Unilateral natural gas import dependence: a new supply security issue for Europe[1]

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Abstract

This paper considers security of supply of energy and how the EU enlargement in 2004 affected security of supply for the EU. Security of supply depends on accessibility to primary energy sources, on system adequacy and on market adequacy. We concentrate on the longer term aspects of supply security, namely access to primary fuels and system adequacy in the gas sector and we consider some statistical measures. Regarding import fuel dependency, we conclude that the 2004 enlargement brought abundant local solid fuel sources into the EU; and brought in two completely import oil dependent nations, Cyprus and Malta. Regarding gas dependency, we conclude that natural gas dependency of continental 2004 new member states are significantly higher than the EU average; Hungary and Latvia have a combined issue of high gas dependence for electricity generation and high economic dependence on gas; that gas import dependency is significantly higher in new member states than in the old ones; and that diversification of sources of gas imports is much less for new than for old member states. Natural gas import dependency is a major energy policy issue for continental new EU members. We consider the asset and supply ownerships for gas markets in the region. A key issue also is the dominance of joint ventures of Russian Gazprom with German companies (particularly E.ON Ruhrgas) in the ownership of gas assets and in gas supplies throughout the central and east European region.

1. Introduction

Since the oil market crisis of the 1970's, energy supply security has always been a key energy policy issue to discuss and, to a limited extent, act on at a European level. The recent proposal of the European Commission [1] identifies the continent's increasing dependence on imported hydrocarbons, the insufficient mechanisms to ensure solidarity between Member States in the event of an energy crisis and the still missing predictability and efficiency of the internal energy and gas markets to host the necessary future investments as the three major security of supply challenges for Europe. Regarding the first two issues, the Commission also acknowledges that 'several Member States are largely or completely dependent on one single gas supplier.' This 'single gas supplier' refers largely to Russia and we can suspect that among the 'several' Member States there are many from those ten which joined the European Union in 2004. Indeed it seems to be the 2004 enlargement that brought the issue of unilateral natural gas import dependence onto the supply security agenda of the EU.

Security of supply depends on accessibility to primary energy sources, on system adequacy and on market adequacy. In turn, system adequacy includes both production and network adequacy. In the following analyses we concentrate on the longer term aspects of supply security, namely access to primary fuels and system adequacy in the gas sector. We provide an assessment of how the primary energy import dependency of the 2004 new member states compares to that of the old members. Special attention is paid to comparing the characteristics of gas import dependency of the old 15 member states to that of the relevant continental new ones.[2]

We can differentiate three sub-groups of 2004 new member states along technical or operational lines:

- the CENTREL group (Poland, Czech Republic, Slovakia, Hungary) and Slovenia, who have strong interconnections to continental western Europe in electricity and gas; sometimes referred to as the EU-5 group,
- the Baltic states (Estonia, Latvia, Lithuania), having no direct interconnections to UCTE countries; sometimes referred to as the EU-3 group, and
- Cyprus and Malta, being isolated systems; sometimes referred to as the EU-2 group.

[2] Cyprus and Malta do not have natural gas sectors.

EU-5 and EU-3 together are sometimes referred to as EU-8, and old member states are referred to as EU-15.

We will rely on two simple (although disputable) assumptions throughout this paper. Regarding primary energy sources, we assume that *ceteris paribus* less reliance on imported fuel and more diversity in fuel sourcing will increase supply security. For infrastructure, we associate higher capacity or capacity reserves with a higher level of supply security. We disregard the cost efficiency aspect of supply security throughout this paper.

First we assess and compare the new and old member states with regard to their primary energy balances and to the diversity in meeting their fuel demand. Special attention is paid to a deeper analysis of gas (import) dependency by country groups. Then gas infrastructure adequacy is analysed. Next a review of initiatives to improve supply security in new member states is provided. We conclude with a summary evaluation of the impact of the 2004 enlargement on EU wide energy security with regard to the aspects under investigation.

2. Access to primary energy sources

We start with examining the primary energy mix of the different country groups of the EU-25 (all members, old and new). Five main primary energy sources are considered: solid fuels, oil, natural gas, nuclear and renewable energy sources. The following characteristics are compared for EU-15 (old members), EU-5 (Central European), EU-3 (Baltic States), and EU-2 (isolated systems: Cyprus and Malta):[3]

(1) gross inland consumption (sometimes used as primary energy supply),
(2) domestic energy production,
(3) net imports, and
(4) fuel structure for electricity generation.

2.1. Gross inland consumption of primary energy sources

The left axis of Figure 1 below depicts the share of different primary energy sources in gross inland consumption, while the right axis shows the change

[3] The source of the data and of the concept definitions is, unless otherwise stated, EUROSTAT and the European Commission's Statistical Pocketbook (2006).

in gross inland energy consumption from 1990 base values for the different country groups (1990 = 1.00).

The gross inland energy consumption of the old member states plus Cyprus and Malta has been steadily increasing. Cyprus and Malta together produced by far the largest increase in consumption among the groups under investigation: an almost 60% increase in the period under investigation.

Oil is the most important fuel source for these countries. In fact, Cyprus and Malta are almost 100% dependent on imported oil to serve their energy needs. It is worth mentioning that for EU-15 the share of oil and solid fuels in primary energy consumption has decreased in the last 15 years while the share of natural gas has increased from 17% to about 25%. The popularity of gas based electricity generation[4] plays a crucial role here.

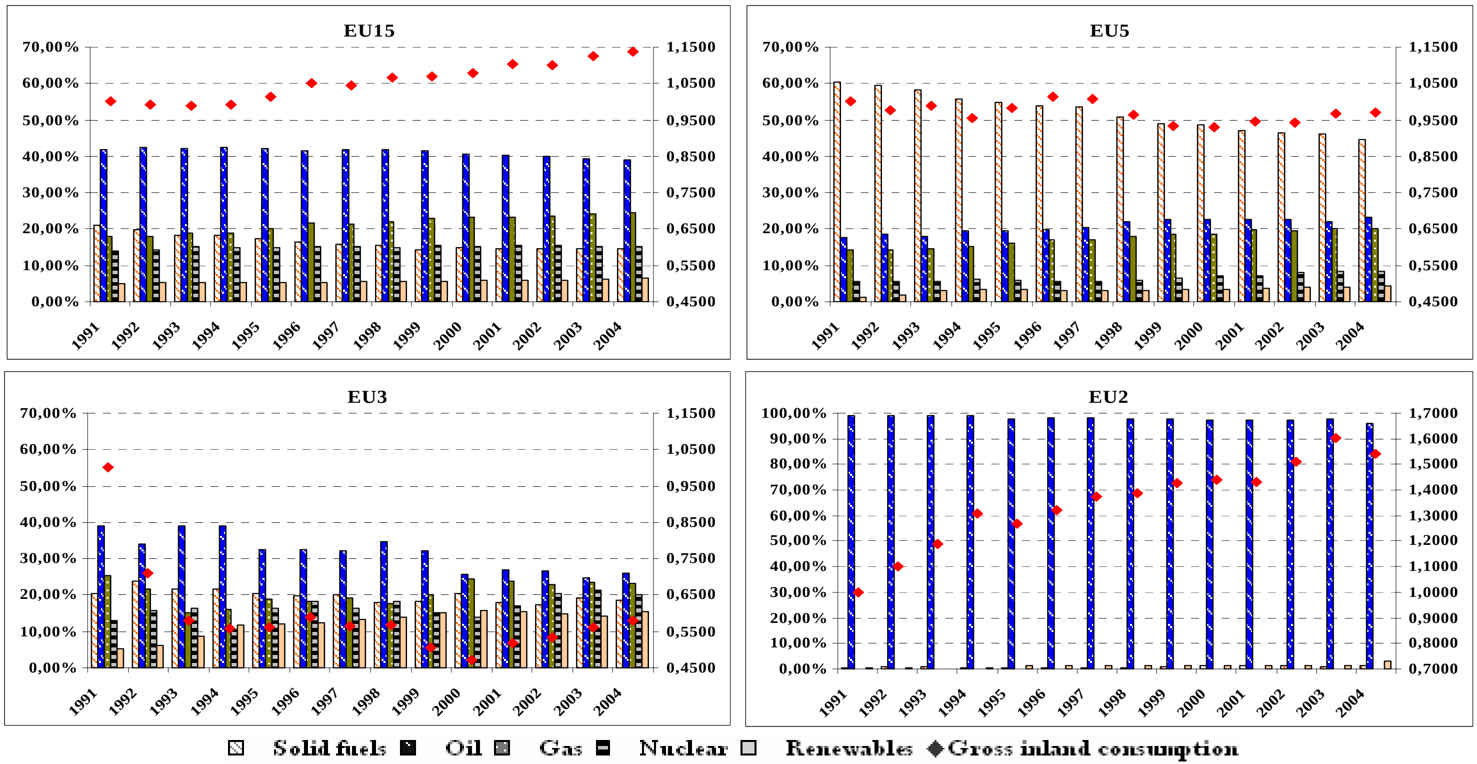
On the contrary, gross inland energy consumption has decreased in both the EU-5 and EU-3 countries in the last 15 years. While this decrease is modest in the case of EU-5, the consumption of the Baltic countries sharply dropped between 1991 and 1992 and continued to decrease until 2000, when gross inland consumption was only 45% of 1990 consumption. Since then demand has started to recover.

For EU-5 the most important primary energy source is solid fuels, that is mostly domestically produced coal and lignite in Poland and the Czech Republic. However, the share of solid fuels has decreased from 60% in 1990 to approximately 45% recently, while both oil, natural gas and nuclear have increased their share in gross final consumption.

The primary fuel mix of the Baltic States (EU-3) seems to be the most balanced. It can be noted that regarding the EU-8, the level of penetration of nuclear fuel in EU-8 is similar to that in EU-15, and the importance of gas in the primary fuel mix of EU-15 and EU-8 is almost identical.

[4] Gas based electricity generation has become more important in the last decade for at least two reasons: first, changes in efficient plant size in electricity generation (and reductions in unit cost) and second, to help meet CO2 standards.

Figure 1: Gross inland energy consumption



2.2. Domestic production

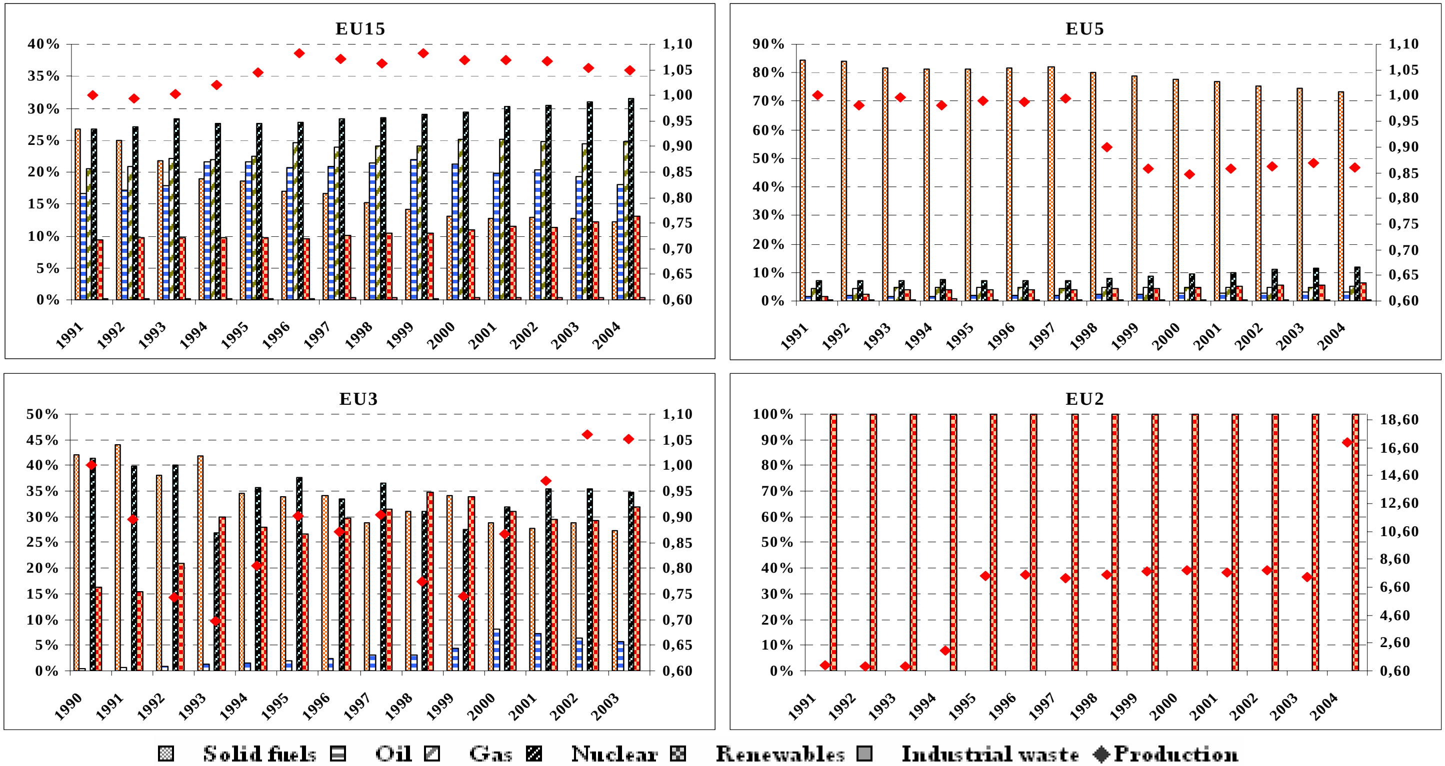
Figure 2 summarizes the trends of primary energy production for the four country groups. The left hand axis depicts the share of the five primary energy sources in total production, while the right hand axis shows the change in total production from 1990 base values (1990 = 1.00).

It can be seen that both the composition of fuels and the trend in production differ considerably between the country groups. Primary energy production of EU-15 countries increased by approximately 10% between 1993 and 1996, but has decreased moderately since then. The importance of solid fuels was decreasing in the past decade, and has been replaced mostly with nuclear and gas.

Solid fuel Czech and Polish coal mining dominate the fuel production of the EU-5 countries, while solid fuel (Estonian oil shale) and nuclear are typical for the EU-3. Malta and Cyprus have only renewable local primary energy sources to rely on.

In the Baltic countries we can see significant changes over the period. There is no domestic gas production. Their solid fuel production has been partly replaced by nuclear and renewable sources, and the share of renewable sources has increased from 15% to more than 30%.

Figure 2: Domestic production of primary energy



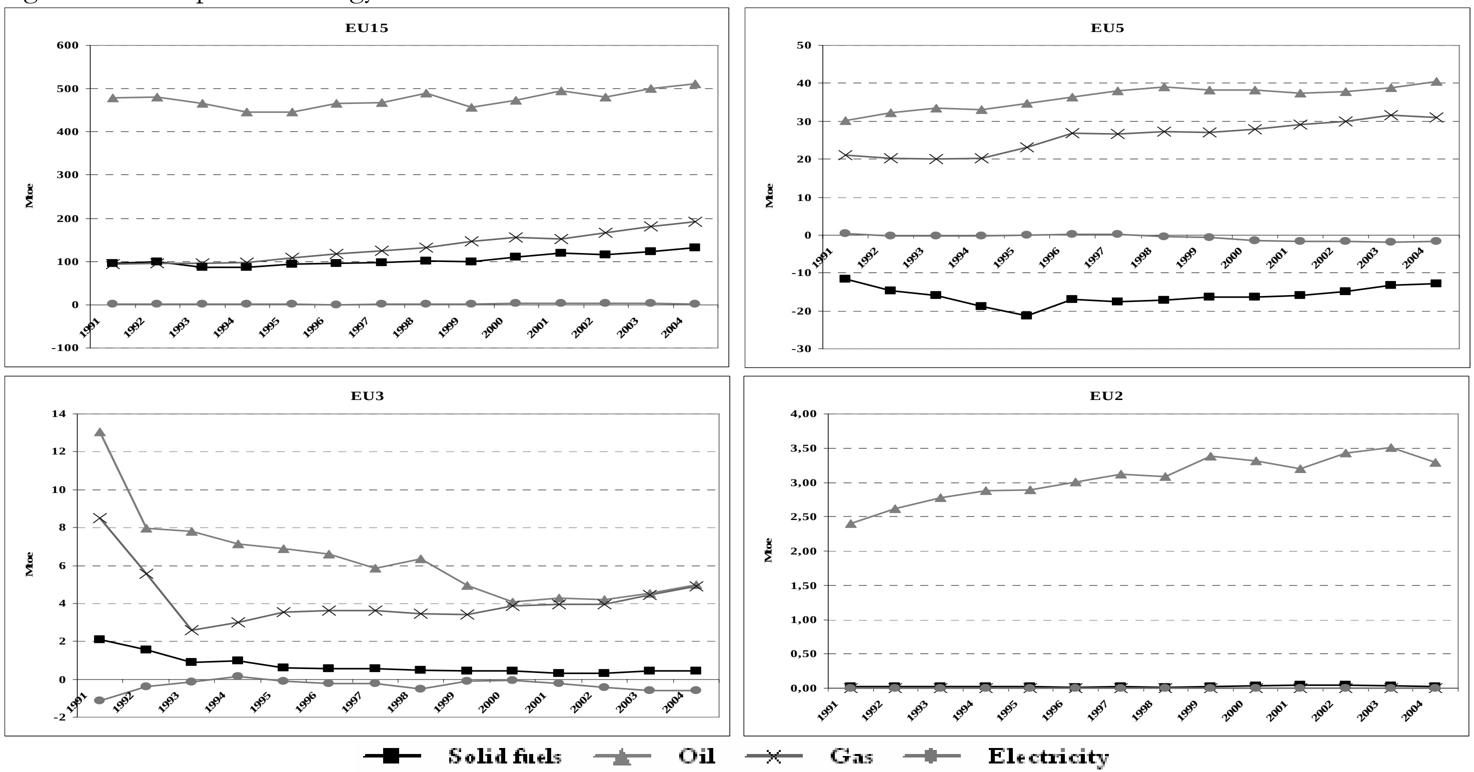
2.3. Net imports

After domestic production, we now look at the net import characteristics of the country groups. Figure 3 below indicates that for all the country groups except for the Baltic States, oil accounts for the largest amount of net imports. Since 1995 natural gas imports show the largest increase: approximately 100% increase for the EU-15, 50% for EU-5 and 25% increase for the Baltic States (EU-3).

The net imports of oil of the Baltic countries show an almost 50% fall in the early nineties. The same also applies to natural gas net imports, but the latter recovered more quickly. We can say that the recent increase in demand for primary fuel imports was supplied largely by oil and natural gas.

The two islands are totally import dependent on oil. Their net imports are around 3-3.5 Mtoe recently, which is approximately 30% more than in 1991.

Figure 3: Net imports of energy sources



2.4. Fuel structure of electricity generation

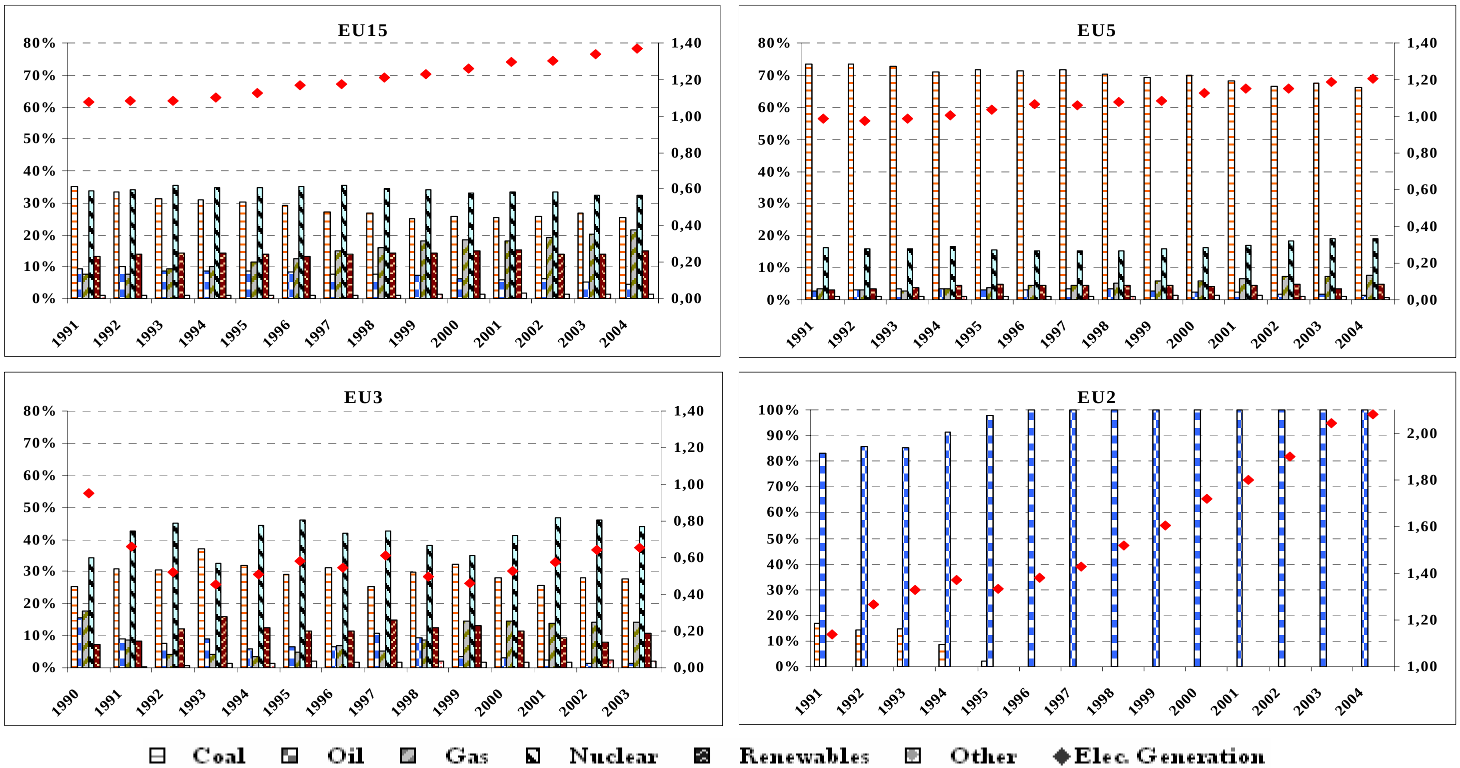
The fuel structure for electricity generation has a special relevance for energy supply security, since the availability of and secure sourcing of the different fuels significantly affect security of supply and the cost of generation. With the increasing reliance of Europe on natural gas as a fuel for electricity generation the security issues of the natural gas and electricity industries become very integrated.

How did the 2004 enlargement change the European situation in this respect? Before turning to the more in-depth analyses on fuel import dependency, let us briefly review the relevant basic statistics for the EU-25.

Regarding the fuel structure of generation, the striking feature of Figure 4 below is that while the dominant fuels in the EU-15 and the EU-3 are coal and nuclear, solid fuels play a much more prominent role in Central and Eastern Europe: while decreasing slightly over time, solid fuels are still the basis for almost 70% of generated electricity. Given that the bulk of the coal used is produced locally, the import dependency of EU-5 generation as compared to EU-15 seems less of a problem than at first sight. This picture is further strengthened by the fact that gas based generation in old member states (EU-15) on average has risen to 21% while its share in EU-5 is only around 8% and in EU-3 is 14%.

Dependency on nuclear generation is highest in the Baltic States (or more precisely, in Lithuania). Given that a precondition of EU enlargement was to gradually phase out the only major nuclear plant of the Baltic (the 1300 MW capacity of the Ignalina nuclear power plant in Lithuania), this issue is very relevant from a security of electricity supply perspective.

Figure 4: Electricity generation by fuel types



2.5. Aggregate measures of diversity in meeting fuel demand

We sum up the previous sections by providing aggregate measures to compare the diversity of meeting fuel demand for the country groups under investigation.

Diversity in meeting the fuel demand of a country or a country group, including imports, is the principal element of supply security. Diversity itself is made up of at least three subordinate properties [2].

- *Variety* refers to the number of different types of fuel to meet gross fuel demand.
- *Balance* refers to the pattern in the apportionment (spread) of that quantity across the relevant fuel categories.
- *Disparity* refers to the nature and degree to which the categories themselves are different from each other (substitution).

We calculate two versions of the *Shannon-Wiener index* (henceforth 'Shannon index') to measure the diversity of meeting fuel use for the regions under investigation.

The Shannon index is similar to the Hirschman-Herfindahl index, but, as Stirling demonstrates, it is not sensitive to the applied logarithm and it is also more robust, because it holds the additivity property [2]. The general form of the Shannon index is as follows:

$$SI = -\sum_{i=1}^{n} p_i \ln p_i$$

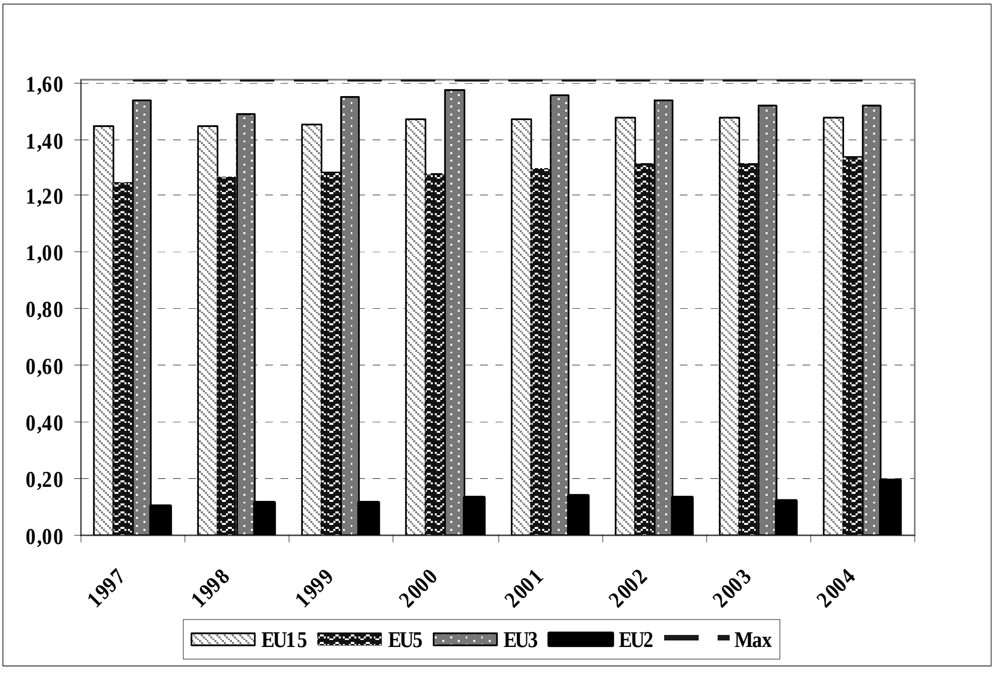
where p_i is the share of fuel type i in gross inland fuel consumption and n is the number of different fuels used.

Figure 5 depicts the Shannon index for the four country groups under investigation. The dotted (red) line above indicates the maximum value for the index in the case of five different fuel types (solid fuels, oil, gas, nuclear, renewable energy sources). [9]

[9] In the case of five alternative primary energy sources, the maximum value of the Shannon index is $s_{max} = -\ln(1/5) \approx 1.6$.

The higher the value of the Shannon index, the higher the diversification in meeting fuel consumption. It can be seen that the diversification is highest in the EU-3 region, which has been at almost the maximum value in the last few years. For the period under investigation the value of the index for old member states remained high and stable. Diversification of the EU-5 countries has been steadily improving and in 2004 it almost reached the level typical for the EU-15 group. Naturally, Malta and Cyprus are the least diversified countries with respect to their fuel imports. We can conclude that the general Shannon index indicates no significant difference in the fuel diversity of EU-8 and old member states (EU-15), thus we can conclude that in the aspect of fuel diversity the 2004 EU enlargement did not significantly change the security of supply situation of the EU.

Figure 5: Shannon index



Beyond diversity, import dependence is also a major determinant of supply security. The general form of the Shannon index is unable to account for the extent of as well as the diversity in imports to meet local demand. In order to account for that, we followed the proposal of *Hirschhausen*, and

Jansen calculated an enhanced version of the Shannon index [3] [4]. The idea behind this index is that supply security is affected not only by the share of net imports in the final consumption of fuels, but also by the diversification of import sources. Hence, in the case of this index the higher the number of sources of imports at a given import rate, the higher the diversification of fuel supply. Formally, the index takes the following form:

$$I = -\sum_{i=1}^{n} c_i\, p_i \ln p_i$$

where c_i is a correction factor for each type of primary energy source. The correction factor takes into account the share of net imports in the total consumption of a given energy source, and the rate of diversification of the import sources.

For the calculation we assume that the world markets for solid fuels, oil and nuclear fuel are highly competitive since there are a number of alternative sources as well as transportation routes available for customers. Trading in gas however is more limited by the physical infrastructure. In the case of renewable sources, the level of international trading is very low, so we disregard the potential for diversification in this regard.

Due to the above reasons, the correction factors of solid fuels, oil, nuclear and renewable sources are set equal to 1, and the correction factor of natural gas only is calculated in the following way:

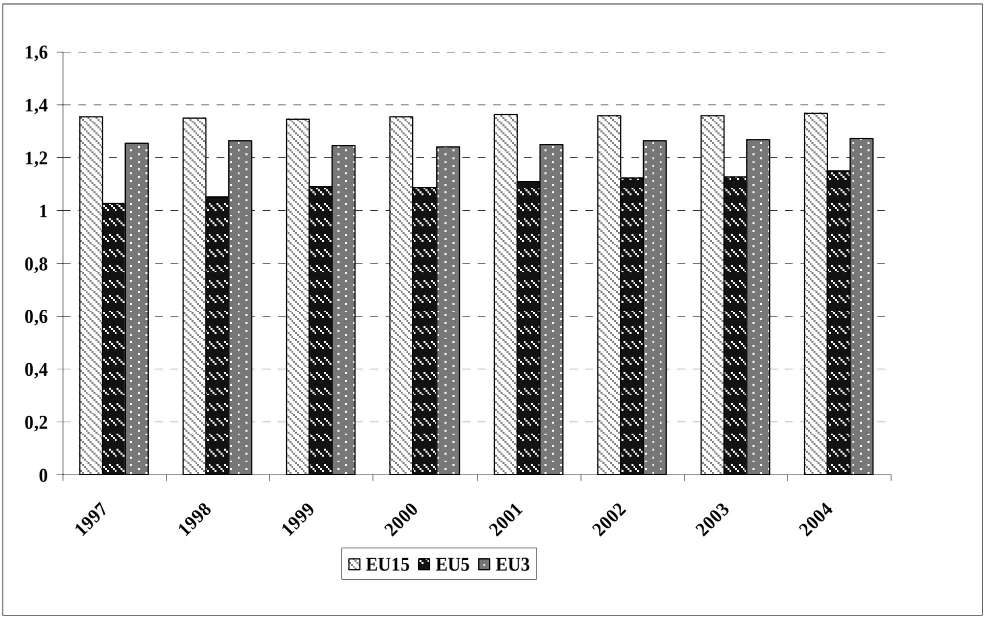
$c_{gas} = 1 - m_{gas}\left(1 - S_{gas} / S^{\max}\right)$, where m_{gas} is the share of net imports in gas consumption, S_{gas} is the Shannon index of gas import flows, $S^{\max}$ is the maximum of the Shannon index, and

$S_{gas} = -\sum_{i=1}^{n} m_{gasj} \ln m_{gasj}$, where m_{gasj} is the share of imports of gas from region *j* in the total imported gas for the given country group.[10]

Figure 6 contains the results for the period 1997-2004.

[10] The following exporting countries were considered: Belgium, Denmark, Germany, France, Italy, Netherlands, Slovakia, the United Kingdom, Croatia, Norway, Serbia and Montenegro, the Russian Federation, Ukraine, Algeria, Egypt, Libya, Nigeria, Trinidad and Tobago, Malaysia, United Arab Emirates, Iran, Oman and Qatar.

Figure 6: Import corrected Shannon index



It seems apparent that the index value for the old member states (EU-15) is more resistant to the inclusion of the gas import issue into the index calculation. On the other hand EU-3 and EU-5 Shannon index values drop significantly. This is mainly the result of the fact that the gas import diversity of the EU-5 member states is much lower than that of the old member states. They have only five big trading partners, of which the share of the Russian Federation is very high. On the other hand, old member states have significant inland sources of gas (imports from EU member states, in particular the Netherlands and the UK). Furthermore, their imports from outside the EU come mostly from three different regions: Norway, the Russian Federation and Algeria. Supplies from these three account for approximately 80% of EU-15 total net gas imports.

The drop in the Shannon index for EU-8 indicates the issue of their very high gas import dependency on Russian gas supplies. Since we consider this as the single most important supply security issue that the 2004 enlargement of the EU brought to the EU, we further analyse it at the country level in the next section.

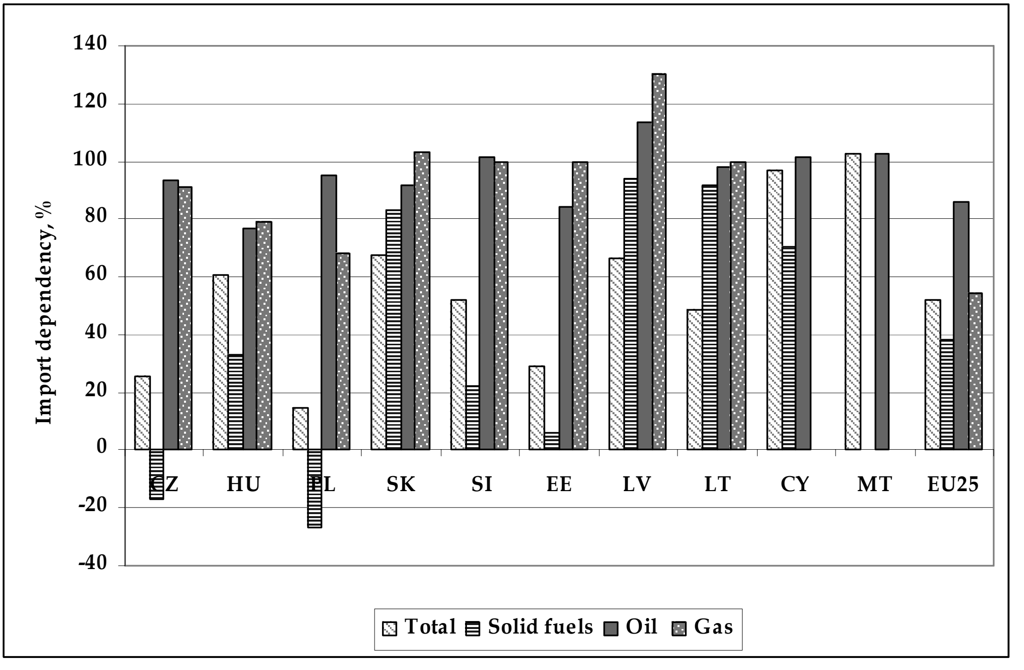
2.6. Measuring import dependency on natural gas

The natural gas industry is young in continental Europe. Its history goes back only four decades with the development of the major physical infrastructure linking production sites and consumption centres. Infrastructure development has traditionally been based on long term contracts for gas delivery. In this period the inland gas production of some EU-15 countries was significant. Gas supply has gradually been diversifying for old member states (Netherlands, Norway, UK, North Africa, LNG etc). In sharp contrast to that, for new Member States the development of the natural gas industry, including the physical infrastructure, was completely based on cooperation with the Soviet Union and within the COMECON block.

In a subsequent section, we discuss network operation and adequacy, and in this section, we analyze gas import dependency. First we consider more systematically the fuel import dependency of new member states compared to old ones. From a security of supply point of view, increased reliance on and decreased diversity in fuel imports poses a higher risk.

Figure 7 indicates the status of new member states' fuel import dependency. Import dependency from gas is higher than the EU-25 average for all those new members that use natural gas. This also applies to oil with the exception of Hungary and Estonia. The bulk of oil and gas imports for EU-5 and EU-3 countries are provided by Russia through pipeline systems. Taking all types of fuels into account, only Poland, the Czech Republic, Estonia (because of their solid fuel sources) and Lithuania (because of its nuclear energy) perform better than the EU average for measures of import dependency.

Figure 7: Net imports / total consumption* in new members, 2004



** Definition: Import Dependency = Net Imports / (Bunkers + Gross Inland Consumption). Source: Commission Pocketbook (2006).*

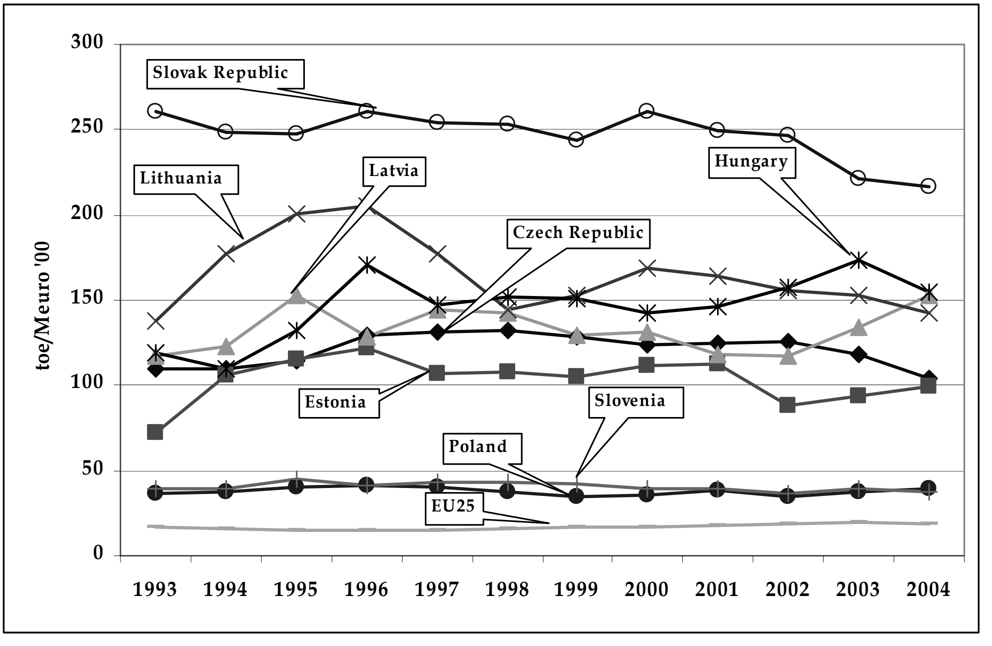
Note: A simplified formula, not taking bunkers into account, is used occasionally. This variant gives higher values for import dependency by overlooking maritime transport. Negative numbers indicate that the country is a net exporter. Values over 100 % are possible due to changes in stocks

Next we apply a measure that is generally used to measure the oil dependency of national economies [5]. This index is a combined one, and it can be expressed as follows:

*(net gas import/total GDP) = (net gas imports/total gas used) * (total gas used/total energy consumption) * (total energy consumption/total GDP).*

Therefore, it is a combination of import dependency, gas dependency and energy intensity. Figure 8 depicts the development of these values for the new member states and compares it to the EU-25 average.

Figure 8: Natural gas dependency of the economies of new Member States*

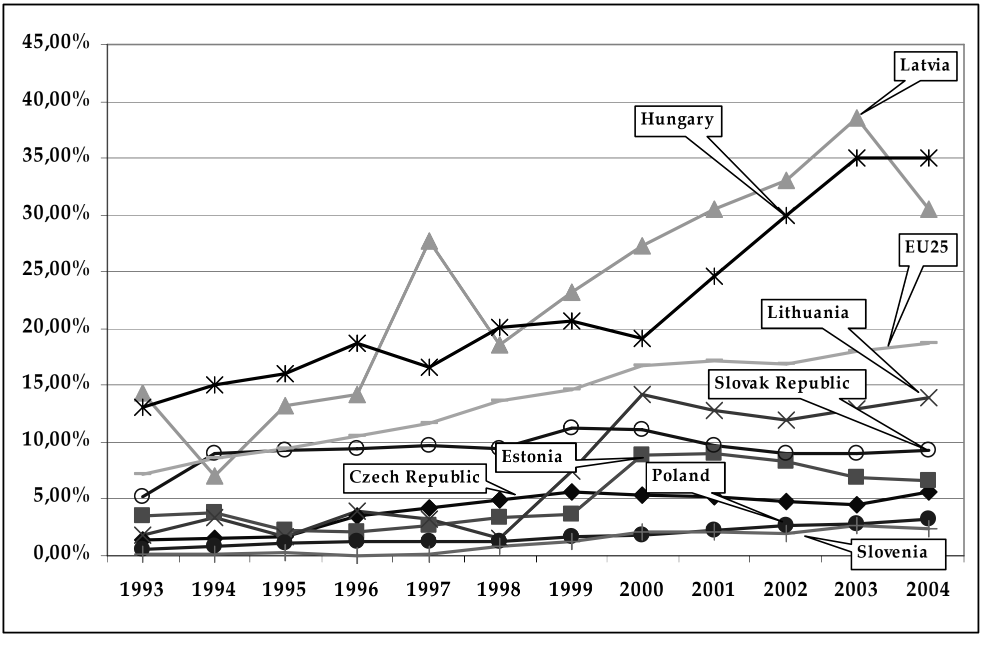


**in year 2000 euro*

The message of Figure 8 is that gas dependency of the economies of continental new member states is higher than that of the old member states by orders of magnitude. The Slovakian, Hungarian, Latvian and Lithuanian economies use 15-25 times more gas to produce a unit of GDP than the rest of EU members. On the other end, Poland and Slovenia are the least dependent economies on gas from the continental new member states group (but still more dependent than the EU average).

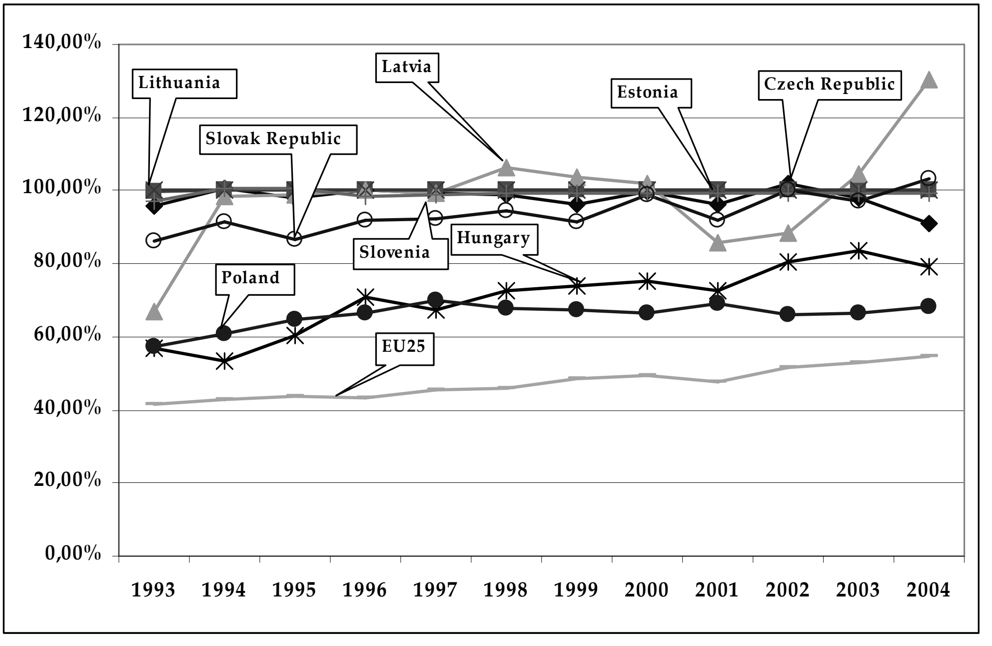
It is also worth having a look on the importance of gas in electricity generation by new member states. Figure 9 below shows that the combined issue of gas dependency of the economy and of electricity production is most apparent in Hungary and Latvia, and has become increasingly so over the period. The importance of gas in electricity generation for the rest of new members is below the EU-25 average.

Figure 9: The share of gas in electricity generation by new Member States



Finally, the level of net gas imports to total gas consumption is depicted on Figure 10. Here we can see that the gas import dependency of the new member states is well above the average for the whole EU (EU-25).

Figure 10: Net gas imports to total gas consumption



Note: Values over 100 % are possible due to changes in stocks

Table 1 provides details of sources of gas supply imports for these countries.

Table 1: Central and Eastern European new Member States' pipeline gas imports 2006 (bcm/%)

Country	PIPELINE GAS IMPORTS 2006 (bcm / year)						
	Algeria	**France**	**Germany**	**Norway**	**Russia**	**Other**	**Total**
Czech Republic				2.9 (30%)	6.8 (70%)		**9.7 (100%)**
Estonia					1 (100%)		**1 (100%)**
Hungary			0.8 (8%)		7.7 (75%)	1.8 (17%)	**10.3 (100%)**
Latvia					1.5 (100%)		**1.5 (100%)**
Lithuania					3.3 (100%)		**3.3 (100%)**
Poland			0.4 (4%)	0.4 (4%)	5.4 (61%)	2.7 (30%)	**8.9 (100%)**
Slovakia					6.4 (100%)		**6.4 (100%)**
Slovenia	0.4 (36%)				0.6 (55%)	0.1 (9%)	**1.1 (100%)**
EU-10	**0.4 (1%)**	**0 (0%)**	**1.2 (3%)**	**3.3 (8%)**	**32.7 (77%)**	**4.6 (11%)**	**42.2 (100%)**

Source: IEA, BP, Other

Although in terms of the gas molecules all imported gas supplies to all east and central European countries come from Russia, in commercial terms, some countries have managed to diversify some of their gas imports. For the group under investigation gas imports from Russia have reduced from 86% of all their gas imports in 1999 to 77% in 2006.

Even though it lies on the route of the Brotherhood Pipeline from Russia via Ukraine, and all gas flows are in an east-west direction, the Czech Republic has nevertheless been able to diversify some of its gas imports.

From taking 82% of its gas from Russia in 1999, the Czech Republic in 2006 had reduced that to 70% and took 30% of its gas supply from Norway. Hungary, Poland and Slovenia have also diversified some of their gas supplies.

The three Baltic Republics of Estonia, Latvia, Lithuania, plus Slovakia (lying right next to Ukraine) in 2006 still took 100% of their gas supplies from Russia.

In summary, of the group of 2004 new member states gas import dependency seems to create the least problems for Poland. At the other end, Hungary and Latvia seem to be the most exposed economies regarding security of gas supply.

Regarding import fuel dependency, we can conclude that the 2004 enlargement:

- Brought the EU-5 region with abundant local solid fuel sources into the European Union;
- It brought two completely import oil dependent nations, Cyprus and Malta into the Union.

With regard to gas dependency, we can conclude that:

- Natural gas dependency of the economies of continental 2004 new member states (EU-8) are significantly higher than the EU average.
- Hungary and Latvia have a combined issue of high gas dependence for electricity generation and high economic dependence on gas.
- Gas import dependency is significantly higher in new member states than in the old ones.
- Diversification of sources of gas imports is much less for new than for old member states.

As a result of the above combination of factors, gas import dependence on Russia has become the number one energy security issue for the continental 2004 new member states.

3. Gas network adequacy and future investment plans

The physical structure of the gas networks together with the fact that Russia has not implemented a regulated third party access regime to its gas transmission networks (which would allow gas transits through Russia, Ukraine or Belarus) partly explains the restricted possibilities for diversification of sources of gas imports for EU-8.

Gas networks in continental new member states reflect the East-West gas transmission routes connecting major Russian gas fields to markets in central and western Europe (Germany, Italy and points further west). North-South connections and consequent cooperation across these member states are essentially missing. The current physical gas infrastructure in the new EU-8 does not allow for much diversity of sources of gas supply.[11]

From a security of supply perspective, there are at least three aspects of the infrastructure that have to be investigated. First, whether the capacity of the current infrastructure is sufficient to serve present and forecast demand. Second, how future investment plans might change the capacity as well as the ability of the infrastructure to support diversification. Since the owners of gas TSOs have a decisive say over their willingness to enter into new gas infrastructure development projects, our third aspect relates to the ownership structure of gas TSOs in EU-8.

3.1. Gas network adequacy

This section provides an assessment of gas transport and storage capacity for EU-8 and considers some basic conditions for diversifying into bringing LNG into the region.

[11] Note also that for EU-5 new member states there is a fundamental difference between how the operations of their electricity as opposed to the gas systems changed as a result of the reorientation process from Russia to the EU. While, as a consequence of UCTE harmonization, the cooperation of the electricity system of EU-5 essentially halted with Russia back in the middle of the 1990s, in the case of gas the political changes had in fact no effect on how the gas transmission system has been operated since then.

3.1.1. Gas transport capacity at the end of 2005

The capacities of the main international gas pipelines at the border points of EU-8 countires are shown in the following table.

Table 2: Capacities at EU-10 Cross Border Nodes (End 2005)

Pipeline	Location	From	To	Max Flow rate	
				mcm/ hour	bcm/ year
Gasum Oy	Imatra	Russia	Finland	0.80	7.0
LV-LT	Kiemenai	Latvia	Lithuania	0.22	1.9
Bel-Lit	Kotlovka	Belarus	Lithuania	1.20	10.5
Yamal	Kondratki	Belarus	Poland	3.72	32.6
EuRoPol	Mallnow	Poland	Germany	3.00	26.3
Brotherhood	Velke Kapusany	Ukraine	Slovakia	12.75	111.7
Brotherhood	Drozdowicze	Ukraine	Poland	0.70	6.1
Brotherhood	Beregdaroc	Ukraine	Hungary	1.72	15.1
Stegal	Lanzhot	Slovakia	Czech	6.50	56.9
Stegal	Hora Svate Kateriny	Czech	Germany	1.83	16.0
Megal	Waidhaus	Czech	Germany	3.97	34.8
TAG, HAG	Baumgarten	Slovakia	Austria	6.00	52.6
HAG	Mosonmagyarovar	Austria	Hungary	0.50	4.4
SOL	Murfeld	Austria	Slovenia	0.42	3.7
SOL	Rogatec	Slovenia	Hungary	0.20	1.8
TAG	Gorizia	Slovenia	Italy	0.19	1.7

Source: Mercados

These various pipeline systems are the main transit pipelines to western Europe: Brotherhood from Russia through Ukraine to the Slovak Republic and its various offshoots (STEGAL and MEGAL through the Slovak and Czech Republics, TAG and WAG through Slovak Republic to Austria, HAG from Austria to Hungary) and Yamal from Russia via Poland to Germany. There are some direct pipeline routes to Finland and to Baltic countries.

These pipeline routes were established in Soviet times and the main Brotherhood and offshoot pipelines date from the mid 1980s. The pipeline system is therefore approximately 20 years old now. More recent developments have been the Yamal pipeline but Yamal II is now in doubt because of the forthcoming Baltic sea pipeline route connecting Russia directly with Germany.

In terms of network adequacy, the Brotherhood pipeline operated in 2005 at about 70% load factor. With a capacity of 111.7 bcm a year and gas flows of 81.3 bcm on the Brotherhood pipeline at the Ukraine – Slovak Republic border, there was an average load factor in 2005 of 73%. This is a well used pipeline but there is sufficient spare capacity now to cope with any demand spikes.

3.1.2. Storage

An important way of balancing gas supplies and also in reducing reliance on a single source of piped natural gas is through using gas storage. The following table shows working gas capacity for the EU-15 and EU-8 countries for three spot years. They show that while the EU-8 countries have been increasing their gas storage, it has been more or less in line with EU-15 storage increases and in line with the growth in domestic demand.

Table 3: European Gas Storage

Country	Working Capacity (mmcm) End 1998	Working Capacity (mmcm) End 2002	Working Capacity (mmcm) End 2005
Austria	2,630	3,020	2,820
Belgium	854	636	655
Denmark	770	700	810
France	10,490	10,800	10,800
Germany	15,450	18,830	18,934
Italy	9,110	12,747	12,792
Netherlands	72	2,478	2,478
Spain	1,274	1,414	2,366
UK	3,114	3,645	3,759
Total EU15	**43,764**	**54,270**	**55,414**
Czech Republic	1,700	2,059	2,285
Slovak Republic	1,700	2,740	2,740
Hungary	3,200	3,340	3,400
Poland	1,100	1,460	1,795
Total EU10	**7,700**	**9,599**	**10,220**

Source: IEA; EU-8 1998, Cedigaz

The conclusion is that EU-8 member states have not fundamentally increased gas storage capacity as a response to the EU enlargement process, or for any other reason except as a balancing tool to manage domestic demand.

The ownership unbundling of gas storage from the transportation assets has recently been completed in Slovakia and Hungary, which might come to allow an increased competition in gas storage, to set against the massive gas storage in Ukraine.

The gas storage capacity in the EU-8 countries, and indeed in the whole EU25, is dwarfed by that of Ukraine. Against the approximately 50 bcm of working gas capacity in the EU25 in 1998, Ukraine alone had 36 bcm, and half of that in one storage field.

3.1.3. LNG

None of the EU-8 countries currently have any LNG import terminals.

LNG terminals for EU-8 countries have to be on the Baltic coast (so only Poland and the three Baltic Republics could be LNG importers). The problem that all these countries face is that LNG cargoes will have to pass through the Skagerrak (the straits between Denmark and Sweden). These straits are very narrow and congested. They also pass by very populated areas (Copenhagen, the capital of Denmark, and Malmö, a major city in Sweden), and at the narrowest point (some four km) they pass by the towns of Helsingor and Helsingborg. As well as congestion through the straits the Danish Government in particular wants to keep the transport of dangerous highly inflammable liquids (oil and LNG) to a minimum.

3.2. Future investments – The fight over controlling the gas infrastructure

EU-25 demand for natural gas is increasing strongly and new gas supplies and pipeline capacity is needed. On the other hand, new member states' companies and national governments have initiated several projects with the aim of having physical infrastructure in place to support gas import diversification. These two factors combined have led to a considerable amount of activity now in developing new gas pipeline and storage projects.

Indeed, what we see is a developing sharp competition over new infrastructure development opportunities and for control over the existing strategic assets. Russia is playing a leading role in this race. Russia wishes to secure its future market share in Europe partly through participating in infrastructure development projects. Control over strategic infrastructure (present and future) is perceived as a way to manage gas supplies to the developing European gas retail markets, Russia wishes to ensure that its gas supplies can reach profitable western European markets without being diverted en-route. Control over key transit infrastructure can also serve Russian interests in channelling Central Asian, Middle East and Caucasian gas supplies to Western Europe through Russian Gazprom-controlled pipelines. The maintenance of gas import dependency of the EU-8 on Russian (or Russian controlled) supplies can provide a profitable quasi-monopoly position for Russia in the region. Finally it may help to re-vitalize or maintain Russian political influence in this part of the former Soviet block [6] [7].

The means that Russia employs to reach its strategic goals are diverse. They include proposing and developing new major pipeline routes (e.g. North European Baltic Sea pipeline project: NEBP) and the upgrading of existing ones (e.g. upgrading Brotherhood pipeline); the takeover, mostly in tandem with Eon-Ruhrgas, of significant stakes in EU-8 gas infrastructure (see later); and blocking non-Russian initiatives diversification projects by putting forward alternative 'phantom' proposals (e.g. Blue Stream 2).

3.2.1. Initiatives to increase security of supply in new Member States

In this section we discuss briefly those major initiatives that EU-8 member companies and / or governments (in cooperation with other partners) have been proposing to improve their access to external natural gas sources and thus to improve their security of supply.[12]

3.2.1.1. Nabucco gas pipeline

The most ambitious gas infrastructure project with a potential major positive impact on the diversity of new member states' gas infrastructure and security of supply is the well-known EU top priority NABUCCO pipeline project. If realised, this pipeline could bring an additional 30 Bcm/year of natural gas to the European market at Baumgarten in Austria.

[12] We do not cover the efforts for contractual diversification. See preliminary results of these efforts in Table 1.

It is important to emphasize that this project could serve several EU-level policy goals at the same time. It could provide Europe with direct physical access to vast Middle East, Central Asian and Caucasus gas reserves; it could fundamentally change gas-to-gas competition on new member states' gas markets; and it could contribute to increased cooperation of the EU with the supply countries.

3.2.1.2. Adria LNG

The idea of building an LNG re-gasification terminal at Krk island close to the Adriatic coast of Croatia and supply this gas to the Croatian, Italian, Austrian and Hungarian markets has a history of 10 years. Due to gas market developments the activity of the project company Adria LNG has been re-vitalized recently. If completed, the project could bring 8-14 Bcm/year additional gas to the region by 2011.

The Adria LNG Study Company is a joint venture by OMV, Total, RWE Transgas, and INA to set up an LNG terminal in Croatia. Adria LNG also signed an alliance agreement with EON Ruhrgas in 2006. Due to the current state ownership in INA and OMV, government support from Austria, Croatia and also from Hungary seems vital for accomplishing this project. The Croatian and Hungarian governments have recently expressed their support for the project several times.

3.2.1.3. LNG in Poland[13]

The Polish oil and gas company PGNiG (Polskie Górnictwo Naftowe i Gazownictwo) and a consulting consortium are working on a detailed feasibility study and technical and economic assumptions for imports of liquefied natural gas (LNG) to Poland. The purpose of the study is to develop a comprehensive concept for LNG supply to Poland.

One of the key elements of the study is to verify the profitability of LNG terminal construction in the Polish Coast. The expected throughput capacity of the terminal is 3-5 Bcm with an option of further expansion.

[13] Source: PGNiG homepage: http://www.en.pgnig.pl/firma/1865.htm. Downloaded: August 11, 2007

The broad range of topics covered by the study includes a number of detailed analyses to be undertaken by PGNiG together with the consulting consortium. The specific topics will include gas demand, LNG sourcing capabilities, transportation options, potential terminal locations in Poland and technical concepts for the terminal. The feasibility study will also comprise an economic part in the form of a detailed financial model, as well as organizational and socio-economic analyses.

At the beginning of 2006 PGNiG signed letters of intent with the ports in Gdansk and Swinoujscie with a view to cooperation in location studies.

3.2.1.4. Polish – Norwegian - Danish gas cooperation[14]

In June 2007, Polish and Norwegian authorities are reported to have agreed on the financial terms for a pipeline to channel natural gas from Norway's offshore fields to Poland, which is trying to lessen its reliance on Russian energy. The commercial terms of the proposed plan are still to be agreed on. The planned gas pipeline from Norway to Poland is due to run via Denmark.

In May 2007, the Polish gas company PGNiG reached a deal on the pipeline with Denmark's Energinet.dk. In March, as part of the project, PGNiG also agreed with ExxonMobil to purchase a 15% stake in three Norwegian offshore gas exploration and production licences.

3.2.1.5. Security gas storage development in Hungary

In order to decrease gas supply security risks, especially in winter peak load periods, the Hungarian Parliament has passed legislation that requires the Hungarian Hydrocarbon Storage Association to build a security gas storage facility with a minimum of 1.2 Bcm annual mobile gas capacity and a daily 20 million cubic metres (Mcm) off-take capacity. The estimated project cost is €400 million. MOL, the major Hungarian oil and gas company, won the investment tender. The storage facility should be operational by 2010. Conditions and pricing of access to this specific storage facility will be regulated by the Minister for economy and transport.

[14] Source: http://www.polandbusinessnetwork.pl/news/index.php?contentid=143568. Downloaded: August 11, 2007

3.2.2. Russian initiatives

Regarding gas from Russia, there are two major existing pipeline routes. For a number of years now it has been increasingly realised that there is room for a North European Baltic Sea pipeline route of some form. Of the various projects under consideration, the NEGP has won out and is now the project under development.

The other North European supply route was pioneered by Yamal I, from the Yamal field in western Siberia in Russia through Poland to Germany. Yamal I is in operation and Yamal II can now be developed. Because of the NEGP Baltic Sear project though, Yamal II is now on hold.

Plans for diversification of gas infrastructure of new member states face some opposition from Russia which is obviously keen to protect its own supply monopoly for the region. These efforts have been supported by acquisitions of strategic gas assets in the region.

3.2.2.1. Changing ownership of EU8 gas infrastructure

In 1990, in the former Soviet system, the central and east European region could be described as being dominated by national single vertically integrated gas companies (as in much of western Europe), but in central and eastern Europe, national gas companies were under a strong degree of control by Soviet Gazprom. During the 1990s and still continuing now (2007), the region has seen a wide transfer of ownership of these previous national companies. The following table shows in a summary form the main players and owners in the gas industries of each of the EU8 member states. It shows the result of 15 years of activity and privatisation.

Table 4: Summary of EU-10 Gas Industry Structure (2006)

Country	National Gas Company	Ownership	Amount of Unbundling	New Entrants	Gas Supply 2006
Estonia	Eesti Gaas	Gazprom (37%) E.ON (33%) Fortum (17%) Others (13%)	Võrguteenus (TSO and DSO) 24 smaller DSOs (DSO, supply)	None	Russia-100%
Latvia	Latvijas Gaze	Gazprom E.ON	None	None	Russia-100%
Lithuania	Lietuvos Dujos AB Dujotekana UAB	Gazprom E.ON State Property Fund	Lietuvos Dujos AB (TSO, DSO, supply) Dujotekana UAB (supply) 6 local DSOs	None	Russia-100%
Czech Republic	RWE Transgas Net	RWE	RWE Transgas Net (TSO) 8 DSOs (6 RWE, 2 E.ON) 105 small DSOs	Wingas (one consumer)	Russia-70% Norway-30%
Slovak Republic	Slovensky Plynarensky Priemysel (SPP)	State (51%) E.ON (24.5%) GdF (24.5%) Option to Gazprom	None	None	Russia-100%

Country	National Gas Company	Ownership	Amount of Unbundling	New Entrants	Gas Supply 2006
Hungary	MOL Földgázszállító Rt	MOL (100%)	MOL Földgázszállító Rt (TSO) E.ON (storage, wholesale trading) a pending asset swap with Gazprom) 6 regional DSOs (Budapest Municipality, Italgas, Gaz de France x 2, Bayernwerk, E.ON) 5 small DSOs 14 other suppliers	Panrusgaz (E.ON 50%, Gazprom 50%) EMFESZ (Hungarian, Russian, Ukrainian) 14 licensed suppliers	Russia-75% Germany-8% Others-17%
Poland	PGNiG	PGNiG (Polish State)	None	None	Russia-61% Germany-4% Norway-4% Others-30%
Slovenia	Geoplin	Geoplin (Slovenian)	None	None	Algeria-36% Russia-55% Others-9%

Source: Mercados

Note: TSO = Transmission System Operator, DSO = Distribution System Operator

It can be seen that many gas companies of the new member states are owned by joint ventures of Russian Gazprom and German E.ON Ruhrgas in joint ventures, or with other German companies (RWE, Wingas and Bayernwerk). There is also a small influence by Gaz de France and Italgas in the region. Of the whole region, every country that has allowed in foreign participation (which is every country except for Poland and Slovenia) has resulted in an E.ON Ruhrgas ownership of gas assets. Of these countries E.ON Ruhrgas made acquisitions in partnership with Gazprom in every country except for the Czech Republic (where another German company, RWE, has a 100% ownership of the gas transport company and six of the eight distribution companies, the other two being owned by E.ON). It could be said that the region has exchanged Soviet dominance for combined German and Russian dominance of their gas industries.

4. Conclusions

Natural gas import dependency has been identified as a major energy policy issue for those continental new EU members who joined the European Union in 2004. We have concentrated on an assessment of one component of the security of supply issue (namely the lack of diversification in sources of supply). It was demonstrated that the natural gas economies of old member states are significantly more diversified, and the security of supply issue has been increased and brought to the forefront of the EU's energy policy agenda by the 2004 enlargement.

A key issue also is the dominance of joint ventures of Russian Gazprom with German companies (particularly E.ON Ruhrgas) in the ownership of gas assets and in gas supplies throughout the EU-8 region.

Without strong efforts to introduce effective competition, an area where European Commission regulation could be very important, the dominance of the region by Russian and German companies (that is to say, by joint ventures of E.ON and Gazprom) is likely to continue. Efforts to promote competition could, among others include: (1) ownership unbundling of gas TSOs; (2) unbundling gas storage from gas transmission and providing effective independent storage; (3) unbundling gas supply from asset ownership; (4) introducing effective regulated third party access within the EU-8; (5) reaching agreement with Russia and with transit countries for the provision of regulated third party access to their gas transmission grids; and (6) promoting key diversification projects (such as Nabucco, LNG, gas storage projects).

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