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Oil and Gas Dependence of EU-15 Countries

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Executive summary

This study seeks to answer two questions: first, which countries and industries within the EU-15 group of countries are most vulnerable to possible supply shocks with respect to crude oil and with respect to natural gas and, second, what is the current state of the EU's debate on Europe's energy security.

In order to assess the first question, a set of dependence and vulnerability indicators is provided and discussed, covering total economy and industry-level energy intensities, import dependence, import diversification indices and electricity generation. These results are then combined into an overall indicator of vulnerability. Using this indicator, it is found that the most vulnerable countries with respect to petroleum products are Finland, Belgium and Greece, while the most vulnerable countries with respect to natural gas are Finland, Austria and Italy.

Bringing all these results together it is found that France is the 'star performer' in the region in terms of energy security. This is thanks to a large share of nuclear power in primary energy supply, combined with a healthy degree of supply country diversification for oil and gas imports. The other main insight from the first part of the study is that the EU-15 as a block is in a less vulnerable position than the average of its constituent parts. This result implies that the European Union's energy security position can be boosted if it adopts a common energy policy with strong solidarity mechanisms between member states, notably through the promotion of increased energy network interconnection.

The second part of the study assesses the current state of the EU's energy security debate. The focal point of this debate is the EU's relationship with Russia and its gas monopoly exporter, Gazprom. Russia is already the leading source of the EU-15's imports of natural gas, accounting for 33% of the (extra-EU) total in 2005. This dependence is set to rise on current trends, given the ongoing depletion of North Sea resources. However, the Kremlin has made no secret of the fact that it views Gazprom as a powerful political and economic lever of influence, while the use of coercive tactics by Russia against some of its neighbours has raised concern within the EU. Furthermore, Gazprom's very active corporate expansion strategy, both downstream within the EU and upstream in Central Asia and elsewhere, further heightens the EU's energy security problem.

It is in the interest of the EU to pursue a policy of diversification of supply sources, and efforts are being made in this direction, notably with respect to the 'Eurasian Energy Corridor' linking Caspian reserves to Europe while bypassing Russia, as well as through increased reliance on liquefied natural gas (LNG). However, the ultimate results the EU is likely to obtain are limited. In the long-run view, given Russia's enormous gas reserves (the largest in the world), it seems desirable as well as practically inevitable that Russia will remain a very important supplier for the EU.

One other major concern in the energy security debate is whether Russia will be capable of honouring all of its supply commitments in the medium run. The reserves are there, but there are concerns about whether current upstream investment flows in Russia are sufficient to guarantee a sufficient and steady future supply flow. There is not very much that the EU can do about this problem, except indirectly, and with limited chances of success. It is nevertheless an issue that requires careful monitoring.

Given Gazprom's majority state ownership and its enormous market power, concerns have also been voiced with regards to the company's downstream penetration into the EU's storage and distribution networks. At the same time, Russia is refusing to modify Gazprom's monopoly status with respect to gas exports and with respect to its ownership and control of Russia's domestic distribution network. The European Commission, which was previously seeking to achieve a fully competitive internal energy market through unbundling of supply and distribution, has responded to this challenge by proposing new legislation that would effectively impose unbundling on EU companies and on non-EU companies that operate inside the EU, Gazprom included.

The legislation that the European Commission proposes is possibly the best response to the EU's current energy challenges. It would limit Gazprom's downstream penetration in the EU, in addition to contributing to a better functioning of the internal energy market. Moreover, the Commission's approach implicitly leaves an open door for Russia to choose between a first-best solution and a second-best solution with respect to EU–Russian energy relations. In the first-best scenario, liberalization occurs bilaterally and both sides are able to invest in each other's energy markets, leading to improved efficiency and security for all concerned. In the second-best scenario, Russia rejects unbundling and the EU uses the legislation to prevent Gazprom from entering the EU's downstream market, thus contributing to improving the EU's energy security at the expense of Gazprom's profits.

It is, however, possible that unbundling will be blocked by key member states, in particular France and Germany. The debate is still very much open. Russia has yet to react in more detail to the Commission's proposals, as do the member states. One should expect decisive positioning on the part of the main actors over the next few months.

***Keywords**: energy dependence, energy security, EU-Russia relations*

***JEL classification**: Q32, Q34, Q38*

Edward Christie *

Oil and gas dependence of EU-15 countries

Introduction

This study addresses the issue of crude oil and natural gas dependence for the 15 'old' member states of the European Union, i.e. those countries that were members of the EU on 30 April 2004. These countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

This group of 15 countries has traditionally been dependent on imported crude oil, as the corresponding reserves in the region have been much below what would be needed with respect to the region's consumption levels. This caused the region to be very strongly dependent on oil from the Middle East in the 1970s, a vulnerability which was laid bare during the oil shocks of that period. The region subsequently went through a comparatively stable period thanks to the following combination of favourable developments: first and foremost, the discovery and extraction of substantial amounts of both crude oil and natural gas from the North Sea region; second, a general drive to diversify sources of fossil fuel imports; and third, a reduction in overall energy intensity as well as in oil intensity of GDP, thus making the economies of the region less vulnerable to possible repetitions of the oil shocks of the 1970s.

These developments all contributed to strengthening the energy security position of the region. However, a number of partly inter-related developments started to arise, especially over the period 1993-2007, which have put the region on a potentially less secure path in terms of energy security. These are the following: first, a significant shift of the fuel mix in favour of natural gas (replacing coal in particular) which was primarily driven by the availability of North Sea resources as well as by environmental concerns, accompanied by the absence or failure of a shift in the fuel mix away from crude oil; second and concomitantly, a significant reduction of North Sea reserves of both oil and gas; third, a long period with consistently low world market prices for crude oil, which partly also contributed to low natural gas prices and which lasted roughly from 1993 to 2005; and fourth and most recently, the rise of Russia both as a very important supplier of fossil fuels to the region and as a revived world power on Europe's doorstep which may be inclined to pursue interests that are at odds with some of the region's interests.

* The author would like to thank Waltraut Urban (wiiw) for extensive data work and support in interviewing Austrian stakeholders, as well as Vladimir Gligorov and Vasily Astrov (both wiiw) for their detailed comments and feedback on the text.

For a number of structural and technological reasons, notably the existence of a world market for crude oil (with minor price dispersion for the various types of crude oil) and the related fact that tanker (sea-bound) transportation of crude oil is widely available and cost-effective, there are important differences to bear in mind when analysing the energy security position of the region with respect to oil and with respect to natural gas, though the option of liquefied natural gas (LNG) somewhat counteracts the key differences. LNG notwithstanding, natural gas is typically shipped to the final consumers in the region by way of purpose-built pipelines. Just focusing on the most significant routes from reserves that lie outside of the region, a set of pipelines exists connecting Russia to Eastern and Central European countries and onwards to, especially, Germany, Italy, Austria and France, while another set of pipelines exists connecting Algeria to Spain and Italy, and Libya to Italy.

Contrary to the situation of crude oil, the contracts that regulate the purchasing of gas from these pipelines are essentially long-term bilateral (i.e. country-to-country) contracts, each with different price-setting clauses. There is no spot market which could enable arbitrage, and buyer and seller typically find themselves in a situation of durable mutual dependence.

This study is divided into two parts. Part I provides, on a country-by-country basis, the energy intensity, and fuel-specific intensities, of GDP, of industry, and of selected economic branches of activity. In addition, import dependence ratios by type of fuel, as well as an analysis of source country diversification, are provided. Vulnerability indicators are then presented and discussed. Part I concludes with an analysis of electricity generation in the EU-15. Part II consists of the energy security debate *per se*, focusing on Russia's strategies and actions with respect to the European Union and on the current state of the debate at the level of European Union member states and institutions.

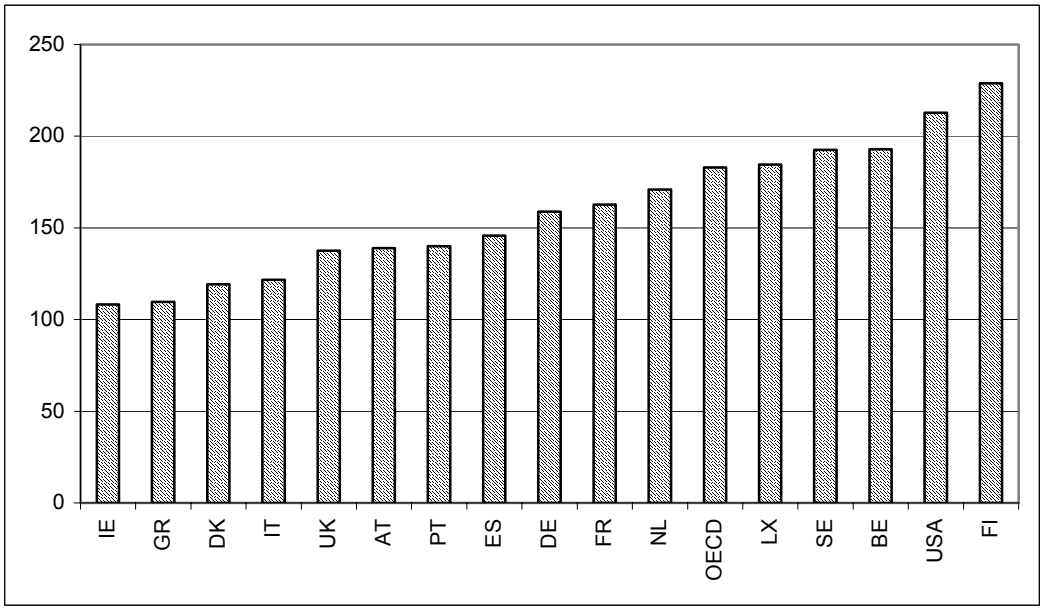
PART I

Intensity and vulnerability indicators for the EU-15

The most recently available IEA data (year 2005) for total real energy intensity for the countries of the EU-15 region is shown in Figure 1. Real energy intensity is here defined as the total primary energy supply (TPES)[1] of all energy products[2] together in thousands of tonnes of oil equivalent (ktoe) divided by real gross domestic product in constant purchasing power parity (base year 2000). For purposes of comparison, Figure 1 also shows the indicator for the United States and for the OECD average.

Figure 1

Real energy intensity, 2005, ktoe per billion dollar of GDP at 2000 PPP



Source: IEA Energy Balances and own calculations.

There are sizeable differences in energy intensity among the group of 15 countries, with Finland being roughly twice as energy-intensive as Ireland. With the exception of Finland all EU-15 countries have a lower energy intensity than that of the United States. What matters most in the context of the current study is specifically the dependence with respect to crude oil, petroleum products and natural gas. Crude oil is not used in any significant manner as a fuel for final consumption. Instead, the bulk of crude oil is refined into a number of petroleum products which are then used by various sectors of the economy (transport being the most important). Also, refining capacity is unevenly distributed across the region. Luxembourg, for

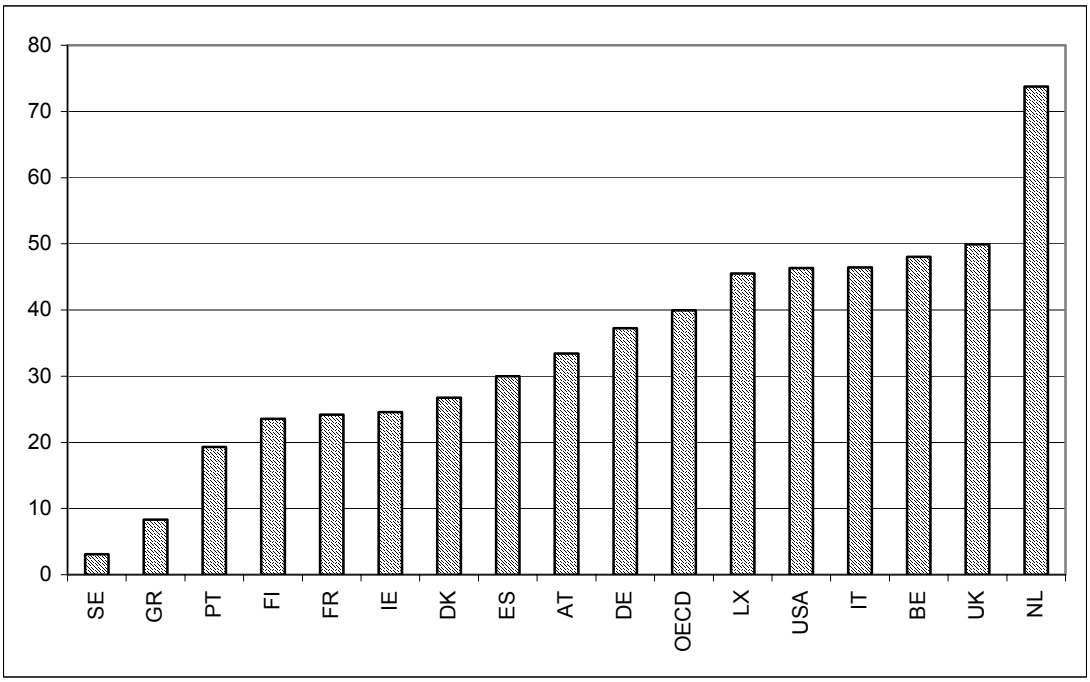
[1] Total primary energy supply is made up of indigenous production plus net imports minus international marine bunkers plus net changes in stocks.

[2] This includes first and foremost coal, oil, gas, nuclear energy and renewables. Electricity is not a primary form of energy (it results from transforming one of the aforementioned energy products), and so appears within TPES indirectly, in addition to appearing directly in the form of net imports.

instance, has no refining capacity and therefore does not use any crude oil at all but imports petroleum products from its neighbours instead. The Netherlands, on the other hand, has more refining capacity than its own consumption would require, and therefore has an annual use of crude oil which is also far above what its annual demand for petroleum products would imply, the difference being exported to its neighbours. In light of this, crude oil use per country is a somewhat misleading indicator, and we shall therefore use total final consumption of petroleum products per dollar of real GDP instead. As for natural gas, we will on the contrary look at primary energy supply of natural gas per dollar of real GDP, given the non-existence of the refining issue and the importance of natural gas both for final use and for power generation. We start with natural gas as shown in Figure 2.

Figure 2

Natural gas intensity, 2005, ktoe per billion dollar of GDP at 2000 PPP



Source: IEA Energy Balances and own calculations.

There are significant differences across the region. Sweden and Greece use negligible amounts of natural gas in their energy product mix. A second group of countries may be defined including Portugal, Finland[3], France, Ireland and Denmark. In those countries natural gas is a relatively unimportant energy product. This is generally due to a less prevalent use of natural gas in industry and by households, but also due to a less prevalent use of natural gas in electricity generation, with coal, petroleum products, nuclear fuels and renewables as the main alternative inputs. Spain, Austria and Germany may be seen as

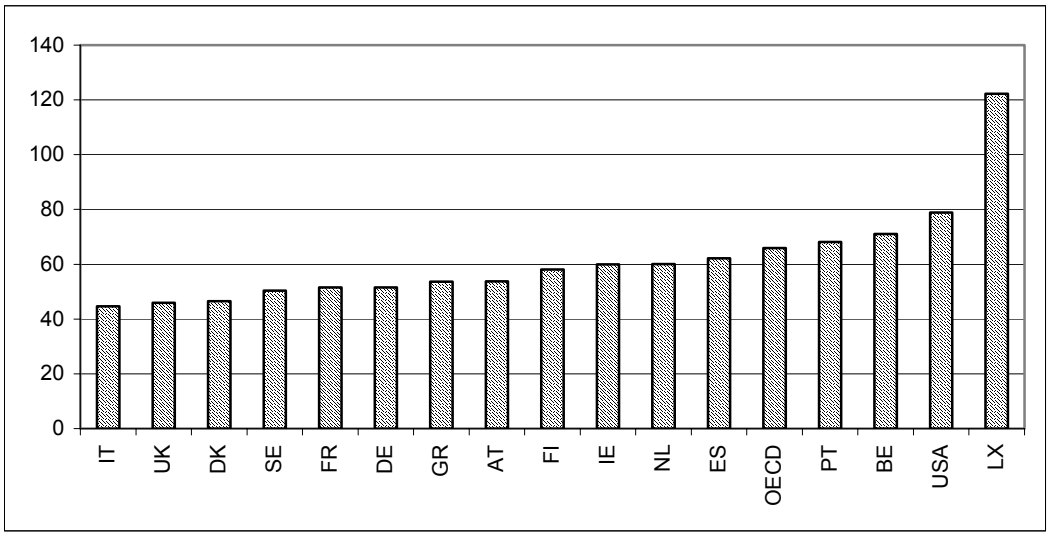
[3] Finland is quite heavily reliant on renewables (23% as compared to an OECD average of 6%), in addition to having a sizeable nuclear component (17%), which together explain the country's relatively low rankings in Figures 2 and 3 in spite of its high ranking in Figure 1.

intermediate cases, while the remaining countries may be seen as significant users of natural gas, namely Luxembourg, Italy, Belgium, the UK and the Netherlands. This structure may be explained from a historical viewpoint. The UK and the Netherlands in particular benefited from high domestic production levels of natural gas, translating into cheaply and easily available gas for their own economies. To a lesser extent Belgium and Luxembourg were also positively affected by the availability of North Sea resources.

In Figure 3 we can see the petroleum product intensity of each of the EU-15 countries as well as that of the OECD and the USA. The measure is taken as total final consumption of petroleum products divided by real GDP. By far the most intensive consumer is Luxembourg, though the data are partly distorted by cross-border 'fuel tourism'. Leaving Luxembourg aside, the major difference compared to natural gas is the fact that cross-country differences are substantially smaller. Certain EU-15 countries such as Belgium and Portugal have intensities close to that of the USA. Also, several of the countries that are heavily reliant on natural gas are found to be relatively less dependent on petroleum products, in particular Italy and the UK, while Belgium is found to be relatively strongly dependent on both types of energy products, alongside being one of the most energy-intensive economies in the region.

Figure 3

Petroleum product intensity, 2005, ktoe per billion dollar of GDP at 2000 PPP



Source: IEA Energy Balances and own calculations.

What do these indicators tell us in terms of vulnerability? In order to deepen the analysis, it is necessary to take into consideration the following questions: what share of each country's natural gas and crude oil comes from imports, where do these imports come from, and which branches of the economy are the most intensive users of each main type of energy product? These topics are addressed in subsequent sections of this study. Also, it is useful to give a separate set of indicators and a discussion concerning electricity generation, given

the importance of electricity as a source of energy both for productive activities throughout the economy as well as for households. This is the subject of a subsequent section.

Fuel intensity indicators for industry sectors

The intensity calculations shown earlier can be made at the level of specific industries in order to give a more precise picture of where exactly country vulnerabilities may lie. We begin with the petroleum products intensity and the natural gas intensity of industry as a whole (mining and quarrying plus the entire manufacturing industry) for each of the 15 countries of the region in 2005. The results are shown in Table 1. The intensities are expressed in thousands of tonnes of oil equivalent (ktoe) per billion euro of output (production) at current prices.[4]

Table 1

Ranking of EU-15 countries by energy product intensity in industry, 2005

Country	Petroleum product intensity	Country	Natural gas intensity
Greece	38.9	Luxembourg	53.3
Portugal	20.2	Spain	29.6
Spain	11.8	Netherlands	27.3
Sweden	11.1	Belgium	22.6
United Kingdom	11.1	Italy	19.8
Finland	10.4	Austria	19.4
Netherlands	9.3	United Kingdom	19.3
Ireland	9.1	France	16.8
Denmark	8.3	Portugal	14.6
Luxembourg	8.1	Germany	14.3
France	7.9	Greece	10.2
Italy	7.6	Denmark	9.7
Belgium	5.8	Finland	7.0
Austria	4.8	Ireland	3.7
Germany	2.6	Sweden	1.9

Units: ktoe per billion euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

'Greece and Portugal are the most petroleum product intensive in industry, Austria and Germany the least'

As can be seen, there are large differences among the countries of the region. This is partly due to the very different choices made in each country with respect to each industry's energy product mix, itself dependent on domestically available prices, but it is

[4] This choice is made due to the unavailability of appropriate industry-level PPP indices for the entire set of countries considered.

also due to intra-single market specialization patterns which have led to very specific location patterns of industrial production by sub-industry. Furthermore, overall energy efficiency also plays a role, itself partly driven by cross-country energy price differences. In any case, petroleum products intensity in industry is particularly high in Greece and Portugal, and particularly low in Belgium, Austria and Germany.

'Luxembourg and Spain are the most natural gas intensive in industry, Ireland and Sweden the least'

As for natural gas intensity, the most vulnerable countries are Luxembourg, Spain and the Netherlands, while the least vulnerable are Finland, Ireland and Sweden.

It is interesting to note that the rankings differ quite significantly from those for overall petroleum products and natural gas intensity. The main reason for this is that three key sectors in terms of energy consumption are not part of industry, namely transport, the residential sector (private and public housing and buildings), and the power generation sector.

Looking now at specific branches within industry, one expects to find the industries that are usually the most energy intensive in most countries, notably non-metallic minerals (cement, glass, ceramics), basic metals and chemicals. The results found confirm this general picture, though the approach used, differentiating by both country and sub-industry, enables a more refined selection. In total, 162 country-specific sub-industries were analysed. This was based on a breakdown of industry into 11 sub-industries for each of the 15 countries, leading to estimates for 165 country-specific sub-industries. Three of these had to be dropped due to data availability problems.[5] Tables 2 and 3 show the 20 most vulnerable industries in the EU-15 region in terms of petroleum products intensity and in terms of natural gas intensity respectively. Complete tables containing the intensities for all 162 country-specific sub-industries are available in Appendix A.

'Non-metallic minerals, basic metals and chemicals are the most sensitive industries with respect to oil and gas intensity'

The labels for the industries are self-explanatory except for 'non-specified industry', which is a heterogeneous grouping of 4 sub-industries. It includes rubber and plastics (NACE 25), medical, precision and optical instruments and watches and clocks (NACE 33), furniture and other manufactured articles not elsewhere classified (NACE 36), and recycling (NACE 37).[6]

[5] Specifically: mining and quarrying in Austria, the Netherlands and Portugal.

[6] This grouping comes as a result of the IEA's own chosen industry classification.

Table 2

Petroleum products intensive industries, top 20, EU-15, 2005

Country	Industry	Petroleum product intensity
Ireland	Basic Metals	241.3
Greece	Non-Metallic Minerals	177.6
Portugal	Non-Metallic Minerals	148.7
Denmark	Mining and Quarrying	116.9
Greece	Non-specified Industry	106.7
Greece	Mining and Quarrying	100.1
Denmark	Non-Metallic Minerals	96.4
Ireland	Non-Metallic Minerals	92.3
Spain	Non-Metallic Minerals	76.2
Italy	Non-Metallic Minerals	73.8
Greece	Chemicals and Petrochemicals	72.3
Luxembourg	Mining and Quarrying	71.8
UK	Non-specified Industry	70.6
Greece	Basic Metals	60.6
France	Non-Metallic Minerals	55.9
Sweden	Non-Metallic Minerals	50.2
Luxembourg	Non-specified Industry	41.8
Spain	Mining and Quarrying	40.6
Greece	Total industry	38.9
Belgium	Non-Metallic Minerals	38.4

Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

As mentioned earlier, it is not surprising to find 9 of the 15 national non-metallic minerals industries among the 20 most petroleum products intensive industries in the EU-15. The second most frequently found industry is mining and quarrying (4 occurrences). In addition there seems to be a geographical pattern in evidence, i.e. that countries belonging to the geographical periphery of the region are over-represented. Greece, for example, appears six times in the table, whereas Germany, Austria and the Netherlands do not appear at all, while France, Italy, Belgium, Luxembourg and the UK each appear only once. This core–periphery effect, which has a bearing on product market competition and transport costs, may be further compounded by the smaller average size of the EU-15's periphery countries. Both effects (being on the periphery and being small) also have an impact on energy infrastructure, as natural gas is an especially attractive fuel if production facilities are located close to a pipeline terminal. This is much more likely to be the case in core countries such as Germany, Austria, Belgium or the Netherlands than it is in countries of the periphery. This issue is illustrated in the case of the glass industry in Christie (2006). Conversely, the relative (financial) unattractiveness of such regions for gas pipeline development is what makes them less dependent on natural gas today, but it is also in some cases what makes them more dependent on petroleum products.

Table 3

Natural gas intensive industries, top 20, EU-15, 2005

Country	Industry	Natural gas intensity
Luxembourg	Non-specified Industry	249.3
Luxembourg	Basic Metals	126.7
Spain	Non-Metallic Minerals	118.0
Portugal	Non-Metallic Minerals	105.7
Netherlands	Non-Metallic Minerals	99.9
Italy	Non-Metallic Minerals	86.2
France	Non-Metallic Minerals	81.6
Germany	Non-Metallic Minerals	80.8
Austria	Chemicals and Petrochemicals	80.3
Spain	Chemicals and Petrochemicals	68.4
United Kingdom	Non-Metallic Minerals	58.5
Belgium	Chemicals and Petrochemicals	58.4
Austria	Non-Metallic Minerals	57.7
Denmark	Non-Metallic Minerals	52.6
Italy	Basic Metals	51.8
Denmark	Mining and Quarrying	51.6
Belgium	Non-Metallic Minerals	50.7
Spain	Mining and Quarrying	49.2
Netherlands	Basic Metals	49.1
Netherlands	Chemicals and Petrochemicals	46.8

Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

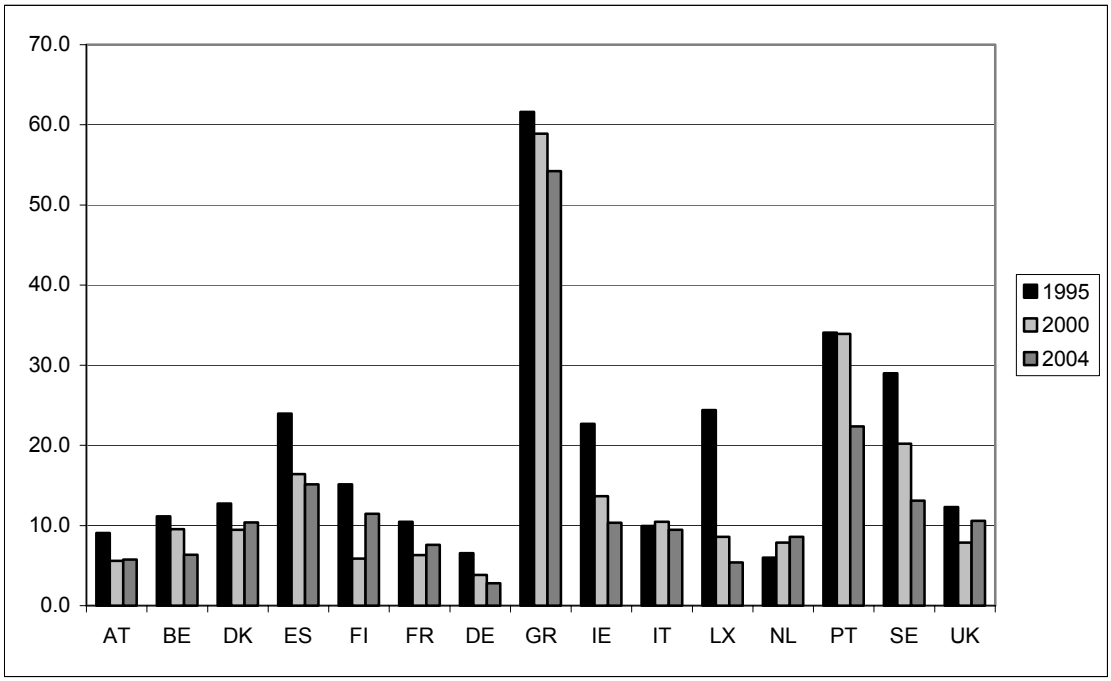
As was hinted at above, while the periphery of the EU-15 region was over-represented among petroleum products intensive industries, the reverse is true for natural gas intensive industries, as shown in Table 3. The Netherlands appears three times among the top 20, Italy, Luxembourg and Belgium twice each. Again it is non-metallic minerals which is by far the most frequent occurrence in the top 20, appearing 10 times, i.e. two thirds of the region's national non-metallic minerals industries can be described as very natural gas intensive. Chemicals and petrochemicals also appears quite prominently in the ranking (4 occurrences), followed by basic metals (3 occurrences).

'Industry has become more petroleum product efficient in most countries'

Now that we have completed this overview of current vulnerabilities, it is appropriate to give some comments about recent trends in fuel intensities. Using time series for the indicators used above from 1995 to 2005, and correcting for changes in prices, it is possible to construct time series of real fuel intensity by country-specific sub-industry. Owing to data availability constraints the series thus constructed spans the period 1995-2004. An overview of that evolution is presented in Figures 4 (petroleum products) and 5 (natural gas).

Figure 4

Petroleum products intensity of industry by country, 1995, 2000 and 2004

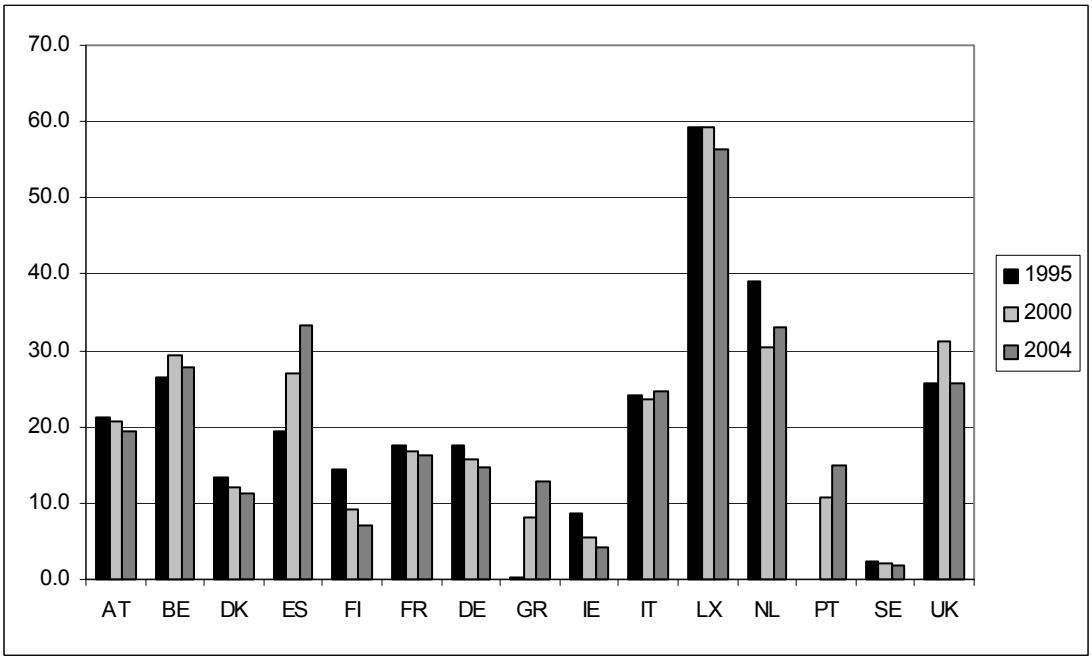


Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

Figure 5

Natural gas intensity of industry by country, 1995, 2000 and 2004



Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

'But natural gas efficiency of industry has not improved significantly'

The broad evolution has been very positive in the case of petroleum products, but less so in the case of natural gas. However, in interpreting these figures, it is important to recall that they each represent partial fuel intensities of fuels that are, to some extent, substitutes. Therefore a fall in one of these partial fuel intensities does not by itself imply that an overall improvement in energy efficiency has occurred. Nevertheless, where these indicators are useful is in helping us to gauge the recent direction of change of EU fuel demand patterns.

Finally we turn to the transport sector, which is generally much more petroleum product intensive than industry. The intensities are shown in Table 4. Data on output for the transport sector were unfortunately not available for 2005, so the estimates refer to 2004. As can be seen, there are sizeable differences between countries, with Luxembourg, Portugal and Ireland more than 4 times more intensive than Denmark. However, one important caveat should be borne in mind: fuel tourism is rather common inside the EU-15, i.e. individual as well as corporate vehicle owners fuelling up in neighbouring countries when petrol or diesel price differences make the additionally travelled distance worthwhile. Thus the results for Luxembourg (due to motorists from all its neighbouring countries) and Ireland (due to motorists from the UK, in particular Northern Ireland) may be higher than the true values. On the other hand the opposite should be true for Portugal (gasoline was cheaper in Spain in 2004). The result for Denmark should be free of distortions given that gasoline prices at the pump were virtually identical in Denmark and in Germany in that year.

Table 4

Petroleum product intensity of EU-15 transport sectors, 2004

Country	Petroleum product intensity
Luxembourg	1034.3
Portugal	1033.6
Ireland	1024.3
Spain	745.4
Greece	723.3
Germany	644.5
France	594.5
United Kingdom	552.9
Belgium	520.1
Netherlands	488.4
Austria	482.6
Finland	457.5
Italy	453.6
Sweden	404.1
Denmark	215.6

Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

'National transport sectors in the EU-15 have very different petroleum product intensities, suggesting that more could be done to improve the European average'

Beyond these caveats, it remains the case that there are very significant differences between EU-15 countries. Geography, in particular population density and country size in square kilometres, are basic parameters that are fixed and that provide a basic level from which it may be difficult to depart. However, the size of the differences suggests that much more could be done to improve petroleum product efficiency in a number of countries of the region.

Import dependence

'Most EU-15 countries are strongly import-dependent for both oil and gas'

Most EU-15 countries are strongly dependent, between 80% and 100% of total primary energy supply, on imports of both crude oil and natural gas. Tables 5 and 6 below give the details in terms of domestic production, imports and exports for each country, as well as for the EU-15 as a whole, the OECD as a whole and the USA (for comparative purposes). The quantities are in thousands of tonnes of oil equivalent. A positive sign for stock changes implies an increase in stocks. Net import dependence is defined as net imports (imports minus exports) plus withdrawals from stocks, divided by the country's total primary supply of the fuel in question.

Leaving Luxembourg aside, all but two of the EU-15 countries have a net import dependence of 90% or above for crude oil. At the other extreme, the UK has a net import dependence of only 5%, while Denmark is entirely self-sufficient and is in fact a net exporter, primarily to other EU countries. It should be noted here that the UK's oil reserves are running out, so the UK's net import dependence is set to rise markedly in the medium run. According to BP (2007), the UK's oil reserves should run out entirely by 2013 at current production levels. As for Denmark, its reserves are forecast to run out by 2016 at current production levels. The effect of the depletion of these EU resources will be significant. Just making a rough estimate based on 2005 production and primary supply data, the absence of British and Danish production would bring EU-15 production down to 123,297 – 88,464 – 19,017 = 15,816 ktoe. Given the EU-15's current primary supply, that would imply net imports of 640,874 – 15,816 = 625,058 ktoe which would equate to a net import dependence of 625,058 / 640,874 = 97.5% by the middle of the next decade. One may further note that Norway's oil reserves are forecast to last only until 2015 at current production levels, so one should envisage a medium-run scenario with the EU-15 having to source virtually all of its oil from countries that are not currently embedded in the EU's institutions.

Table 5

Production, trade and import dependence for crude oil, ktoe, 2005

Country	Production	Imports	Exports	Stock changes	Total primary energy supply	Net import dependence
Portugal	0	13,757	0	50	13,706	100%
Sweden	0	20,683	562	184	19,937	100%
Belgium	0	36,286	3,280	-155	33,161	100%
Ireland	0	3,348	0	-38	3,386	100%
Spain	169	61,385	0	99	61,455	100%
Greece	92	20,053	918	-774	20,001	100%
Finland	89	11,267	0	-180	11,536	99%
France	1,314	84,144	45	-189	85,602	98%
Netherlands	2,338	63,251	1,162	246	64,181	96%
Germany	4,575	114,695	718	396	118,156	96%
Italy	6,260	95,303	1,606	95	99,863	94%
Austria	980	8,221	29	-174	9,346	90%
EU-15	**123,297**	**596,160**	**78,748**	**-165**	**640,874**	**81%**
United States	322,552	599,509	4,911	5,516	911,635	65%
OECD Total	965,845	1,670,048	408,349	8,880	2,218,664	56%
United Kingdom	88,464	60,909	56,307	388	92,677	5%
Denmark	19,017	2,859	14,121	-112	7,866	0%
Luxembourg	0	0	0	0	0	0%

Source: IEA Energy Balances and own calculations.

The pattern for natural gas is rather similar to the one for crude oil. Domestic production levels are however slightly higher on average, so that countries such as Germany, Italy and Austria end up with net import dependence ratios that are several percentage points lower. The EU-15 ratio is further brought down by the full self-sufficiency of the Netherlands, in addition to self-sufficiency in the case of Denmark, and near self-sufficiency in the case of the UK, as with crude oil. Similarly, the UK's reserves are running out (full depletion in 2012 at current production levels), as are those of Denmark (full depletion in 2014 at current production levels), leading to a rather substantial increase in EU-15 demand for imports in the medium run. The reserves of the Netherlands are however more sizeable relative to its production levels (full depletion in 2028 at current production levels), while those of Norway should last longer still. Using the same type of estimate as with oil, and focusing only on the medium-run scenario of the depletion of British and Danish reserves, one would obtain, based on the 2005 data, an EU-15 production level of 83,207 ktoe for a primary supply of 384,429 ktoe. This would lead to a net import dependence of 78% by the middle of the next decade.

It is this very development, i.e. a substantial depletion of North Sea resources leading to an increased dependence on non-EU sources, which constitutes the structural backdrop to the current debate on the EU's energy security.

Table 6

Production, trade and import dependence for natural gas, ktoe, 2005

Country	Production	Imports	Exports	Stock changes	Total primary energy supply	Net import dependence
Finland	0	3,597	0	0	3,597	100%
Luxembourg	0	1,178	0	0	1,178	100%
Portugal	0	3,892	0	142	3,750	100%
Sweden	0	842	0	0	842	100%
Belgium	0	14,187	0	78	14,109	100%
Spain	144	30,240	0	548	29,836	100%
Greece	18	2,332	0	-3	2,353	99%
France	828	41,612	903	552	40,984	98%
Ireland	461	3,009	0	1	3,469	87%
Italy	9,883	60,147	324	-925	70,631	86%
Austria	1,403	8,122	836	428	8,261	83%
Germany	14,220	73,510	7,795	-897	80,833	82%
EU-15	**171,388**	**272,515**	**59,679**	**-205**	**384,429**	**55%**
OECD Total	911,593	539,493	247,853	-8,207	1,211,440	25%
United States	423,838	100,845	16,689	-1,417	509,411	17%
United Kingdom	78,800	13,413	7,441	-102	84,874	7%
Denmark	9,381	0	5,009	-26	4,398	0%
Netherlands	56,249	16,435	37,370	1	35,314	0%

Source: IEA Energy Balances and own calculations.

Imports by country of origin – crude oil

Looking at the EU-15 as a whole, and focusing only on crude oil imports originating from outside the current European Union (27 member states), we find the distribution of imports by source country to be as shown in Table 7.

'Russia is the most important source of crude oil, followed by Norway, Saudi Arabia and Libya'

Russia is the most important source country with just over one quarter of the total, followed by Norway, Saudi Arabia and Libya. The EU-15's crude oil is thus sourced essentially from its 'extended neighbourhood', i.e. the CIS, the Middle East and North Africa, with Sub-Saharan Africa (e.g. Nigeria, Angola) and the Americas (e.g. Mexico, Venezuela) playing only a minor role.

Does this distribution vary significantly between individual EU-15 countries, and if so, are there EU-15 countries that are more or less vulnerable to potential future supply shocks in terms of the pattern of source countries? An answer to that question requires at least two

Table 7

Crude oil imports into the EU-15 by source country, 2005

Source country	Quantity (ths tonnes)	Share of total
Russia	134,096	25.8%
Norway	97,340	18.7%
Saudi Arabia	60,748	11.7%
Libya	50,339	9.7%
Iran	35,385	6.8%
Algeria	22,642	4.4%
Kazakhstan	22,296	4.3%
Nigeria	18,618	3.6%
Iraq	12,290	2.4%
Mexico	10,647	2.0%
Syria	8,987	1.7%
Kuwait	7,621	1.5%
Other	38,578	7.4%

Source: Eurostat and own calculations.

components: first, what does the distribution of shares of source countries look like? Is it strongly concentrated on a small number of countries or is it rather well diversified? And second, which are the most important source countries? A third component, which is crucial but not part of the remit of this report, would then be to assess the nature and level of risk with respect to potential future supply shocks for each source country.

Table 8

Crude oil import concentration, EU-15 countries, 2005

Importer	HHI	First source	Share	Second source	Share	Cumulative share
Denmark	**1.00**	Norway	100.0%	-	-	100.0%
Ireland	**1.00**	Norway	100.0%	-	-	100.0%
Finland	**0.88**	Russia	93.5%	Kazakhstan	4.2%	97.7%
United Kingdom	**0.57**	Norway	74.4%	Russia	10.1%	84.5%
Sweden	**0.40**	Russia	51.0%	Norway	35.9%	87.0%
Belgium	**0.30**	Russia	47.8%	Saudi Arabia	18.8%	66.6%
Greece	**0.29**	Russia	32.3%	Saudi Arabia	31.1%	63.4%
Germany	**0.23**	Russia	40.3%	Norway	18.3%	58.6%
Netherlands	**0.19**	Russia	31.7%	Saudi Arabia	23.8%	55.4%
Austria	**0.18**	Russia	28.9%	Kazakhstan	20.1%	49.0%
Italy	**0.15**	Libya	26.1%	Russia	20.6%	46.8%
EU-15	***0.14***	*Russia*	*25.8%*	*Norway*	*18.7%*	*44.5%*
Portugal	**0.11**	Algeria	23.1%	Brazil	10.4%	33.5%
France	**0.11**	Norway	20.7%	Saudi Arabia	13.3%	34.0%
Spain	**0.10**	Mexico	15.4%	Russia	14.6%	30.0%

Source: Own calculations.

Several measures of diversification may be considered. In this report the choice is to use the Herfindahl-Hirschman concentration index (HHI), which is typically used to measure market power concentration (for instance when assessing whether the merger of two firms will adversely affect competition). HHI is equal to the sum of the squared shares of each source country, and is thus between 0 (an infinite number of source countries each holding a share of zero) and 1 (one source country holding 100%). To back this up, a second indicator is also used: the sum of the shares of the two most important source countries. The rankings obtained from these two indicators are very similar, as shown in Table 8.

'Denmark, Ireland and Finland have the highest source country concentration for imports of crude oil'

The most vulnerable countries in terms of source country distributions are Denmark and Ireland which each import 100% of their (non-EU) oil from Norway, with Finland, the UK and Sweden also appearing as strongly vulnerable. At the opposite end, Portugal, France and Spain have well diversified source country distributions and may be considered to be weakly vulnerable. However, it seems fair to assume that Norway poses a substantially lower potential risk in terms of security of supply. Beyond the country's high levels of transparency and accountability, one may also argue that Norway's status as a member of the EU's single market (through its membership of the European Economic Area), of NATO and of the IEA all provide solid political and institutional guarantees to EU-15 countries. We therefore choose to focus only on the exports that come from outside of the European Economic Area (EEA). Recalculating the indices, we find the ranking shown in Table 9.

Table 9

Extra-EEA crude oil imports, country concentration index, 2005

Importer	HHI – extra-EEA
Finland	0.917
Sweden	0.654
Belgium	0.358
Germany	0.290
Greece	0.287
Netherlands	0.227
United Kingdom	0.207
Austria	0.181
Italy	0.163
EU-15	**0.154**
Portugal	0.117
Spain	0.108
France	0.107

Source: Own calculations.

Denmark and Ireland do not appear as they source all of their crude oil from within the EEA. Now the most vulnerable countries are (by far) Finland and Sweden, and the least vulnerable are Portugal, Spain and France. The full structure of import shares for the EU-15 countries is shown in Table B1 in Appendix B.

Chained import vulnerability indicator – crude oil

How can we combine the data presented earlier on import dependence and the concentration index presented above? We propose that these indices can be chained, i.e. multiplied one by the other, in order to yield an overall measure of vulnerability relating to imports. Considering the two extreme cases, a country would have a vulnerability index of 1 (or 100%) if it had an import dependence ratio of 100% (it must import all of its fuel needs) in addition to having a concentration index of 1, i.e. that all of its imports comes from one country. Conversely, a country would have a vulnerability index of 0 (or 0%) either because it is entirely self-sufficient and hence does not import any fuel at all, or because it has an infinitely diversified 'portfolio' of source countries. Naturally, this latter case is purely theoretical, but it serves to illustrate how both variables enter the chained index that we propose. We furthermore insert the intermediate step of multiplying by the share of imports that originate from outside of the European Economic Area (EEA). Implicitly this means that we consider that dependence on imports from within the EEA poses no energy security problem at all. The other implicit property of our indicator is that we do not differentiate between non-EEA source countries. Given two hypothetical countries, A and B, if each has the same import dependence ratio, and if A imports 80% of its oil from Russia and 20% from Saudi Arabia (for example) while B imports 80% of its oil from Nigeria and 20% from Iran, both would have an identical vulnerability index.

Table 10 shows our chosen vulnerability index for each of the 15 countries of the region. Net import dependence multiplied by the share of imports from outside the EEA (extra-EEA imports) yields the share of a country's primary supply of crude oil that comes from outside the EEA. This is then multiplied by the source country concentration index.

'Finland is the most vulnerable EU-15 country with respect to crude oil imports'

Finland is by far the most vulnerable country in the region, as it has both a high import dependence ratio and a highly concentrated source country structure, the overwhelming share of its imports coming from Russia. Next in the ranking are Sweden, Greece and Belgium with similar index values. The least vulnerable countries are Denmark (because it does not import any oil) and Ireland (because all its imports come from within the EEA).

The index value for the EU-15 as a whole is lower than the arithmetic average of the indices of the 15 individual countries. This is due to the fact that a union automatically has a more

diversified source country pattern than the average of its constituent parts. This is more than just a theoretical curiosity: energy security is an area in which having a union between countries is an asset that has the potential of promoting the security position of the constituent countries. However the question that immediately arises is how well the union works, i.e. how good is the union at risk- and burden-sharing among its members. If that capacity is zero, then the true level of vulnerability of a group of countries is in fact the average of the vulnerabilities of its constituent parts. On the other hand if the union is as good at risk- and burden-sharing as are regions within a traditional nation-state, then one may consider that the union is 'like a country', and then the vulnerability indicator for the union which is calculated above is a fair and accurate assessment. The practical reality is of course somewhere between these two extremes. A number of solidarity mechanisms exist, both in the context of IEA membership and in the context of EU membership. Member states have an obligation of solidarity towards one another in case of supply disruptions, for example. A more refined quantitative assessment of these issues would be beyond the scope of this report. However the general issue of how to move actual overall vulnerability closer to the Union average is briefly addressed in the final section of this report.

Table 10

Oil import vulnerability index, EU-15 countries, 2005

Country	Net import dependence	Share of extra-EEA imports	Share of non-EEA oil in oil supply	Source country concentration index (HHI)	Oil import vulnerability index
Finland	99%	84%	84%	0.92	0.77
Sweden	100%	45%	45%	0.65	0.29
Greece	100%	100%	100%	0.29	0.29
Belgium	100%	79%	79%	0.36	0.28
Germany	96%	69%	66%	0.29	0.19
Netherlands	96%	76%	73%	0.23	0.16
Austria	90%	97%	87%	0.18	0.16
Italy	94%	96%	90%	0.16	0.15
Portugal	100%	96%	96%	0.12	0.11
Spain	100%	93%	93%	0.11	0.10
EU-15	**81%**	**74%**	**60%**	**0.15**	**0.09**
France	98%	73%	72%	0.11	0.08
United Kingdom	5%	25%	1%	0.21	0.002
Denmark	0%	0%	0%	0.00	0.00
Ireland	100%	0%	0%	0.00	0.00

Source: Own calculations.

Imports by country of origin – natural gas

We now turn to natural gas imports by country of origin. As noted earlier, Denmark and the Netherlands have a net import dependence of zero with respect to natural gas (though

there is roughly balanced trade in natural gas between the Netherlands and Germany, which we will ignore). According to Eurostat data[7] for 2005, Ireland and Sweden furthermore import gas only from other EU-15 countries. Leaving these countries aside, and given the inherently more sensitive nature of natural gas in the energy security debate, we give below the source country shares for all of the remaining EU-15 countries, as well as for the EU-15 as a whole. This is presented in Tables 11 and 12.

Table 11

Natural gas imports by country of origin, 2005, part I

Country	EU-15	Belgium	Germany	Greece	Spain	France
Russia	32.6%	8.0%	53.1%	83.6%	0.0%	23.3%
Norway	25.4%	43.1%	40.9%	0.0%	6.3%	27.6%
Algeria	22.4%	30.3%	0.0%	16.4%	43.3%	19.1%
Other / unallocated	7.9%	18.7%	6.0%	0.0%	0.2%	17.3%
Nigeria	4.4%	0.0%	0.0%	0.0%	15.7%	9.0%
Libya	2.1%	0.0%	0.0%	0.0%	2.7%	0.0%
Egypt	2.0%	0.0%	0.0%	0.0%	10.1%	3.7%
Qatar	2.0%	0.0%	0.0%	0.0%	13.9%	0.0%
Oman	0.7%	0.0%	0.0%	0.0%	5.1%	0.0%
Trinidad and Tobago	0.3%	0.0%	0.0%	0.0%	1.2%	0.0%
Malaysia	0.1%	0.0%	0.0%	0.0%	0.8%	0.0%
United Arab Emirates	0.1%	0.0%	0.0%	0.0%	0.7%	0.0%
Total (extra-EU)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Eurostat and own calculations.

Table 12

Natural gas imports by country of origin, 2005, part II

Country	Italy	Luxembourg	Austria	Portugal	Finland	United Kingdom
Russia	36.0%	0.0%	70.0%	0.0%	100.0%	0.0%
Norway	8.8%	0.0%	11.6%	0.0%	0.0%	95.9%
Algeria	42.3%	0.0%	0.0%	61.9%	0.0%	3.5%
Other / unallocated	5.6%	100.0%	18.4%	0.0%	0.0%	0.0%
Nigeria	0.0%	0.0%	0.0%	38.1%	0.0%	0.0%
Libya	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Egypt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qatar	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Oman	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Trinidad and Tobago	0.4%	0.0%	0.0%	0.0%	0.0%	0.7%
Malaysia	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
United Arab Emirates	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total (extra-EU)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Eurostat and own calculations.

[7] The Eurostat data do have one caveat though: for reasons that are not entirely clear, a small share of gas imports is not allocated to any specific source country. Rather than speculate about these unallocated amounts we simply present the shares as directly calculated from the data.

'Russia is the most important source of natural gas, followed by Norway and Algeria'

Russia is the largest supplier of natural gas to the EU-15, accounting for just under a third of non-EU natural gas imports. Norway is in second place with around one quarter, closely followed by Algeria with 22.4%. As with oil, source country patterns differ strongly between EU-15 countries. Finland sources 100% of its natural gas imports from Russia. Another case of strong concentration is the UK, with 95.9% of its imports coming from Norway. Spain, the UK and (apparently) Luxembourg do not import any Russian natural gas at all. Greece and Austria on the other hand are strongly reliant on Russia for their gas imports, while Portugal is strongly reliant on Algeria. Italy, Belgium, Germany and Portugal are almost wholly reliant on two main suppliers each, while Spain and France have the most diversified (least concentrated) source country patterns. This can be seen from Table 13 where we show the Herfindahl-Hirschman concentration index for the countries of the region. Denmark, Sweden, Ireland and the Netherlands are excluded for the reasons mentioned earlier. It is also necessary to exclude Luxembourg. It is unfortunately not clear from the Eurostat data whether the unallocated import flows are attributable to one or several source countries, and whether or not some or all of those countries are EEA countries. The country with the least well diversified source country pattern is Finland (100% from Russia). Germany, the UK and Greece also have quite strongly concentrated patterns. France and Spain on the other hand have well diversified source country patterns and correspondingly low concentration indices.

Table 13

Extra-EEA natural gas imports, country concentration index, 2005

Country	HHI
Finland	1.00
Germany	0.82
United Kingdom	0.73
Greece	0.73
Austria	0.67
Portugal	0.53
Belgium	0.41
Italy	0.38
EU-15	**0.30**
Spain	0.28
France	0.25

Source: Own calculations.

Chained import vulnerability indicator – natural gas

We computed the same indicator as we did for crude oil, i.e. by chaining import dependence with the share of extra-EEA imports and with the concentration index. The results are shown in Table 14.

Table 14

Natural gas import vulnerability index, EU-15 countries, 2005

Country	Net import dependence	Share of extra-EEA imports	Share of non-EEA gas in gas supply	Concentration index (HHI)	Gas import vulnerability index
Finland	100.0%	100%	100.0%	1.00	1.00
Greece	99.2%	100%	99.2%	0.73	0.72
Portugal	100.0%	100%	100.0%	0.53	0.53
Austria	83.0%	88%	73.4%	0.67	0.49
Germany	82.4%	46%	38.2%	0.82	0.31
Italy	86.0%	81%	69.3%	0.38	0.26
Spain	99.5%	94%	93.2%	0.28	0.26
Belgium	100.0%	37%	36.5%	0.41	0.15
France	98.0%	61%	59.5%	0.25	0.15
EU-15	**55.4%**	**59%**	**32.5%**	**0.30**	**0.10**
United Kingdom	7.2%	3%	0.2%	0.73	0.002
Denmark	0.0%	0%	0.0%	0.00	0.00
Ireland	86.7%	0%	0.0%	0.00	0.00
Netherlands	0.0%	0%	0.0%	0.00	0.00
Sweden	100.0%	0%	0.0%	0.00	0.00

Source: Own calculations.

'The most vulnerable country for natural gas imports is again Finland'

The most vulnerable country is again Finland, only this time vulnerability is 100%. Greece's vulnerability is also high, as with crude oil. Portugal also has a relatively high vulnerability index. The vulnerability indices for Denmark, Ireland, the Netherlands and Sweden are of course zero (no extra-EEA imports).

Combined vulnerability indicators

Earlier we looked at the petroleum products intensity and the natural gas intensity of GDP for the countries of the region. In themselves, these intensities are a good indication of countries' vulnerability to pure price shocks. If the markets for oil and gas functioned under perfect competition, and if it were possible to instantly correct for supply disruptions from any given supplier by switching to other suppliers, then those indicators would be sufficient. This is of course not the case in practice, hence the presentation of import vulnerability indicators in this report. However, at this stage it seems desirable to try to combine the fuel intensity of GDP indicators with the import vulnerability indicators. We therefore develop a more comprehensive indicator by chaining fuel intensity of GDP with our chosen import vulnerability indicator in order to yield an overall fuel vulnerability indicator.

'Combined vulnerability for crude oil is highest for Finland, Belgium, Greece and Sweden'

Our chosen combined vulnerability indicator is defined as real fuel intensity of GDP, in thousands of tonnes of oil equivalent (ktoe) per billion US dollar of GDP at constant (year 2000) purchasing power parity (PPP), multiplied by the corresponding import vulnerability index. The indicator thus obtained has the same measurement unit as the fuel intensity indicator. The results are shown in Tables 15 and 16 for petroleum products and for natural gas respectively.

Table 15

Combined vulnerability indicator – crude oil

Country	Net import dependence	Share of extra-EEA imports	Source country concentration index (HHI)	Petroleum products intensity of GDP	Combined vulnerability indicator – crude oil
Finland	99%	84%	0.92	58.0	44.5
Belgium	100%	79%	0.36	71.1	20.1
Greece	100%	100%	0.29	53.6	15.3
Sweden	100%	45%	0.65	50.4	14.7
Netherlands	96%	76%	0.23	60.1	9.9
Germany	96%	69%	0.29	51.5	9.9
Austria	90%	97%	0.18	53.8	8.5
Portugal	100%	96%	0.12	68.1	7.7
Italy	94%	96%	0.16	44.6	6.6
Spain	100%	93%	0.11	62.2	6.2
EU-15	**81%**	**74%**	**0.15**	**52.3**	**4.8**
France	98%	73%	0.11	51.5	4.0
United Kingdom	5%	25%	0.21	45.9	0.1
Denmark	0%	0%	0.00	46.5	0.0
Ireland	100%	0%	0.00	59.9	0.0

Units: ktoe per billion US dollar of GDP at 2000 PPP (last two columns).

Source: Own calculations.

In the case of petroleum products the indicator we propose is in a sense a mixed indicator and is a result of a compromise solution. We chain the import dependence of crude oil with the petroleum products intensity of GDP, rather than with the crude oil intensity of GDP. This choice, which is consistent with what was presented earlier, is made in order to avoid distortions due to the location of refining capacity in the EU-15. As for the results, we find that the most vulnerable countries with respect to the security of supply of crude oil are Finland, Belgium, Greece and Sweden. The least vulnerable are the UK, Denmark and Ireland. However, as was noted previously, the situation and ranking of both the UK and Denmark are set to change dramatically over the next 10 years. A more interesting example, therefore, would seem to be France, which in spite of high import dependence and not particularly low petroleum products intensity of GDP has a low combined

vulnerability level. This is primarily due to its low source country concentration index, i.e. to its well-diversified source country pattern. The situation of the EU-15 as a whole is similar.

Table 16

Combined vulnerability indicator – natural gas

Country	Net import dependence	Share of extra-EEA imports	Source country concentration index (HHI)	Natural gas intensity of GDP	Combined vulnerability indicator - natural gas
Finland	100%	100%	1.00	23.5	23.5
Austria	83%	88%	0.67	33.4	16.4
Italy	86%	81%	0.38	46.4	12.2
Germany	82%	46%	0.82	37.3	11.6
Portugal	100%	100%	0.53	19.3	10.2
Spain	100%	94%	0.28	30.0	7.8
Belgium	100%	37%	0.41	48.0	7.2
Greece	99%	100%	0.73	8.3	6.0
EU-15	**55%**	**59%**	**0.30**	**37.2**	**3.6**
France	98%	61%	0.25	24.2	3.6
United Kingdom	7%	3%	0.73	49.9	0.1
Denmark	0%	0%	0.00	26.7	0.0
Ireland	87%	0%	0.00	24.6	0.0
Netherlands	0%	0%	0.00	73.8	0.0
Sweden	100%	0%	0.00	3.1	0.0

Units: ktoe per billion US dollar of GDP at 2000 PPP (last two columns).

Source: Own calculations.

'Combined vulnerability for natural gas is highest for Finland, Austria, Italy and Germany'

In the case of natural gas, the most vulnerable countries are Finland, Austria, Italy and Germany. The least vulnerable countries are the UK, Denmark, Ireland, the Netherlands and Sweden. Each of these has a combined indicator of zero or relatively very close to zero for different reasons. The UK, Denmark and the Netherlands have significant domestic production of natural gas. Ireland and Sweden do not, but they import all of their needs from within the EEA. In addition, Sweden's energy product mix relies overwhelmingly on products other than natural gas.

'The region's star performer is France'

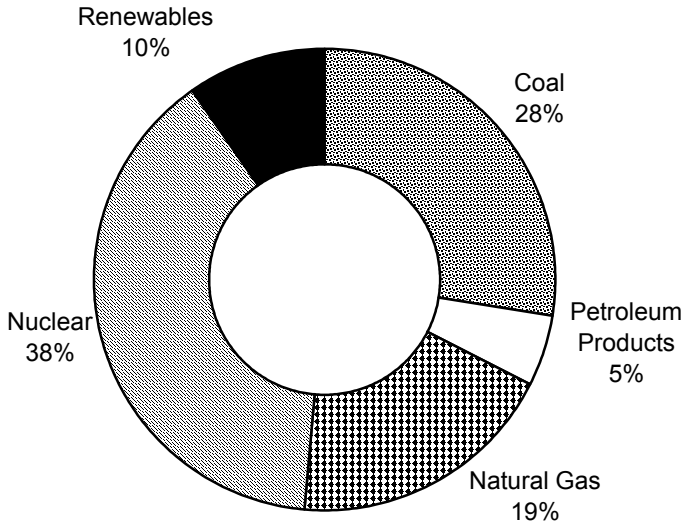
Given foreseeable medium-run developments with respect to North Sea reserves, which will push the UK, Denmark and the Netherlands into much more vulnerable territory, the region's star performer is again France: in spite of an import dependence of almost 100%, the country's well-diversified source country pattern and somewhat below-average natural gas intensity of GDP lead to a very favourable combined vulnerability indicator.

Electricity generation in the EU-15

Electricity represents an important component of final energy consumption and may be generated using petroleum products (not crude oil) or natural gas. In addition, coal is still used to a significant extent in certain EU-15 countries, especially Germany, while nuclear fuels account for a large share of electricity generation in France, Belgium and Sweden. As a whole, the EU-15 distribution of fuel use in electricity generation for the year 2005 is as shown in Figure 6.

Figure 6

Fuel mix in electricity generation, % of total, EU-15, 2005



Note: Shares calculated based on energy content of inputs.

Source: IEA Energy Balances and own calculations.

Nuclear fuels are the most important type of fuel for electricity generation in the EU-15, accounting for 38% of the energy value of all fuel inputs in 2005. The chief contributing country to this is France, which accounts for around 50% of the EU-15's nuclear electricity generation. The second most important is coal, the chief contributing countries being Germany and the UK. Natural gas comes in third place with 19%. The main contributing countries to the EU-15 total are the UK and Italy, followed by Germany, Spain and the Netherlands.

Turning now to the fuels that interest us in this study, it is interesting to look at which countries use petroleum products (respectively natural gas) the most in their domestic electricity generation industries. Table 17 provides the percentages and rankings for each country in turn. As can be seen, Portugal, Italy, Greece and Ireland are the countries that rely the most on petroleum products. However the highest share found (Portugal) is only 22.3%. Luxembourg, the Netherlands, Italy and Ireland are the countries that most rely on natural gas for their electricity generation.

Table 17

Share of petroleum products and of natural gas in electricity generation

COUNTRY	Petroleum products	COUNTRY	Natural gas
Portugal	22.3%	Luxembourg	90.1%
Italy	16.6%	Netherlands	54.3%
Greece	16.0%	Italy	45.0%
Ireland	15.8%	Ireland	41.4%
Spain	9.8%	United Kingdom	31.2%
Austria	5.1%	Austria	29.0%
EU-15	4.8%	Portugal	26.8%
Denmark	4.5%	Denmark	26.0%
Netherlands	2.8%	Belgium	20.2%
Germany	2.7%	Spain	20.0%
Belgium	2.1%	EU-15	18.9%
France	1.9%	Finland	14.7%
United Kingdom	1.2%	Germany	12.4%
Sweden	1.1%	Greece	12.4%
Finland	1.1%	France	3.9%
Luxembourg	0.0%	Sweden	0.7%

Source: IEA Energy Balances and own calculations.

What are the most recent trends in electricity generation in the EU-15? And how do these trends indicate responses to energy security concerns? To answer these questions we look at recent data from the EU-15's three largest economies: Germany, France and the United Kingdom. These three countries are chosen not only because of their size, but also because they provide illustrations for three completely different approaches to guaranteeing security in electricity generation.

Table 18

Electricity generation (TWh) in France by energy source

Year	Total	Nuclear	Thermal	Hydro and renewables	*Share of thermal*
2002	535	417	53	66	*10%*
2003	542	421	57	65	*11%*
2004	550	428	57	65	*10%*
2005	550	430	63	57	*11%*
2006 (p)	549	429	57	63	*10%*

Notes : (p) = preliminary.

Source: INSEE, Observatoire de l'Energie.

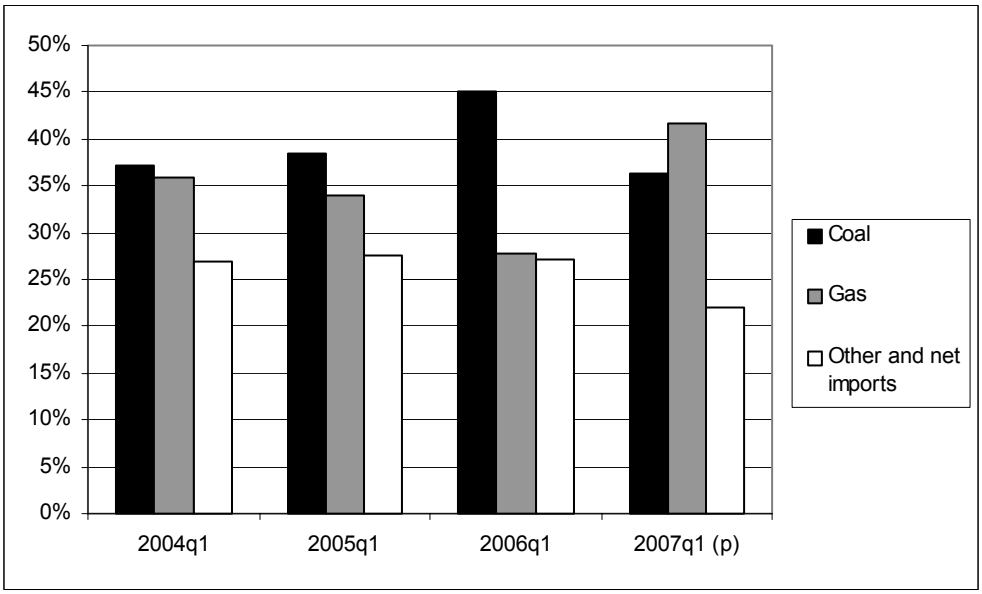
France has a very high reliance on primary electricity, in particular nuclear electricity. As shown in Table 18, the share in total electricity generation from thermal plants (e.g. gas-fired or coal-fired) has fluctuated around 10% to 11% of the total in recent years without

any discernable trend. Thanks to its important nuclear-power capacity, France is shielded from supply shocks with respect to both oil and gas as far as its domestic electricity production is concerned. This also applies to its domestic consumption of electricity, given that France is a net exporter of electricity.

The case of the UK is completely different, as the UK's electricity generation relies on three important sources, namely coal, gas and nuclear. Petroleum products-based electricity generation plays a very minor role, as do renewables. This structure is very responsive to changes in relative prices, in particular between gas and coal. This in turn is made possible due to the more liberalized market structure one finds in the UK, whereby domestic gas prices result from transactions on a relatively liquid market, which is not the case in many mainland European countries. The results can be seen from Figure 7, which shows the breakdown of UK electricity supply according to its source for the first quarter[8] of each year from 2004 to 2007. The price of coal was high relative to that of gas in 2003-2004, leading to more electricity generation from gas-fired plants. The situation then reversed as gas prices rose relative to coal prices (partly due to the link between gas prices and oil prices).

Figure 7

Electricity generation (% of total) in the UK by energy source



Notes : (p) = preliminary.

Source: DTI, Energy Trends.

This development started slowly in 2005 and accelerated strongly in 2006, showing a strong rise in the use of coal for electricity generation and a drop in the use of gas for the

[8] This is done in order to include the most up-to-date data that are available, which are the data for the first quarter of 2007. Then, comparisons must be made with the first quarters of previous years, not with entire past years, in order to strip out seasonality effects.

same purpose. However, the preliminary data for the first quarter of 2007 indicate that this trend is now being completely reversed, because it is now gas that is cheap relative to coal. As we can see, gas-fired generation is now the most important type of electricity in the UK. Gas has also taken up the slack left from the steady reduction in nuclear electricity generation.

In the case of Germany, coal has traditionally been the most important source, while gas has been, and still is, rather unimportant. Nuclear energy is also quite important in Germany, accounting for just under 30% of electricity generation in the country, while coal accounts for a bit more than 50% (roughly evenly split between hard coal and brown coal). The most recent trend in Germany's mix of sources for electricity generation is shown in Table 19. The changes are much less drastic than those seen in the UK case, as Germany's power-generation sector is rather less flexible and so responds to price changes more slowly and less drastically. The recent change, which is small, indicates a slight increase in the use of coal and a slight fall in the use of gas when comparing the fourth quarter of 2006 to the fourth quarter of 2005. In addition, the trend in investment in Germany seems to favour coal-fired plants over other types of facilities. Two forces contribute to this development: oil prices (which affect gas prices) may remain high; furthermore, energy security concerns have made a comeback, while Germany is abundant in brown coal. At the same time, there are concerns that such a trend would make environmental targets, notably CO_2 emissions targets, impossible to achieve in future, so that there is also ongoing political lobbying against the current investment trend.

Table 19

Electricity generation (% of total) in Germany, by energy source

	2005q4	**2006q4**
Nuclear	29.9%	29.6%
Coal (hard and brown)	51.8%	52.4%
Gas	11.3%	10.9%
Other	7.0%	7.2%
Total	100.0%	100.0%

Source: Statistisches Bundesamt Deutschland.

The conclusion of this section on electricity generation is that the three countries discussed have adopted completely different structures and strategies with respect to electricity generation. Each approach has its advantages and drawbacks with respect to energy security concerns, as well as with respect to environmental concerns.

France is, strictly from an energy security perspective, by far the most secure country. Its reliance on domestic nuclear electricity generation is an effective shield against oil price fluctuations and natural gas supply concerns. Nevertheless, France's heavy reliance on

nuclear power does raise broader security issues, as well as environmental ones. The United Kingdom is a completely different case. While nuclear power does provide, in a sense, a partial safety cushion, the main feature of the UK structure is its highly flexible nature in being able to switch between coal and natural gas. This enables a smoothing effect with respect to price shocks. However, this does not shield the UK from future import dependence for natural gas when its reserves run out in the course of the next decade. As for Germany, nuclear power also plays the role of a safety cushion, but the main feature is Germany's reliance on coal, notably domestically-produced coal. This is good from an energy security viewpoint, but much less so from an environmental viewpoint.

'A combination of the French and British models would seem ideal: more nuclear power, and flexible fuel-switching capabilities for thermal power'

The main lesson from this comparison is that there are several possible strategies for enhancing energy security on the demand side. However, if one takes CO_2 targets seriously, the German model seems less desirable, while a combination of the French and British models would seem ideal, i.e. a high share of nuclear power combined with flexible fuel-switching capabilities for fossil-fuel-based facilities. In this respect it would be wise for those EU member states that are more sceptical with respect to nuclear energy to initiate a properly fact-based domestic political debate in which the environmental and security risks of the various available options are assessed in a rigorous manner.

PART II

The European Union's Energy Security Debate

Russia is today the focal point of the EU's energy security debate. The reasons for this development are manifold. First and foremost, Russia has vast reserves of natural gas, besides sizeable reserves of oil, and is located on Europe's doorstep, with an already existing network of pipelines that penetrate deep into EU territory and with an already long history as a key supplier of fossil fuels to many of the EU's current member states. These basic facts alone are enough to explain why any discussion on the EU's energy security will inescapably devote a large space to Russia and to its strategies and incentives. The intensity of the debate and the salience of its Russian dimension were furthermore dramatically raised in the wake of the Ukraine supply cut of January 2006. Further incidents, as well as renewed assessments of previous incidents, have further contributed to the anxiety felt in certain quarters in the European Union. As President Putin stated on 17 February 2003, Russia's gas export monopolist Gazprom is 'a powerful political and economic lever of influence over the rest of the world'.

In sum, these developments have led to an increased state of concern in the European Union with respect to its relations with Russia. Energy relations are very much at the core of this development and also very much at the core of Russia's newly-found confidence. As the quote shown above illustrates, part of the debate revolves around the degree of politicization of Russian energy supplies, in particular supplies of natural gas. In this part of the study we seek to clarify these issues and present a coherent framework for understanding Russian strategies, intentions and tactics. Most importantly, we will try to give a taste of what future developments in EU–Russian energy relations may look like, focusing on the risks and opportunities at hand. This assessment shall also offer thoughts about the EU's current policy options and about likely developments in the EU's energy policies.

We start off with the main question that was raised in the light of the Ukraine supply cut of January 2006, i.e. that of Russia's reliability as an energy supplier and of its use of energy as a tactical tool of influence. We then broaden the discussion to tackle the more fundamental structural issues at hand, namely Russia's strategic objectives, what incentives Russia faces today, what incentives it will face in the future, and what steps the European Union may take to improve its energy security position.

Russia's reliability as an energy supplier

Russia's (and preceding it, the USSR's) general record as an energy supplier is positive, i.e. one would be correct in asserting that supply has been reliable, with respect to EU-15 countries. If one switches over to the countries of the former socialist world, things look

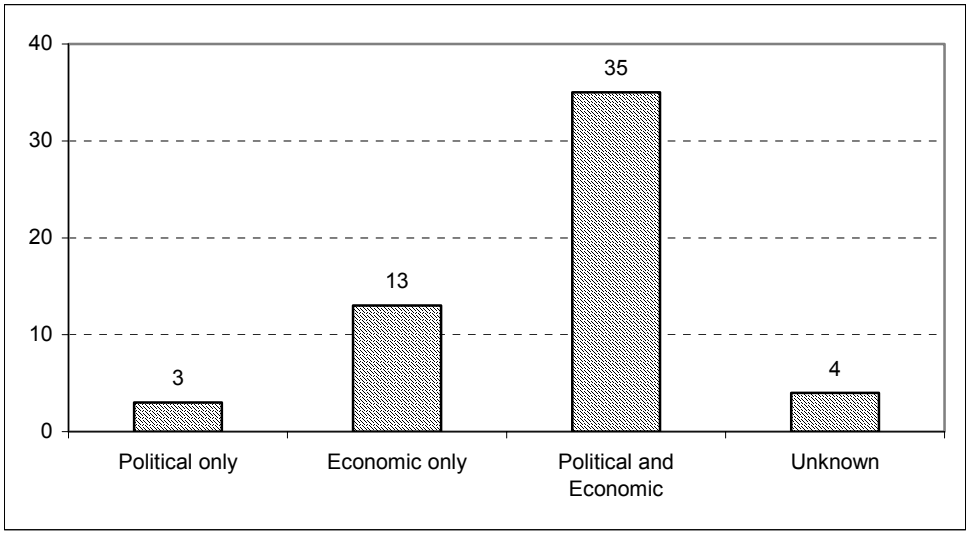
decidedly different, in particular with regards to the countries of the former Soviet Union. The most salient case was in January 2006 when supply was cut to Ukraine, ostensibly due to a price dispute. Because of Ukraine's key role as a transit country the incident raised concern across Europe. However, this was by no means the only such incident.

'The 2006 supply cut to Ukraine was by no means the only such incident'

A recent report by the Swedish Defence Research Agency, Larsson and Hedenskog (2007), identifies a total of 55 incidents over the 1991-2006 period which it describes as incidents of a coercive nature that Russia undertook against countries of the former Soviet Union. Several aspects should be mentioned. First of all, incidents of a coercive nature did not start with the now notorious Ukrainian supply cut of January 2006. There had been a large number of other incidents before that, but they were essentially ignored in Western media because of their limited impact on Western Europe. Second, a large number of incidents happened during the Yeltsin years. It is therefore incorrect to assume that such incidents are a hallmark of the Putin Presidency only. Third, the majority of incidents have both economic and political underpinnings, making it in most cases impossible to identify a single clear motivation for a single incident. The breakdown is given in Figure 8. The existence of a small number of incidents that seem purely political in nature suggests that both political and economic incentives shape Russia's energy policy. In other words, Russia's external energy policy is neither purely economically or commercially motivated, nor purely politically motivated. It is motivated by a combination of both forces, although, as suggested by the data, the economic motive is the stronger of the two.

Figure 8

Russian coercive actions in energy relations with the CIS, by motive, 1991-2006



Source: Larsson and Hedenskog (2007) and own calculations.

Concerning the countries targeted by these actions, it may come as a surprise that the main target so far in terms of the number of incidents has been Lithuania. This is partly due to a methodological choice made by Larsson and Hedenskog (2007) regarding whether a specific case, e.g. the Mazeikiu oil refinery, was affected by a series of incidents (i.e. counting each separate incident) or by a clear campaign of incidents (i.e. counting the entire case as one incident).

As is clearly shown above, Russia has used coercive actions in the field of energy in relations with its neighbours in the past. If the past is any indication of what may happen in the future, then it would be wise to worry about potential future incidents of a similar nature. However, in order to make sense of future risks, one needs to develop a better understanding as to why Russia in certain cases took such drastic actions. Identifying the main incentives behind Russia's actions should then help to determine the likelihood, nature and risk of similar events happening in the future, notably with respect to EU-15 countries.

Russia's incentives

Russia's incentives can be understood within the following theoretical framework. Russia's fossil fuel resources are, arguably, a case of 'natural monopoly'. Whether the exploitation and sale of natural resources are organized monopolistically of course depends on both market conditions and the institutional framework. However, it is clear that it is in the interest of the Russian state to control the natural resources of Russia and control what happens to the proceeds of export sales. Failing that, for example in the case of a weak state, the energy companies may (partially) capture state power, rather than the other way around. To simplify, this latter scenario is in a sense what was happening during the Yeltsin years, while the reverse has been happening under the Putin Presidency (although who exactly controls whom and to what extent is not entirely clear-cut). In any case, the most helpful insight into the issue is to view the current situation as a merger of the Russian state and the main energy companies, first and foremost Gazprom.

'A merger of Russia's energy companies and the Russian state'

Because the proceeds from the energy companies are large, this is almost a merger of equals: profit maximization of the energy sector becomes a significant political objective, while the promotion of the broader national interest of Russia as a political entity becomes significantly intertwined with the commercial policies of Russia's main energy companies. In essence, one can therefore view Russia's objective as being the maximization of the joint interests of its energy companies and of the Russian state itself. Concretely this means that pure profit maximization is not the pursued goal, since it is possible to find cases of Russia forgoing small sources of profits in favour of political objectives it considers

more important, e.g. losing Georgia as a consumer but being able to pressure it against joining NATO. On the other hand, the profit component is vital to Russia. Its export structure is still highly concentrated on energy products (though attempts at diversification are being pursued), while profit margins on other exported commodities are much lower. All in all, losing large consumers such as Germany is clearly out of the question.

The sustainability of future profit flows is hence crucial to Russia's interests. For this reason, the Russian state supports efforts on the part of its energy companies, most notably gas export monopolist[9] Gazprom, to expand its downstream penetration in its main markets, i.e. the European Union, but also in its neighbourhood, i.e. the CIS countries. As is evident from any mark-up pricing model of a distribution chain, there are net profit margins all along the chain. Gazprom wants to be at every node of the chain, and thus be able to extract larger profits than it does already. In turn this policy has desirable political implications for the Russian state. If Russia were not only to be the source of most natural gas consumed in the European Union, but also to have a large pervading presence throughout the EU's distribution network, this would give the Kremlin considerable political leverage over the European Union, potentially enabling linkages with other areas of bilateral relations which may be of interest for the Russian state, be they economic or political.

To see this one should consider Russia's actions with respect to its neighbourhood. The tough price negotiations that took place between Gazprom and Russia's neighbours over the last years have most often been linked to issues that went beyond gas quantities and prices. As summarized in Larsson and Hedenskog (2007), some of Russia's successes have included the ability to purchase key parts of the energy infrastructure as well as key energy companies in CIS countries. The case of Armenia is a revealing example. Gazprom's announced policy is to raise the price of natural gas to a 'Western European' level (around 250 USD per thousand cubic metre in 2007) for all its CIS customers. However, in the case of Armenia Gazprom settled for a fixed price of USD 110 (up to 1 January 2009) in exchange for a stake in the Iran–Armenia gas pipeline and a stake in Armenia's electricity network. In contrast, negotiations with Georgia broke down, leading Gazprom to raise the price to USD 235 from January 2007, in turn leading Georgia to break off from Russian supplies altogether. Similarly in the case of Belarus, Gazprom threatened to drastically increase gas prices, and then obtained a compromise deal enabling it to acquire a 50% stake in Belarus' gas pipeline company, Beltransgaz. In exchange, gas prices to Belarus will be increased by small increments over several years (up to 2011), rather than in one sharp hike. As a result of these manoeuvres, Russia obtains its declared objective of charging 'normal' prices to all foreign countries in the space of just a few years, while additionally making significant acquisitions in these same

[9] There are several independent gas producers in Russia but Gazprom is a monopolist in terms of export routes as well as in terms of Russia's domestic pipeline network.

countries in terms of energy distribution assets. It should however be borne in mind that Russian coercive tactics have not always borne fruit. Apart from the Georgian case, Larsson and Hedenskog (2007) also point out two other failures: the attempt to obtain control of the Ventspils port in Latvia and the attempt to obtain control of the Mazeikiu oil refinery in Lithuania. Regarding the former case, Russia ultimately chose to build its own sea oil terminal in Primorsk on Russia's Baltic Sea coast, rather than to continue to depend on sea oil terminals that it could not control.

Ostensibly, and this has been the official public relations line coming from both Gazprom and the Kremlin, these tensions over gas pricing are a one-off, a distorted structure inherited from the Soviet past which had to be corrected. After all, their argument goes, there is no reason why Russia should subsidize what have been *de jure* foreign countries for more than a decade and a half already. What this argument implies is that as soon as everybody is paying around the same price per thousand cubic metre, then no such incidents will occur. Is this true? To some extent it probably is, because the price gap that existed at the beginning of this century was particularly large. Gazprom was charging roughly the same price as it does within Russia, somewhere around USD 50 per thousand cubic metre, roughly five times less than is currently charged in Western Europe. It was therefore both desirable and fair business practice on the part of Gazprom to wish to raise those prices and bring them somewhat more in line with those charged to Western European customers. There was thus a clear and perfectly understandable commercial framework that underpinned these negotiations. Another issue which should be mentioned in Russia's favour is the phenomenon of illicit siphoning-off of oil and gas which has taken place in transit countries such as Ukraine. Clearly, such incidents were likely to harden the Russian position in its price negotiations.

What was however neither clear nor perfectly understandable, at least initially, was why price negotiations between Russia and its neighbours were conducted with such intensity. It then became evident that the price negotiations were being used as a lever to extract strategic concessions (e.g. Belarus, Armenia), or to effect retribution (e.g. Georgia) for unrelated, generally purely political, disagreements.

Selected transit issues

A significant proportion of Russian resources are transported overland by pipeline. This structural aspect has a number of implications which are important from an energy security viewpoint. In its simplest form, transit is a three-country problem (or more if there is more than one transit country). The source country sells resources both to the transit country and to the destination country. The transit country benefits economically by charging transit fees, in addition to having a security lever by having the physical possibility of applying coercive measures on the resource flow, i.e. siphoning of resources and/or disrupting the flow.

In the general case, the existence of a transit country represents additional costs as well as additional risks for both the supplying country and the country of final destination. One way around this problem is to invest in 'transit avoidance' transport infrastructure. If the net present value of the (future) energy transaction flows is higher for the source and destination countries in the case of transit avoidance (taking into consideration the capital costs of the new infrastructure), then it makes economic sense for the source and destination countries to build the transit avoidance infrastructure. If this is the case, there will however be consequences for the transit country as well. The transit country will continue to import from the source country by the former route, but will lose the ability to charge a transit fee as well as its former leverage on the transaction between source and destination countries.

One example of such a project is Nord Stream, which is a projected offshore gas pipeline that should connect North-western Russian gas fields directly to Germany, bypassing the Baltic States and Poland. The joint interest of source and destination countries, in this case Russia and Germany, is clear: avoiding transit fees and removing the influence of third countries on the resource flow means that both countries gain. However, as pointed out above, the transit countries are net losers from such a project. This explains why there is opposition to Nord Stream especially in Poland and in the Baltic States, so that there is a conflict of interest between EU member states on this particular transit issue. This in turn naturally raises the question of how the European Union as a whole should react. So far, what has happened is that the EU transit countries, especially Poland, have made their displeasure known within EU debates. In this particular case, timing was of the essence. The project had already passed through some crucial preparatory phases just before Poland and the Baltic States became member states and before the EU had got around to formulating a more solid common external energy policy. In retrospect, it is reasonable to assume that a project such as Nord Stream would be blocked from the outset at the EU level if it was proposed as a new project today. However, given the timeline of the project, both the Commission and the German government have signalled a wish to stick to what has been agreed with the Russian side, while Poland and the Baltic States, with support from Finland and Sweden, are perhaps still hoping (whether realistically or not) that the project may be cancelled. Assuming in any case that Nord Stream does go ahead as planned, a second-best solution from the point of view of the EU transit countries is already being pursued with encouragement from the European Commission in the shape of improved interconnectedness between member states. This explains the recent 'Balticconnector' project which aims to build a gas pipeline linking Estonia with Finland. Similar projects in the wider Baltic region (i.e. involving Germany, Scandinavia and Poland) are also under consideration for the same reason.

The example of Nord Stream carries important lessons for future dealings between the EU and Russia. Of course, having to pay an effective premium to transit countries remains a

problem for both sides. What has changed is the set of countries that are considered by the EU to be 'third countries'. This set has shrunk to, chiefly, Belarus and Ukraine for supplies to Northern and Central EU states, and Turkey for supplies to Southeastern, Southern and Central EU states.

The Southeastern route into the EU is however a more complex issue. Turkey sits at the heart of a route with potential supplies coming from three sources: Russia, the Caspian and the Middle East, including Iran. In addition, Turkey is a relatively large market in its own right, and serves as a bridge between the Black Sea and the Mediterranean, in addition to being a bridge between Europe and the three sources mentioned above. This exceptional geo-strategic importance explains why there is talk of Turkey as a major 'energy hub'. The role of Turkey is discussed in more detail in the next section, given how competing infrastructure projects relate to the debate on supply country diversification.

The diversification debate

One key element of energy security for countries that are net importers of energy is to have diversity in terms of sources of imports. What countries might constitute appropriate sources is first and foremost a function of their reserves. Table 20 shows the world's top 20 countries in terms of oil and gas reserves, in physical units and in share of world total. Oil is overwhelmingly located in the Middle East region, with around 60% of world reserves distributed among Saudi Arabia, Iran, Iraq, Kuwait and the United Arab Emirates. Russia has 6.6% of world reserves.

The situation is quite different with natural gas. Here it is Russia that is in the lead, with more than one quarter of the world's reserves, followed by Iran and Qatar. Algeria, a key supplier to Western Europe, holds just 2.5% of the world's reserves, while Norway holds only 1.6% of the world's reserves.

'Russia has by far the world's largest reserves of natural gas'

What the data on reserves clearly suggest is that the European Union will depend on Russian natural gas not only in the short run, but also most likely in the long run, given the way resources are distributed. A similar comment could be made about the European Union's reliance on Middle Eastern oil. Whatever choices were made in recent years (we saw in Table 7 that the EU-15 is not strongly dependent on that region for now), the Middle East is the indispensable source of oil in the long run. However, decisions can be made for the medium run, say over a horizon of 10-15 years, which need not track, even remotely, the world's distribution of reserves. This is what has happened with respect to crude oil up until today. The EU-15 was strongly dependent on oil from Arab countries (chiefly Persian Gulf Arab countries) in the 1970s. The oil embargo of October 1973, imposed by the main

Arab oil exporting countries against the United States and the Netherlands for their support to Israel in the Yom Kippur War, as well as price increases with respect to other Western European countries, taught the countries of Western Europe a useful lesson. The result has been diversification in favour of countries with smaller oil reserves such as Russia, Nigeria or Kazakhstan.

Table 20

Reserves of crude oil and natural gas by country, end 2006

Country	Oil reserves	Share	Country	Gas reserves	Share
Saudi Arabia	264.3	21.9%	Russian Federation	47.65	26.3%
Iran	137.5	11.4%	Iran	28.13	15.5%
Iraq	115.0	9.5%	Qatar	25.36	14.0%
Kuwait	101.5	8.4%	Saudi Arabia	7.07	3.9%
United Arab Emirates	97.8	8.1%	United Arab Emirates	6.06	3.3%
Venezuela	80.0	6.6%	USA	5.93	3.3%
Russian Federation	79.5	6.6%	Nigeria	5.21	2.9%
Libya	41.5	3.4%	Algeria	4.50	2.5%
Kazakhstan	39.8	3.3%	Venezuela	4.32	2.4%
Nigeria	36.2	3.0%	Iraq	3.17	1.7%
USA	29.9	2.5%	Kazakhstan	3.00	1.7%
Canada	17.1	1.4%	Norway	2.89	1.6%
China	16.3	1.3%	Turkmenistan	2.86	1.6%
Qatar	15.2	1.3%	Indonesia	2.63	1.5%
Mexico	12.9	1.1%	Australia	2.61	1.4%
Algeria	12.3	1.0%	Malaysia	2.48	1.4%
Brazil	12.2	1.0%	China	2.45	1.3%
Angola	9.0	0.7%	Egypt	1.94	1.1%
Norway	8.5	0.7%	Uzbekistan	1.87	1.0%
Azerbaijan	7.0	0.6%	Kuwait	1.78	1.0%
Other	74.7	6.2%	Other	19.55	10.8%
World Total	1208.2	100.0%	World Total	181.46	100.0%

Units: Oil: billions of barrels; Gas: trillions of cubic metres.

Source: BP (2007).

Such a medium-run diversification strategy for natural gas has of course already started. Western European countries, along with the United States, have expressed enormous interest in developing a *Eurasian Energy Corridor* which would link non-Russian Caspian energy reserves to EU territory while avoiding both Russia and Iran as transit countries. Instead, the route of the corridor runs through the South Caucasus, Turkey or the Black Sea, and onwards to the European Union. This is based on the quite sizeable oil and gas reserves of the Caspian basin which belong first and foremost to Kazakhstan, Turkmenistan and Azerbaijan. The first step in the development of the energy corridor has

already taken place with the completion and start of operation of the Baku-Tbilisi-Ceyhan oil pipeline ('BTC pipeline') and of the Baku-Tbilisi-Erzerum gas pipeline ('South Caucasus Pipeline'). The next step upstream, which is the real key to the longer-term success of the energy corridor given that Azerbaijani reserves are not particularly large, is to link up these pipelines with the resources of Kazakhstan, and possibly with those of Turkmenistan, by way of trans-Caspian pipelines (one for oil and one for gas). Transit to European markets may then be achieved either by underwater pipelines under the Black Sea or by overland pipelines through Turkey. A summary of the most important current and planned pipelines for Caspian gas exports to Europe can be found in Table C6 in Appendix C.

The Eurasian Energy Corridor is an important plank of the West's energy diversification strategy. However, it faces stiff competition from Russia, which seeks to undermine its creation both at the transit level and at the upstream level. We start by discussing the former.

As mentioned earlier, Turkey's key role as an energy hub is indisputable. The country has close relations with most EU member states, especially due to joint membership of the IEA and of NATO which both lead to solidarity obligations. This certainly explains a preference on the part of certain EU member states and corporations (and the United States) for promoting projects that use it as a transit country. From the Russian perspective, Turkey is however more than simply a transit country which is broadly aligned with Western interests: it is also an interesting final destination market, hence the existence of the Blue Stream underwater gas pipeline which connects Russia to Turkey directly. Furthermore, and this is where the competitive game between Russian and EU interests becomes more complex, both Russia and EU member states have expressed simultaneous (and competing) interests in developing energy transportation infrastructure through Turkey and onto Europe, as well as purely Black Sea-based transportation infrastructure that bypasses Turkey. At the heart of this competition are four main rival projects with respect to natural gas. The main EU-backed project is the Nabucco pipeline, which would run from the Turkish end-point of the South Caucasus pipeline (which brings natural gas from the Caspian to Turkey) through Southeast Europe and into Austria. In addition, a new proposal which would also suit EU interests is the White Stream project, which would run from Georgia (branching off from the existing South Caucasus Pipeline) to Romania (below the Black Sea) and then onwards to Poland. The first Russia-backed project would be an extension of the existing Blue Stream pipeline (which links Russia to Turkey). This extension would run from Turkey through Southeast Europe and into Hungary. The second Russia-backed project is South Stream, a planned underwater pipeline that would link a Russian Black Sea terminal directly to the Bulgarian coast. Overland the pipeline would then have two possible branches: one to Greece and onwards to Southern Italy, and a second one through Romania, Hungary, Slovenia and Northern Italy. An alternative route

which would transit through Northern Serbia in addition to transiting through the above-mentioned countries is also under consideration.

'Russia seeks to undermine the creation of the Eurasian Energy Corridor'

We now turn to the upstream level of the Eurasian Energy Corridor. Russia has made strenuous efforts of late to try to secure as large a share as possible of Central Asian resources for itself. As detailed in Socor (2007a), Russia moved quickly in May 2007 to try to guarantee that the bulk of resources from Kazakhstan and Turkmenistan would flow into Russia (whether for further export to Europe or for Russian consumption) by way of, first, a modernization of the Soviet-era 'Central Asia Center' gas pipeline to bring it back up to its former (higher) capacity level and, second, an expansion of that same capacity. On 12 May 2007 the leaders of Russia, Turkmenistan and Kazakhstan signed a declaration of intent in this regard. As is shown in Table C6 in Appendix C, Russia would like to expand that capacity up to an enormous 90 billion cubic metres per year. If this were to arise it would give Russia control over an overwhelming share of Central Asian gas exports, thus depriving the European Union of the alternative non-Russian route through the trans-Caspian pipeline. This would effectively close down the most important potential component of that entire energy corridor for the European Union, while further strengthening Russia's market power vis-à-vis the EU. However, the game is not quite over yet. According to Socor (2007a), the agreement signed on 12 May is a non-binding expression of intent, not a binding contract or treaty. There may, therefore, still be a chance for the EU to 'slip in' and develop the energy corridor as originally planned. As for the Central Asian countries, they are of course in a position of strength and are being actively courted. One should add to this issue that the Central Asian countries, in view of their strategic location, are also natural partners for Asian countries, notably India and China. Generally speaking, Central Asian countries are said to pursue what is called a 'multi-vector foreign policy', which in the current discussion may be loosely understood as a willingness to be on relatively good terms with all major partners. Conversely, this also means that the field is open for competition between major external players, a phenomenon which has been dubbed the 'New Great Game' by certain analysts of the region. The key issue for the European Union at this stage will hence be to secure an agreement from the Central Asians. For this purpose the EU will have to have something to offer if it wishes to clinch the deal it seeks, as this will require beating off competing offers from Russia.

The other complicating factor in the Caspian–Europe energy corridor issue is the fact that certain pivotal downstream countries have not always stood on the same side. Within the European Union, and as recently as March 2007, Hungary was signalling through its prime minister that it might support the Russian project of an extension of Blue Stream rather than the Nabucco project. The situation has now reversed however, as Ferenc Gyurcsany

was reported to have expressed clear support[10] for Nabucco. This latter phenomenon is another sign of a lack of EU unity on energy security issues, although the most recent developments suggest that coordination between member states is improving.

Another recent development in the EU's attempts to secure resources lies in improved relations with Libya, which is increasingly coming out of its political isolation after abandoning its ambitions in terms of weapons of mass destruction and releasing the five Bulgarian health workers it had imprisoned. Libya recently expressed increased interest in commercial bids from international energy companies to help develop its oil and gas production capacities.

The other plank of a possible diversification strategy for the EU lies in the rise of liquefied natural gas (LNG), which can be transported by tanker over the seas, as an alternative to gaseous natural gas which is best transported by pipeline. Globally speaking, LNG markets are booming. According to IEA (2007), world LNG production grew by 11% in 2006, with Qatar as the world's largest exporter, followed by Indonesia. While the largest LNG markets are in the Pacific region, the Atlantic LNG market is forecast to grow strongly. As regards the EU, Spain is the most reliant on LNG which accounts for two thirds of the country's gas demand. The key producer to watch is Qatar, which IEA (2007) forecasts may be supplying 20% of the world LNG market by 2010. Significant new capacity in LNG regasification terminals is in construction in the UK and in Spain. Unsurprisingly, Russia is also beginning to show interest in LNG, though its two main projects for liquefaction facilities are still at the stage of planning.

To conclude on the issue of the European Union's diversification efforts, it is fair to say that the case for diversification is overwhelming, but that the concrete end-result will most likely not lead to a significant reduction of Russia's importance for the EU. Part of the reason is simply that the EU's demand for imported gas is set to rise quite significantly due to the depletion of North Sea resources. Unless drastic changes are made to the EU's fuel mix and fuel efficiency (which is unlikely in the short to medium run), even comparatively successful diversification efforts will most probably only mitigate the growth of demand for Russian imports, rather than actually reverse the trend towards greater demand. Also, as pointed out in Monaghan (2007), some of the options that could in principle be on offer for the EU are 'worse' than dealing with Russia (e.g. Iran, which has large gas reserves as well). Thus, whichever way one looks at the problem, Russia seems an obviously logical and attractive partner: it has the reserves, it is close, and much of the transport infrastructure is already there. Given these elements, it seems clear that while diversification efforts will continue and may to some extent be successful, Russia will continue to be a major source.

[10] *Financial Times*, 17 September 2007.

'But Russia needs the European Union'

We now turn briefly to the other side of the diversification issue, which is the diversification of Russia's export markets. Russia has made a point of occasionally signalling interest in the Chinese market. There is also the idea that Russia could develop its LNG capacity and export LNG for instance to North America. One argument for such diversification on the part of Russia which is sometimes heard is that demand growth is higher outside of Europe. However, this argument is incorrect: EU demand is growing due to the depletion of North Sea reserves. Monaghan (2007) assesses the potential for Russia to diversify away from Europe and finds that Russia's choices are in fact limited and that the best choice for Russia would be to stick to Europe as its top priority. IEA (2007) indicates that there is a strong case for exporting to China in the longer run based on fields situated in Eastern Siberia, but that it would not make economic sense to export production from existing Western Siberian fields other than to Europe. IEA (2007) suggests that some of the declarations made were therefore not more than a 'negotiating stance'. Be that as it may, it is important to consider the dynamic interactions that arise between the EU and Russia when signals in favour of diversification become stronger. The more the EU expresses interest in diversification, the more Russia is likely to believe that it should follow its own diversification strategy. According to certain analysts, for example Monaghan (2007), bilateral signalling of strong drives towards diversification could lead to a sub-optimal solution for both the EU and Russia, as confidence in future relations is eroded. It is therefore desirable for both parties to bear in mind the most important structural elements which point towards a potentially strong and mutually beneficial bilateral energy relationship.

'The European Union and Russia need each other, and should remain very important partners in the field of energy'

The general conclusion on diversification is really that the EU and Russia need each other and, barring seriously adverse developments, should remain very important partners in the field of energy. However, Russia's attempts to cement the EU's dependence on Russian supplies does raise serious questions. Russia is actively seeking to thwart some of the EU's diversification efforts, notably through its interventions in Central Asia, as well as through its interest in North African production and its expressed interest in creating an international cartel for natural gas. These developments are entirely understandable from the Russian perspective, but they are not conducive to reassuring the EU about its energy security.

Russia's expansion within the European Union

The conclusion of the elements above is that the EU is the priority market for Russian gas and that Russia's strategic objective is primarily to secure the highest possible stream of future profits from the EU and, secondarily, to ensure that it has political influence and leverage on the EU. Also, as was evidenced by Russian actions in CIS countries, Russia has understood that a key to securing future profits lies not only in just selling energy products across the border but also in acquiring stakes in the transport, distribution and storage facilities of its customer countries. Gazprom's recent actions in the EU's corporate landscape are a clear confirmation of such interests. Furthermore, it is clear that the foreign policy aspect of Russia's objectives would be furthered if it succeeds in acquiring substantial downstream participations inside the European Union. Finally, Russia reduces both the costs and the risks inherent to transit by moving further downstream.

Given Russian interests, it is interesting to look at some of the most recent developments in the corporate landscape in Central Europe. The case of Hungary is particularly interesting. According to Socor (2007b), German and Austrian energy companies are acting in concert with Russian interests, notably Gazprom, in order to enable Russian companies to acquire assets in Hungary, presumably in exchange for stakes in energy assets inside Russia. In particular, Socor (2007b) describes the Austrian company OMV's interest in the Hungarian company MOL as a 'Trojan Horse' tactic. That there are such fears in Hungary is confirmed, unofficially, by Hungarian government officials in Dempsey (2007). Socor (2007b) and Kramer (2007) also give the example of the German company E.ON Ruhrgas, which, openly in this case, has offered to swap shares in its Hungarian subsidiary companies with Gazprom, in exchange for shares in Gazprom's Yuzhno-Russkoye gas field.

Russia is in a position to exploit existing differences in interests between EU member states, and does so in furtherance of its own interests. What is apparent is that Russia, notably through the Nord Stream project, decided that it should cultivate a strategic relationship with Germany over the heads of its former satellites in Central and Eastern Europe.

The second phase of Russia's general strategy is apparent from the Hungarian example, i.e. that Russia is notably interested in a re-distribution of stakes in Central and Eastern Europe, leading to even higher Russian influence in that region, while securing direct and stable access to markets in the heart of Europe such as Germany, Italy and Austria.

'Russia seeks a redistribution of stakes in Central and Eastern Europe'

Ultimately Russia seeks to move into the EU as deeply as its export capacity will allow, e.g. to countries such as Belgium and the UK, which are target markets for a planned extension

of Nord Stream and in which Gazprom is seeking downstream investments as well. Also key to this approach is the basic fact that Gazprom deals with EU countries and companies on a bilateral basis, using long-term bilateral contracts to fix the terms and pricing of its supplies. Again, such an arrangement is favourable to Russia, and potentially opens up the possibility of monopoly pricing, or at least significantly higher bargaining power than it would have if it had to negotiate with the EU as a single entity.

An alternative future: Russia's energy crunch

Beyond Russia's deliberate actions, a lively debate has emerged as to whether Russia, in spite of its vast reserves of natural gas, will actually be able to deliver gas to the EU in the quantities that the EU is forecast to wish to purchase from Russia in the medium to long run. As we saw earlier, Russia's reserves are not in question. The central feature of the debate concerns current upstream investment flows for the development of new extraction capacities inside Russia, as well as the state of Russia's domestic gas transportation network of pipelines. In parallel, Russia's domestic consumption of natural gas raises concerns. Domestic prices for gas are still very low in Russia, and profits are really only made on the export markets.

'Russia's level of domestic consumption of natural gas raises concerns'

However, this effective and prolonged subsidization of gas prices within Russia has meant that Russian gas intensity has remained very high by European standards (although it has decreased by 21% from 1995 to 2004). Using IEA data for 2004, one finds that Russia's natural gas intensity of GDP was 264.7 ktoe per billion USD at 2000 PPP. This is the same measure that was presented for the EU-15 countries in Figure 2 (albeit for the year 2005), where we saw that by far the most natural gas intensive country was the Netherlands, with around 73 ktoe per billion USD at 2000 PPP, while the OECD average is just 40. In other terms, Russia's gas intensity is more than 6 times higher in real terms than the OECD average. This of course has a number of important consequences. Given Russia's strong economic growth, Russia's domestic consumption of its own natural gas is eating away at its export potential while foreign demand for Russian gas is also rising.

Some of the first signs of this looming problem are described in Fredholm (2006). During the month of January 2006, while the media were mainly focusing on the price dispute with Ukraine, Gazprom supplies to Bosnia and Herzegovina, Serbia, Croatia, Italy[11], Romania and Poland were reduced, falling short of expected delivery levels. The official explanation initially given by Gazprom was that the shortfalls were due to Ukraine siphoning off gas. This was not implausible, and Ukraine subsequently admitted that this had occurred, then

[11] See, for example, http://news.bbc.co.uk/2/hi/business/4625092.stm.

as well as at other times in the past. Fredholm (2006) nevertheless suggests that the real reason was higher-than-forecast Russian domestic consumption due to the extremely cold weather that Russia was experiencing at the time. Most analysts concur with the views expressed in Fredholm (2006). Gazprom found itself in a position in which it was not able to fully and promptly honour its contractual obligations to several of its customers. While weather conditions were indeed particularly harsh in Russia at the time, and while siphoning of gas in Ukraine also played a role, this example demonstrates the lack of slack in Gazprom's supply capacity already today.

'There is a growing consensus that a severe winter could lead to gas shortages …'

Fredholm (2006) further describes how several estimates made independently by different analysts all point to significant shortages arising over the 2010-2015 period, with smaller shortages arising even sooner, which would force Gazprom to choose between honouring its contractual export commitments and satisfying domestic Russian demand. In fact, according to a senior IEA official,[12] there is a 'growing consensus' that Gazprom will run into problems if the coming winter (2007-2008) is much colder than average. One should add here that awareness of this problem is beginning to catch on in Russia both at the corporate level[13] and at the government level. However, the necessary upstream investments in new fields, which in all likelihood will materialize eventually, may not enable new production to come online early enough to compensate for the current decline of production from Russia's mature gas fields.

'… because upstream investment flows are insufficient, or may come too late'

Furthermore, there is an information problem which affects the analysis of this issue: since February 2004, detailed information about Russia's reserves and production levels, e.g. production by location, have the status of State secrets. IEA (2007) also complains about the fact that the information provided by Gazprom with respect to its investment plans by field is insufficiently detailed, and that this may have an adverse effect on market confidence. Fredholm (2006) suggests that one may gain a feeling for what might be happening indirectly, by analysing the behaviour of Gazprom's closest German partners, namely E.ON and BASF. Both companies signed up to additional long-term supply contracts with Gazprom in 2006 which is something that, arguably, they did not need to do at that stage, or for quite the amounts and long-time horizons that they agreed to. The speculation would be that they were well informed and decided to agree to long-term commitments now so as to avoid problems later when Gazprom becomes over-extended.

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[12] See Cronshaw (2007).

[13] See, for example, http://www.kommersant.com/p-10112/r_33/gas_shortage_/.

The key issue of Gazprom's investment choices is also assessed in IEA (2007), which expresses the concern that the level of investment planned by the company at the production level is insufficient, in addition to the risk of delays in new production coming online. On the other hand, IEA (2007) notes Gazprom's investments in 'transit avoidance' pipelines, e.g. the Nord Stream pipeline, and states that the earmarked capital would be better spent on upstream capacities instead, while other efforts could be made in order to improve relations with transit countries.

Meanwhile, given how current capacities are stretched, the fact that Russia seeks to secure Central Asian gas makes a lot of sense, not as a longer-term strategy to prevent the success of the Caspian–Europe energy corridor (though that is an added benefit), but as a short-term fix, as a way of plugging the gap between supply and demand. Sherr (2007) describes the overall picture as 'an aggressive rather than productive pattern of investment', in the sense that Gazprom is putting much more effort into seeking resources in other parts of the world, as well as participations in downstream assets, than it is in crucial upstream investments which are necessary for medium- and long-run sustainability. The obvious question now is why Gazprom should take such a risk with the sustainability of its future profit flow. Part of the reason is structural. The obvious solution to Gazprom's potential gas shortage problem would be to raise Russian domestic gas prices by a relatively significant amount. This would immediately provide an incentive for both industry and households to adopt energy-saving strategies, in addition to an increase in revenues. However, given Gazprom's status this is a purely political decision, and there has been strong reluctance to raise prices until very recently, in particular for households. Social policy arguments are a genuine and valid part of the debate in a country with a harsh climate and relatively high poverty rates. Also, it has clearly been advantageous for short-term Russian economic growth to keep energy prices down. This, however, encourages inefficiency and wastefulness in both the industry and residential sectors and merely puts off needed technical improvements across both sectors.

The domestic-foreign price gap is also a built-in disincentive for Gazprom to improve domestic infrastructure, hence the bias in favour of export-oriented and 'transit avoidance' infrastructure projects. As the crunch comes nearer, Gazprom must of course find some kind of solution, so trying to secure Central Asian gas makes perfect sense in this context. In this respect, one could even go so far as to re-interpret Russian actions as driven by a short-sighted attempt to finance its domestic gas consumption with foreign income, one way or another, and always at the last minute. While this alternative explanation for Russia's actions may be kinder with respect to Russia's deeper motives (but less kind with respect to its ability to plan ahead)[14], it is no more reassuring from the EU perspective, and

[14] This view is defended by certain analysts, such as Nadejda M. Victor from Stanford University. She nevertheless comes out in strong support of both price reform and market and export liberalization in Russia, see for example http://iis-db.stanford.edu/evnts/4454/Russian_Gas,_March_14.pdf.

in any case would lead to the same end-result if left unchecked: high dependence and high vulnerability, and hence less energy security for the European Union.

'Gazprom's legal status encourages inefficiency and wastefulness'

Another reason seems to be the inherent distortions in strategic planning that arise due to Gazprom being so deeply intertwined with the Kremlin, i.e. the extent of its politicization. A third reason is Gazprom's now official monopoly status[15] as Russia's gas exporter, as well as its special status as the owner and operator of Russia's domestic transport and storage system. In other words, Gazprom's market power allows it to be run rather inefficiently due to the lack of competition. Inefficiency in a company that has huge market power and/or a special protected status takes many forms. Cost inefficiency and wastefulness in the use of inputs is one aspect which is important, but inefficiency and political involvement may also expand into other functions of the firm. However, as expressed for example in *The Economist* (2007), Russia's current political orientation means that it is futile to hope that the state will divest from Gazprom, or that its monopoly status will be revoked, or that it will be somehow split up, e.g. between production and distribution. There is, therefore, a structure of incentives in place which, while still conducive to more-or-less standard profit-seeking, does create and entertain certain risks for the future.

The European Union's policy options

The debate on how best to react to the new energy security landscape, notably with respect to relations with Russia, has shifted dramatically in the past few months, both at the level of the EU's institutions and at the level of individual member states, with France and to a lesser extent Germany adopting a new and tougher line. At the Austrian level, discussions with stakeholders in the national debate reveal a variety of opinions and perceptions about Russia's intentions and strategy, as well as a variety of views concerning how Austria, or indeed the EU as a whole, should react. There are however a number of common points that may be thrashed out. The key red line that many advocate at both the Austrian and EU levels is that there needs to be a *principle of reciprocity* in energy matters between Russia and the EU. Most importantly, it is felt that if Russia wishes to make further downstream investments in the EU's energy storage and distribution networks, then EU companies should be permitted to do likewise inside Russia, for example by being permitted to acquire stakes in Russian gas storage facilities and/or sections of gas pipelines inside Russia.

[15] It had for some time been solely a *de facto* monopoly on Russian gas exports. It is now a *de jure* status. On 5 July 2006 the Russian parliament gave final approval to a bill granting Gazprom the exclusive right to export gas from Russia.

This raises a theoretical issue, depending on how Russia reacts to such demands. The question is this: what is the optimal, so-called first-best, solution to sort out economic relations between a consumer market and a supplier market for a strategic commodity such as natural gas? Ideally one would want to have the benefits of competition within a proper institutional and legal framework so as to ensure that any commercial disputes, e.g. late or non-delivery, late or non-payment, could be dealt with swiftly and fairly. This would necessitate both sides agreeing on and upholding a set of common rules and standards, as well as institutional arrangements. At the corporate level one would then have competitive tenders for both upstream and downstream licences which would be open to firms from both sides, and possibly to firms from third countries. However, if one assumes that state monopolization has already happened and is irreversible in the medium run (as is the case with Gazprom and Russia), then much hinges on political and security relations between the two partners. One would have to ensure that the political and security interests and goals of the two sides are in strong concordance, for example by joint membership of a political and security alliance. An example of this is Norway. The fact that Norway's leading oil company, Statoil, is state-owned does not raise any security concerns in the EU because Norway is embedded in Euro–Atlantic institutions. It has security obligations with respect to its partners through NATO, economic and commercial obligations through the EEA (EU single market) and, more specifically, energy solidarity obligations through the IEA. Such a case may be described as the first-best solution in the case of a state monopoly or quasi-monopoly in the producer country. Finally, one may also add the simple fact that Norway is a small country, and therefore unlikely to pursue strictly national interests with much force.

'If the producer country is practising a form of economic nationalism, the rational course of action on the part of the consumer country is to do likewise'

If one assumes that political and security relations between the consumer and producer countries fall somewhat short of the conditions described above (as is the case of relations between Russia and the EU), then one needs to look for a second-best solution. As security cannot be achieved commercially, i.e. by having corporations from the consumer country owning controlling stakes in upstream assets in the producer country, and as security cannot be achieved politically either, the question of security becomes strictly unilateral: the producer country should take its own measures to guarantee its security unilaterally (which Russia has already done), and so should the consumer country. Concretely, this implies restricting downstream penetration on the part of the producer country, in particular by preventing the producer country from acquiring controlling stakes in downstream assets in the consumer country. To put this in slightly different words: if the producer country is practicing a form of economic nationalism, the rational course of action on the part of the consumer country is to do likewise.

These considerations lead us to consider the intermediate case of non-controlling stakes. To the extent that these are permitted and happen on a more-or-less level field of play, then both sides will find it profitable to invest in each other's capacities. This way there is a sharing of the rents along the production and distribution chain, with the added benefit of fostering some level of cooperation and understanding between the two sides. This type of symmetric arrangement may be a useful component of what is termed politically as a policy of 'engagement'. Nevertheless, even in this area some concerns have been raised about Russia's respect for the rule of law (for its own laws) due to what many analysts perceived as being a selective and self-serving application of laws and regulatory standards, for example in relations with BP and Shell. Nevertheless, the interests at stake are so large that such investments will continue to happen anyway, even in the face of regulatory difficulties.

The conclusion from the arguments presented above is that the EU and/or its member states should introduce legal restrictions for non-EU controlling stakes in strategic parts of its (their) energy distribution and storage networks. In March 2007 the European Council (the heads of government of the EU's member states), as noted in European Council (2007), officially called upon the European Commission to 'assess the impact of vertically integrated energy companies from third countries on the internal market and how to implement the principle of reciprocity'.

One way of doing this is to strengthen the role and prevalence of so-called 'golden shares', as suggested by EU trade commissioner Peter Mandelson in July 2007. As reported in Financial Times (2007a), the idea would be to create an EU framework for golden shares in strategic industries, e.g. defence and energy, rather than have individual member states each come up with different solutions which would ultimately undermine the single market. Ostensibly, the motivation for these defensive measures is to ward off the acquisition of stakes by foreign state-owned companies, with Russia and China being the most often mentioned targets of these measures. At the same time, the European Commission naturally continues to favour competition in the EU's energy market as the best solution. One key element of the Commission's strategy is to push for full unbundling in the energy sector, i.e. that transmission and distribution of energy, in particular gas and electricity, be completely separated from production and supply activities. The ultimate goal is to have a healthy degree of competition within the single market between supra-national distribution companies, as well as promoting more investment in distribution networks. The Commission argues that such investments fail to materialize to a sufficient degree when vertically-integrated companies dominate.

On 19 September 2007 the European Commission presented two proposals for new EU legislation concerning, on the one hand, common rules for the internal market in natural gas (EC, 2007a) and, on the other hand, conditions for access to the natural gas

transmission networks (EC, 2007b). Besides the key questions of unbundling and non-EU companies' access to the EU market, which we discuss in more detail below, the proposed legislation mentions a number of important energy security aspects, notably obligations on member states in terms of energy solidarity, as well as the promotion of increased interconnection capacities between member states for both electricity and gas. The role and importance of interconnection capacity was already touched upon in the section on selected transit issues. One may add a further theoretical insight on that issue. As we saw in the first part of this report from Tables 15 and 16, the vulnerability of the EU-15 as a block is lower than the average vulnerability of its constituent parts, the member states. It would be easy to show, with the appropriate data, that the same is true for the entire European Union with its current 27-country membership. Implicitly, vulnerability analysis makes sense at the country level if interconnection and solidarity between member states is weak or non-existent. The high vulnerabilities of certain member states would matter less if member states were highly interconnected and had high and efficient responsiveness to supply shocks that affect the Union asymmetrically. Policies designed to reduce vulnerability should therefore seek to fulfil two simultaneous objectives: driving down total EU vulnerability, and promoting a decentralized EU-wide cross-border re-distribution network with redundant parts.

More generally, EC (2007a) notes that the European Commission undertakes to hold a 'rapid and in-depth review of the wider aspects of the EU's external policy in energy', and that it will make the results of its analysis and conclusions available to the public. This comes as further confirmation that the debate surrounding the EU's energy security is moving at a fast pace, and that there is a sense of urgency in coming up with appropriate policy responses and a coherent strategy at the EU level as soon as possible. One should therefore expect that decisive policy choices will be made over the next few months.

We now turn to the two core questions addressed by the recently-proposed legislation: unbundling and regulations concerning the access of non-EU companies to the EU's energy distribution networks. EC (2007a) proposes that companies from third countries be subject to the same unbundling requirements as EU companies, in other words, that a supply or production company active in the EU may not also own or operate a transmission system in the EU, regardless of the company's nationality. However, the debate on unbundling is causing a stir among EU member states. France, Germany, Austria, Greece, Bulgaria, Slovakia, Latvia, Luxembourg and Cyprus have expressed opposition to full unbundling prior to the new proposals, while Britain, the Netherlands, Denmark, Belgium, Finland, Romania, Spain and Sweden are in favour[16] of the new proposals. For this reason, EC (2007a) contains the option of allowing a derogation to full unbundling in the shape of allowing ownership of distribution systems by producers, but only under certain

[16] http://www.iht.com/articles/ap/2007/09/18/business/EU-FIN-EU-Energy.php.

strict conditions regarding control of the distribution part of the company and under strict supervision from regulators. This option, called the Independent System Operator (ISO) option, is foreseen in EC (2007a). Furthermore, EC (2007a) proposes that the Commission should have a right of veto on companies from non-EU countries acquiring ownership or control of a transmission system inside the EU (draft article 7a of EC, 2007a).

'The Commission's newly proposed legislation would force Gazprom to unbundle its EU assets'

Concretely, in the case of Gazprom the adoption of the legislation would mean that Gazprom would be forced either to sell off its stakes in EU transmission networks, or to unbundle them according to the ISO option, as clarified in Traynor (2007). There is no doubt that the proposed legislation has Gazprom and Russia very clearly in mind, as expressed rather directly in Traynor (2007) and Financial Times (2007b). The latter, however, expresses the view that the Commission has not gone far enough, as the proposed legislation does not, for instance, cover LNG terminals as part of the third country clause.

Russia, predictably, is not keen on the new proposals and complains that the EU is becoming protectionist. This is true in a narrow sense only. The legislation does indeed target Gazprom / Russia (though not exclusively). However, one should recall that Russia refuses EU access to its transmission network and has repeatedly refused to unbundle Gazprom. The Commission is therefore on a solid footing: it can argue that all it wants is a properly functioning energy market, while applying the same rules (on unbundling) to EU and non-EU companies alike. Of course there is an asymmetry in that non-EU firms would be subject to special approval by the Commission, but then one could perceive this provision as a bargaining chip. Russia could choose to unbundle and open up its energy storage and distribution facilities to EU companies and obtain access to the EU's distribution and storage networks in exchange. This brings us back to the discussion on first-best and second-best solutions. If the Commission prevails with its proposed legislation, the ball will then lie firmly in the Kremlin camp, and it will be up to Russia to choose whether it prefers the first-best solution (openness on both sides), or the second-best solution (protectionism on both sides).

In the wake of the Commission's release of the draft legislation there were also indirect hints that supply may ultimately be adversely affected, as reported for example in Tomberg (2007), though this sounds either like an exaggeration or like a form of bluff from a person not officially affiliated with either Gazprom or the Kremlin. Gazprom's official statement, reported in Traynor (2007), was that it was sure that 'its voice will be heard'. Most recently the EU and Russia have agreed to set up a joint panel of experts in order to assess the newly proposed legislation and its impact.[17]

[17] http://www.rferl.org/featuresarticle/2007/10/A34BE55F-7BE3-42AC-A4A8-6A4C796FC750.html.

'France, Germany and Austria might block the new proposals'

It remains yet to be seen how well received the ISO option will be within the EU. The debate is now in full swing. Italy is cautiously optimistic about the proposals, as reported in Financial Times (2007c). However, opposition from France, Germany and Austria seems solid. The latter countries, in particular France, have a traditional attachment to the idea of 'national champions'. As for security aspects, a golden share or some other form of controlling stake held by the respective national government is still seen as an option that is preferable to unbundling. The question at this stage is therefore the following: will the chief opponents of unbundling, i.e. essentially France and Germany, be convinced to come onboard, pending perhaps some watering down of the conditions regulating the ISO option? Or will unbundling simply be booted out altogether, forcing the Commission to adopt a different approach? And, if the latter occurs, how will the EU nevertheless find a way of keeping Gazprom and other non-EU companies out of its distribution networks?

The debate around unbundling has been presented by the Commission as a necessary condition for a well-functioning internal energy market for some time. What is new with the currently proposed legislation, besides the fact that it takes a much more decisive step towards unbundling than previous EU legislation, is that it includes the special provision on non-EU companies. The Commission has sought to create a linkage between the two issues, in the knowledge of current energy security concerns in Europe. The key question is whether it is possible, or indeed desirable, for this linkage to be lifted. After all, if one looks at the details of EC (2007a), one notices that the draft article (7a) on non-EU participation in distribution is quite separate from those on unbundling. In principle it might be possible to propose legislation that imposes unbundling on non-EU companies on the EU market, but not on EU companies on the EU market. An even simpler solution would be to enact the Commission's proposed veto right on non-EU companies in EU energy distribution without further specifications, or simply to ban non-EU companies outright, or to introduce special rules with respect to controlling stakes or golden shares. This could end up remaining the preferred option for countries such as France. However, the obvious drawback of such an approach is that it would make the Commission and the EU appear decidedly less principled about free market objectives.

'The Commission's proposals can solve an important part of the EU's energy security problem, while leaving the door open to a mutually beneficial opening of markets on both sides'

As things stand, the option chosen by the Commission should be recognized for being a good way of upholding competition within the EU while offering a level field of play for further cooperation between the EU and Russia. While Russia may not be quite ready to open up its domestic market to EU competition, it seems timely and justified to send a firm

signal to Moscow that it may no longer play an asymmetric game of economic nationalism with the EU, but that, as soon as it is ready to do so, a mutually beneficial bilateral opening up of each side's energy markets will be on offer.

The key to solving EU–Russian energy relations (and indeed EU–Russia relations in general) lies in creating a web of joint interests and mutually beneficial areas of cooperation. Russia has a severe energy efficiency problem, alongside huge remaining challenges in terms of economic and social development. While Russia wishes to make its mark and take control of its own destiny, it is in the EU's best interest to accompany this process by ensuring that mutual dependence leads to a cooperative equilibrium rather than zero-sum competition. This, given Russia's current political orientation, can only be achieved if the EU exploits its own market power in such a way as to lock Russia into market and institutional solutions of a cooperative type.

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APPENDIX A – Fuel intensities of industries

Table A1

Petroleum products and natural gas intensities of EU-15 industries, part I

Country	Industry	Petroleum products intensity	Natural gas intensity	Country	Industry	Petroleum products intensity	Natural gas intensity
Austria	Basic Metals	1.9	36.4	Austria	Paper, Pulp, Print.	3.6	32.6
Belgium	Basic Metals	3.3	41.8	Belgium	Paper, Pulp, Print.	4.0	8.9
Denmark	Basic Metals	8.4	19.5	Denmark	Paper, Pulp, Print.	2.1	10.5
Finland	Basic Metals	15.1	6.9	Finland	Paper, Pulp, Print.	16.5	29.9
France	Basic Metals	2.4	25.0	France	Paper, Pulp, Print.	2.7	25.8
Germany	Basic Metals	2.4	44.1	Germany	Paper, Pulp, Print.	2.4	26.6
Greece	Basic Metals	60.6	37.9	Greece	Paper, Pulp, Print.	14.6	7.1
Ireland	Basic Metals	241.3	0.0	Ireland	Paper, Pulp, Print.	0.7	0.0
Italy	Basic Metals	4.1	51.8	Italy	Paper, Pulp, Print.	4.7	36.2
Luxemb.	Basic Metals	1.5	126.7	Luxemb.	Paper, Pulp, Print.	0.0	0.0
Netherl.	Basic Metals	0.5	49.1	Netherl.	Paper, Pulp, Print.	0.0	26.0
Portugal	Basic Metals	28.5	35.9	Portugal	Paper, Pulp, Print.	17.8	8.7
Spain	Basic Metals	17.2	42.7	Spain	Paper, Pulp, Print.	6.4	38.4
Sweden	Basic Metals	32.2	3.0	Sweden	Paper, Pulp, Print.	29.4	1.4
UK	Basic Metals	3.5	40.5	UK	Paper, Pulp, Print.	1.3	16.0
Austria	Chemicals and P.	3.7	80.3	Austria	Textile and Leather	5.7	13.6
Belgium	Chemicals and P.	5.1	58.4	Belgium	Textile and Leather	0.5	12.7
Denmark	Chemicals and P.	2.9	10.0	Denmark	Textile and Leather	4.1	15.2
Finland	Chemicals and P.	30.7	5.0	Finland	Textile and Leather	22.3	7.2
France	Chemicals and P.	27.7	27.3	France	Textile and Leather	3.8	46.2
Germany	Chemicals and P.	0.7	40.5	Germany	Textile and Leather	4.1	15.1
Greece	Chemicals and P.	72.3	22.7	Greece	Textile and Leather	11.5	3.9
Ireland	Chemicals and P.	3.0	2.4	Ireland	Textile and Leather	27.2	0.0
Italy	Chemicals and P.	9.5	38.4	Italy	Textile and Leather	3.2	13.1
Luxemb.	Chemicals and P.	5.3	0.0	Luxemb.	Textile and Leather	0.0	0.0
Netherl.	Chemicals and P.	30.1	46.8	Netherl.	Textile and Leather	0.0	21.9
Portugal	Chemicals and P.	35.5	16.6	Portugal	Textile and Leather	4.2	12.3
Spain	Chemicals and P.	15.2	68.4	Spain	Textile and Leather	9.4	18.3
Sweden	Chemicals and P.	16.2	5.8	Sweden	Textile and Leather	14.4	2.5
UK	Chemicals and P.	2.6	45.3	UK	Textile and Leather	6.9	34.4
Austria	Food and Tob.	4.1	21.5	Austria	Transport Equip.	9.1	3.4
Belgium	Food and Tob.	5.2	15.7	Belgium	Transport Equip.	0.0	4.7
Denmark	Food and Tob.	8.6	11.0	Denmark	Transport Equip.	3.6	5.3
Finland	Food and Tob.	6.6	4.5	Finland	Transport Equip.	5.5	0.0
France	Food and Tob.	4.4	20.0	France	Transport Equip.	0.4	6.0
Germany	Food and Tob.	4.1	14.9	Germany	Transport Equip.	0.6	3.4
Greece	Food and Tob.	11.1	7.8	Greece	Transport Equip.	15.8	0.0
Ireland	Food and Tob.	7.3	9.8	Ireland	Transport Equip.	4.9	0.0
Italy	Food and Tob.	7.3	17.3	Italy	Transport Equip.	0.0	0.0
Luxemb.	Food and Tob.	9.9	0.0	Luxemb.	Transport Equip.	0.0	0.0
Netherl.	Food and Tob.	0.4	30.8	Netherl.	Transport Equip.	0.3	4.2
Portugal	Food and Tob.	13.3	5.3	Portugal	Transport Equip.	0.2	5.2
Spain	Food and Tob.	6.5	12.2	Spain	Transport Equip.	2.4	4.9
Sweden	Food and Tob.	9.7	9.3	Sweden	Transport Equip.	1.9	0.4
UK	Food and Tob.	3.3	22.9	UK	Transport Equip.	1.5	8.7

Units: Thousands of tonnes of oil equivalent (ktoe) per billion Euro of output at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

Table A2

Petroleum products and natural gas intensities of EU-15 industries, part II

Country	Industry	Pet. Prod. Int.	Nat. Gas Int.	Country	Industry	Pet. Prod. Int.	Nat. Gas Int.
Austria	Machinery	1.2	3.4	Austria	Wood and Prod.	4.1	11.6
Belgium	Machinery	0.9	0.1	Belgium	Wood and Prod.	0.0	5.1
Denmark	Machinery	3.1	4.6	Denmark	Wood and Prod.	6.7	2.4
Finland	Machinery	0.6	0.1	Finland	Wood and Prod.	6.8	1.1
France	Machinery	2.0	5.0	France	Wood and Prod.	3.2	0.0
Germany	Machinery	1.6	3.9	Germany	Wood and Prod.	3.6	7.9
Greece	Machinery	1.3	0.4	Greece	Wood and Prod.	2.5	1.0
Ireland	Machinery	2.3	0.0	Ireland	Wood and Prod.	7.4	0.0
Italy	Machinery	2.7	9.0	Italy	Wood and Prod.	0.0	0.0
Luxemb.	Machinery	0.0	0.0	Luxemb.	Wood and Prod.	0.0	0.0
Netherl.	Machinery	11.8	7.1	Netherl.	Wood and Prod.	0.4	6.3
Portugal	Machinery	3.1	1.7	Portugal	Wood and Prod.	7.6	3.1
Spain	Machinery	2.5	6.0	Spain	Wood and Prod.	6.0	14.5
Sweden	Machinery	2.4	0.2	Sweden	Wood and Prod.	3.9	0.0
UK	Machinery	0.9	7.8	UK	Wood and Prod.	1.2	0.0
Austria	Mining and Quarr.	NA	NA	Austria	Total industry	4.8	19.4
Belgium	Mining and Quarr.	12.2	1.7	Belgium	Total industry	5.8	22.6
Denmark	Mining and Quarr.	116.9	51.6	Denmark	Total industry	8.3	9.7
Finland	Mining and Quarr.	14.8	0.0	Finland	Total industry	10.4	7.0
France	Mining and Quarr.	23.5	8.8	France	Total industry	7.9	16.8
Germany	Mining and Quarr.	14.5	29.7	Germany	Total industry	2.6	14.3
Greece	Mining and Quarr.	100.1	0.0	Greece	Total industry	38.9	10.2
Ireland	Mining and Quarr.	22.0	11.6	Ireland	Total industry	9.1	3.7
Italy	Mining and Quarr.	8.5	5.6	Italy	Total industry	7.6	19.8
Luxemb.	Mining and Quarr.	71.8	0.0	Luxemb.	Total industry	8.1	53.3
Netherl.	Mining and Quarr.	NA	NA	Netherl.	Total industry	9.3	27.3
Portugal	Mining and Quarr.	NA	NA	Portugal	Total industry	20.2	14.6
Spain	Mining and Quarr.	40.6	49.2	Spain	Total industry	11.8	29.6
Sweden	Mining and Quarr.	24.2	0.0	Sweden	Total industry	11.1	1.9
UK	Mining and Quarr.	20.0	0.0	UK	Total industry	11.1	19.3
Austria	Non-Met. Min.	18.1	57.7	Austria	Construction	28.4	1.6
Belgium	Non-Met. Min.	38.4	50.7	Belgium	Construction	1.7	1.8
Denmark	Non-Met. Min.	96.4	52.6	Denmark	Construction	5.8	0.2
Finland	Non-Met. Min.	36.7	18.1	Finland	Construction	15.7	0.0
France	Non-Met. Min.	55.9	81.6	France	Construction	5.2	1.4
Germany	Non-Met. Min.	28.2	80.8	Germany	Construction	2.1	0.6
Greece	Non-Met. Min.	177.6	21.4	Greece	Construction	10.7	0.0
Ireland	Non-Met. Min.	92.3	11.1	Ireland	Construction	0.0	0.0
Italy	Non-Met. Min.	73.8	86.2	Italy	Construction	0.4	0.0
Luxemb.	Non-Met. Min.	8.4	0.0	Luxemb.	Construction	5.8	0.0
Netherl.	Non-Met. Min.	3.2	99.9	Netherl.	Construction	1.7	1.3
Portugal	Non-Met. Min.	148.7	105.7	Portugal	Construction	10.8	0.2
Spain	Non-Met. Min.	76.2	118.0	Spain	Construction	0.8	0.2
Sweden	Non-Met. Min.	50.2	5.3	Sweden	Construction	0.0	0.0
UK	Non-Met. Min.	12.0	58.5	UK	Construction	0.7	0.8
Austria	Non-spec. Ind.	1.2	6.2	Italy	Non-spec. Ind.	4.1	9.1
Belgium	Non-spec. Ind.	20.7	5.9	Luxemb.	Non-spec. Ind.	41.8	249.3
Denmark	Non-spec. Ind.	2.8	5.5	Netherl.	Non-spec. Ind.	0.3	10.1
Finland	Non-spec. Ind.	24.6	0.0	Portugal	Non-spec. Ind.	0.2	3.5
France	Non-spec. Ind.	5.2	4.2	Spain	Non-spec. Ind.	5.4	39.4
Germany	Non-spec. Ind.	3.4	5.0	Sweden	Non-spec. Ind.	11.6	1.2
Greece	Non-spec. Ind.	106.7	4.5	UK	Non-spec. Ind.	70.6	10.7
Ireland	Non-spec. Ind.	7.1	9.2				

Units: Thousands of tonnes of oil equivalent (ktoe) per billion Euro of output at current prices.

Source: IEA Energy Balances, Eurostat and own calculations.

APPENDIX B – Oil imports by source country

Table B1

Crude oil import shares by (non-EU) source country, 2005

SOURCE	EU-15	BE	DE	GR	ES	FR	IT	NL	AT	PT	FI	SE	UK
Russia	25.8%	47.8%	40.3%	32.3%	14.6%	12.4%	20.6%	31.7%	28.9%	0.0%	93.5%	51.0%	10.1%
Norway	18.7%	9.8%	18.3%	0.0%	5.0%	20.7%	3.7%	12.8%	0.0%	1.9%	2.3%	35.9%	74.4%
Saudi Arabia	11.7%	18.8%	4.4%	31.1%	10.8%	13.3%	14.1%	23.8%	14.8%	8.9%	0.0%	0.0%	2.6%
Libya	9.7%	0.2%	13.6%	6.9%	10.5%	5.8%	26.1%	0.9%	4.2%	5.4%	0.0%	0.0%	1.1%
Iran	6.8%	16.1%	0.5%	28.6%	8.4%	8.8%	10.7%	4.2%	6.9%	2.7%	0.0%	4.1%	0.0%
Algeria	4.4%	0.0%	4.8%	0.0%	3.6%	6.9%	3.3%	5.7%	0.3%	23.1%	0.0%	0.0%	3.2%
Kazakhstan	4.3%	0.0%	7.8%	0.3%	0.0%	11.0%	3.4%	1.0%	20.1%	6.5%	4.2%	0.0%	0.0%
Nigeria	3.6%	1.1%	2.2%	0.3%	12.2%	3.7%	1.7%	3.1%	16.0%	10.0%	0.0%	0.9%	0.6%
Iraq	2.4%	0.9%	0.0%	0.6%	5.0%	1.9%	6.6%	1.4%	0.0%	7.5%	0.0%	0.0%	0.0%
Mexico	2.0%	0.0%	0.0%	0.0%	15.4%	0.0%	0.1%	0.0%	0.0%	8.3%	0.0%	0.0%	0.9%
Syria	1.7%	0.2%	3.6%	0.0%	0.9%	1.6%	2.9%	0.6%	2.2%	0.0%	0.0%	0.0%	1.4%
Kuwait	1.5%	0.2%	0.0%	0.0%	0.0%	3.1%	0.3%	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Other	1.4%	0.4%	0.4%	0.0%	3.9%	1.1%	0.7%	1.9%	0.0%	7.6%	0.0%	0.0%	1.9%
Angola	1.4%	1.5%	0.2%	0.0%	2.9%	5.5%	0.2%	0.3%	0.0%	1.1%	0.0%	0.0%	0.1%
Venezuela	1.3%	2.9%	1.4%	0.0%	1.9%	0.2%	0.0%	1.9%	0.0%	0.0%	0.0%	8.0%	2.9%
Azerbaijan	1.1%	0.0%	1.0%	0.0%	0.0%	1.7%	3.2%	0.0%	4.4%	0.0%	0.0%	0.0%	0.0%
Cameroon	0.7%	0.1%	0.0%	0.0%	2.9%	0.5%	1.2%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Brazil	0.5%	0.0%	0.5%	0.0%	0.2%	0.4%	0.0%	0.8%	0.0%	10.4%	0.0%	0.0%	0.0%
Egypt	0.3%	0.0%	0.6%	0.0%	0.0%	0.1%	0.8%	0.1%	0.0%	0.0%	0.0%	0.0%	0.6%
Tunisia	0.3%	0.0%	0.3%	0.0%	0.9%	0.3%	0.1%	0.3%	2.3%	0.0%	0.0%	0.0%	0.0%
UAE	0.2%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	6.6%	0.0%	0.0%	0.2%
Gabon	0.1%	0.0%	0.0%	0.0%	0.3%	0.4%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Congo	0.1%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Turkey	0.1%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ukraine	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Congo, DR	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total extra-EU27	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total (ths tonnes)	519587	28083	94696	18699	58552	77640	89315	53486	7630	12913	9143	13985	50225

Notes: Ireland and Denmark (not shown) import 100% of their (non-EU) crude oil from Norway. The quantities were 2500 and 2720 thousand tonnes respectively in 2005. Luxembourg does not use crude oil at all as it has no refining capacity.

Country codes: BE=Belgium, DE=Germany, GR=Greece, ES=Spain, FR=France, IT=Italy, NL=Netherlands, AT=Austria, PT=Portugal, FI=Finland, SE=Sweden, UK=United Kingdom.

Source: Eurostat and own calculations.

APPENDIX C – Transport and storage indicators

Table C1

Security stockholdings of petroleum products by category

COUNTRY	ASSESSED	CATEGORY I		CATEGORY II		CATEGORY III		TOTAL	
		Days (1)	1000 t	Days (1)	1000 t	Days (1)	1000 t	Days (1)	1000 t
Belgium	30.06.07	142	682	67*	2,455	232	740	87	3,877
Denmark	30.06.07	127	482	117	1,143	432	566	147	2,191
Germany	30.06.07	127	7,664	110	18,862	178	2,968	119	29,494
Greece	30.06.07	98	1,083	100	2,345	110	846	102	4,274
Spain	31.07.07	122	2,423	98	10,307	149	2,588	107	15,318
France	30.06.07	117	3,252	104	15,051	201	1,831	111	20,134
Ireland	31.07.07	96	449	106	1,527	114	407	105	2,383
Italy	31.07.07	103	3,275	96	8,311	271	5,876	125	17,462
Luxembourg	30.06.07	98	120	92	616	100	1	93	737
Netherlands	31.07.07	217	2,427	158	4,795	11,998	1,560	211	8,782
Portugal	30.06.07	161	740	111	1,884	167	816	130	3,440
UK	30.06.07	99	3,698	88**	7,469	850	1,674	103	12,841
Austria	30.06.07	151	754	98	2,060	337	1,012	132	3,826
Sweden	30.06.07	115	1,279	95	1,475	301	1,124	127	3,878
Finland	30.06.07	116	596	155	1,950	160	667	147	3,213
EU-15 Total	**N.A.**	**121**	**28,924**	**103**	**80,250**	**230**	**22,676**	**118**	**131,850**

Key: * not in compliance (90-day rule); ** preliminary data; (1) equivalent volume in terms of days of consumption;

Category I : Motor spirit and aviation fuel of gasoline type
Category II : Gasoil, diesel oil, kerosene and jet-fuel
Category III : Fuel oils

Source: DG Energy web-site, data as available on 6 November 2007.

Table C2

Underground gas storage capacities by country, 2004/2005

Country	**Number of facilities**	**Total working volume (mn m3)**
Germany	42	19,179
Italy	10	17,415
France	15	11,643
Netherlands	3	5,000
UK	4	3,267
Austria	4	2,820
Spain	2	1,981
Denmark	2	820
Belgium	1	550
Ireland	1	210
Sweden	1	9
EU-15 Total	**85**	**62,894**

Comment: the EU-15's total primary energy supply (TPES) in natural gas was 384,429 thousands of tonnes of oil equivalent. Assuming an average gross calorific value for natural gas of 39,000 kilojoules per cubic metre (Russian natural gas has an average GCV of 38,231, Algerian 42,000 and Norwegian 39,520), one finds an estimate of EU-15 TPES in natural gas of 412,700 million cubic metres. In other terms, total underground gas storage capacity amounts to approximately 55 days of consumption at 2005 levels. This suggests that more should be done to increase this total capacity, e.g. up to a total of 90 days of consumption.

Source: International Gas Union (2006), 'Underground Storage of Gas', June.

Table C3

Exports of crude oil from the Former Soviet Union, by type of route

Millions of barrels per day	2006q3	2006q4	2007q1	2007q2	Shares 2006q2	Latest data: Average of July and August 07	Countries of origin
Black Sea	2.27	2.08	2.30	2.23	35%	2.07	KAZ, RUS, AZE
Baltic Sea	1.49	1.43	1.58	1.60	25%	1.54	RUS
Arctic and Far East	0.20	0.19	0.29	0.30	5%	0.41	RUS
Ceyhan (BTC pipeline)	0.22	0.38	0.43	0.58	9%	0.68	AZE
Total seaborne	**4.18**	**4.08**	**4.60**	**4.71**	**75%**	**4.70**	**ALL**
Druzhba pipeline	1.23	1.19	1.17	1.13	18%	1.05	RUS (mostly), KAZ
Other routes	0.38	0.45	0.47	0.46	7%	0.44	ALL
Total exports	**5.79**	**5.72**	**6.24**	**6.30**	**100%**	**6.18**	**ALL**
Total (mn tonnes)	*290*	*286*	*312*	*315*	*100%*	*309*	*ALL*

Note: The data excludes intra-CIS trade, e.g. Russian exports of crude oil to Ukraine.

Comment: the Baku-Tbilisi-Ceyhan (BTC) pipeline is progressively being used to capacity. The August 2007 throughput was 0.72 million barrels per day, as against a full capacity of 1 million barrels per day.

Source: IEA Oil Market Report, 11 October 2007 (constructed from estimates by Petrologistics Ltd and IEA).

Table C4

Selected existing and planned oil pipelines for Westbound CIS resources

Name	Origin	Destination	First stage capacity	Second stage capacity	Existing vs. Planned	Notes
Baku-Tbilisi-Ceyhan (BTC)	Baku (AZE) (Caspian)	Ceyhan (TUR) (Med.)	1.0	1.5	E	1
Trans-Caspian Oil Pipeline	Aktau (KAZ) (Caspian)	Baku (AZE) (Caspian)	0.5	-	P	2
Samsun-Ceyhan Pipeline (SCP)	Samsun (TUR) (Black S.)	Ceyhan (TUR) (Med.)	1	1.5	P	3
Western Early	Baku (AZE) (Caspian)	Supsa (GEO) (Black S.)	0.115	-	E	4
Caspian Pipeline Consortium (CPC)	Tengiz (KAZ)	Novorossisk (RUS) (Black S.)	0.61	1.4	E	5
Druzhba	Russian oil fields	Central Europe	1.3	1.5	E	6
Druzhba-Adria Pipeline Integration	Druzhba pipeline	Omisalj (HRV) (Med.)	0.1	0.3	P	7
Burgas-Alexandroupolis (BA)	Burgas (BGR) (Black S.)	Alexandroupolis (GRC) (Med.)	0.3	0.7	P	8
Pan European Oil Pipeline (PEOP)	Constanta (ROU) (Black S.)	Trieste (ITA) (Med.)	1.2	-	P	9
Albania-Macedonia-Bulgaria (AMBO)	Burgas (BGR) (Black S.)	Vlore (ALB) (Med.)	0.75	-	P	10
Odessa-Brody	Odessa (UKR) (Black S.)	Gdansk (POL) (Baltic)	0.18 - 0.28	0.9	E	11
Baltic Pipeline System (BPS)	Russian oil fields	Primorsk (RUS) (Baltic)	0.24	1.3	E	12
Druzhba-Ventspils	Russian oil fields	Ventspils (LVA) (Baltic)	NA	NA	E	13
Druzhba-Butinge / Mazeikiu	Russian oil fields	Butinge (LTU) (Baltic)	NA	NA	E	14

Units: capacities are expressed in millions of barrels per day.

Notes:

(1) Started operating 2006, should utilize full capacity ~ 2009; second stage depends on Aktau-Baku pipeline or other options for Kazakh oil.

(2) Accord signed between AZE and KAZ; But KAZ-RUS relations are complex. A core element of the "New Great Game" between Russia and the West.

(3) Construction started in April 2007. Expected start of operation in 2010. Purpose is to ship both Russian and Caspian oil to the Mediterranean. Other names: SCCOP - Samsun-Ceyhan Crude Oil Pipeline and Trans Anatolian Pipeline (TAP);

(4) Of limited use due to new BTC pipeline; we do not list the Baku-Novorossisk pipeline for the same reason;

(5) Second stage delayed due to Russian disagreement on transit fees

(6) The Druzhba pipeline separates into two main branches in Eastern Europe. The northern branch goes to Poland and Germany. The southern branch goes to Slovakia, Hungary and the Czech Republic. The Druzhba-Adria project would connect with the southern branch. An expansion is planned for 2010.

(7) Status unclear, though current Ukrainian Presidency is in favour.

(8) Trilateral agreement signed between Russia, Greece and Bulgaria in March 2007. Likelihood of completion very high, with construction to start in 2008 and operation scheduled to start in 2011. Should primarily ship Russian crude to the Eastern Mediterranean.

(9) Now seems very likely to go ahead as planned after Croatia, Italy, Romania, Serbia, and Slovenia signed a joint agreement to start construction in April 2007.

(10) High likelihood of going ahead. Trilateral agreement ratified by parliaments, 80% of financing secured, support from the EU and the USA.

(11) Initially the idea was to bring Caspian oil to Poland and the Baltic Sea, i.e. a supply diversification project by-passing Russia. Russian pressure on Ukraine resulted in the pipeline being used in the reverse direction, taking Russian oil from Druzhba at Brody down to Odessa. The most recent development is that the initial plan may go ahead after the signing of multilateral agreements was announced by Ukraine at the Vilnius Conference in October 2007 involving Ukraine, Poland, Lithuania, Azerbaijan and Georgia. Finally an additional branch through Slovakia to the Czech Republic is also under consideration.

(12) Launched in 2001, second stage completed April 2006; Primorsk is ice-free only around 260 days per year and would not have made sense in Soviet days

(13) Traditionally Russia's main Baltic outlet, traffic now strongly reduced due to BPS alternative and poor relations with Russia.

(14) Temporarily used by Russia as a partial alternative to Ventspils. Rocked by multiple supply disruptions by Russia. Supply totally cut off since mid-2006. The refinery at Mazeikiu (the only one in the Baltic states), now gets oil by tanker arriving at Butinge. The pipeline branch from Russia will likely remain closed.

Source: EIA, media reports, company web-sites.

Table C5

Gazprom's westbound export pipelines

Pipeline name(s)	Transits through	Destination	Current capacity	Planned capacity
Soyuz and Brotherhood	Ukraine	Slovakia, Hungary, Romania	130	130
Northern Lights (1)	Belarus, Ukraine	Poland, Slovakia	25	25
Trans-Balkan	Ukraine, Moldova	Bulgaria, Turkey, Balkans	20	20
Finland Connector	-	Finland	20	20
Yamal-Europe	Belarus	Poland, Germany	28	28
Blue Stream (2)	Black Sea	Samsun (TR) (Black Sea)	16	16
Nord Stream (3)	Baltic Sea	Greifswald (D) (Baltic Sea)	-	55
South Stream (4)	Black Sea, Bulgaria	Italy and Austria	-	30
Total Capacity (5)			**239**	**324**

Units: billions of cubic metres per year.

Notes:

(1) The complete Northern Lights has a larger capacity deeper in Russia. Part of it branches off into Yamal-Europe. Here we refer to the remaining branch which starts in Belarus and heads down south into Western Ukraine / Eastern Slovakia.

(2) An extension running from Turkey into Europe is under consideration (competes with Nabucco).

(3) Construction has started on the Russian side (on land). Environmental concerns are leading to a complex debate for the German-Russian consortium behind the project, notably a recent change in the planned under-sea route the pipeline should take. If all goes to plan the first of two parallel lines should operate from 2010 (27.5 bcm) and the second from 2012 (a further 27.5 bcm per year). An initial option of extending the line to the UK through Belgium and The Interconnector has been replaced by an option to extend to the Netherlands, including an option to supply the UK through the BBL pipeline. Options of branches to Sweden and Kaliningrad are also under consideration. Poland and the three Baltic States voice strong opposition to the entire project.

(4) South Stream would have either one of the two following branches or both. The first branch would run through Greece and onto Southern Italy, the other would run through Romania, Serbia (optional), Hungary and Slovenia and then onto Northern Italy, with a smaller branch to Austria. A Memorandum of Understanding between Italy and Russia was signed in June 2007 and Bulgaria announced its official approval in January 2008. Completion is therefore highly likely.

(5) The total capacities shown may be compared to current Gazprom export volumes, which were approximately 248 billion m3 in 2006 for the entire market served by the set of pipelines listed in the table (Europe, Turkey and Western CIS). This suggests that current routes are operating at full capacity, while the remaining discrepancy may be due to measurement and rounding errors. A part of the capacity indicated, e.g. a large part of the supplies to Ukraine, is used up by Central Asian natural gas (e.g. from Turkmenistan) which transits through Russia.

Sources: www.gazprom.com, DGO and Forschungstelle Osteuropa, media reports.

Table C6

Westbound pipelines for (non-Russian) Caspian gas

Pipeline name	Origin	Transits through	Destination	Current capacity	Planned capacity	Notes
Central Asian Center	Turkmenistan	Uzbekistan, Kazakhstan, Russia	Soyuz and Brotherhood	44	55 – 90	1
South Caucasus Pipeline	Baku (AZE)	Georgia, Turkey	Erzerum (TUR)	16	16	2
Trans-Caspian Pipeline	Turkmenistan, Kazakhstan	Caspian Sea	Baku (AZE)	-	30	3
Nabucco Project	Erzerum (TUR)	Turkey, Bulgaria, Romania, Hungary	Austria	-	30	4
White Stream	Georgia	Black Sea, Ukraine (Crimea)	Poland or Romania	-	8 – 32	5
Turkey-Greece Pipeline	Turkey	Marmara Sea	Greece	7	11	6
Greece-Italy Pipeline	Greece	Mediterranean	Italy	-	9 – 10	7
Trans Adriatic Pipeline (TAP)	Greece	Albania, Adriatic	Italy	-	10	8

Units: billions of cubic metres per year.

Notes:

(1) Russia has signed new agreements with Kazakhstan and Turkmenistan in May 2007 for renovation and expansion. The pipeline could reach the planned capacity of 55 bcm per year by 2010, while even more ambitious expansions (up to 90 bcm per year) are also under discussion.

(2) First deliveries started in December 2006.

(3) would then be connected to the South Caucasus Pipeline

(4) consortium led by OMV; if all goes to plan: construction starts in 2008, completed in 2011. In competition with Russian extension of Blue Stream.

(5) The pipeline would branch off the existing South Caucasus Pipeline close to Tbilisi and thus expand and diversify the export route for Azerbaijani (and potentially other Caspian) natural gas. Extensions of capacity up to 32 bn m3 would be considered if the Trans-Caspian Pipeline is built.

(6) This pipeline has recently been completed, and an expansion to 11 bcm per year is planned for 2012, with the expectation of allocating 8 bcm to Italy which would be carried either by the Greece-Italy Pipeline or by the Trans Adriatic Pipeline.

(7) Construction should start in 2008 and operation in 2011. The goal is to bring Caspian gas (through Turkey and Greece) to Italy.

(8) In many ways a competing project w.r.t. the Greece-Italy Pipeline and has roughly the same time-line.

Sources: EIA, media reports, company web-sites.

Table C7

Selected North Sea and Baltic pipelines and interconnectors

Pipeline name	Connected countries	Current capacity	Planned capacity	Notes
Norpipe	Norway to Germany	14	14	
Europipe I	Norway to Germany	18	18	
Europipe II	Norway to Germany	24	24	
Franpipe	Norway to France	15	15	
Zeepipe	Norway to Belgium	13	13	
Tyra West - F3 Pipeline	Denmark to Netherlands	5.5	5.5	
Vesterled	Norway to UK	12	12	
Langeled	Norway to UK	20	20	
The Interconnector	UK and Belgium	25.5	25.5	1
BBL (Balgzand Bacton Line)	Netherlands to UK	15	15	2
Baltic Pipe	Denmark and Poland	-	5	3
Skanled	Norway to Sweden and Denmark	-	7 - 8.75	4
Baltic Gas Interconnector	Germany, Denmark, Sweden	-	3	
Balticconnector	Finland and Estonia	-	2	5

Units: billions of cubic metres per year.

Notes:

(1) The Interconnector has a lower capacity (20 bcm) in the UK to Belgium direction, however what is relevant for the future is the recently increased capacity in the Belgium to UK direction, given the UK's fast-changing natural gas balance.

(2) Started operation in December 2006 and at full capacity would account for 15% of total UK consumption at 2006 levels.

(3) This project was dormant, then revived in 2007 but is still at the evaluation stage. Potentially it may turn out to be either a one-way pipeline for Danish (and potentially Norwegian from Skanled) gas to Poland, or an interconnector, working in both directions. In the latter case Baltic Pipe would also enable Denmark to import Russian gas through Poland.

(4) Skanled will probably be given the definitive go-ahead in 2009. If so it would be operational from late 2012. Capacity will depend on whether Baltic Pipe goes ahead.

(5) Feasibility study completed, environmental impact assessment yet to be made. If all goes to plan, the line would start operating in 2010. The primary objective is to offer Finland an alternative route for Russian gas (rather than relying only on the Finland Connector) and would thus bring Russian gas from Latvia through Estonia onto Finland. However the line could also operate in both directions, and should therefore be interpreted as an energy security / energy solidarity project between Latvia, Estonia and Finland. Although only Russian gas would transit through the line, it reduces the isolation of the countries concerned, thus reducing both the risk and the potential damage of possible Russian supply disruptions.

Sources: EIA, media reports, company web-sites.

Table C8

North African gas export pipelines to Europe

Pipeline name	Origin	Destination	Current capacity	Planned capacity
GALSI (1)	Algeria	Italy	-	9 - 10
Greenstream (2)	Libya	Italy	8	11
Maghreb-Europe	Algeria	Morocco, Spain, Portugal	8.6	11.7
Medgaz (3)	Algeria	Spain	-	8
Transmediterranean (4)	Algeria	Italy and Slovenia	24	33.5
Total capacity (5)			**40.6**	**74.2**

Units: billions of cubic metres per year.

Notes:

(1) Expected start of operation in 2008.

(2) ENI reported in December 2006 that full capacity of 8 bcm would be reached "upon completion", and announced in October 2007 plans to expand capacity by 3 bcm per year following new extraction agreements.

(3) Construction started in 2007 and start of operation is forecast for mid-2009.

(4) This pipeline (also called the Enrico Mattei Pipeline) has been in operation since the 1980s and underwent an expansion in the early 1990s. A third expansion to 33.5 bcm per year is under consideration.

(5) An analysis of North African supply capacities would require an assessment of LNG facilities.

Sources: EIA, media reports, company web-sites.

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