Gas Supply Security in Europe in the Long Term: Some Key Issues

*By Frits van Oostvoorn**

Introduction

The current trends and development of the European gas market in relation to a number of structural changes such as the creation of one single European gas market led to great reluctance to invest in gas production and pipeline infrastructure, which led to great concern in the EU that security of gas supply is declining to unacceptable levels for EU-30 consumers in the long term. It is expected that EU import dependency will strongly increase in the next decades from currently 40% to around 75% or more in 2030.

In its 2000 Green Paper on energy security[1], the European Commission identified the purpose of an EU gas supply security policy as securing the immediate and longer-term availability of a diverse range of gas supplies at a price that is affordable to all consumers while respecting the environment. In practice, this involves reducing to an acceptable level the risks and consequences of gas supplies not being available. Some of the risks of disruption in key supplies are analysed and discussed in the next sections.

Security of gas supply for consumers is basically an issue of risk. All energy supply systems inherently contain a certain level of risk for consumers, but the question is what level and type of risks are acceptable. This depends on the context in which the question is posed. The scope in this study is the medium and long-term gas market in Europe wherein the EU consumer is largely and increasingly depending on natural gas import. Moreover, he is mainly depending on a relative small number of key gas exporters with remote production locations. Furthermore, gas supply security is generally more important for political and economic reasons than supply security in other industries, because of the essential nature of gas. It is difficult to get alternatives and its supply depends on monopoly pipeline networks. Consequently there are high costs involved in gas supply interruptions. Adequate security levels for consumers depend very much on the perception of the consumers' willingness to pay for higher security levels, which tend to fall if risks are reduced and the 'costs of providing extra security' that tend to rise if risks are reduced. Unfortunately optimal levels of security are difficult to assess due to uncertainties and different perceptions of risks by the different stakeholders. What policy makers can do, however, is try to assess if security levels are within a certain and acceptable margin for a majority of consumers.

The paper is organised as follows. In the next section we present a recent view on the long-term developments of gas demand, supply and import dependency in Europe analysed with model and data support of the IEA. In the next section we analyse the role that Russia's gas exports play in securing the consumption of the EU and the final section we investigate the flexibility of the gas network connecting main suppliers with the EU by analysing the effects of unexpected supply interruptions to the EU on prices and trade volumes. We end with a brief summary of the key conclusions on the issue of long term gas supply security for Europe.

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Long Term Adequacy of Gas Supply in Europe[2]

Approach

The objective is to formulate different scenarios of natural gas supply in Europe for the period 2000-2030 and analyse their implications for supply security and policy. This study seeks to provide the European Union and particularly the candidate accession countries with recommendations for enhancing their gas-supply security, taking account of the enlargement of the EU and the liberalisation of the EU energy market. In the next section the risks and consequences of unexpected gas supply interruptions are presented. The focus of this section is on the long term and strategic natural gas supply security situation through to 2030 in the light of the implementation of EU Directives and proposed supply security policies in the EU-30 and specifically those implemented in the candidate accession countries. Scenarios were prepared for the European Union in aggregate in two different configurations, namely the current membership of states (EU-15) and for an enlarged Union of 30 member states (EU-30). The additional members include the ten accession countries that joined the Union in 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) and five other countries that might join at some time in the future (Bulgaria, Norway, Romania, Turkey and Switzerland).

The scenarios consider the balance of energy demand and supply under various assumptions concerning macroeconomic trends, population growth, energy prices, technology and government policies. Each scenario determines the gap between indigenous production of natural gas and demand for each configuration and the breakdown of net imports by region of origin.

In line with the approach adopted in the *World Energy Outlook 2002*, baseline or core projections for this study were derived from a Reference Scenario. The projection period is 2001 to 2030. The last year for which complete energy demand and supply data are available is 2000, although some preliminary data are available for natural gas for 2001. Modifying assumptions concerning energy prices and government policies on nuclear power, renewables and energy efficiency and conservation generated two variants of the Reference Scenario. Basic assumptions on macroeconomic conditions and populations are the same as for the Reference Scenario. These variants correspond to higher and lower gas imports into the European Union compared to the Reference Scenario. These alternative scenarios were designed so as to capture key uncertainties with respect to the evolution of European energy markets. These include the pace of liberalisation and

the impact on energy prices and government strategies for dealing both with rising energy-related emissions of greenhouse gases and the prospect of increased dependence on imports of natural gas.

Key Assumptions

The Reference Scenario incorporates a set of explicit assumptions about underlying macroeconomic and demographic conditions, energy prices and supply costs, technological developments and government policies. It takes into account many new policies and measures in European countries and in other parts of the world designed to combat climate change. Many of these policies have not yet been fully implemented; as a result, their impact on energy demand and supply does not show up in the historical data, which are available in most cases up to 2000. These initiatives cover a wide array of sectors and a variety of policy instruments.

The Reference Scenario does not include possible, potential or even likely future policy initiatives. Major new energy policy initiatives will inevitably be implemented during the projection period (2001 to 2030), but it is impossible to predict precisely which measures among those that have been proposed will eventually be adopted and in what form. For that reason, the Reference Scenario projections should not be seen as forecasts, but rather as a baseline vision of how energy markets might evolve if governments individually or collectively do nothing more than they have already committed themselves to do.

Electricity and gas market reforms aimed at promoting competition in supply are assumed to proceed, although the emergence of effective competition is expected to be gradual. Energy taxes are assumed to remain unchanged. Likewise, it is assumed that there will be no changes in national policies on nuclear power. As a result, nuclear energy will remain an option for power generation solely in those countries that already have a nuclear industry and that have not yet officially abandoned it, namely Bulgaria, the Czech Republic, Finland, France, Hungary, Lithuania, Romania, Slovenia, Spain and the United Kingdom. Nuclear power is assumed to be phased-out progressively in Belgium, Germany, the Netherlands, Sweden and Switzerland. The key underlying assumptions about macroeconomic trends, population growth and energy prices are summarised below.

Economic growth is the most important determinant of energy demand. In the past, European energy demand has risen broadly in line with gross domestic product. Since 1971, each 1% growth in GDP has yielded a 0.47% increase in EU-30 primary energy consumption. Only the oil price shocks of 1973-1974 and 1979-1980 affected this relationship to any significant degree (Figure 1). Energy demand is expected to continue to follow economic activity over the next three decades. Consequently, all the energy demand projections, including natural gas, in this study are sensitive to underlying assumptions about economic growth. Economic activity in Europe has slowed considerably since 2000. GDP growth is now barely positive in many European countries, with overall growth of less than 1% expected in EU-30 in 2003. The Reference Scenario assumes that macroeconomic prospects in European countries will improve in the coming years: GDP growth is assumed to average 2.3% during the period 2000-2010 in both EU-15 and EU-30, see Table 1. In the longer term, however, GDP growth is assumed to trend down, averaging only 1.9% per year in the last decade of the projection period in both groupings.

Table 1
Average Annual Real GDP Growth in Europe

	1971-2000	1990-2000	2000-2010	2010-2020	2020-2030	1971-2030
EU-30	2.5	2.0	2.3	2.0	1.6	1.9
EU-15	2.4	2.0	2.3	2.0	1.6	1.9

Source: IEA analysis.

Energy Prices

Energy prices, exogenous variables in the IEA World Energy Model, are important drivers of total energy demand and supply and the fuel mix. Average end-user prices are derived from assumed fossil fuel prices on wholesale or bulk markets. They take into account current tax rates, which are assumed to remain unchanged. Final electricity prices are derived from marginal electricity-generation costs. The price trends assumed in the Reference Scenario reflect judgments about the prices needed to ensure sufficient supply to meet projected demand in Europe and in other regions. The smooth price trends assumed should not be interpreted as a prediction of stable prices, but rather as long-term paths around which prices could fluctuate. Indeed, oil and gas prices will probably remain highly volatile. The underlying assumptions for EU import prices for oil, natural gas and steam coal are summarised in Table 2 (in fuel-specific units).

Table 2
EU Fossil Fuel Import Price Assumptions ($2000)

	Units	1990	2000	2001	2010	2020	2030
Crude oil	Per barrel	27.30	28.00	23.39	21.12	25.00	29.00
Natural gas	Per Mbtu	3.27	3.00	3.63	2.76	3.29	3.80
Steam coal	Per tonne	62.62	34.61	37.28	38.84	41.21	43.60

Source: IEA (2002), World Energy Outlook

The assumed trend in European gas import prices to 2030 reflects the underlying trend in oil prices together with costs and market factors specific to the region. Oil and gas prices remain linked through price indexation clauses in long-term supply contracts as well as through inter-fuel competition between gas and oil products at the burner tip. Gas prices are assumed to remain flat at around $2.80/Mbtu in year 2000 dollars. Gas-to-gas competition is expected to put some downward pressure on border prices as spot trade develops. Lower downstream margins and efforts by national regulators to reduce access charges could further depress end-user prices. But the cost of bringing new gas supplies to Europe is expected to increase as the distances over which the gas has to be transported lengthen and project costs rise. This factor is assumed to offset the impact of growing competition. Prices are assumed to rise after 2010 in line with oil prices. As a result, the ratio of gas to oil prices remains flat throughout the projection period at around 80%, which is

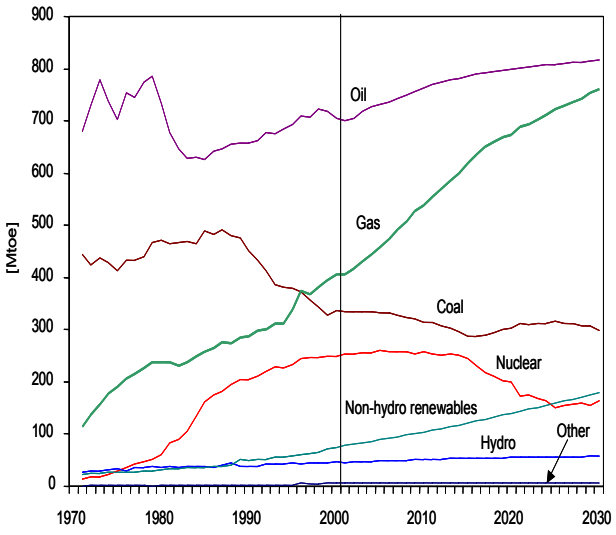
close to the average for the last decade.

International steam-coal prices are assumed to remain flat in real terms over the period 2002 to 2010 at $39/metric tonne, —the average for the preceding five years. Thereafter, prices are assumed to increase very slowly in a linear way, reaching $44/tonne by 2030. Declines in the cost of mining and increasingly stringent environmental regulations that restrict the use of coal in many countries are expected to offset to a large extent the impact of higher oil prices on the value of coal and, therefore, its price from 2010.

Development of Gas Demand and Import Dependency

Total primary energy demand in EU-30 is projected to rise by an average 0.7% per year over the projected period, well below the rate of 1.2% for 1971-2000. The fuel mix is expected to change markedly. An enlarged European Union faces the prospect of a substantial increase in gas imports in the next three decades in the absence of rigorous new government policies at EU and national levels. In a Reference Scenario, natural gas demand in EU-30 is projected to grow by an average 2.1% per year over the projection period - the most rapid growth rate of any fuel other than non-hydro renewables. The share of gas in total primary demand will continue to grow, from 22% at present to 33% in 2030. The power sector will be the main driver of gas demand, especially in the first half of the projection period.

Figure 1
EU-30 Primary Energy Demand



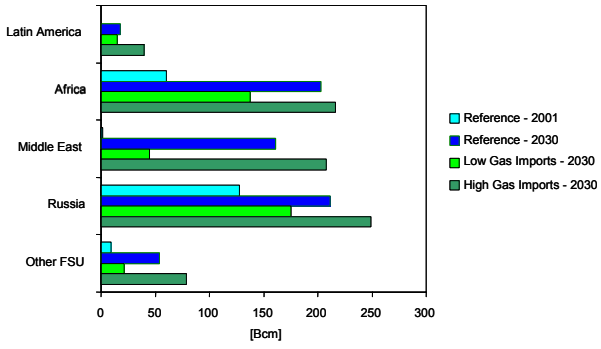
Source: IEA analysis.

Under an alternative *Low Gas Imports Scenario*, a combination of sharply lower gas demand, due to higher gas prices and policies that reduce gas demand, and slightly higher indigenous gas production, results in a significantly lower rate of growth in gas imports into EU-30. By the end of the projection period, imports in this scenario are little more than 60% of their level in the Reference Scenario. Most of this difference is due to lower gas consumption in the power sector which will use more coal and nuclear instead of gas. Gas imports nonetheless virtually double over the projection period. Imports are somewhat higher in a *High Gas Import Scenario*, mainly due to even more rapid growth in power-generation demand than in the Reference Scenario.

With indigenous production projected to stagnate, all of EU-30's projected increase in demand will have to be met by increased imports. *Net imports are projected to surge from 200 Bcm in 2001 to almost 650 Bcm in 2030.* The share of imports in the region's total gas demand will rise from 38% to just below 70% over the same period. The bulk of imports are expected to come from EU-30's two main, current suppliers, Russia and Algeria, and a mixture of piped gas and LNG from other African and Former Soviet Union countries, the Middle East and Latin America. The enlargement of the European Union to twenty-five countries will temporarily increase the degree of gas-import dependence, as eight new accession countries are net gas importers. But the enlargement to thirty countries would reduce the degree of gas-import dependence because of the inclusion of Norway. Both short- and long-term supply security concerns are likely to be exacerbated. The high degree of dependence of the candidate accession countries in Central and Eastern Europe and their unusually heavy dependence on imports from a single country - Russia - will have an impact on supply-security risks in the EU. Reliance on a single supply route in some accession countries adds to the short-term risks.

Imports are somewhat higher in the *High Gas Imports Scenario*, mainly due to stronger demand. Imports reach 400 Bcm in 2010 and 790 Bcm in 2030. The Middle East and Russia would account for most of the additional gas imports under this scenario compared to the Reference Scenario as most of the low-cost sources of supply in North Africa would have been committed by then. Such a large increase in dependence of supply in North Africa would raise enormous concerns about security of supply (see final section). Transit volumes across the accession countries would also be substantially higher.

Figure 2
Natural Gas Imports by Origin under Alternative Scenarios



Source: Menecon Consulting analysis based on IEA projections.

Implications for supply security and policy of the enlargement of the European Union would reinforce concerns about gas-supply security. Security risks fall into two broad categories:

- The short and medium term risk of disruptions to existing supplies caused by political events, strikes, accidents or technical failures.

- The long-term risk that new supplies cannot be brought on-stream quickly enough to meet growing demand for either political or economic reasons.

Potential of Russian Gas Supply to EU

Russia's view is that their gas export policy regarding Western and Eastern European markets depends on the gas market developments in neighbouring regions and the re-structuring of the Russian gas industry. The export policy in the 'optimistic economic growth scenario' (if crude oil prices are high in world markets) is based on the assumption that Russia revenues for Russia support the economic growth and Russia will keep its share in the supplies to foreign markets and even continue to expand its market share if import demand rises. Russian gas export in this scenario is expected to grow from 139 Bcm in 2001 to 181 Bcm in 2020. At the same time gas reserves of East Siberia and the Far East will be mobilized to enter Asian-Pacific markets, first of all in China, Korea, and Japan.

In the pessimistic economic growth outlook for Russia, the so called 'Constrained scenario', (if crude oil prices are low in world markets) for internal reasons the gas export volumes to Europe will be constrained slightly in the short and medium term. However, if gas prices as a reaction to this development rise again to a relatively high level in Europe in the period 2010-2020, it will be possible to exploit the Shtockman gas fields and export these volumes to Western Europe. As a result gas export volumes might reach the levels of the 'optimistic scenario' again in 2020. At the same time, if gas prices in Asian-Pacific countries stay tightly linked to the low world crude prices, export projects in the Far East continue to be unattractive for investors. Gas deliveries to CIS and Baltic countries are expected to rise to about 62-69 Bcm, while the main demand comes from Ukraine and Belarus. West Siberia will remain the main resource base of the Russian gas industry. Its resources will dominate supply to all regions in Europe, the Ural and the industrial areas in the south of West Siberia. Gas from Tyumen will remain the main export source.

Finally, one should not underestimate the potential of gas production and exports of Turkmenistan and Kazakhstan via Russia and Ukraine to the EU. The production and export volumes in Turkmenistan might rise from 45-56 Bcm in 2005 towards around 85-100 Bcm in 2020 and in Kazakhstan from 16-20 Bcm in 2005 to 40-50 Bcm in 2020.

Investment Needs in the Russian Gas Sector

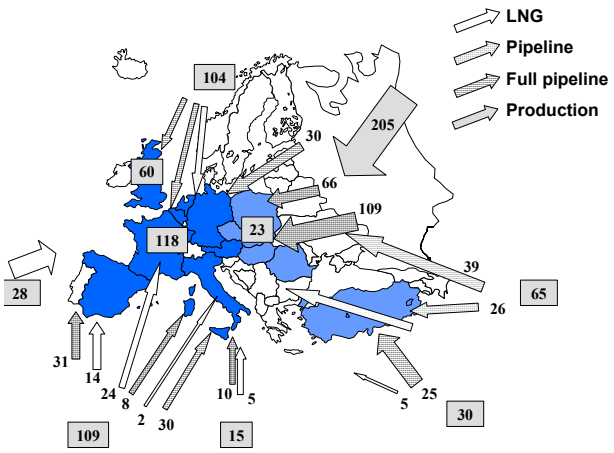
Gazprom's strategy for further development of their gas resource base, production, the reconstruction and extension of gas transport and distribution system, gas processing plants, and the construction of more underground gas storage facilities, requires large investments in the next decades. In the next five years (2001-2005), investments in gas production and transport are estimated at around $16-17 billion, and for the whole period till 2020 investments in the operation and further development of the industry are crudely estimated to be about $90-100 bln. Compare this with the investments by Gazprom PLC in 1999 of only $ 3.1 bln. and in 2000 of $3.2 bln. Conclusion is that to mobilise these large investments for the exploration and production of gas, foreign investors are needed. But currently their exist a hesitation to invest in the Russian gas sector.

Ukraine's Transit Issues

Currently, the Ukraine is clearly the most important gas transit country for Europe with an extensive gas network of pipelines and storage facilities in order to transport large volumes of gas mainly from Russia to Europe through Slovakia, Poland and Romania. It is, therefore, important that the Ukraine meets EU standards for safe and reliable transport of natural gas. Russian gas transit to Europe takes place in volumes of around 110 - 120 Bcm a year, while gas supply to Ukrainian consumers is currently around 65 - 70 Bcm per year.

Insufficient actions and financing of maintenance of Ukraine's gas transport system has led to a worsening of the network conditions in the last decade, which creates great doubts about reliability of gas supply to Europe in the next decade. It is one of the key reasons for developing alternative routes for gas transit from Russia to the European Union. Urgent measures are needed to keep Ukraine's pipeline system effective for gas transit to Western Europe.

Figure 3
Gas Production and Major Gas Flows to EU, CEEC and Turkey, in the Reference Case in 2020 [Bcm]



Resilience of the European Gas Transport Network

Next to insufficient supplies of gas from the key exporter Russia and its neighbouring countries another risk is increasingly looming, namely the declining and insufficient investments in pipeline capacity and related services to supply EU consumers in the next decades with gas from remote regions. In order to identify potential bottlenecks and risks in the future gas transmission system, we analysed some effects of sudden and prolonged 'gas supply disruption cases' for the year 2020. Four disruption cases are analysed. Without assuming any probability for these cases to happen, they merely are used as a tool to analyse the resilience of the European gas transport network. Figure 3 gives an overview of the main gas flows to Europe in the reference case in 2020. It shows production volumes in each region, as well as the LNG and

pipeline flows to the countries considered. The darker countries in the figure are the consuming countries we distinguish (eight EU15 countries, five CEECs and Turkey). Note that production volumes in the EU and CEEC include exogenous production. The within each region capacity usage must be interpreted carefully. For example, EU15 internal flows use only 39% of available capacity. However, the capacity of 354 Bcm is a result of two-way counting; pipelines like the UK-Belgium Inter-Connector are counted for both directions.

The four disruption cases analysed are:

- Disruption of Russian supply through the Ukraine and the complete transmission-pipeline capacity across the Russian-Ukrainian border becomes unavailable (Russian/Ukraine Case) for exports to EU.
- Disruption of Algerian supplies to EU altogether (Algerian Case).
- Disruption of transits through Turkey, i.e., transit pipelines from Turkey to Greece and Bulgaria become unavailable (Turkish Case).
- Disruption of Norwegian supplies to EU altogether (Norwegian Case).

The main results of these gas disruption cases, evaluated with respect to a reference case in which there are no disruptions in gas supply to the EU in 2020, are summarised below.

Russian Case Impacts

In the reference case it is expected that about 50% of Russian exports pass the Ukrainian border in 2020. So Russian supplies decline by 97 Bcm in case of a disruption. Alternative routes, particularly Blue-stream and Russian LNG, absorb about 12 Bcm of gas diverted from the Ukraine route. The Baltic pipeline to Germany cannot be used as an alternative, since it is already fully used in the reference case. EU-30 demand is falling sharply due to the sharp price increases, caused by strongly rising costs of alternative supplies. But CEECs are hit most severely.

Algerian Case Impacts

In the reference case Algerian exports are at their maximum level, as pipeline and LNG exporting capacities are fully used. However if interrupted there is no alternative for the transport of Algerian gas to Europe, consequently countries currently directly supplied by Algeria (Spain, France and Italy) are severely hit, because alternatives are lacking. The reserve capacity for alternative supplies is very small and Spain and Italy will have to rely on additional LNG from more remote and expensive sources. About two-thirds of interrupted supplies is replaced by those expensive LNG alternatives. Therefore, gas price levels in these countries increase substantially. The CEECs however, are hardly affected by a complete interruption of gas exports from Algeria.

Turkish Case Impacts

The impact of the interruption of gas transit through Turkey, which mainly consists of Iranian gas exports to Italy, are relatively small, since transit volumes in 2020 are assumed to be rather small (about 10 Bcm). Since Iran can only supply the EU via Turkey, Caspian supplies are 'pushed out' of Turkey (and into the Ukrainian route). On the other hand the 'lost supplies' from Iran to Italy are partly substituted by additional Caspian supplies via Ukraine.

Norwegian Case Impacts

Norway supplies at almost full production capacity to the EU in the reference case in 2020. However, alternatives for disrupted Norwegian supplies are hardly available. Russia and Algeria are already exporting at full capacity to Europe. Therefore, LNG from remote regions is the most important alternative supplies available. The CEECs are hardly affected, except Czech Republic and Hungary, but other EU 30 countries are severely hit by a disruption in Norwegian gas supply.

General Conclusions Regarding the Flexibility of the European Gas Network

Existing and planned gas supply and transmission infrastructure (both LNG and pipeline) seems sufficient to meet expected gas demand in 2020. In case of disruption in one of the key supplies, the transmission network capacity is a constraining factor leading to price rises. In the Russian and Algerian cases, EU 15 gas consumption would be reduced by some 6%. Prices in eight selected Member States would increase between 10-40% in the Russian case and between 2-60% in the Algerian case. In the Norwegian case, EU 15 gas consumption would be reduced by some 13%. Prices in the eight Member States would rise between 5 and 60%.

Caspian gas supplies become increasingly important for CEECs and Turkey, assuming that pipeline capacity is expanded accordingly.

In the next decades LNG supplies from remote sources play an increasingly important role in filling the supply gap in any of the disruption cases. Consequently, investment in expanding LNG regasification capacity will be very important for ensuring security of gas supply to EU-30 in the medium and longer term.

The following bottlenecks are identified in the European pipeline transmission network:

- Iran into Turkey and further into Europe.
- Bulgaria and Romania into Europe.
- Cross-links between CEECs, which are important for mutual assistance in case of emergencies.
- From the west and south into CEECs. Trade flows and pipelines are currently dimensioned for deliveries from East to Western Europe. Spain, however, is addressing this by developing its LNG facilities.
- Belarus and Ukraine into EU-30.

Turkey's role as transit country for gas from the Caspian Region and Iran to Europe depends critically on:

- Development of domestic gas demand in Turkey,
- Further expansion of pipeline capacities from Turkey to Greece and Italy,
- Expansion of pipeline capacities from Turkey to Bulgaria and further to Romania, Hungary and Austria and thereby improving interconnections with West-European

markets,

- Availability for Turkey of gas supplies from the Caspian Region and Iran.

Conclusions

The projected increases in gas demand and imports in the Reference Scenario imply a need for substantial investment in gas production, transportation and storage capacity both within EU-30 borders as well as in those countries that will supply gas to Europe. *Just under $500 billion will need to be invested in gas-supply infrastructure in EU-30 countries and a further $190 billion in external supplier countries over the period 2001-2030.* The sheer scale of the capital needs as well as a number of developments, including longer supply chains, geo-political factors and energy-market liberalisation, raise question marks about whether this investment will be forthcoming in a timely manner. There is a risk that supply bottlenecks could emerge and persist for long periods due to the physical inflexibility of gas-supply infrastructure and the long lead times in developing gas projects.

EU and national policy makers will clearly need to tread very carefully in reforming their gas and electricity markets to ensure that the new rules and emerging market structures do not impede or delay investments that are economically viable. Policymakers will also need to take account of the increased risks facing both upstream producers and merchant gas companies as a result of energy liberalisation in setting rules for long-term supply contracts and joint marketing arrangements. An intensified political dialogue with the governments of supplier countries could support investment in certain high-risk, large-scale gas projects by lowering country and project risks. The development banks, including the European Investment Bank, as well as national and multilateral export credit agencies, will continue to play an important role in backing major cross-border pipeline projects in the future. The restructuring and privatisation of gas companies in major gas producing and transit countries may contribute to reducing future investment risks.

Footnotes

[1] European Commission (2000), *A Green Paper: Towards a European Strategy for the Security of Energy Supply*.

[2] Section 2 is based on a study of T. Morgan of Menecon on behalf of IEA Economic Analysis Group for ECN.

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[1] Van Oostvoorn, F. et al (2003): *Long-term Gas Supply Security in an enlarged Europe,* ECN-C--03-122, ECN, December 2003.

[2] IEA (2002): *World Energy Outlook 2002*, Paris, OECD.

[3] European Commission (2000): *A Green Paper: Towards a European Strategy for Security of Energy Supply*, Brussels, 2000.