SECURITY OF ENERGY SUPPLY

A QUESTION FOR POLICY OR THE MARKETS?

REPORT OF A CEPS WORKING PARTY

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This report is based on discussions in the CEPS Working Party on EU Options to Improve the Security of Energy Supplies. The members of the Working Party engaged in extensive debates in the course of several meetings and submitted written comments on earlier drafts of this report. This statement should not be construed, however, to read that each individual member subscribes to every sentence of the text. Participants in this CEPS Working Party include senior executives from a broad range of industry – including energy-intensive industries, energy supply, energy trading, cars and energy services – and representatives from business associations as well as environmental non-governmental organisations. A full list of members and invited guests and speakers appears in Annex 2.

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PREFACE

This CEPS Working Party was launched for the purpose of offering input to the discussions related to the European Commission's Green Paper of November 2000, *Towards a European Strategy for the Security of Energy Supply*, which has initiated a very timely debate on an important issue of European concern.

The point of departure of the CEPS Working Party was that the rapidly changing economic environment in which the energy sector operates calls for new concepts and policies to deal with security of supply. Liberalisation of energy markets, the completion of the EU's internal market, growing global economic interdependency and competitive pressures stemming from globalisation increasingly call into question the utility of traditional approaches. These approaches, which have relied predominantly on national responses, driven by governments and with a focus on physical availability of energy, increasingly have to be replaced by an economic risk-management strategy in which responsibility is shared between the EU, member states, energy companies and customers. In addition, the emerging international climate change regime will lead to a reassessment of fuel choice.

The CEPS Working Party met four times between June and October 2001. The objective was to bring together the decision-makers from the EU institutions and the stakeholders – including business, industry and NGOs – to consider how both the problems of and the solutions to security of supply differ today from the past. Based on presentations given by Working Party members and invited guest speakers, the group had intensive discussions on how to meet the challenges of security of supply in a liberal market. Its principle conclusions are summarised in the Executive Summary. A longer version of the main findings can be found in Chapter 6.

I want to thank the members of the Working Party for their active and positive contributions. Although all members endorse the general content of the report, this should not be construed to mean that each member subscribes to every sentence of the text.

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EXECUTIVE SUMMARY

The European Commission's Green Paper on security of energy supply (European Commission, 2000a) has initiated a debate on the challenges posed to Europe by security of energy supply now and in the future. This debate is being launched at a time of major changes. Liberalisation of energy markets across the entire European Economic Area (EEA) is leading to a new allocation of responsibilities between governments, firms and consumers but also to a new balance between EU/EEA and member state action. Liberalisation is also transforming the way energy is produced and consumed. At the same time, climate change policy affects fuel choices and is leading to calls for increased speed of innovation. The attacks of 11 September in the US, finally, have brought to the surface new uncertainties of crime, civil strife and war. The CEPS Working Party report has analysed security of supply in this new context. It identifies the likely major supply risks and proposes concrete recommendations on how to address them.

Taking the new context of energy security as its starting point for discussion, this report found that the prime *responsibility* for achieving security of supply has moved from government to market participants. Security of supply becomes a shared responsibility among energy companies, governments, and, directly and indirectly, all consumers.

This report defines security of supply as insurance against supply risks. Security of supply is defined as a cost-effective risk management strategy, which is the collective responsibility of governments, firms and consumers, resting broadly on three pillars. The first pillar is energy efficiency, which increases the flexibility of the energy chain and provides an additional margin of security or achieves the same security margin at a reduced cost. The second is technology development, which is essential to ensure efficient production and use of energy and to cope with environmental challenges. The third pillar is supply optimisation, by which we mean diversification by fuel and region and support for the proper functioning of the market, which should increase the number of market participants and thereby the flexibility and resilience of the system.

In many instances, markets are an efficient tool for achieving security of supply. The report provides ample support for this assertion. This is not to say, however, that the market can achieve everything. Sometimes liberal markets create new risks that need to be addressed if the current level of security is to be maintained. Especially for the long-term, beyond the time period in which liquid energy markets can be expected to operate, government action will be needed. The report also identifies the scope for this action.

The report draws a distinction between continuity and reliability of supply (i.e. short-term security of supply) on the one hand, and long-term concerns about fuel availability, including network investment (i.e. long-term security of supply) on the other. The analysis concludes that the most likely and striking risks are associated with continuity, particularly – but not only – in electricity. Examples include the possible erosion of reserve capacity or a lack of investment in network capacity. Liberalisation can lead to new solutions. Distributed generation, e.g. decentralised power generation, is one example. It can potentially reduce the vulnerability and increase the flexibility of the electricity grid, provided that technical and financial issues related to the interaction with the grid are solved. Another potential risk is that unwarranted public opposition should prevail, for instance, against necessary new investment in generation capacity and overhead lines. The risks to security of supply posed by a lack of reserve capacity were illustrated by the protests over high short-term electricity prices in the Nordic market and the power shortages caused by regulatory failure in California. The importance of public opinion was demonstrated by the blockages of refineries and roads in the UK throughout 2000.

The report also analyses the long-term concerns, which concentrate mainly on fuel availability, including network development. Fuel availability might become a cause for concern beyond 2020, but before then the outlook for fuel sources is good, with Europe surrounded by diverse and abundant sources of gas and oil. The actual situation will be heavily influenced by the progress achieved in developing exploration and extraction technologies as well as by improvements made in energy efficiency and renewable energy technologies.

Long-term risks relating to oil are mainly associated with ensuring sufficient investment to develop and physically deliver the necessary oil to the markets, as well as the ability to manage the political risks associated with supplier countries. In natural gas, long-term security of supply relates to investment and political risk. Considerable investment is needed for infrastructural development, especially upstream and in storage. As a result, producers must be made to feel confident that they will be able to sell the gas on the wholesale markets and be provided with sufficiently clear market (price) signals to assess the economics of a potential project.

In conclusion, CEPS proposes that any discussion on security of supply should focus on the following key messages:

Key Messages

1. Security of supply consists of different approaches aimed at insuring against supply risks. Security of supply can become a cost-effective risk-management strategy of governments, firms and customers. The main tools for risk-management are energy efficiency, technology development and optimisation of supply. Thus, according to this logic, import dependency is not a supply problem as long as imports are diversified and the associated risks are properly managed. Growing concerns over climate change and uncertainties – such as crime, terrorism and warfare – are important factors to be considered.

2. The prime responsibility for achieving security of supply has moved from governments to market participants in liberalised markets. Security of supply becomes a common responsibility to be shared among government, energy firms and, directly and indirectly, all customers. Markets can be an efficient tool for delivering the policy aim of security of supply but can change the nature of supply risks, necessitating a variety of government responses. EU and member state action is especially needed for the long-term, beyond the period when liquid energy markets can be expected to operate effectively.

3. A distinction can be drawn between continuity and reliability of supply on the one hand, and long-term concerns about fuel availability, including network investment, on the other. The most likely and striking supply risks are associated with reliability, especially in electricity and natural gas markets. Major risks associated with electricity supply include ensuring adequate reserve capacity, especially in liberalised markets. Security of supply could also be undermined if unwarranted public opposition prevails against the construction of necessary new generation projects or the installation of transmission lines. To effectively respond to the public's concerns, firms should step up efforts to provide transparent information and full justification of new projects.

4. To address security-of-supply concerns, the EU should develop a policy framework relying on energy efficiency, technology development and optimisation of supply.

CHAPTER 1
INTRODUCTION

Security of energy supply, having attracted only limited interest on the part of policy-makers in recent years, is back on the agenda. This new interest is evidenced by the wide-ranging debate launched by the European Commission with publication of its Green Paper on security of supply (European Commission, 2000a). The revival of OPEC, higher crude oil prices and international political instability – evidenced most recently by the terrorist attacks of 11 September and the war in Afghanistan – have highlighted anew the risks of disruptions to supply. This report, however, is not about the geopolitical dimension, but rather the modified outlook for security of energy supply in light of a rapidly changing economic environment.

Energy market liberalisation and growing international economic interdependence have affected governments' ability to react to security-of-supply challenges. The internal market (which increasingly covers energy) and EU enlargement have not only changed the policy instruments available to governments. They have also altered the reference framework for policy and market participants alike. Whereas in the past security of supply was largely seen – with some exceptions – as a national responsibility, for the frame of reference has increasingly become the EU/EEA (European Union/European Economic Area, the latter comprising the EU member states plus Norway, Iceland and Liechtenstein) as well as the candidate countries of Central and Eastern Europe. Hence, there is a need for a debate on what constitutes the "European dimension" of security of supply and what are the "new" ingredients of such a policy.

The relationship between liberalisation and security of supply is multifaceted. In general, liberalisation increases security of supply by increasing the number of market participants and improving the flexibility of the energy systems. Liberalisation may, however, also pose new risks, as this report shows. Moreover, governments may need to re-assess the level of security of supply they seek to achieve. Markets make the costs of security of supply more transparent, which in turn can lead to a situation in which consumers are prepared to pay a premium for increased security of supply or to accept a reduced level of security in exchange for lower prices. Liberalisation's main effect, however, is that it has shifted the prime responsibility for achieving security of supply from governments to market participants. The reason is simple. As can be witnessed in other markets, for example financial markets, fully competitive markets significantly reduce the government's scope for intervention. Over the long-term, measures that rub against the grain of the market are doomed to fail. Markets can actually serve as a very effective and efficient tool in achieving policy objectives: governments establish the objectives and set the rules that enable firms to achieve those objectives. As a result, security of supply has become a common responsibility shared among firms, government and, sometimes, individual consumers, with the primary responsibility resting on firms, including both supply companies and large industrial customers. It is the objective of this report to identify the respective roles of supply companies, large industrial users, individual customers and governments.

Security-of-supply objectives need to be consistent with other EU policies, notably the other two pillars of EU energy policy: environmental protection and competitiveness (see European Commission, 1995). In the environmental field, climate change can be expected to have a major influence on security of supply through its effect on fuel choice. The vulnerability to terrorist attacks is also likely to figure higher on the list of possible risks in the future. In an increasingly competitive world, we can expect that cost-effectiveness will become more important. This leads to the question of whether the EU's two energy policy pillars – security of supply and environmental protection – should be complemented by a third pillar of "cost-effectiveness" – as opposed to "competitiveness", the Commission's preferred term. A well managed competitive energy market is the most cost-effective way to satisfy EU energy policy objectives.

This report analyses the period between now and 2020, although Chapter 3.2 provides a brief outlook beyond. Thus, by "long term" we mean basically 2020, and by "short term", a period of up to five-to-ten years. This report also uses the terms "long term" and "short term" as they have been introduced in the literature by the International Energy Agency (IEA), among others. In this context "short-term" security of supply describes issues of continuity and reliability or system security such as risks of power failure or of accidents. "Long-term" security of supply means (long-term) political risks of unreliable supply sources or economic risks of insufficient investment.

We have chosen as our geographical frame of reference the European Economic Area. This is based mainly on the role Norway plays in the EU's internal market including energy and its importance as a primary fuel supplier. If we speak of government other than those of the EU member states, we refer to either the EU or the EEA. In most cases we use the term EU, acknowledging the fact that it is the EU institutions that will be responsible for action throughout the EU/EEA. Although we focus on the EU/EEA in its current form, the analysis also recognises that within the reference time frame (i.e. the next two decades), the EU's membership will have changed considerably. At the same time, however, the issues associated with security of supply will only be slightly altered by enlargement. By and large, the energy issues in the candidate countries are similar to those pertinent to the current EEA member states.

This report attempts to develop a conceptual framework for security of energy supply in the EU/EEA. It therefore takes a broad view and does not cover sector-specific issues that have been described, for example, in the numerous responses to the Commission's Green Paper on security of supply. These are published on the website of the European Commission's Directorate-General of Transport and Energy (http://europa.eu.int/comm/dgs/energy_transport/index_en.html).

Chapter 2 of this report describes the new context of security of supply, identifies possible risks and puts forward a definition of security of supply. Chapter 3 provides an outlook of demand projections by sector and fuels until 2020 and beyond. This chapter also prepares the ground for the analysis of supply consequences undertaken in Chapter 5. Chapter 4 zooms in on security of supply at the EU level to assess the role of energy efficiency and technology. It closes with a discussion on public opinion and large investments. The fifth chapter discusses strategies to optimise supply by sector. It distinguishes between primary fuels and electricity and identifies major risks for the latter. The concluding Chapter 6 outlines a proposal for an EU insurance policy both for the short and long term. The report concludes with two annexes. Annex 1 lists in tabular form the major supply risks and their possible impact. Annex 2 lists members of the CEPS Working Party and their invited guests and speakers.

CHAPTER 2
SECURITY OF SUPPLY REDEFINED IN AN AGE OF LIBERAL ENERGY MARKETS

Liberalisation, privatisation and globalisation have fundamentally altered the policy instruments at the disposal of governments. In the past, security-of-supply policy has predominantly consisted of government-initiated diplomatic – and sometimes military – actions to ensure physical supply, with limited emphasis on costs. With regard to the external aspects of security-of-supply policy, the focus was on diversification, both in terms of regions and types of fuel. This policy often led to relatively rigid long-term contracts, an emphasis on physical infrastructures, a dialogue between consumer and producer countries and mechanisms that could deal with emergency situations (e.g. strategic stocks or interconnections). The frame of reference was usually the member state, and seldom the EU. Domestically, the member states' response was to commit resources to developing indigenous energy sources, such as coal, peat, hydro or nuclear fission (considered as almost indigenous), combined with largely unconvincing demand-side policies. Moreover, strong domestic companies or even monopolies were created, which could carry the "necessary weight" externally and be able to support heavy investments internally. There were some initiatives at the EU-level, however, such as in the fields of research and external relations, and national borders played a smaller role in areas where market integration was more advanced, such as for oil products.

2.1 Security of supply defined

Any serious discussion of security of supply requires a common understanding of the definition of the concept and the kinds of risks that should be considered. A number of different approaches to and definitions of security of supply were considered by the Working Party. See Box 1 for a description of the three most commonly encountered definitions.

As agreed by the Working Party, this report uses the following definition:

> Security of supply consists of a variety of approaches aimed at insuring against supply risks. Security of supply becomes a cost-effective risk-management strategy of governments, firms and consumers.

Note that this definition avoids the term "policy". This stems from the fact that security of supply is a shared responsibility between governments, firms and customers. In fact, as we show, most of the risk can be assumed by industry – both suppliers and industrial consumers. Only where industry is unable to take the risk or has no influence to mitigate the risk is government policy demanded. The tools applied by governments, firms and consumers are energy efficiency, technological development and optimisation of supply.

Security of supply has two equally important constituent parts: physical availability and price. Given that energy prices crucially affect economic growth and wealth and the competitiveness of industries, price and physical availability are inextricably linked.[1] This link also prevails for domestic customers, although in a different way and on a different scale. It is low-income groups in particular that are the hardest hit by high energy prices, whether they are a result of a too-costly security-of-supply policy or a supply shortage that tends to lead to price increases. As a result, cost-effectiveness of the insurance is an important part of the definition of security of supply.

[1] Since all major OECD countries including the US, Japan and the EU are price takers (of world market prices), the distortions to competition due to different border prices should not be excessive, as long as world markets function. Energy price differentials are usually a result of different tax levels or a lack of competition in energy markets.

Box 1. Zooming in on security of supply

European Commission: "*… 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, 2000a, p. 2)

International Energy Agency: "*Technological developments will affect the choice and cost of future energy systems but the pace and direction of change is highly uncertain. Governments will … have an important role to play in reducing the risk of supply disruptions. Regulatory and market reforms … will also affect supply. Increased competition between different fuels and between different suppliers of the same fuel will tend to narrow the gap between production cost and market prices, reducing monopoly rents, encouraging greater efficiency and lowering the cost of supply."* (International Energy Agency, 2001a)

European Parliament: "*Being dependent on imports is neither necessarily a bad thing nor economically inefficient provided the sources are diverse, no one supplier is dominant and we can produce sufficient goods and services to pay for them.… We cannot alter the fact of where the oil comes from, but we can do a number of things on the demand side, in particular in the transport sector."* (European Parliament, 2001)

This does not mean that *price volatility* itself is a concern of security-of-supply policy, however. On the contrary, price volatility can be seen as proof that the markets work. If demand and supply are not in balance, prices change to provide market signals to close the gap. Another important feature is that markets provide for financial products such as derivatives to deal with price volatility.

2.2 What are the supply risks?

In order to make the Working Party's definition operational, it is necessary to first identify the risks that should be insured against and to agree on their likelihood (i.e. a *risk assessment*) as well as the potential consequences. The second step of the analysis is to identify the possible responses and the responsible actor (i.e. *risk management*). Note that some risks might deliberately go uninsured because they are "uninsurable" at least in the short term (e.g. terrorist attacks) or may be extremely unlikely (e.g. a meteorite falling on a major installation).

It is important to note that the time scale of different risks differs considerably from fractions of a second to hundreds of years. In the past, risks have sometimes been divided between short- and long-term risks (see International Energy Agency, 1995). Short-term risks are generally associated with supply shortages due to accidents, terrorist attacks, extreme weather conditions or technical failure of the grid. Long-term risks are usually separated into *economic* and *political* risks. The former could include an inability to deliver sufficient quantities of energy due to an imbalance of supply and demand (e.g. unexpected demand growth). Political risks might stem from a deliberate government policy to suspend deliveries or a war or civil war that prevented exports.[2] Regulatory failure is also a political risk. While such a distinction is helpful in identifying and distinguishing the different risks, it is less helpful in identifying adequate risk-management strategies, given that linkages between the responses to short- and long-term risks are closely interrelated.

In line with the European Commission's Green Paper on security of supply, the following risks can be identified:

[2] See Egenhofer and Labory (1998), European Commission (1999a) and International Energy Agency, (1995).

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

A more complete discussion of major risks and suitable risk-management strategies will be provided in the concluding Chapter 6. Annex 1 presents in tabular form the major risks identified by the Working Party.

2.3 The economic and political environment revisited

The traditional notion of security of supply has come under pressure from a number of sources. EU market integration, for example, notably for oil products, electricity and gas and in the future for energy service companies, has meant that the EEA, if not beyond, has increasingly become the reference framework. National responses are defined by EU law and policy, notably the internal market and competition policy. Widespread privatisation of (national) energy companies and the increasing cross-border or even cross-continental character of energy companies have changed the outlook for governments to use private business for public policy goals such as security of supply. The global nature of competition in capital markets forces companies to satisfy shareholders. This is also true for infrastructure, which is now mostly privately financed and needs to satisfy capital market requirements for an adequate rate of return. Major companies increasingly deal with security of supply as part of their business strategy. While this was common for oil companies for some time now, gas and electricity companies are increasingly taking a similar approach.

With the liberalisation of energy markets, the role of the customer has also changed. In the previous monopolistic situation, responsibility for security of supply lay almost entirely with the supply company, which was supervised by the government. In liberal markets, customers have a choice whether to assume responsibility for security of supply themselves or to allow the supply company to bear the responsibility and subsequently pay for it[3] through higher energy prices. The former is typically done by large *industrial users*, for which (short-term) security might not be a problem if they can switch fuels. A large industrial user may choose to buy gas from a risky but cheap source, accepting the risk of higher short-term prices from a spot market or mitigating the risk by installing a dual firing capability or a back-up from another supplier.

At industry level, a number of measures to reduce the risk of disruptions can be taken, such as storage close to consumers, interruptible supplies, encouragement of new entrants and short-term markets. Some of these solutions show that supply security is increasingly becoming a commercial concern. Thus, storage close to customers and interruptible supplies are established primarily for commercial reasons in a competitive liberal market. In such markets, the customer may switch suppliers or choose to sell some or all of his energy back to the market, thus enhancing security of supply for others. That the customer can exercise an economic choice

[3] Including a risk premium. In oil, for example, prices in long-term energy supply contracts tend to be higher than in spot markets, reflecting a higher security-of-supply risk.

enhances security-of-supply, and the market provides an efficient mechanism for sharing the benefits with other customers.

Responsibility for security of supply can be more effectively distributed in more competitive markets. More competitiveness means more actors, hence less dependence on single companies or monopolies, and more competitive prices. As a result, to take a long-term perspective, large industrial customers have an interest in supporting new entrants in newly opening markets. Similarly, industrial customers may take a stake at least temporarily and therefore a risk in new infrastructure investment, should this increase competition (thereby leading to lower prices) or flexibility (thereby promoting security of supply). Direct involvement by large energy users means an increase in the numbers of players, however, and hence more flexibility and higher security of supply in general.

The same scope does not exist for *residential, commercial or small industrial consumers*, although they may through intermediaries, e.g. energy service companies, achieve some flexibility in handling (short-term) supply risks. Generally, the short-term risks are either covered by commercial considerations of the supply company, which wants to avoid failing to deliver the energy that it has promised to sell, or as a last resort by public-service obligations. Such obligations have been widely used throughout Europe, in different forms, financed by different means, in both regulated and liberalised markets. In a monopoly market, if the supply is cut off, the supplier fails, but in a properly regulated and fully competitive market, an alternative supplier always emerges to maintain the supply and to take over the failed supplier's customer base.

But change is not limited to the economic and regulatory environment. Additional challenges have emerged. First and foremost, climate change has become a major driver of energy and environmental policy. Climate change policy affects the choice of fuel by making high carbon fuels less attractive in the market. In addition, climate change is becoming the major driving force for a renewed interest in energy efficiency and conservation. This is why the European Commission has made energy efficiency a priority goal in its Green Paper. Security-of-supply priorities will also be influenced by unexpected events such as the terrorist attacks in the US on 11 September, although it is too early to foresee the consequences of this incident.

As a result of the changed economic and political environment, the balance of responsibility for security of supply has been shifted towards a shared responsibility between governments, firms and consumers with the primary burden falling on firms, both energy supply companies and industrial consumers. The main tools available to government in this new context are energy efficiency, technology development and optimisation of supply.

CHAPTER 3
EUROPEAN ENERGY DEMAND UNTIL 2020 AND BEYOND

Approaches to security of supply will depend on long-term trends for demand growth to ensure that energy demand can be met. This chapter therefore gives a brief overview of the expected demand growth in the main sectors (e.g. transport, industry, electricity and heating) and the resulting possible fuel mixes. This chapter also analyses the potential of technological developments and how these are likely to impact demand and by extension security of supply.

3.1 The EU until 2020

The European Commission projects a continuation of the historical trend of demand growth of over 1% a year since 1986.[4] This growth in demand is projected despite the fact that energy demand growth is largely decoupled from economic growth and taking into account current and in-the-pipeline climate policies. The accession countries are expected to experience a somewhat higher growth than the EU as a whole (European Commission, 2000a). As a result Europe's absolute energy consumption is expected to rise in the period leading up to 2020 and beyond.

The security-of-supply consequences of this rising demand depend, first, on the policy decisions that could otherwise divert Europe from this business-as-usual outlook, and second, on the future fuel mix of European energy consumption. The main growth areas for demand will be transport and energy in buildings (mainly electricity and heating); industry growth will remain relatively stable.[5]

3.1.1 Trends in energy consumption under business-as-usual conditions[6]

Energy consumption in the *industrial sector* in 2000 was around 27% of the annual EU final energy use – 258 Mtoe (million tonnes of energy equivalent) out of a total final energy demand of 957 Mtoe. It is forecast to rise at a relatively modest rate of between 0.4 and 0.9% by 2020 (an absolute increase of 32.4 Mtoe). Industry, therefore, presents only limited extra demand up to 2020.

Contrary to total gross energy consumption, which has been largely decoupled from GDP growth, the *transport sector* is expected to grow at the same rate as GDP, with a particular emphasis on road and air traffic. Energy consumption in the transport sector is likely to grow at an annual rate of 1.5-1.7% until 2010 and thereafter by 0.4% per annum until 2020 (from 300 Mtoe in 2000, to 360 Mtoe by 2020, retaining a constant share of total energy demand of about 32%).[7] Unlike other sectors, transport is almost entirely dependent on a single fuel, oil. Significantly, alternative fuels are not likely to make strong inroads into transport fuel before 2020. Policy options are limited for transport growth: whereas the European Commission expects to be able to stabilise growth in energy consumption for passenger transport by 2010, consumption from freight transport will increase by 28% by 2010 even if policy measures are put into place.[8]

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[4] The European Commission's Shared Analysis Project predicts average annual growth of 1.1% in final energy demand until 2010, slowing to 0.5% growth from 2010 to 2020; growth in the accession countries' energy consumption will be higher than for the current EU-15 (European Commission, 1999b, p. 186).

[5] Figures from European Commission, (2000b), pp. 48-52.

[6] All figures from European Commission (1999b).

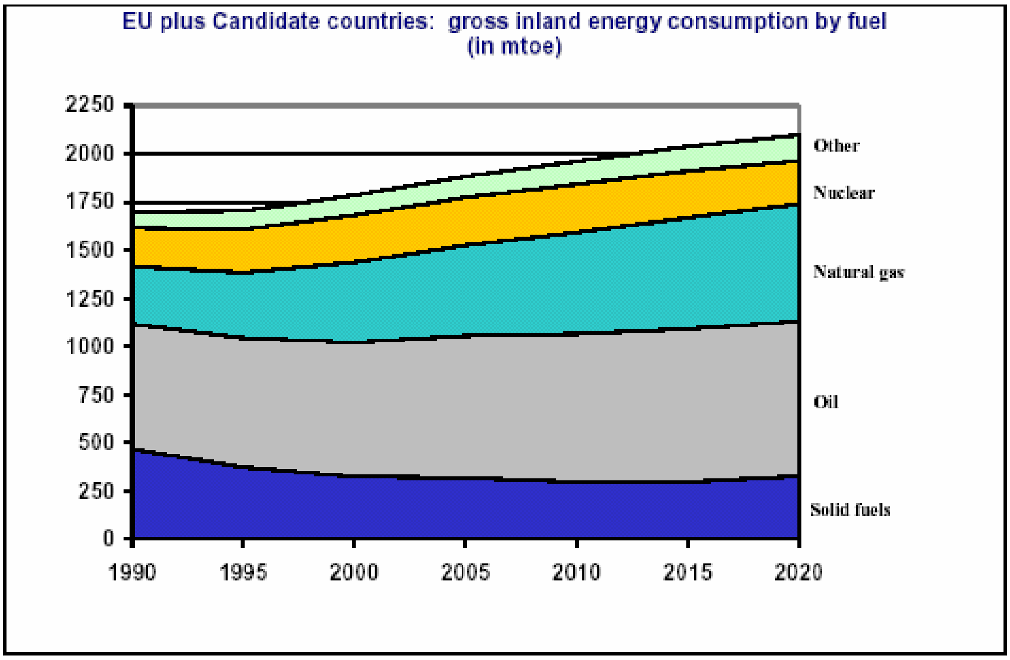
[7] European Commission (2000b), p. 50.

[8] This is assuming a rather optimistic annual 3% GDP growth per annum (see European Commission, 2001a).

Fossil fuels will thus dominate the transport sector's energy needs for the next two decades. Nevertheless, there is great scope – of up to 40% – for optimising conventional powertrain systems and cars and thus reducing fuel consumption. Alternative fuels for use in internal combustion engines such as bio-fuels could offer a partial alternative (of less than 5%) or supplement to oil-based petrol. A promising alternative is the production of conventional liquid fuels from a synthesis gas gained by gasification of natural gas or biomass, which could theoretically be produced indigenously within the EU, particularly by the accession countries of Central and Eastern Europe. Due to economic advantages, however, these fuels are likely to be produced outside the EU.

The EU's 2000 energy consumption in the *residential and tertiary sector* was at around 40% of the annual EU final energy demand, or 396 Mtoe. Energy consumption in this sector is forecast to rise to 459 Mtoe by 2020 (41% of total projected European final energy demand). According to the Commission, great potential still exists for refurbishment of existing stock and domestic equipment and investment in energy-efficient appliances, as well as education in energy-efficient use. The use of renewable energy in the residential sector could also be increased dramatically with appropriate incentives, the Commission believes.[9]

Figure 1. Projected EU-30 fuel mix until 2020



Source: European Commission (2000), p. 6.

Electricity consumption in the European Union grew by 2.1% per annum between 1985-95, and by 1.9% per annum since 1995.[10] Electricity consumption is projected to rise from the current 600 Gigawatt electric (GWe) of installed capacity to 800-900 GWe in 2020 (European Commission, 2000a, p. 14). Most of this new capacity will be met by non-renewable sources such as nuclear, solid fuel and natural gas, or be offset by increased demand-side management, even if the ambitious targets for renewables of 22.1% of total electricity in 2010 under the

[9] See European Commission (2000b), p. 51.

[10] Ibid., p. 47.

recently adopted directive on electricity from renewable energy sources are met.[11] Moreover, 300 GWe of existing capacity will have to be replaced over the next 20 years to replace power stations that have reached the end of their lives (European Commission, 2000a, p.14). This means that up to 600 GWe of the installed capacity in 2020 has yet to be built, presenting a potentially crucial opportunity to affect fuel technology choice.

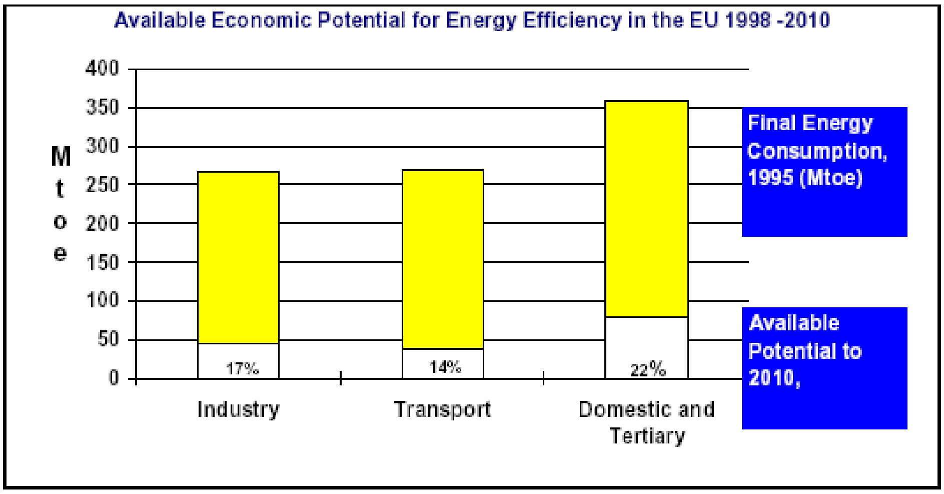
The *overall fuel mix* is expected to remain by-and-large unchanged in Europe up to and beyond 2020 (see Figure 1). Oil will remain dominant for the transport sector, with biofuels not expected to provide more than 5% of transport's energy needs. Overall, oil's share will remain constant at about 42% of gross inland consumption. Natural gas will slightly increase its share in the overall energy balance from 23% in 2000 to 27% in 2020.

3.1.2 Demand-side policy implications

These trends give weight to the European Commission's conclusions (European Commission, 2000a, p. 20) that the European Union faces an increase in its energy dependence to about 70% by 2020-30. The policy implications of this growing dependence are not automatic, however. As will be explored later in this report, it is not so much the dependence on external supplies that matters as how that dependence is spread across different suppliers and fuels and how the security-of-supply implications of this diversification are managed.

On the demand side, there is much scope for offsetting demand through energy efficiency, to a lesser extent in the transport sector and to a greater extent in the tertiary and domestic sectors. Figure 2 graphs the Commission's estimates of the economic potential for energy efficiency in three sectors. Other studies indicate higher efficiency potential. For example, a study for EuroACE has identified efficiency potential of up to 50-60% in the domestic and tertiary sectors using available technologies (CALEB Management Services, 1999).

Figure 2. Available economic potential for energy efficiency in the EU, 1998-2010



Source: European Commission (2000b), p. 49.

[11] Proposal for a Directive of the European Parliament and of the Council of 10 May 2000 on the promotion of electricity from renewable energy sources in the internal electricity market, COM(2000)279, final adoption by Council 7 September 2001. The European Commission accepts that the 22.1% target in 2010 will not be met without additional policy measures (see European Commission, 2000a, p. 79).

The most dramatic influence, however, could be exerted by technology, which could alter the fuel mix for electricity, heating and even transport. Technology, especially fuel-cell technology, holds great potential to shift energy production away from sources associated with security-of-supply risks. Fuel cells, which produce electricity through an electrochemical reaction with very low emissions and high efficiency, hold out the promise that petrol could eventually be substituted by hydrogen for vehicle transport, although fuel-cell automobiles will most likely enter the market gradually through a process of evolution, not revolution. The potential widespread use of fuel-cell cars may not occur before 2020, or at least not before the production costs are lowered, the storage tanks for the hydrogen is reduced in size, an infrastructure for the distribution of hydrogen is in place and sustainable and economic sources of hydrogen (i.e. based on renewables) are available. The situation for electricity may be different. Fuel-cell technology for fixed-point electricity production could substantially offset fossil-fuel consumption for electricity production given the right market conditions, reduction in fuel-cell production costs and, crucially, the production of hydrogen by non-fossil-fuel processes.

3.2 The global context up to 2020 and beyond

A major challenge to Europe's security of energy supply lies in competition for supply posed by the rising energy consumption that is predicted under business-as-usual scenarios in third countries. Total final energy consumption in the EU is projected to grow by 22% in the period 1990-2020, but demand in the world outside the EU is likely to be even faster, particularly in non-OECD countries (European Parliament, 2001). Beyond 2020, when energy consumption will continue to rise, the EU will almost certainly have lost its monopsony status for the gas suppliers that surround it, which could affect its bargaining power. The limiting factors to primary energy production in the future are not likely to be energy resources, however, since there are ample resources of oil, coal, gas and uranium to support growth in the longer term. Rather, the rate at which energy consumption will rise will partly be set by the cost of recovery and production, which will in turn be informed by technological developments.

Rising energy demand in Europe and outside, the growing importance to Europe's energy supply of individual supply sources or transportation routes, and the expected environmental constraint posed by climate-change policy comprise the long-term challenges to Europe's security of supply. One partial response to these challenges is increased energy efficiency, which could arise as a result of an increasingly stringent obligation to reduce CO_2 emissions. Technological development will be another major part of the solution, both for the production of primary energy and the development of innovative processes such as carbon sequestration, CO_2 injection or scrubbing, that could allow the production of energy from coal despite a restraint on CO_2 emissions. The supply situation is further discussed in Chapter 5.

Table 1. Global primary energy demand by region

Country	Percentage of total		
	1990	2010	2020
EU	15.9	13.3	10.7
Non-EU OECD	33.2	31.2	27
Developing countries	30.4	43.3	49.1
CEE & FSU	20.5	12.2	13.2
Total world (Mtoe)	8273	11669 (+41%)	14907 (+80%)

Note: CEE: Central and Eastern Europe; FSU: Former Soviet Union.

Source: European Commission (1999b).

CHAPTER 4
SECURITY OF SUPPLY AT EU LEVEL

The lack of an energy chapter in the EC Treaty has not meant that the European Union has been absent in EU energy policy. Other competencies conferred on the EU via the Treaty, such as in the fields of the internal market and competition policy, the environment, research and trans-European networks, have allowed the EU to play an active part in energy policy and, by extension, security of supply (Egenhofer, 1997). The growing economic and political interdependence of member states resulting from deepening integration (e.g. the internal market including energy, monetary union, common foreign and security policy) or international environmental agreements, such as the Kyoto Protocol, are increasingly leading to a convergence of EU member state policies. This in turn may lead to a change in the perceived added value of EU action, notably in the areas of energy efficiency, technology development and optimisation of supply.

4.1 Energy efficiency

Energy efficiency and conservation measures were identified in the European Commission's Green Paper as among one of the overriding priorities in EU policy on security of supply and on energy in general. As a consequence, the Green Paper states, "the Union must rebalance its supply policy by clear action in favour of a demand policy" (p. 3) and designate energy efficiency as the first pillar of security of supply.

While it is true that achieving security of supply was a driver behind energy efficiency measures initiated during the oil crises of the 1970s, energy efficiency and conservation have more recently been undertaken primarily for environmental reasons. Irrespective of the motivation, past policies on energy efficiency have not lived up to expectations due to a failure to address a number of barriers to energy efficiency. These include fossil fuel subsidies, distorting taxation systems, a lack of incentives, information and capital, the supply-side paradigm, the landlord/tenant barrier and sometimes a lack of internalisation of external costs. Some fear that energy efficiency will suffer further with falling prices as a consequence of energy liberalisation. But even if prices fall, energy efficiency and opportunities provided by the market for demand-side management offer ways to hedge against future price spikes.

As a side benefit, energy efficiency is also a means to reduce import dependency, but whether this will increase security of supply depends on a number of assumptions. The first is whether one considers import dependency as a risk *per se*. This need not necessarily be the case. As Giles Chichester, Member of the European Parliament and Rapporteur for the Parliament's report on the Commission Green Paper, writes, "being dependent on imports is neither necessarily a bad thing nor economically inefficient provided the sources are diverse, no one supplier is dominant and we can produce sufficient goods and services to pay for them" (European Parliament, 2001, p. 17).

Nevertheless, energy efficiency achieved by way of reducing demand increases the flexibility of the whole energy chain and thereby provides an additional margin of 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 is reduced if overall energy demand is reduced. Another standard argument about the relationship between energy efficiency and security of supply is less clear cut. Although in theory conservation and efficiency should allow the EU to rely on less-risky supply areas, this might no longer be true if one takes into account the strong growth projected in other parts of the world, notably developing countries.

Domestic EU savings could be eaten up by growth elsewhere unless similar policy actions are introduced on a worldwide scale.[12]

It should be remembered that energy efficiency has been the beneficiary of technological development.. Refrigerators today are several times more efficient than they were 20 years ago. This improvement, however, is not explained so much by a "desire to save energy" as by a "desire to save money". On the other hand, technological development can also be driven by inventions such as the internal combustion engine, which has replaced less energy-intensive means of transport.

4.2 The role of technology

"In the long term," says the European Commission (2000a, p. 38), "it will be technological developments that pose the principal threat to OPEC, namely, new production techniques in difficult areas, using non-conventional oil, and the development of new fuel substitutes and the associated technologies, chiefly in the transport sector." Irrespective of whether or not one shares this view, technology is crucial for meeting the EU's energy challenges related both to security of supply and the environment.

4.2.1 R&D funding

New technologies will be developed if they promise economic rent. Where this is the case, research and development (R&D) can firmly be left to the market and companies. Since technological innovation is one of the areas in which companies compete, liberalisation in principle has a beneficial effect on technological innovation with regard to both the speed of innovation and the efficiency with which the resources will be used. Technological innovation is one of the areas where companies want to distinguish themselves from their competitors. Typically this is in the area of commercial development and the *application* of new technologies.

The situation is different for those areas where the economic rent is *uncertain* due to, for example, the level of economic risk or a very long time horizon or both (e.g. fusion, hydrogen, CO_2-sequestration). In the language of economists, this is described as market failure. Market failure is usually associated with basic research or the pre-commercial *development* of new technologies. In many cases, some state intervention is then needed. The market supports efficiency but not necessarily research.

Private-sector spending on energy R&D is in rapid decline. Moreover, R&D investments are being redirected from longer-term projects that might be seen as having a higher value from a public-good perspective, towards short-term research to meet the more immediate needs of energy companies in competitive markets. For instance, utilities in the UK appear to have reduced their R&D investments steadily over the past decade, to a level that currently stands between 0.1 and 0.3% of sales. The largest oil and gas companies in the US reduced their R&D investments by 43% on average throughout the 1990s (Dooley and Runci, 1999). The fact that central R&D spending has decreased in a period of liberalisation may be a pointer, although the witnessed reduction of private energy R&D spending cannot only be associated with liberalisation: reductions have also taken place in those countries and companies where liberalisation was slower to develop. In addition, the level of spending does not reveal the efficiency with which funds were used.

More worrying perhaps is the fact that public funding has also gone down (see Table 2). Nine OECD countries currently perform more than 95% of the world's public-sector energy R&D (the US, Japan, Germany, the Netherlands, the UK, France, Italy, Canada and Switzerland).

[12] The same is true for nuclear, coal or renewables.

Between 1985 and 1995, these nine countries each reduced their budgets for energy R&D on average by more than 20% in real terms. In Germany, Italy and the UK, budgets were slashed by 70% or more over the same period. The US federal energy R&D programme fell by 26% over the period 1990-97 (a decline of $1.2 billion in real terms). The notable exceptions are Switzerland and Japan. Public R&D funding is now almost non-existent for energy efficiency materials and equipment.

Table 2. OECD public energy R&D funding, 1985-95

Country	Percentage in real growth, 1985-95
Switzerland	32
Japan	8
France	-6
US	-9
Netherlands	-33
Canada	-45
Germany	-74
Italy	-75
UK	-88

Source: OECD data.

There are two possible responses to this decline. One is to increase public funding while the other is to address the market failures.

The *first* option to increase public funding will find its limits in the almost universal – certainly European – drive towards fiscal consolidation. In addition, it raises a number of difficult practical issues. The first question is how governments should intervene, i.e. what instruments should they use. Should governments fund third-party research or should they maintain research institutes such as the EU's Joint Research Centres? Another instrument would be to provide generous tax breaks for R&D. A second question relates to the respective role of EU and member-state funding. It appears that the EU's attempts to focus on creating EU-wide research networks and centres of excellence have been successful. At a minimum this has avoided the duplication of research efforts in the EU. The third question is who pays for government-sponsored research. Research subsidies could for example be obtained from the general budget or secured through earmarked funds.

The *second* option is to address the market failures such as spillover effects, inefficiencies in the financial sector, risk aversion, knowledge as a public good or lack of coordination. More recent scientific evidence seems to suggest that making research more "profitable" (i.e. increasing the economic rent) may yield better results than improving the supply side. An important observation is that companies with healthy profits and a solid cash flow tend to invest more in R&D than those facing economic constraints.[13] A policy mix directed at addressing these market failures might therefore significantly improve the effectiveness of R&D. Such a policy mix could consist of increased financial resources provided by banks, guarantees for the protection of innovation (e.g. patent laws), support for cooperation and research joint ventures, broader diffusion of information on a national and international scale, improvements in basic

[13] For an overview, see Galeotti and Carraro (2002).

learning and innovation (e.g. increased interaction between universities and applied research) and technology diffusion via firm-level cooperation agreements.

4.2.2 Prioritising technologies

Irrespective of whether governments focus on option 1 or 2, the question of how to define research priorities remains important. Although new areas such as renewables or hydrogen rightly attract a lot of attention, there is a risk that the potential of existing technologies will be overlooked. For example, recent technological developments suggest that the efficiency of the conventional combustion engine in cars can still be improved by over 40%. Considerable potential exists as well in other parts of the energy chain including technological advances in transmission and distribution. Of particular importance is the development of the power grid capable of collecting electricity produced from decentralised sources. Substantial improvements are possible for gas turbines, which will remain the critical part of power generation but also other fossil fuel technologies, such as steam power plants or so-called "clean coal technologies". Improvements can also be achieved in construction and many electrical goods. A striking example for improvements already achieved is the oil and gas upstream business. Deep-water technology has improved to such an extent that the depth at which deep-water production is possible has been increased by a factor of ten in the last 20 years, from 200 to 2,000 metres. At the same time the recovery rate has risen from 30 to 50%. This suggests that research support should in principle be provided to all areas of the energy chain including, in addition to renewables, transmission and distribution as well as conventional energies.

4.3 Public opinion and large investments

Any kind of major investment project, regardless of the sector involved, increasingly faces public opposition in the EU. Such opposition is less a result of liberalisation than of the development of the concept of *civil society*, which has become an integral and important part of modern democracy. It manifests itself, for example, in the direct participation of citizens in the decision-making process via elements of direct democracy (e.g. referendum), the rise of non-governmental organisations (NGOs) and the increasing importance of public opinion in policy-making.

Opposition to new investment in itself is not a new phenomenon, even if it appears to be increasing. What is different, however, is that the risk of public opposition has a different effect on investment decisions in the new competitive market environment in which companies operate than it had during the era of monopolies. Within competitive markets, firms are "technology-neutral" and invest in those technologies that promise the highest long-term return on capital. Controversial technologies tend to reduce this return. Faced with almost certain public opposition against any major project, private companies will shy away from new investments if they judge the risk to be high – unless governments provide insurance. Prevailing negative public opinion represents economic, political and market risk. The economic risk arises from delays and measures to accommodate opposition that change the economics of the project. The political risk is that the government retreats from its original decision, a risk that is particularly high after a change of government. The market risk could involve the damage of a well established brand name in the face of sustained public opposition. The problem is that costs and benefits of such investments are unevenly distributed.

Most of the energy sources face increased public opposition, one prominent example being nuclear energy – both production and waste disposal. It is questionable whether private companies would today embark on a nuclear strategy given the unknown inherent political risks. But nuclear energy, despite widespread acceptance in France and the Czech Republic, is not the only controversial technology. LNG terminals encounter strong opposition in Italy, while in Norway and Switzerland, large hydro power plants increasingly provoke protests. In

Germany there is opposition against open coal mining, and in Sweden, Vattenfall had to abandon the construction of a gas-fired power plant. In the Netherlands, it is increasingly difficult to build wind parks or explore for oil or gas. In general, there are objections to heat production from waste. Even more important, it appears to be virtually impossible to build overhead transmission lines in the more populated areas of the EU, where they are often opposed on grounds of health (owing to electromagnetic fears), the visual impact or the detrimental effect on flora and fauna. By contrast, it is worth noting that there are no public objections to encouraging investments in energy efficiency. One must ask the question whether this public opposition is justified. The potential incapacity to produce sufficient quantities of fuel or to deliver energy to consumers resulting from the prevalence of unwarranted public opinion against new investment constitutes a major, if not the greatest security-of-supply risk posed today.[14]

The increasing importance of public opinion obliges governments and firms to ensure that sufficient analysis is undertaken regarding potential health, environmental or other concerns related to large investment projects. There is also a need for better justification of projects, which could be done through information campaigns and transparent consultation procedures that facilitate full public participation. Such procedures should fulfil clearly laid out criteria, and in turn the relevant authorities should ensure that the planning procedure is efficient and streamlined.

[14] Not to mention the fact that constraints on building new generation capacity or networks will undermine competition in the EU internal energy market.

CHAPTER 5
OPTIMISATION OF SUPPLY: A SECTOR PERSPECTIVE

Whereas the previous chapter concentrated on horizontal aspects, this chapter focuses on sector-specific issues related to supply. A distinction is drawn between primary and secondary fuels, i.e. electricity and hydrogen. Secondary fuels pose some of the most important challenges to security of supply in liberalised energy markets today.

5.1 Primary fuels

Security-of-supply issues related to traditional primary fuels are well known. In the case of oil and gas, the questions are associated with geopolitics, investment and market developments, whereas in the case of coal and renewables, they relate to the environment and subsidies.

5.1.1 Oil and gas

The point of departure for the analysis of both long- and short-term security of supply of oil and gas is the assumption that both fuels will be available in sufficient quantities to meet demand in the long-term. Proven oil reserves continue to grow, as does the trend of new discoveries. Conventional proven oil reserves are currently about 45 years, but this figure is expected to increase with improvements in the recovery factor – the amount of oil that can be recovered from reservoirs. Thanks largely to improvements in exploration technologies and extraction methods, the recovery rate rose from 30 to 50% between 1985 and 1995, and the rate is expected to continue to improve beyond 2020. The long-term prospects for oil production look to so-called non-conventional oil reserves – such as tar sands, oil shale, heavy oil and bitumen – whose known volumes are effectively unlimited. With the exception of tar sands, which are quickly becoming competitive, the economic cost of recovering this oil is currently very high, and the environmental costs, especially taking into account a possible constraint on greenhouse-gas emissions, could make such non-conventional production prohibitively expensive in the long term. From a security-of-supply point of view, a shift to non-conventional oil production would be beneficial because these resources are widely dispersed across the world.

Similarly, there is enough gas around Europe to satisfy an annual 3% growth in demand. Europe is surrounded by sufficient primary energy and possesses the technologies needed to produce it. Estimates of conventional gas resources suggest that there will be ample resources to support the projected growth in consumption until at least 2020 and probably for some time beyond. For several years, the reserves-to-production ratio has remained relatively stable at 20 years, despite rising production. But production over probable reserves is estimated at 120 years. Methane hydrates are thought to be an abundant long-term source of natural gas, but their exploitation is problematic and creates the risk of possible leakage of this important greenhouse gas (European Commission, 2000b, p. 56).

In the short term, Algeria and Russia will remain the main external sources for natural gas. Other sources such as Nigeria, Libya, Trinidad, Tobago, UAE and Qatar so far have played only a supplementary role due to the high transport cost of natural gas, which works out to be between four and ten times higher than for crude oil. The high transport cost combined with the lack of market liquidity have made it uneconomical to transport natural gas over very long distances, thereby hampering the development of a fully global natural gas market. Instead, three distinct markets exist: Europe, the US and Japan/Pacific. Increasingly, however, these markets are gradually being linked by liquefied natural gas (LNG).

The main issue for oil and gas therefore is not so much the availability of reserves as ensuring that sufficient funds are invested to develop and physically deliver the necessary oil and gas to the market. Security-of-supply issues boil down to diversification, consumer/producer dialogue, market functioning and the investment climate both upstream and downstream.

Box 2. The difference between proven reserves and probable resources

OECD Europe proven gas reserves and undiscovered resources (Gm3)

	Proven reserves (at 1/1/2000)	Undiscovered gas resources (mean, at 1/1/1996)
Netherlands	1 714	242
Norway	3 808	5 180
United Kingdom	760	662
Others	872	4 647
Total	7 154	10 811

For several years, the reserves-to-production ratio has been relatively stable at about 20 years despite rising production – mostly in the North Sea. Estimates of reserves have been significantly revised upwards since the end of the 1980s, most often as a result of better assessments of existing fields. Geological knowledge of gas basins is well advanced in the region. It is estimated, however, that very significant gas potential still exists in the North Sea, in particular on the Norwegian continental shelf which has not been extensively explored. Cedigaz estimates remaining ultimate European gas resources at 13-16 Tm3.

Source: International Energy Agency (2001a).

Oil

Global investment in oil is projected to be in the magnitude of $100 billion per annum from now to 2010, reflecting an annual production growth of approximately 7%. Such investment will only materialise in a functioning market.[15] With an average lead time for a project of seven to eight years and a project life span of several decades, there is an argument to be made for providing regulatory certainty.

To mitigate long-term security risks, worldwide diversification is and will remain the classical tool to accompany a strategy aimed at improving relations with supplier countries. In Europe, the latter includes the EU-Russia energy dialogue, strengthened cooperation with other countries of the former Soviet Union, notably Central Asia and the Caucasus, and the Euro-Mediterranean partnership. This cooperation should aim both at improving the political and economic relations and at facilitating improvements in the investment climate. In some cases, there are tensions between the EU domestic agenda and security-of-supply considerations. One example is destination clauses[16] in long-term contracts, which are incompatible with EC competition law but are insisted upon by some producers. Another example is high fossil fuel taxation, which is described by some producer countries as a means to retain the economic rent

[15] The functioning of the market is reflected by price volatility. Thus, price spikes (as well as troughs) are part of the normal pattern of the market.

[16] Destination clauses are contractual provisions demanded by suppliers that natural gas cannot be sold in any other market than the one specified to avoid the gas being sold to another country where gas prices are higher (as long as there is limited cross-border competition).

of oil. Thirdly, sanctions against producer countries for political reasons can undermine long-term security of supply.

Gas

Security of supply in natural gas can be affected by both short- and long-term issues. Both areas have been influenced by the recent ongoing liberalisation in the EU.

Short-term security of supply in gas

Liberalisation can be expected to benefit short-term security of supply. Following liberalisation in the UK, for instance, security of supply improved due to new entrants, more efficient price signals in the market, a more efficient use of assets, better demand forecasts (which have become part of the entrepreneurial risk) and, generally, a better customer focus. Full market opening does not remove public service obligations on the part of govenrment. For example, the crucial elements for security of supply – meaning sufficient capacity and continuity of deliveries – are set as obligations on and incentives for the Transmission Systems Operators (TSOs). A general approach could entail making TSOs liable for non-delivery including compensation schemes,[17] which should create incentives for sufficient infrastructure-building. It is important that the costs for these rules are included in tariffs by the transmission companies, excluding the costs for failure to comply. TSOs should be able to recover costs that are incurred to meet agreed security-of-supply criteria, but should not recover those costs when they fail to meet the criteria or have to compensate consumers or network users for disruption in supply. Such liability rules are equally important for domestic and industrial customers, and such obligations are usually part of the licencing or the regulatory process.

Long-term security of supply

One set of concerns raised by ong-term security of supply of gas is related to financing and investment. In the gas sector, considerable investment is needed for infrastructure, especially upstream.[18] Estimated investments in gas until 2020 amount to around €300 billion in total for Europe. Producers need to feel confident that they will be able to sell the gas on the wholesale markets and be provided with sufficiently clear market (price) signals to assess the economics of a potential project. Other elements favourable to upstream infrastructure investment include speedy planning and construction procedures but also sensible rules for access to upstream pipelines. Otherwise there is a danger that infrastructure investments will be deferred in liberalised markets, ultimately posing a risk that sufficient supply will not be available. Hence the first and most important issue in ensuring supply is to ensure that sufficient investment is made in production, transport and storage facilities. This can either be done via monopoly buyers or throughout a well established competitive market. A hybrid system could present the worst of both worlds, whereby investment risk could not be reasonably assessed or mitigated.

The second set of concerns raised is strategic in nature, i.e. (political) problems resulting from the dependence on foreign sources of supply, i.e. Algeria and Russia. For this reason, diversification of gas sources is not possible to the same extent as it is for oil. A number of measures have been proposed that are likely to contribute to security of supply. Increasingly, such measures will have to be placed in the context of market dynamics. Measures could include specific targets, such as the ability to cope with six months' disruption from any source. Most European countries have defined such targets and are able to cope with disruption of several months duration. The development of other infrastructure, such as storage and LNG, can

[17] Such rules are in place in several countries, including Norway for electricity and the UK for gas and electricity. Compensation includes damages for losses.

[18] Possible development projects include additional infrastructure in Azerbaijan, Turkmenistan, Iran, Iraq, Egypt and Libya, and LNG shipments from Nigeria and Trinidad to Europe.

provide alternative sources of supply in case of disruptions. International agreements such as the Energy Charter Treaty (see CEPS, 1996) or the EU-Russian energy partnership could be useful in providing an umbrella under which companies can internationally trade and invest. In addition, they facilitate constructive cooperation between importing and exporting countries, as well as transit countries, due to shared supplier/user concerns over the level and non-versatility of infrastructure investments. Barriers, such as fiscal obstacles or public opinion to the development of indigenous resources, should be addressed.

5.1.2 Coal

As the European Commission's Green Paper on security of supply states in referring to hard coal, the "production of coal on the basis of economic criteria has no prospect either in the EU or in applicant countries. Its future can only be maintained within the framework of the European Union's security of supply" (p. 38). As the Green Paper also acknowledges, the flexibility in (hard) coal contracts and the development of a spot market are a sign of efficiently functioning world markets. As a result of market functioning and the lack of political risk, coal supply are secure and appear not to need any particular insurance such as maintaining minimum access to reserves.[19] Similarly, there are no major political risks associated with the physical availability of lignite, which is a domestic non-traded commodity.

The constraints that coal faces are related to cost and its environmental consequences. How these constraints will play out in the future will depend on technological developments (e.g. "clean coal" technology, carbon scrubbing, efficiency improvements in coal-fired power stations) that will reduce the environmental impact and the economic efficiency of coal burning. The other major factor influencing the future of coal is price, which is related to obligations to use domestic vs. imported coal and to fluctuations in the price of gas.

5.1.3 Nuclear and uranium

Security of supply is one of the ostensible reasons for renewed interest in nuclear power.[20] Sometimes nuclear is also brought into the debate as a means to hedge against primary energy price rises, or at least as a way to cope with volatile global energy markets. There are however risks related to political acceptability, commercial viability and environmental health and safety, including the risk or perceived risk of terrorist attacks.[21]

Whether new investment in nuclear power will play a role as insurance against supply risks depends on how investors, possibly together with governments, judge the balance between supply risks and other risks associated with nuclear. It also depends on whether governments decide to reinsure or fully assume liability for political acceptability and risks in case of terrorist attacks. This balance could change if other considerations, such as climate change, are added to the equation.

The likelihood of a nuclear revival for security-of-supply reasons to a large extent depends on whether one assumes that import dependency is a problem. As stated above, this is not necessarily the case as long as sources are sufficiently diversified. Nevertheless, nuclear energy

[19] A call for a 15% set-aside from the liberalised market for domestic fuels, or an extension of subsidies to the coal industry on the basis of security of supply, seems to be unwarranted.

[20] European Commission (2000a) and International Energy Agency (2001b).

[21] An example of the sensitivity of nuclear power to this risk of public disapproval is the Irish government's reaction in October 2001 to the expansion of the UK Sellafield nuclear power plant: Joe Jacob, the Irish minister in charge of nuclear safety, was quoted in Reuters, 4 October 2001, as describing the approval of the MOX facility as "highly irresponsible" given the current political climate and the risks posed by terrorism, while the Prime Minister announced Ireland's intention to bring the matter to the European Court of Justice and the United Nations.

is a potential asset in a risk-management strategy for three reasons. First, it is part of a diversification strategy, which could reduce supply risks. Second, although the EU depends 100% on imported uranium, uranium is readily available and cheap and can be stockpiled. There are currently relatively few political or economic supply risks associated with uranium, although public opposition to mining is increasing, and supplies of ore are diminishing – but only to a significant level beyond the 2020 time horizon. Thirdly, it is CO_2-neutral.

There is some renewed interest in nuclear, not least due to the fact that nuclear energy does not emit greenhouse gases. This interest has taken several forms including the US energy plan, the possibility of a fifth reactor in Finland, the renewed UK discussion and the debate launched in the Green Paper. Nevertheless, no new reactor has been licensed to date. In Finland the request to build a fifth nuclear unit is scheduled to be examined by the national parliament before summer 2002. Should the parliament approve, the Finnish government will issue the license opening the way for construction. Although Finland's discussion on whether to build a new reactor is an interesting illustration of the relationship between nuclear power and security of supply, the country's situation might be atypical. Finland has to meet its Kyoto target in an environment where power generation relies heavily on coal, where existing biomass potential has been utilised and where further dependence on Russian gas is regarded as unacceptable for historical and geopolitical reasons.

The crucial difference in the new nuclear debate is that it can no longer be portrayed as a confrontation between energy supply companies and the public. In a liberalised market, energy companies await guidance and decisions by the government on whether nuclear energy should play a role in the energy mix. If governments want nuclear to play a role, it either needs to be economical and commercially viable (including publicly acceptable) or governments need to take a pro-active stance within the boundaries of EU internal market and state aid rules.

5.1.4 Renewables

The potential contribution of renewable energy sources to Europe's energy needs beyond 2020 is difficult to predict, but there is no doubt that the sector has great promise. Biomass could provide a low-cost fuel, but its development depends on the availability of land and is affected by competition for land use for food production. Wind power holds promise for continuous growth beyond 2020, but it will require cost-effective energy storage technologies to allow its larger integration into networks. Solar, geothermal, small hydropower and ocean energy are all potential future energy sources but require technological advances. Hydrogen, as an energy carrier, has unlimited potential theoretically to supply future energy needs, but the cost-effective production of hydrogen from renewable sources – which for environmental reasons is the best alternative – has not yet been accomplished. For this reason and owing to the considerable necessary investment in a hydrogen infrastructure, the arrival of a hydrogen energy system seems to be a long-term and rather distant prospect.

Renewables can be produced indigenously in Europe and therefore do not constitute a risk as regards physical availability. Of equal importance, renewables contribute to the diversification of energy supply sources, which is vital to increasing energy supply security. Even potential shares of 5%, such as is projected for biofuels in the transport fuel sector, contribute to this diversification and justify temporary fiscal measures for their promotion. The crucial element in the relationship between renewables and security of supply is price. To recall the CEPS definition, security of supply incorporates both physical availability and price. The main issue is therefore the subsidy system for renewables that is put in place, given that it is acknowledged that renewables should temporarily be supported, mainly for environmental reasons.

The need for subsidies for renewables is artificially increased further due to the existence of historical subsidies to other fuels such as nuclear and direct subsidies to coal. Conversely, subsidies could potentially be lowered if the external costs of competing fuels were fully incorporated. In the case of biofuels, it will be necessary to allow EU member states to reduce excise duties on pure or blended biofuel or to further increase the high excise duties on conventional fuels in order to promote alternative fuels.[22] The role of renewables with regard to security of supply and the environment will largely depend on EU policy regarding subsidies as laid out in the European Commission's state aid guidelines, (European Commission, 2001b, pp. 3-15), which set the limits for future member state aid in an increasingly competitive market.

Support for renewables for power generation in most countries is currently directly linked to prices, for example through feed-in laws. This has the effect that electricity consumers (in the end) will pay for what could be seen as a public good, the environment. In addition, feed-in laws tend to perpetuate subsidies to existing installations. There are signs that support via feed-in may gradually be reduced. For example, Denmark is switching from its price support system for wind energy to a domestic green credit, or certificate, trading system, which will also allow it to participate in a European-wide credit trading system when that is established (American Wind Energy Association, 2001). The European Commission's future stance on direct price support will be the main determinant, however. The European Court of Justice's decision in March 2001 in favour of the German federal feed-in law seems to permit this form of support for the immediate future, although it remains to be seen whether such laws will be compatible with a fully liberalised internal energy market.[23]

In principle, renewables support could be de-linked from energy prices to end consumers. This could be done via subsidies from the public budgets. Such an approach would have to be compatible with EU internal market and state aid rules, however.[24] In addition, the funds would either have to be raised via extra taxes (whether earmarked or not) or savings on other budgetary expenditures, which is difficult in times of budgetary consolidation. Another possibility is the scheme for green certificates, which are fully tradable. Although internal-market compatible, green certificates nevertheless still have a price-effect and thereby increase energy prices. Such price increases, however, should be lower than in other schemes through higher efficiency as a consequence of the equalisation of the marginal costs.[25]

Renewables, which are basically produced in a decentralised way (with some exceptions such as large wind farms, large hydro or solar-thermal), have a number of impacts on the way the grid operates. These issues are discussed in the next section dealing with security of supply and electricity. This is only true however for renewable energy sources in power production. A number of EU member states use renewables for heat production or as transport fuels.

5.2 The specific case of electricity

Liberalisation has heightened the interest in security-of-supply issues in the electricity sector, notably in the aftermath of recent events, such as the California power crisis, temporary electricity shortages in the Nordic power market in the winter of 2000 and the power failures that occurred in many parts of the EU as a result of the heavy storms around Christmas 1999. Although the cause in each case was very different, all of them highlight the fact that power supply can eventually fail, i.e. that security of supply is a real ongoing concern. As the periodical *European Gas Markets* reported in its October 2001 issue, "Ireland faces energy shortages this winter as the gas and power industries struggle to keep up with rapidly increasing demand."

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[22] See "Brussels puts forward biofuel plans for roads", *Financial Times*, 8 November 2001.

[23] Reuters, 15 March 2001; ECJ case C-379/98.

[24] According to the state aid rules, paragraph 24, member states are allowed to promote renewables and CHP (combined heat and power) through state aid where such aid is not in breach of other provisions of the Treaty or secondary legislation.

[25] See www.recs.org; Bräuer et al. (2000).

The Californian power crisis was special in that it was due at least in part to mishandled regulation. One should also add that the Californian situation is different from the European Union market in many respects. The EU for example does not foresee an obligatory pool (except for Italy) or prohibit bilateral agreements that allow companies to hedge their risks. A second set of issues relates to the absence of tendering for new capacity and planning rules for new capacity, which on average lasts for seven years. In addition, there was no internal US energy market, and trading arrangements were largely absent.[26] The new Commission liberalisation package aimed at further opening up the electricity (and gas) sector, including facilitating cross-border trade, should therefore be seen as potentially beneficial to security of supply. The electricity shortages in the Nordic power market (Nordel) were caused by a lack of peak capacity. Finally, the power cuts that occurred mainly in France during Christmas 1999 point to the vulnerability of centralised power systems.

Most of Europe is in a comfortable position for the time being, given that there is considerable over-capacity in generation, thus making the problems of both California and Nordel appear unlikely at least for the moment. Additional measures are currently being taken by the European Commission to improve security of supply. These include the monitoring of generation capacity and interconnections, the progressive implementation of the internal energy market to enhance trading as well as the harmonisation of networks and security standards (e.g. public service obligations). Finally, the European Commission's new liberalisation proposal also foresees tendering possibilities where additional generation capacity is needed.

5.2.1 Reserve capacity

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. The obvious downside was high costs. In competitive markets the situation has reversed. Investment decisions for generation capacity are based on calculations of profitability. Particularly if peak demand is only seldomly reached, which by definition is the case for the marginal KWh, incentives to build reserve capacity are low. There is a difference between electricity and other markets because electricity cannot be stored. This has been witnessed in the hydro-dominated Nordel market, where in February 2001 the peak load capacity was tested. The result was that the capacity was not sufficient to meet peak demand. The question is whether a similar situation could arise in part of or across the EU.

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. Table 3 demonstrates that Ireland, Nordel and Greece in particular have very little spare capacity to deal with peak load. Nordel is especially vulnerable with a high share of hydroelectric power (see Table 4).

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, i.e. not available for dealing with peak-load problems. In addition there might be internal bottlenecks such as in the case of former East Germany, which rules out imports from Poland, for example.

[26] Although EU trade is partially also inhibited due to a lack of transparency as well as a lack of interconnection capacity.

Table 3. Remaining capacity at peak load

Country/region	Percentage remaining capacity at peak load of national generating power capacity
Ireland	0%
Nordel	1%
Greece	2%
England & Wales	3%
Iberian peninsula	4%
Continental Europe	4%
Italy	6%
Centrel (Central and Eastern Europe)	13%
Scotland	22%

Note: Data for January 2001.

Source: UCTE.

Table 4. Comparing installed capacity across several regions in the US and the EU

	California	PJM*	Iberian peninsula	Italy	UK	Scandinavia (S,N,FI)	Core Europe
Installed capacity (1998, in GW)	52.3	57	60.3	72.5	73	75.4	296.4
Increase 90-98 Average/year	-0.6%	1.2%	2.3%	3.2%	-0.1%	0.5%	1.4%
Share of hydro	25.8%	5.0%	31.2%	27.7%	5.9%	61.3%	20.0%
Peak/installed capacity**	85%	85%	63%	64%	83%	76%	66%

* PJM = Pennsylvania, New Jersey and Maryland, an electricity trading zone.

** The ratio of peak and installed capacity alone is not sufficient to judge the potential risks of a lack of actually available peak capacity. One of the crucial factors for judging the level of risk that an area is exposed to is the level of hydro, which depends on weather conditions (i.e. rain). Given that the share of hydro is particularly high in Scandinavia (e.g. ten-fold that of the UK), the situation of the Nordic countries is more problematic than appears at first glance.

Source: CEPS Working Party.

Under certain conditions, competitive markets can lead to an erosion of reserve capacity. This is at least what the Nordic evidence suggests. This does not need to be the case, however, as was shown in England and Wales – although there are important differences between the two regions. The Nordic countries rely to a far bigger extent on hydro than England and Wales (61% vs. 6%), which traditionally is a less reliable source than thermal capacity. In addition, Nordic electricity prices have fallen to the level of – and sometimes even below – short-term marginal costs, which has eroded incentives to build new capacity. This was not the case in England and Wales partly due the generation oligopoly, reinforced via the mandatory pool. As a result electricity prices did not fall to short-term marginal costs. In principle, though, concentration should be detrimental to security of supply. Especially where generation is oligopolistic – which is the case for most member state markets – there are strong incentives to keep reserve capacity small. It was said that market power of generators was another factor that contributed to the California crisis. Market power is especially damaging to security of supply if peak capacity (such as pumped storage, which has a fast reaction time) is monopolised. 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.

In the meantime Nordic countries consider tendering for peak capacity, in line with a similar provision (Art. 6) foreseen in the new Commission proposal to accelerate liberalisation.[27] The Commission realises that if under certain conditions, on economic considerations alone, peak capacity would not be built, some financial incentive will need to be associated with new peak-load capacity. To apply the CEPS insurance approach, the incentive should equal the insurance premium for security of supply. The insurance premium could also be built into pricing, i.e. end-use prices or network access prices.

The option should be tested economically against providing such insurance by better energy efficiency. The issue of reserve capacity could also be approached via the demand side, i.e. by flattening the peaks. If the actual demand comes close to the peak, new capacity becomes more economical, but if the peak is only reached once a year, the marginal units do not pay off and will be closed eventually. To flatten peaks, connection charges to customers could be linked to the fuse (i.e. the size of the cable), which determines the maximum capacity at which a customer can draw on the grid and therefore the profile of peaks. Such an approach would at the same time provide incentives to reduce peak load while receipts from connection charges could be used to fund marginal or reserve capacity.

5.2.2 Pressures on the transmission grid

Separation of generation, supply and distribution (i.e. unbundling) has also changed responsibilities for the security of the transmission grid. Generators and suppliers as market participants are basically responsible for the short-, medium- and long-term balance between supply and demand. TSOs on the other hand are responsible for the safe and efficient operation of the transmission grid, which enables the market to work. This includes responsibility for ancillary services and the balancing market as well as facilitating the spot market. It also includes the long-term development of the transmission grid. Thus, the starting point is to provide sufficient obligations and incentives to TSOs to be able to undertake their tasks. It is the responsibility of government to design and implement the appropriate regulatory framework.

TSOs face a number of challenges linked to security of supply. As a consequence of increasing international trade, there is a need for market-based congestion-management rules. With a greater number of market players, there is a need for appropriate ancillary-services specification, including enforceability rules and the definition of the relationship between power exchanges and TSOs. As was discussed in the previous chapter, there is increased pressure on the transmission system to bring in reserve capacity.

The biggest risk for security of supply from a TSO perspective is the lack of public acceptance of new transmission grid construction. In most parts of Europe, notably in central and densely populated areas, it is virtually impossible to build new overhead lines. As a consequence, TSOs have to resort to installing underground cables, which are more expensive by a factor of between 10 to 30 in extreme cases. The risk originating from insufficient grid capacity is

[27] Proposal amending the directives on electricity (Directive 96/92/EC) and gas (Directive 98/30/3C). Com (2001) 125 of 13.3.01

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 (see Vandenberghe, 2001).

Similar risks are associated with the medium and long-term. They include the following:

a) Different time horizons between planning of new generation (e.g. three years for Combined Cycle Gas Turbines) and network assets (e.g. typically 5-10 years).

b) Public acceptance of network construction.

c) Pressures from third countries (east and south) to be interconnected to the EU grid. Massive electricity trade could further increase pressure on grids.

d) The regulatory framework has to ensure a fair rate of return; this is particularly important in the light of higher costs of underground cables as compared to overhead lines. This framework should also include incentives to build power plants in proximity to energy consumption.

These risks are mainly associated with government action. Except for the area of public acceptance of network construction (see Chapter 4.4, above), there is little that companies can do regarding different planning horizons or pressures to interconnect third countries to the grid. The question of a sensible regulatory framework is by definition the task of governments.

5.2.3 Distributed generation

Distributed generation is decentralised electricity generation from small-scale sources, especially combined heat and power (CHP), which are connected to the grid at the distribution rather than at the transmission level. The overall market share of CHP in the EU is still low, at 10%. Nevertheless, the growth of distributed generation is supported by a number of long-term trends, including the demand for higher fuel efficiency caused by climate-change and other environmental policies, as well as pressures to increase economic efficiency due to liberalisation. Decentralised generation may also be driven by congestion problems in the cross-border grid ("to have the plant on the right side of the congestion"). Distributed generation lends itself well to the use of natural gas, which is the fuel of choice in liberal markets, and renewables, which will benefit from government support. Finally, technological developments – including micro-turbines, Stirling engines (a type of clean, low-polluting engine) and fuel cells – will both increase the efficiency and tend to lead to decentralised solutions. The future energy landscape is likely to consist of traditional large-scale plants conbined with new decentralised approaches. Decentralised power production is likely to reach domestic scale within the next few years with units as small as 1-5 Kw. Distributed generation also enables greater local involvement with and awareness of electricity issues.

These developments have a number of implications for security of supply. At the general level, the existence of distributed generation adds another actor to the energy chain, which in turn increases the flexibility and thereby the security of supply. By bringing a new technology into play, the scope for innovation is increased. Decentralised systems may turn out to be "scalable", i.e. additional capacity can be added if needed. This increases the system efficiency by reducing waste (e.g. capital costs). In principle, distributed generation contributes to reducing import dependency due to higher efficiency, which reduces energy demand. Distributed generation has one potential advantage compared to centralised power production and distribution, which is that it makes the system less vulnerable to damages due to heavy weather and storms. In light of the previous analysis, the most important advantages are the following:

a) Distributed generation increases the statistical reliability of the electricity system. 1000 small generators are more unlikely to fail than one centralised unit. They are also less vulnerable to terrorism. Distributed generation could even be used as reserve capacity for peak-load demand. A precondition is that issues of technical harmonisation and grid access are solved.

b) Decentralised generation will also reduce the pressures on grids, as was discussed in the previous section. Its most important contribution may be that it puts less strain on the highest voltage grids, which are the most expensive to put underground.

It is clear that distributed generation will prevail in a liberal market and, as a complement to existing grid connections, it has a positive effect on security of supply. Its exact contribution, however, very much depends on how the interaction with the grid will be priced. Since cost characteristics of electricity distribution are such that they almost equal fixed costs – the variable part is losses – decentralised generators will face a difficult pricing structure. This could change if the positive effects of distributed generation can be accounted for. Should distributed generation become a mass phenomenon, back-up capacity will consist of decentralised generation capacity installed in households and in smaller sources. This will only be possible, however, if transmissions and distribution grids are technically adapted so as to be capable of collecting the electricity produced in decentralised modes.

Thus, distributed generation could become an important part of the risk-management strategy to deal with security-of-supply risks in the electricity sector. Distributed generation is part of a technical solution to improve security of supply. If decentralised generation is a mass phenomenon, however, the distribution grid will need to be adapted and redeveloped in order to allow the technical issues to be settled.

CHAPTER 6
PROPOSAL FOR AN EU INSURANCE POLICY TO MANAGE SUPPLY RISKS

In applying the CEPS approach to security of supply, which is understood as insurance against supply risks, this final chapter draws conclusions from our analysis and proposes concrete recommendations for policy-makers.[28]

Liberalisation of energy markets and globalisation have changed the very nature of security of supply. In the past, security of supply was mainly the responsibility of government, which delegated responsibilities to supply companies. In liberal energy markets, security of supply becomes a shared responsibility of governments, firms and customers. It is large industrial consumers in particular that are willing and able to cover their risks for security of supply. Since the level of security of supply is strongly related to energy prices, security-of-supply concerns are part of the commercial strategy of industrial consumers (Chapter 2.3). Many companies prefer to assume the risk themselves and benefit from lower prices or to set their own level of supply security.

In order to facilitate the interaction between markets and government policy, CEPS proposes a new approach to security of supply. *Security of supply becomes a risk-management strategy for all players in the energy market including government, companies and, directly or indirectly, all users* (Chapter 2.1). Security of supply comprises two equally important parts: physical availability of energy sources and the price element. Given that the level of energy prices crucially affects economic growth, wealth and the competitiveness of industries, price and physical availability are inextricably linked.

The approach to security of supply cannot simply consist of putting a "policy" in place; market forces must at the same time be harnessed to improve supply security. In many cases, "policy" alone will not do the job and may be in tension with one of the constituent parts of security of supply, "price" ("policy tends to cost money"). As a first step, therefore, we have examined what role market forces can play. Our conclusion is that market forces can possibly play an even larger role than government policies.

In order to apply the insurance concept, it is indispensable to identify the risks as well as the likelihood of their occurrence and their possible consequences (Chapter 2.2). This is attempted in itemised form in the table presented in Annex 1. In order to classify the various risk categories, we have borrowed the classification scheme applied in the European Commission's Green Paper: technical, economic, political and environmental risks to security of supply. Analytically, we distinguish between short-term and long-term risks, a concept that is now widely used in the analysis of security of supply. The short-term concept describes risks that are associated with system failures such as (limited) supply interruptions due to lack of capacity, extreme weather conditions or accidents. The long-term notion implies supply risks associated with political (e.g. war, civil war or embargo) or economic (e.g. lack of investment with a resulting imbalance between supply and demand) risks. We acknowledge, however, that short- and long-term risks cannot always be disentangled, especially with regard to responses, e.g. risk-management strategies.

Both technology development and energy efficiency are crucial for meeting the EU's energy and environmental challenges, but their contribution to security of supply is indirect. Technological development will improve overall efficiency of the energy sector and reduce waste, thereby having a positive impact on the efficiency of markets. Energy efficiency by way of reducing demand increases the flexibility of the whole energy chain and therefore provides an

[28] Note that the key messages have already been posted in the beginning of the report.

additional security margin. The detailed analysis can be found in Sections 1 and 2 of Chapter 4, respectively.

This report has not analysed in depth the consequences of the events of 11 September 2001 in the US. Since the risk of terrorist attacks of this magnitude was previously considered low, no insurance had been taken out. This will certainly change in the future and issues of security from terrorist attacks will play a more prominent role in considering security of energy supply. The most likely effect will be seen in higher insurance costs, which in their literal sense and in the CEPS concept will change the relative prices for different fuels and generation technologies.

6.1 Priority for insurance against short-term risks

Our analysis shows that the highest risks are associated with short-term security of supply. There are major risks associated with continuity and reliability of electricity supply (Chapter 5.2) and to a lesser extent, of natural gas. Security of supply could also be undermined if unwarranted public opposition (Chapter 4.3) to necessary new investment projects prevails or if, for other reasons, energy installations such as refineries become the target for blockades. This is also confirmed by recent empirical evidence. Security-of-supply problems arose as a result of regulatory failure in California or a lack of reserve capacity and concern over high short-term electricity prices in Nordic countries (i.e. Nordel). Blockades of refineries and roads in the UK or elsewhere as a consequence of fuel price protests in Europe in the autumn of 2000 are another recent example. As a consequence, the following have been identified as the major concerns for security of supply.

1) *Reserve capacity for power generation.* Although Europe at present is in a comfortable position due to over-capacity in generation, liberalisation without a well thought-out regulatory framework might lead to a reduction in reserve capacity. This has been witnessed in Nordel, but might occur elsewhere if there is a slow transition to fully competitive EU energy markets. One solution is to identify responsibilities for maintaining reserve capacity associated with *market-based* compensation schemes.[29]

2) *Network obligations in natural gas and electricity*. One crucial element for security of supply are the obligations on and incentives of the network operator to maintain sufficient capacity. This could best be done via network-operator liability rules for network failure and the ability of network operators to recover costs that are incurred to meet agreed security-of-supply criteria (Chapter 5.2).

3) *Public opinion and new investment.* There is growing opposition to new investment including new generation capacity and grid development, notably overhead lines (Chapters 4.3 and 5.2.). To minimise and manage the risks, there is a need for stronger justification of new projects, which could be done via information and transparent consultation procedures including full public participation. This is a role for firms and governments alike. Governments need to make sure that unwarranted public opposition to necessary new investment will not prevail or unnecessarily slow planning procedures. The need for new investment should be checked against the possibility to reduce demand.

4) *Decentralised or distributed generation* may have a positive effect on security of supply by increased flexibility, higher efficiency and the fact that decentralised systems are less vulnerable to heavy storms (such as those at Christmas 1999, in Europe) or terrorist attacks. At the same time, the development of distributed generation requires the technical redevelopment of the network as well as solutions to the cost of connecting to the network (5.2.3). Distributed generation for the time being will be mainly based on gas-fired sources.

[29] In the UK, the pool-based compensation scheme for reserve peak capacity was discredited and has been withdrawn.

The consequent effect on long-term security of supply becomes closely linked to the security of gas supply.

5) *Diversification*, both by fuel and region, is a means to minimise risks associated with any specific fuel, be it gas or any other fuel.

6.2 Priorities for insurance of long-term political and economic risks

This report has also analysed the long-term risks to security of supply. The first point of departure is that import dependency is neither necessarily a bad thing nor economically inefficient (Chapter 2) as long as the portfolio regarding both fuels and import regions is diversified. The second point of departure is that price volatility is not a supply "problem" but rather the opposite. Price volatility in a typical long-term business with long lead times from well development to actual physical delivery should be expected and is proof that markets work. Even if one does not share this point of view, the question is what governments can realistically do to influence world oil prices, which are still the reference point for fuel prices. The very limited medium-term effect on prices of the US release from the strategic stocks on 21 September 2000 is a case in point.

1) *Oil*. Risks with oil are mainly associated with ensuring sufficient investment to develop and physically deliver the required oil to the markets in addition to coping with the political risks associated with supplier countries (e.g. Middle East, Algeria, Russia and the Caucasus). As a consequence the best insurance against supply risks appears to be diversification and enhanced attempts to improve international relations and the investment climate (Chapter 5.1.1).

2) *Natural gas*. Similar to oil, long-term security of supply of natural gas relates to investment and political risk. Considerable investment in infrastructure, especially upstream, storage and network interconnections is also needed in the gas sector. As a result, producers need confidence to be able to sell gas on proper wholesale markets and require sufficiently clear market (price) signals to assess the economics of a potential project. As liquid traded gas markets develop on mainland Europe and gas prices decouple (at times) from oil, then the investment signals for gas will become clearer. Other elements favourable to upstream infrastructure investment are speedy planning and construction procedures but also sensible rules for access to upstream pipelines. The first and most important issue in ensuring supply is to ensure that sufficient investment in production, transport and storage facilities is made. Regarding the political risks, a similar strategy to oil would be appropriate (Chapter 5.1.1).

3) *Coal*. This fuel offers an opportunity to diversify fuel, which in turn enhances security of supply. The limiting factor of hard coal and lignite is price and its environmental impact, however. Whether it will be competitive depends on obligations to use domestic hard coal, the future of environmental regulation, particularly regarding CO_2 emissions and development of gas prices (Chapter 5.1.2).

4) *Nuclear energy*. A potential asset in a risk-management strategy as part of diversification. It also has the advantages of producing virtually no CO_2 emissions, and uranium, although entirely imported, is readily available and cheap, with few political or economic supply risks foreseen prior to 2020. There are, however, considerations related to public acceptability and environmental impacts, including a cost-effective solution to the issue of nuclear waste. Managing these factors has a potentially negative effect on nuclear's competitiveness and therefore may create tension with the second element of security of supply, i.e. price (5.1.3).

5) *Renewables* will enhance security of supply, provided the necessary measures are taken regarding the interaction with the grid. Renewables such as biomass will also play an important role in the future of Europe's energy mix through decentralised heating and

transport (using biofuels). The contribution of renewables to security of supply is crucially constrained by their current high cost and the limits to their potential share in the overall energy mix. It is nevertheless acknowledged that renewables deserve temporary public support for environmental reasons (Chapter 5.1.4). The main issue therefore becomes the nature and provisions of any subsidy system for renewables that is put in place.

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

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

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

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

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

ANNEX 2

LIST OF WORKING PARTY MEMBERS AND INVITED SPEAKERS & GUESTS

Chairman

Carl-Erik Nyquist
Former Chief Executive Officer
Vattenfall

Rapporteurs

Christian Egenhofer
Senior Fellow
CEPS

Thomas Legge
Research Fellow
CEPS

Working Party Members

Jacques Aknin
Représentant
Electricité de France (EDF)

Jason Anderson
Energy Specialist
Climate Network Europe

Jack Ashton
Media Relations Manager
European Atomic Forum
Foratom

Helena Bräutigam
Consultant
Prisma Consulting Group

Jürgen Cuno
Assistant Director
European Government Affairs
BP Europe

Karen Daifuku
Communications Director
Foratom

Jeannette De Beus
Macro Economist
Economic Research Department
Rabobank Nederland

Giuseppe De Palma
Vice-President
European Union Affairs
Exxon Mobil

Bo Diczfalusy
Programme Director
Energy and Cimate Policy
Confederation of Swedish Enterprise
(Svenskt Näringsliv)

Nailia Dindarova
Delegation Coordinator
Enron Delegation to the EU

Stig Goethe
Senior Vice President
Corporate IT Strategy & European Matters
Vattenfall

Guy Goyeau
European Affairs Coord., Social Affairs
Schlumberger/Sofitech

Alain Heilbrunn
Director
European Affairs
Total Fina Elf

Hartmut Heinrich
Head of Environment Technology
Volkswagen AG

Arthur Janta-Polczynski
Managing Director
Russell Reynolds Ass.

Staffan Jerneck
Deputy Director & Director of Corporate
Relations, CEPS

Gunnar Lundberg
Vice President & General Manager
Corporate Markets
Vattenfall AB

Colin Lyle
Director, European Policy
Energy Department
Centrica plc.

Simon Minett
Secretary General
Cogen Europe

Olivier Müller
Siemens Munich

Assaad-Emile Saab
Chef de Mission
Direction Stratégie
Electricité de France (EDF)

Wolf Schmidt-Küster
Secretary General
Foratom

Stéphane Smets
EU Liaison Adviser
Shell International Ltd

Ulrich Sollmann
Director Technology & Science
Volkswagen Liaison Office

Helen Stack
European Advisor
Management Group
Centrica Energy Group

Magne Sveen
Director of Gas
Schlumberger - Sofitech NV

Tore A. Torp
EU R&D Coordinator
Research Centre
Statoil asa

Klaus Willnow
Representative Energy Policy
Siemens AG

Hilarius Zerres
Energy Manager
Stora Enso

Invited Speakers and Guests

Johannes Enzmann
DG TREN
European Commission

Lars Hydén
National Expert
DG TREN
European Commission

Kurt Lekas
Senior Vice President
Energy Procurement
SCA

Johannes Maters
Head of Unit
Security of Supply – internal and external
DG TREN
European Commission

Gerassimos Potamianos
Principal Administrator
European Commission

Hugh Rees
Head of Unit
DG TREN
European Commission

Matti Supponen
Electricity & Gas C.2
DG TREN
European Commission

Nathalie Vande Velde
Electricity & Gas Unit C.2
DG TREN C.2
European Commission

Frank Vandenberghe
Head
European Affairs Department
ELIA

Andrew Warren
Director
Association for Conservation of Energy