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**Work Package 3
Task 3.1**

**BACKGROUND PAPER ON LONG-TERM SECURITY STRATEGY
FOR EUROPE**

Arianna Checchi
Christian Egenhofer
Arno Behrens

STRUCTURE

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INTRODUCTION

1. The concept of security of supply

A discussion on security of supply requires a common understanding of the concept. The existence of different interpretations and approaches makes its definition difficult and elusive. The literature is divided between those who interpret energy security from an economic perspective and those who stress the political and strategic side of it. The former like to challenge the concept of energy security considering it nothing but a myth (Noël, 2008). Indeed, the majority of economists consider the expression meaningless since they believe that energy matters are subject to market rules only, leaving political and hard power factors aside. The idea is to let markets work, calling for government intervention only in case of market failures. In line with this view, the world nor the EU are currently facing severe energy security challenges to be dealt within a strengthened international framework, with heavy government intervention or even with military means. Instead, “the world economy does face a mid-term risk of liquid fuel scarcity and short-term risk of oil supply distortion, but there is nothing we are ill-equipped to deal with. [...] Similarly, higher prices are not an energy security problem but a solution” (Noël, 2008).

On the contrary, foreign policy analysts are convinced that the increasing nationalisation of energy resources and the politicisation of energy management by resource-rich countries have made energy security – as back in the 1980s – a matter of national security (Yergin, 2000). According to them, the market alone is not able to deal with the mounting and multifaced challenges that energy consuming countries have to face in a globalised world. Energy security therefore requires international cooperation, government intervention and military control. Neither of these two interpretations can be dismissed, but neither can catch the whole picture of security of supply. In fact, the economic and the so-called political interpretation are two sides of the same coin, they complement each other and they are both necessary to explain the challenges as well as the solutions for dealing with the security of energy supply in Europe.

The complementarity of the two dimensions becomes clear when we get to the definition of energy security or security of supply. Although a common interpretation does not exist, it is possible to identify a number of features which are always included, namely physical availability and prices (see box 1). Given that commodity prices affect economic growth, wealth and industrial competitiveness, 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 supply – but in this case it would be naïve to say that the security of supply was guaranteed. In what extent it is acceptable to let prices vary to restrict demand and allocate scarce supplies is a question that can only be decided politically by governments or international cartels (such as OPEC). Yet, the security of supply implies also an “uninterrupted availability” of resources which depends on geological and economic dynamics as well as government interventions (especially on the demand side) and some political compromises. In addition to prices and uninterrupted availability of resources,

security of supply is characterised by other features which are resource-specific which will be analysed in the following chapter (see chapter 2).

Box 1. Definitions of security of supply

Political View

“Energy supply 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 maximise energy self-sufficiency or to minimise dependence, but aims to reduce the risks linked to such dependence” (European Commission, 2000, p. 2). However, the Commission later noted that the risk of supply failure associated with increasing dependency on imported hydrocarbons is growing (European Commission, 2007).

“[Energy security is] the continuous availability of energy in varied forms, in sufficient quantities and at affordable prices” (UNDP, 2001).

Economic View

“A condition in which a nation and all, or most, of its citizens and businesses have access to sufficient energy resources at reasonable prices for the foreseeable future free from serious risk of major disruption of services” (Barton, Redgewell, Ronnel and Zillman, 2004).

“[Energy security is] the concept of maintaining stable supply of energy at a reasonable price in order to avoid the macroeconomic dislocations associated with unexpected disruptions in supply or increase in price (Bohi and Toman, 1996).

“Free markets are the consumers’ first line of defence” (Noël, 2008).

The literature is further divided between those who see the security of supply as exclusively related to energy and those who like to couple it with the environmental dimension. Energy experts generally prefer to keep energy and climate change issues separated, especially when it comes to policy implications (see Hartley and Medlock 2008). Accordingly, different approaches are adopted to study the two topics, different solutions are required, and different policies are suggested. Climate change experts also tend not to deal with questions of energy demand and supply. However, with energy and climate change being strictly interlinked, it would be non-sense to assess their risks and consequences separately. We therefore call for an integrated approach of energy and climate change. Indeed, security of supply is essentially a strategy to reduce or hedge risks that derive from energy use, production and imports. All security-of-supply approaches are aimed at ‘insuring’ against supply risks with an emphasis on cost-effectiveness and the shared responsibility of governments, firms and consumers.

2. Supply Risk Analysis

Defining energy security is also complicated by the variety of views of what is at stake: to some it means protecting against politically induced supply disruptions or technically induced supply problems, to others it is facing the challenge of terrorism or to

deal with price shocks, while to many it means addressing the issue of global warming (Monaghan, 2005, pg. 2). Indeed, there is no consensus among economists, energy experts and politicians on the correct hierarchy of energy challenges for Europe in the near to long-term future. In line with the current debate on energy security of supply in Europe, we identify the following types of risks:

- Geological risks refer to the possible exhaustion of an energy source. Oil and gas reserves in the EU decreasing (BP, 2007) and over 90% of world hydrocarbon reserves are controlled by state-owned companies in the Middle East and Eurasia. Not only are oil and gas difficult to access for European companies, but total hydrocarbon reserves and resources remain unknown. To some, oil production will peak in the next 20 years or so. Others believe that we are far from reaching the peak since only one third of the world reserves has been exploited so far (Yergin, 2006). However, even assuming this last optimistic view, the increasing pace of world energy consumption is a source of concern for the future availability of resources: between 1973 and 2005 world energy consumption doubled and by 2030 a further 55% increase has been predicted, mainly because of developing countries' rapid economic growth (IEA, 2007).
- Technical risks include system failure owing to weather, lack of capital investments or generally poor conditions of the energy system. The nine-hour electric blackout, which occurred in Italy on September 2003 and the power interruptions of November 2006, which originated in Germany by the tripping of several high-voltage lines and affected 15 million European households, are good examples (UCTE, 2004 and 2007).
- Economic risks mainly cover erratic fluctuations in the price of energy products on markets. Price variations can be due to actual or anticipated imbalances between supply and demand, but they can also result from speculative movements and market power abuse. On the one hand, the rise in fuel prices creates monetary and trade imbalances between energy producing and consuming countries especially harming the economy of the latter. Yet, high prices tend to slow down global economic prosperity eventually damaging producing countries economies. On the other hand, decreasing prices of energy sources tend to diminish capacity enhancing investment in energy producing countries creating new bottlenecks to oil and gas supply. In addition, economic risks may include regulatory risks. Government-regulated policies in energy-producing countries may underplay the level of future investments causing related effects on production and prices. In the past, many suppliers have indeed proven unable to increase production, adding to the pressure on market prices (e.g. Riley, 2006)
- Geopolitical risks concern potential government decisions to suspend deliveries because of deliberate policies, war, civil strife and terrorism. Energy industries in most supplier countries are subject to extensive government interference, and do not function necessarily in a competitive market framework. This adds to the fears that energy will increasingly be used as a political weapon. In addition, security of supply is threatened by political instability of exporting regions where civil wars, local conflicts and terrorism have often been cause of temporary damage of energy facilities and

infrastructures.

- Environmental risks describe the potential damage from accidents (oil spills or nuclear accidents), or emissions such as greenhouse gas emissions. It is generally assumed that industrial countries will need to reduce emissions by 60-80% or more by 2050. Given that within the EU 80% of all emissions are related to fossil fuel burning in the energy, transport, household and industrial sectors, energy policy will increasingly be constrained by climate change objectives. While near zero carbon energy or possibly fusion will ultimately be essential to meet the climate change challenge, the present focus is on how to reduce GHG emissions from fossil fuels which continues to dominate the EU's energy mix. The principal obstacle facing the EU is the absence of a comprehensive global climate-change agreement that would provide the necessary certainties for investors (Behrens and Egenhofer, 2008).

It is important to note that the time scale of different risks differs considerably from fractions of a second to hundreds of years (International Energy Agency, 1995, Stern, 2006, Mandil, 2008). In the short term, the concern is with the disruptive impacts of a price shock or an unanticipated cut in supply. The latter is generally associated with supply shortages due to accidents, extreme weather conditions, terrorist attacks or technical failures of grids. Such risks are sometimes referred to in the context of 'operational security' or 'systems security'. In the long term, the concern is more with the availability of sufficient energy supply that allows stable and sustainable economic development. Here the emphasis is on geological depletion, adequacy of investments in generation capacity, transport infrastructure and grids, as well as the quality of systems' management, including pricing mechanisms and mitigating market power.

Another necessary distinction concerning risks refers to the fact that the EU is confronted with both external and internal energy security risks. All the elements linked to energy imports dependence belong to external risks, including geopolitical issues, international transit, upstream technical issues in non EU countries, etc. While uncertainties related to European energy demand, infrastructure, as well as energy policy orientations and institutional developments refer to internal energy insecurity. Accordingly, market risks in the framework of liberalisation, either due to bottlenecks, market power or regulation, have to be addressed, as well as their potential impact on import development. The distinctions between internal and external insecurity are fundamental as far as tools available to the EC and to European governments are concerned. Dealing with external issues involves developing diplomacy and relying on European energy companies present in international markets.

3. EU Energy Trends¹

Barely half of the energy consumed in Europe is produced within the region while the other half needs to be imported.² Accounting for almost 37% of total energy consumption, oil remains the dominant fuel followed by natural gas, coal, nuclear energy and renewable sources (European Commission, Statistical Pocketbook 2007-2008). Together the UK and Denmark supply just a quarter of the oil consumed in the EU while the rest is imported from Russia (30% of all oil imports), the Middle East (20%), Norway (16%), North Africa (12%), and other regions (23%) (European Commission, 2008a).

For environmental and economic reasons, natural gas has become more popular over the last decade mainly at the expenses of coal. Natural gas currently accounts for one quarter of total EU energy consumption and its consumption is predicted to grow further (IEA, 2007). With 1.3% of world natural gas reserves — mostly in the North Sea -- and a general depletion of the fields, slightly above one third of natural gas consumed in Europe is produced domestically (BP Statistics, 2007). The remainder needs to be imported from Russia (45% of all natural gas imports), from Norway (24%), from Algeria (21%), and some 11% from Nigeria, Libya, Egypt, Qatar and Oman (European Commission, 2008a).

Accounting for just 6.6% of consumption, renewable energy sources play a modest role in the EU, but much more potential could be exploited. The most developed forms of renewable are biomass, hydropower – especially in Nordic, Alpine and Iberian Mountains -- and, to a lesser extent, wind power (especially in Germany and Spain), geothermal (in Italy) and solar power (European Commission, 2008a).

Conventional thermal account for most of electricity production (57.7%), nuclear ranks second (18%), and renewables for 24.1%. However, the mix of energy production is quite different from country to country: electricity from conventional thermal dominates in Germany, Italy, and the UK; nuclear power accounts for almost 80% of electricity production in France and for half of national consumption in Germany, Spain, and the UK, while countries such as Italy, Portugal, Denmark have banned nuclear generation; renewables have been growing especially in Austria, Sweden, Latvia, Romania and Denmark (European Commission, 2008a).

It has been estimated that by 2030 energy consumption in the EU will augment by 15% whereas production will stagnate causing a further increase in oil and natural gas imports (up to 70%) (European Commission, 2006b).

¹ All data refers to EU 27.

² However, the Norwegian share of oil and gas supply to the EU is misleadingly treated as imports here. In fact, Norway belongs to the European Economic Area and should not be considered as an external supplier to the EU.

4. General policy context and current developments

Given the increasing risks related to the security of energy supplies and climate change, the European Union has recently committed itself to take actions in these new areas of concern. The policy approach of European institutions has evolved: it moved from prioritising energy security concerns to a progressive integration of energy and climate change.

Features and challenges of Europe's security of energy supply were first addressed by the European Commission in the 2000 *Green Paper* on «Security of Energy Supply» (European Commission, 2000). Given a preliminary analysis on facts and figures about energy, the document brought up three main energy concerns for Europe: high dependence on energy imports; limited influence of the EU on the supply side; and difficulties to meet the requirements of the Kyoto Protocol. In line with this first document, on 8 March 2006, the European Commission issued a second *Green Paper* on «A European Strategy for Sustainable, Competitive and Secure Energy» (European Commission, 2006a). The latter put forward suggestions and options for shaping EU's future energy policy in six priority areas:

- the completion of the internal European electricity and gas markets;
- solidarity among member states;
- a sustainable, efficient and diverse energy mix;
- an integrated approach to tackling climate change;
- a strategic energy technology plan;
- a common European external energy policy.

Following the publication of the second Green Paper the European Commission tabled a major energy policy package on 10 January 2007, entitled “Energy Policy for Europe” (EPE), which was accompanied by a number of sectoral policies to implement the overall strategy.³ The EPE contained 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 Lisbon Treaty.

After discussions in the EU Energy and Environment Councils, the EU heads of state and governments at their European Council meeting of 8 and 9 March 2007 (European Council, 2007), by and large endorsed the European Commission's strategy presented three months earlier, including:

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

- 1) A binding absolute emissions reduction commitment of 30% by 2020 compared to 1990 conditional on a global agreement,⁴ and a “firm independent commitment” to achieve at least a 20% reduction by 2020. At the same time, the EU advocated that industrialised countries reduce their emissions collectively by 60% to 80% by 2050 compared to 1990. The European Parliament in its resolution has insisted that the EU should unilaterally commit to 30%.
- 2) A 20% reduction of primary energy consumption by 2020 compared to projections;
- 3) A binding target of 20% of renewable energy in total energy consumption by 2020;
- 4) A binding minimum target of 10% biofuels of all transport fuels by 2020;
- 5) The development of a European Strategic Energy Technology Plan;
- 6) An endorsement of the European Commission’s carbon capture and sequestration policy.

In the follow-up to the spring 2007 Council, the European Commission has tabled various proposals to implement the European Council decisions. A Strategic Energy Technology Plan⁵ was published in November 2007, focusing on specific technologies that may help to achieve the 2020 commitments. On 23 January 2008, the Commission presented a whole package of proposals,⁶ containing an update of the EU emissions trading system (ETS),⁷ binding national targets for the reduction of greenhouse gas (GHG) emissions outside the EU ETS until 2020,⁸ binding national targets for increasing the share of renewable energy sources in final energy consumption in 2020,⁹ proposals on biofuels including environmental sustainability criteria,¹⁰ new rules to stimulate CCS,¹¹ as well as new state aid rules. The adoption of the package by member states is foreseen for the end of 2008, or early 2009.

⁴ Provided that other developed countries commit themselves to “comparable” reductions and economically more advanced countries to contributing “adequately” according to responsibility and capabilities.

⁵ COM(2007) 723: “Towards a low carbon future – A European Strategic Energy Technology Plan”.

⁶ See also COM(2008) 30: “20 20 by 2020 – Europe’s climate change opportunity”.

⁷ COM(2008) 16: “Proposals for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the EU greenhouse gas emission allowance trading system”.

⁸ COM(2008) 17: “Proposals for a Decision of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community’s greenhouse gas emission reduction commitments up to 2020”.

⁹ COM(2008) 19: “Proposals for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable resources”.

¹⁰ Included in the proposal on renewable energy resources.

¹¹ COM(2008) 13: “Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels”, and COM (2008) 1830: “Proposals for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006”.

Priorities for international cooperation have been formulated in the Action Plan that is annexed to the European Council Presidency Conclusion of 8-9 March 2007. Priorities in regard to developing countries are: bilateral energy dialogues with China, India, Brazil and other emerging economies, focusing on the reduction of GHG emissions, energy efficiency, renewables and low-emission energy technologies—notably CCS; enhancing energy relationships with Algeria, Egypt and other oil-producing countries in the Mashreq/Maghreb region; a special dialogue with African countries on energy and the use of Community instruments to enhance decentralised renewable energies in particular, and generally energy accessibility and sustainability in this region, as well as energy infrastructure of common interest; and promoting access to energy in the context of the UN Commission on Sustainable Development (UNCSD). In addition, further cooperation with Russia is recommended.

At the same time, the EU continues to play a key role in the development of emerging carbon markets, both in running the world’s largest GHG allowance market in the form of the EU ETS and in generating the significant demand for clean development mechanism (CDM) and joint implementation (JI) credits.

The last step in the development of Europe’s energy policy has been the Commission’s Second Strategic Energy Review published, as a first draft, on November 13, 2008. In the related EU Energy Security and Action Plan, the Commission focuses on five points that chart the policy priorities for the next Commission, due to take office in September 2009. These five-points are:

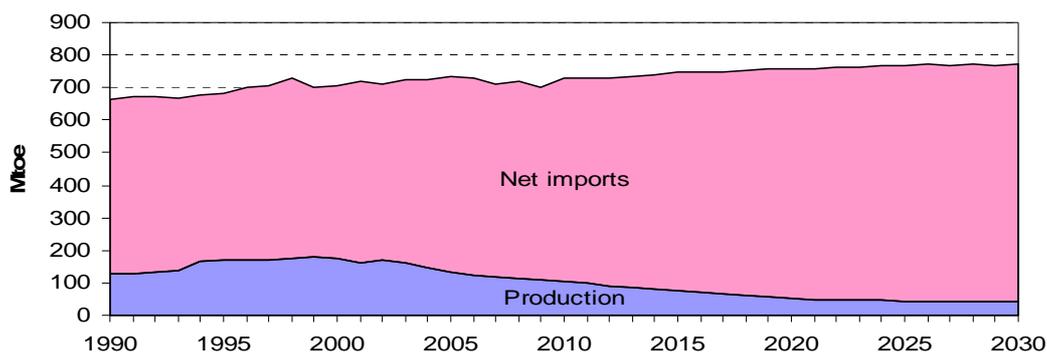
- Infrastructure needs and the diversification of energy supplies
- External energy relations
- Oil and gas stocks and crisis responses mechanisms
- Energy efficiency
- Making the best use of the EU’s indigenous energy resources.

OIL

Oil is an energy source of critical importance for the European Union. Its relevance is especially related to transport, followed by the industrial sector. Oil use for power generation has declined since 1990 thanks to fuel switching to natural gas and, to a lesser extent, to renewables. This trend is expected to continue: oil will be used as a fuel only in niche markets but it will continue to dominate the transport sector. The overall EU transport demand is indeed projected to increase by 18% by 2020 and the proposed European target of replacing 10% of transport fuel use with renewables energy sources – even if it is reached – is expected to only moderately reduce the European dependence on oil with incontrovertible negative impact on climate change (IEA, 2008).

EU-27 oil demand (crude oil and oil products) increased from 665 million tons of oil equivalent in 1990 to 731 Mtoe in 2006 (see Figure 1). Notwithstanding this relatively small increase, the gap between internal demand and supply is widening. Today, domestic oil production in the EU is less than in 1990 and it only covers 14% of EU consumption. The rest of the oil demand is met by imports. A third of crude oil imports in the EU come from Russia, followed by Norway (15%), Saudi Arabia (9%), Libya (8%) and Iran (5%) (IEA, 2008) (see Figure 2). Oil imports from Norway are not a source of concern since the country belongs to the European Economic Area, but the other suppliers are sometimes perceived a potential source of insecurity for Europe’s energy supply. Although import dependence is not necessarily risky due to a relatively well diversified source of supply origins. Instead, some EU members, such as Slovakia, Poland, Hungary, Lithuania, are almost completely dependent on Russia for oil imports.¹²

Figure 1: EU-27 oil production, consumption and net imports¹³



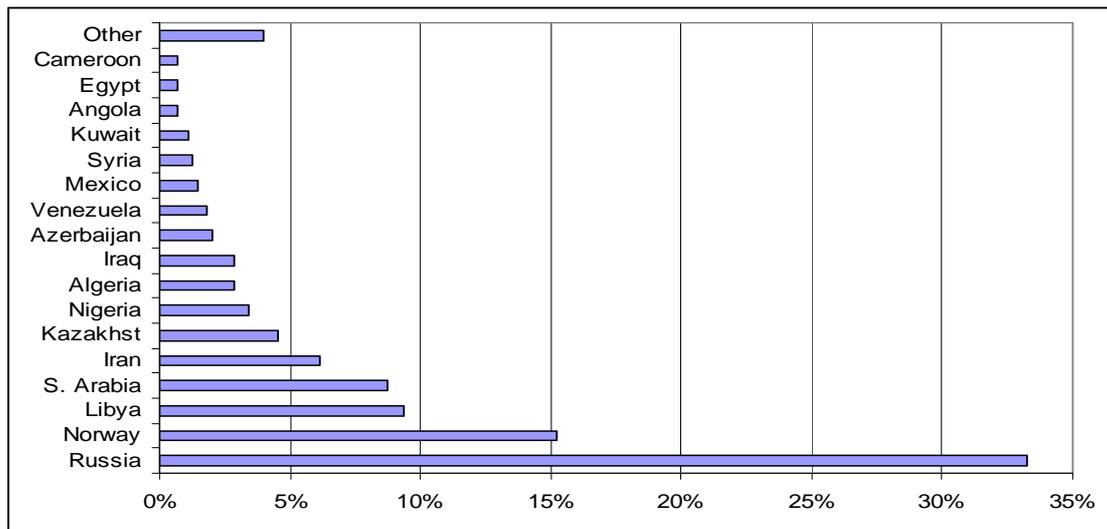
Source : Eurostat for 1990-2006, EC (2008) for 2006-2030

¹² This paragraph is mainly based on the contribution of Sohbet Karbuz from OME.

¹³ In the graph, Norwegian’s supplies are considered as net imports. Taking into account that Norway is part of the European Economic Area, the picture looks slightly different: Enlarged EU “domestic production” is in fact 15% higher than stated here.

While small discoveries continue to be made in a number of EU countries, it is unlikely that the rate of import dependence will decrease in the near future. By 2030, oil production in the EU is expected to be only one-third of today's level. Yet, according to the latest EC estimates¹⁴ the demand in EU-27 is expected to reach some 770 Mtoe by 2030.¹⁵ As a result, net oil import requirements of the EU will increase by 20% in the next two and half decades, reaching 730 Mtoe in 2030 (or almost 95% of domestic consumption), compared to 608 Mtoe in 2006. Russia will remain the biggest supplier of oil to the EU, although only a slight increase in its exports is expected. Libya and Saudi Arabia will both increase their export share to Europe. Norway, on the other hand, will become less important by 2030 due to the depletion of its oil reserves, which already peaked in 2001. By 2030, OME expects Norwegian oil exports to be only 10% of that of today. Also, EU member states will receive less crude oil in the future from the Americas, mainly because of increasing oil needs in the US whose demand will preferably be met by imports from other countries in the American continent. This means that Europe will become more dependent on Russia, the Caspian region, Africa and the Middle East for oil imports.¹⁶

Figure 2: EU-27 imports of crude oil in 2006 (intra-EU27 trade excluded)



Source: Calculated from Eurostat data

¹⁴ European Energy and Transport Trends to 2030 – Update 2007, Directorate General for Energy and Transport, European Commission. April 2008.

¹⁵ However, EU projections do not yet include the effects of planned and soon to be adopted climate change measures such as stringent emissions standards for cars.

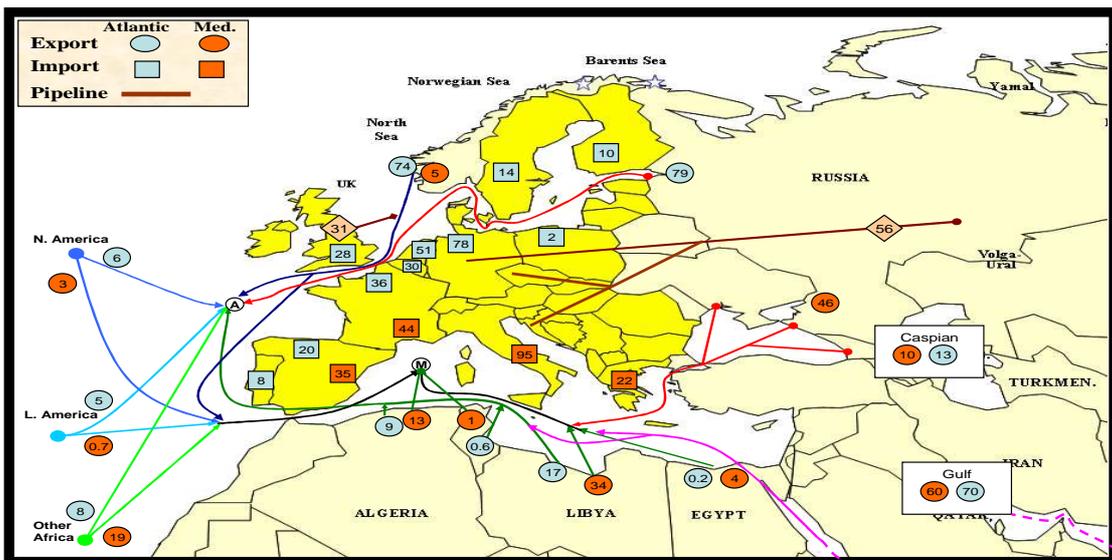
¹⁶ This paragraph is mainly based on the contribution of Sohbet Karbuz from OME.

This expected increase in oil consumption is at the centre of Europe’s energy policy debate. Because of the existence of a number of oil suppliers around the world and the global nature of the oil market, the real concern for Europe is not increasing oil import dependence *per se*, but the risks related to it: the vulnerabilities of transporting oil, the possible rivalry over oil resources around the world, and the oil price.

1. Oil transport risks

Over 85% of crude oil imports to the EU are transported by sea while only 14% are transported by pipelines. Pipeline imports come from Russia through the Druzhba North and South pipelines, and from Norway through Norpipe (to the UK). As a consequence of falling Norwegian crude oil production and exports, the share of Europe’s pipeline imports is expected to decrease down to 11%. However, pipeline oil imports from the Former Soviet Union region will increase adding to the security of supply risk for two reasons. The first reason is related to the capacity constraints of the Druzhba pipeline. Its transport capacities are fully exploited and they will need to be nearly doubled to meet Europe’s import needs. The second risk of increasing oil imports by the Druzhba line is linked to Russia’s possible supply interruptions to the states of the Former Soviet Union. If supply cuts to Western countries are not a credible threat due to their relatively diversified supply sources, some central European countries with a quasi-total dependence on Russian oil exports have some reasons for fear. Especially land-locked countries with high dependency on Russian oil exports - such as Hungary, Slovakia and the Czech Republic – are sometimes perceived as vulnerable to technical supply interruptions or to Russia’s use of energy as a tool of political pressures. However, in this context, existing IEA and EU stock policies are an important assurance tool and minimize possible geopolitical threats coming from Russia.

Figure 3: Major EU Crude Oil Import Routes, 2005 (in Million tonnes)



Source : OME

But the majority of Europe's oil imports is shipped by tankers (see Figure 3). Nearly 60% of seaborne crude oil imports to Europe go to the North of Europe (to the Atlantic ports of which Rotterdam is the most important) while over 40% go to the Mediterranean ports of the EU. According to OME estimates, in 2030, more than half of EU crude oil imports will be delivered to the Atlantic ports of the EU, while only 35% will go to its Mediterranean ports. Atlantic ports will gain main importance in share mainly because of two factors: on one hand, the increase in demand of northern EU countries (especially from the UK and other countries relying on decreasing Norwegian crude) will push Northern countries of the EU to rely more and more on oil from the Middle East and Africa; on the other hand, the foreseen decrease in demand, especially in Italy, will limit the demand of Mediterranean countries. However, most of the import volumes to Atlantic ports will have to transit through the Mediterranean.¹⁷

Although shipping oil has the flexibility advantage of allowing both exporters and importers to re-direct their exports/imports, this way of transport is vulnerable to the so-called "chokepoints", namely the narrow sea-lanes through which the oil tanks have to transit. The 106 million tons of crude oil shipped every year from the Middle East to Europe (including Turkey), have to pass through different chokepoints: the Bosphorus linking the Black Sea to the Mediterranean Sea, the Bab el-Mandab Strait from the Arabian Sea to the Red Sea, and the Suez Canal together with the Sumed pipeline connecting the Red Sea to the Mediterranean Sea. Shipping accidents, and some pirate attacks, could cause serious impediments to transport on these routes, with significant impact on oil supply and prices (Willenborg, Tönjes and Perlot, 2004).¹⁸

¹⁷ Some of this information is based on the contribution of Sohbet Karbuz from OME.

¹⁸ The Bosphorus Strait represents one of the most important supply and environmental vulnerabilities for Europe, especially for Southern countries. The straight is less than 1km wide at its narrowest point and has several blind turns that make its waters difficult to navigate. With 5,500 oil tankers transiting the straight every year, the possibility of accidents is a real threat (Willenborg, Tönjes and Perlot, 2004). The Black Sea has always been the largest outlet for Russian oil exports but the volume of oil passing through it has further increased after the collapse of the Soviet Union contributing to enlarge the accidents record of the straight. There are fears that the projected increase in Caspian Sea exports might exceed the ability of the Turkish Straights to accommodate the tanker traffic. However, the risk could be mitigated as some of the planned projects bypassing the straight should be realised soon, such as the BTC oil pipeline which started to operate in 2006 (EIA, World Oil Transit Chokepoints). Some of these projects include: the connection between the Romanian port of Constantia and the Adriatic ports of Omisalj and Trieste; the oil pipeline project from Constantia or from the Bulgarian port of Bourgas, either through Macedonia to the Albanian port of Vlore, or to the Greek port at Alexandroupolis; the reversal of the Odessa-Brody oil pipeline; the Samsun-Ceyhan oil pipeline; and a shorter oil pipeline from the Turkish port of Kiyikoy to Ibrikkaba or Saros. All these projects would help to decongest the Bosphorus but none of them are currently among the priorities of the EU (Nies, 2008).

The other key chokepoint for Europe's oil imports is the Bab el-Mandab Strait. The closure of this passage -- through which 3 million barrels are channelled every day -- would force tankers from the Persian Gulf to navigate around the southern tip of Africa instead of passing through the Suez Canal. This would add greatly to transit time and cost, shrinking spare tanker capacity. The fact that security remains a major concern in the Strait was proven by the terrorist attack on the French-flagged tanker Limburg in October 2002 (World Oil Transit Chokepoints). Close to the Bab el-Mandab Strait is the Suez Canal and the Sumed pipeline which are very important for Europe's oil imports from Saudi Arabia. A closure of the

Yet the risks related to oil transport -- either by pipelines or tankers -- are limited compared to the geological challenges that the oil sector is currently facing.

2. Increasing competition for global resources: is an oil crunch possible?

Europe's security of oil supply mainly depends on the future equilibrium between global demand and supply for oil and the related competition for available resources. Today, the world demands 86 million barrels of oil per day – i.e. 1000 barrels a second – and, according to the IEA, EIA and OPEC, oil demand is expected to rise by 35% until 2030. Yet about 42% of this increase will come from China and India and, to a lesser extent, from transition economies. More specifically, the annual increase in oil demand is expected to be 3.6% in China, 3.9% in India, 1.9% in the Middle East, 2.2% in Africa and 1.6% in Latin America, but only 0.1% in Europe. Accordingly, by 2030, the number of vehicles on the world's roads will double (up to 2.1 billion) but Europe's share of the increase in world transport oil demand will only be 3% of the total (IEA, 2008). The global increase in oil demand would therefore require an additional production of more than 1 million barrels of oil per day each year up to 2030.¹⁹ Would the oil industry be able to provide this level of production in the near future allowing Europe to meet its energy demand?

Suez Canal or the Sumed pipeline would cause oil tankers to navigate around Africa's southern tip, making the route much longer and forcing a reduction in tanker capacity with an overall effect on oil import prices (Willenborg, Tönjes and Perlot, 2004).

¹⁹ OPEC countries are expected to take a growing share of the world oil market since they hold the bulk of remaining oil reserves and their production costs are relatively low. Saudi Arabia will keep its position as the leading oil producer and exporter. Yet its production potential will stay around 12.5 Mb/d because new projects will compensate the natural decline in existing fields. In addition, it is expected that Saudi officials will avoid accelerating the depletion rates or damaging the giant field reservoirs due to overproduction. The biggest change in the region is expected in Iran and Iraq: with their large reserves and resource base, both countries are expected to boost their production. In the long run, we expect Iraq to be the second largest producer and exporter in the region, behind Saudi Arabia. For the rest, Qatar is expected to have a flat production of around 1 Mb/d, the UAE and Kuwait are expected to increase their production; while Bahrain, Oman, Yemen and Syria will try to keep their decline rates as low as possible. Bahrain and Syria will become net oil importers around 2020 and 2015, respectively. In Africa, Nigeria will remain the largest producer (5 Mb/d by 2030) followed by Libya and Angola. Oil production in Algeria -- the second largest oil producer in Africa today -- is expected to peak around 2020 and to decline thereafter. Similar paths will be followed by minor producers in the region: Cameroon, Gabon, Equatorial Guinea, Chad and Congo. Sudan, on the other hand, is expected to almost triple its production by 2020, reaching close to 1 Mb/d, but by 2030 production will probably fall to 0.5 Mb/d. Russian oil production may reach 11 Mb/d, keep that level for a while, then start to decline staying over 10 Mb/d by 2030. As a result, Russian oil exports are expected to stay at around 7 Mb/d after 2010. The Caspian Sea region is expected to become an important exporter around 2010, when the big projects go online: Kazakhstan will be the country to benefit the most from oil exports; Azerbaijan will be able to export slightly over 1 Mb/d over the next 25 years, even though its production is expected to peak around 2020; Kazakhstan, however, is very likely to reach a production level of 3.5 Mb/d by 2020 and keep that level until 2030; only Turkmenistan will remain a minor producer and exporter. Finally, in the Americas, Venezuela and, to a lesser extent, Brazil are expected to increase their oil production considerably over the next 25 years, followed by Canada which will especially focus its production on oil sands and extra heavy crude oil projects (this information was provided by Sohbet Karbuz from OME).

A key concern for the oil sector today is indeed the diminishing inventory of oil. About half of the world production comes from 116 giant fields, each producing more than 100 thousand barrels per day. Yet the majority of them are 50 years old and their resources are depleting (e.g. Ghawar in Saudi Arabia and Burgan in Kuwait). The consequent loss in production is partly (1/4) offset by newly discovered oil fields whose size is decreasing. Oil companies are struggling to replace their reserves, not only for geological reasons but also for pecuniary and political constraints. Although the injection of capital in new exploration and extraction has more than doubled between 2002 and 2006, no parallel impact has been registered on production. This is mainly due to the increasing share of unconventional oil resources (such as tar sands, extra heavy oil and oil shale) among untapped reserves. Because unconventional oil is characterised by limited fluid quality, low recovery rate and negative environmental impact, the work of international oil companies (IOCs) has become much more difficult and costly. In addition, because of spreading “resource nationalism” in oil producing countries (such as Venezuela, Kazakhstan, Russia, etc), IOCs are increasingly facing a strong competition with national companies. The latter claim their rights especially on easy-access reserves, pushing IOCs towards remote and geological complex areas (Karbuz, 2007).

This harsh context is complicated by uncertainties over a possible exhaustion of oil reserves in the near future. In reality, the data shows that there is still plenty of oil in the ground but the problem is how to recover it. Today’s average global recovery rate is only about 35%, which means that 65% of the world’s discovered oil is left in the ground. Although new technologies and exploration techniques may be able to increase the recovery rates and make unconventional oil become conventional, the era of “easy oil” seems to be over. This is what the peak oil debate is about. On the one hand, there are the pessimists who argue that unconventional resources will be able to postpone the oil peak until no later than 2015. Then, they foresee oil prices to skyrocket causing economic issues, social and environmental collapse, massive dislocation and a dying civilization.²⁰ On the other hand, there are the optimists who believe that unconventional oil sources would be able to offset the decline in conventional oil sources meeting the future increase in oil demand. To them, the oil peak will not be visible before 2030 (Karbuz, 2007).²¹ Assuming that a peak is inevitable, it is difficult to tell which view is correct because of different methodologies, data, definitions and assumptions used (Mabro 2006). Yet both of them foresee a future – sooner or later – of a world without oil.²² Peak oil may

²⁰ The most relevant representative of this group is the International Association of the Study of Peak Oil and Gas (ASPO).

²¹ The main supporters of this view are the US Energy Information Agency, the International Energy Agency and Cambridge Energy Research Associates. These two views are also divided on whether the decline in global oil production will be preceded by a peak or a plateau. The optimists generally think that before a peak the world will experience an “undulating” plateau. The pessimists are divided between those who talk about a “pumping plateau” and those who expect a sharp decline after the peak.

²² Mabro (2006) identifies three different sets of problems. First, the definition of important concepts such as crude oil, production, reserves and resources is not always the same. Second, estimates of proven reserves may be understated or overstated depending on who delivers them, e.g. oil companies or OPEC. Third, some use recoverable reserves to make their estimations, others use proven reserves.

however become irrelevant the moment the world engages onto aggressive climate change policies.

These difficulties in oil extraction, coupled with the rise in world energy demand, rise concerns about Europe's future competition for oil not only with emerging economies but also with oil producing countries. Although this does not have to remain the case in a scenario where global oil prices are relatively high, for the time being, many oil-exporting countries subsidize their domestic oil price. As a consequence, domestic oil consumption in the Middle East and Central Asia has been growing notwithstanding the increase in world oil prices. For example, between 1999 and 2007, Middle East domestic oil consumption grew on average 3.9% per year, while OECD growth rate was only 0.4% (Stevens, 2008). Domestic oil demand in Middle Eastern countries is expected to more than double by 2030, due mainly to high population and income growths. This is especially the case in Saudi Arabia which will remain the biggest oil consumer in the region and, in 2030, despite its production growth, will have an oil export potential not much higher than today. In Russia, although weak demographic developments will help reducing the growth of oil consumption in the future, the high level of energy intensity is also expected to contribute to relatively high level of oil consumption. Moreover, in most of the African countries, demand is expected to more than double but, due to increasing use of gas in power generation and in residential sectors as well as government policies to free more oil for exports, export potential over 2004 - 2030 period will mimic the production. However, this will not prevent some African countries – such as Egypt -- to become net importers as soon as 2010. Finally, economic development of Latin American countries will cause an increase in demand of around 2 mb/d in the period 2006-2030. Mexico, one of the main producers of the region, will not be able to prevent the decline of its reserve capacity and will join the importers club. Although some of these areas seem far and therefore irrelevant for Europe's security of oil supply, they are closer than one can imagine: regardless where they are located, rising domestic consumption in major oil producing countries seriously constraint their ability to export to international markets putting pressure on oil volumes and prices (Stevens, 2008).

3. The impact of oil prices

Although the oil price has recently decreased towards \$50 per barrel, in the last years, the world has been facing the highest period of oil prices after the crises of 1979. The year 2008 has been the seventh consecutive year of crude oil price increase: the barrel passed \$100 at the end of 2007 and it reached its peak in summer 2008 (\$147). Since then, the oil price has gone down. In any case, the growth of oil prices of the last years has mainly been caused by a narrowing gap between supply capacity and demand for oil. As mentioned above, booming economies -- such as China, India and Middle Eastern countries -- are the driving force behind high global demand for oil and the

relative increase in oil price.²³ On the supply side, the market is tight, the investment is low and the technical and geological hardships are numerous. Other factors, such as the weak dollar, financial speculation on oil driven by large trader banks and hedge funds, global political insecurity and unexpected weather conditions have also played a role in pushing oil prices up but their impact seems to be temporary rather than structural. Yet there is no consensus in the literature on the most important causes of this prolonged increase in oil prices.

Jan-Hein Jesse and Coby van der Linde (2008) argue that oil prices are expected to remain high for two main reasons. First, “there is no credible cushion of spare capacity in the core OPEC countries: [...] although spare capacity has improved since 2004, it is still fragile, uncertain and not perceived as adequate”. As a consequence, when unexpected events occur (e.g. hurricanes in the Gulf of Mexico, terrorist attacks to oil pipeline in oil producing countries of the Middle East or Africa), there can hardly be a response in volume, which has to be compensated with an equivalent upward pressure in the price of oil. This trend is reinforced by the conviction that, notwithstanding a temporary downturn of the demand growth due to the financial crisis, global oil consumption will continue to increase putting supply under pressure. Second, the two authors explain that the demand-supply tension is aggravated by the problem of under-investment in the upstream sector, especially in those countries – such as Russia and the OPEC states -- where the access to international oil companies is becoming more and more limited. Having no alternative but to invest in remote and difficult areas, international oil companies are contributing to drive up the costs of the marginal oil barrel creating further pressure on its price (Jesse and van der Linde, 2008).

To others, the extreme oil price situation is nothing but a speculative bubble. R.S. Eckaus (2008) from MIT University, argues – for example -- that “hedge funds have been very active in the oil market and their activity, along with other speculators, has raised the volume of oil transactions far above the volume warranted by ordinary commercial transactions” causing a prolonged increase in oil prices. According to Eckaus (2008), only a “strong dose of reality” could break the bubble. Following this view, one may wonder if the ongoing financial crisis – which has already put downward pressures on the oil market – could be the solution to make the bubble burst. However, strong criticisms of the “speculation theory” exist in literature.

Whatever view on oil price mechanisms is correct, it does not change the fact that the high level of oil prices reached in the last two years has a negative impact on the welfare of energy-importing countries, including Europe. Generally speaking, an increase in oil prices affects the price of many other energy carriers, especially and most directly natural gas. Oil is not only the main fuel for transport but it is also the basic raw material for the plastics and petrochemical industries. Moreover, an increase in oil prices leads to

²³ It is important to note that while Asian and Middle Eastern countries are the main responsible for the increase in the oil global price, their consumers are not very much affected because of their government subsidise oil prices giving disincentives to reduce the demand.

an increase in costs of production of all other goods requiring energy for their manufacture and transport. As a result of higher production costs, inflation («imported inflation») raises and triggers lower levels of consumption and higher level of unemployment with negative consequences on the economy as a whole. (Willenborg, Tonjes and Perlot, 2004). However, this link between high oil prices and unemployment has been weakened over the last decades due to increasing levels of energy efficiency in the EU. Yet the European Commission in 2006 suggested that at the time more than 2.5% of EU GDP per year went for the energy bill and, considering the high level of oil imports, most of this money was spent outside of the EU (Annex to the Green Paper, 2006).

What does this mean for Europe's security of energy supply? Although a "moderate price level" is usually considered one of the two drivers -- together with adequate volumes -- of energy security, it can be argued that current and (probably) future increases in oil prices could in fact work in favour of Europe' security of supply. With increasing average long-run oil prices a long-term fuel substitution will become more likely. As a consequence, the challenges related to oil imports and high oil prices would be eased and transition towards a low-carbon economy facilitated.

4. Possible fuel substitution

Since oil is mainly used for transport, the European Commissions' proposal of increasing the share of renewable energy in transport to 10% by 2020 may have some impact on improving the security of European oil supplies. By decreasing the amount of fuel subject to the risks of transport, import and scarcity, biofuels and other renewables may indeed benefit the security of fuel supply. Moreover, the increased use of renewables could potentially contribute to a reduction of EU greenhouse gas emissions, 27% of which are produced by the transport sector.

However, biofuels seem to have a number of drawbacks. First, their production could accelerate the destruction of natural habitats causing the alteration of the ecosystem's equilibrium. Deforestation and the release of carbon sinks in the atmosphere are only two of the problems related to biofuels production. Second, although they have the potential to reduce greenhouse gas emissions (up to 3% according to the OECD), not all biofuel options benefit the global climate. To the contrary, some of these options lead to increased greenhouse gas emissions as compared to their conventional alternatives. Third, from a European security of supply point of view, the role of biofuels is disputed: the EU would need to import about 50% of its biofuel demand without gaining very much in terms of self-sufficiency (see also Behrens, 2008). Also, as biofuels production is strictly related to the food sector, its price may vary according to changes in the commodity sector and vice-versa (Jesse and van der Linde, 2008).

Other alternatives to oil are second generation biofuels, gas-to-liquids, coal-to-liquids and electricity to fuel up plug-in hybrid electric vehicles. These technologies are still in different stages of research and development and, for the time being, they remain

too costly to be able to make a relevant impact in the transport sector before 2020 and may be unsustainable due to the large carbon contain (Jesse and van der Linde, 2008). In conclusion, the EU should think about building a framework to encourage investment in some of the most promising new technologies which all together may be able to improve fuel security of supply and the impact of the transport sector on climate change. On top of this, a social effort to educate European consumers to a less oil-based life-style may accelerate the transition towards oil substitutes.

NATURAL GAS

Gas and oil reserves often occur together and are concentrated in similar countries. They also share same economic characteristics such as relatively high fixed upstream costs and physical transportation constraints to reach the market. However, gas has its own features. First, gas is mostly transported by pipeline unless it has to cross oceans or run over long distances, in this case LNG is preferred. The pipeline physical link creates a two-way dependence, or interdependence, which is the essence of the security of supply/security of demand issue for natural gas. Second, gas markets are regional and not global as for oil although increasing LNG trade may change this. The regional nature of gas supply makes geography matter: depending on where the sources of supply are located and where demand is concentrated, dependency is different. Finally, gas is the fuel of choice for electricity generation and it has several potential substitutes, instead, oil is mainly used for transport and it cannot be replaced anytime soon (Helm, 2007). Given these differences, it can be argued that the concept of security of supply and the related risks for natural gas differ significantly to the case of oil.

The IEA defines the security of gas supply as “the capability to manage, for a given time, external market influences which cannot be balanced by the market itself”. In the short term, “security of gas supply covers the adequacy of supply and capacity to avoid unforeseen interruptions of customers” under rare and extreme events. In the long term, “it includes the capacity to mobilise investment to develop supply and infrastructure as well as the insurance to ensure reliable supply” (IEA, 2004).

Gas security challenge in the EU has an external and an internal dimension (IEA, 2004). The first is linked to increasing import dependence from external suppliers. It includes three different risks: investment and facility risks, exporters’ reliability risk and transit risks. The internal dimension of gas security of supply is linked to the development of the internal EU market and the liberalisation of gas sector. The risks attached to this second dimension are concerned with under-investment in the internal gas market -- both in the short- and in the long-run.

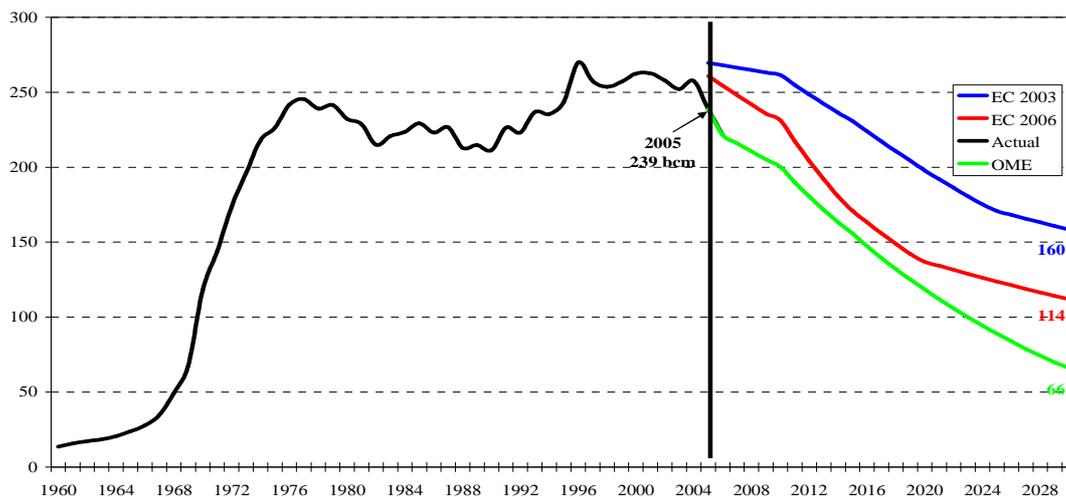
1. Rising demand, declining production and increasing import dependence

An important factor in Europe’s natural gas supply is the clear trend towards declining domestic gas production and resource discovery vis-à-vis increasing demand for gas. From 1990 to 2005, EU gas consumption rose by 50% and a further increase in its demand is expected in the next twenty years or so (IEA, 2008). In the DG TREN reference scenario²⁴ published in 2006, for example, the EU natural gas demand was forecasted to grow by 24% (from 537 bcm to 666 bcm) between 2005 and 2030, while in 2008, DG TREN reduced the expected demand growth to 16%. These trends will mainly be driven by increased use of natural gas in the power sector, but also by rising use for

²⁴ European Commission – Directorate-General for Energy and Transport, “European Energy and Transport, Trends to 2030 – Update 2005”, May 2006.

space heating and in the industrial and commercial sector. Yet major uncertainties about future EU gas demand exist mainly because of inadequate knowledge about future gas prices and their impact on demand: power generation is very sensitive to gas price increases compared to those of its alternatives like coal, fuel oil and nuclear. Uncertainties about government policies also matter. How they will affect the development of new technologies (such as Carbon Capture and Storage), the increase of renewables share in electricity production and the development of European Emission Trading Scheme will strongly influence Europe's future natural gas demand (Tonjes and de Jong, 2007). Finally, demand for gas will also depend on the degree of commitments to fulfil environmental and climate change related targets such as those set by the Kyoto Protocol and the EU Emission Trading Scheme. To what extent these factors will affect the EU gas demand is a matter of debate, but there is no doubt that natural gas consumption will continue to exceed Europe's indigenous production and that import dependence will increase.

Figure 1. EU gas production outlooks to 2030 (in bcm)

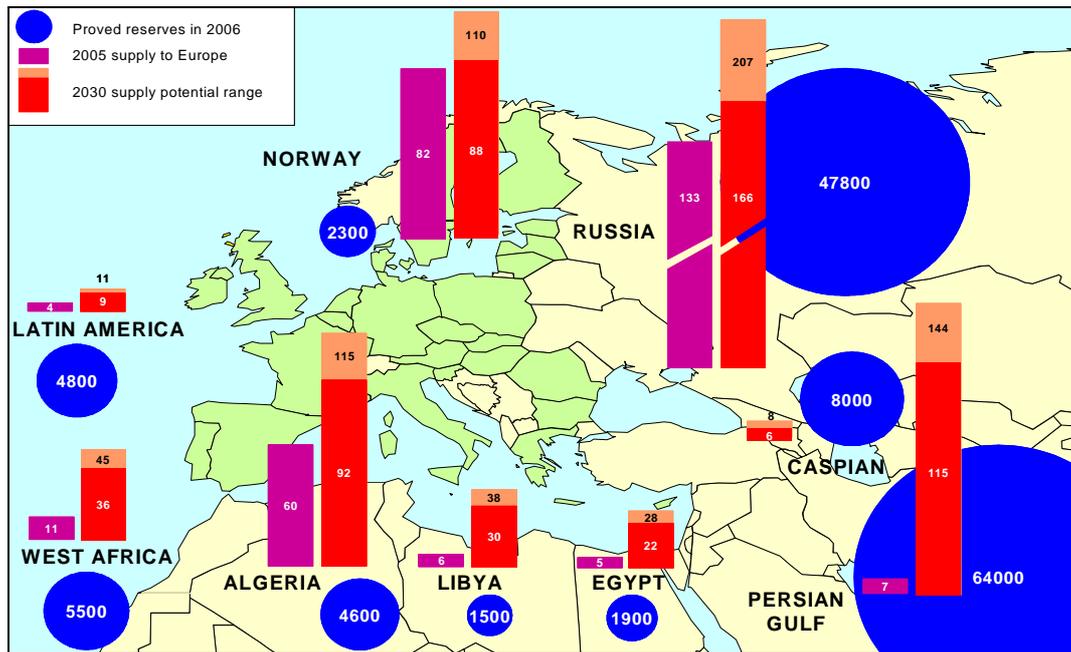


Sources: DG TREN (2003, 2006) and OME (2007)

EU domestic gas production passed its peak in 1996 entering a period of pumping plateau and long-term decline exacerbated by the progressive exhaustion of off-shore fields in the North Sea (see Figure 1). The United Kingdom potential has largely been explored and, although some fields have been put on-stream in the past ten years, a future decline in production seems irreversible. Accordingly, the UK has ceased to be a net gas exporter and is now an importer of gas. The Department of Trade and Industry has projected that by the 2020 the UK may import 80% of its natural gas needs. The Dutch government has announced a cap of 425 bcm over the period 2006-2015 on production from the Groningen field to compensate for declines in small fields production. Yet, it seems that, after 2010, Groningen will no longer be able to make up for the decline of small fields. Except for Norway, in the rest of Europe most countries will experience a gradual decline in gas reserves. Natural gas production in Norway has increased by 60%

in the first half of this decade and it is expected to continue to grow substantially up to 2010; thereafter it will probably reach a steady phase (IEA, 2006 and 2004). Overall, OME expects Europe’s production rate of decline to be rather slow until 2010 due to some new fields coming on-stream, mainly in the UK. However, the EU’s natural gas production in 2030 will be less than 30% of today’s production. Even if demand remained at its 2005 level, the EU would need over 100 bcm of additional external gas supply just to compensate the loss of production.²⁵

Figure 2. Reserves and main suppliers’ export potential to the EU (in bcm)



Note: Uncertainty range for 2030 is +/- 20%. Sources: OME, Oil and Gas Journal, CEDIGAZ and Norwegian Petroleum Directorate.

Therefore, in the absence of new gas field discoveries in Europe, EU’s import dependence is expected to rise. Over the period from 1990 to 2006, natural gas imports of EU-27 already doubled, exceeding 300 bcm. By 2030 imports are expected to increase to 625 bcm, that is 65% of EU demand (IEA, 2004). The bulk of OECD European imports are projected to come from its two main current suppliers -- Russia (151 bcm) and Algeria (60 bcm) -- but the number of suppliers will probably go up allowing for further diversification. According to the IEA, Russia – which owns 27% of world’s reserves -- will remain the largest exporter for Europe and, in 2030, it will export around 200 bcm to OECD Europe; while Algeria’s export capacities will increase to 115 bcm/yr. Other African countries will also increase their exports to Europe (Libya, mostly by pipeline, Egypt and Nigeria by LNG) both by pipeline and LNG (see Figure 2). Yet the biggest increase is believed to be from the region with the largest reserves (36% of the world

²⁵ This paragraph is mainly based on the contribution of Sohbet Karbuz from OME.

total)²⁶, the Middle East. Here exports will mostly develop in the form of LNG, while pipelines from Iran and possibly Iraq could also play an increasing important role (IEA, 2004). Other regions which are seen by the EU as suppliers of potentially increasing importance are Central Asia and the Caspian region, but their resource share is less than 5% of the world's total and could therefore provide only a limited relief to Europe's increasing gas needs. In sum, EU's potential main suppliers have significant reserves that will enable to increase production and meet Europe's gas demand, at least until 2030.

2. The external dimension of security of gas supplies

The economic and geopolitical risks attached to energy production and export activities in regions outside Europe are often perceived as a source of increasing vulnerability for the EU. As noted by Stern (2002), there are three main risks associated with Europe's gas import dependence: investment and facility risks, exporters' reliability risks and transit risks. Those associated with facility dependence can be technical or financial in nature, while source dependence and transit dependence refer to political risks associated with government decisions of producing and transit countries.

2.1 Investment and facility risks

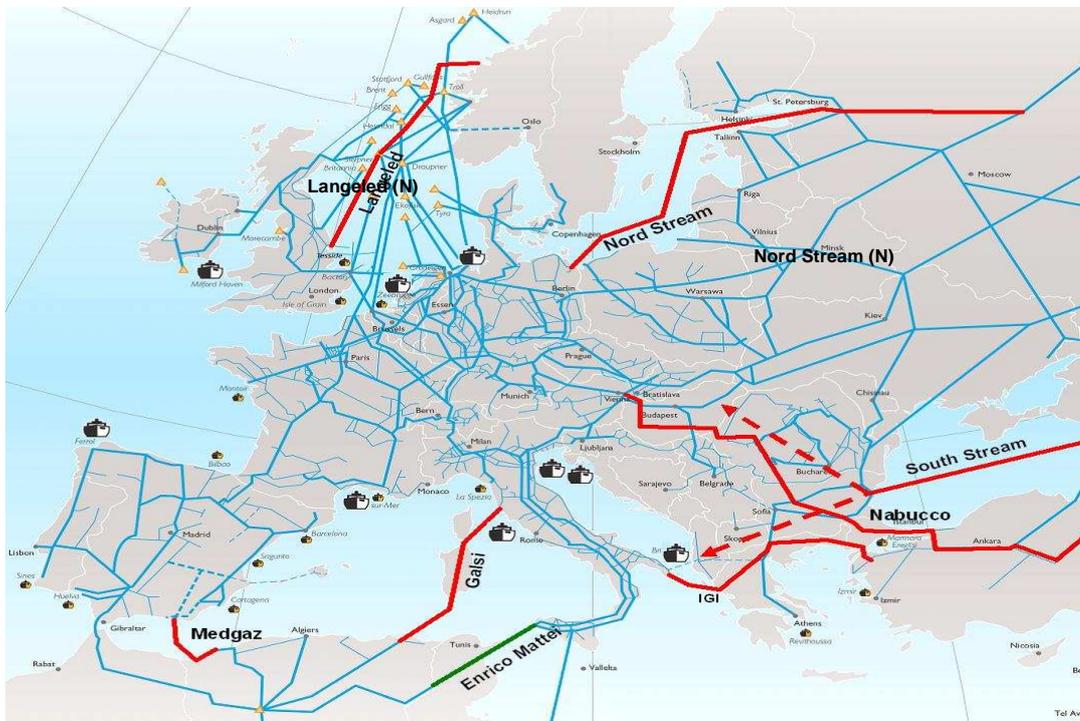
As gas imports grow, massive investments in the Middle East, Africa and the CIS are required. WEO 2003 projects that the total investment necessary to meet growing European gas demand up to 2030 would be \$333 billion for Russia, \$160 billion for other transition economies, \$280 billion for the Middle East and \$226 billion for Africa, respectively (IEA, 2004). Despite energy revenues being abundantly available in gas producing countries, a certain reluctance to reinvest in the energy sector is quite common. Gazprom's production, for example, depends on aging and inefficient facilities built during the Cold War and its ability to manage and develop its gas reserves is limited. Yet this does not prevent the company to invest its gas revenues in other commercial or financial businesses -- such as telecommunications. The evidence so far is not encouraging: the IEA reports that Russia's three major gas fields (Urengoy, Yamburg and Medvezhye) are declining at a combined rate of 20 bcm per year; similarly, the Zapolyarnoye field -- which came on-stream in 2001 -- has already peaked due to lack of investments (IEA, 2006).

Foreign investment could be a solution but even in this regard the picture looks daunting. For foreign investment to be attracted, competitive and predictable legal, fiscal and regulatory terms are needed but in non-OECD countries the sovereign risks of investment remain high. More important it is the will of gas producing countries to limit foreign influence in their gas industry. Russia, for example, does not allow foreign companies to operate on its territory unless they are in a partnership with Russian

²⁶ Qatar and Iran account for the majority, each about 15%.

companies. Yet, as the Sakhalin II deal with Shell and the BP-TNK Kovykta gas field case showed, also this option seems to no longer appeal the Kremlin (Helm, 2007). But Russia is not the only country where joint-ventures seem to have become unwelcomed. Similar restrictions have recently been adopted in Algeria through the introduction of new unfavourable tax conditions for foreign companies investing in the country. However, national oil companies are slowly becoming aware that neither they have the technological know-how nor the capital to bring on-stream most of their resources. This may open new perspectives for technological cooperation between NOCs and IOCs meaning that the days of IOCs predominance are over, but not the days of investment per se (Noël, 2007).

Figure 3: Import pipelines to Europe, projects and reinforcements, 2008



Source: Eurogas and OME

Nabucco (N)

As gas imports from external suppliers rise rapidly and cross-border gas trade becomes increasingly important, the need for investing in international gas pipelines increases. However, cross-border gas trade implies substantial start-up and maintenance costs, which can only be recouped in the long-term. This raises the risk of underinvestment in interconnectors: European gas supplies are vulnerable to potential accidents at key transmission and import facilities, some of which are remote from European territory and therefore far from its control. The Yamal-Nenets pipeline corridor -- which carries 90% of Russian gas production -- and the Trans-Mediterranean gas pipeline connecting Algeria to Italy are good examples of facilities which cannot completely monitored by Europe and rely on gas exporting countries' willingness to keep them in a

good shape. The problem is that Europe's security of gas supply could be temporarily affected in case of a technical accident affecting the gas infrastructure because of bad maintenance (Stern, 2002).

As European production decreases, future dependence from importing points or pipelines from more remote areas will increase. Only diversification of routes, import points and interconnection grid could help to mitigate this and related risks. Accordingly, a number of multi-billion pipeline projects leading to Europe have been proposed and considered (see Figure 3). Among them, it is important to recall the Nord Stream gas pipeline connecting Russia with Germany via the Baltic Sea, the Nabucco gas pipeline from the Middle East and Caspian regions, the South Caucasus pipeline from Azerbaijan, the Turkey-Greece-Italy interconnection, the two new lines (Medgaz and Galsi) connecting Algeria with Spain and Sardinia (IEA, 2004 and 2006) as well as South Stream from Russia to Europe via the Black Sea.

2.2 Exporters' reliability risks

In the EU, the main source of concern and debate associated with the projected increase of gas imports from Russia, the Middle East and Africa is related to the political reliability of these countries: nationalistic policies or possible internal instability are perceived as major energy security threats. Part of this European sensitivity is the product of a new assertiveness of energy producing countries which stemmed from the post-2003 increase in hydrocarbon prices. Because of resource nationalism, international oil and gas companies and OECD governments have faced reduced access to resources and increased requests by host governments for substantial shares of rents from joint activities (Stern, 2006). The main fear is that gas and oil producers, together with their national companies, will increasingly link their export policies to political considerations using Europe's dependence as a tool of political pressure. Would this be the case, natural gas will be the preferential tool of producers because, being to a larger extent pipeline-bound than oil, it allows deliveries to be suspended to target countries pushing them towards a specific political behaviour. In addition, European concern for exporters' reliability is justified by the unpredictability of supplies interruption caused by internal political turmoil. The risk of terrorism, riots and political downturn in countries governed by undemocratic regimes is indeed an issue.

For European policy makers the main source of concern is Russia. As the recent war in Georgia has shown, Russia does not seem to have abandoned the ambition of keeping its influence on CIS countries nor the desire to regain a relevant position within the international system. Hydrocarbon resources seem to have become the preferred tools to pursuing these objectives, especially natural gas which represent the biggest chunk of Russia's exports. Different sort of episodes have contributed to rising doubts about Russia as a reliable supplier and commercial partner. The gas supply cuts (1993, 1994, 1995, 2005/2006 and 2007) to Ukraine illustrate this point. In particular, the December

2005 crisis was officially triggered by a price dispute (Stern, 2006),²⁷ but its coincidence with the political victory of the pro-Western candidate Viktor Yuschenko has raised doubts about the purely commercial nature of Gazprom's price rivendication (Baran and Tuohy, 2006). Russia's "pipeline politics" is also a matter of concern, especially in the context of opposing gas pipeline projects bypassing its territory. It has indeed favoured the South Stream gas pipeline and the extension of Blue Stream at the expenses of the Nabucco project. Moreover, Gazprom has jealous preserved its monopoly over natural gas transiting from Central Asia, namely Turkmenistan and Uzbekistan, to Europe.

However, interdependence between Russia and Europe should not be underestimated as a deterrent for Russia to use the energy weapon. The latter is in fact very much dependent on its gas exports to European countries. For Russia, gas exports to Europe (52% for western Europe and 20% for Eastern Europe) account for 3/4 of Gazprom's total export revenues (Heinrich, 2006 and Stern, 2005). Accordingly, Russia has never voluntarily interrupted its supply to European customers but it has to CIS countries which only accounts for 5% of Gazprom's export revenues. In addition, the degree of interdependence between Moscow and Europe varies from country to country. On average, Eastern Europe imports 60% of its total gas consumption from Russia (73% in Czech Republic, 66% in Hungary, 58% in Poland and 97% in the Slovak Republic). This amounts to 87% of all Eastern European gas imports. Western European countries, on the other hand, import only 18% of total consumption from Russia (amounting to 28% of all gas imports to Western Europe) (Stern, 2005).

The other important exporter, Algeria, has shown relative political stability during the mid-2000s, notwithstanding its internal upheavals and conflicts akin a civil war (Stern, 2006). But the consequences of resource nationalism of the early Eighties have not been forgotten. The extent of reliability of other emerging gas producing states in North African – such as Libya and Egypt – may be difficult to predict. As for West Africa, it is worth mentioning Nigeria, the most important LNG producing country where petroleum-related unrest highly increased in 2006 (Stern, 2006). Finally, the Middle East's political instability raises questions whether gas producers in the region will be able to turn into reliable exporters to meet Europe's future gas needs. Iran's regular confrontations with the West on issues – especially on nuclear issues -- does not give positive signals. Notwithstanding new investments in Iraq, the very unstable political situation of the country and the continuous risk of Islamic-extremist terrorism makes it a highly unsecure supplier. Qatar is also supposed to become a major LNG exporter but internal political strains should not be understated when it comes to gas exports (Stern 2006).

It has also been mentioned that Europe is facing the possible formation of a gas exporters' cartel in control of supplies and prices. Since the Gas Exporting Countries Forum (GECF) was lunched, in 2001, major producers such as Algeria, Qatar, and Russia

²⁷ In 2005, Ukraine was paying \$50 per 1000 m³ of gas while Gazprom wanted to augment the price up to \$230.

have at various occasions signalled their support for it. In part, this was a reaction to Europe decision to liberalise energy markets increasing competition and putting at stake long-term contracts. But the GECF is also related to Russia's ambitious to increase its bargaining power towards European customers. Although it formally denies to pursue a cartelisation plan, Russia continues to search for forms of cooperation with other producing countries: the 2007 agreement between Sonatrach and Gazprom is only one example. However, the institutional basis for a European gas cartel is at present relatively weak (Finon, 2007).²⁸ First, gas trade is mainly based on long-term contracts making cartelisation of gas markets very difficult if not impossible. Only a further increase of on-spot contracts, possibly related to LNG trade, could favour cartelisation. Second, to be effective, a gas cartel should include the other two major gas exporters to Europe -- the Netherlands and Norway -- but it is difficult to imagine that these two European countries could comply to a cartel. Third, differently from oil, natural gas has a number of substitutes (coal, renewable and oil) which also influence gas prices making producers' control over prices limited. Finally, the nature of natural gas should not be underestimated as a limit: holding significant spare capacity will be much more costly and complicated for natural gas than it is for oil, as the necessary transport infrastructure in form of pipelines of LNG are very capital intensive (Tönjes and de Jong, 2007, Stern 2002, McCracker 2007).

2.3 Transit risks

Europe's natural gas imports are mostly (89%) delivered by pipelines which run across, at least, one transit country before reaching the EU border. This adds to import risks. Trade negotiations among several countries is indeed complex and costly, especially if politically unstable countries are on the route or if their relationships with the exporter are tense. When one of these conditions is fulfilled, the risk of supply interruption increases.

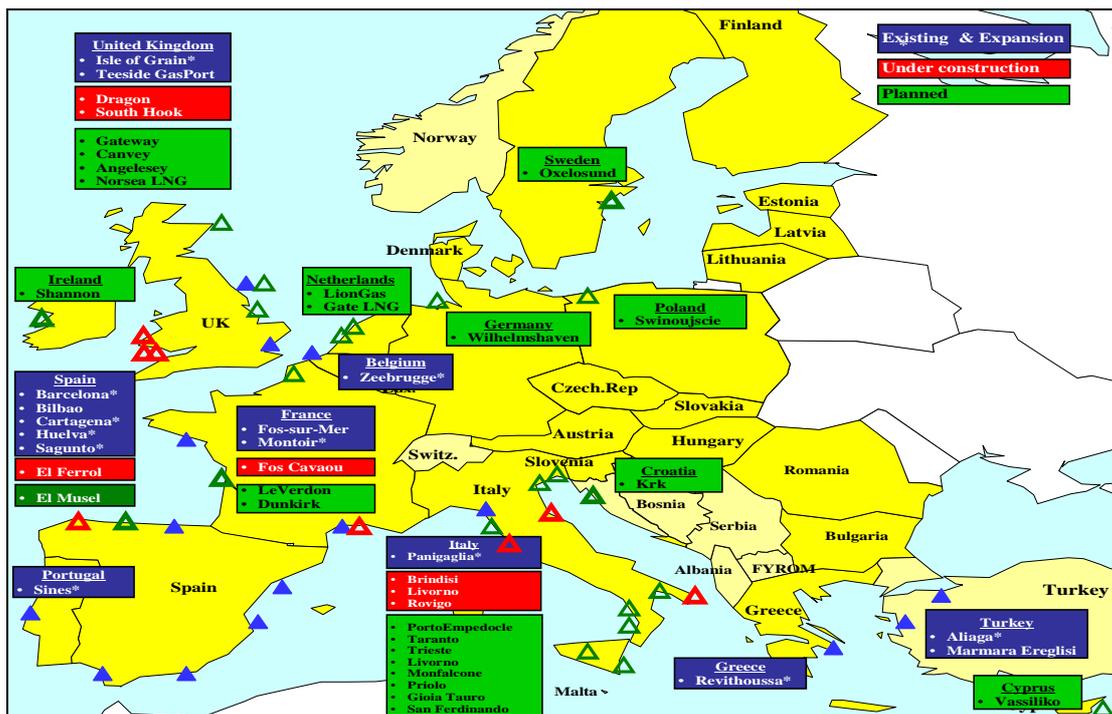
Despite internal political problems (the Algeria-Morocco dispute over the Western Sahara) and some disagreements over transit fees, the flow of gas from Algeria to Europe has never been disrupted. But the main concern for transit is related to Russia's gas export. Most of its pipeline system was built during the Soviet period when there were no borders within the Eastern block. When the Cold War ended, the pipeline soviet system turned into an inter-state system raising several issues: lack of transparency over the conditions on which access is granted to export capacity; lack of clearly-established criteria for the setting of transit tariffs; rising gas debts in Former Soviet Republics. Around 90% of Russian gas exports to Europe pass through Ukraine or Belarus before reaching the EU border. As Russia's relationships with other Former Soviet Republics remain tense this settlement represents a threat for European security of supply. The 2004

²⁸ However, the next summit of the Forum of Gas Exporting Countries (on December 23, 2008) will probably agree on a draft charter to make it a more formal organization. Also, it should be mentioned that, in early November 2008, Russia, Iran and Qatar formed a "big gas troika" to discuss key developments in the gas markets.

gas dispute between Russia and Belarus, the 2006 Russia-Ukraine dispute over gas prices as well as a number of similar episodes during the Nineties showed Europe’s vulnerability to events occurring in Eastern European transit countries, although the reported consequences of this crisis were limited to a few days.

As the EU borders enlarge, the transit risk decreases but being at the end of a transnational pipeline will always entail a certain extent of uncertainty for European importers. In addition, Russia’s monopolisation of gas transit coming from Central Asia and the Caspian enhance Europe’s concerns. Hence, several projects aimed at a diversification of routes and bypassing transit countries have been implemented or are currently underway, e.g. the Nabucco project. Thanks to technological improvements allowing to lay longer undersea pipelines at increased depth under acceptable economic conditions, some international gas transportation projects directly connect the country of origin of the gas to the European gas market. This is the case of the Galsi and Medgaz gas pipeline from Algeria to Spain and Sardinia.

Figure 4. LNG gasification terminals in Europe: existing plants and projects



Source: OME

Once some of the LNG projects planned and under construction in Europe will become operational (see Figure 4), transit risks could be eased. In Italy, for example, there are four proposals for the construction of LNG terminals and two of them – at Rovigo and Brindisi – have already been authorised. Spain has two LNG regassificators under construction: at Sagunto and El Ferrol. France has authorized the construction of

For-sur-Mer 2, while the UK has a couple of projects at Milford (IEA 2004). By eliminating the physical connectivity of pipelines, LNG is expected to limit and diversify security of supply risks, especially with respect to Russia (Helm, 2007). Far from being the panacea of Europe's security of supply, LNG has its own uncertainties and drawbacks. First, it still represents a small part of the gas market and it currently accounts for barely 11% of Europe's gas supply. However, a number of new LNG projects are in the construction and planning stages, notably in the UK, Spain and Italy. As OME's gas infrastructures database foresees, by 2030, in EU-27 total regasification terminal capacity will triple reaching over 380 bcm/yr.²⁹ Second, LNG facilities are high capital intensive: for a 4.5 mtpa project in the Middle East, liquefaction facilities may cost between \$900 and \$1200 million and regasification facilities based in Europe between \$300 and \$400 million; shipping costs for 5 ships from the Middle East to Europe are around \$850-950 million (Clingendael, 2003). As a consequence, exporters are not keeping up with increasing facilities in importing countries, leading to some re-gasification terminals standing idle. Third, LNG is sensible to physical – both technical and political in nature -- threats as much as pipelines. Finally, the EU is expected to face fierce competition from other importing countries such as the US (Larsson, 2007).

3. Internal security of supply

While Europe's increasing import dependence from non-OECD regions raises external concerns about the security of supply, the completion of the internal market and the liberalisation process add some internal concerns. The implementation of Directive 98/30/EC gave the first input for the reorganisation of the gas sector and, in particular, towards the opening of several activities to the competition rules in Continental Europe. The liberalisation process has been particularly accelerated with the implementation of the second Directive (2003/55/EC) regarding common rules for the internal market of natural gas.³⁰ To favour the integration of the gas market, two years later, a Regulation 1775/2005/EC on conditions for access to the natural gas transmission networks was implemented.³¹ Then, Directive 2004/67/EC established a common framework within which Member States shall define general, transparent and non-discriminatory security of supply policies compatible with the requirements of a competitive internal gas market. The last EU document on the European internal gas market is the draft directive proposed by the Commission in the context of the Third Liberalisation Package (European Commission, 2007c). In order to ensure the effective separation between the operation of gas transmission network from supply and generation activities, the Commission proposed to break up big companies by forcing them to sell their transmission networks ("ownership unbundling"). The intention was to improve access of competitors to the

²⁹ This information was provided by the contribution of Sohbet Karbuz from OME.

³⁰ The latter is divided in two sections, one on third-part access for transportation (Article 18) and one on new infrastructure (Article 22). In addition, the directive mandates access to storage and ancillary services (Article 19) leaving the choice between negotiated or regulated access to member states.

³¹ It sets non-discriminatory rules for access conditions to natural gas transmission system taking into account the specificities of national and regional markets with a view to assuring the proper functioning of the internal market.

transmission network. As an alternative, the Commission also proposed a system of independent system operators (ISOs), which would allow vertically integrated firms to keep their transmission infrastructure, but to hand over management of pipeline and storage assets to ISOs. To avoid a sell out of strategic assets to third countries, the Commission also included a clause which would force foreign companies to comply with the same unbundling regulations at home before buying EU assets. This clause is commonly referred to as the “Gazprom clause”, as it intends to limit acquisitions by Gazprom and thus a unilateral increase of the Russian sphere of influence into the European market. In addition, the Third Liberalisation Package called for more power and independence for national regulators, for the creation of an EU regulator together with an agency for the cooperation of energy regulators and system operators as well as for increased market transparency.

The idea behind the creation of the EU single market for natural gas is that it should bring economic efficiency due to higher competition and, allowing customers to choose their supplier, it should push operators to reduce costs and propose improved quality of services. However, moving from centralised to de-centralised decision-making and from volume-signals to price-signals, unless the market is “perfect”, could in reality lead to less efficiency in the allocation of gas in the system. In this case competition may reduce the quality of the system management.³² The opening of the gas sector raises indeed the question of whether the market itself will be able to guarantee the security of supply. The main concern regards the ability of the market to deliver timely signals and competitive incentives for investment to guarantee secure and reliable gas supply all the way to the final consumer. As we explain below, this applies both to the short- and the long-term security of supply.

3.1 Short-term security: coping with low-probability events

An important challenge for the security of gas supply is to meet the demand not only under regular circumstances, but also when a supply disruption or an unexpected event – such as extreme weather conditions or a technical accident -- occurs. A failure to deliver gas on a cold winter day would indeed have serious consequences for most of the households and, to a lesser extent, for industry – unless they have the possibility to switch to other sources. To ensure a high degree of supply reliability to the customers during low-probability events, there are a number of traditional insurance instruments. The most important are the diversification of supply sources and routes, the interconnection of national grids, long-term contracts, flexibility instruments (supply flexibility, interruptible contract, etc) and storage facilities (IEA, 2004). In the past, the gas industry has had a very good record in covering low-probability/high-impact events because companies used to provide these instruments passing them to customers. Yet there is a risk that the liberalisation of the European gas market will undermine some of these instruments contributing to the insecurity of supply.

³² Some of these ideas reflect the views of OME’s contribution by Sohbet Karbuz.

First of all, in open markets, the possibility to get extra-supply by buying gas in spot markets is increased, while counting on long-term contracts decreases. Accordingly, a certain consensus exists that, in a competitive market, gas sales contracts would become more short-term, while long-term take-or-pay contracts will be undermined. So far, the latter have played a very important role in Europe, as everywhere else: committing sellers and buyers to trade gas for a long period under specific conditions, long-term contracts allow the risks associated with large gas projects to be divided between producers and importers. In particular, they put the price risk on the seller, and the risk related to marketing the gas on the buyer. More important, they have been regarded up to now as necessary requirements for financing and investment in new long-distance transport infrastructure. In light of this, it may be assumed that European security of supply would seriously be threatened if long-term contracts were to disappear as a consequence of gas market liberalisation.³³ However, liberalisation emphasises short-term trading without necessarily eliminate long-term contracts. The recent signing of long-term contracts between some European countries (e.g. Italy) and Russia also confirms this thought. Certainly, liberalisation implies shortening long-term contracts from 15-25 to 8-15 years and the shift of take-or-pay obligations from 80-90% to 50-60% and a flexible level of price indexation level (Stern, 2002). But long-term and spot contracts will probably co-exist in the new European gas market because the two are complementary: the first allow the financing of large new gas supply sources, but the second allow short and medium-term balancing of supply and demand and therefore offer more efficient use of existing infrastructure and better flexibility and security (IEA, 2004).³⁴

In order to cope with short-term security of supplies, gas storage and availability of spare capacity are also important. At the moment, Europe is relatively well-endowed with gas storage facilities. At the end of 2004, OECD Europe had 103 underground gas storage facilities with a working volume of 64.7 bcm, or the equivalent of 48 days of average consumption. Three countries dominate the European storage scene: Germany (30% of capacity), Italy (20% of capacity) and France (17% of capacity). Storage at LNG import terminals also plays a role in Europe, particularly in Belgium and Spain. Overall, there are 14 LNG import re-gasification terminals in Europe with a capacity of 75 bcm per year and a storage capacity of 1.4 bcm (2% of European storage capacity) (IEA, 2006). By 2030, WEIO 2003 projects a further investment of around \$23 billion for enlargements of existing facilities and the construction of new underground storage. However, as low-probability/high-impact events occur very rarely, the incentive of market players to invest in insurance is projected to be low in the future because of scarce incentives within a liberalised environment.

³³ Indeed, in the second directive and in the Directive on security of gas supply, the European Commission has recognized the importance of long-term contracts for security of supply and the financing of major new gas supply projects.

³⁴ For a further discussion on the survival of long-term contacts in liberalized energy markets see Coop (2006).

3.2 Long-term security: dealing with timing signals for investment in transmission and distribution

In general terms, the long-term reliability of supply depends on timing and sufficient investment in production and transportation facilities. For the specific case of internal security of supply, the concern is especially over investment in transmission and distribution facilities.

With gas market reforms and unbundling of the transportation and supply functions, incentives for investment decisions on infrastructure may decrease. In the past, in most countries, governments delegated responsibility for security of supply to one single actor, namely a monopoly state-owned company which was responsible for reliability of gas supply across the whole gas market. In open markets, the responsibility for transmission security is shared: the unbundling of gas companies implies unbundling the responsibility along the whole gas chain – from the production site to the burner tip (IEA, 2004; Eurogas 2006). Under these conditions, the risk is that new competitors will be tempted to ‘free-ride’ on the security provided by the incumbent suppliers and the ‘heat of competition’ may push operators to play down security and prioritise cost-cutting (Luciani, 2004).

The propensity to invest seems to decline in liberalised markets, especially because of increased risks for operators. Competition has introduced a new risk of loss of market share for retailers as well as uncertainty over regulation development. Unbundling threatens the past stable relations between complementary operators reducing the possibility of cooperation. More specifically, the changes in the rules of the game due to liberalisation have had two consequences on companies’ strategies. The first is horizontal integration: incumbents are merging in order to restore part of their past market power and, hence, protect themselves against new downstream market risks. These mergers are also a way of improving the bargaining power of importers in their negotiations with exporters. The second is vertical integration: importers try to accede to production and exporters try to develop on downstream markets. Germany is a good case in point for both cases: EON and Ruhgas have merged (horizontal integration), while EON and RWE has progressively acquired small municipalities (vertical integration) (Jacobsen, Fristrup and Munksgaard, 2005). This is a way of reducing the uncertainty introduced by the unbundling of the gas chain.³⁵

Looking at the past years, it seems that competition development has not led to a significant increase in infrastructure investment. For the time being, the European transportation grid seems sufficient to cover Europe’s transmission needs. However, almost all gas connections between European countries are fully used and many peripheral parts of the national networks are entirely dependent on a single feeder-line, which makes them vulnerable to disruption. The projected increase in gas imports will

³⁵ This paragraph is based on the contribution of Sohbet Karbuz from OME.

add further capacity risks to the European grid requiring, among other things, a substantial enlargement of the network and therefore massive investment. Accordingly, the WEIO 2003 projects that, by 2030, the gas sector would need \$110 billion for transmission and \$108 billion for distribution (IEA, 2004). Given the scarce incentives to invest, reaching these targets may be difficult, unless gas operators will get higher rates of return and more flexibility in project development. The central point is indeed whether investment into networks is attractive for them: operators need a predictable, reliable and transparent framework in order to commit for a given project. The role of regulators -- both at national and at EU level -- then becomes crucial in the extent they are responsible for providing attractive incentives.

COAL

On the global scale, coal is currently the fastest growing fossil energy carrier and continues to be the second most important fossil fuel, slowly closing the gap with oil. In the reference scenario of its World Energy Outlook, the IEA (2007) predicts a 73% increase in the global demand for coal between 2005 and 2030. Over the next 10 years, China alone will install more power-generation capacity based on coal than Europe's entire current stock. Steam coal will continue to play a dominating role in world coal production with projected 79% in 2030 (up from 73% in 2005). The share of coking coal and especially brown coal and peat, on the other hand, will remain comparatively small.

In Europe, however, primary coal demand has decreased considerably since the 1980s, largely due to the switch from coal- to gas-fired power production in Western Europe and economic transition in the East. While demand is expected to remain roughly constant between 2005 and 2030 (IEA, 2007), the volume of coal produced domestically within the EU27 will continue to decrease. As a result, the EU will become ever more dependent on imports. Domestic coal production is forecasted to fall to 37% of consumption by 2030, down from 61% in 2005 (IEA, 2008). In 2005, the main suppliers of coal to the EU27 were South Africa with a share of 23% of total imports, followed by Russia (21%), Australia (12%), Colombia (11%), USA (7%) and Indonesia (6%) (European Commission, 2008e).

These figures suggest that coal imports are far more regionally diversified than natural gas imports, for example, and most exporting countries qualify as stable democracies which largely respect the same market and political rules as the EU. In addition, the coal market is a truly global, open and well-functioning one, not dominated by a single supplier such as OPEC. At the same time, there are still considerable global proven coal reserves, which – at the current global rate of production – may be sufficient for another 133 years (BP, 2008). Finally, coal is relatively safe to transport and store. It can be transported quickly by ship and rail, without the need for expensive long-run infrastructure and related security issues. All these factors contribute to the assessment that European import dependency does not pose an elevated risk to its uninterrupted supply of coal in the long-run. However, there may be some risks in the short-run.

The global coal market's just-in-time supply chains remain vulnerable to temporary supply disruptions. This has been confirmed in early 2008, when disruptions in three of the five major exporting countries led to record global coal prices. Australia's coal mines were hit by heavy rains and floods and continued port congestion resulted in delays and cancellations of coal deliveries. China, on the other hand, experienced heavy snowstorms in early 2008, which reduced output and rail transport capacities, causing the country to temporarily stop all coal exports (EIA, 2008). South Africa also experienced problems, not due to force majeure but rather due to power shortages/outages as a consequence of years of underinvestment in its energy sector. Heavily dependent on coal itself, the resulting reductions in coal supply directly affected coal export operations. In

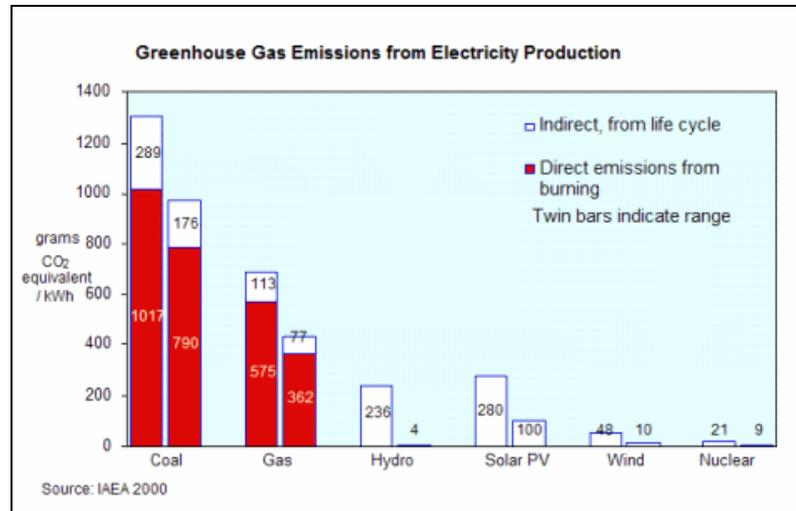
the long-run, however, such supply disruptions are expected to be overcome and the total volume of coal traded on the global market will continue to increase.

Another short-term risk for European coal supplies may stem from changing global demand structures. While China is still the world's largest coal producer, its consumption is increasing rapidly. In 1990, China's coal consumption was still at 534 Mtoe. By 2005, it had already doubled to 1094 Mtoe, and by 2030, it is expected to double again to 2399 Mtoe (IEA, 2007). According to MIT (2007), China's expansion in coal-fired power plants compares to the equivalent of two 500 megawatt plants per week, "and a capacity comparable to the entire UK power grid each year". As a result, China has recently turned into a net coal importer. The global surge in demand for coal, however, is faced with short-term supply constraints and disruptions resulting in skyrocketing coal prices over the last year. Europe has been directly affected by this increase with the export price for one metric tonne of South African coal tripling from \$50 in May 2007 to \$143 in June 2008 (IMF, 2008) resulting in upward pressures on European electricity prices. More recently, prices have started to decrease again.

Given that import dependence is not a major long-term security issue in the case of coal, there are other risks that need to be dealt with. This applies first and foremost to environmental risks associated with the extraction and combustion of coal. Coal mining, especially surface mining, is still responsible for large amounts of soil erosion, dust, noise and water pollution and impacts on local biodiversity. Another risk associated with underground coal mining is the subsequent subsidence of mines, i.e. the lowering of the ground above (former) coal mines. Examples of Germany and Poland illustrate this point. In addition, coal mining releases large amounts of methane (the same is true for abandoned mines, unless flooded), a greenhouse gas. Many of these effects can be kept to a minimum with modern mine management methods. For example, the amount of dust can be reduced with water sprinkler systems, acid mine drainage can be treated actively or passively, and methane can be collected and used for electrical generation or industrial chemical processes. Similarly, detailed rehabilitation and reclamation plans need to be developed to reintegrate formerly mined land into surrounding ecosystems (see also WCI, 2008). With decreasing coal mining activity in Europe, it can be argued that many of the aforementioned environmental consequences of mining pose only a limited direct threat to Europe in the future. However, they need to be taken into consideration reflecting the long-run responsibilities associated with European coal consumption.

On the global scale, a far greater long-run risk is climate change. As shown in figure 1, the use of coal in electricity production causes far more greenhouse gas emissions than the use of any other energy carrier. To put this into perspective, with 28% coal is the second largest source of electricity generation in the EU27, just behind nuclear (30%). In some countries, this share is considerably higher, such as in Poland (91%), Estonia (91%), the Czech Republic (59%) and Greece (59%) (European Commission, 2008e). In view of Europe's ambitious energy and climate change targets, clean coal technologies must be developed quickly, otherwise coal cannot continue to play a major role in Europe's energy mix.

Figure 1: Greenhouse Gas Emissions from Electricity Production



In its climate change communication of 10 January 2007, the European Commission (2007d) clarified that global greenhouse gas emissions must decrease by 50% until 2050, with decreases in developed countries of about 60-80%. This is necessary to keep average global temperature rise below 2 degrees Celsius, an increase above which climate change is said to become unmanageable. The current energy mix of EU27, however, is largely characterized by carbon intensive fossil fuels which made up 79% of Gross Inland Consumption in 2005 (European Commission, 2008e). Given the carbon intensity of the European energy mix and the possibility of a “renaissance” of coal on security of supply grounds, Europe can only achieve such ambitious greenhouse gas reduction targets if it develops carbon capture and storage (CCS) focused on coal-fired power production, but also on emissions from other fossil based forms of power production and emissions from industry. Recent papers presented by the European Commission (2008e; 2008d) identify the possibility for sustainable energy production from fossils and provided a legal framework for CCS technology.

In this context, CCS refers to a three-step process in which CO₂ is captured at source, compressed and transported, and finally injected and stored in deep saline formations, depleted oil/gas fields, or unmineable coal seams. In addition, the captured CO₂ may be used for enhanced oil and gas recovery. Under current technological conditions, CCS processes can capture around 85% of the CO₂ emitted at source. However, these processes reduce thermal efficiency of plants by 8-12% (IEA, 2008), thus increasing the need for coal inputs.

The intention of the European Commission is to have 10-12 CCS demonstration projects ready by 2015 and to have the technology ready for wide-scale commercial application in 10-15 years. To get there, however, investments of about €1 billion will be required until 2020 to bring CCS to commercial deployment (European Commission

2008e). Among the issues that need to be addressed until CCS can become commercially viable are (a) financial issues in terms of carbon pricing which will make CCS more competitive, (b) legal and regulatory issues, including the allocation of liabilities and risk-management procedures, (c) technical issues related to the isolation of reservoirs and the potential long-term leakage of CO₂, and (d) public awareness and acceptability.

The success of the CCS technology will largely depend on the speed of adopting EU legislation and of providing a secure legal framework, and on the success of the EU-ETS and the price of CO₂. To improve liability and reduce costs of CCS technologies, it is important in the short to medium term is to develop appropriate demonstration projects, in which currently used CCS technologies are adapted for use in large-scale power plants and improved through research and development. The Commission notes, that over 20 such demonstration projects have been identified by European industry in recent months. To achieve wide-scale deployment of this technology, the EU will need to accelerate domestic research and will also need to get involved in international research cooperation, for example with China. After all, CCS is not just an opportunity for the EU to continue benefiting from the advantages of coal but also for cleaning China's power sector and related technology export possibilities.

NUCLEAR

Nuclear energy is currently the largest single source of low-carbon electricity in the EU. In 2007, it accounted for 14% of the EU total energy supply and provided 31% of the electricity generated. Overall, there are some 146 power plants located in Europe, run in fifteen member states (IEA, 2008). Currently there is a divide among the EU member states regarding nuclear energy. Several countries such as France, Finland, the UK, Italy and some Eastern European member states (e.g. Bulgaria and Slovak Republic) want to increase the number of nuclear power plants in their home country while several other member states such as Germany, Spain, Belgium, the Netherlands and Sweden have committed to a complete phase-out of nuclear power. In addition, countries like Ireland and Austria remain sceptic of the technology and refuse to produce nuclear energy within their borders. However, due to factors such as the rising price of oil, increasing energy demand, and the requirements of Kyoto emission reduction targets, the governments in some of the countries that have agreed to phase-out nuclear power are reconsidering the role of nuclear energy in their country.

Table 1: Electricity generating cost projections for 2010 (5% discount rate)

	nuclear	coal	gas
Finland	2.76	3.64	-
France	2.54	3.33	3.92
Germany	2.86	3.52	4.90
Switzerland	2.88	-	4.36
Netherlands	3.58	-	6.04
Czech Republic	2.30	2.94	4.97
Slovakia	3.13	4.78	5.59
Romania	3.06	4.55	-
Japan	4.80	4.95	5.21
Korea	2.34	2.16	4.65
USA	3.01	2.71	4.67
Canada	2.60	3.11	4.00

Source: IEA, 2005

Those in favour argue that nuclear energy could contribute to increase Europe's security of energy supply and contribute significantly to reaching the EU's climate objectives. First, this stated support comes from the over time increasing competitiveness of electricity generation from nuclear. This is due to declining fuel (including enrichment), operating and maintenance costs, while the plant concerned has been paid for (World Nuclear Association, 2008). A 2005 OECD comparative study shows that at 5% discount rate nuclear generation is expected to become cheaper than coal or gas

generation. More specifically, nuclear is comfortably cheaper than coal in seven of ten countries, and cheaper than gas in all but one. At 10% discount rate nuclear ranged 3-5 cents/kWh (except Japan: near 7 cents, and Netherlands), and capital becomes 70% of power cost, instead of the 50% with 5% discount rate. Here, nuclear is again cheaper than coal in eight of twelve countries, and cheaper than gas in all but two (see Table 1 and 2). In addition, although uranium prices have been increasing in the last few years (\$1787 per kg in 2007), and the trend may continue (up to \$2286 per kg according to the World Nuclear Organisation, 2008), the repercussions on the price of electricity from nuclear generation are limited.

Table 2: Electricity generating cost projections for 2010 (10% discount rate)

	nuclear	coal	gas
Finland	4.22	4.45	-
France	3.93	4.42	4.30
Germany	4.21	4.09	5.00
Switzerland	4.38	-	4.65
Netherlands	5.32	-	6.26
Czech Republic	3.17	3.71	5.46
Slovakia	4.55	5.52	5.83
Romania	4.93	5.15	-
Japan	6.86	6.91	6.38
Korea	3.38	2.71	4.94
USA	4.65	3.65	4.90
Canada	3.71	4.12	4.36

Source: IEA, 2005

Second, the indigenous nature of nuclear power production reassures member states against risks related to import dependency. It is not surprising that the most supportive of nuclear power are central and eastern European countries with the highest dependency on Russia's gas imports. Uranium has also to be imported, but its availability in reliable countries such as Canada and Australia (45% of EU uranium requirements) usually does not raise import-dependency concerns. To some, availability of uranium is not a concern and its actual level – 14.4 million tons – would allow a four-fold increase in nuclear generation (Bouttes, Leban and Trochet, 2006). However, some studies state that, unless investments into closed fuel-cycle reactor designs are undertaken, uranium may become a risky factor for nuclear power generation (Edenhofer, Luderer, Flachslund and Fussel, 2008). Also, Besides Canada and Australia, the major producers of uranium are countries such as Turkmenistan and Russia which have not always been considered reliable trade partners.

The third reason for nuclear support is related to the fact that, together with renewable energy sources, nuclear energy is one of the least carbon intensive sources of energy. This argument is often used by proponents of nuclear energy in relation to achieving climate change objectives at current levels of energy consumption.³⁶

Despite the recent declarations of intent of many European countries to undertake new nuclear projects (e.g. 2 in Bulgaria and Slovakia, 1 in France, Finland, Lithuania and Poland), some scepticism exists on a real boost to nuclear power generation in Europe. Without massive investments to replace aging facilities and build new plants, Europe's nuclear generating capacity is in fact expected to shrink rather than grow. Accordingly, the IEA forecasts that electricity generation from nuclear will decrease from 31% to 21% by 2020 (IEA, 2008). This expected trend is due to a number of risks that investors have to face when operating in the nuclear sector. More specifically, the main reasons for possible stagnation and decline of nuclear power generation are costs, safety, perception, waste and proliferation (MIT, 2003).

Costs. Although operating costs of running a nuclear power plant are relatively low (for short periods of time could also be negative), capital investment, operations and maintenance costs highly reduce the financial attractiveness of nuclear projects. The start-up costs of a nuclear plant (66% of the total costs) are the biggest challenge for investors. Building a new nuclear plant in Europe is estimated to cost roughly € 2 to 3 billion and the initial capital costs will not start its pay back any time before 15-20 years (Nuttall and Taylor, 2008).³⁷ In addition, decommissioning and waste management requirements mean that financial assets must be made available for 50 to 100 years after the shutdown of the reactor (European Commission, 2006c).

Safety. Relying on nuclear generation means paying continuous attention to the safety of nuclear infrastructures which are vulnerable to technical accidents, human mistakes and terrorist attacks. This is also true for other generation technologies and large scale technology projects. But additional safety measures will most likely make nuclear plants expensive. Modern reactor designs have very much limited the risks of major accidents and until now the safety and reliability record of EU nuclear power plants is excellent. However, what happened in Chernobyl (1986), the Three Miles Islands (1979), Tokai-mura (1999) and Forsmark (2006) has left a memory that nuclear power plants can fail causing long-term and even irreversible damage. The importance of nuclear safety for European countries was recognised for the first time in 1958 in the Euratom Treaty, but since then Europe has never been able to introduce a common approach on nuclear safety standards (and radioactive waste). Common decisions such as Euratom loans for aging nuclear plants (e.g. in 2000 Bulgaria and in 2004 to Romania) have been implemented. Yet the attempt to create a common approach failed in 2004 when the Commission

³⁶ Institute Thomas More (2008) suggests figures in the range of 2.5-5.7 grams per KWh vis-à-vis 105-366 grams for the production of electricity from thermal sources and 2.5-76 grams from renewables.

³⁷ However, following the so-called "fleet approach" of building a large number of reactors with similar design may save between 10% and 40% of the costs of the first plant (EU Commission, 2006).

proposed a “nuclear package”.³⁸ More recently (2007), a Nuclear Forum and a high-level group on nuclear safety (and radioactive waste) has been put forward but this will hardly change the perception of nuclear power (IEA, 2008; European Commission, 2006c).

Perception. Public opinion and perception of nuclear power is fundamental to the future developments of European nuclear policy because public opposition further increases the risks of undertaking a nuclear project. The 2007 Eurobarometer reported indeed that 53% of European citizens still consider nuclear energy as a problem rather than a solution for their security of supply.

Waste. In the EU, some 40 000 m³ of radioactive waste is generated every year. Most of this waste is low-level and short-lived and it is generally stored in surface or near-facilities spaces. For high-level and long-lived waste a solution has generally not been found yet (Finland is the exception) not for technical reasons but mainly because people are reluctant to have nuclear waste in their backyards (European Commission, 2006c).³⁹ Research projects to find additional techniques for dealing with radioactive waste are under way but the absence of a clear-cut solution raises environmental and health issues which have a strong influence when it comes to considering new nuclear projects.

Proliferation. Although the proliferation of nuclear weapons is a major global problem, all European countries are robust in their measures to prevent proliferation. Removing highly enriched uranium and separating plutonium from civil nuclear activities in one of the EU-12 countries cannot raise proliferation concerns (Nuttall, 2007). In principle, the same is true for the new European member states but some scepticism may still exist on their long-term reliability. However, the export of nuclear technologies to third countries may raise concerns about the proliferation of nuclear weapons in the future.

Notwithstanding all these issues and the resulting economic disincentives for investing in new nuclear power plants, many governments continue to directly subsidise nuclear technologies. This is especially popular in the United States, where nuclear

³⁸ More specifically, the package included the proposal for a directive on the safety of nuclear installation which suggested: common safety standards and monitoring mechanisms based on the internationally recognised principles of the International Atomic Agency and the Western European Nuclear Regulator’s Associations; the requirement for all member states to have an independent safety authority; a peer review system to inspect the inspectors community rules for the construction, management and use of decommissioning funds to ensure the availability of funds to carry out decommissioning operations. In the same package, a directive on radioactive waste was also proposed to focus on: priority to geological burial of waste as the safest method of disposal; obligations for all member states to adopt by 2018 national programs for the disposal of radioactive waste; and more support and more funding for research on waste management.

³⁹ The possible recognised solutions are basically two: deep disposal in stable rock formation or near-surface storages.

energy is supported by means of government incentives such as production tax credits and state portfolio standards including incremental nuclear power capacity (Nuttall and Taylor, 2008). In the EU, nuclear research and development continues to receive substantial amounts of public funds (e.g. through the FP7), but nuclear sectors may benefit most from the establishment of a stable and well-functioning EU Emissions Trading Scheme (ETS), which will decrease the price of nuclear energy (and other low-carbon technologies) relative to more greenhouse gas intensive alternatives. Similarly, it may be expected that continuing high prices of oil and gas may benefit the nuclear industry in the long-run (Nuttall and Taylor, 2008).

RENEWABLE ENERGY SOURCES IN ELECTRICITY AND HEAT

Since 1997, renewable energies have increased their contribution to gross inland consumption in EU-25 by 55%. This is mainly due to the rise of new renewable energy such as wind, biomass or solar. Accounting for 66% of the total renewable electricity (2005), hydropower is the most important renewable source in electricity generation in Europe. Yet other sources have started to play a role. Wind energy, in particular, has made good progress moving from 8.000 GWh in 1997 to almost 70.000 GWh in 2005 registering – since 2000 – an increase of some 150%. Accordingly, in 2005, 56% of world wind capacity was installed in Germany and Spain with the UK, Portugal and Italy also making a small but evident improvement. Biomass electricity has also rise at a growth rate of 13% in 2003 up to 23% in 2005. Installed photovoltaic solar energy has also been growing at an annual rate of 70% in the EU (especially in Germany), but its contribution to electricity generation currently accounts only for 0.3% of the total generation from renewables (European Commission, 2007a and 2007b).

Although the power sector has registered the most significant growth in renewables, the most important end-use is taking place in heat (57% vis-à-vis 43%) (IEA, 2008). Differently from the electricity sector, renewables for heat have not improved very much in the last years because they do not have a network that they can access, but depend on the creation of new infrastructures and networks and the development of technologies (IEA, 2008). Biomass use – especially wood heating -- make most of Europe's renewable heat consumption. Countries -- such as Italy, Sweden, Hungary, France and Germany – are the major producers of geothermal heat in Europe. Solar thermal energy has taken off in Germany, Greece, Austria and Cyprus. That is to say that there are evident differences in the use of renewable energies among European countries, both for electricity and heating (European Commission, 2007a and 2007b).

Notwithstanding their increasing penetration in European energy markets, renewable energies only contribute by 8.5% to EU total primary energy supply. This level seems to be below the European Commission's expectation to reach, by 2010, a 12% share of renewables. Similarly, the target set by Directive 2001/77/EC to reach 21% share of renewables in electricity consumption by 2010 will not be fulfilled: Europe is expected to achieve a figure of only 19% by then (European Commission, 2007b). As a consequence of missed targets and growing concern over security of supply and climate change, the Commission has decided to adopt a more firm stand over renewables. In January 2007, it launched a long-term Renewable Energy Roadmap including a binding target of 20% share renewable energy in total energy consumption by 2020 (and a binding minimum target of 10% for biofuels in transport, which was later reformulated into a 10% target for renewable energy sources in transport).⁴⁰ The European Council of March 2007 approved these proposals and asked the Commission to submit a new legislative proposal. On 23 January 2008, the European Commission tabled a proposal for

⁴⁰ The biofuels target will not be treated here since it has been addressed in the oil chapter.

a Directive on the promotion of the use of energy from renewable sources which will be the legislative act to implement the 20% renewables target. As to the content of the draft Directive, the proposal contains the following novelties as compared to previous legislation (Behrens and Fujiwara, 2008):

- The setting of mandatory national targets for the overall share of energy from RES in energy consumption and in transport in 2020
- The requirement for national action plans
- The standardisation of “Guarantees of Origin”
- The possibility of intra-EU trading of Guarantees of Origin
- Possibility to exclude already subsidised RES from trading of Guarantees of Origin
- The harmonisation of hydropower accounting

The draft Directive, which is expected to be adopted in late 2008/early 2009 emphasises the role of renewables. The attention given by the Commission to renewable energy sources is not only aimed at combating climate change and reducing CO₂ emission in the EU but it is also part of a strategy to increase the economic competitiveness of the EU and to reassure Europe’s security of supply. As regards the latter, renewables energies have at least three main potentials:

Reduced import dependency from fossil fuels. Since renewables are produced indigenously, increasing their share in the EU energy mix can help to reduce the dependence on imported fossil fuels – such as natural gas -- from unstable geopolitical regions.⁴¹ As a side effect, competition with major energy consuming countries over depleting oil and gas sources is reduced. In addition, the local and de-centralised nature of renewable production downplayed the risks related to transport disruption as well as cross-border transmission losses. Small hydro applications and small wind turbines for self-production tend, for example, to be widely dispersed and not to involve major security risk in terms of exposure to sabotage (IEA, 2007a).

Structural and technical advantages. First, scarcity is not a concern for many renewable sources. Some of them have indeed an unlimited potential: solar and geothermal sources are virtually inexhaustible, especially in Southern European countries such as Italy, Spain, Portugal and Greece. Moreover, having the advantage of being storable, biomass can add to the security of supply by providing spare-capacity for either electricity or heat production. Second, renewable energy technologies are flexible in scale and type of use. Hydropower, for example, has a very fast response time generation and is therefore able to meet unexpected fluctuation in demand or help to compensate for the loss of other sources. Moreover, hydropower as well as biomass can be stored and be ready to offset other variable power production systems (IEA, 2007a).

⁴¹ This view reflects also FEEM’s contribution provided by Daniele Benintendi.

Reduced energy price risks and energy price volatility. The problem of security of supply is also reflected in the fossil-fuel price risk notably for natural gas and oil. Electricity or heat supplied using renewable energy is less prone to fuel fluctuations than in the case of fossil fuel plants. Also, using more renewable inputs at the expense of natural gas put downward pressures on natural gas prices. As distinct from generating portfolios in which gas-based electricity generation is assuming an increasing dominant role, portfolio with a substantially rising share of renewable electricity (RES-E) will see their long-term portfolio price risk fall. More specifically, increasing the share of renewables in the EU electricity mix in a cost-effective way will help to reduce: the (average EU) portfolio (electricity) price at the same year-to-year portfolio (price) risk; or the portfolio risk at the same portfolio price; or the portfolio price and year-to-year portfolio price risk. In other words, it will help move the EU's electricity mix closer to the efficient frontier of electricity mixes (Egenhofer and Jansen, 2006).

Improved energy prospects for rural and isolated regions. Electricity supply in rural and isolated regions might be improved cost-effectively by on-grid and distributed generation options based on renewables. These options imply deployment of more local labour, including labour in the supplying industry (Jansen, Gialoglou and Egenhofer, 2005).

However, the contribution of renewables to EU security of supply may have to be reconsidered when taking into account some specific structural characteristics of renewable inputs. Increasing the share of renewables in the EU portfolio means to focus on wind energy, biomass and photovoltaic, which can have a number of drawbacks. Wind is intermittent because turbines do not operate when wind speed is either low or too high since there are risks of damage for the turbines. Solar photovoltaic is subject to seasonal variation from winter to summer as well as to daily variation from diurnal to night time. In addition, PV is not dispatchable, meaning its output cannot be controlled and scheduled to respond to the variable consumer demand for electricity (IEA, 2007a).⁴² The possible lack of continuity in electricity generation from wind and solar energy requires a backup capacity from more flexible sources. This could ideally be provided by other renewables such as large hydro but, more realistically, the difference would be met by fossil fuels such as natural gas or coal. Natural gas however increases import dependency further while coal has high CO₂ emissions. Back-up capacity increases costs of renewables.

The nexus between renewables and reduced fossil fuels import dependency should in fact not be overstated. As the Commission's study on future *Scenarios on Energy Efficiency and Renewables* reports, assuming that the share of renewables in electricity generation increases to 23.5% in 2010 (see Table 1), 39.4% in 2020 and 45.6% in 2030, import dependency in 2010 would moderately be reduced to 52%, reaching 58% in both 2020 and 2030 instead of 55%, 64% and 65% in the Baseline scenarios (European

⁴² Some of these ideas reflect also FEEM's contribution provided by Daniele Benintendi.

Commission, 2006e). In other words, doubling the share of renewables in electricity generation by 2030 would reduce import dependency by about 6-7%. Similar conclusions have been reached by an assessment of EU energy policy analysis published by the Energy Research Centre of the Netherlands (Groenenberg, Ferioli, van den Heuvel, Manders, Slingerland, and Wetzelaer, 2008). That is to say that renewables would decrease import dependency but would not be able to reverse the import dependency trend alone.

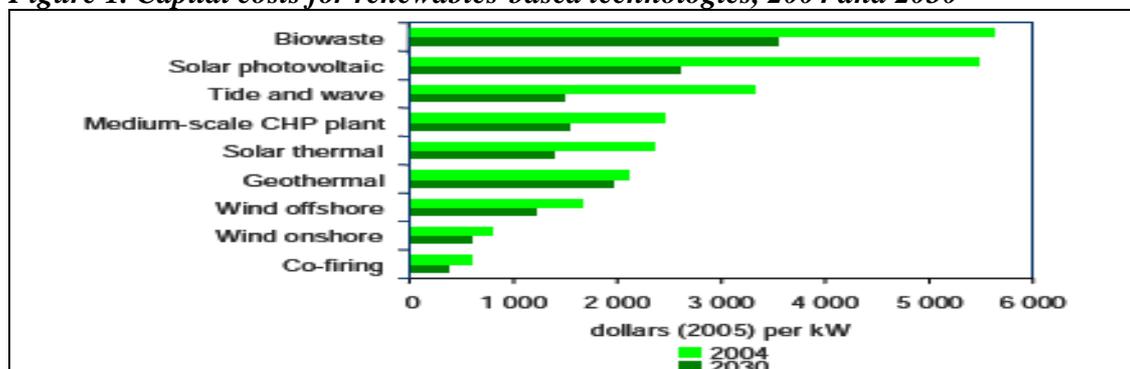
Table 1: Import dependency in EU-25 in the “High Renewable” case

	2000	2010	2020	2030
<i>Solid fuels</i>	30.8%	43.2%	51.1%	50.2%
<i>Liquid fuels</i>	76.4%	83.3%	92.3%	93.3%
<i>Natural gas</i>	49.6%	61.4%	79.7%	83.6%
TOTAL	47.2%	52.1%	58.2%	57.8%

Source: adapted from PRIMES

Moreover, it should be taken into account that, in the long-run, some renewable inputs may become tradable across countries raising import dependence risks. In this regard, biomass is the most eligible source. Its physical characteristics, namely storability and transportability, allow a parallel between security of supply risks of biomass and traditional energy sources, both in terms of physical availability and prices. For biomass, competition risks are worsened by the fact that biomass is used not only for energy uses - - such as electricity, heat and transport -- but also for food, fibre and chemical production. In turn, this leads to price volatility of biomass inputs. Another import dependency concern is related to solar energy and the on-going discussion to build a large-scale grid to import solar electricity (by concentrating solar power) produced in North Africa and the Middle East. On the one hand, the project would allow Europe to diversify its energy portfolio augmenting the share of a clean energy sources but, on the other hand, imports of solar power from these regions would further increase Europe’s dependence from unstable regions. On balance, how much Europe would gain, or possibly lose, in terms of energy security is a matter of discussion.

Figure 1. Capital costs for renewables-based technologies, 2004 and 2030



Source: IEA 2007a

The relatively infant nature of most of renewables-based technologies makes them not very much competitive from an economic point of view.⁴³ Only generation of electricity from hydropower has had the time to amortise its costs which have gone down to \$0.03 per kW, for large hydropower, and \$0.2 kW for small hydropower (IEA, 2006a). Instead, solar PV electricity is produced at a cost of \$0.35/\$0.45 kW (IEA, 2006a), while capital costs for solar thermal are about \$2500 per kW, and \$5500 per kW for solar photovoltaic (see Figure 1 and Table 2; IEA, 2007a). The average price for large, modern wind farms is about \$1000 per kW and off-shore wind installation can cost between 35% and 100% more (IEA, 2007a). In the long term, learning-by-doing effects and economies of scales are expected to drive down capital and production costs of renewables-based technologies making them more competitive. The IEA (2006a) expect that renewables (except wind) will experience a 15-19% cost reduction for each doubling of capacity. This is what happened over time: in 1960s, for example, a solar PV module cost about \$100 000 per kW, today the price is between \$2000 and \$3000 per kW (IEA, 2006a). Similarly, in 2020, capital costs for solar photovoltaic are expected to drop by half, while capital-costs for off-shore wind will be one third cheaper (see Figure 1). However, these technologies are not expected to become ready for mass deployment before 2030 (IEA, 2006a). In order to make these technologies economically viable, a considerable public support is necessary, at the level of both investment incentives and changing consumer behaviour. In order to have a successful deployment, a set of coherent and coordinated policy actions is required in the whole chain of activities concerning a specific technology.

Table 2. Costs of electricity generation technologies in OECD countries, 2005 and 2030

Technologies based on:	Investment costs (USD per kW), 2005	Investment costs (USD per kW), 2030	Typical electricity generation costs ¹⁸ , 2005 (USD per MWh)	Typical electricity generation costs, 2030 (USD per MWh)
Large hydro	1,500 – 5,500	1,500 – 5,500	30 – 120	30 – 115
Small hydro <10 MW	1,800 – 6,800	1000 – 3000 ¹⁷	60 – 150	50
Wind onshore	900 – 1,100	800 – 900	30 – 80 ¹⁹	30 – 70
Wind offshore	1,500 – 2,500	1,500 – 1,900	70 – 220	60 – 180
Geothermal	1,700 – 5,700	1,000 – 2,000	30 – 90	30 – 80
Solar PV	5,000 – 8,000 ¹⁸	1,200 – 1,800	180 – 540	70 – 325
Solar thermal	2,000 – 2,300	1,700 – 1,900	105 – 230	90 – 190
Biomass	1,000 – 2,500	400 – 1200	30 – 100	30 – 100
Ocean (current, tidal, wave)			55 – 180	
Coal	1,000 – 1,200	1,000 – 1,250 ¹⁹	20 – 60	35 – 40
Coal with CCS ²⁰	1,850 – 2,100	1,400 – 2,100 ¹²	40 – 90	45 – 60
Natural gas	450 – 600	400 – 500	40 – 60	35 – 45
Nuclear	2,000 – 2,500	1,500 – 3,000	25 – 75	47 – 62 ²¹

Source: IEA 2007a

⁴³ Costs are not the only obstacles for further penetration of new renewables-based technologies, public acceptability concerns are indeed another barrier. Public resistance has for example emerged against the installation of off-shore wind turbines in Italy as they are considered aesthetically damaging.

ENERGY EFFICIENCY

Following the EC Green Paper of 2000, energy efficiency has become a cornerstone of the European Commission energy policy. The 2005 Green Paper on Energy Efficiency recognised that actions on the demand side are as crucial as supply-side initiatives to pursue the three EU energy policy objectives: competitiveness, security of supply and environment protection (European Commission, 2005). Accordingly, energy efficiency has become one of the three pillars of the Energy Policy for Europe Action Plan (2007-2009) as well as a crucial tool to achieve the Commission's 20/20/20 policy targets. At the heart of the EU energy efficiency initiatives lies the Energy Efficiency Action Plan (EEAP) presented by the European Commission in October 2006 (European Commission, 2006d).⁴⁴ The objective of the plan is to control and reduce energy demand and to take targeted action on consumption and supply in order to save 20% (1.5% or 390 Mtoe per year) of annual energy consumption of primary energy by 2020. According to the Commission Action Plan on Energy Efficiency, the largest cost-effective saving potential is in the household and in the tertiary sectors -- 27% and 30%, respectively. For manufacturing industry, the overall potential is estimated to be around 25%, while for transport the figure is 26%. In an effort to address the economic potential of unrealised energy savings, the Commission proposed for Member States to adopt and aim to achieve an overall national indicative energy savings target of nine percent by 2016. This target, which translates into savings of at least one percent of energy each year starting 2008, shall be reached by way of energy services and other energy efficiency improvement measures. The directive on the promotion of end-use efficiency and energy services requires Member States to submit National Energy Efficiency Action Plans (NEEAP) to the Commission, describing the measures to that are aimed at achieving this target. In its first assessment of the NEEAPs the commission came to a rather negative conclusion, criticising that the Action Plans follow a business-as-usual approach and that the few which are more progressive lack concrete definitions of the new measures and how they should be implemented (European Commission, 2008c).

Notwithstanding the Commission's attention to energy efficiency, the latter is expected to improve less than expected for few reasons. First of all, while the 2020 targets for the reduction of CO₂ emissions and the increase in renewable energy production are binding, the energy efficiency target is not. The Commission was in fact in favour of making it legally binding, but member states were opposed to this option. They were concerned that the financial burden of saving energy would have been unevenly biased towards them. Since energy efficiency was already subject to a number of other directives, the Commission agreed to make the related target non-binding. According to the IEA, since the directives aimed at promoting energy saving do not always capture the full energy efficiency potential, the non-binding nature of the energy efficiency target rise

⁴⁴ The Energy Efficiency Action Plan focuses on the following priority areas: dynamic energy performance requirements for products, buildings and services; energy transformation; transport; financing, economic incentives and energy pricing; energy-efficient and energy-saving behaviour of energy consumers; international partnerships.

concerns regarding whether it will eventually be fulfilled. (IEA, 2008). Moreover, the strategy of ameliorating Europe’s security of supply through better energy efficiency needs qualification. Energy efficiency achieved by reducing demand increases the flexibility of the whole energy chain and thereby provides an additional margin for security. Put another way, if the flexibility needed to cope with supply failure is a proportion of overall energy demand, then the cost of providing a constant level of security of supply decreases if the overall energy demand is reduced (Egenhofer and Legge, 2001). Other than that, not very much evidence exists that increased energy efficiency enhances Europe’s security of supply.

In particular, as a strategy to increase the security of supply, energy efficiency is generally related to its presumed ability to reduce import dependency. Yet there are two doubts on this regard. First, it is not clear whether import dependency can be considered as a risk *per se*. As argued before (see chapter on oil and gas), this does not have to be the case if there is a sufficient level of diversification of sources, no supplier is dominant and prices are affordable. Secondly, one may wonder if a correlation between energy efficiency, on the one hand, and energy imports, on the other hand, hold good. Past energy trends and future projections do not in fact lead to this conclusion. The IEA (2008) reports that Europe’s energy efficiency has consistently improved over time: from 1200 Mtoe of Negajoules (i.e. avoided energy consumption through energy saving) in 1970, to 2000 Mtoe in 1990, to 2800 Mtoe in 2005. However, this improvement has not translated into a parallel downward trend for Europe’s total primary energy imports: Europe’s import dependence has augmented from 42% in 1990 to 52% in 2005 (EIA, 2008). Accordingly, a Commission’s study on future *Scenarios on Energy Efficiency and Renewables* reports that, even assuming the full application of the existing EU directives on energy efficiency, in 2030, Europe’s import dependency will be higher than in 2000, i.e. 65.5% vis-à-vis 47.2% (see Table 1). In fact, the difference between the 2030 Baseline scenario in which energy efficiency measures are not implemented, and the “energy efficient case” is very slim: in the former import dependence is 65.5%, in the latter 64.9% (European Commission, 2006e).

Table 1: Import dependency in EU-25 in the “Energy efficiency” case

	2000	2010	2020	2030
<i>Solid fuels</i>	30.8%	45.3%	50.1%	54.2%
<i>Liquid fuels</i>	76.4%	83.4%	92.2%	93.1%
<i>Natural gas</i>	49.6%	61.9%	78.8%	82%
TOTAL	47.2%	54.5%	63.1%	65.5%

Source: adapted from PRIMES

The absence of an apparent correlation between energy efficiency, on the one hand, energy imports and security of supply, on the other hand, has different – although complementary -- explanations. The progressive exhaustion of Europe indigenous resources – especially oil and gas -- is one. Secondly, there is the so-called “rebound

effect”. Improvements in energy efficiency make energy services (e.g. heat or mobility) cheaper encouraging their further use. This can result into an overall increase in energy consumption, despite the initial demand reduction. The rebound effect is very difficult to measure and it can have different impacts depending on the sector but, generally speaking, its impact has so far been underestimated. In industrialised countries, for any increase in energy efficiency there is a rebound effect of at least 10% (up to over 50%). This means that the actual reduction in energy consumption is equal to a certain percentage of the expected energy saving (UK Energy Research Centre, 2007).

Furthermore, the strong projected growth of energy demand in developing and transition countries is expected to level-off any possible energy efficiency improvement in the EU, both from a security of supply and CO₂ emissions perspective (Egenhofer and Legge, 2001). While Europe’s total energy consumption is expected to increase by 0.7% between 2005 and 2030, the biggest emerging consumer country in the world, namely China, will register a growth of 3% (IEA, 2007). This means that if the EU was able to save 20% of energy consumption, China alone would make up for more than Europe’s improvements. In other words, Europe’s efforts to reduce greenhouse gases will be neutralised by China’s record. This point is reinforced when taking into account the projected demand growth of other emerging economies -- such as India – and transition economies. A parallel adoption of energy efficiency measures in third countries and a proper implementation of the latter is thus of utter importance.⁴⁵ For this reason, a proactive cooperation between the EU and key third countries is necessary. The International Framework agreement on Energy Efficiency could be a first step in this direction. The proposal, initially suggested in the European Commission’s paper An Energy Policy for Europe on 10 January 2007 (European Commission, 2007), was endorsed by the European Council on 8 March 2007 (European Council, 2007). The EC’s proposal was then noted in the G8 communiqué of Heiligendamm in June 2007; legislators from the G8 and G8+5 supported the need for a global energy efficiency agreement when they met in Berlin in June 2007. The idea is to develop a multilateral partnership for energy efficiency involving, at first, member countries of the OECD with a possible future enlargement to other partners. The agreement could include various issue-areas of cooperation such as regulatory cooperation, information exchange on energy saving strategies, methods of measurement and research cooperation on energy efficiency technologies. The next crucial step for the development of an International Framework agreement on Energy Efficiency will be at Copenhagen summit in December 2009 (Kosugi, 2008).

⁴⁵ In China, for example, the real problem is the implementation of the energy efficiency measures. The Chinese Law on Energy Conservation set a target to increase energy efficiency by 20% between 2005 and 2010, but the current performance is far from achieving this objective.

ELECTRICITY

Security of electricity supply refers to “the ability of an electricity system to supply final customers with electricity” (European Parliament and the Council, Directive 2005/89/EC). More specifically, two are the necessary components of electricity security of supply: operational network security and demand-supply balance, namely adequate generating capacity. At both levels, the key challenge is reaching adequate and timely investment. As in other sectors of the economy, the market should be able to provide investment adequacy through price movements. Yet due to the specific characteristics of the electricity sector, price signals are rarely strong enough to stimulate a correct level of investment.⁴⁶ Also, in newly liberalized electricity markets, regulatory uncertainties add to the risk of under-investment: companies that are supposed to make investments in the power sector are prevented to do so if they perceive strong uncertainties over their returns (IEA, 2002).

Operational network security means the continuous operation of both the transmission and the distribution networks. Transmission System Operators (TSOs) are responsible for the safe and efficient operation of the transmission grids. More specifically, their tasks include balancing the market, facilitating spot exchanges and developing the transmission grids. In this context, TSOs face a number of challenges linked to the security of electricity supply. First, increasing international trade for electricity and rising demand from third countries to be interconnected to the EU grid has augmented pressures on grids triggering the risk of congestion. For example, Italy has congested links with France, Switzerland and Austria, while the Netherlands has congested connections with Germany and Belgium (IEA, 2002). Second, TSOs face the problem of lack of public acceptance of network construction. In most of Europe, notably in densely populated areas it is virtually impossible to build new overhead lines. As a consequence, TSOs have to install underground cables, which are more expensive by a factor of 10 to 30 in extreme cases. The risk originating from insufficient grid capacity is significant. The costs of unserved energy are estimated to be at between 3-20 euro per KW and for short-term interruptions of under 15 minutes at between 1-100 euro per KW; the damage easily runs into the billions of Euro. Third, TSOs have also to face the problem that there are different time horizons between planning of new generation (e.g. three years for combined cycle gas turbines) and network assets, typically 5-10 years (Egenhofer and Legge, 2001).

⁴⁶ First, demand for electricity is highly inelastic. This is caused by the fact that there is no available alternative for most applications of electricity and prices information rarely reach consumers in time to adjust their behaviour. Moreover, electricity consumption is usually measured over long periods so consumers have no incentive to shift their consumption from peak hours to off-peak hours. Second, the supply of electricity is only partially characterised by a gradually increasing marginal-cost function. When all available generation units are producing electricity, no marginal increase is possible in the short term. As a result, the marginal-cost curve ends with a perfectly price-inelastic section. Third, electricity is a strong time-limited product: it cannot be stored, other than in pumped-hydro facilities (de Vries and Hakvoort, 2004).

Imbalances between demand and supply can also cause major disturbances to the electrical system, such as general or local interruptions of the flux of electricity to both household and industry. Such events are usually the result of scarce reserve generation capacity, which is necessary to face peak demand, maintenance and outages needs (European Commission, 2003). In the monopolised market structure, capacity shortages were never a problem. The system was inherently producing overcapacity in the knowledge that costs could easily be passed on to consumers. Additional safety margins were possible “just in case” since they did not entail a business risk. In many countries regional or local monopolies considered it prestigious to own generation capacity. In addition, under the vertically integrated structure, prices were regulated and used to be very stable: they were set to cover total costs and hence enable the utility to finance investment (Roques, Newberry and Nuttall, 2005). In competitive markets the situation has reversed. Investment decisions for generation capacity are based on calculations of profitability. Particularly if peak demand is seldom reached, which by definition is the case for the marginal KWh, incentives to build reserve capacity are low. Also, in liberalised electricity markets, the risk of price volatility has increased.

Peak-load capacity is not a problem at the EU aggregate level. However, due to the fragmentation of the internal electricity market and a lack of cross-border trade or even unused cross-border interconnection capacity, the aggregate figure is largely irrelevant. Relevant reference points are regional trading areas where the spare capacity to deal with peak loads differ considerably. Theoretically, shortages of generation capacity could be offset via trade. However, interconnection capacity is generally insufficient and where it is sizeable such as in the case of France and Italy, it is linked to regular imports or exports, i.e. not available for dealing with peak-load problems. In addition there might be internal bottlenecks which can restrict cross-border flows in a wider region.

Under certain conditions, competitive markets can lead to an erosion of reserve capacity. In principle, though, concentration should be detrimental to security of supply. Especially where generation is oligopolistic or monopolistic – which is the case for most member state markets – there are strong incentives to keep reserve capacity small. Further liberalisation to speed up import competition to challenge the dominant generators should reduce this risk. Market liberalisation also gives large customers the possibility of offering frequency response and standing reserve services, as well as demand-side management; these all contribute to reinforcing the integrity of supply at times of peak demand.

Yet the process of liberalisation of the European electricity market is far from complete. This is why the so-called Third Energy Liberalisation Package has been proposed. Central to this Package is the separation between electricity (and gas) transmission networks and supply from generation activities. The Commission initially proposed two options: full ownership unbundling and independent system operator (ISO). The first option – strongly preferred by the Commission -- forbids companies involved in transmission to get involved, at the same time, in energy generation or supply. The second option allows production and supply companies to keep their network assets but

their management would have to be left to an independent company to be designated by national governments (the ISO). Following the opposition of eight member states, led by Germany and France, a “Third Way” option – the so-called regulating unbundling -- was proposed in June 2008: companies would retain full network ownership and control, while operations would be managed by an independent transmission operator (ITO) that would ensure fair network access and push for investments (Riley, 2008). The proposal was approved by a majority of MEPs in the case of gas but strong differences remain for electricity: the Parliament voted against both the ITO and ISO option, preferring full ownership unbundling as the only option for electricity. Talks among member states and MEPs will probably go on until the beginning of 2009 causing the delay of approval of the Third Energy Package.

EUROPE'S EXTERNAL ENERGY POLICY

1. Speaking with one voice

One of the recurring themes of the EU integrated climate and energy package is the alleged need for Europe to speak with one voice towards third countries. This primarily entails the geographical diversification of suppliers and fuels, the establishment of further energy cooperation with major producer, transit and consumer countries, and a common reaction to external energy crises.

In March 2006, the Green Paper (European Commission, 2006a) identified a “coherent external energy policy” as one of the six EU energy policy pillars. The Green Paper has taken a procedural approach and put its faith in the Strategic EU Energy Review to serve as the basis for establishing a common EU vision, which will gradually become a common external voice. Another important step has been the June 2006 European Council decision to adopt the legal framework for the external energy policy proposed in the joint paper by the European Commission and the High Representative. Pointing out the need for creating an EU strategy on external energy relations to pursue the objective of securing reliable flows of affordable and environmentally sustainable energy, the paper considers two “building blocks” of energy security: functioning markets and diversification. Moreover, it says that an EU external energy policy should be “coherent (backed up by all Union policies, the Member States and industry), strategic (fully recognizing the geo-political dimensions of energy-related security issues) and focused (geared towards initiatives where Union-level action can have a clear impact in furthering its interests). It must also be consistent with the EU’s broader foreign policy objectives such as a conflict prevention and resolution, non-proliferation and promoting human rights.” In order to fulfil these objectives, the EU has created a network of energy correspondents (consisting of representatives by member states and the General Secretariats of both the Commission and the Council), an early-warning system and the European Energy Supply Observatory to be coupled with bilateral, regional and multilateral dialogue at political level (Commission/SG/HR 2006).

The 2007 Spring European Council finally agreed on an Action Plan for international energy policy focused on speeding-up the development of a common approach to external energy policy, involving consumer-to-producer as well as consumer-to-consumer and consumer-to-transit countries, dialogues and partnerships. More concretely, the European Council formulated the following objectives: i) negotiating and finalising a post-partnership and cooperation agreement with Russia in particular relating to energy issues; ii) intensifying the EU relationship with Central Asia, the Caspian and the Black Sea regions, with a view to further diversifying sources and routes; iii) strengthening partnership and cooperation, building on the bilateral energy dialogues with the US as well as with China, India, Brazil and other emerging economies, focusing on the reduction of GHG emissions, energy efficiency, renewables and low-emissions energy technologies, notably carbon capture and storage (CCS); iv) ensuring the implementation of the Energy Community Treaty, with a view to its further development

and possible extension to Norway, Turkey, Ukraine and Moldova; v) making full use of the instruments available under the European Neighbourhood Policy; vi) enhancing energy relationships with Algeria, Egypt and other producing countries in the Mashreq/Maghreb region; vii) building a special dialogue with African countries on energy and using Community instruments to enhance in particular decentralised renewable energies and generally energy accessibility and sustainability in this region, as well as energy infrastructure of common interest; and xiii) promoting access to energy in the context of the UN Commission on Sustainable Development (UNCSD) (European Council 2007). Finally, the Presidency Conclusions of March 2008 recalled the importance attached to the external dimension of the 2007-2009 Energy Policy for Europe encouraging the Commission for further improvements in the context of the forthcoming Commission's Second Strategic European Energy Review on November 2008.

Notwithstanding the numerous recalls on the need for an external energy strategy, the EU is far from "speaking with one voice". EU member states still pursue their national interests diverging on issues such as the degree of energy market liberalisation, the right energy mix, the level of diversification, and especially their approaches on energy foreign policy objectives (Mandil, 2008 and Geden, Marcelis and Maurer 2006). A good case in point is the liberalization of the gas market: this has been immediately embraced by the Nordic countries and the UK, while other countries – such as France and Germany – have been reluctant to fully comply to the EU directives. Even more significant is the case of the Nord Stream gas pipeline which has recently divided the external energy policy of two big European countries: Germany and Poland. The first, together with Russia, is the main promoter of the project, while the second – mainly for historical reasons -- has strongly opposed its realisation.

2. The nexus between the internal energy market and the external energy policy

One possible reason for the slow progress of the EU foreign energy policy is the incompleteness of the internal markets for electricity and gas which overall remain a collection of regional markets. According to the European Commission, an effective internal market would increase efficiency of the sector, bringing down costs of goods and services by better resource allocation while internationally increasing the economic and political weight of the EU and its member states. By increasing competition, ensuring effective regulation and encouraging investment in power plants and transmission networks, integrated EU electricity and gas markets are also expected to avoid interruptions in power or gas supplies⁴⁷. Helping to increase the economic and political weight of the EU and its member states, a common energy market would serve as a basis for strengthening EU external initiatives on energy security. Instead, without a functioning common energy market, member states have an incentive to pursue national energy interests, concluding bilateral deals rather than looking for multilateral agreements with third countries (unpublished Behrens and Egenhofer 2008).

⁴⁷ European Commission (2007), *Energising Europe: A real market with secure supply*, IP/07/1361

Not only the internal market is seen as a prerequisite for a common external energy policy, but the latter is often perceived as the extension of the former (Youngs 2007). In the Green Paper, for example, the Commission asserts that energy security can be achieved “by the EU extending its own energy market to include its neighbours within a common regulatory area with shared trade, transit and environmental rules”. The Commission’s 2007 Strategic Energy Review stresses the search for international partnerships based on “shared rules or principles derived from EU [internal] energy policy” and the need to promote ‘transparent legal frameworks’ in producer states. In short, the EU has tried to develop an inter-connected energy market with its periphery using EU regulatory norms which have been put forward by different energy treaties and agreements with third countries. The Energy Charter Treaty (ECT) is a good case in point: as a legal instrument on non-discriminatory and market based conditions for trade, transit and investment in energy products, the ECT is largely based on WTO rules and EU legislation which are not shared by the major energy suppliers – such as Russia, Algeria and Norway. Following Russia’s refusal to ratify the ECT, the EU has tried other ways to persuade its main gas supplier to commit to some of Europe’s market principles, namely through the creation of the EU-Russia energy dialogue (2000), the EU-Russia Technology Centre (2002), the WTO access negotiations and the Partnership and Cooperation Agreement (PCA). Similarly, numerous regional energy dialogues -- such as the Energy Community South East Europe Treaty, the Baku initiative (2004), the Black Sea initiative (2004) as well as the recent proposal for a new EU-Black Sea-Caspian Sea Common Energy House (2006) -- are aimed at driving EU-style energy reforms in the Balkans, Central Asia and the Caucasus region, progressively integrating them into the European energy market and favouring a stable market environment capable of attracting investments. In addition, the promotion of regional energy integration between Europe and the Maghreb countries – the so-called Euro-Mediterranean cooperation -- began with the inception of the Barcelona Process and, in the context of the Commission’s new Mediterranean aid Programme (2007-2013), the integration of the European and Maghreb gas markets has also become a requirement for funding the aid programme. In the rest of Africa, energy partnership is understood through the lens of development policy and governance issues: the EU Energy Initiative for Poverty Eradication and Sustainable Development (2002) is aimed at improving access to energy as part of poverty reduction strategies. Finally, the series of new energy partnerships – signed with Ukraine, Azerbaijan and Kazakhstan – represent a similar EU-style approach of attempting to use contractual agreements to attain adherence to rules-based behaviour on market regulations, transport and safety. Officials also believe that rules-based governance offers the most promising way to deal with the rise of new energy consumers, such as India and China. Accordingly, an EU-China Energy Environmental Programme and an EU-India Environment Forum were launched in 2004 and 2007, respectively.

Yet the effectiveness of a market-governance external energy policy approach is unsure. First, this logic is undermined by the fact that the internal energy market remains very much less than unified and bilateral deals with third countries remain the preferred means of energy negotiation. Second, whether the stated approach of norm-based energy

governance is accepted by producer states is in doubt. In fact, resistance has strengthened in many, if not most, of the EU's main energy suppliers to the 'import' of EU energy-pertinent norms. This is the case in the Arabian Peninsula, which still accounts for by far the largest share of global oil reserves. The EU-GCC free trade area talks have been running for 18 years without conclusion: the EU proposed a Memorandum of Understanding on energy cooperation, the GCC states rejected the idea, insisting that a free trade agreement was the precursor to deepening other areas of cooperation. Even after Saudi Arabia's entry into the WTO at the end of 2005, the GCC remains far from accepting EU-style market and governance norms. Indeed, Gulf states blame the EU for trying to export its own model of regional integration, without recognizing that intra-regional dynamics are quite different within the GCC. Even in the EU's immediate periphery the reach of internal market-governance norms sometimes looks distinctly limited. Algeria, for example, has rejected the whole edifice of governance norms incorporated into the Neighbourhood action plan offered to it. Similar trends can be witnessed across the Caspian and Central Asia: in negotiations for its ENP action plan, Azerbaijan only accepted a non-specific and diluted commitment on joining the WTO seeing market liberalisation as unnecessary; Kazakhstan has resisted EU regulatory and market norms while it has no prospect of a place in the ENP. More important is Russia's resistance to EU efforts to spread its norms and standards (Youngs 2007).

3. Underplaying politics?

However, as High Representative Javier Solana states, the market is "only part of the answer" and an external energy policy "must also be consistent with the EU's broader foreign policy objectives such as conflict prevention and resolution, non-proliferation and promoting human rights". Yet Richard Youngs (2007) notices that, in practice, decisions over European peace support, democracy and human rights policies remain strikingly disconnected from Europe's energy policy. For example, in North Africa, the EMP technical cooperation on energy has been conducted regardless African politics impacts upon security interests. Similarly, in the Arabian peninsula, there has been no debate on how the EU's new energy strategy will impact on the political dimensions of European relations with the Gulf monarchies. And yet, again, the Gulf's internal politics present real dilemmas, of high and evolving significance for European energy interests. In Iran European diplomats stress that their approach is to 'keep out of politics' and rather try to improve governance conditions to help with oil and gas extraction, but the European offer of technical energy cooperation as an incentive to Iran looks incongruous. Similarly, in the Caspian and Central Asia, Commission aid priorities are technical assistance for reform of energy policies lacking a broader approach to the region's political and security challenges. Finally, Russia's suspicious internal politics has sometimes been disregarded when energy negotiations were at stake.

In light of all this, Richard Youngs (2007) calls for "a far more political approach" to frame Europe's external energy policy. As he says, "the EU needs to extend its work on technocratic norms to embrace a more holistic focus on the broader political governance of producer state regimes. [...] This not only involves realising that backing

‘friendly autocrats’ rarely optimises energy security in its broadest concept. It also requires policy-makers to question their tendency to consider only a narrow range of governance issues directly within the energy sphere.” Similarly, Zeyno Baran (2007) laments that European leaders often prefer not to discuss the political and geopolitical context of energy delegating these issues to market initiatives. Instead, she recommends a European external energy strategy deeply incorporated into the CFSP framework to also involve the highest political levels. A more politicized approach, according to Baran, should imply greater scepticism towards Moscow and greater reliance on the Caspian Sea region.

A deeper integration between the market and geopolitics may be advisable in order to provide a more coherent and effective meaning to Europe’s external energy policy, but someone may wonder how, in practice, this would be feasible. First of all, given the low level of Europe’s coordination in the realm of foreign policy and the related incompleteness of the CFSP, it is hard to believe that a common external approach on energy could steam from the CFSP framework as it is. For Europe to speak with one voice on energy issues a common view on foreign policy is required but the EU is still far from reaching this ambitious objective. Secondly, one may wonder what “less market” and “more politics” in energy policy actually means. Caring about conflict prevention and resolution, non-proliferation and human rights, while seeking to secure energy supplies, is extremely difficult in a world where over 90% of fossil fuels are located in unstable and non-democratic countries and fossil fuels remain the principal energy source for the near future. Thirdly, an increasing engagement in energy affairs by the CFSP structures could be interpreted by energy producing countries as a EU resort to military means to secure energy supplies leading to undesired situations which could also end up into conflicts (Larsson, 2007).

CLIMATE CHANGE

According to the Intergovernmental Panel on Climate Change (IPCC), there is persuasive evidence that most of the temperature rise that has occurred over the last 50 years is attributable to human activity (IPCC, 2007a). As GHG concentrations continue to increase, the potential impact of GHG emissions on people and ecosystems may prove to be significant. In their contribution to the Fourth Assessment Report in 2007, Working Group 1 (IPCC, 2007b), of the IPCC highlights the unprecedented level of observed climate change. For the next two decades, it projects a rise of about 0.2°C per decade across a range of emission scenarios. And even with the concentrations of all GHGs and aerosols being kept constant at year 2000 levels, a rise of about 0.1°C per decade could be anticipated. The same body finds that this is likely to trigger serious consequences for humanity and other forms of life. Ramifications include a rise in sea levels, thus endangering coastal areas and small islands, as well as provoking a greater frequency of extreme weather events, impacts on agricultural production and higher incidences of the spread of diseases, damage to infrastructure or migration. Without global action on climate change, this trend is expected to continue.

The principal source of global GHG emissions is CO₂, on which this chapter concentrates. Roughly speaking, about 60% of total GHG emissions come from the use of fossil fuels and 20% from land-use changes, e.g. deforestation. The rest is attributed to GHGs other than CO₂.

According to the reference scenario of the IEA (2008), emissions may increase by almost 60% between 2005 and 2030, thus putting additional pressure on the global climate and life on earth. Limiting global warming to 2 °C above pre-industrial levels – a level below which the EU believes that irreversible ecological damages may still be avoided – will require cuts in global emissions of 50% by 2050 relative to 1990 levels (European Commission, 2007e). There is a growing consensus that GHG emissions will need to be reduced globally by around 50% by 2050. This would translate into reductions for industrialised countries by 80-95% by the same period. Industrial countries will need to take the lead due to their historic responsibility of having emitted most of the current GHG emissions stock that is responsible for climate change. However, emissions reductions by developed countries alone will not be sufficient because emissions from developing countries are projected to surpass those of developed countries by 2020. At the latest by then, fast growing developing countries will need to start reducing their emissions in absolute terms.

Given that energy accounts for about 80% of all greenhouse gas emissions in the EU, climate change policy based on such reduction targets will require profound changes in European energy systems. Climate change thus plays an ever increasing role in energy policy making and the value of considering interactions between global warming and energy security is increasingly recognised.

Keeping within the 2 °C boundary will require stabilisation of greenhouse gas concentrations in the atmosphere at around 450 parts per million (ppm of CO₂e), up from an estimated 280 ppm before the industrial revolution and roughly 380 ppm in 2005. For the energy sector, this means peaking CO₂ emissions in 2012 and a reduction thereafter (IEA, 2007). In relation to the reference scenario, some 19 Gt of CO₂ emissions will need to be abated by the year 2030. More efficient use of energy in industry and buildings (incl. electricity) could account for almost 40% of the envisaged reductions in CO₂ emissions. Carbon capture and storage in power generation and industry (21%), renewables (19%) and nuclear energy (16%) are also projected to contribute substantially to CO₂ abatement. While oil, gas and coal will remain to be the three most important global energy sources in 2030, demand will need to stay roughly at levels of 2005.

Climate change policy may at the same time be beneficial to security of supply. Areas are for example better efficiency, renewables, nuclear and generally a new innovation drive (Groenenberg et al., 2008). However many of these benefits are not always straightforward. Renewables often are intermittent, thus causing additional, albeit different security of supply problems. Energy efficiency reduces import dependency. Thus, a security of supply benefit requires that import dependency is a problem. This is not automatically the case as we have seen. Nuclear has its own security of supply risks (see nuclear chapter). Only technology development seems to be univocally beneficial to security of supply.

Paradoxically, there is a risk however that current climate change policy discourages rather than encourages urgently needed investment. To an extent this is result of international indecision regarding a global climate change agreement, which in return reduces predictability. However, some of the design options and implementation by member states of the EU emissions trading scheme (EU ETS) – the EU's flagship policy on climate change – have made the situation worse: they include short-term allocation periods and allocation methodologies, notably including new entrants and closure rules. A second, less prominent but more fundamental aspect on investment is related directly to the ETS itself. Cap-and-trade schemes or carbon market instruments are not capable to provide sufficient incentives to develop and bring to the market new breakthrough technologies, i.e. make R&D at massive scale profitable. Price signals need to be much higher and more credible in the long-term to generate a significant amount of private resources for R&D (e.g. Egenhofer 2007). This will require a portfolio of policy measures including R&D, deployment of promising technologies and policies to overcome market failures. The EU's energy and climate package can be read as an attempt for such a portfolio of measures.

In addition to mitigating greenhouse gas emissions, the European energy sector will also need to adapt to changing climatic conditions – both on the supply and the demand side. The intensity of required adaptation will depend on future GHG emissions and will be different across member states depending on their geographical location, present climate and future changes. Southern countries will most likely be faced with less demand for heating but substantially increased demand for air conditioning. They may also experience losses in hydropower and problems with cooling of thermal power plants.

Northern countries will equally experience less demand for heating and may gain potential for electricity production from hydropower. At the same time, they may have to adapt to more storms and heavy precipitation. In both regions, electricity supply disruptions due to storms, floods and heat waves may increase the need for more decentralised electricity generation in order to avoid negative impacts on electricity users (see also Eskeland et al., 2008).

Finally, there are systems effects of climate change policy. In the EU they include insufficient fuel switching capacity or the fact that gas contracts continue to be indexed to oil prices. The latter had the effect that the higher oil prices increased, the more expensive gas became with the effect that the EU burned more coal and emitted more GHG emissions. These are just a few interactions between climate change/climate change policy and security of supply. To date, these interactions are not yet assessed although work is gradually starting (e.g. Behrens, forthcoming).

CONCLUDING REMARKS

The aim of the *Background Paper on Long-term Security Strategy for Europe* is to identify and evaluate existing and potential EU energy supply risks on the basis of a sector-specific approach. Moving away from common generalisations on security of energy supply as well as from those studies which focus only on one sector, the *Background Paper* brings together all fuels and analyses the risks related to each of them. The outcome is a comprehensive picture of the energy security challenges faced by the EU in the long-term. In fact, the idea is to build a map from which policy-makers could identify policy options to address sector-specific challenges. The *Background Paper* can be seen as a tool to avoid overlapping, incoherence and contradictions in the process of assessing security of supply risks and formulate a consistent and more united European energy policy.

After a brief overview on the concept of security of supply -- both from an economic and a political point of view -- the paper proposes a classification of security of supply risks including geopolitical, geological, economic, technical and environmental risks. Then, recognizing the existence of fuel-specific diversities in EU energy trends and policies, the paper calls for a sector-specific approach to analyze Europe' security of supply challenges. Accordingly, the core of the work focuses on sector-specific supply risks and long-term policies for the major energy sources: oil, gas, coal, nuclear energy and renewable energy sources (RES). The second part of the paper addresses cross-cutting issues -- energy efficiency, electricity, Europe's external energy policy and climate change -- and analyses their contribution to the security of energy supply in the European Union. The work is accurately embedded into the past, present and planned policy context of the European Union and takes into account the interconnection of energy security and climate change.

The findings of the *Background Paper's* analysis are summarised in the table below (Table 1). Although the security of energy supply in the EU faces four major categories of risks, not every fuel has to cope with all four of them. The combination of risks affecting EU energy supply (type of risks), their possible causes (events) and impacts (price rise), as well as their duration (duration) and future probability (probability in 20 years) is different from sector to sector. For example, geopolitical factors are a potential threat for all fuels analysed but the specific risk of "resource nationalism" is expected to affect only the hydrocarbon sector -- namely oil and natural gas. Similarly, economic risks may affect all energy sources in terms of under-investment, but price fluctuations would hardly touch sectors such as coal and nuclear. Also, all energy sources are somehow related to environmental risks but the link is stronger for hydrocarbons and weaker for RES. Finally, technical risks seem always a possibility, but they have their own specificities: intermittency is a risk only for RES and, as a consequence, for electricity, but not really for other energy sources. The table shows that generalisations on the concept of security of supply may be misleading given the fact that there are different risks for different sectors.

The next step should be the formulation of coherent and consistent policy options to face the above mentioned energy supply risks. CEPS plans to develop a set of strategies covering three different levels of governance: the global level, the EU level and the member states' level. In line with the sector-specific approach of the paper, the content of these policy recommendations will be both cross-cutting and fuel-specific. However, under its current status, the *Background Paper* accomplishes the function to supply the SECURE partners with a comprehensive overview on the most important energy challenges faced by the European Union. More specifically, for the SECURE project, this paper is the starting point to build a set of qualitative long-term security of supply storylines which -- in the context of WP4 -- will then be modelled by CNRS to be transformed into quantitative outcomes.

Table 1. Classification of security of supply risks in the EU

Type of risk	Events	Price rise		Probability in 20 years	Duration	Fuel affected					
		Intl.	Domestic			Oil	Gas	Coal	Nuclear	RES	Elec.
<i>Geological risks</i>											
Resource depletion/shortage	Lack of investments; extraction difficulties; unsustainable global demand; political constraints	Yes	Yes	Low	Decades, permanent	x	x	x	(x)	-	-
<i>Geopolitical risks</i>											
Voluntary output reduction	Quotas on production (by OPEC cartel; by a possible gas cartel); supply cut-off	Yes	Yes	Low-medium	Months, days	x	x	-	(x)	(x)	-
Involuntary output reduction	Civil unrest; political turmoil; war; terrorism	Yes	Yes	Low-medium	Variable	x	x	-	-	-	-
Transport and transit risk	Transport: sea-lanes bottlenecks; lack of investment; piracy Transit: political instability of transit countries; tense relations with exporting countries	Yes	Yes /No	Low-medium-high	Variable	x	x	-	-	-	x
Resource nationalism	Limited access for foreign investors to producing countries' resources	Yes	Yes	High	Years	x	x	-	(x)	-	-
<i>Economic risks</i>											
Under-investment	Transition towards liberalization; lack of investment incentives; capital shortage; public opinion opposition	No	Yes	High	Years	x	x	x	x	x	x
Market disruption	Regulatory failure/shortcoming	Yes	Yes	Medium	Variable	x	x	-	-	x	x
Price fluctuation	Supply-demand imbalance; lack of spare capacity; speculation	Yes	Yes	High	Months, years	x	x	-	-	-	x
<i>Environmental risks</i>											

Accidents	Major oil spill (land or sea)	Yes	Yes	Medium	Variable	x	-	-	-	-	-
	Nuclear accident	No	Yes	Low	Variable	-	-	-	x	-	x
Climate change	Increasing greenhouse gas emissions	Yes	Yes	High	Permanent	x	-	x	-	x	x
From production	Coal extraction and combustion	No	Yes	Medium	Variable	-	-	x	-	-	x
	Radioactive waste form nuclear	No	No	Medium	Permanent	-	-	-	x	-	-
<i>Technical risks</i>											
System failure	Extreme weather conditions; under-investment; technical neglect	Yes/no	Yes	Medium	Days, weeks	x	x	x	x	x	x
Intermittency risks	Absence/low inputs (e.g sun, wind)	No	No	Medium	Hours, days	-	-	-	-	x	x

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