions, as well as rising emissions of greenhouse gases (GHG) and their adverse effect on the global climate are just some of the issues associated with current patterns of energy use. Policy makers in the EU are aware of the pressing nature of these issues. The recent initiative to develop a sustainable integrated European climate and energy policy is a clear indication of this. While EU energy policy for the last 40 years has in principle been confined to the narrow fields of nuclear energy and coal, the EU and its Member States are starting to develop a coherent internal and external energy strategy or "vision" to ensure the competitiveness of European industries while at the same time combating climate change and ensuring security of energy supply.

This paper intends to outline policy options to reduce insecurities associated with the EU's energy supply. After classifying and analyzing the security of supply risks in the EU, it will briefly describe those measures adopted by the EU in the European Council Action Plan[1] and the related Energy Policy for Europe (EPE). Chapter four will give a comprehensive overview about the most important market-compatible, economic risk-management strategies, in which responsibility is shared among Member States, the EU, energy companies and customers. An effective energy policy, however, cannot solely rely on markets. Especially for the long-term policy objectives government action will be needed, as laid out in chapter five.

2. Risk assessment

In its 2000 Green Paper on the security of supply, the European Commission (EC) notes that "energy security must be geared to ensuring … the proper functioning of the economy, the uninterrupted physical availability … at a price which is affordable … while respecting environmental concerns. […] Security of supply does not seek to maximize energy self-sufficiency or to minimize dependence, but aims to reduce the risks linked to such dependence" (EC, 2000). However, the Commission also noted that the risk of supply failure associated with increasing dependency on imported hydrocarbons is growing (EC, 2007). The European Commission thus shares the view expressed in other definitions (see, for example, Egenhofer et. al., 2004), that security of supply is essentially a strategy to reduce or hedge risks that derive from energy use, production and imports. These security-of-supply concepts consist of a variety of approaches aimed at 'insuring' against supply risks with an emphasis on cost-effectiveness and the shared responsibility of governments, firms and consumers.

There are nuances regarding cost-effectiveness, which are mainly driven by different appreciations of risks. Either directly or indirectly, the approaches include price as a

[1] Council document 77224/1/07 REV 1

concern. While price volatility can be seen as proof that markets work, nevertheless, security of supply is, albeit more loosely, tied to a concept of price. Energy must be available at a 'reasonable' price – not at any price. By definition, if the price were allowed to increase without a limit, there would always be a sufficiently high price at which demand would equate to available supplies – but it would be naïve to say in this case that the security of supply was guaranteed. Yet just how far it is acceptable to allow prices to move in order to restrict demand and allocate scarce supplies is a question that can only be decided politically (by the government or regulator) or contractually (by the parties accepting limits to price increases). On the other hand, price fluctuations may themselves be considered as a threat to security – in particular with respect to crude oil. Indeed, in the case of oil, the logistics are such that the risk of physical shortages is minimal and any tightness of supplies would immediately be reflected in prices. Natural gas market, however, are characterized by different logistics, different pricing mechanisms, etc.

2.1 What is a risk?

The literature traditionally distinguishes between two different kinds of risks: short term and long term (see for example IEA, 1995 and Stern, 2006). Short-term risks are generally associated with supply shortages because of accidents, terrorist attacks, extreme weather conditions or technical failure of the grid. Such risks are sometimes described as 'operational security' or 'systems security'. Long-term security concerns the long-term adequacy of supply, the infrastructure for delivering this supply to markets and a framework to provide strategic security against major risks (such as non-delivery for political, economic, force majeure or other reasons). In line with the European Commission's 2000 Green Paper on the security of energy supply, the following types of risks can be identified:

- *Technical risks* include systems failure owing to weather, lack of capital investment or generally poor conditions of the energy system.
- *Economic risks* mainly cover imbalances between demand and supply, stemming from a lack of investment or insufficient contracting.
- *Political risks* concern potential government decisions to suspend deliveries because of deliberate policies, war or civil strife, or as a result of failed regulation, which is referred to as 'regulatory risk'.
- *Environmental risks* describe the potential damage from accidents (oil spills or nuclear accidents), including pollution, the effects of which are less tangible or predictable (e.g. greenhouse gas emissions).

It is also interesting to note that most supply disruptions experienced in the EU in recent decades have had domestic causes. In the UK, for example, the worst disruptions to energy supplies in recent history were those caused by the strikes of British coal miners in 1973-74, and the blockade of access to oil refineries by protesting truckers and farmers in autumn 2000 (Mitchell, 2007). Similarly, the power interruptions of November 2006, which affected 15 million European households, were caused by the tripping of several high-voltage lines, which started in Northern Germany (UCTE, 2007). Other reasons for disruptions included grid failure, lack of reserve capacities, etc. As the above list and the following risk assessment show, there are many different risks to the security of supply, of which import dependence on politically unstable or unpredictable countries is but one. In any case, independence from imports is no option and would be no guarantee for security, as shown by the above examples of supply disruptions. Therefore, in order to identify a suitable response, it is necessary to first clarify the exact nature of the risks including its likelihood and potential consequences (i.e. a risk assessment) (Table 1). The second step in this respect is then to identify the possible responses and the responsible actor/s (more specifically, those involved with risk management).

Table 1. Classification of Security-of-Supply Risks in the EU: Illustrations by Sector (oil, gas, coal, nuclear, renewables and electricity)

	Classification	**Event**	**Disruption**	**Price rise**		**Probability in 20 years**	**Duration**	**Fuel affected**					
				Intern'l	**Domestic**			**Oil**	**Gas**	**Coal**	**Nuclear**	**RES**	**Elec-triciy**
Political risks													
1	Export embargo	Embargo of specific exporter (e.g. oil-for-food in Iraq)	Little	Little	Little	High	Months, years	Y Yes	Y				
2	Output reduction	Quotas on production to raise prices (e.g. OPEC cartel)	Yes	Yes	Yes	High	Months, years	Y					Y
3	Local market disruption I	By pressure groups (e.g. fuel price protest)	Yes	No	Yes	Medium-high	Weeks, months	Y					Y
4	Local market disruption II	Regulatory shortcomings (e.g. California power crisis, Nordic market)	Yes	No	Yes	Medium-high	Weeks, months						Y
5	International market disruption	Regulatory failure, e.g. regulation, competition, financial markets	Yes	Yes (or rationing)	Yes	Medium	Weeks, months, years	Y	Y				Y
6	Force majeure	Civil unrest, war, deliberate blockage of trade routes, etc.	Yes	Yes	Yes	Low-medium	Variable	Y	Y				
7	Import embargo	Embargo of importing state by export or transit country (e.g. gas cut off)	Yes	No	Yes	Very low for EU	Months, years	Y	Y?				

Economic risks													
8	Public opinion on large-scale investment	Delay in planning, under-investment	Yes	No	Yes	High	Years	Y	Y	Y	Y	Y	Y
9	Supply discontinuity	Lack of infrastructure	Yes	Yes	Yes	Low-medium	Months, years	Y	Y				Y
10	Production discontinuity	Shortage of production capacity	Yes	Yes	Yes	Low	years	Y	Y				Y
Environmental risks*													
11a		Major oil spill (land and sea)	No	Yes	Yes	Medium	Weeks, months	Y					
11b	Accident	Major nuclear accident	Yes	No	Yes	Low	Months, years				Y		Y
11c		Burst of major gas pipeline	Yes	Yes	Yes	Low	Weeks, months	Y	Y				Y
12	Disruption/ destruction of habitat	a) Massive biomass plantations b) Ultrasonic waves (of windturbines)	Yes	No	Yes	High	Months, years						Y
12	Run-away greenhouse effect	Positive feed-back in bio-sphere (e.g. melting of permafrost)	Yes	No	No	Very low	Perm't/ irreversible	Y	Y	Y		Y	Y
Technical risks													
13	System failure	Technical failure, e.g. due to extreme weather condition, technical neglect	No	No	Yes	Medium	Days, weeks						Y

* Environmental risks are risks to supply only in an indirect way. Risks from accidents or other environmental dangers are related to subsequent government action, which might act as a dampener to investment and therefore create bottlenecks. Strictly speaking, environmental risks could also be listed under political risks.

Source: Adapted from Andrews-Speed et al. (2001).

Turning to gas and notably European dependence on Russia, the risks associated with import dependency can be mitigated by a number of general, well-known (horizontal) measures. These not only include diversification by region or by fuel to the extent possible, but also storage requirements, mutual solidarity and the development of liquefied natural gas (LNG). In addition, measures for network development and for improving the functioning of the internal gas and electricity markets will provide for further flexibility within the gas markets with positive impacts on security. Moreover, previous work by CEPS (Luciani, 2004) has shown that in the case of Russian gas, import dependence does not necessarily entail greater insecurity, provided adequate EU policies are in place.

2.2 Security of supply as an externality

The old monopolists used to claim that they guaranteed the security of supply – a statement supported by the experience of decades of service to the public, during which very little disruption was experienced. It is not clear, however, that security of supply was truly guaranteed in the past – as it was in fact never challenged by any major disruption. The old monopolists were in a position to decide unilaterally how much security they intended to provide and did engage in some precautionary investment, thanks to their ability to pass on the cost to the final consumer. The security they provided may have been too little or too much. There was no benchmark for measurement. The concern about security of supply in liberalised markets is connected to viewing security as a public good or externality. In liberalised markets, new competitors will be tempted to 'free-ride' on the security provided by the incumbent suppliers and competition may have a negative effect by downplaying security or prioritising cost-cutting. Similar fears have been expressed with regard to other network industries such as airlines, railways and electrical grids.

Normally, security is viewed as a matter for governments to look after. This perception holds true for small commercial or household customers, who will not be in a position to judge their security requirements exactly and will need standard contract formulae that set the level of protection to be decided by the regulator. The level of protection does not need to be 100%. Gas in households and small commercial establishments is primarily used for cooking and for ambient- and water-heating. In situations of emergency, all such uses can be reasonably curbed to some degree. It is therefore also reasonable to set the guaranteed level of supplies at an appropriate percentage of 'standard' consumption.

Not all customers need to be protected against supply disruptions. In liberal markets, customers have a choice of whether to assume responsibility for security of supply themselves or to allow the supply company to bear the responsibility and subsequently to pay a risk premium through higher energy prices. The former is typically done by large industrial users, for which (short-term) security might not be an issue, given they can switch fuels. A large industrial user may choose to buy gas from a risky but cheap source, accepting the risk of higher short-term prices from a spot market or mitigating the risk by installing a dual-firing capability or a back-up from another supplier.

Indeed, the Commission has frequently argued that a unified EU gas market would be intrinsically more secure than the individual member countries' markets. The reasoning here appears to be based primarily on scale: a larger market, served by a wider and well-interconnected network that receives supplies from a larger number of exporters, may be expected to be more stable. This conjecture may well be the case; however, numerous conditions need to be fulfilled, notably functioning markets, established interconnections and more generally that the necessary regulatory or contractual arrangements are in place.

3. A European response: The Energy Policy for Europe

In recognition of the risks and challenges to European energy supply, the Heads of State and government of the 27 Member States of the EU at the Spring 2007 European Council have committed themselves to a low-carbon energy future. Based on the European Commission's energy policy package entitled "Energy Policy for Europe" (EC, 2007)[2], which was accompanied by a number of sectoral policies to implement the overall strategy[3], the Member States adopted an Energy Policy for Europe (EPE) which pursues three objectives:

- Increasing security of supply,
- Ensuring the competitiveness of European economies and the availability of affordable energy, and
- Promoting environmental sustainability and combating climate change.

In the centre of the new energy policy is the EU's commitment to reduce its greenhouse gas (GHG) emissions by at least 20% by 2020 compared with 1990 levels, not least because CO2 emissions from energy make up 80% of EU GHG emissions. By using less energy and using cleaner, locally produced energy, the EU aims to increase energy security by limiting its growing exposure to increasingly volatile prices for oil and gas, while stimulating competitiveness in the European energy market.

In general terms, the EPE is based on five pillars. First, the EU aims at increasing its energy efficiency by saving 20% of its energy by 2020. This will save about 780 million tones of CO2 from being emitted into the atmosphere. Second, the share of renewable energy sources in the total energy mix is intended to triple to 20% by 2020, while aiming

[2] Other major contributions to this debate include the climate change communication "Winning the battle against climate change" (European Commission 2005a; 2005b), the Green Paper on Energy Efficiency (European Commission 2005c), the Energy Efficiency Action Plan (European Commission 2006b), the ongoing works of the High Level Group on Competitiveness, Energy and the Environment (European Commission 2006c; 2006d) and the enquiry into the energy sector by DG Competition of the European Commission in 2006.

[3] An Energy Policy for Europe, COM(2007) 1; Action plan on energy efficiency, COM(2006) 545; Biofuels progress report, COM(2006) 845; Renewable energy road map, COM(2006) 848; Report on progress in renewable electricity, COM(2006) 849; Prospect for internal gas and electricity market COM(2006) 841; Priority interconnection plan, COM(2006) 846; Strategic energy technology plan, COM(2006) 847; Sustainable power generation from fossil fuels: Aiming for near-zero emissions from coal after 2020, COM(2006) 843; Nuclear illustrative programme, COM(2006) 844; Climate change communication "limiting global climate change to 2° C", COM(2007) 2.

for a 10% biofuel component in vehicle fuel by 2020.The third pillar focuses on reducing the carbon emissions from hydrocarbons. Of particular importance in this context is the role of coal, which is relatively cheap and available in Europe, but "dirty" in environmental terms as compared to other energy sources. The development of carbon capture and storage (CCS) technologies is thus a crucial factor in securing future energy supplies. The fourth and fifth pillars of the EPE are the EU's carbon market and an open and competitive internal energy market. A competitive market is expected to increase security of supply by improving the conditions for investment in power plants and transmission networks, which in turn will help avoid interruptions in power or gas supplies. To facilitate its creation, the European Commission has recently published its third legislative package[4] including proposal for a number of measures to increase competition in the EU electricity and gas markets. These include, amongst others, the separation of production and supply from transmission networks ("unbundling"), the facilitation of cross-border energy trade, as well as greater transparency of the markets. These proposals are currently being discussed by the Member States within the Council. While a pan-European energy market is under development, Member States will likely continue to implement national policies suited for the specific market-situation. It is vitally important that Member State measures do not delay or hinder cross-border markets from emerging, in order not to undermine the potential efficiency gains from a functioning pan-European market, and avoiding a further renationalisation of energy policy.

The EPE also contains a chapter dedicated explicitly to increasing security of supply, which calls on a "spirit of solidarity" between Member States, especially in case of an energy supply crisis. A similar notion has been included in the Reform Treaty ("Lisbon Treaty") which should be adopted by the end of 2007. Other proposed measures include:

- Diversification of energy sources and transport routes (e.g. the Nabucco pipeline project has been selected as a "priority project of European interest"),
- Developing an effective crisis response mechanism (incl. warning capacity),
- Improving oil data transparency and reviewing oil supply infrastructures and oil stocks mechanisms,
- Analysis of availability and costs of gas storage facilities in the EU,
- Assessment of impact of current and potential energy imports and the conditions of related networks on each Member State's security of supply,
- Establishment of an Energy Observatory within the European Commission.

In addition the Council called for deepening dialogues and partnerships with a large number of producer, transit and consumer countries. By mainstreaming energy issues into its external policy dimension, the EU intends to maintain/create a long term framework as a basis for stable relations with its international partners in the energy field. This will be crucial in strengthening the power of the EU's foreign and security policy. However, as pointed out by Larsson (2007), Europe's first priority should be to take care of its

[4] Electricity proposals: COM(2007) 0528, COM(2007) 0531; Gas proposals: COM(2007) 0529, COM(2007) 0532

domestic problems by making sure that internal challenges, such as market liberalization and ownership unbundling, are not exploited by foreign actors. Similarly, the EU should focus more on decreasing demand for energy, increasing efficiency and developing alternative energy sources, rather than on giving priority to plentiful, secure and reliable energy supplies to support economic growth (Larsson, 2007). Such a strategy will effectively reduce risks associated with current energy supplies.

4. Market compatible strategies to increase the security of energy supply

4.1 Security of supply and natural gas

The European Economic Area will become increasingly dependent from gas pipe supplies coming from very few countries. Whereas over 80% of the global natural gas reserves of 181.5 trillion m3 (BP, 2007) are located at a distance from Europe which allows for pipeline transport (Mueller, 2007), Europe lacks the infrastructure to tap resources in the Middle East, the region with the largest proved reserves (over 40% of global reserves). Over 80% of Europe's natural gas imports come from three countries (EC, 2006), where the gas market is tightly controlled by governments. In this respect, fears of "gas cartels" or of energy being used as a political weapon do not seem unfounded. Similarly, there is a risk of a lack of investment in exploration, production and transportation, despite reserves being abundantly available in areas surrounding Europe. If gas is unable to take a larger share in power generation, it will not be able to live up to its expectation to be a "bridge" to a low-carbon economy and may even become a sunset industry[5]. In addition, the future carbon price will have an impact on the future of the gas markets.[6]

Current energy scenarios show that a reduction of dependency on gas through an increase of domestic production or through energy savings is not credible. The situation is different with regard to diversification of exporting countries. Europe's position in the world market could be more favourable depending on whether African/Middle Eastern exports grow substantially, backed by significant volumes of LNG. The latter's growth (especially in a spot market) seems to be a key factor for improving Europe's position in the gas market, as it increases market flexibility.

Another critical factor is transportation capacity towards Europe, as it seems very likely projected infrastructure will not be able to meet expected demand. This implies the need to gain access to gas reserves, to open up producing areas to international investments and to give due attention to the stability of 'transit countries'.

Finally, regarding the risk of depleting gas reserves, there is no problem of scarcity even in the long term and conventional reserves should be sufficient at least until 2035–40, so

[5] Unless a combination of demand reduction, new and renewable energies and nuclear power can fill the gap, the substitute would be coal resulting in higher GHG emissions (Stern, 2006).
[6] Most of the gas companies have adjusted the gas market growth expectations downwards after the first carbon market experience, due to competition of gas with coal and nuclear for power generation.

that the risk of price increases (owing to the need for unconventional reserves) is also small.

Diplomacy and diversification

A key strategy to secure supplies is based on diplomacy and stable international relations. In this respect, the EU needs not only to focus on its Eastern neighbors, but also on major energy players in Africa and the Middle East. Nevertheless, good diplomatic relations and stable external affairs cannot reduce risks to zero. There is always a risk associated with import dependency.

Importers should be encouraged to diversify their sources and promote demand flexibility. Policymakers should put forward measures (e.g. exemptions from competition law, financial instruments) that welcome the introduction of geographical diversification of gas imports, while increasing imports from an established source should be avoided. Although such policy measures are best formulated at the member-state level, they should be based on a systematic and formal market-surveillance mechanism, coordinated by the European Commission together with national regulators – possibly within the Council of European Energy Regulators or another agency.

The case for the EU to develop a set of policies to promote diversification and redundancy of import capacity is strengthened by the fact that it would not only improve security, but also and indeed primarily because it would support competition in gas markets.

A proposal to deal with import-dependency risks

Identifying relevant risks is a political responsibility that should be addressed at the EU level, in close consultation with Member States and stakeholders. This effort is greatly helped by a Community solidarity mechanism, taking into account the technical, economic and infrastructural situation. At present, the only significant threat could arise from Europe's single most important foreign supply country, Russia. The already dominant role that Russia plays as a supplier is exacerbated by the importance that it has in new Member States. Such a threat means that if gas of such a significant proportion is not delivered, it can cause physical interruptions over a period of time but not indefinitely.

Not all consumers have the same needs. A differentiation among priority (firm or non-interruptible) and interruptible customers should be made. Suppliers should be required to protect their priority customers. As long as their exposure to the possible negative event (percentage shortfall in supplies) is lower than the share of priority over total customers, they may not need to worry about security of supplies. This idea suggests that the security of supply standard could be defined as the guarantee that all the gas volumes demanded by non-interruptible (firm or protected) customers, are available at a reasonable price. Such a standard is best established at the EU level.

As a result, an increase of natural gas in power generation will improve the non-interruptible and interruptible consumer ratio and therefore increase security of supply for gas. Nevertheless, to some extent this increases the risks for power generators, who would eventually need to invest in dual-fired generation, which is likely to increase their costs.

Interruptible customers need to be offered lower prices since they do not require protection in the event of a crisis (they may opt to withdraw from the market or maintain their own alternative fuel capacity).

The distinction among various kinds of customers can be contractual, in which case the law or regulatory system should guarantee the meaning of contractual obligations. Thus suppliers' claims of force majeure as an impeding factor to the delivery of gas are limited. Details would need to be agreed at the member-state level.

In an interconnected, competitive market, well-diversified companies enjoying a small protected-customer base could be permitted to sell emergency supply rights to other companies that possess less diversified supplies or customer bases (or both), or that are more oriented towards priority customers.

An agency should be in charge of general oversight of the security of the system, including the surveillance of interconnection capacity and ensuring a supplier of last resort. The agency could be organised as either an EU or Member State body, such as an EU agency or a system of national agencies, possibly placed within the national regulators. The agency could be funded partly by taxpayers and partly by a levy on emergency supply rights for importers to meet their minimum security obligations. A company's gas procurement portfolio and the composition of its customer base should determine storage obligations.

Costs could be socialised to some extent, because diversification of sources and redundancy of import infrastructure or a provider of last resort are also tools to encourage competition. As such, they may be assumed to be a systemic priority. Who will be called upon to finance this activity is an open question that will need to be decided by policy.
Cost implications for the power sector should be included in estimations.

Liquefied Natural Gas (LNG)

Supply flexibility, which is a function of diversification, the mode of transmission – pipeline versus liquefied natural gas (LNG) – and redundancy in import infrastructure, is very important for both security of supply and competition. However, it is also very expensive.

The development of LNG markets is expected to ease some concerns about security of supply, especially in terms of pipeline diplomacy, because of its advantages of flexibility and diversification. Currently, about 11% of Europe's gas imports are in the form of LNG. However, some drawbacks remain. Besides the fact that LNG technology is sensible to physical threats, exporters have not kept up with increasing facilities in importing countries, leading to some regasification terminals standing idle. In addition, the EU is expected to face fierce competition from other importing countries, such as the US (Larsson, 2007).

Overall, the enlarged EU faces the challenge of major investment in natural gas and LNG capacity to secure a possible demand of 629 bcm by 2015 (up from 532 bcm in 2006). LNG imports are expected to cover a large share of this increase, with LNG regasification capacity likely to double to 198 bcm in 2015 (up from 93.2 bcm in 2007). However, global regasification capacity will continue to exceed liquefaction capacity due to the requirement for spare capacity resulting from arbitrage and seasonal demand variations (Toenjes/de Jong, 2007).

In reality, demand for natural gas and LNG may be even higher, depending on the degree to which the current and future commitments from the Kyoto Protocol are fulfilled. Investment in expanding current gas pipeline links and LNG receiving facilities along with new infrastructure over the next 20 years translates into a total cost estimate of between $150 and 200 billion.

Sustained uncertainty about future gas prices may have an adverse impact on raising appropriate financing. Gas prices will be influenced by new infrastructure investment, production in more difficult conditions and longer transportation routes. The EU emissions trading scheme – itself another gas ‘driver’ – creates additional uncertainty about prices, although it is generally expected that it will push prices up. For example, McKinsey (in Lekander, 2003) assumes that CO_2 regulation increases demand growth from 2.7% to 3.8% p.a., translating into an increase of gas border price by 15% in 2014.

The good news is that technological progress is expected to reduce both capital investment and unit transport costs, thereby opening up new supply opportunities for pipelines and LNG.

This calls for a well-calibrated policy regarding the regulations applied to construction and access to infrastructure facilities (LNG tankers, terminals and pipelines), to avoid hampering their development. The establishment of a systematic and formalised market-surveillance mechanism will be crucial in this respect, coordinated by the European Commission together with national regulators, possibly within the CEER or an EU agency.

4.2 Oil security

The supply of oil in the European Economic Area and OECD countries has largely been secured by existing infrastructure, topped up by security measures such as the IEA strategic stocks and demand restraint measures. However, Europe and all other major consumer regions are faced with declining domestic oil extraction rates, leading to increasing import dependency and stronger competition between oil importers. At current production rates, the EU-25 will have exploited all its proved reserves by the end of 2014

(BP, 2007). On the other hand, global estimates of how much recoverable oil remains have consistently increased over time. BP (2007) estimates proved oil reserves to amount to 1.2 trillion barrels at the end of 2006. At the current rate of global production, these remaining reserves would last for another 40.5 years. This reserves-to-production (R/P) ratio has remained rather constant when compared with 1996 and 1986 levels of 41 and 39.8 years, respectively. However, appropriate investment is key for future production to match demand. Additionally, undiscovered conventional resources are estimated to amount to 880 billion barrels (IEA, 2006). In the long-run, non-conventional oil resources (e.g. oil sands, gas-to-liquids, coal-to-liquids, oil-shale, etc.) will play an increasing role in global oil supply. With estimated reserves of at least 1 trillion barrels, they are expected to contribute almost 8% to global oil supplies by 2030 (IEA, 2006). Moreover, these resources are mostly located outside the current oil-producing countries. Whether non-conventional alternatives will be commercially available will depend on world oil prices and technology/infrastructure development.

A primary mission of the IEA was the creation of a mechanism to mitigate the negative effects of oil disruptions. The mechanism of emergency response was set up under the 1974 agreement on an International Energy Programme (IEP). The IEP Agreement requires IEA countries to hold oil stocks equivalent of at least 90 days of net imports of the previous calendar year and to increase supply (by releasing oil stocks and increasing domestic production) and reduce demand (by means of demand restraints and fuel switching) in the event of an oil supply disruption of 7 per cent or more to the IEA or individual countries (IEA, 2007). The IEA emergency measures are kept in constant readiness through periodic tests involving administrations and the oil industry. They have been mobilised on several occasions over the years making a significant contribution to restoring market stability in terms of uncertainty.

There are two different categories of stocks, depending on the holder: *public* stocks, held exclusively for emergency purposes, are oil reserves held by agencies or owned directly by governments; *industry* stocks include stocks held to meet government stockholding obligations and stocks held for commercial purposes. In June 2007, total oil stocks in IEA member countries totaled some 4.1 bn barrels (about 150 days of net imports), of which 1.5 bn barrels were public stocks and 2.6 bn barrels were industry stocks (IEA, 2007a). IEA stocks seem adequate for a medium-scale disruption of short- to medium-term duration, while for larger disruptions the instrument is sufficient only for short periods of time.

Stockdraw and demand restraint policies are the most feasible and effective measures in the IEA context, because of high oil stock capacity, great dependence on oil (high demand), the reduced spare capacity and the reduced fuel-switching capacity. A recent example of their effectiveness has been the 2005 IEA Collective Action in response to the hurricanes in the Gulf of Mexico, which resulted in 57.5 m barrels made available by the IEA's 26 Member States from all forms of stock release and increased indigenous production, in addition to 1.7 m barrels made available in from of demand restraint (IEA, 2007a).

Demand restraint as a policy approach refers to the short-term oil savings that can be achieved during a period of crisis. The measures to achieve demand restraint fall into three main categories: persuasion and public information, administrative and compulsory measures, and allocation and rationing schemes. Demand-restraint programmes reflect local demand patterns and economic structures, legislation and emergency-response policies.

In general, IEA countries must have a ready programme of demand restraint measures equal to 7% of oil consumption if supplies are cut by 7% (approximately equivalent to 3.4 mb/d, see BP, 2007), and 10% of oil consumption (approximately equivalent to 4.9 mb/d, see BP, 2007) if supplies are cut by more than 12%. Some measures that can be adapted to changing market conditions include: reduced speed limits, carpooling, odd and even car registration plates, car-free days, restrictions on residential and commercial energy consumption related to heating and lighting, and free urban public transport. Restraint measures are designed mainly for the road transport sector, which is the biggest oil-consuming sector in OECD countries (>50%), but price elasticity of the sector remains very low in the short term and is decreasing. While the diversity of energy sources characterises the electricity and low-grade heating sectors of the economy, surface transport and aviation remain persistently committed to only one fuel technology. A more proactive policy on transport price elasticity could be envisaged along three parallel tracks. The first is the capability of bringing increased supplies of non-Middle Eastern oil on stream. The second is to free oil from other uses by fuel substitution. The third is to open up a new transport-fuel supply grid, which may include biofuels, hydrogen or electricity. Among these three suggestions, the third has possibly the best political prospect – at least in the longer term – although such a strategy has major cost implications.

4.3 Electricity adequacy in liberalised electricity markets

Issues for the electricity sector are continuity and reliability of supply. Risks include electricity blackouts due to ageing infrastructure and a lack of investment in networks, especially cross-border capacity, erosion of reserve capacity, unwarranted public opposition to new investment projects in generation and transportation, bad regulation and increasing domestic generation market share of incumbent companies. A particular aspect is the slow progress in liberalisation and integration of the electricity market. Markets in "transition" create their own risks such as erosion of reserve capacity. Such issues are likely to disappear, once the market functions properly.

In general, liberalisation increases security of supply by increasing the number of market participants and improving the flexibility of the energy systems. Liberalisation may, however, also pose new risks. Reserve capacity is one of them. In the monopolised market structure, capacity shortages have never been a problem. The system inherently produced excess capacity in the knowledge that costs could easily be passed on to consumers. In competitive markets the situation has reversed. Investment decisions for generation capacity are based on calculations of profitability. Particularly if peak demand only rarely occurs, which by definition is the case for the marginal kWh, incentives to build reserve capacity are low. Theoretically, shortages of generation capacity could be offset by trade but interconnection capacity is not sufficient.

Sufficient investment in electricity capacity in unregulated markets does not take place continuously but in a cyclical manner. At present, there is no scientific consensus on whether markets are expected to produce adequate capacity levels continuously. Practical experience is too limited and available cases involve complex and disputed data.

Most European electricity systems do not have any specific provisions to ensure adequacy of capacity. They rely on the electricity market to provide the incentive for investment. Price (expected) is the only driver of investment incentives. While in theory spot pricing can deliver optimal results with regard to securing supply in the long and the short term, real markets seem not to be able to verify theory and therefore raise questions over their ability to secure supply. The specificities of electricity (non-storability) make wholesale prices highly volatile, making it vulnerable to supply interruptions.

There are a number of factors that instigate market failure in the setting of optimal investment signs (based on price) to invest in generation adequacy. These include price restrictions, imperfect information (about consumer willingness to pay or future supply and demand), regulatory uncertainty and/or restrictions relating to investment regulation and risk-averse behaviour by investors.

Regulatory intervention towards the maintenance of reserve capacity is desirable because of the public good character of it. The more reserve capacity exists, the higher the reliability of the supply system and the service. At the same time, consumers having the certainty of existence of reserve capacity will opt for understating their willingness to pay, and attempt to free-ride on the demonstrated willingness of others (as demonstrated by the premiums they would be willing to pay) and thus distort the market to their benefit.

Long-term contracts are not optimal investments where they concern peaking units, as they allow for free-riding by consumers (prices are received from competing retail companies that buy from generators at probably higher prices and then have to compete); furthermore, such contracts do not have a sufficient duration to dampen the business cycle.

The provision of electricity is characterised by a strongly asymmetric loss-of-welfare curve. The loss of welfare because of under-investment by a certain amount is many times higher than the loss of welfare as a result of over-investment by the same amount.

Two strategies are proposed to reduce the risk of under-investment. The first is to continuously over-invest in the electricity system. This strategy, however, is flawed by a welfare loss with regard to the social optimum, but at the same time it insures against the much greater risk of under-investment. The second strategy is to ‘flatten’ the investment optimum by changing the dynamics of the system. By making demand more responsive to price, random rationing and extreme prices could be avoided. The least valuable loads would reduce their demand and thereby the overall social cost of a disruption would be reduced from the average value of lost load to the value of lost load of the least valuable customers.

There are a number of suitable cost-effective mechanisms that could address the issue: mothball reserves, capacity payments, capacity requirements, reliability contracts and capacity subscriptions. These all have different merits and shortcomings. The baseline should be that the demand for reserve capacity should be made explicit, i.e. that the solutions should be market-based. Capacity markets, reliability contracts and capacity subscriptions satisfy this condition. Reliability contracts and capacity markets are the most market-based and they also pose the fewest legal issues at the EU level in terms of state-aid rules, public service obligations and cross-border problems.

The analysis has shown that in order to be effective in a cost-efficient way, the instrument finally chosen should be applied to the entirety of the market, which could be the EU as a whole or 'regional markets', should this concept be implemented as the European Commission has suggested. The existing reality in the European Union is that it is the national governments or their regulators that are responsible for ensuring adequacy.

5. Beyond the market

The above focus on market oriented policy options does not imply that markets can achieve everything. Especially for long-term policy objectives government action will be needed. Examples include R&D or the development of new and breakthrough technologies to cope with climate change. Moreover, the EU is dependent on imports from areas, where market rules do not apply and economic decisions on whether to explore, produce or sell energy is largely linked to political considerations.

There may thus be a need for the EU to act on the following fronts.

On the demand side, the promotion of a strong and ambitious energy saving and energy efficiency policy in the EU and ideally across the OECD or even globally could reduce dependence on politically unstable or unreliable countries. Another area is investment in energy efficiency programmes by utilities with a focus on networks upgrade and smart metering systems to give the customers awareness of their consumption through a real time measure. A particular objective should be to limit the use of oil to essential areas such as transport and petrochemical, or a reflection on how to make best use of natural gas.

On the supply side, focus should be laid on supporting near zero carbon technologies such as renewables and carbon capture and storage (CCS). This would include especially temporary support mechanisms for renewables electricity or second-generation biofuels[7]

[7] Second-generation biofuels are ligno-cellulose based bioethanols, Fischer-Tropsch diesel and bio-dimethylether. Although conventional biofuels such as pure vegetable oil, biodiesel and ethanol are cheaper, as CO_2 reduction of second-generation biofuels are about the double of those of conventional ones,

to help bring down costs, creating the regulatory framework for carbon capture and storage as well as facilitating pilot and demonstration projects in the area. Ultimately, it should be up to the markets to choose the appropriate technologies (be they renewables, CCS or nuclear) based on the political objectives of the EU and/or its Member States. Choices will most likely be different across member states depending on political preferences, political acceptability and resource endowment.

Regarding R&D, the EU should focus on all energy technologies including both demand and supply with the objective of maintaining or increasing diversification and flexibility of EU and global energy markets but also to reduce GHG emissions from fossil fuels. Attention will be needed to ensure the deployment[8] of technologies to bring down costs – once these have come close to being competitive – while minimising the environmental impact.

For oil, the objective should be to maintain or increase market flexibility both in the EU and globally (e.g. by increasing spare oil production capacity), liquidity (e.g. by preventing oil resources to be excluded from the global market) and diversity (e.g. develop unconventional oil), essentially to reduce transaction costs by improving the functioning of markets.

For natural gas, the objective should be to improve the functioning of the internal gas market, notably by increasing liquidity both for piped gas and LNG. Liquidity of the market presupposes that it remains attractive for producers to deliver sufficient volumes to the EU and the right incentives for infrastructure investment are in place. In addition, existing bodies such as the Gas Coordination Group could be used to identify possible measures to cope with possible supply disruptions, including better co-ordination or harmonisation of national regulations on gas supply and on gas stocks.

For the electricity sector, continuity and reliability will be enhanced by a more harmonised or even unified management of the European grid, more investment in generation and grids and improved cooperation between Transmission System Operators (TSOs). These measures, in particular, are a key to foster the regional markets and ultimately European energy markets integration.

The above measures constitute the existing “EU consensus” of no-regret options to address EU energy policy objectives. Too often, however, such no-regret options fail due to policy inertia, expediency or simply lack of interest. To avoid such failure in the future, the European Commission in its role as Guardian of Treaty could be given special responsibility for tracking member states and EU progress towards the implementation of these measures.

Röller, et al (2007) show that member states’ energy policies remain largely determined by exogenous factors such as availability to domestic resources and geography. Member

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the former have a far better cost-benefit ratio (e.g. Jansen and Bakker, 2006). However, this cost-benefit ratio is highly dependent on land-use parameters.

[8] See the presentation of A Stouge at the CEPS Task Force meeting on 8 November (Stouge 2006).

states have very different starting points, facing different energy challenges. Against such a background of heterogeneity, identifying the “European added-value” beyond the above consensus will be difficult. On the other hand, if an energy policy for Europe attempts to go beyond the “lowest common denominator”, i.e. the policies and measures that all member states agree with, such a policy will need to submit member states to the test on whether domestic energy policies meet “agreed EU policy objectives”.

Bibliography

BP (2007), *BP Statistical Review of World Energy*, BP, London

Egenhofer, C., Gialoglou, K., Luciani, G. (2004), *Market-based Options for Security of Energy Supply – Summary and Conclusions*, INDES Working Paper No.1, CEPS, Brussels

European Commission (2000), *Towards a European Strategy for the Security of Energy Supply*, Green Paper, COM(2000) 769 final, Brussels

European Commission (2006), *A European Strategy for Sustainable, Competitive and Secure Energy*, Green Paper, COM(2006) 105, Brussels

European Commission (2007), *An Energy Policy for Europe*, COM(2007) 1 final, Brussels

IEA (1995), *Natural Gas Security Study*, OECD/IEA, Paris

IEA (2006), *World Energy Outlook 2006*, OECD/IEA, Paris

IEA (2006a*), The IEA's Emergency Response Policies, Measures and Practices,* Presentation of Kristine Kuolt, Deputy Head, Emergency Planning and Preparations, at the 2nd Fossil Fuel Forum, 8-9 October 2006, Berlin

IEA (2007), *http://www.iea.org/Textbase/subjectqueries/keyresult.asp?KEYWORD_ID=4103*, as of 14 November 2007

IEA (2007a), *IEA Response System for Oil Supply Emergencies*, OECD/IEA, Paris

Larsson, R. (2007), *Tackling Dependency: The EU and its Energy Security Challenges*, Swedish Defence Agency, Stockholm

Luciani, G. (2004), *Security of Supply for Natural Gas Markets: What is it and what is it not?*, INDES Working Paper No. 2, CEPS, Brussels

Mitchell, J. V. (2007), *Analysing Energy Insecurity*, Oil, Gas & Energy Law Intelligence, London

Mueller, F. (2007), *Energy Security – Demands Imposed on German and European Foreign Policy by a Changed Configuration in the World Energy Market*, SWP Research Paper No. 2, SWP, Berlin

Roeller, L., Delgado, J., Friederiszick, H. (2007), *Energy: Choices for Europe*, Bruegel Blueprint Series, Bruegel, Brussels

Stern, J. (2006), *The New Security Environment for European Gas: Worsening Geopolitics and Increasing Global Competition of LNG*, Oxford Institute for Energy Studies, NG15, Oxford

Stouge, A (2006), *Improving the innovation chain in Europe*, Presentation at the second meeting of the CEPS Task Force, Brussels, 8 November 2006

UCTE (Union for the Co-ordination of Transmission of Electricity) (2007), *Final Report – System Disturbance on 4 November 2007*, Brussels