5. THE GAS SECTOR

Problem statement

- *identification of the current technical status of the gas transmission grids in the EU 30;*
- *display of investment patterns in the period from 1996 to 2004 and main sources of financing;*
- *assessment of the ageing of the electricity transmission grids and its impact on the future investment needs;*
- *assessment of mid-long term investment trends.*

Methodology

- *Data collection and elaboration;*
- *The future investments in the gas infrastructure have been divided into the following 5 groups:*
  - ***TSO Investments**: are investments that the TSOs are expected to make in their own national gas transmission grid in order to extend, upgrade and maintain the current system, excluding gas storages, LNG terminals and import pipelines.*
  - ***Storage**: new investments in storage facilities have been evaluated with reference to a specified threshold of production/gas storage and import/gas storage;*
  - ***Interconnectors and gasification**: Investments in pipelines connecting the gas infrastructures of two EU members and gasification of geographical areas which presently do not have access to gas.*
  - ***Ongoing projects**: Include recently approved and ongoing gas projects which increase the gas import capacity in Europe.*
  - ***Import pipelines**: Import pipelines or LNG receiving terminals in EU 30. These projects are to ensure that Europe has sufficient gas transmission or LNG facilities to meet future gas demands.*

Major results

Current status:

- *the European gas transmission system varies significantly regarding technical characters such as pipeline size and design pressure; presently, there are no common criteria for the classification of gas transmission;*
- *most TSOs have gas transmission pressure levels approaching or above 70 bar; as for the minimum pressure, variations between TSOs are significant; the offshore pipelines have pressure levels above 200 bar, which is significantly higher than the onshore pipelines;*
- *the European gas system is not composed of a number of pools as theelectricity transmission grid. There are, however, different gas qualities and the energy content in a cubic meter of gas varies from one geographical location to another;*
- *the European TSOs do not have networks for olefin gasses and only two have networks for wet gases*

Investment patterns during the years 1996 till 2004 and financing sources

- *on the whole, the investments were quite constant in this period with an average investment level of about 2.6 b€ yearly in internal national gas transmission;*
- *the reasons for these historic investments include: lack of transmission capacity, extension of pipeline systems to new areas, need for reaching power plants, diversification, new cross border points, development of international transit, need for solving air pollution problems in the cities and for improvement of the security of supply.*
- *EU loans or other aid instruments have been widely used to gas support transmission projects and studies;*
- *a large majority of the TSOs reported that financing is not slowing down investments in energy projects.*

Ageing of the system

- *There is a clear tendency that, over time, the gas transmission pipelines are built with larger diameters and a higher design pressure. The result is that the new gas transmission pipelines have a higher physical gas transmission capacity in comparison with the old transmission pipelines;*
- *For most TSOs, the design life of the gas transmission system is between 30 and 50 years. The average age of the various TSO gas transmission networks varies significantly. On average, the youngest transmission systems are about 6 years, whereas the oldest gas transmission systems are about 31 years;*
- *the TSOs generally expect their gas transmission systems to be able to work safely and reliably well beyond the next 20 years, with the exception of two TSOs;*
- *The compressor stations are an integrated part of the gas transmission system. A majority of the companies replied that there were significant saving potentials in modifying or changing the compressor stations. Some of the companies which did not see any further saving potentials in their compressor stations mentioned that there might be a need for new investments if stricter environmental legislation is implemented.*

Mid-long term investment patterns

- *The "Baseline scenario" calls for significant new investments of 100 b€ to 2023; the investments are expected to be 48 b€ in the TSO transmission system, 22 b€ in storage, 6 b€ in future interconnectors, 1 b€ in already started gas import projects and 23 b€ in import pipelines and LNG terminals*
- *The "Soaring oil and gas price scenario" has the lowest expected investment costs of 51 b€ in total, which is about 50% less than the "Baseline." The main reason for this is that gas demands are only increasing by 40 bcm, compared with 215 bcm in the "Baseline scenario";*
- *The high oil prices seen in 2005 may have a major impact on gas transmission investments. If this is a shift to a permanent high oil price level, the long-term gas demand is likely to drop and, therefore, also the investment needs in the gas transmission system. A short-term spike, on the other hand, is likely to have limited impact on investments.*

5.1 Introduction

Before describing the European gas transmission network it is useful to provide an overview of the various ways adopted in Europe for the classification of gas transmission.

There are several approaches to defining the gas transmission system. In order to highlight a definition, the TSOs (Transmission System Operators) were asked the question*: How does your TSO define the transmission network?* Some TSOs define it by the pressure level, others by the function of the pipeline and yet others in other ways – some of the replies can be seen below.

There are several ways of defining gas transmission system…	
…by pressure (examples)	…by other definitions (examples)
>16 bar	By function
50-80 bar	By dynamic simulation of flow and pressure
>40 bar Main Transmission Grid, > 8 bar Regional Transmission Grid	Pipeline system competing with other national TSOs, high pressure, interconnections at cross border points with other European TSOs, connections to regional TSO and DSO.
>60 bar (primary) > 16 bar (secondary)	Transmission network is defined by the Energy law as the network from the producer or connection with the neighbouring transmission network to the distribution networks or final customers
High pressure pipelines to city gates	
Pipelines with diameters between 2" and 48" operating at pressures between 6 and 55 bar	

Tab. 5.1 – Definition of gas transmission pipelines in the EU 30

The implication is that the European gas transmission system varies significantly regarding technical characters such as design pressure and pipeline size. The next figure shows the minimum and maximum pressure levels in the various gas transmission systems in Europe.

Most of the TSOs have gas transmission approaching or above 70 bar. As to minimum pressure, the variations amongst the TSOs are significant. Several companies have down to 40 bar, others down to 20 and some down to below 10 bar. The figure also clearly illustrates the difference between onshore and offshore pipelines as to pressure levels.

The figure underlines the variations in the European gas transmission system. The consequence of these differences is that in one country a gas pipeline may be attributed to the transmission, whereas in another country a pipeline with the same characteristics may be classified as distribution. When analysing the European gas transmission system it is important to bear these variations in mind.

The length of the European gas transmission system also differs significantly between the countries. This is partly due to the size of the countries, the level of gasification in the countries, but also the variations in the definition of the transmission system, as we have seen.

The European TSOs do not have networks for olefin gasses and only two have networks for wet gases. Thus, this analysis will focus on the natural gas transmission network.

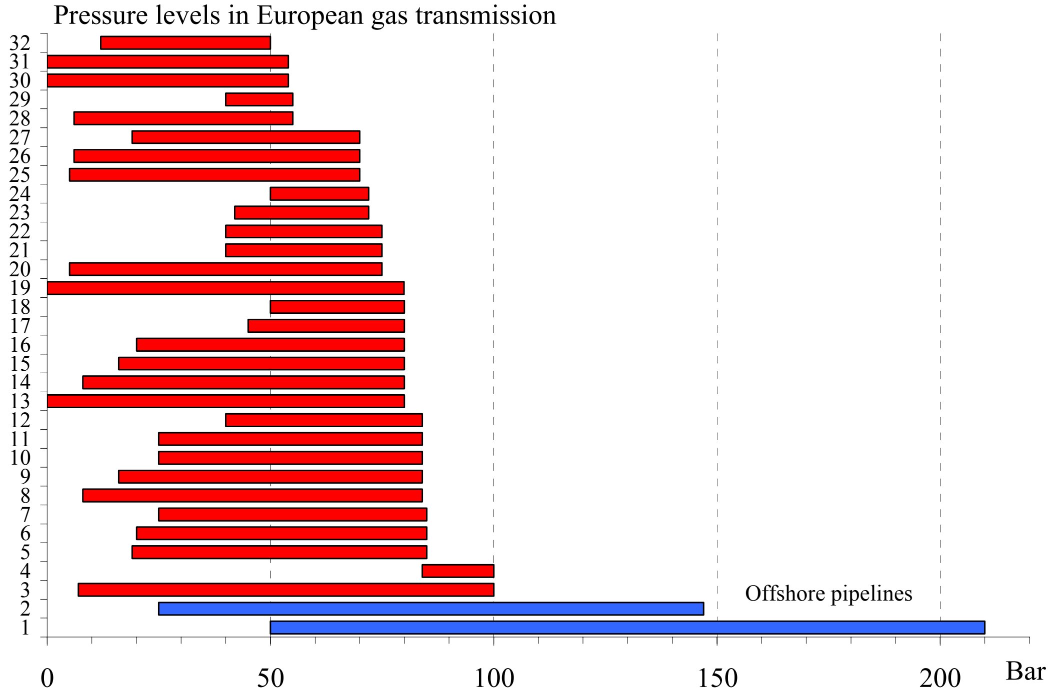

Fig. 5.1: EU 30 transmission pipeline systems have various pressure levels (four of the TSOs have not provided the lower pressure level)

5.2 Historic investments

The most obvious method in identifying historic investments is to ask the TSO, who is responsible for the development of their individual networks, for the amount of investments undertaken in the time period under examination (1996-2004). This procedure was applied through the preparation and issue of questionnaires to the TSOs concerned, and 28 out of the 32 companies participating in the survey answered this question.

For the past nine years, the investment level in the EU 30 gas transmission has been around 2.6 b€/yr (see Fig. 5.2). This includes investments in TSO internal national gas transmission systems, excluding investments in gas storages, LNG terminals, import pipelines and new interconnectors such as between the UK (Bacton) and Belgium (Zeebrugge).

The background justifying the historic investments is: lack of transmission capacity, extension of pipeline systems to new areas, need to reach power plants, diversification, new cross border points, development of international transit, need to solve cities' air pollution and improvement of the security of supply.

The creation of the European Single Market has had a significant impact on the investments in the gas transmission system. The investments were necessary to: implement TPA (Third Party Access), deal with uncertainty over the future gas flow in networks, increase the capacity and reduce the number of tariff zones.

The development of the European gas transmission network has varied significantly from country to country. Countries with late gasification include Greece, Portugal and Spain.

Greece was not supplied with gas until the 1990s. The infrastructure was built from 1995 and onwards. The main gas pipeline runs from the border of Bulgaria to the North of Athens in the South. There is also an LNG import terminal in the South. Greece hereby has a new gas transmission system, major investments having been made in the 1990s and limited investment being needed today. Spain started receiving gas from France in 1993, followed by gas deliveries from the Europe-Maghreb pipeline. Gas is also received via the LNG terminals in

Spain. After gas was introduced in Spain, the gas infrastructure in Portugal was developed in the second part of the 1990ies. The investments have been fairly significant until now but will fall to a lower level in the years to come. Spain, Portugal and Greece are examples of countries with a new gas transmission system.

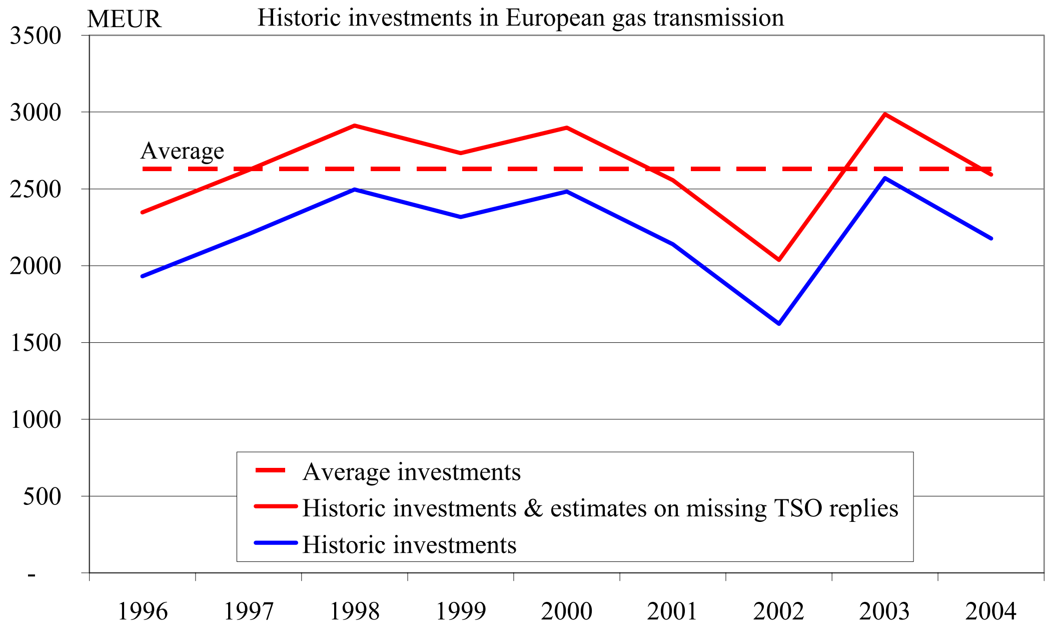

Fig. 5.2: EU 30 historic investments in EU gas transmission, (data were missing, and therefore estimated according to the length of the transmission system, for Luxemburg, Czech Republic, Austria, Bulgaria, Slovakia, three TSOs from Germany and partly for Spain). The data has been adjusted to 2005 real prices taking inflation rates into account.

5.2.1.1 Overview over the major historic projects

The table below is based on the projects reported by the TSO to be the major projects or investments within their area, including internal TSO projects, interconnector, import pipelines & LNG regasification terminals. Therefore, not all of these projects are included in the total internal investment costs displayed in Fig. 5.2. Additional projects form part of the investment costs, which are not described in this table.

Country	Project Name	Year	Location
Belgium	VTN/RTR	1998	Zeebrugge-Zelzate-Eynatten
Denmark	MR NewTech	2003	
France	**Lussagnet Captieux**	2002	
Germany	Storage Rehden	1993	
	Pipelines MIDAL	1993	Oude Statenzijl/Rysum-Jockgrim
	Pipelines STEGAL	1992	Grenze CR/D Olbernhau – Reckrod
	Pipelines JAGAL	1996-1999	Oder/Mallnow – Rückersdorf
	Pipelines WEDAL	1997-1998	Bad Salzuflen – Grenze Belgien/D
	Compressor units Bunde, Mallnow, Olbernhau, Reckrod and Rückersdorf, Weisweiler	1992-1999	
	TEN Code f08	1999	Burghausen-Schnaitsee
	TEN Code f19		Berlin-Szcecin
Greece	High Pressure Main Line	1995	Srymonochori – Revithoussa
	LNG Terminal	1999	Revithoussa
	Above Ground Installations & Remote Control	2000	
	High Pressure Branches & Marine Crossing	2000	
Ireland	Gas to the West	2003	Dublin/Limerick
	IC2	2003	UK/Ireland
	North West Pipeline	2004	Belfast/Derry
Italy	Add. Importation from Russia	2002-2007	Tarvisio-Zimella
	Importation from North Europe	1998-2002	P.sso Gries-Mortara
	Bussi-Roccasecca	1999	Abruzzo–Lazio
	Larino-Campobasso	1999-2002	Larino-Campobasso
Latvia	Expansion of Incukalns UGS	1968-	Latvia, close to Riga
Lithuania	A.Paneriai MR station reconstruction	1997	Vilnius
	Vilnius MR station reconstruction	1999	Vilnius
	Expansion of gas transmission network	1996-1998	Panevezys-Siauliai, etc.
	Transmission line to Ignalina Nuclearn Plant	2004-2005	Pabrade-Visaginas
Nederland	Zebra I	1998	Zelzate (B) – Bergen op Zoom
	Zebra II	1999-2002	Bergen op Zoom – Wouw - Klundert

Country	Project Name	Year	Location
Norway	NET 1 and KEP 2005	2003-2005	Expansions of Kårstø terminal
	TOP	2004	Expansion of Kollsnes terminal
Portugal	LNG Terminal	2004	Sines
	Pipeline 7	2004	Sines - Setúbal
Romania	Gas transit pipeline Isaccea - Negru Voda	2000-2002	
	Interconnection pipeline Szeged - Nadlac – Arad	2004	
Slovenia	KPK Compressor station	2001	Kidričevo
Spain		2003	Bilbao Regasificaction Plant
	Gajano-Treto-Laredo Pipeline	2002	Vizcaya/Santander
	Cartagena-Lorca Pipeline	2002	Murcia/Murcia
	Puente Genil- Málaga pipeline	2002	Córdoba/Málaga
	Collado Hermoso-Turégano Pipeline	2003	Segovia/Segovia
	Getafe-Salida Cuenca Pipeline	2003	Madrid/Cuenca
	Tarancón-Cuenca-Fuentes Pipeline	2003	Cuenca/Cuenca
Sweden	The Stenungsund Project	2004	Gothenburg - Stenungsund
Turkey	Russian Federation-Turkey Main Transmission Line	1986-1989	Malkoçlar-Ankara
	The Liquefied Natural Gas Import Terminal	1989-1995	Marmara Ereğlisi
	Eastern Anatolia Main Transmission Line	1997-2001	Doğu Bayazıt Erzurum …
	Samsun-Ankara Transmission Line	1999-2002	Samsun-Ankara
	Southern Natural Gas Transmission Line	2002-2005	Sivas-Mersin
	Konya-İzmir Natural Gas Transmission Line	2002-2006	Konya-İzmir
UK	1-Interconnector	1998	Bacton – Zeebrugge
	St. Fergus related	2001-2004	St Fergus-Aberdeen-Lochside
	Bacton related	2003	Bacton to Kings Lynn

Tab. 5.2: EU 30 Major investments reported by the TSO
Note: this is not to be considered a complete list of TSO projects).

5.3 Overview of the present technical status of the European Gas Network

5.3.1 Present technical status

The European gas transmission companies have been asked to give detailed information on their current gas transmission system concerning pipeline age, design pressure and pipeline diameter. Data for about 100 thousand km gas transmission pipelines has been gathered and is displayed in a synthetic way in Fig. 5.3.

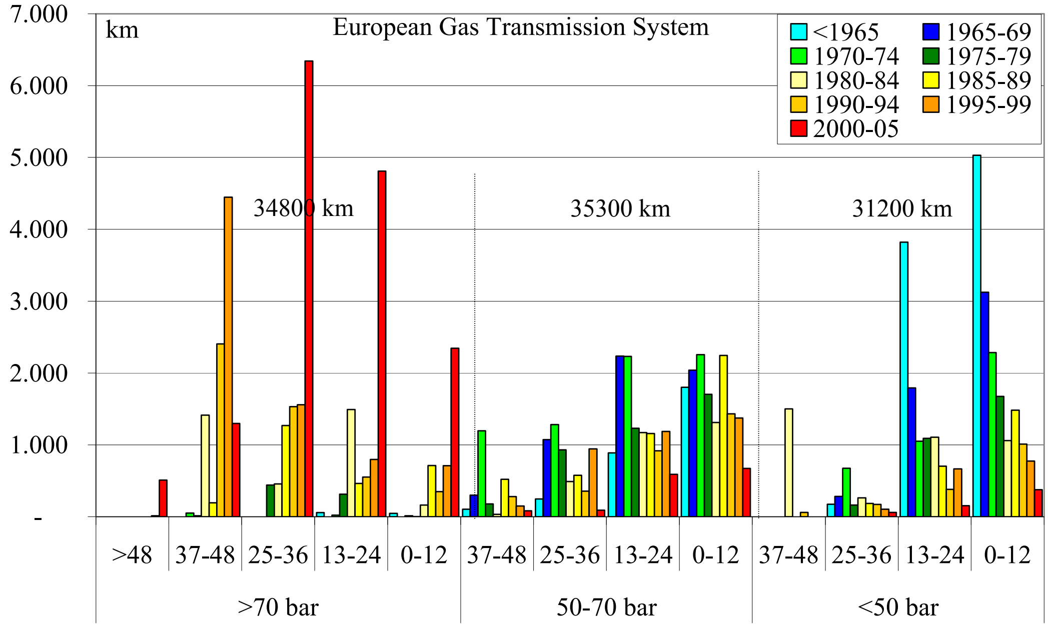

Fig. 5.3: EU 30 current gas transmission system showing age, pipeline diameter and pressure level (data are missing for several TSOs).

The pipelines built in the 1960s (blue colours) are fairly small, mainly with diameters of 0-12 inches and 13-24 inches. A large part of these pipelines also has a design pressure below 50 bar. Most of the pipelines built in the 1970s (green) have diameters of up to 48 inches and a large part also has a design pressure between 50 and 70 bar. In the 1980s (yellow) and 1990s (orange), the diameters were increased and more pipelines have a design pressure above 70 bar. There is a clear tendency that, over time, the gas transmission pipelines are built with larger diameters and a higher design pressure. The result is that the new gas transmission pipelines have a higher physical gas transmission capacity.

To provide a good overview of the development of the gas transmission infrastructure in Europe, a "Gas Pipeline index" been defined. The index consists of the key issues in pipeline capacity, i.e. pipeline diameter and pressure together with a main factor behind the cost level, which is the pipeline length in km. The formula used is the following:

$$Pipeline\ Index = \sum (\ Diameter^2\ [inch] x\ Pressure\ [bar]\ x\ Length\ [km]\ )$$

Using the data from the previous figure and the formula presented above, we obtained the following trend in pipeline index:

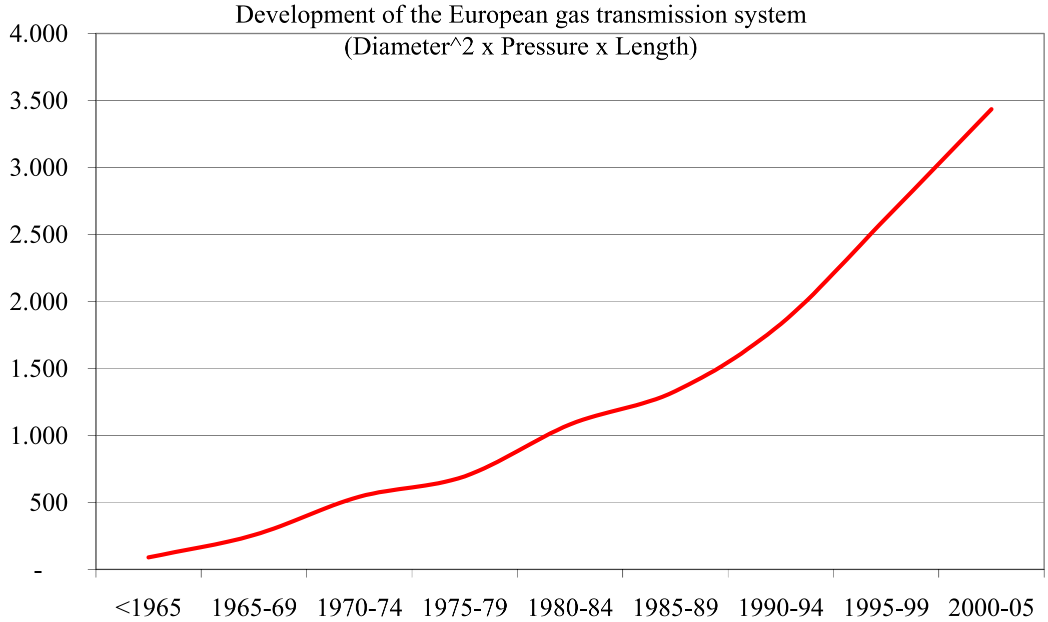

Fig. 5.4: EU 30 pipeline index (data are missing for several TSOs).

The index shows that there has been significant construction activity during the past decades. There are at least two issues to keep in mind. Firstly, there is a lack of information from some of the large and old companies underestimating the early development. Secondly, the newest pipelines operate with higher pressure and several also have large diameters resulting in a high vale on the index.

5.3.2 Outline of the available cross-border transmission capacities

5.3.2.1 Europe's current gas import volumes and capacities

Europe's gas imports from Russia, Northern Africa, Middle East and Asia by pipeline and by LNG was just over 226 bcm in 2004[1]. The majority of the gas, 82% or 186 bcm, was imported via pipeline and 18%, or 40 bcm, through LNG. The below figure shows the origin of Europe's gas imports in 2004:

The main part of the gas pipeline imports comes from Russia and Northern Africa. From North Africa, mainly Algeria, 34 bcm gas were imported via pipelines. The import capacity from the south Mediterranean coasts to Spain and Italy totals 39.5 bcm. This gives a load factor of 0.9 for these two gas import routes (see Tab. 5.4).

In 2004, Europe imported 148 bcm gas from Russia. There are several import routes from Russia with a total capacity of 200 bcm. This gives an average load factor of 0.7.

[1] BP Statistical Review of World Energy 2005

From	To	Comment	bcm
Russian Federation	Europe	Pipelines (via Belarus and via Ukraine)	148.4
Algeria	Europe	Pipelines (via Morocco & Tunisia)	33.8
Libya	Europe	Pipelines (via Tunisia)	0.5
Iran	Turkey only	Pipeline	3.6
TOTAL PIPELINE			**186**
Africa	Europe	LNG (from Algeria, Nigeria & Libya)	34.5
Middle East	Europe	LNG (Qatar, Oman & UAE)	5.4
Asia	Europe	LNG (Malaysia)	0.2
TOTAL LNG			**40**
Total gas supply to Europe		**By pipeline and LNG**	**226**
[Norway	Europe	Pipelines (to the UK, France, Belgium & Germany)	74.9]

Tab. 5.3: European Gas Import via pipelines and LNG in 2004

Export country	to	Max. hourly flow rate in mio Nm3/h	Max. hourly flow rate in mio Nm3/d	Max. yearly flow rate bcm	Total Max. yearly flow rate bcm	Pipeline Import in 2004	Load factor
Russia	Finland	0.80	19.2	7.0			
Russia	Estonia	0.25	6,0	2.2			
Russia	Latvia	0.50	12,0	4.4			
Russia	Lithuania	1,00	24,0	8.8			
Russia	Poland/Germany	3.57	85.7	31.3	199.5	148.4	0.7
Russia	Slovakia (via Ukraine)	10.50	252.0	92.0			
Russia	Hungary (via Ukraine)	1.75	42.0	15.3			
Russia	Romania (via Ukraine)	3.16	75.8	27.7			
Russia	Turkey (Blue Stream)	1.25	30.0	11.0			
Algeria	Spain (via Morocco)	1.07	25.7	9.4	39.5	34.3	0.9
Algeria	Italy (via Tunesia)	3.44	82.6	30.1			
Lybia	Italy (Greenstream)	1.02	24.4	8.9	8.9	New	New
Iran	Turkey	1.50	36.0	13.1	13.1	3.6	0.3
Norway	UK (St Fergus)	2.57	61.7	22.5			
Norway	France (Dunkerque)	1.95	46.8	17.1			
Norway	Belgium (Zeebrugge)	3.23	77.5	28.3	126.6	74.9	0.6
Norway	Germany (Emden)	4.60	110.4	40.3			
Norway	Germany (Dornum)	2.1	50.4	18.4			
Total		44.3	1062.1	387.7	387.7	261.2	0.7
Total excluding Norway		29.8	715.3	261.1	261.1	186.4	0.7

Tab. 5.4: Pipeline capacities and gas imports in 2004

There are many new gas import projects in Europe. From Russia, the transportation capacity in the Yamal-Europe pipeline has also been increased by about 6 bcm yearly since two compressor stations have been added. Green stream also increases the import capacity in Italy by about 9 bcm yearly. In addition to these recently finalised and ongoing projects, many projects are proposed, as will be shown later.

Norway is part of the EU 30 and a significant and increasing internal EU 30 gas supplier. In 2004, about 75 bcm were imported from Norway. The gas came via five major import routes with an import capacity of about 127 bcm equalling to a load factor of 0.6. A new gas import pipeline is expected to be put into operation at the end of 2006 from the Ormen Lange gas field in Norway to Easington in the UK with a capacity of about 70 mcm per day or 26 bcm per year. There are currently 11 LNG receiving terminals in Europe – four in Spain, two in France and one in Belgium, Greece, Portugal, Italy and Turkey. The maximum hourly flow rate of the terminals is shown in the table below. By converting to yearly capacities, the receiving LNG terminals have a yearly capacity of 76 bcm. The LNG imports in Europe were 40 bcm, equalling a load factor slightly above 0.5.

Receiving Country	Location	Max. hourly flow rate in mio Nm3/h	Max. hourly flow rate in mio Nm3/d	Max. yearly flow rate bcm	Total Max. yearly flow rate bcm	LNG Import in 2004 bcm	Load factor
Belgium	Zeebrugge LNG	0.95	22.80	8.3	8.3	2.9	
France	Fos-sur-Mer	0.65	15.60	5.7	15.8	7.6	
	Montoir de Bretagne	1.15	27.60	10.1			
Spain	Barcelona	1.20	28.80	10.5	33.6	17.5	
	Cartagena	0.92	22.19	8.1			
	Huelva	0.91	21.92	8.0			
	Bilbao	0.80	19.20	7.0			
Italy	Panigaglia	0.51	12.32	4.5	4.5	5.9	
Greece	Revithoussa	0.22	5.28	1.9	1.9	0.6	
Portugal	Sines	0.60	14.40	5.3	5.3	1.3	
Turkey		0.74	17.81	6.5	6.5	4.3	
Total		8.7	208	75.9	75.9	40.0	0.5

Tab. 5.5: LNG regasification capacities and gas imports in 2004

5.3.3 Gas transmission capacities

In order to create competition and thereby lower gas prices for the consumers, the European Union is striving to create a Single Market. To achieve this goal it is necessary to have available transmission capacities at the cross-borders points as well as internally in the TSO transmission systems.

The TSOs were asked if there were any bottlenecks in their transmission systems (may exist at cross border points as well as internally). About half of the TSOs reported to have current bottlenecks in their transmission system. It is difficult to predict how the future development concerning the bottlenecks will be. About one third of the companies did not answer this question.

GTE (Gas Transmission Europe) has published a list containing the transmission capacities (max hourly flow rate) at 61 of the major cross border points on the primary market.[2] These capacities are shown in Tab. 5.6. Some of the TSOs participating in this analysis are not represented in the GTE overview, but have supplied data for the study. The capacities of these TSOs appear in Tab. 5.7.

[2] Latest update: 26 March 2004

GTE does, however, not publish the available capacities. Some of the TSOs have been willing to supply the available capacities and for some TSOs the information has been retrieved from their web pages.

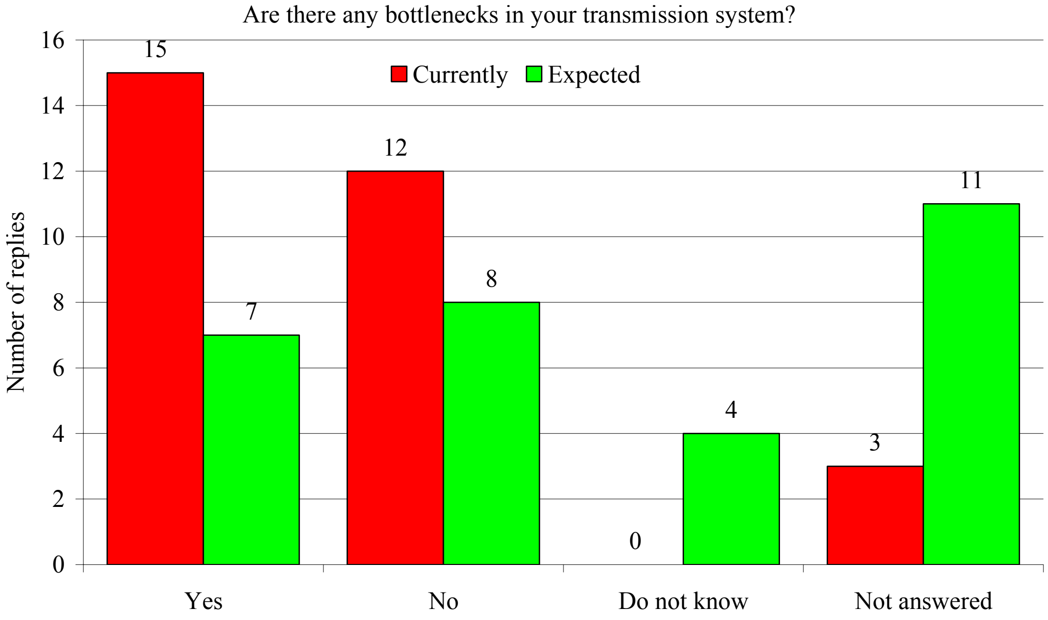

Fig. 5.5: Bottlenecks in the transmission system

The symbols of available capacities have the following meaning:

- (green) More than 10% of the capacity is available
- (yellow) Between 2% and 10% of the capacity is available
- (red) Less than 2% of the capacity is available

No	Location	From	To	Max. hourly flow rate Mio Nm3/h	Available
1A	Zeebrugge ZPT	Gassco (N)	Fluxys (B)	1.60	
1B	Zeebrugge IZT	Interconnector(UK)	Fluxys (B)	2.30	
1C	Zeebrugge IZT	Fluxys (B)	Interconnector (UK)	1.00	
1D	Zeebrugge LNG	LNG	Fluxys (B)	0.87	
2A	Zelzate Zebra	Fluxys (B)	Zebra (NL)	0.70	
2B	Zelzate GTS	Fluxys (B)	GTS (NL)	0.50	
3	Hilvarenbeek	GTS (NL)	Fluxys (B)	2.40	
4	Obbicht	GTS (NL)	Fluxys (B)	0.20	
5	's Gravenvoeren	GTS (NL)	Fluxys (B)	1.10	
6A	Eynatten	Fluxys (B)	WINGAS (D)	0.23	
6B	Eynatten	Fluxys (B)	Ruhrgas (D) / Thyssengas(D)	0.75	
7	Bras	Fluxys (B)	SOTEG (Lux)	0.19	
8	Petange	Fluxys (B)	SOTEG (Lux)	0.06	
9A	Quévy (H)	Fluxys (B)	GDF (F)	1.10	
9B	Taisnières (L)	Fluxys (B)	GDF (F)	0.95	
9C	Blaregnies (H)	Fluxys (B)	GDF (F)	0.95	
10	Bocholtz	GTS (NL)	Ruhrgas (D)	1.43	
11A	Zevenaar	GTS (NL)	Ruhrgas (D)	2.53	
11B	Zevenaar	GTS (NL)	Thyssengas (D)		
12	Winterswijk	GTS (NL)	Ruhrgas (D)	1.75	
13A	Oude Statenzijl H-gas	GTS (NL)	WINGAS (D)	0.08	
13B	Oude Statenzijl H-gas	GTS (NL)	Ruhrgas (D)	0.70	
13C	Oude Statenzijl H-gas	GTS (NL)	BEB (D)	0.40	
13D	Oude Statenzijl L-gas	GTS (NL)	BEB (D)	0.82	
13E	Oude Statenzijl L-gas	GTS (NL)	EWE (D)	0.60	
14A	Emden (NPT)	Gassco (N)	Ruhrgas (D)	1.45	
14B	Emden (EPT1)	Gassco (N)	Ruhrgas (D)		
14C	Emden (NPT)	Gassco (N)	GTS (NL)	0.40	
14D	Emden (EPT1)	Gassco (N)	GTS (NL)	1.90	
14E	Emden (NPT)	Gassco (N)	BEB (D)	0.85	
14F	Emden (EPT1)	Gassco (N)	BEB (D)		
14G	Emden (NPT)	Gassco (N)	Thyssengas (D)		
14H	Emden (EPT1)	Gassco (N)	Thyssengas (D)		
15	Dornum	Gassco (N)	Ruhrgas (D)	2.10	
16	Ellund	Gastra E-S (DK)	BEB /Ruhrgas (D)	0.34	
17	Dragør	Gastra E-S (DK)	Nova Naturgas (S)	0.27	
18	Nybro	DONG Trade (DK)	Gastra E-S (DK)	1.35	

No	Location	From	To	Max. hourly flow rate Mio Nm3/h	Available
19	Frankfurt/Oder	PGNiG (PL)	WINGAS (D)	2.00	
20	Görlitz	VNG (D)	PGNiG (PL)	0.26	
21	Olbernhau	Transgas (CZ)	WINGAS (D)	0.50	
22A	Sayda	Transgas (CZ)	VNG (D)	1.53	
22B	Sayda	Transgas (CZ)	Ruhrgas (D)	0.28	
23A	Waidhaus	Transgas (CZ)	Ruhrgas (D)	1.30	
23B	Waidhaus	Transgas (CZ)	Ruhrgas(D)/GDF(F)	2.60	
24	Oberkappel	OMV (A)	Ruhrgas (D)	0.52	
25	Burghausen	OMV (A)	WINGAS(D) + Bayerngas (D)	0.37	
26	Kiefersfelden	Bayerngas (D)	OMV (A)	0.10	
27	Wallbach	Ruhrgas (D)	Transitgas (CH)	1.20	
28	Obergailbach	Ruhrgas(D)/GDF(F)	GDF (F)	1.55	
29	Remich	Ruhrgas (D)	SOTEG (Lux)	0.19	
30	Dunkerque	Gassco (N)	GDF (F)	1.95	
31	Oltingue	GDF (F)	Transitgas (CH)	0.85	
32	Fos-sur-Mer	LNG	GDF (F)	0.65	
33	Col de Larrau	GSO (F)	Enàgas (ES)	0.27	
34	Montoir de Bretagne	LNG	GDF (F)	1.15	
35	Barcelona	LNG	Enàgas (ES)	1.20	
36	Cartagena	LNG	Enàgas (ES)	0.60	
37	Tarifa	SAGANE (Mor)	Enàgas (ES)	1.07	
38	Huelva	LNG	Enàgas (ES)	0.45	
39	Badajoz	Enàgas (ES)	Transgás (PT)	0.35	
40	Tuy	Transgas (PT)	Enàgas (ES)	0.04	
41	Griespass	Transitgas (CH)	SNAM Rete Gas (I)	2.40	
42	Panigaglia	LNG	SNAM Rete Gas (I)	0.40	
43	Mazara del Vallo	TMPC (Tun)	SNAM Rete Gas (I)	3.44	
44A	Gorizia	SNAM Rete Gas (I)	Geoplin (Slov)	0.17	
44B	Gorizia	Geoplin (Slov)	SNAM Rete Gas (I)	0.03	
45	Tarvisio	OMV (A)	SNAM Rete Gas (I)	3.12	
New	Gela	Libya	SNAM Rete Gas (I)	1.00	
46	Murfeld	OMV (A)	Geoplin (Slov)	0.42	
47	Mosonmagyarovar	OMV (A)	MOL (H)	0.50	
48A	Baumgarten	SPP (SK)	OMV (A)	4.56	
48B	Baumgarten	OMV (A)	SPP (SK)	No transit	
49	Lanzhot	SPP (SK)	Transgas (CZ)	6.50	
50	Velke Kapusany	UKRTRANSGAS (UKR)	SPP (SK)	10.50	

No	Location	From	To	Max. hourly flow rate Mio Nm3/h	Available
51	Revithoussa	LNG	DEPA (GR)	0.22	
52A	Bacton	National Grid Transco (UK)	Interconnector (UK)	2.30	
52A	Bacton	Interconnector (UK)	National Grid Transco (UK)	1.00	
53	Moffat	National Grid Transco (UK)	BGE UK (IRL)	1.24	
54	Twynholm	BGE UK (IRL)	Premier-Transmission Ltd (IRL)		
55	Kula	Bulgargaz (Bul)	DEPA (GR)	0.36	
56	Imatra	Gazprom (RU)	Gasum (FI)	0.80	
57A	St. Fergus (Vesterled)	Gassco (N)	National Grid Transco (UK)	2.57	
57B	St. Fergus (Flags)	Gassco (N)	National Grid Transco (UK)		
58	Beregdaróc	UKRTRANSGAS (UKR)	MOL (H)	1.75	
59	Kiskundorozsma	MOL (H)	NIS (Nafta Industrija Srbije)	0.55	
60	Bilbao	LNG	BBG (ES)	0.80	
61	Sines	LNG	Transgás (PT)	0.90	

Tab. 5.6 Gas capacities (Max hourly flow rate and available) at cross border points

Country	Location	From	To	Max. hourly flow rate Mio Nm3/h	Available
Latvia	Izborsk-Incukalns UGS			0.58	
	Reverse flow			0.46	
Lithuania	Kotlovka	Belarus	Lithuania	1	
	Sakiai	Lithuania	Kaliningrad	0.13	
Turkey	MALKOCLAR	MALKOCLAR	CS-1 Kirlareli	3.0	
	CS-1 Kirlareli	CS-1 Kirlareli	CS-2 Ambarli	3.0	
	CS-2 Ambarli	CS-2 Ambarlı	CS-3 Gebze	2.4	
	CS-3 Gebze	CS-3 Gebze	EAST	2.0	
	BLUE STREAM	Durusu	Ahiboz	1.25	
	IRANIAN	Bazargan	Ahiboz	1.5	

Tab. 5.7 Gas capacities at selected locations in Latvia, Lithuania and Turkey

5.4 Ageing of the gas transmission system

The European TSOs have reported an average age of their gas transmission systems between 6 and 31 years. The design life of the gas transmission system has been reported to be between 20 and 70 years. The remaining lifetime of the current gas transmission system is stated to be between 5 to 55 years (see Tab. 5.8).

The oldest gas transmission pipelines generally have lower design pressure and a smaller pipeline diameter and consequently less gas transmission capacity than new transmission pipelines. Replacement of the old capacity is therefore less costly than replacement of the new gas transmission capacity would be.

The TSO estimates on the remaining lifetime of the European gas transmission system are summarised in Fig. 5.6.

Two approaches have been used in establishing the remaining lifetime of the European gas transmission system.

The first approach is based on the design life of the transmission system, subtracting the present age of the system. The result is the calculated remaining lifetime. E.g., if a TSO estimates the average design life of the transmission system to 40 years and the average age of the system is 10 years, the expected remaining lifetime of 30 years is reached by subtracting 10 years from the 40 years. This is shown in the above diagram by green bars.

It may, however, be problematic to use this approach without further evaluation. The second approach is to ask the TSOs to estimate how many years the transmission system is expected to be able to operate safely and reliably. As an example, one of the TSOs explains that the average design life of the transmission system is minimum 60 years and the average age of the system 31 years. However, the expected remaining lifetime is minimum 50 years. In other words, over the past 31 years, the transmission system has only aged 10 years. In this case, the estimated remaining lifetime is shown in the diagram by red bars.

The vertical blue dotted line highlights the expected remaining lifetime at the end of the time period under examination (year 2023). It appears that, with a few exceptions, the European gas TSO transmission systems are expected to have remaining lifetime beyond the long term horizon (2023). The TSOs, therefore, generally expect their gas transmission systems to be able to work safely and reliably for the next 20 years. There are, however, two exceptions: In Bosnia and Herzegovina, the reported expected remaining lifetime is between 7 and 10 years, but the gas transmission system is only 190 km long; in Romania, the reported expected remaining lifetime is between 5 and 10 years. Here, the gas transmission system is about 12,500 km long.

A TSO explains that if a pipeline is correctly designed, protected and maintained, there is no reason to define a design life. External factors will have more effect on the expected life.

Generally, there are no plans to replace the European gas transmission system within the next twenty years. Future investments in the current infrastructure will mainly be to extend, upgrade and maintain the current system.

Nr	Age	Design life	Remaining lifetime	Comments
7	-	-	-	Depends on applied maintenance concepts
10	6	50	50	
16	6	25	19	
18	6	35	35	Performans of periodic in-line inspections (via intelligent pigging of the pipeline system) and cathodic protection system surveys on a regular and periodic basis.
22	9	50	41	
5	10	40	30	
24	10	40	30	
3	12	40	50	Detailed study would be required to quantify
4	12	40	30	
1	15	>50	>40	
19	15	40-50	25-35	
6	16	20-30	No limit expected	There is an inspection and preventive maintenance service program
20	20	70	-	Remaining lifetime depends on the yearly maintenance expenditure and investments
23	20	-	-	Remaining lifetime varies and depends on maintenance diff. parts of the system
2	21	40	30	
14	22	40	18	
17	22	20	7-10	
11	24.7	40	20	
12	25	40	55	
13	25	30-50	-	The expected safety and reliable operational time of the pipeline system is not exact, because the continuous maintenance can vary the lifetime of assets
9	27	n.a.	30	The transmission system is still in a good condition due to regular and professional maintenance
15	25-30	25	5-10	The real pipeline operation period is different from case to case, depending on the working conditions (how aggressive the soil is, gas quality, etc.). The investigations performed on regular basis show the affected pipeline sections, which need to be repaired
8	26/27	30	-	Compressors are normally designed for an indicative life of 30 years, but the real lifetime is subject to the real conditions of use
21	31	60	50	If a pipeline is correctly designed, protected and maintained, there is no reason to define a design life. External factors will have more effect on expected life

Tab. 5.8: EU 30 pipeline age and expected lifetime

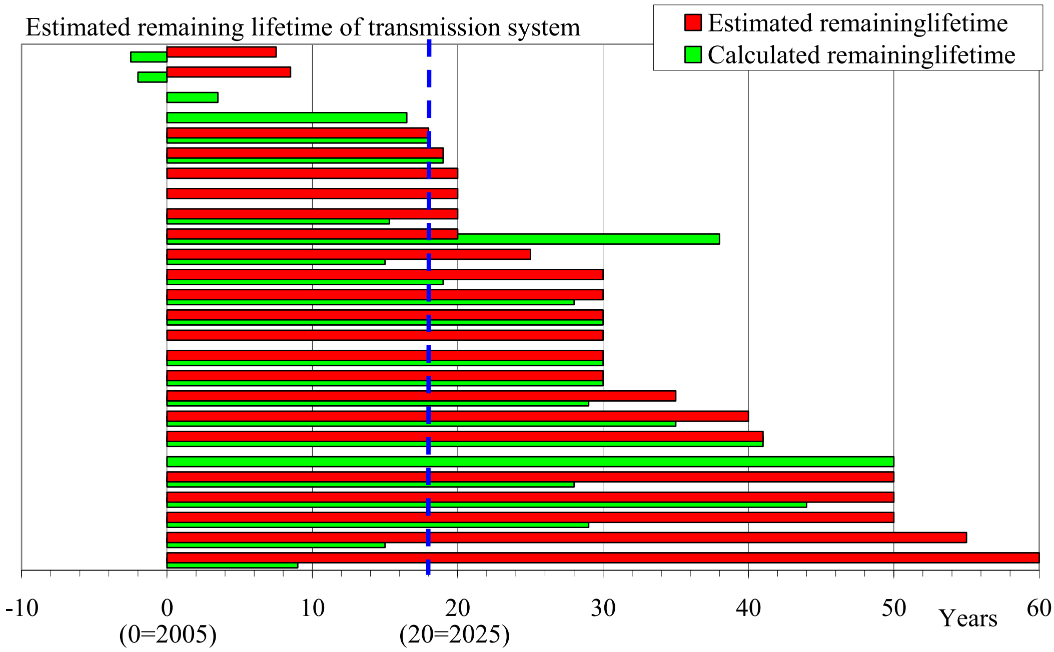

Fig. 5.6: EU 30 pipeline age and expected lifetime

5.4.1 Need for repair and upgrading

There are several other ways of estimating the present status of the current transportation system. Here, we will take a closer look at the current grid losses, the number of incidents and the compressor stations.

Loss of gas from the gas transmission system may be an indication of the condition of the current gas transmission system. An overwhelming majority has been reported at below 0.5% grid loss.

Grid loss	Number of companies
>= 1%	4
1-0.5	1
<0.5	21
Not answered	3
Total	29

Tab. 5.9 – Losses in transmission gas grids

Four companies have reported grid losses of above 1%. These companies have reported different methods of reducing the losses:

- Planned reduction of gas loss from 2.4% to 1.5% by 2007, through rehabilitation of the transmission system, modernization of installations and equipment in the metering and regulating stations (the average age of the system is between 25-30 years, and the expected remaining lifetime between 5-10 years)
- Planned reduction of gas loss to under 1% by further reducing the stealing of gas
- Planned reduction of gas loss from about 2% to 1% by better condition of measurement

The companies with losses below 0.5% have reported the following activities for reducing the grid loss:

- Enhancement of metering, telemetry systems and work practices

- Upgrading of the metering stage of the custody transfer station
- Modernization of the pipelines
- Introduction of better safety procedures
- Pipeline monitoring, in-line inspection

Another way of estimating the present status of the current transmission pipelines is to record the number of incidents[3], injuries and damages in the transmission system. A large number of incidents may be an indication of lack of quality in the gas transmission pipelines, but this is not necessarily the case as pipelines may also be damaged by large machines unaware of the pipeline location etc.

The TSOs have in total reported about 60 incidents per year. These statistics are, however, rather difficult to use as 40-50% of the total incidents derived from one company and did not lead to any fatalities or injuries and no property damages were reported. This makes it difficult to draw conclusions. On the one hand, the numbers could indicate that some companies have problems with the high number of incidents. On the other hand, it also leaves the impression that some companies are better at registering their incidents than others.

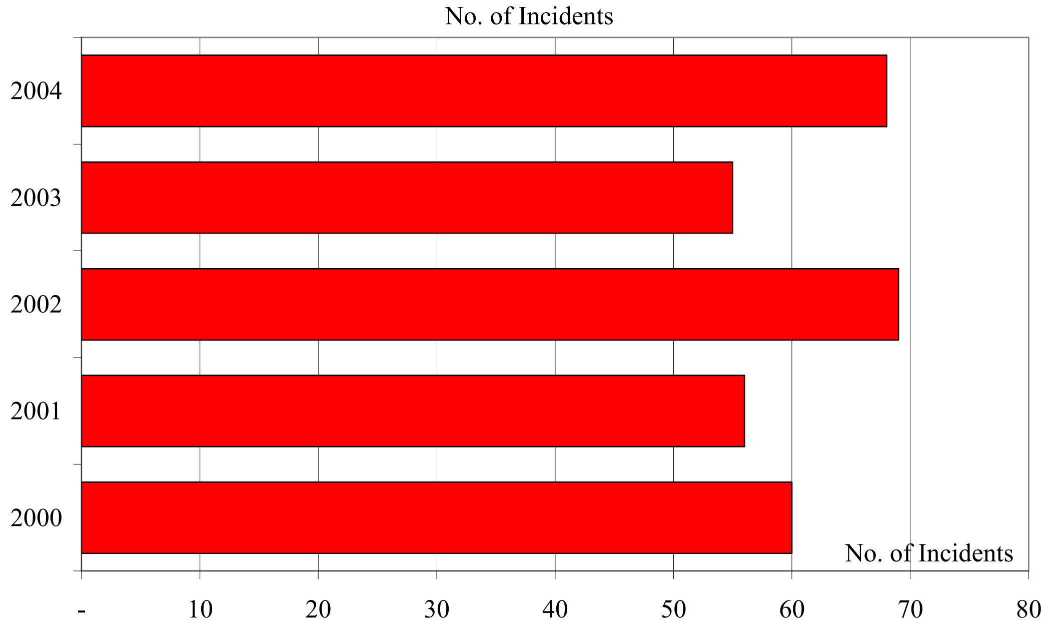

Fig. 5.7: EU 30 Number of incidents (Excluding answers from Norway)

Two companies reported injuries and fatalities. One company has reported 3 incidents in 2003. The other company is Fluxys of Belgium, which has recorded a major incident in 2004 at which 24 people died and 124 were injured and which led to property damages of over 100 million €.

The compressor stations are an integrated part of the gas transmission system. Ten companies replied that there were significant saving potentials in modifying or changing compressor stations. Seven companies do not believe that there are saving potentials in relation to their compressor stations. Some of these companies, however, mentioned that there might be a need for new investments if stricter environmental legislation is implemented (Fig. 5.8).

[3] Incident refers to an event that may lead to human or property damages.

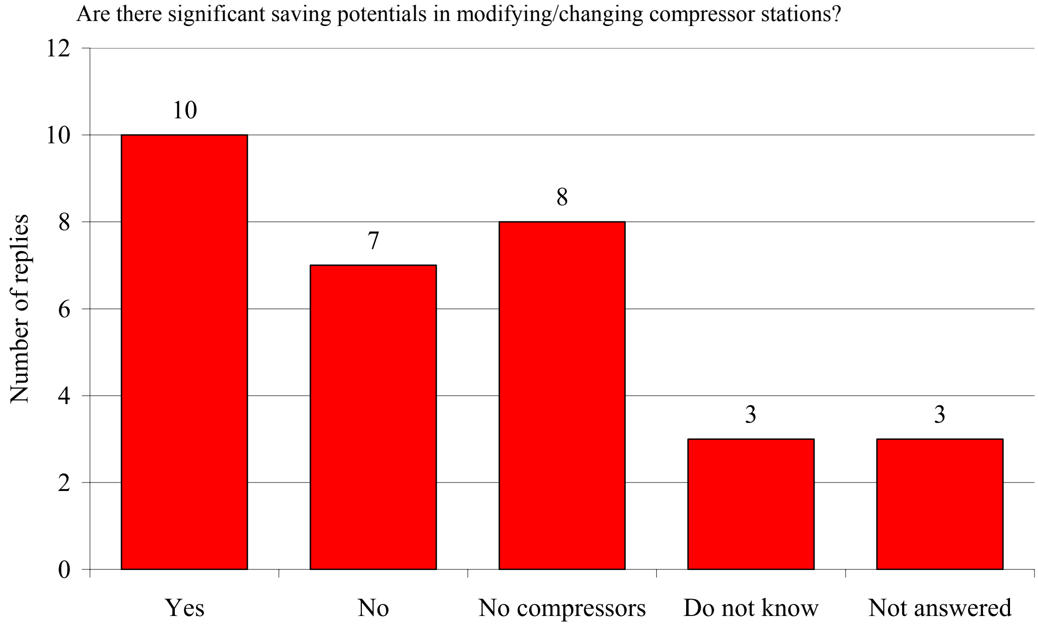

Fig. 5.8: Great potential for improvement of compressor stations

5.5 Transmission network impact on the EU single market

Some of the TSOs didn't need to make investments in the gas transmission system, as they have experienced the establishment of the Single Market as business as usual. Nine of the TSOs replied that the creation of the Single Market has had a major impact on the historic decisions of investing in their gas transmission system. This has taken place by either higher investments (six) or by accelerated investments (three).

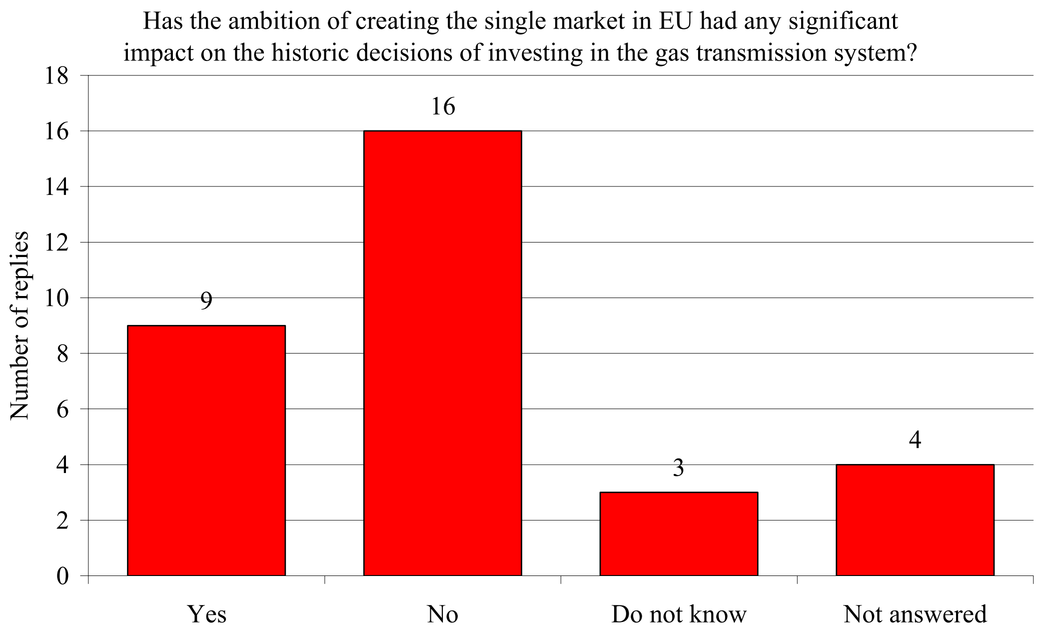

Fig. 5.9: Single Market impact on historic investments

Amongst the comments by the companies, the following ones are the most meaningful:

- Significant investments have been made in a fully regulated/TPA regime. The national Regulator has issued a connection policy providing clarity to industry participants.
- Additional investments were needed to deal with an increased uncertainty over gas flows in networks. There is no simple explanation neither regarding acceleration nor delay in investments.
- Higher investments were mainly based on the decrease in the number of tariff zones needing removal of bottlenecks and uncertainties as to the sourcing of gas.
- Yes and No. Evidence from the UK shows that there has been a high degree of investment in order to meet the changing supply situation predicted to unfold over the next few years. The investments have been driven by upstream sellers of gas bringing their product to the market and the presence of the open market, which has provided a clear market price for gas fostering the financing of these projects. Investments, which do not have the backing of upstream supply appear more difficult, e.g. storage.
- Greater flexibility due to multiple nominations by a plurality of shippers.
- Additional investment is needed for additional entry capacity (changed upstream portfolio of market) and for evolution towards an NBP.
- Necessity to create new capacity.

The comments from the TSOs show that the creation of the European Single Market has had a significant impact on the investments in the gas transmission system for nine of the TSOs. The investments were needed to: implement TPA, smooth the uncertainty over the future gas flow in the networks, increase capacities and reduce the number of tariff zones.

The gas infrastructure has also had an impact on the internal gas markets. As an example, it may be mentioned that Finland, constituting an isolated market with only one gas supplier, is allowed to derogate from the EU gas directive.

5.6 Obstacles preventing rapid construction of needed pipelines

To ensure sufficient gas supplies and to avoid bottlenecks it may prove necessary to proceed to a rapid construction of transmission capacity.

A significant number of companies have stated that obstacles exist which prevent the rapid construction of transmission capacity, in the case of internal lines as well as between transmission systems (Fig. 5.10) .

The majority of the TSOs experience many obstacles. The comments from the companies include the following:

a) Regulatory obstacles

- Regulatory approval process for new investments
- Uncertainty regarding regulatory environment
- Regulatory issues and issues related to obtaining permit
- Excess regulat, i.e. slow bureaucratic authorization and uncertainty over remuneration associated with investments
- No specific obstacles, but regulatory delay related to authorizations
- A stable regulatory framework with co-operation between member states is essential

- Regulatory differences of countries
- Other transmission systems are allocated in different national (and regulatory) environments

b) Technical procedures

- There are also various problems of a technical nature in connection with operators from neighbouring countries
- Many different interoperability conditions

c) Approval procedures

- Time consuming spatial procedures regarding environmental approvals and local population consensus
- The main obstacles to new investments are complicated formal and legal procedures associated with acquiring „transfer rights" and also negotiations with landowners.
- Administrative permission process
- Rapid construction is primarily limited not by technical obstacles but by authority approvals

Fig. 5.10: Obstacles preventing rapid construction of needed transmission capacity

One of the gas TSOs even gave the following example of an obstacle preventing the rapid construction of needed gas transmission lines:

The mayor of a town along a transmission line asked the TSO to gasify his town, despite the fact that the major potential consumer, the central boiler house, would not use gas and the project would be not economical. According to the mayor, the major new consumers would be the cooking gas consumers (flats are connected to district heating). The mayor threatened only to give the right of way for the transmission line if the TSO would run the uneconomic project of gasifying his town. The TSO was subject to political blackmail.

Although the transmission line is officially included in the National Development Plan, the local authorities may act independently.

The obstacles expressed by the TSOs in the construction of gas transmission may be summarized as being regulatory, technical and procedural as to approvals.

5.7 Concluding remarks on past investments and current status

The European gas transmission system varies significantly in technical character such as design pressure and pipeline size. The consequence of these differences is that in one country a gas pipeline may be attributed to the transmission, whereas in another country a pipeline with the same characteristics may be classified as distribution.

From the second half of the 1990s till today, the investment level has been at about 2.6 b€/yr in the European gas transmission network. In addition to investments by the large TSOs, some of the biggest projects include investments in the development of the gas transmission systems in Greece, Portugal and Spain in the period.

There is wide variation in the average age of the gas transmission networks of the various gas TSOs in Europe. The youngest transmission systems are about 6 years old and the oldest gas transmission systems are about 31 years old on average. The reported design life of the gas transmission system is between 20 and 70 years, but most companies have stated 40 to 50 years. The TSOs generally expect their gas transmission systems to be able to work safely and reliably for the next 20 years. There are, however, two exceptions. In Bosnia and Herzegovina, the reported expected remaining lifetime is between 7 and 10 years, but the gas transmission system is only 190 km long. In Romania, the reported expected remaining lifetime is between 5 and 10 years. Here, the gas transmission system is, however, about 12500 km long. In Europe, in general, the future investments in the current infrastructure will mainly be in rehabilitation and maintenance of the system.

The oldest gas transmission pipelines generally have a lower design pressure and a smaller pipeline diameter and consequently less gas transmission capacity than new transmission pipelines. Replacement of the old capacity will therefore be less costly than replacement of a newer gas transmission capacity would be.

The current condition of the European gas transmission system seems to be fairly good when measuring the grid losses. An overwhelming majority has reported well below 0.5% in grid loss. The country with the highest grid loss reported 2.4% and is aware of the challenge. The ambition is a reduction of the grid loss to 1.5% by 2007.

Several of the TSOs have reported that there were significant saving potentials in modifying or changing the compressor stations. Also, some companies have mentioned that there might be a need for new investments in the compressors if stricter environmental legislation is introduced.

About half the companies reported to have bottlenecks in their transmission systems. The list of cross border points also shows that there is currently limited free transportation capacity. It is difficult to predict the future development of the bottlenecks. About one third of the companies did not answer this question.

The creation of the Single European Market has had a significant impact on the investments in the gas transmission system. The investments were needed to: implement TPA, prepare for uncertainty over the future gas flow in networks, to increase capacity and to reduce the number of tariff zones.

The gas infrastructure also has an impact on internal gas markets. Being an isolated market with only one gas supplier, Finland has, e.g., been allowed derogation from the EU gas directive.

The obstacles expressed by the TSO in the construction of gas transmission may be summarized as being regulatory, technical and procedural as to approvals. One TSO even feels subject to political blackmail.

The findings from the questionnaire raise some relevant issues: What is gas transmission? Is there a need for a definition of gas transmission? The term, gas transmission, is currently used differently by the various member countries. Another issue is the lifetime of gas transmission pipelines. The expected lifetime varies significantly between different countries. Some TSOs expect a very high lifetime. Is it reasonable that this is reflected in the gas transmission tariffs of the systems in order to reduce the total gas bill of the European gas consumer? These are relevant issues, the answers however might not being straightforward.

5.8 MID-long term investment patterns on Gas

This section addresses future investment needs in the gas transmission system in the medium term, till 2013, as well as in the long term, till 2023, for the *Baseline scenario* and four alternative scenarios (*High RES* called also *"12% renewable in 2010", High Energy Efficiency, High energy efficiency with high renewables, Soaring oil and gas prices*).

5.8.1 Methodology for evaluation of investments

Future investments in the gas infrastructure have been divided into the following 5 groups:

1. **Internal investments in each country:** The TSOs were asked about their historic and future investments. These constitute investments that the TSOs are expected to make in their own national gas transmission grid to extend, upgrade and maintain the current system. Investments in gas storages, LNG terminals and major import pipelines have been subtracted from these investments.

In addition, four other groups of investments are foreseen.

2. **Storage:** To utilise the gas import pipelines system with a high load factor it is necessary to resort to gas storage facilities. The historic flexibility of the European gas production is dwindling together with the falling production in Europe. The increasing gas demand and the associated increase in gas imports therefore calls for further gas storage capacity in Europe, as explained in par. 5.8.3.
3. **Interconnectors[4] and gasification:** Comprises interconnectors, which are pipelines that connect the gas infrastructures of two EU member states and introduction of gas into geographical areas, which are presently not recipients of gas. The projects included appear in par. 5.10.1
4. **Ongoing import projects:** Comprises recently finalised and ongoing gas projects aiming at an increase of Europe's gas import capacity. The projects are described in par. 5.10.2
5. **Import pipelines and LNG:** Import pipelines or LNG receiving terminals for the EU 30. The object of the projects is to ensure that Europe is provided with sufficient gas transmission or LNG facility to meet the future gas demands (par. 5.10.3).

5.8.2 TSO Internal investments

One method to identify the future investment needs is to ask the TSOs, who are responsible for the individual TSO networks, for their point of views as to future TSO investments in their area. This was done by the dissemination of a questionnaire to the European TSOs to which 32 companies submitted their replies.

Most of the companies have plans as to medium-term investments till 2013, but not concerning long-term investments till 2023. The below figure shows the historic investments as reported in the questionnaire for the past nine years (dark green) and future investments (dark red) for the coming 9 years, i.e. medium-term till 2013 and long-term till 2023.

The future investments reported by the TSOs mainly comprise replacements of the existing ageing system and means to meet a rise in demand. Such investments are related to the internal TSO system. The investments

[4] An Interconnector is generally considered a pipeline linking two unconnected pipeline systems. Ownership of an interconnector is not necessarily limited to the TSOs of the two systems connected.

shown are general for the TSOs, and future investments in storage have been excluded where possible as they are presented separately later in this report.

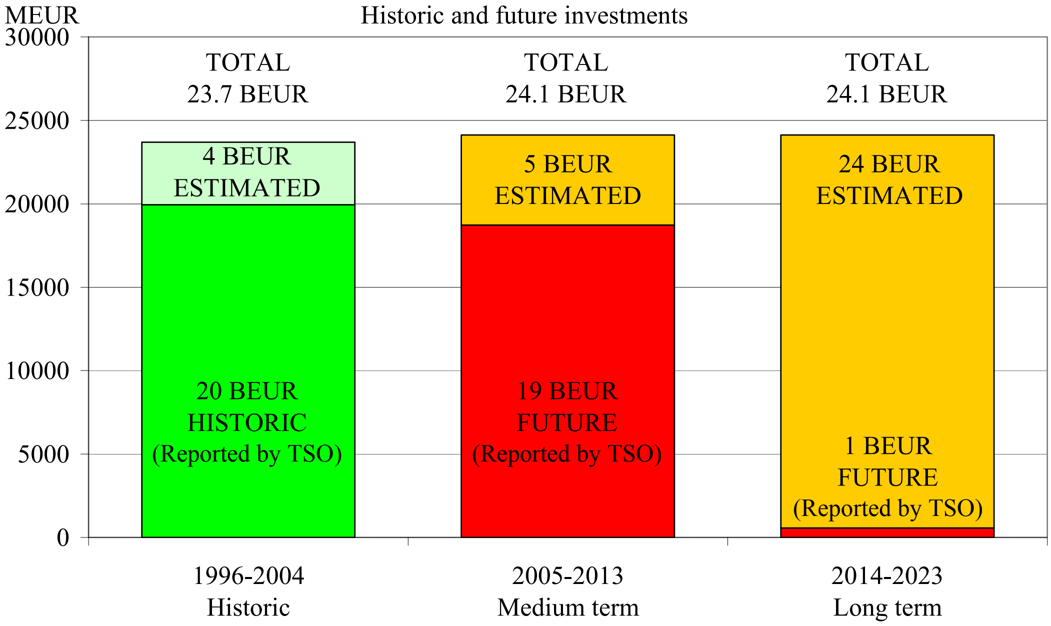

Fig. 5.11: EU 30: TSO reported historic and future investments (result of survey) – investments in TSO national grid

The individual TSOs do not just aim at projecting their historical investments in the future, but display great variation as to historic and future investment levels. Nevertheless, based on the aggregated replies, the historic investment level is reflected fairly well in the future investment for the medium term till 2013. As already mentioned, the companies do not generally have long-term investment plans till 2023, even though those TSOs which reported the expected investments for both the medium term (2005 to 2013) and the long term (2014-2023) tend to have quite similar investment levels for both periods. Investments on the long term (2014-2023) might therefore be expected to reach the medium-term range.

Estimates were made for those TSOs, which did not participate or did not report any data on historic and future investments. This was done by multiplying the length of the TSO's transmission system either by the average historic investment costs per km transmission pipeline or by the average expected investment costs per km transmission pipeline. This is shown in light green concerning the historic investments and light red concerning future investments.

There are several important issues to consider when looking at the future investment level of the European Gas Transmission.

Regulatory uncertainty

There are uncertainties in some countries, e.g. Germany, as to the development of the future regulation and thereby also the future income from the transmission assets. If the TSOs perceive the risks by investing in gas transmission as considerable, they do not know how their future investments will be. This uncertainty is also reflected in the future investment level.

Future gas flow from outside Europe

At present, it is unknown which alternative pipeline will prevail and consequently also where the route of future gas supplies to Europe will run. This means that the European gas TSOs do not know which pipeline systems will be used for transit – and they can therefore not know which capacities and investments will be needed in their area.

Environment

New environmental legislation on e.g. air pollution may have an impact on the gas compressor stations. It is therefore unclear how significant future investments in the compressor stations will be.

Ownership

Companies which are also active in other business areas compare the return on investments in gas transmission with the return on investments in other business units such as power generation and as oil and gas exploration and production. A TSO belonging to a vertically integrated company might therefore request a higher return on investments than a company whose only object is to be a TSO. Therefore, the ownership structure can also impact on the investment level.

In addition, several TSOs are reluctant to reveal information on their future investments. In their view, revealing the future investment level would potentially be revealing too much information to their competitors as to current business strategies and timing. This was a problem even when underlining the confidentiality of the investigation and reassuring that no company specific data would be disclosed.

5.8.3 Gas storage capacities and investments

Historically, European gas production has had a certain spare capacity, which has made it possible to increase the gas production when needed. Significantly colder weather than normally, as in 1996, increases the demand for gas in Europe. In the case of 1996, the European gas production was increased by 18% as shown in the next figure. The main increases derived from the UK, 13 bcm, Norway 10 bcm, the Netherlands 9 bcm. As these and other European gas reserves are depleted, the option of receiving additional gas from European producers, if additional supply is needed, is dwindling.

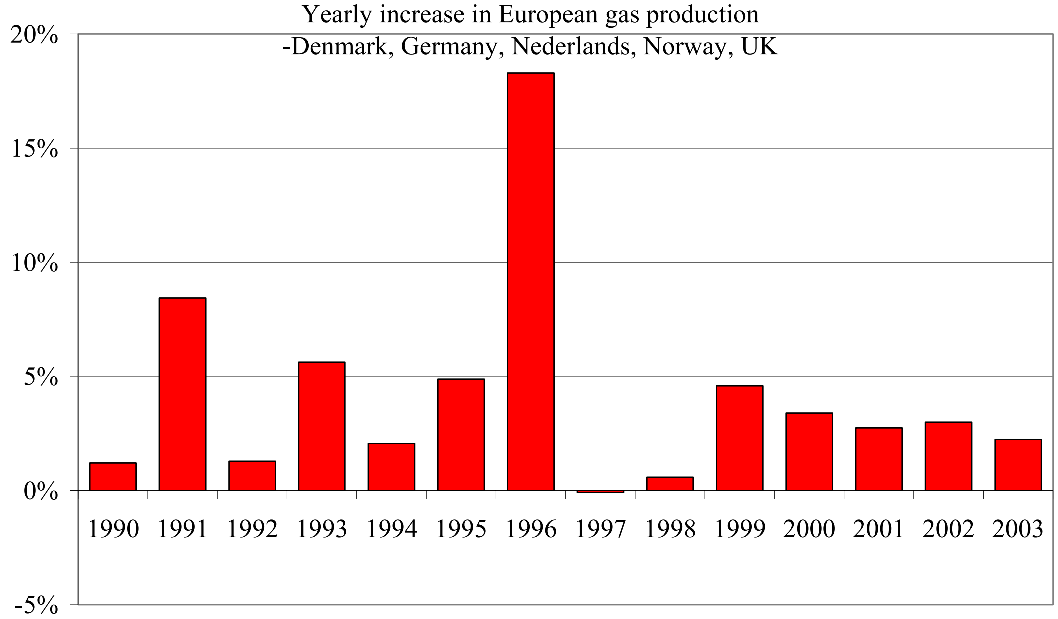

Fig. 5.12: Yearly increases in the gas production in five European countries

The decline in the UK gas production has widely been subject to discussions in recent years. The decline is now a reality as shown in the next figure. In particular, the peak production during wintertime is declining; whereas the summer production has been almost constant in recent years. This means that the seasonal variation is falling and that the utilisation of the capacity is improving. However, it also means that the potential for increasing the production, if needed, is reduced.

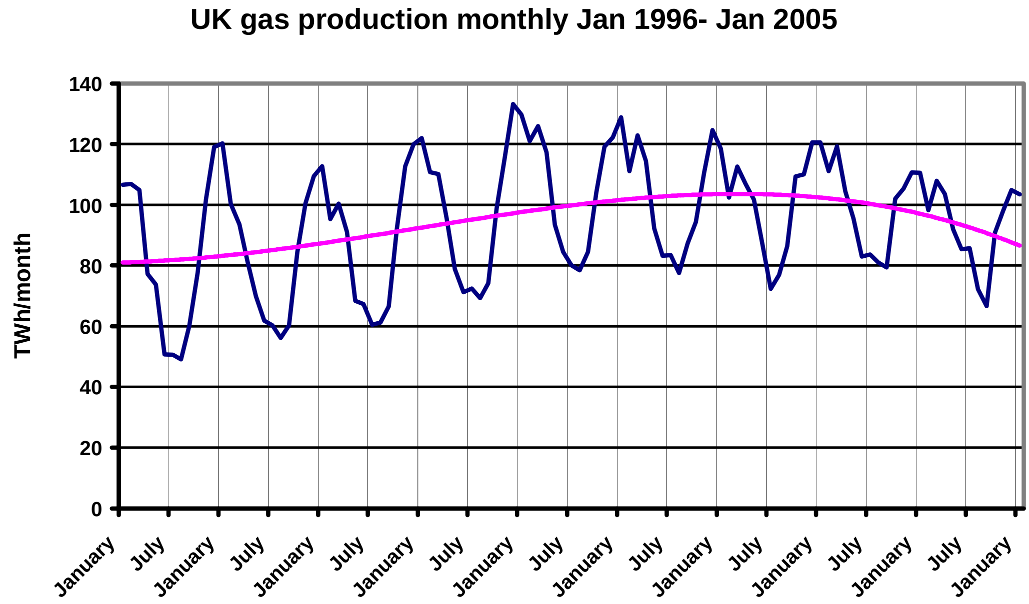

Fig. 5.13: UK gas production, 1996-2005

There are still relatively large reserves in the Netherlands. However, the Government has imposed a ceiling on the production at 76 bcm/year for the years 2003 to 2007 and 70 bcm/year for the period from 2008 to 2012. However, the real production has been lower and is already declining to below 70 bcm/year.

German reserves are declining at an even faster relative pace than in the UK. This has often been outshined by the focus on the UK gas sector. With a yearly gas production in Germany of about 22 bcm/year and gas reserves of less than 300 bcm, a rapid decline in production may be foreseen.

To summarize on the European gas production, there is flexibility in the set up of the current gas supply, which is diminishing. New flexibility is needed in the European gas system in order to be able to cope with very cold winters and supply disruptions. This may be obtained by larger import capacity in the pipeline system and by expanding the storage capacities in Europe.

There are over 100 gas storage facilities in EU 30 today[5]. The total maximum working volume of the EU 30 gas storages is 77 bcm, and the maximum withdrawal capacity is 1.5 bcm per day[6]. The below figure shows the gas storage capacities in the EU 30 countries.

[5] Eurogas Annual Report 2003-2004

[6] Eurogas and IEA Natural Gas Information 2005

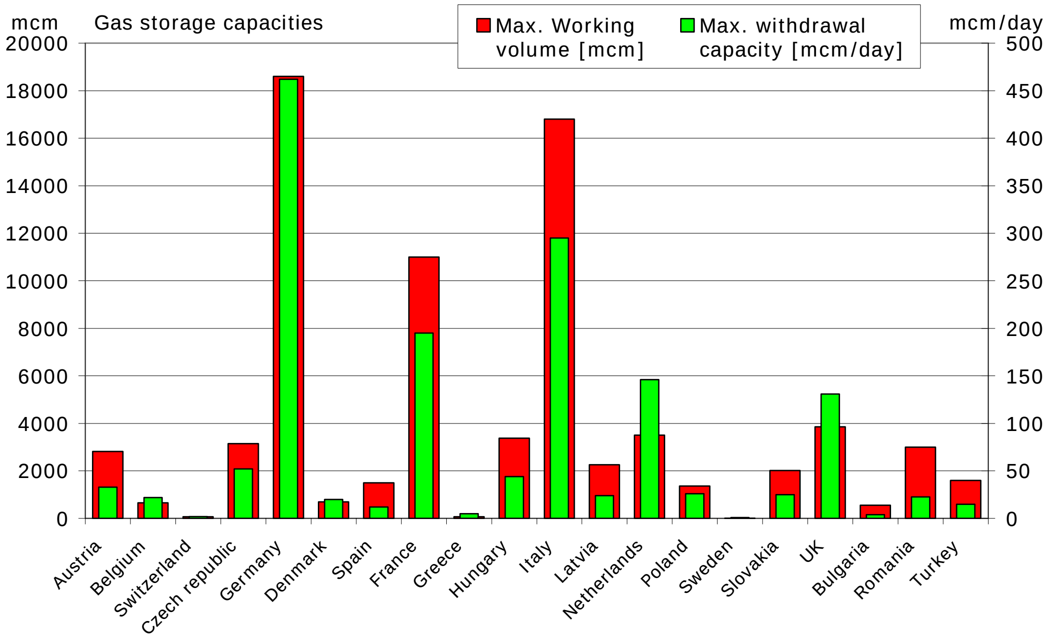

Fig. 5.14: Current gas storage capacities in Europe

Of the over 100 gas storages in Europe about 50% are depleted gas fields, about 20% are aquifer storages and about 20% are salt cavity storages. The remaining gas stages are LNGs, depleted oil fields and other forms of storage.[7]

As shown in Tab. 5.10, the internal gas production in EU 15 was 193 bcm and the gas storage capacity was 60 bcm, equalling a production/storage ratio of 3.2. The imports were 169 bcm equalling an import/storage ratio of 2.8. This means that the internal gas production is 3.2 times higher than the total seasonal gas storage capacity, but the gas imports are only 2.8 times the seasonal gas storage capacity - meaning that more gas storage is in place per cubic meter gas imported.

EU 15: Gas storage ratios 2003	Comment	bcm	Gas/storage Ratio	
Gas demand		362		
Internal gas production		193	3.3	Production/storage
Gas import		169	2.8	Imports/storage
Gas storage capacity - Seasonal	Max working volume	60		

Tab. 5.10: Current gas storage capacities in Europe – Source: Eurogas Annual Report 2002-2003 and European Union Energy & Transport in Figures, 2004 edition.

The gas demand is expected to rise considerably which will call for more gas storage capacity. Similarly, the import dependence on gas is also expected to increase substantially, leading to an expected climb in future needs for gas storage capacity. To reach a high load factor in the large gas import pipelines a relative greater need for gas storage capacity is foreseen.

The expected need for gas storages and the associated costs in the various scenarios appear from the table below.

[7] IEA Statistics, Natural Gas Information

EU 30: Gas storage 2005 - 2013 Expected capacity and invetment	EU production 2013 bcm	Ratio 3.3	Gas Imports 2013 bcm	Ratio 2.8	Gas storage need bcm	Gas storage in 2004 bcm	Growth in Gas storage need bcm	Investment costs Billion EUR
Baseline Scenario	289	47%	327	53%	103	77	26	10
12% renewables in 2010	290	49%	298	51%	97	77	20	7
Energy efficiency	290	52%	265	48%	91	77	14	5
Efficiency case with high renewables	285	54%	242	46%	87	77	10	4
Soaring oil and gas price scenario	310	60%	206	40%	86	77	9	4

EU 30: Gas storage Total till 2023 Expected capacity and invetment	EU production 2023 bcm	Ratio 3.3	Gas Imports 2023 bcm	Ratio 2.8	Gas storage need bcm	Gas storage in 2004 bcm	Growth in Gas storage need bcm	Investment costs Billion EUR
Baseline Scenario	257	36%	463	64%	133	77	56	22
12% renewables in 2010	265	39%	422	61%	123	77	46	17
Energy efficiency	276	44%	350	56%	106	77	29	11
Efficiency case with high renewables	262	44%	330	56%	101	77	24	9
Soaring oil and gas price scenario	287	53%	256	47%	89	77	12	5

Tab. 5.11: Gas storage capacity need in 2013 and 2023

In the Baseline scenario, the additional need for gas storage is 56 bcm, which is an increase of more than 70% in the present capacity. The soaring oil and gas price scenario has the lowest need for gas storage of 12 bcm. An investment cost[8] of 0.4 EUR[9] per cubic meter gas working volume, based on depleted gas fields and aquifer storages is assumed. The capital unit costs are assumed to be the same over the period. Stricter environmental and security regulation is likely to increase the storage investments costs, but technological improvements are likely to offset this increase.

It should be noted that the various scenarios are based on the EU publication, "*European energy and transport scenarios on key drivers"* from 2004, which is based on the PRIMES model. This model also uses different EU gas production levels for different scenarios. The Soaring oil and gas price scenario, which has the highest gas price, is also the scenario where the EU gas production is expected to be highest.

The Baseline scenario calls for a significant increase in storage. The total investment costs related to gas storages are expected to be about 22 b€ over the period. In the Soaring oil and gas prices scenario, the investment costs will fall to 5 b€.

The effects of the Commission Directive proposals from 11 September 2002 for improving the security of EU gas supply have not been included in this analysis. It states that the Member States should take the necessary measures to ensure that the supply to vital consumers, who are not in a position to replace gas with another fuel, is guaranteed for sixty days in average weather conditions in the event of the single most important source of gas supplies being disrupted.

[8] Study on Underground Gas Storage in Europe and Central Asia, UN 1999
[9] The investment costs for depleted gas fields in Europe are used, corrected for inflation, assumed doubling of the cushion gas price which consists of 35% of the costs, and using the current exchange rate of 1 USD = 0.81 EUR.

5.9 Estimation of future import needs and location

5.9.1 Expected future development in gas demand

The future development in the European gas demand is important in relation to the future investment needs in gas transmission. This section presents the expected gas demand in the baseline scenario and the other scenarios.

The analysis concerning future investments needs in the gas transmission network makes reference to a Baseline scenario and four alternative scenarios worked out by the EC in other projects. For a detailed description of the scenarios see the publication "*European energy and transport scenarios on key drivers*" published in September 2004 by the European Commission, Directorate-General for Energy and Transport.

It should be noted that the effects of a high oil price on the gas transmission investments differ to a great extent depending on whether it is a question of a short-term spike or a permanent shift to a higher level. A shift to a permanent high oil price level is likely to reduce the long-term gas demands and therefore also to reduce the investment need in the gas transmission system. On the other hand, a short-term spike is not likely to reduce the long-term gas demand and is therefore not likely to have an impact on the investments.

In the EU, the combined effect of an increasing demand for fossil fuels together with the falling production of primary energy is causing an increase in the import dependence. For the EU 25 energy system, the import dependence will increase from over 47% in 2000 up to 67% in 2030, an increase of more than 20 percentage points. This is also the case for natural gas where the EU 25 external dependence in terms of natural gas is projected to a strong increase, reaching 81.4% by 2030 compared with 49.5% in 2000.

The below figure shows that the future gas demand for EU 30 (red line) is expected to increase in the Baseline scenario from 505 to 720 bcm in 2023. The primary gas production is expected to fall from 283 to 257 bcm. As a consequence of these two effects, the net import is expected to increase from 222 to 463 bcm.

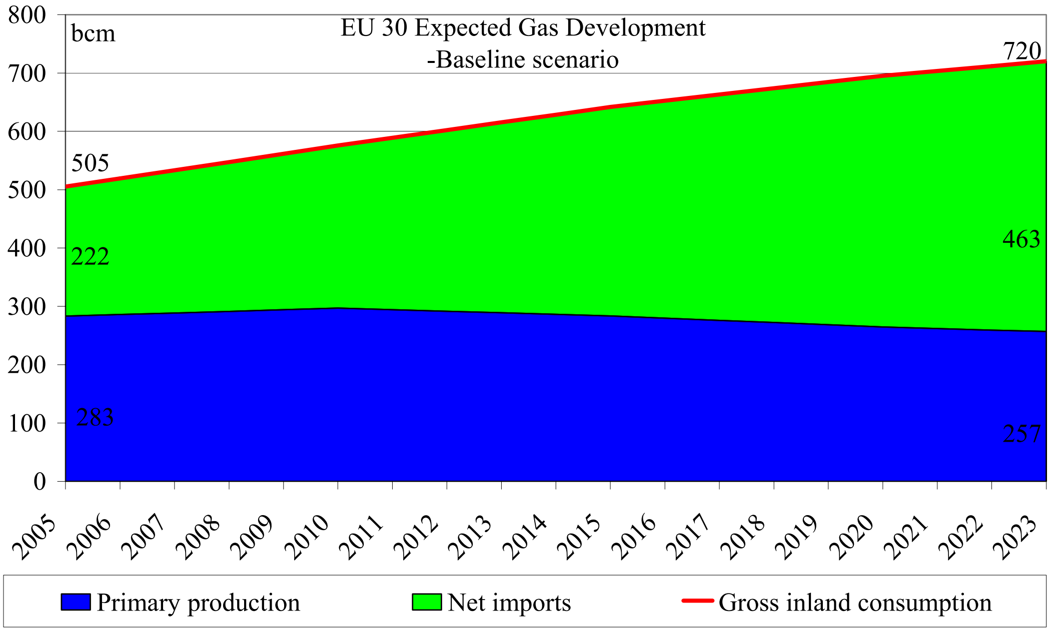

Fig. 5.15: Expected development in gas for the baseline scenario

The increase in net gas imports is illustrated in the below figure. The current gas import capacity is illustrated by the red line. The red dotted line shows the import capacity when utilising the pipelines with a load factor of 0.8, and the LNG regasification terminals with a load factor of 0.58.

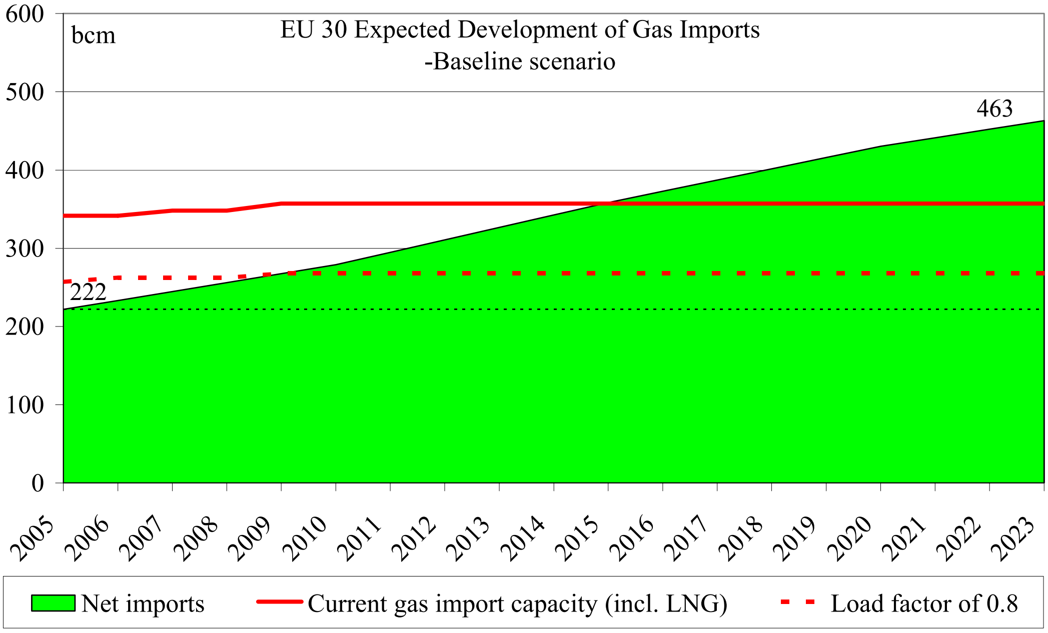

Fig. 5.16: Increase in import demand and current transmission capacity

The first increase on the red line illustrates the effect of the South Caucasus Pipeline in 2007 and the second increase is the extension of the new Isle of Grain LNG terminal in the UK.

The below table shows the expected increase in gas demand for the Baseline scenario and the other scenarios. The highest increase in gas demand is found in the Baseline scenario with an increase of 215 bcm and the lowest increase is to be found in the soaring oil and gas prices scenario of 40 bcm.

EU 30:	Consumption (bcm)			Increase
Expected increase in demand	2005	2013	2023	to 2023
Baseline Scenario	505	615	720	215
12% renewables in 2010	482	588	686	205
Energy efficiency	470	556	626	155
Efficiency case with high renewables	458	528	592	135
Soaring oil and gas price scenario	503	515	542	40

Tab. 5.12: Expected increase in demand, 2005, 2013 and 2023[10]

As to the expected increase in gas imports, the highest increase is found in the Baseline scenario, at 241 bcm, and the lowest increase is in the soaring oil and gas prices scenario, at 36 bcm.

[10] Source: European energy and transport scenarios on key drivers, September 2004 – based on the Primes model.

EU 30: Expected increase in import	Gas import (bcm) 2005	2013	2023	Increase bcm
Baseline Scenario	222	327	463	241
12% renewables in 2010	206	298	422	216
Energy efficiency	197	265	350	153
Efficiency case with high renewables	184	242	330	146
Soaring oil and gas price scenario	220	206	256	36

Tab. 5.13: Need for import capacity, 2005, 2013 and 2023[11]

These forecasts as to future gas demands compared with present gas demands and import capacities form the basis of the estimate of the future investment needs in the gas transmission system.

5.9.2 *Location of future gas imports*

The future changes in gas production, consumption and imports in the various nations are shown in the second figure below. It is clear that all the existing EU member states are experiencing a drop in the gas production whereas a significant boost is taking place in the gas production in Norway. In Turkey there is also limited growth in the gas production. The falling gas production combined with the increase in demand determines the change in the need for gas imports. The major increase in gas imports is expected to take place in the United Kingdom, Germany, Italy, Turkey, Poland, Spain, France and Denmark. By 2023, the Netherlands will be the only EU member state with higher gas production than its national gas consumption.

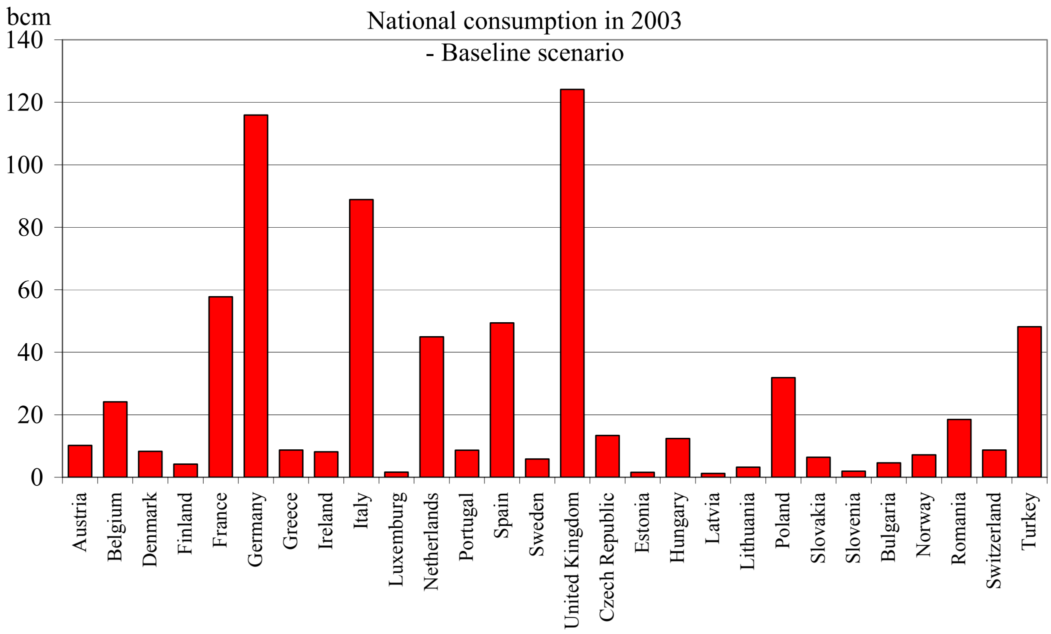

Fig. 5.17: EU 30 Baseline scenario - National gas consumption

[11] Source: European energy and transport scenarios on key drivers, September 2004 – based on the Primes model.

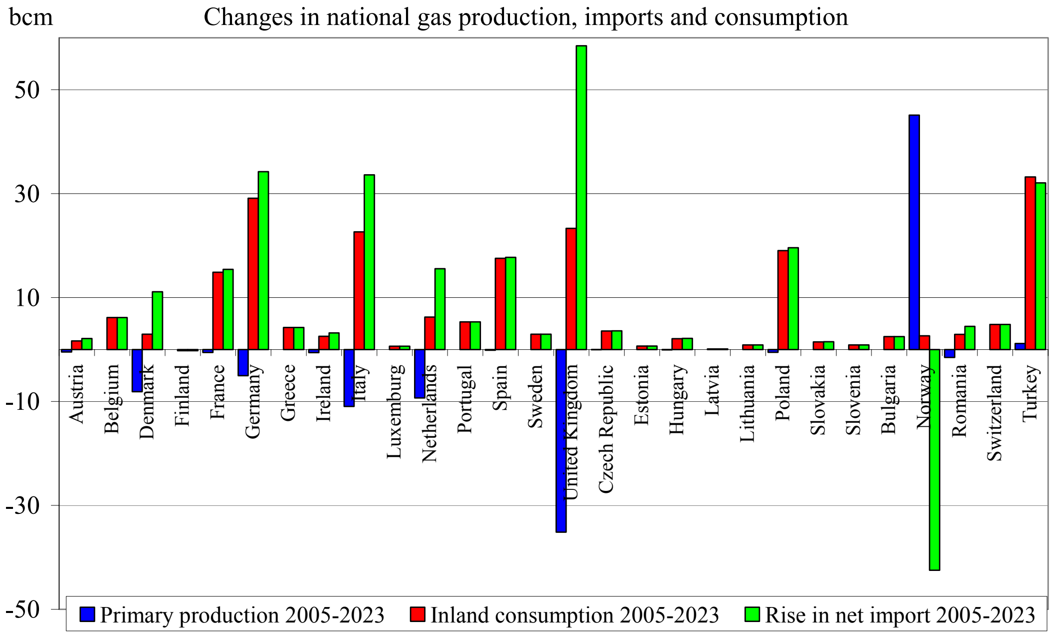

Fig. 5.18: EU 30 Baseline scenario - Changes in national gas production, import and consumption

EU 30 countries can be divided into two groups: the EU 30 border countries able to import gas directly, and the countries which must transit their gas through other EU 30 countries first. The EU 30 border countries are Finland, Estonia, Latvia, Lithuania, Poland, Slovakia, Hungary, Romania and Turkey.

As illustrated in Fig. 5.16, the rise in the need for imports will grow from 222 bcm today to 463 bcm in 2023, which is an increase of 241 bcm to 2023. About 25% or 64 bcm of this growth will be in the border countries, which do not need to have gas transported across other EU30 countries. The remaining 75% or 178 bcm increase in gas imports needs to be transported across other EU 30 countries. The increasing future gas supplies from Norway must also be transported through other EU 30 countries.

5.10 Interconnectors, ongoing and new import projects and related investments

5.10.1 Future interconnections

Several interconnectors are expected built before 2023 (see Tab. 5.14).

EU 30: Expected investments M EUR Future interconnectors and gasification	First gas flow	Capacity bcm	Investment M EUR
BBL (Nederlands-UK)	Dec 2006	16	500
Bacton Interconnector Upgrade (now: 8.5bcm)	Dec 2006	23.5	250
Langeled (Norway-UK)	2007	25.6	2300
Norway-Europe	Unknown	17	1520
Balticconnector (Finland-Estonia)	Unknown	2	210
Amber (Poland-Lithuania)	Unknown	1	350
Scandinavian Gas Ring (Gas to Sweden & Oslo)	Unknown	1.3	650
Total			5780

Tab. 5.14: EU 30 Expected interconnectors and gasification of new area

The BBL and the upgrade of the Bacton Interconnector are ongoing projects for the UK.

To improve the internal European gas market, it has been assumed that there is also a need for two more interconnectors to ensure that four countries, which today are only connected to non-EU countries, will be connected to the main EU gas infrastructure in the future. An interconnector between Poland and Lithuania, the Amber Project, will ensure that the three Baltic States are linked to the remaining EU gas infrastructure. An offshore interconnector between Finland and Estonia, called Balticconnector, will provide Finland, which is presently only connected to Russia, with a direct connection with the EU gas infrastructure and the gas storage in Lithuania.

In this study, the Amber project is defined as an interconnector between Lithuania and Poland and not as a major import pipeline to Europe. The Langeled pipeline and a new Norway-Europe pipeline are internal EU30 pipelines needed to transport Norwegian gas to the EU30 gas market.

There are several areas within the European Union with a potential for introducing natural gas. Twelve regions are listed in a proposal for a decision of the European Parliament and of the Council laying down the guidelines for trans-European energy networks from June 2005. Only the Scandinavian Gas Ring, which transports gas to parts of Sweden and the Oslo area in Norway, which currently does not have gas, has been specifically included in these analyses.

5.10.2 Ongoing import projects

The ongoing import projects to EU30 are shown in Tab. 5.15.

Pipelines	Year	bcm	M EUR	LNG	Year	bcm	M EUR
Baseline	2005	261	-	Baseline	2005	75.9	-
Yamal compressors	2005	(6 bcm)	353	UK - Isle of Grain	2005	4.6	190
South Caucasus Pipeline	2006	6.6	-	UK - Isle of Grain	2009	9.0	520
Total:			353				710

Tab. 5.15: Current, new and future pipeline and LNG import capacities – including cost of expansion

A further decline in the UK production is foreseen in the coming years. This is the background for new import infrastructure as the new LNG terminal on the Isle of Grain. National Grid Transco (NGT) has invested £130 million in a LNG (Liquefied Natural Gas) importation terminal at the Isle of Grain in Kent. The facility has the capability to import and process 3.3 million tonnes (4.6 bcm) per year, representing about four per cent of the UK's current annual gas demand. The second phase is to triple the capacity by the end of 2008. When complete, this further £ 355 million investment will allow the terminal to import an additional 6.5 million tonnes of LNG (9 bcm) per annum, taking its total planned capacity to 9.8 million tonnes (13.5 bcm). This capacity expansion has been included in the analysis.

5.10.3 Future gas import routes into Europe

There is a need for further capacity for gas import into Europe in future. Many projects have been proposed but only some of them will be realised. Fig. 5.19 provides an overview of the main import routes proposed.

There are four main gas-supplying sources from outside Europe, which are Russia, Middle East, North Africa and LNG where gas can be supplied from sources even further away. Each one of the four main gas sources has several potential gas supplying routes or can be utilised by a LNG terminal.

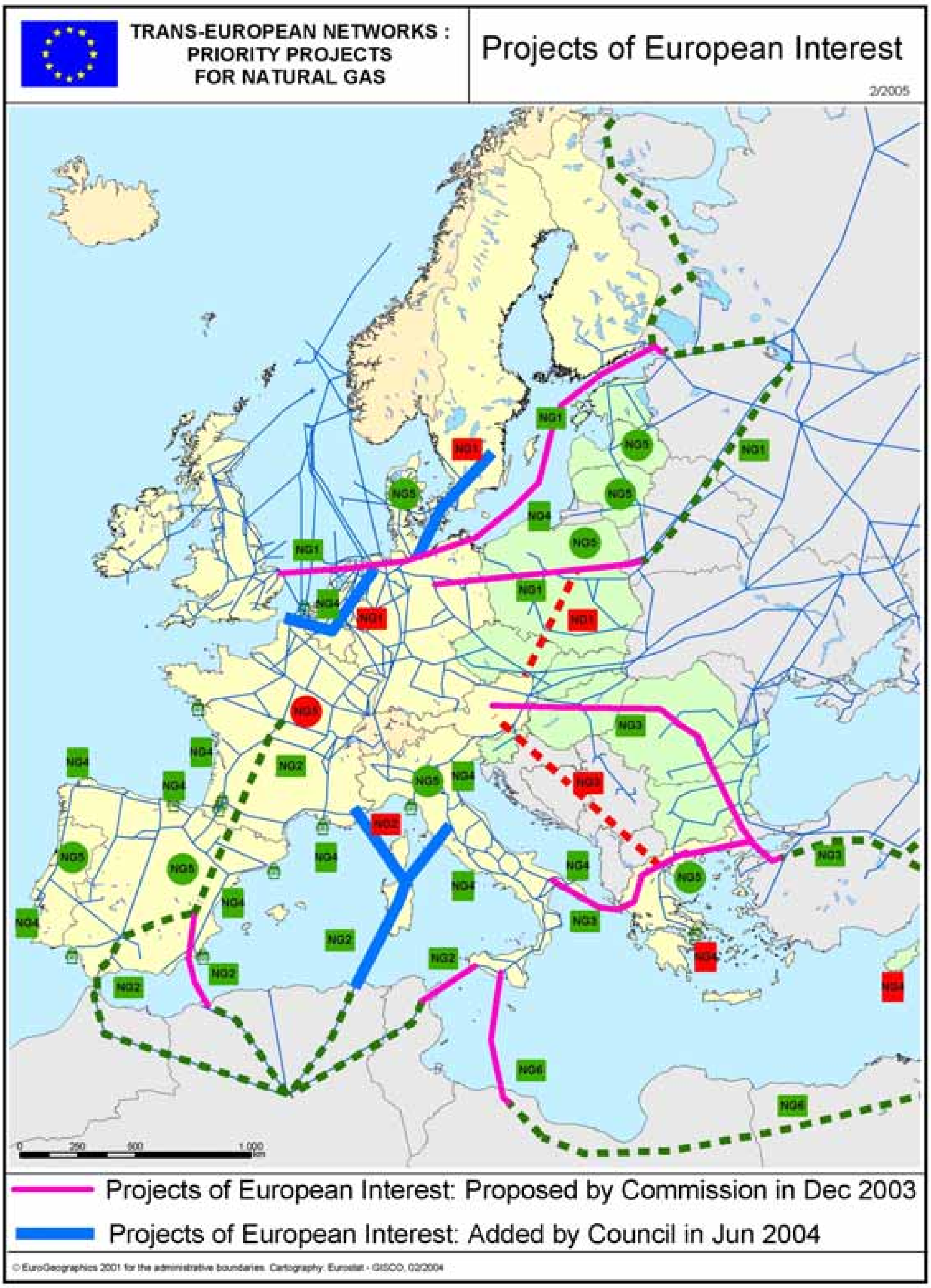

Fig. 5.19: Potential new gas supply routes to Europe (Source: Report on the proposal for a decision of the European Parliament and of the Council laying down guidelines for trans-European energy networks, 3.5.2005)

So far, some of the proposed gas import projects have not been possible to implement, but the development in the gas pipeline technology has broken old barriers, as will be explained later in this report.

Russia:

The gas supplies from Russia may be transported via four main routes: 1) the Baltic Sea Region, 2) a second Yamal-Europe pipe, or 3) through a system further south via Ukraine as today (not shown on the map) and in addition, gas can be supplied as 4) LNG from the Barents Sea – an option already used in Norway by the Snøhvit project (not shown on the map).

North Africa:

The gas from North Africa may be transported via seven main routes: increasing the current connections from 1) Morocco to Spain or 2) Tunisia to Italy (Transmediterranean), 3) Libya to Italy (Greenstream), 4) constructing a direct line from Algeria to Spain (Medgaz), 5) from Algeria or Tunisia to Italy via Sardinia, 6) from Egypt up to Turkey (and onwards further up into Europe). Another option is to 7) further increase the LNG gasification capacities in North Africa, and also further to the south of Africa. In addition to this, studies have been made on the potentials of building a Trans-Sahara pipeline from Nigeria to North Africa and onwards to Europe.

Turkey's transit:

Gas is currently supplied to Turkey from both Russia and Iran, and there is a potential for further gas supply from other sources in the Middle East and even Egypt. From Turkey there are three supply routes into Europe: 1) to Greece crossing the sea to Italy, 2) to Greece up through the western Balkans, 3) up through Bulgaria, Romania and Hungary to Austria (Nabucco pipeline).

LNG:

In addition to the pipelines, the LNG receiving terminals also represent an option to increase the gas import capacity in many European countries.

Storage:

A high degree of utilisation of the gas import pipelines is necessary to achieve low transportation costs. To achieve this it will also be necessary to invest in gas storage.

Potential projects:

Many gas pipeline projects are promoted to be used for importing gas into Europe. Some of the specific gas-pipeline projects planned appear in the list below. These projects are also used to estimate the needs for future investment in the gas import transmission system.

Pipeline Route	EU list	Type of Work	Capacity bcm/year	Estimated cost M EUR
Russia-Germany	NG1	New pipeline offshore in Baltic Sea	35	4700
Yamal Europe II	NG1	Second line across Poland	32	1520
Yamal Europe, doubling capacity	NG1	Third line across Poland	32	1520
Across the strait of Gibraltar	NG2	New pipeline	9	150
Algeria-Spain (Medgaz)	NG2	New deep water offshore pipeline	18	1437
Algeria-France/Italy	NG2	New pipeline	20	5000
Turkey-Grece-Italy	NG3	New pipeline	8	1612
Turkey-Austria	NG3	Nabucco pipeline	30	4400
Total			184	20340

Tab. 5.16: Gas pipeline supply routes

To a significant extent, pipelines have economies of scale, i.e. large capacity pipelines have significantly lower unit transportation costs than smaller capacity pipelines. This will generally call for investments in large gas transmission projects.

LNG Receiving terminal	Type of Work	Storage m^3	Capacity bcm/year	Estimated cost M EUR
Zeebrugge (Belgium)	Extending the LNG receiving capacit	210 000	10	100
Fos-sur-Mer (France)	Extending the LNG receiving capacit		8	365
Mugardos (Galicia) (Spain)	New terminal	300 000	2	320
Tuscany region (Italy)	New terminal	320000	6	600
North Adriatic coast (Italy)	New terminal	500000	8	1200
New LNG terminal France	New terminal		9	520
Total			43	3105

Tab. 5.17: LNG receiving terminals

LNG also has economies of scale, which makes an extension of the existing LNG receiving terminals much less costly than the construction of a new terminal as can be seen from the above table. The economies of scale are attained by sharing facilities such as infrastructure and storage tanks. The focus is therefore likely to be directed towards extension of the existing LNG receiving terminals and the construction of new larger terminals.

The capacity to import gas to Europe requires investments both within Europe and in the neighbouring areas. Inside Europe, investments go to gas transmission pipelines with the associated compressor stations, gas storages and LNG regasification plants. A LNG regasification plant generally represents only about 20% of the total cost of the LNG chain.

Investments outside Europe include exploration and production costs, gas transmission pipelines and LNG plants. Such investments are not included in these analyses.

5.10.4 Future investments in gas import routes till 2023

There is a need for further investments in gas import capacity. These investments are defined to take place when the gas demand reaches the gas import capacity – the pipelines are calculated with a load factor of 0.8 and LNG regasification terminals with a load factor of 0.6.

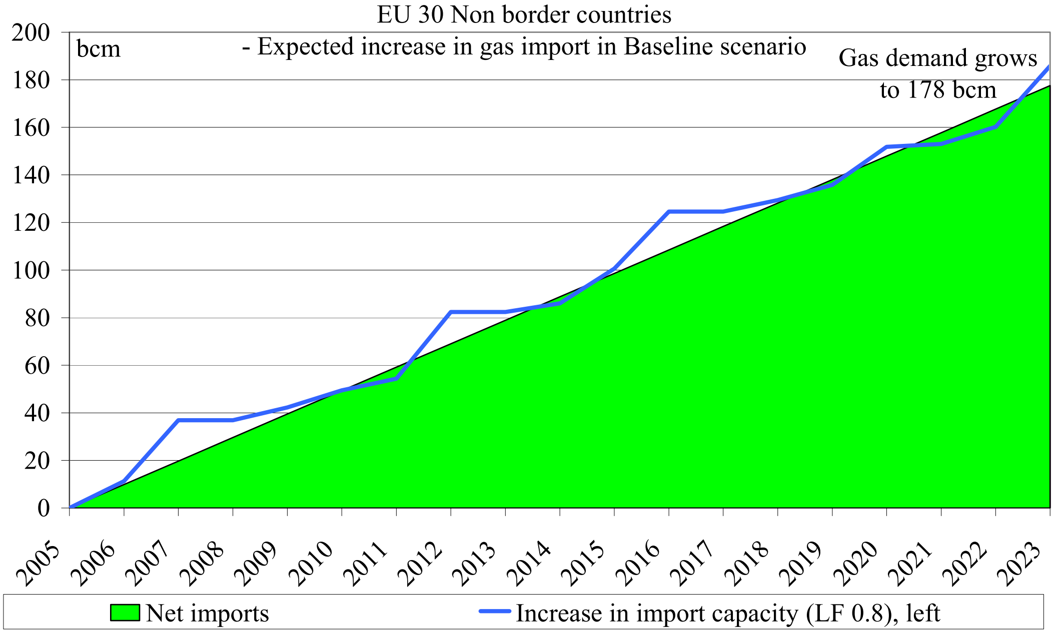

Fig. 5.20: Increase in new import capacity

The cost of increasing the gas import capacity is illustrated in the figure below by the green line. The investment costs occur at the same as the capacity increases. The investments with the lowest unit capacity costs, i.e. the most cost efficient investments, are generally introduced first.

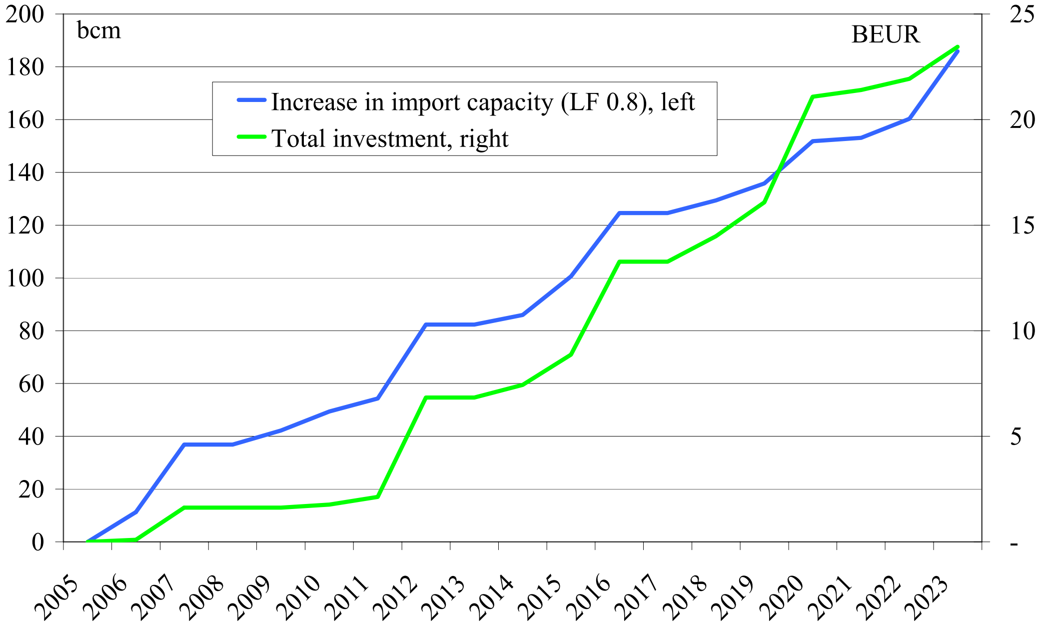

Fig. 5.21: The development of investment needs in new import routes only

Tab. 5.18 depicts the expected future investments in the gas transmission system for the Baseline and in the alternative scenarios.

EU 30: Expected investments BEUR For new import capacity	Total Investment to 2013	to 2023
Baseline Scenario	10	23
12% renewables in 2010	9	21
Energy efficiency	7	15
Efficiency case with high renewables	6	14
Soaring oil and gas price scenario	0	3

Tab. 5.18: Investments in new import capacity

The results show that very limited new investments are needed in the Soaring oil and gas price scenario where the gas import need is significantly lower than in the baseline scenario.

5.11 Total investments

The total investments in the European gas transmission system consist of 1) the investments reported by the TSOs, 2) investments in gas storages, 3) investments in interconnectors, 4) investments in ongoing projects and 5) investments in new gas import routes.

The reported past years' historic investments were in the range of 24 b€ (see sect. 5.2). The investments reported by the TSO constituted about 24 b€ for the nine years from 2005 to 2013. The TSO did generally not report their expected investment for the ten years from 2014 to 2023. These investments are therefore also expected to be in the range of 24 b€. For the years 2005 to 2023, the total expected investments were therefore expected to be about € 48 billion.

Tab. 5.19 summarises the expected total investments presented in the previous sections.

EU 30: Expected investments B EUR 2005-2013: New import capacity	TSO internal Investment	Storage	Intercon-nectors etc.	Ongoing Projects	Import Pipelines & LNG	Total Investment
Baseline Scenario	24	10	3	1	10	48
12% renewables in 2010	23	7	3	1	9	43
Energy efficiency	21	5	3	1	7	37
Efficiency case with high renewables	20	4	3	1	6	34
Soaring oil and gas price scenario	18	4	3	1	0	26

EU 30: Expected investments B EUR 2014-2023: New import capacity	TSO internal Investment	Storage	Intercon-nectors etc.	Ongoing Projects	Import Pipelines & LNG	Total Investment
Baseline Scenario	24	12	3	0	13	52
12% renewables in 2010	23	10	3	0	12	48
Energy efficiency	21	6	3	0	8	38
Efficiency case with high renewables	20	5	3	0	8	36
Soaring oil and gas price scenario	18	1	3	0	3	25

EU 30: Expected investments B EUR TOTAL: New import capacity	TSO internal Investment	Storage	Intercon-nectors etc.	Ongoing Projects	Import Pipelines & LNG	Total Investment
Baseline Scenario	48	22	6	1	23	100
12% renewables in 2010	46	17	6	1	21	91
Energy efficiency	42	11	6	1	15	75
Efficiency case with high renewables	40	9	6	1	14	70
Soaring oil and gas price scenario	36	5	6	1	3	51

Tab. 5.19: Total investments till 2013 and till 2023

For the Baseline scenario, the investments are expected to be 48 b€ in the TSO transmission system, 22 b€ in storage, 6 b€ in future interconnectors, 1 b€ in already started gas import projects and 23 b€ in import pipelines reaching 100 b€ in total.

The Soaring oil and gas prices scenario has the lowest expected investment costs of 51 b€ which is about 50% less than the baseline.

The high oil & gas price scenario has very limited need for investment compared to the other scenarios. The reason for this is the large changes in the EU energy system fuel mix. By 2030, the demand for gas will decline from Baseline levels by 28.2% and the demand for solid fuels will increase by nearly 40% from Baseline levels. The changes occurring in the fuel mix mainly relate to an increase in the demand for solid fuels and a similar decline in the use of natural gas or vice-versa. The shift is a result of the decisions by electricity producers as to the expansion and/or replacement of the existing power generation capacity as solid fuels are an energy form almost exclusively used in the EU 25 power sector. This result clearly underlines the importance of the future development of oil and gas import prices. For other energy sources it is noteworthy that the impact on the primary energy need for liquid fuels is still much less important than the changes in the demand for solid fuels and gas. This is due to the specific uses of liquid fuels in the EU 25 energy system (for transportation and in the petrochemical industry). There is also an increasing contribution of renewable energy forms to the EU 25 energy system under the high energy prices.

5.12 Other issues

5.12.1 Interaction between the TSOs and the internal market

The establishment of the internal market is likely to have an impact on the TSO behaviour, e.g. a perceived increase in the risk might delay projects. Similarly, the TSO behaviour (e.g. the decisions to invest in new gas transmission capacities) is likely to have an impact on the performance of the internal market. The current gas market has affected the interaction between the TSOs and the internal market. This section addresses TSOs' views on these issues as expressed in the questionnaires and in interviews with selected companies.

Increased competition is a major driver behind the creation of the internal market. Increased competition also increases companies' business risks. The TSOs were, therefore, asked if planned future investments currently are put on hold due to insecurity about the development of the internal market. A clear majority of 18 companies replied no and 5 companies replied yes.

This result may leave the impression that the TSO insecurity about the future development of the European gas market is negligible; this is, however, not the case. Some of the largest European gas TSOs in the major gas consuming countries replied that they do put future investments on hold because of insecurity about the development of the internal market.

To make the internal market operate there is a need for sufficient gas transmission capacity to avoid major bottlenecks which are likely to have negative effects such as reduced competition and increasing prices.

Fig. 5.23 illustrates that a significant number of the TSOs have invested in the transmission system with the main aim of improving the functioning of the internal market. In future, a majority of the TSOs is also expected to invest with the main goal of improving the market. Two of the TSOs, which stated that they did not expect to invest in the transmission system with the main aim of improving the functioning of the internal market, said that planned future investments were currently put on hold due to insecurity about the development of the internal market.

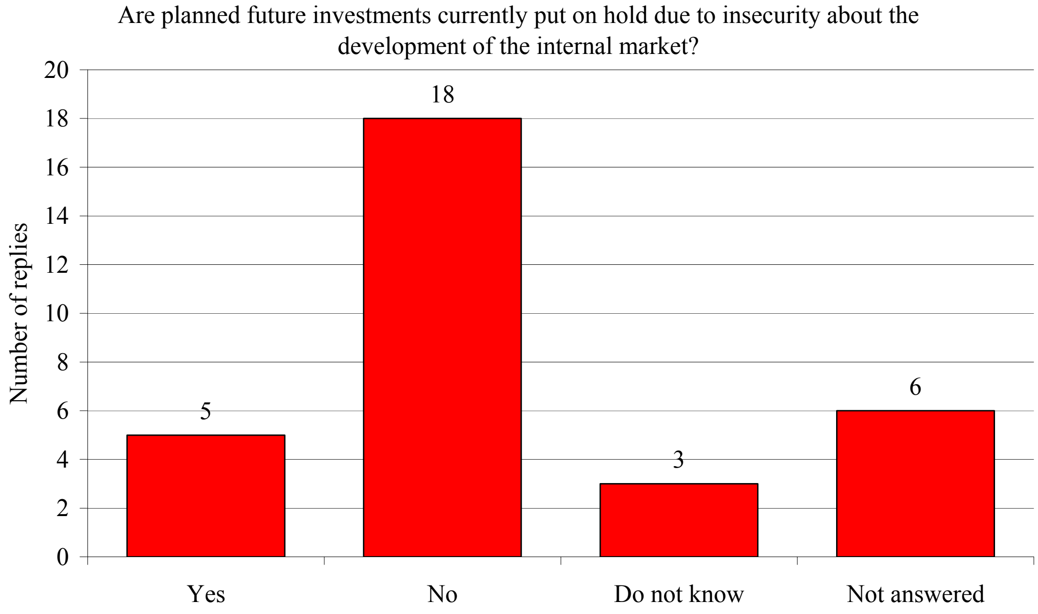

Fig. 5.22: Are planned future investments currently put on hold

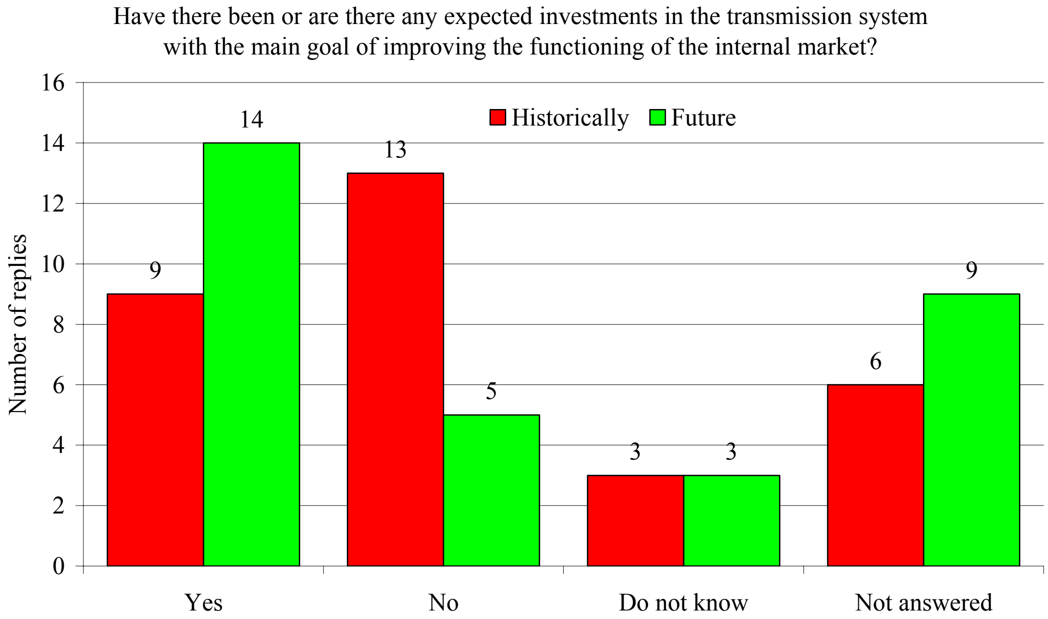

Fig. 5.23: Investment made to improve the functioning of the market

The TSOs do generally not place investments in other countries (3/29 – red in the below figure). The TSOs do, however, invest in interconnections (13/15 - green). The interconnections are important as they will reduce the bottlenecks between different countries and TSO areas and facilitate the European gas market.

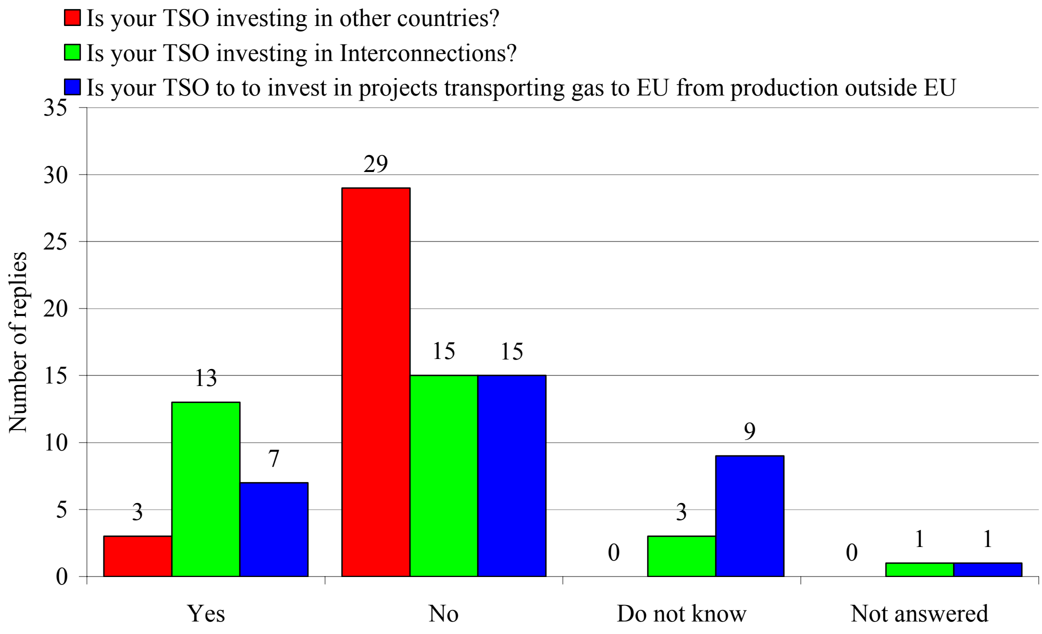

Fig. 5.24: Investments by the TSO

The TSOs were asked the question: "*Is your company likely to invest in projects transporting gas to the EU from production units outside the EU (e.g. Russia, Caspian Sea Area, North Africa or LNG)?*" Several companies (9 - blue) answered that they did not know. Many companies have not made such investments before and it might therefore not be surprising that a great number of companies do not a clear view on the issue. It is likely that basic decisions on such issue must be taken by the board of directors or directly by the owners. Seven of the TSOs, which have a clear view on the issues answered "yes" and 15 "no."

5.12.2 Advantages and disadvantages of pipeline versus LNG gas supply

Pipelines have historically proven to be a safe and reliable source of gas supply to Europe. Pipelines create an inter-dependability between the gas producers and the consumers. For the gas consumers, the advantage of the pipeline is that the gas supply is limited to the pipeline's route. This is in contrast with gas supply from LNG where the ship may be directed to the location with the highest price, whether this is Asia Pacific, USA or Europe. Pipelines and LNG import have their strengths and weaknesses as illustrated in Tab. 5.20.

For a gas importing country the strengths in pipeline import lie in the restricted alternatives for the gas exporter. The drawback is a high degree of limitation in receiving gas from new gas supplying countries if there are problems with current supplies or a need for additional supplies, but this is eliminated in LNG imports. Pipeline imports frequently also depend on transit countries, which may be avoided by LNG imports. Both Poland and Lithuania have recently experienced the problems that may arise when being dependent on transit countries. In this case there was disagreement between the gas producers in Russia and the transit country, Belarus, which led to a short-term limitation in the gas supply to Belarus and therefore also to Poland and Lithuania.

Gas importers using pipelines for import will not be directly affected by increases in the gas price in other regions. Nor will they benefit from possible lower gas costs in other regions. The flexibility in LNG supplies means that price differences between various gas areas may cause price impact between the regions.

	Strengths	Weaknesses
Pipelines	• Dedicated route means limited alternative use as the gas supply • Not pressured by high gas prices in other regions	• Dependence on current gas supplier and the transit countries • Dependent on current gas infrastructure (not same flexibility as LNG) • Not benefiting from lower gas prices in other regions
LNG	• Flexibility to change supplying country if difficulties with current supplier • Flexibility to receive additional gas, from other areas, if needed • Increasing number of gas supplying countries	• Flexibility from LNG ships means that there may be competition over LNG supply • High gas price in other regions transferable to Europe

Tab. 5.20: Benefits of pipelines and LNG to the gas users

The LNG trade has a regional character, as most of the LNG to Europe comes from the northern part of Africa, most of the LNG to the USA comes from South America and most of the LNG to Japan comes from Asia Pacific. There are, however, other trades such as trades form Algeria to both the USA and South Korea and from Oman and Qatar to the USA and Europe. It is expected that a global LNG market will gradually emerge and this will create impact from one gas price area to the others. As an example, a high gas price in the USA will not directly have an impact on the European gas supplies or the gas price. In future, a larger share of the gas market will belong to LNG and a stable high gas price in the USA, assuming available receiving capacity, will lead to a lower gas supply to Europe and an upward pressure on European gas prices.

The LNG market is increasing. Norway and Russia are currently the two largest suppliers of gas to the EU member states, and the gas is transported via pipelines. The latest Norwegian gas project, the Snøhvit LNG project, is to export 5.7 bcm gas yearly, which equals over 8% of the total Norwegian gas exports. The Snøhvit gas project is located in northern Norway, north of the Artic circle, and is situated about 900 km away from the closest gas pipeline to Europe. If a dedicated pipeline were to be built all the way to the continental European gas market, this would mean about another 1500 km of pipeline. Further to the east from the Snøhvit LNG project, in the Russian territory, there are plans to build another LNG project. The Snøhvit project is to sell the LNG both to the EU and to the USA. This serves as an example of how future gas production in Europe will not necessarily be consumed in Europe.

In future, the LNG import share of the European gas market may increase. Today, LNG represents 22% of the total global cross-border gas trade. This high percentage is mainly reached due to countries such as Japan, Korea and Taiwan whose gas is supplied only as LNG. The LNG share of the total gas market is expected to increase in future, also in Europe where it is currently about 13%.

5.13 Concluding Remarks on future investments in the gas sector

In the Baseline scenario, the gas demand is expected to rise from 505 bcm in 2005 to 615 bcm in 2013 and to 720 bcm in 2023. The internal gas production is expected to increase from 283 bcm in 2005 to 289 bcm in 2013 and subsequently to fall to 257 bcm in 2023. The import dependence on gas will therefore increase from 222 bcm in 2005 to 327 bcm in 2013 and further to 463 bcm in 2023.

The gas production in all of the current EU member states is falling while the gas production in Norway is increasing significantly – Turkey also has limited growth in the gas production. The country with the largest change in gas demand is the UK where the primary gas production is expected to fall significantly at the same time as an increase in the gas demand. The countries with the largest expected increase in gas import are Germany, Italy, Turkey, Poland, Spain, France and Denmark. By 2023, the Netherlands will be the only EU member state with a gas production that is higher than the national gas consumption.

The Baseline scenario calls for significant new investments. The investments from 2005 to 2023 are expected to be 48 b€ in the internal TSO transmission system, 22 b€ in storage, 6 b€ in future interconnectors, 1 b€ in already started gas import projects and 23 b€ in import pipelines reaching 100 b€ in total. The soaring oil and gas price scenario has the lowest expected investment costs of 51 b€ which is about 50% less than for the baseline. The reason for this is that gas demands are only increasing by 40 bcm, compared with 215 bcm in the Baseline scenario.

There are several issues that the TSOs emphasise as being important when analysing the expected future investments in the gas transmission systems. These issues are: uncertainty regarding the future regulation of the TSO, e.g. in Germany; the locations of future gas imports routes and thereby also the supporting national gas transmission; and environmental regulation. Furthermore, the investment level may also be dependent on the ownership structure as integrated companies might demand the same return on investment from their TSO as from their power companies or oil and gas production activities. This may lead to a lower investment level.

As to gas import capacity, there will be a need for one new large gas pipeline or LNG project every second year for the next twenty years. A development similar to what Europe