

**ASSESSMENT OF INTERNAL AND EXTERNAL  
GAS SUPPLY OPTIONS FOR THE EU, EVALUATION OF THE  
SUPPLY COSTS OF NEW NATURAL GAS SUPPLY PROJECTS  
TO THE EU AND AN INVESTIGATION OF RELATED  
FINANCIAL REQUIREMENTS AND TOOLS.**

**EXECUTIVE SUMMARY**

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This study forecasts European natural gas demand and import requirements and assesses future supply options and potential supply volumes to the European Union as well as the infrastructure required. For each supply option, the cost of supplying the gas to Europe has been estimated and supply cost curves elaborated. The cost of future supplies is compared to the future value of the gas to the consumers of the European Union. Finally, the impact of liberalisation of the EU gas market on the financing of supply projects is examined. The European Union has been studied under two configurations: the present European Union of 15 member states (EU15) and an enlarged EU of 30 member states (EU30)<sup>1</sup>.

### **1 - Natural gas demand projections**

According to the results of the study, natural gas demand is expected to increase strongly in European countries. In the EU-15, gas demand is projected to increase from 386 bcm in 1999 to some 600 bcm in 2020, at an average rate of 2.1 % per annum over the two decades. Gas demand in accession countries (e.g. the fifteen non EU-15 countries) is expected to grow at a higher pace of 4.2 % p.a., fuelled by the economic recovery of Central and Eastern European countries and the large potential market of Turkey. In 2020, gas demand in the EU-30 will reach 777 bcm, from 462 bcm in 1999, which gives an average growth rate of 2.5 % p.a. Accession countries will then account for 23 % of the EU-30 demand.

	1999	2010	2020
EU-15	386	500	597
Accession countries	76	142	179
EU-30	462	642	777

	1999-2010	2010-2020	1999-2020
EU-15	114	97	211
Accession countries	66	37	103
EU-30	180	134	314

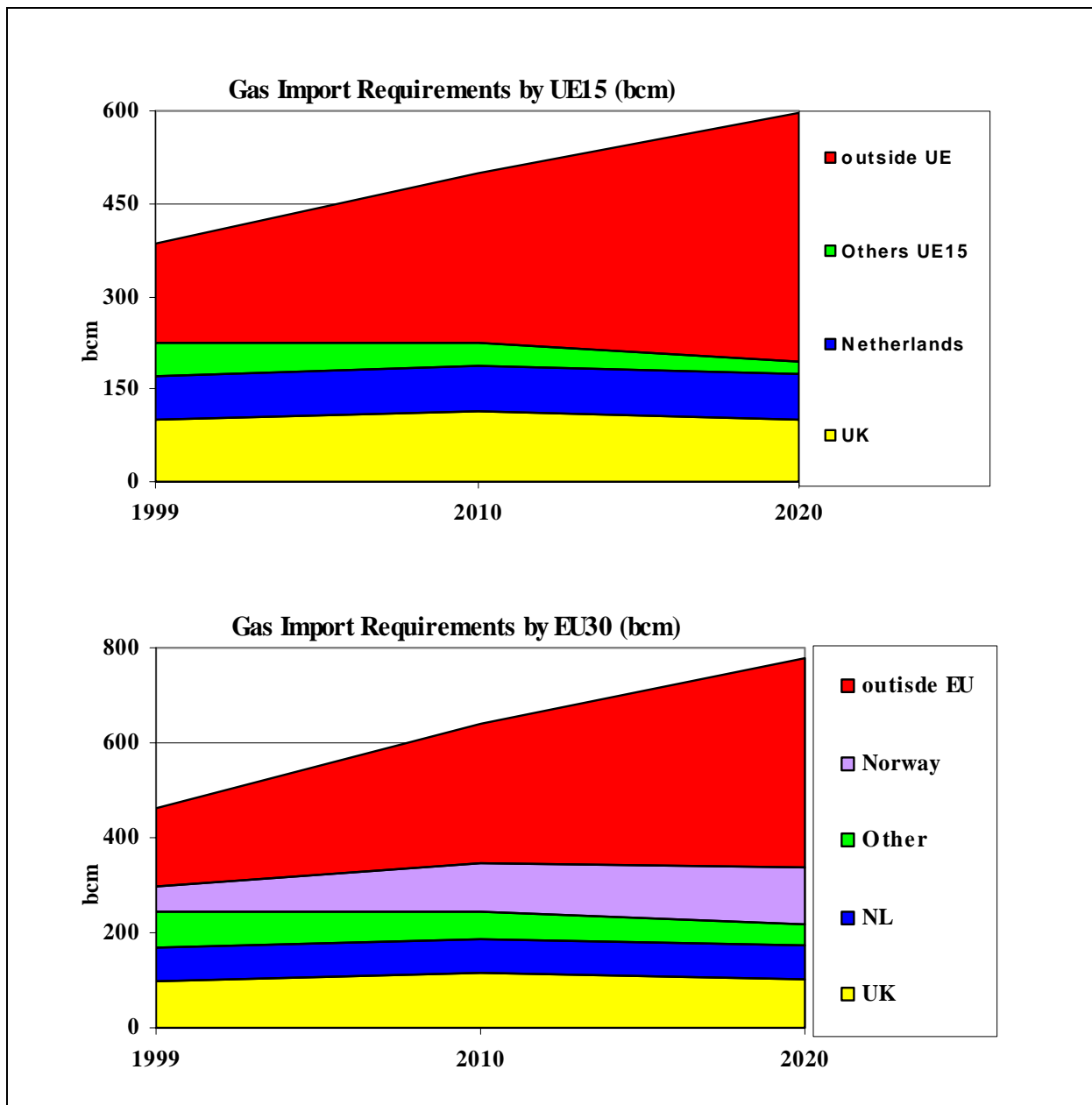
In both the EU-15 and EU-30, increasing gas demand is determined by the dramatic surge of gas for power generation. In 2020, power generation will account for 41 % of the total gas demand in the EU-30, from 26 % in 1999. The larger share of the incremental demand (202 bcm/yr, i.e. 64 % of the incremental demand in the EU-30) will come from this market.

<sup>1</sup> EU30: In addition to the EU15, the EU30 includes Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Romania, Bulgaria, Turkey, Cyprus, Malta, Switzerland and Norway.

## 2 – Gas import requirements

Internal domestic gas production of the EU15, on the other hand, is expected to decline from 224 bcm in 2000 to 196 bcm by 2020. Import dependence is therefore set to increase dramatically. Whereas today some 40% of Western European (EU15) gas demand is met by imports, by 2020 the EU15 is expected to import some 67 % of its gas requirements. This proportion is lower in the EU30 due to the presence of Norway as an internal supplier.

Diagram 1 - Gas import requirements



**2 - Value of incremental gas demand**

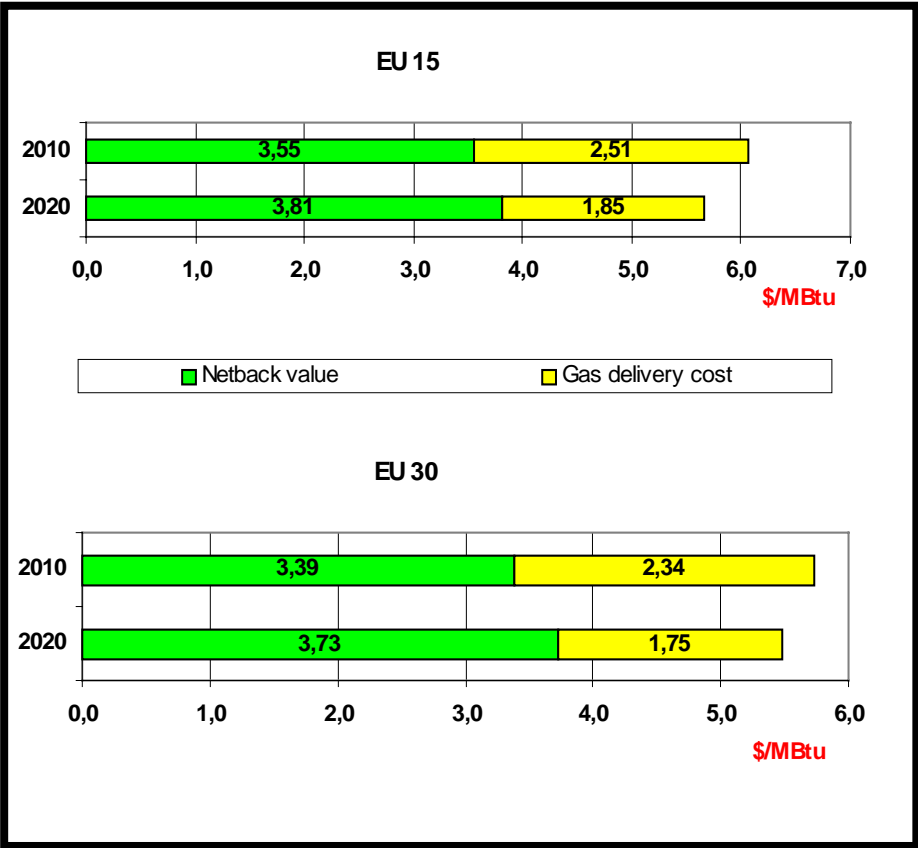
The value of gas to the final consumer of the incremental gas demand by 2010 and 2020 has been calculated using an opportunity cost approach. The netback value has then been computed at the border of the European Union by removing from the opportunity cost the cost of delivering gas from the EU border to the consumer.

Netback values are based on oil at \$25/bl, with no price change over the period. Sensitivity tests have been conducted for oil at \$20 and \$30/bl, respectively. Coal price is considered to increase slowly from \$44 to \$51/ton in 2020.

Diagram 2 presents the average opportunity cost and netback value of gas for the EU-15 and EU-30 in 2010 and 2020. The attached maps show the netback value of gas in each Region of the EU-15 and EU-30 in the same reference years. The main conclusions are :

- Average gas values at the border of the EU range from \$3.39 to \$3.81/MBTU, depending on the configuration (EU-15; EU-30) and the period considered (2010; 2020).
- Gas values are higher (by about 7 to 10 %) in 2020 than in 2010, due to the increasing share of gas for power, i.e. the market where the delivery cost of gas is lowest, compared to industry and R&C, and the sectoral netback value highest;
- Differences between countries may be substantial. Gas values are lower in Central and Eastern European countries due to the higher share of coal in the industry and R&C markets;

Diagram 2 – Opportunity Cost and Netback Value in the EU-15 and EU-30 (\$/MBTU)



### 3 - Potential supply options and volumes

The following tables summarise the export potential by 2010 and 2020 from the various sources as estimated by this study for EU15 and EU30. The Tables give also the potential incremental export volumes by supply source up to 2010 and up to 2020. It is interesting to compare potential incremental supply volumes to the EU with the forecast import requirements

#### - *EU15*

The total potential incremental external supply available for EU15 by 2010 corresponds to some 167 bcm, to be compared to import requirements of the EU15 by 2010 of 112 bcm. This represents a potential supply surplus of 49% of import requirements.

By 2020, potential incremental external supply available for the EU15 is estimated at almost 300 bcm, to be compared with total import requirements of some 240 bcm. This still represents a potential supply surplus of 24% over import requirements.

#### - *EU30*

The total potential incremental external supply available for EU30 by 2010 corresponds to some 182 bcm (Norway is an internal supplier in the EU30 configuration). This figure is to be compared to import requirements of the EU30 by 2010 of 130 bcm. This represents a potential supply surplus of 40% of import requirements.

By 2020, potential incremental external supply available for the EU30 is estimated at some 316 bcm, to be compared with total import requirements of 271 bcm. This represents still a potential supply surplus of 24% over import requirements.

It can be seen that an important surplus exists in 2010 which shrinks somewhat by 2020, but which remains nevertheless considerable. If, however, by 2020 some of the proposed supply options were not to materialise so that additional gas volumes would be needed, Russia, Iran, and North Africa would easily be able to supply them.

With 65 % of the potential additional supplies in 2010 and 50% in 2020, the current three main suppliers of Europe (Algeria, Norway and Russia) will still account for the bulk of supplies. New gas supply sources, will develop, however, in particular in the Middle East and the Caspian area, stimulated by the large potential market in Turkey. These new sources have a greater impact when the EU-30 is considered.

<b>EU 15</b>	<b>Export potential to Europe EU15</b>			<b>Incremental potential exports EU15</b>	
	<b>(bcm)</b>	<b>2000</b>	<b>2010</b>	<b>2020</b>	<b>2000-2010</b>
Norway	50	90	110	40	60
Algeria	55	82	105	27	50
Libya	1	11	35	10	34
Egypt	0	12	25	12	25
Russia	73	113	113	40	40
Azerbaijan	0	6	13	6	13
Turkmenistan	0	0	0	0	0
Iran	0	0	16	0	16
Qatar	1	5	10	4	9
UAE	1	2	2	1	1
Oman	0	0	0	0	0
Yemen	0	2	4	2	4
Iraq	0	7	17	7	17
Nigeria	1	15	20	14	19
Trinidad&Tobago	1	5	10	4	9
<b>Total Supply:</b>				<b>167</b>	<b>297</b>
<b>Import needs</b>				<b>112</b>	<b>239</b>
<b>Surplus(bcm)</b>				<b>55</b>	<b>58</b>
<b>Surplus (%)</b>				<b>49%</b>	<b>24%</b>

<b>EU 30</b>	<b>Export potential to Europe EU30</b>			<b>Incremental potential exports EU30</b>	
	<b>(bcm)</b>	<b>2000</b>	<b>2010</b>	<b>2020</b>	<b>2000-2010</b>
Norway	50	100	120	50	70
Algeria	60	90	115	30	55
Libya	1	11	35	10	34
Egypt	0	12	25	12	25
Russia	130	200	200	70	70
Azerbaijan	0	15	30	15	30
Turkmenistan	0	0	10	0	10
Iran	0	10	30	10	30
Qatar	1	5	10	4	9
UAE	1	2	2	1	1
Oman	0	0	0	0	0
Yemen	0	2	4	2	4
Iraq	0	10	20	10	20
Nigeria	1	15	20	14	19
Trinidad&Tobago	1	5	10	4	9
<b>Total:</b>				<b>232</b>	<b>386</b>
<b>- Norway</b>				<b>-50</b>	<b>-70</b>
<b>External supply</b>				<b>182</b>	<b>316</b>
<b>Import needs</b>				<b>130</b>	<b>271</b>
<b>Surplus(bcm)</b>				<b>52</b>	<b>45</b>
<b>Surplus (%)</b>				<b>40%</b>	<b>17%</b>

#### **4 - Infrastructure requirements**

The study has shown the importance of the gas reserves and resources available outside the EU in supplying the growing gas demand in the EU15 and EU30. However, the study has also shown the key importance of further development and expansion of gas transport infrastructures between Europe (EU15 and EU30) and the key gas suppliers which are Norway, Algeria and other North African countries, Russia and the Caspian sea countries, the countries of the Gulf and the more remote gas suppliers in Africa and the Caribbean.

The EU-15 will need to be connected to the Turkish network by 2010 to receive gas from the Caspian area and / or the Middle East. As the Turkish corridor is expected to become a major transit route in the following decade, the construction of the two southern routes (to Austria via Southeast Europe, and to Italy via Greece) should be carefully studied.

The development of a major gas pipeline network in the Balkan area is also of great importance for the EU and the economies of the countries of the region. The construction of new gas pipelines in the western Balkan countries Albania, Macedonia (FYROM), Serbia, Bosnia-Herzegovina, Croatia, and Slovenia would enable these countries to have adequate supplies of gas and also facilitate gas transmission from Greece and Turkey to Italy and central Europe.

Additional re-gasification terminals (or the expansion of existing facilities) will be required to accommodate the development of LNG schemes that are planned in Egypt and the Gulf, as well as the expansion of LNG supplies from Algeria, Nigeria, and Trinidad & Tobago

The EC is promoting the development of gas supply infrastructures both within the EU and with external suppliers through the TEN (Trans European Network) in the gas sector. The political and financial support from the EC and the EIB has been crucial for example, in the development of gas pipelines from Algeria (Transmed and GME pipelines) and it is vital that this support be continued and expanded in the future. The INOGATE programme is also supporting the cooperation in the gas sector between the EU and the countries of eastern Europe, Russia and the CIS and the countries of the Caspian sea region.

To increase gas exports to Europe from the main suppliers, new pipelines and LNG schemes will have to be built. The projects needed can be grouped in two main areas : The Mediterranean/Balkan area and the North Europe/Baltic area :

### Mediterranean/Balkan Area

As described previously, major gas pipelines and LNG plants have been built in the past to export gas from Algeria to Europe. In the future new projects are needed to develop export capacities from North Africa and the eastern Mediterranean :

- Expansion of the GME pipeline from Algeria to Spain via Morocco ( +10bcm/yr)
- Expansion of the Transmed pipeline from Algeria to Italy via Tunisia (+5bcm/yr)
- New direct pipeline from Algeria to Spain (MEDGAS project) (10 bcm/yr)
- New pipeline from Algeria to Sardinia and Corsica and mainland Italy and France (10bcm/yr)
- Expansion of LNG plants in Algeria
- New pipeline from Libya to Italy (10 bcm/yr)
- Expansion of LNG plants in Libya
  
- New LNG plants in Egypt
- New pipeline from Egypt to eastern Mediterranean countries and Turkey (10 bcm/yr)
  
- New pipeline from Azerbaijan to Turkey via Georgia (16 bcm/yr with 6.6 already contracted)
- Expansion of the existing pipeline from Iran to Turkey
- Completion of the Blue Stream pipeline from Russia to Turkey under the Black Sea (now under construction with a capacity of 16 bcm/yr)
  
- Bi-directional pipeline from Turkey to Greece
- Onshore pipeline from Greece to northern Italy/Austria crossing the western Balkan countries
- Offshore pipeline from Greece to Italy

### Northern Europe/Baltic area

- Additional pipeline capacity from Norway to the UK and mainland Europe.
- New pipeline from Norway via Denmark to Germany, Poland and other Baltic states.
  
- Upgrading of the existing export pipelines from Russia
- Expansion of the Yamal I gas pipeline from Russia to Germany via Belarus and Poland
- New pipeline from Russia to Germany under the Baltic sea, and the related development of the Shtockman gas field in the Barents sea.

### LNG

It will be also important to enhance cooperation with countries having LNG projects (in operation or planned) such as Qatar, Iran, Nigeria, Trinidad and Tobago which are mostly destined to the southern European market and which, for the projects in the Gulf region, will involve LNG tankers transiting the Suez canal. Additional re-gasification terminals (or the expansion of existing facilities) will be required in Europe to accommodate the development of LNG schemes that are planned.

## 5 - Supply costs

Future supply costs (2010-2020) for incremental supply volumes have been assessed using the Long Run Marginal Cost (LRMC) approach. The assessed supply costs, calculated on full cost basis, include technical production cost, technical transport cost and transit fees (where applicable).

Expected technological progress has been taken into account when assessing future transport cost by 2010-2020. Transport cost for new pipelines can be considerably reduced by using The following diagrams 3 and 4 and maps 1 and 2 present the supply cost to the border of the EU15 and EU30 countries with the shortest distance to a supplier. Market conditions and project destination have, however, been taken into consideration<sup>2</sup>.

- *EU15*: As far as supply cost is concerned, the different supply options can be divided into four groups :
  - North Africa and in particular Algeria, due to its geographic proximity, is and will continue to be the least cost supplier to the EU15. Of 33 supply schemes studied, the four cheapest ones are pipeline gas from Algeria, followed by pipeline gas from Libya. All of these schemes have supply costs below 1.7 \$/MBTU with the planned Medgaz pipeline being able to carry Algerian gas to Madrid or Barcelona at a total technical supply cost of 1.1 \$/MBTU.
  - Norway (first North Sea, then Norwegian sea), and new, more remote supplies from the Middle East and the Caspian region (Azerbaijan, Turkmenistan, Iran) have supply costs between 2.0 and 2.2 \$/MBTU;
  - New gas from Russia's Nadym-Pur-Taz region in Western Siberia to Germany costs at least 2.3 \$/MBTU (through Belarus) and 2.5 \$/MBTU through the Baltic route. Gas from the Barents Sea would cost some 2.7 \$/MBTU and gas from Yamal some 2.8 \$/MBTU.
  - All new LNG supplies are above 2.4 \$/MBTU, starting with North African LNG (between 2.4 and 2.6 \$/MBTU), and followed by Gulf, Nigeria and Trinidad LNG (around 3 \$/MBTU).
- *EU30*: Due to the fact that Turkey is very close to major potential gas suppliers in the Middle-East and the Caspian, in the EU30 configuration the least cost suppliers are much more diversified. Seven producers have supply costs below 1.7 \$/MBTU: Algeria to Spain and Italy; Libya to Italy; Iraq, Iran, Egypt and Russia to Turkey. The rank of the other suppliers is similar to that described in the EU15 configuration.

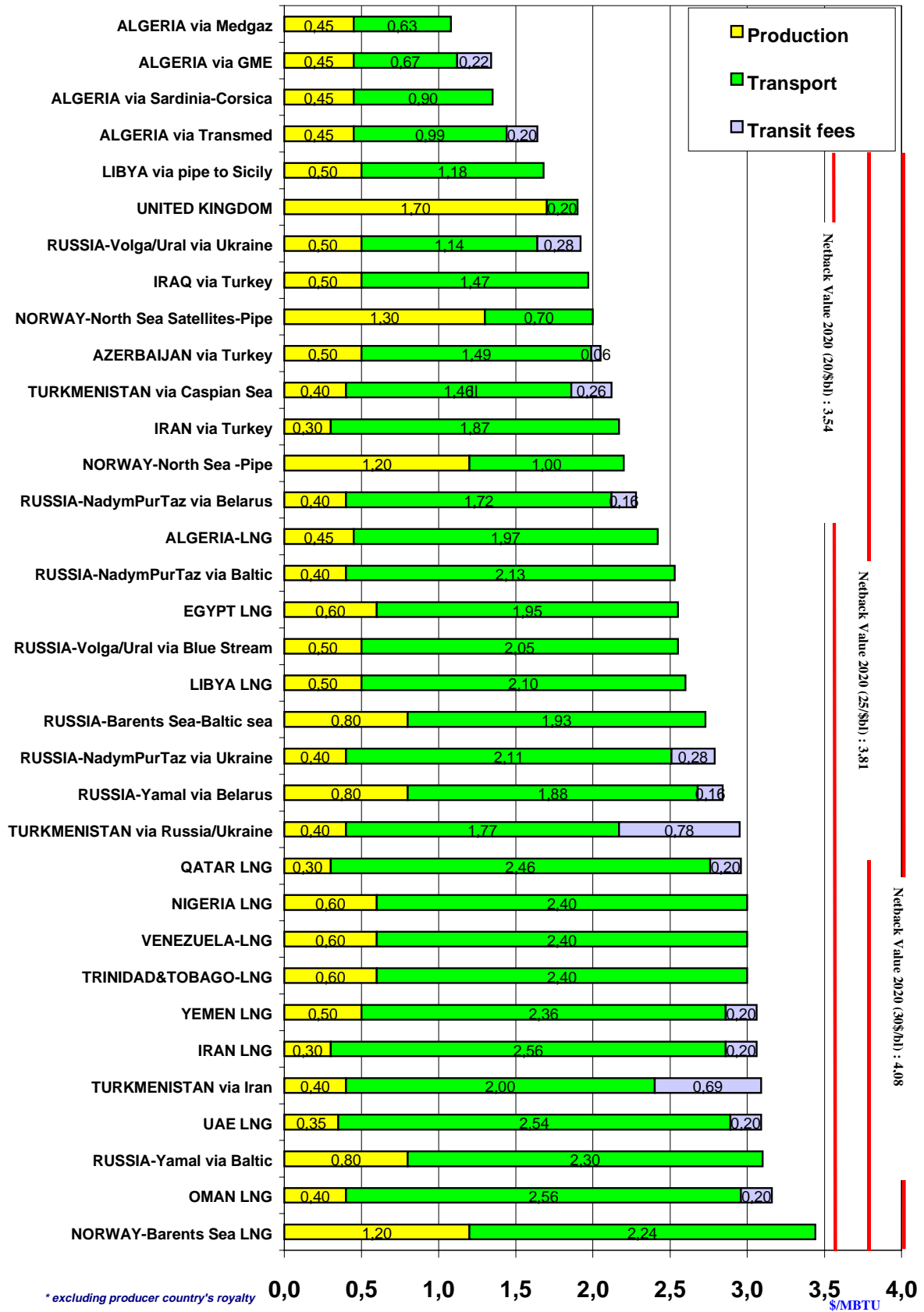
Diagrams 3 and 4 show also the netback value of the incremental gas demand by 2020 at the EU border for different oil price scenarios (20 \$/bl, 25 \$/bl and 30 \$/bl). These netback values are based on opportunity costs and provide the maximum price European consumers are willing to pay in order to switch to gas. The difference between the total supply cost (excluding producer country royalties) and the opportunity cost netback value is the economic rent for the gas chain and in particular in form of producer's country royalty.

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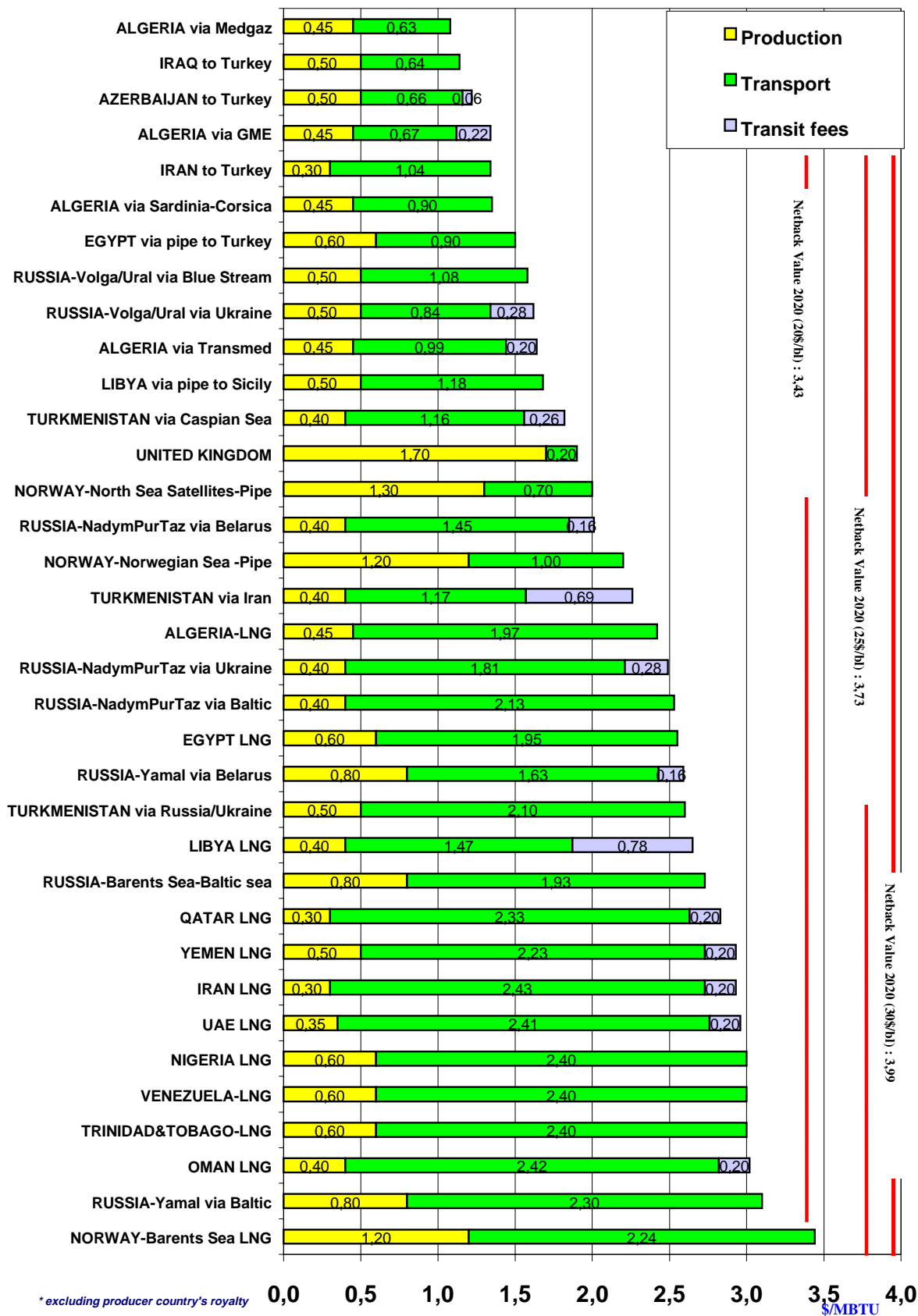
<sup>2</sup> Entry point for EU15 : Norway (border Germany); Russia (border Germany); Central Asia & Middle-East via Turkey (border Austria); North Africa (Madrid or Barcelona for Spain, Rome for Italy); LNG from North Africa and the Gulf (western Mediterranean terminals); Atlantic LNG (Iberian Atlantic terminals).

Entry point for EU30 : : Norway (border Germany); Russia via Bluestream (Ankara for Turkey); other Russia (border Belarus or Ukraine); Central Asia & Middle-East (Ankara for Turkey); North Africa (Madrid or Barcelona for Spain, Rome for Italy); LNG from North Africa (western Mediterranean terminals) and the Gulf (eastern Mediterranean terminals); Atlantic LNG (Iberian Atlantic terminals).

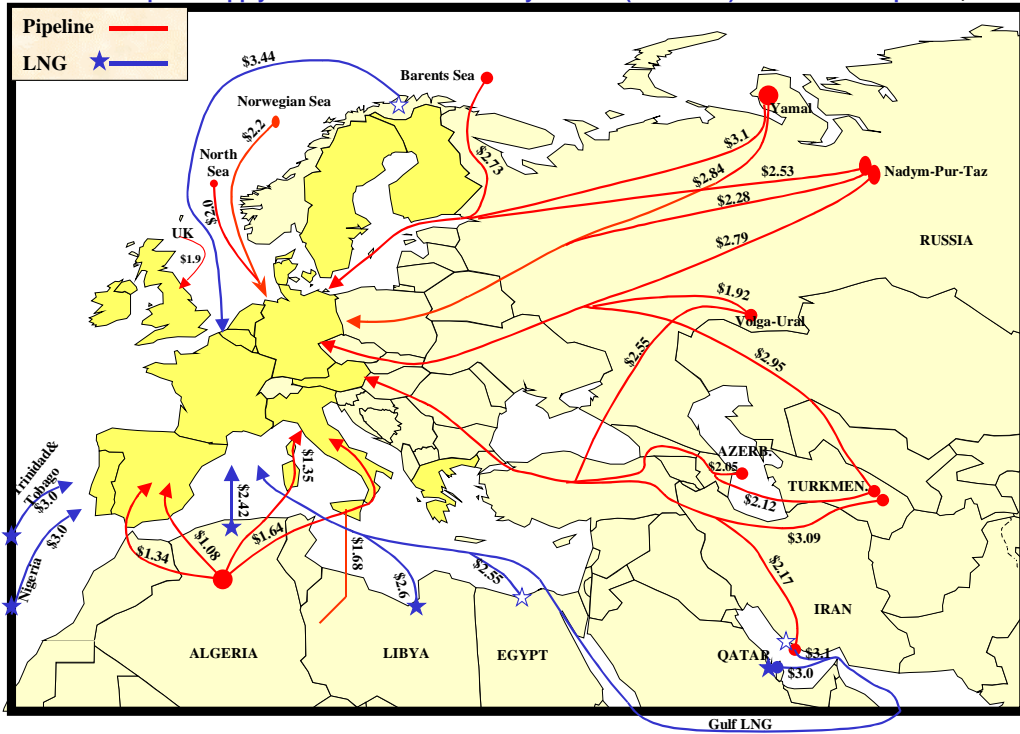
**Diagram 3: Gas Supply Costs\* and Netback Values at EU15 border**



**Diagram 4: Gas Supply Costs\* and Netback Values at EU30 border**

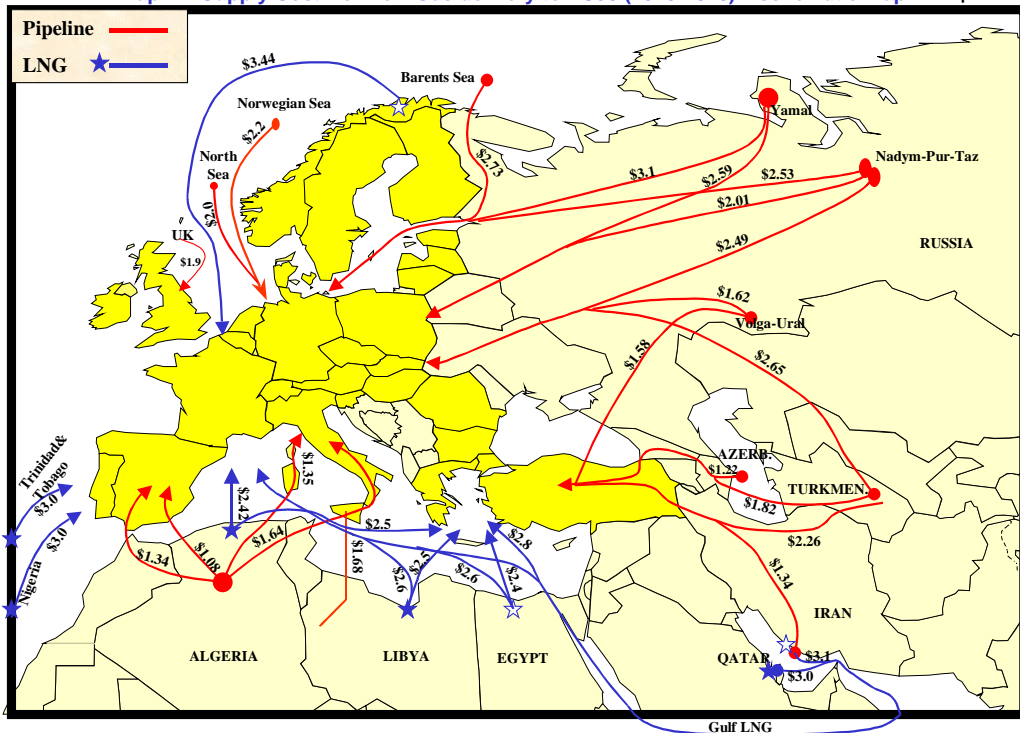


Map 1 : Supply Cost\* for New Gas delivery to EU15 (2010-2020) – schematic map \$/Mbtu



Source: OME, 2001 \* excluding producer country's royalty

Map 2 : Supply Cost\* for New Gas delivery to EU30 (2010-2020) – schematic map \$/Mbtu



Source: OME, 2001 \* excluding producer country's royalty

## 6 - Supply cost curves

- *EU-15*

As can be seen in the diagrams 5 and 6:

- some 75 bcm are potentially available by 2020 (36 bcm by 2010) for the EU15 from North Africa for a supply cost below 1.7 \$/MBTU;
- some additional 120 bcm are potentially available by 2020 (73 bcm by 2010) for a supply cost below 2.3 \$/MBTU from Norway, Russia, Iraq and Azerbaijan;
- and some additional 110 bcm are potentially available by 2020 (66 bcm by 2010) for supply costs between 2.4 and 3.1 \$/MBTU. These consist of LNG supplies and pipeline gas from the Stockmanovskoye field in the Russian Barents Sea.

By 2010, some 36 bcm are potentially available at a total supply cost below 1.7 \$/MBTU, some 110 bcm for a cost below 2.3 \$/MBTU, and some 175 bcm for a cost below 3.1 \$/MBTU. This compares with incremental import requirements for the EU15 of 112 bcm by 2010 and to an average netback value of gas at the border of the EU15 of 3.55 \$/MBTU.

By 2020, some 75 bcm are potentially available at a total supply cost below 1.7 \$/MBTU, almost 200 bcm for a cost below 2.3 \$/MBTU, and some 300 bcm for a cost below 3.1 \$/MBTU. This compares with incremental import requirements for the EU15 of 230 bcm by 2020 and an average netback value of gas at the border of the EU15 by 2020 of 3.8 \$/MBTU.

- *EU-30*

As can be seen in the diagrams 7 and 8 :

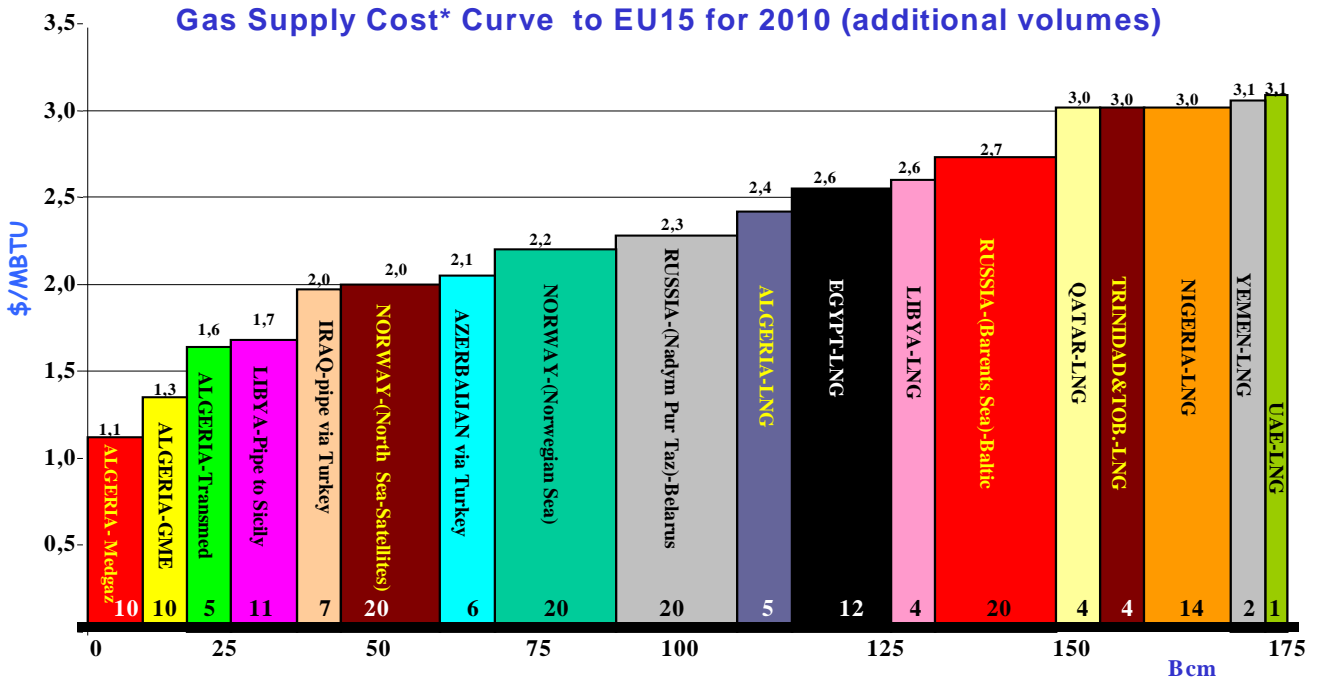
- some 166 bcm are potentially available by 2020 (87 bcm by 2010) for the EU15 from North Africa, Iraq, Azerbaijan, Russia and Libya for a supply cost below 1.7 \$/MBTU;
- some additional 100 bcm are potentially available by 2020 (84 bcm by 2010) for a supply cost between 2.0 and 2.2 \$/MBTU from Norway, Russia, Iraq and Azerbaijan;
- and some additional 125 bcm are potentially available by 2020 (66 bcm by 2010) for supply costs between 2.4 and 3.0 \$/MBTU. These consist of LNG supplies and pipeline gas from Turkmenistan and from the Shtockmanovskoye field in the Russian Barents Sea.

By 2010, some 87 bcm are potentially available at a total supply cost below 1.7 \$/MBTU, some 170 bcm for a cost below 2.3 \$/MBTU, and some 237 bcm for a cost below 3.1 \$/MBTU. This compares with incremental import requirements for the EU30 of 180 bcm by 2010 (excluding Norway as an internal supplier to the EU30) and an average netback value of gas at the border of the EU30 by 2010 of 3.39 \$/MBTU.

By 2020, some 166 bcm are potentially available at a total supply cost below 1.7 \$/MBTU, some 266 bcm for a cost below 2.3 \$/MBTU, and some 390 bcm for a cost below 3.1 \$/MBTU. This compares with incremental import requirements for the EU30 of some 320 bcm by 2020 (excluding Norway as an internal supplier to the EU30). The average netback value of gas at the border of the EU30 by 2020 have been calculated at 3.73 \$/MBTU (see section 3.3).

If by 2020 some of the proposed supply options for the EU15 and/or the EU30 were not to materialise so that additional gas volumes would be needed, North Africa, Russia and Iran would easily be able to supply them.

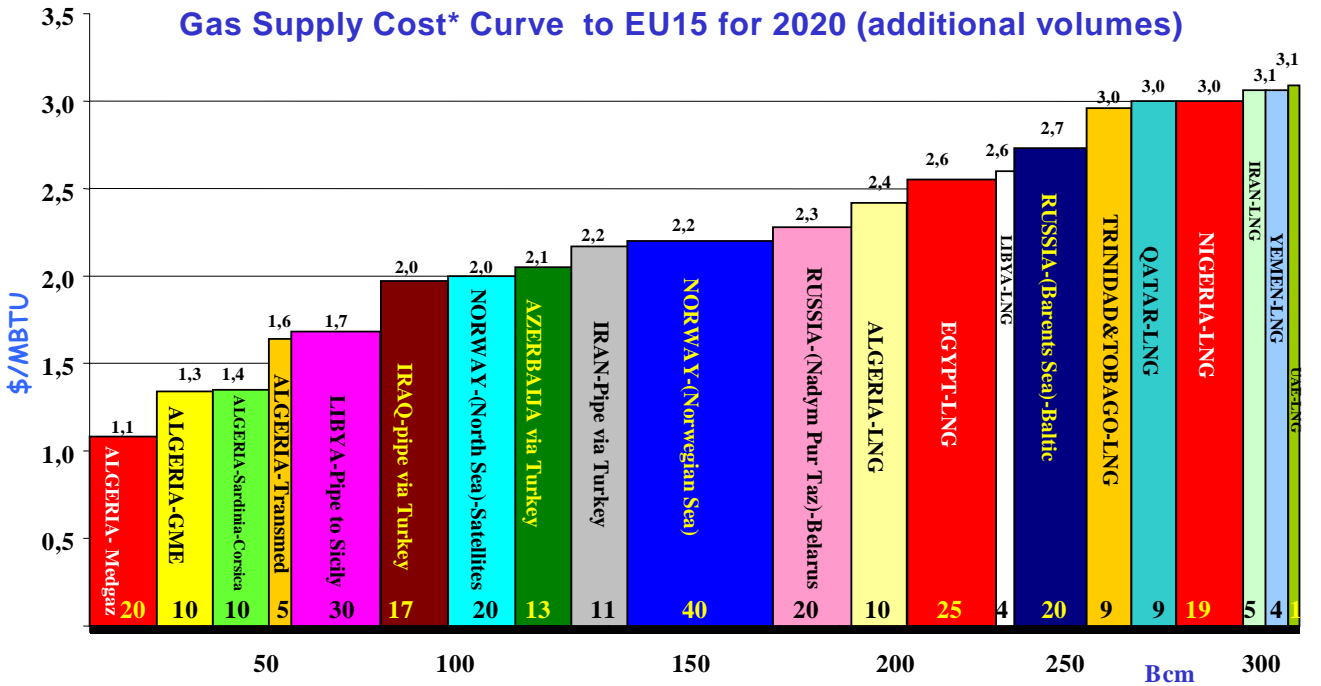
Diagram 5



\* excluding producer country's royalty

Source: OME

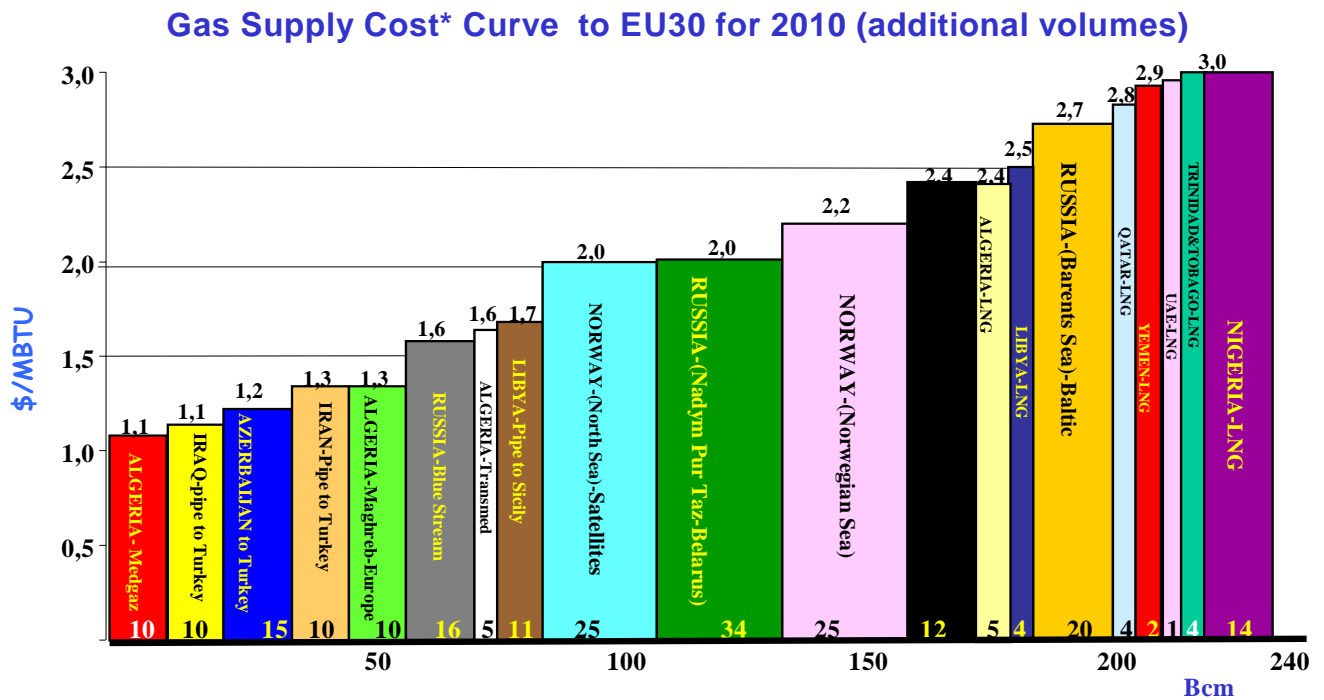
Diagram 6



\* excluding producer country's royalty

Source: OME

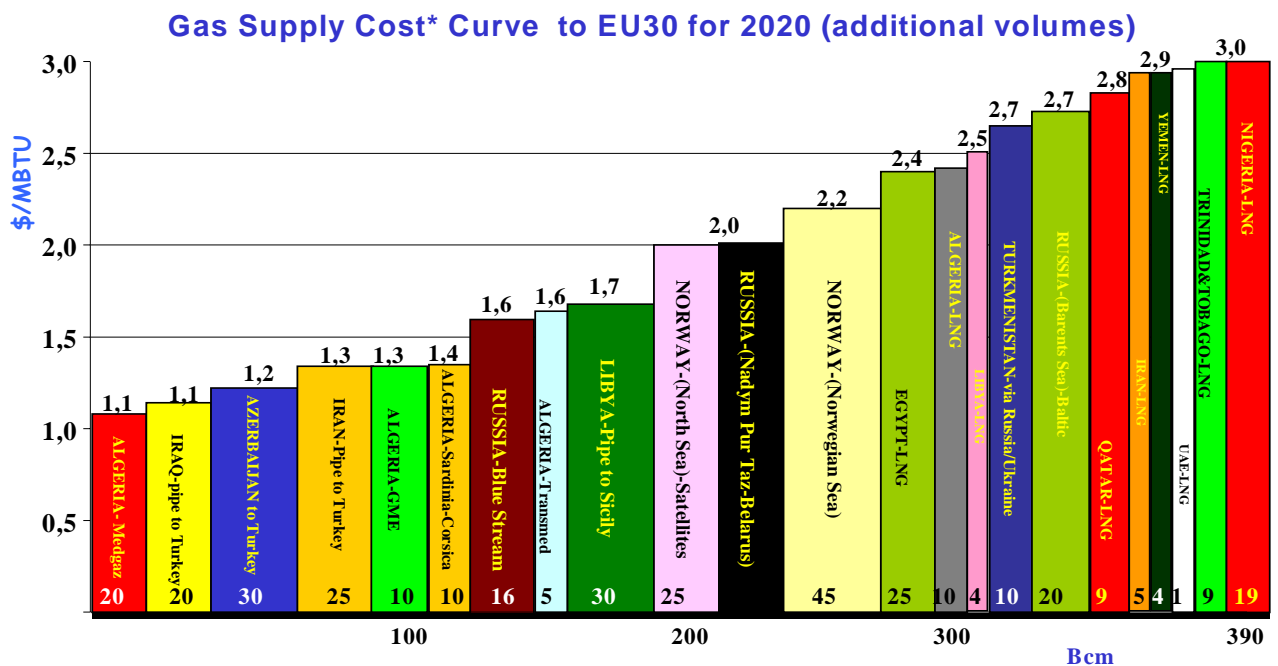
Diagram 7



\* excluding producer country's royalty

Source: OME

Diagram 8



\* excluding producer country's royalty

Source: OME

## **7 – Financing of new infrastructure in a liberalized gas market**

The financing requirements over the next two decades to insure the European gas supply are very large: over \$ 200 billion. The financing from the sponsors of the project and the banks will be related to the estimation of the profitability of these projects. This profitability is linked to certainty of quantities to be sold and of future gas prices.

Liberalisation in the downstream market develops market uncertainty for traditional gas purchasers (the incumbents), and as a consequence, for producers and transporters as regards the ability of gas purchasers to commit on volumes and prices over the long term. This becomes ever more stringent as the size of the projects increases. Overcoming this risk is by far the strongest challenge that the new environment imposes on the gas industry

There is an overwhelming consensus that long term contracts (LTC) are an invaluable tool to secure financing and to create confidence among investors and the lending community. The principle of LTC will therefore remain, but adjustments are required to improve its, for the time being, few mechanisms and low level of flexibility. Risk on volume may be offset by selling gas volume surplus in the spot market, which implies that the contract allows the re-sale of gas. The adverse effects of price volatility may be mitigated through hedging mechanisms.

From a technical standpoint, trading surplus or deficit gas to meet temporary or long term conditions requires that spot markets develop and reach a threshold or critical mass beyond which fast, reliable operations become feasible.

Partnerships along the gas chain provide another effective response to market uncertainty. They allow development of markets while limiting exposure.

The European Investment bank (EIB) is supporting the Trans European Network (TEN) programme of the EU in the energy sector. In the future, a key responsibility for the EIB will be to work closely with project sponsors to continue to finance major gas pipelines and possibly LNG projects outside the EU in a new context that will involve new types of long term agreements. While the mandate of the EIB does not allow the charging of a premium to cover risk, the policy already implemented of working with insurers is a way to underpin the involvement of the EIB, as well as its participation in feasibility studies where no clear investor has emerged. This may well be the case, in particular, for large-size interconnectors, i.e. those transmission pipelines aimed at linking several potential sources to several markets, which may need a strong sponsorship or catalytic function to develop, particularly in the initial absence of declared investor(s).

In the future, the involvement of the ECAs and other insurers such as MIGA of the World bank group or private insurers is set to continue and a close cooperation will be required in order to achieve the financing of the major gas infrastructure projects needed to supply Europe. To reduce the cost of financing, the insurance premia have to be calculated according to the evaluation of the risk of each project on a case by case basis and taking into account the strategic importance for Europe of these gas supply projects. To facilitate the cooperation between the project sponsors, the EIB, the commercial banks and the ECAs, the European Commission has a key role to play as a catalyst to promote these projects.

## **8 - Political and financial support**

In the framework of the Trans European Network (TEN) in the gas sector, it is important that the EC and EIB provide political and financial support to the new gas infrastructure projects needed in the future to secure the growing gas supply needs of the EU 15 and later EU30.

This support should be a key element of the strategic partnerships in the energy sector launched by the EU on one side with the Mediterranean/Balkan countries (Euro-Mediterranean Partnership and Balkan Initiative) and on the other hand with Russia.

Such partnerships should be further developed in order to promote continued dialogue, implementation of energy projects of mutual interest, financing of the major gas projects needed, and the establishment of a suitable and efficient legislative framework in order to encourage projects and investments in the gas sector by European companies and local companies.

The EIB has a key role in the development of these partnerships, and cooperation should also be promoted with other financial institutions such as national export credit agencies, commercial banks, World Bank/IFC, and the EBRD.

It is also important to underline the role of international agreements related to international investments and trade (WTO). In particular, in the EU context, the Energy Charter Treaty provides a helpful framework for energy trade between the EU and its external energy suppliers.

Concerning transit issues, it is also important for the EU to develop partnership in the energy sector with the major transit countries, in particular Ukraine. Topics of mutual interest concern investment in the gas transport network and the related legislation relating to issues such as ownership and access. In the future, Turkey will also play a key role for the transit of gas from the Caspian region and the Middle East to Europe.

*Summing up, EU-15 and EU-30 may look at their future gas supplies with great confidence because of the considerable base of gas reserves and resources of their actual and potential suppliers. Available technologies and ongoing progress in this field are additional items for optimism. Financing does not seem to be a major constraint if we look at the considerable availability of capitals on the financial market, provided that long term gas supply contracts continue to have a fundamental role. Political support and cooperation is a key element, but political cooperation among all the interested countries of the region is a must that has to be achieved because it is requested by other even more important reasons than gas supplies.*