Security of Energy Supply: Comparing Scenarios From a European Perspective

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Security of Energy Supply: Comparing Scenarios From a European Perspective

Summary

This paper compares different results from a set of energy scenarios produced by international energy experts, in order to analyze projections on increasing European external energy dependence and vulnerability. Comparison among different scenarios constitutes the basis of a critical review of existing energy security policies, suggesting alternative or complementary future actions. According to the analysis, the main risks and negative impacts in the long term could be the increasing risk of collusion among exporters due to growing dependence of industrialized countries and insufficient diversification; and a risk of demand/supply imbalance, with consequent instability for exporting regions due to insufficient demand, and lack of infrastructures due to insufficient supply. Cooperation with exporting countries enhancing investments in production capacity, and with developing countries in order to reinforce negotiation capacity of energy importing countries seem to be the most effective policies at international level.

Keywords: Energy security, Energy scenarios, Oil and natural gas markets

JEL Classification: Q40, Q41, Q48

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1. Introduction

Energy security is defined as the availability of a regular supply of energy at an affordable price (IEA, 2001a). The definition has physical, economic, social and environmental dimensions (EC, 2000); and long and short term dimensions.

A *physical* disruption can occur when an energy source is exhausted or production is stopped, with a temporary or permanent horizon. *Economic* disruptions are caused by erratic fluctuations in the price of energy products on the world markets, which can be caused by a threat of a physical disruption of supplies. Recent energy market trends show that there is another cause for concern, linked to speculative movements in anticipation of a potential disruption of supplies. The general perception by operators of a potential future disruption leads to panic buying even when supply and demand are apparently in balance. The result is sharp price rises, which directly affect business costs and the purchasing power of private consumers.

The instability of energy supplies may cause serious *social* disruption. Today, oil is vital for the functioning of the economy, and any disruption of supply is likely to lead to social demands, and possible social conflict.

Lastly, there are many *environmental* concerns about damage to the ecosystems caused by the energy chain, whether accidentally (oil slicks, nuclear accidents, methane leaks) or as a result of polluting emissions (urban pollution and greenhouse gas emissions).

Finally the definition of energy security can be seen from a short term perspective or a long term perspective. In the short term, the concern is with the disruptive impacts of an unanticipated cut in supply or rise in price. In the long term the concern is more with the availability of sufficient energy that allows stable and sustainable economic development.

Energy security has risen in importance on the international policy agenda during recent decades, due to growing dependence of industrialized economies on energy consumption and the increased frequency of disruptions in supply. In this context, the current European domestic energy system is not sufficiently reliable or affordable to support economic growth. OECD European countries are consuming more and more energy and importing more and more energy products. As a result, external energy dependence for all sectors of the economy is constantly increasing, especially for oil and natural gas.

For the future, it is vitally important to be able to implement measures that will allow an orderly and effective response to the threat from energy insecurity. For this purpose, we need reliable forecasts of future energy demand as well as quantitative assessments of future supply, together with a geopolitical analysis of distribution of resources.

A number of researchers have tried to develop a set of security indicators (IEA, 2001a; Kendell, 1998; von Hirschhausen and Neumann, 2003). The measures of supply security can be grouped into two categories: dependence, and vulnerability, represented both in physical and economic terms. Physical measures describe the relative level of imports or the prospects for shortages and disruptions. Economic measures describe the cost of imports or the prospects for price shocks.

The type of dependence will vary according to energy type and according to the structure of the international market. Oil shows high dependence on market price volatility and on geopolitical instability of exporters. Gas, on the other hand, could be an insecure source of energy scarce supply if the importer depends only on a single gas pipeline.

The physical and economic dimension of dependence and vulnerability are strictly connected, because physical shortages or disruptions quickly manifest themselves as price increases. Nonetheless, economic dependence measures are probably less relevant to long-run thinking about energy security than are economic vulnerability measures, which are more representative of real effects of energy disruptions on the national system.

In this paper, dependence and vulnerability of European energy system have been analyzed through a comparison of the results of energy scenarios produced by the International Energy Agency (IEA), the International Institute for Applied Systems Analysis with World Energy Council (IIASA-WEC), the Intergovernmental Panel on Climate Change (IPCC), the US Energy Department (EIA-DOE) and the European Union with last available energy outlook (World Energy Technology and climate policy Outlook, WETO).

The forecasts from these scenarios vary widely, as we will see below. Pessimistic projections of increasing uncertainties on energy markets are not confirmed by all available scenarios, and there are substantial differences both on the supply and demand side. Considering those divergences, the aim of the analysis will be to underline geopolitical factors emerging from those results. In the following sections a general overview on geopolitics of oil and natural gas will be provided together with a contextual report of divergent energy security measures coming from scenarios. A final assessment on key issues, risks and policies for the long term will be addressed both for oil and gas.

2. Comparing long term scenarios for oil and gas reserves and resources

In order to describe a comprehensive framework of energy security, dependence and vulnerability data have to be gathered both on supply and demand side. Resources availability projections are supported by long term forecasts, while production and consumption figures come from both medium and long run models.

Considering the supply side, a preliminary condition for a long-term economic sustainability of the present oil-intensive energy system is the physical availability of fossil fuels (oil and natural gas). Here it is normal to make a distinction between: a) reserves and resources,[1] since the more the energy system will have to count on resources the more uncertain the assessment is; and b) conventional and unconventional reserves, since the exploitation of the second will probably continue to be more expensive, implying a higher cost of energy when such reserves become necessary.

To assess the relation between the estimated availability of exhaustible energy sources and their possible future consumption, thirteen long-term energy scenarios (up to 2100) have been analysed: six IIASA-WEC scenarios (Nakicenovic et al., 1998) and seven IPCC scenarios (IPCC, 2000). These can be classified as follows:

- IPCC A1B, IPCC A1C, IPCC A1G, IPCC A2, IPCC B2, IIASA-WEC A1, IIASA-WEC A2 and IIASA-WEC B are “fossil intensive scenarios”, as total consumption of fossil fuels continues to grow until the end of the century (in OECD countries until 2030/2050, with consumption larger than today even in the very long run);
- IPCC A1T, IPCC B1, IIASA-WEC A3 are scenarios “with fossil fuel consumption decreasing in long-term”, as total consumption of fossil fuels continues to grow until 2050, when it begins to decrease (in OECD countries after 2020);
- IIASA-WEC C1 and IIASA-WEC C2 are “green” scenarios, as total consumption of fossil fuels increases only until 2020 (for OECD countries in 2020 it is 30% less than today).

[1] Reserves are defined as: a) proved reserves, which have been discovered (but not produced) and are expected to be economically producible, and reserve growth, an increase in proved reserves that occurs over time as oil and gas fields are developed, or technological improvements occur. Undiscovered resources are defined as what remains to be found through new field exploration, that is expected to become economically recoverable (EIA-DOE, 2003). Total resources are the sum of reserves and undiscovered resources.

Comparing the cumulative consumption of oil and gas (from the base year, 1990, for every five years) in each scenario with the U.S. Geological Survey (USGS, 2000), which provides estimates of reserves and resources both conventional and unconventional, the year up to which the physical availability of fossil fuels can meet the expected demand has been calculated (Table 1).

For the oil sector the results clearly show how catastrophic outlooks about oil availability are unjustified. Looking at the distribution of scenarios it appears that in twelve out of thirteen scenarios the *resource-base* (i.e. the sum of reserves and resources) can broadly fulfil the cumulative consumption requirements until 2100. There is no need to count on a large "transformation" of resources into reserves, because *total reserves* are able to satisfy the expected consumption at least until the middle of the century, and in the majority of scenarios they can fulfil consumption well after 2060. There is, however, a need to count on unconventional reserves, if demand is to be met up to the middle of this century. As a matter of fact, for the same twelve scenarios, *conventional* reserves can only last until 2030, so that beyond that there is a significant need for *unconventional* reserves. Finally we note that if cumulative consumption is to be satisfied from reserves alone beyond 2050, one of the two «green» scenarios will have to hold. Thus, while it appears that the estimated availability of reserves is sufficient to meet demand well beyond the medium term. there could be a reason to be concerned: in the medium run the energy system will have to count on unconventional oil - at the moment substantially more expensive than the conventional oil - with the risk of increasing energy cost, that becomes plausible if the Hubbert curve theory is accepted.[2]

A comparison of available reserves and resources shows that for natural gas the relation between the expected future consumption and physical availability is even better than for oil. As for the oil sector, the resource base is sufficient to meet demand until 2100 in almost all scenarios, without any additional quantities or large transformation of resources into reserves.

If, however, we focus solely on the reserves, the data are slightly better for gas than for oil, because, while total reserves can fulfil cumulative consumption until 2100 only in three scenarios, in all scenarios they are sufficient at least until 2045/2050. Furthermore, there would be less need for unconventional reserves, because conventional gas reserves should be sufficient at least until 2035/2040. The upward pressures on gas price, due to the need to count on unconventional reserves, will probably occur later than for oil.

[2] According to the Hubbert theory, the production of an exhaustible resource starts declining well before its physical availability is going to finish. Similar hypothesis are accepted even in optimistic analysis about the future of oil (Odell, 2001).

Table 1 – Breakdown of scenarios by the year until which oil and gas demand would be fulfilled by reserves/resources

Last year of availability	Reserves				Resources			
	Conventional		Conventional + non conventional		Conventional		Conventional + non conventional	
	Oil	*Gas*	*Oil*	*Gas*	*Oil*	*Gas*	*Oil*	*Gas*
2020	2	-	-	-	-	-	-	-
2025	**6**	-	-	-	-	-	-	-
2030	2	3	-	-	-	-	-	-
2035	1	4	-	-	-	-	-	-
2040	2	**5**	-	-	1	-	-	-
2045	-	1	1	1	1	-	-	-
2050	-	-	1	1	**4**	-	-	-
2055	-	-	1	1	1	1	-	-
2060	-	-	**3**	1	1	1	-	-
2065	-	-	1	1	2	-	-	-
2070	-	-	1	**3**	1	3	-	-
2075	-	-	1	-	-	-	-	-
2080	-	-	2	2	-	2	1	1
2085		-		-		-		
2090		-		1		2		1
Beyond 2100	-	-	2	2	2	4	12	11
Total # scenarios	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*

Source: our elaborations on IPCC (2000), IIASA-WEC (Nakicenovic et al., 1998).

3. Comparing scenarios for oil and gas supply and demand

The following analysis of the distribution and concentration of oil and gas demand and supply has been based on a comparison among six scenarios, three of the six IIASA-WEC long term projections (scenarios A1, B, C1), and three medium term Reference scenarios, respectively from IEA (World Energy Outlook, IEA, 2002a), EIA-DOE (International Energy Outlook, EIA-DOE, 2003) and WETO (World Energy Technology and Climate policy Outlook, EC, 2003). These span the full range of forecast from the larger set of 13 scenarios and are summarised in the Annex.

3.1 Distribution of oil and gas reserves and resources

The data on the distribution of oil and gas reserves and resources is given in Table 2. The main features of the projections of oil and gas resources are the following.

Oil

(a) The distribution of world oil reserves depends critically on how non-conventional oil is treated in the definition.[3] If it is included, the share of total reserves in the Middle East falls from 64% to 56% for 2002, while with the wider definition North and Latin America’s oil share increases to 26%, leading to a possible reduction of future US pressure on Middle East oil.

(b) In terms of the development of the non-conventional resources the main constraining factors will be the available investments, water requirements, and emissions of CO_2 and other pollutants (Bentley, 2002).

(c) There is a substantial difference between EIA-DOE and IEA about the data of North America and Former Soviet Union. For the EIA/DOE the great difference both in the

[3] *Non-conventional* oil includes oil shale, sands-derived oil and derivatives such as synthetic crude products, and liquids derived from coal (CTL), natural gas (GTL) and biomass (biofuels). It does not include natural bitumen (IEA, 2002a). Most of non-conventional oil reserves are situated in Canada, Venezuela (Orinoco Belt), and Russia (Volga-Ural and West Siberia).

reserves and undiscovered shares of total oil resources arises from different assumptions concerning Canadian oil. In the IEA scenario conventional and non-conventional oil are still separated, so North American reserves are consistently lower. For the Former Soviet Union (FSU) the lower assessment in the EIA-DOE scenario (77 billion barrels to the 166 billion of IEA) is compensated by the projections of reserves growth by 2025, where FSU's reserves will increase up to 138 billion barrels. However, a major issue for the near future is Russia's ability to exploit its reserves, at present economically and technically uncertain.

(d) Even allowing for these factors, undiscovered shares in EIA-DOE scenario maintain the growing importance of the American continent (over 30% of world's undiscovered resources), while the IEA scenario gives the Middle East a much higher role in covering oil world demand.[4]

Two further points to be addressed are the following (Cordesman, 2002): (a) Asia is "oil poor" in reserves, as reserves are depleting faster than new discoveries and China is having little success in finding new reserves; and (b) total West African reserves (Angola, Nigeria, etc.) represent only 2.8% of world oil reserves.

Table 2 – Distribution of oil and gas reserves and resources

	Oil				**Gas**	
	Proved Reserves 2002		**Undiscovered**		**Proved Reserves 2002**	**Undiscovered**
	Conv.	**Conv + non conv.**	**EIA-DOE 2025**	**IEA 2030**		**EIA 2025**
North America	4.8%	18.3%	17.2%	11.3%	4.6%	13.1%
Latin America	9.4%	8.1%	13.3%	8.4%	4.5%	9.4%
FSU	7.4%	6.4%	18.2%	18.2%	35.5%	31.0%
Other Europe & Eurasia	1.9%	1.6%			3.7%	
Iran	*8.6%*	*7.3%*	-	*7.1%*	*14.8%*	-
Iraq	*10.7%*	*9.2%*	-	*5.4%*	*2.0%*	-
Saudi Arabia	*25.0%*	*21.4%*	-	*14.5%*	*4.1%*	-
Other Middle East	*21.1%*	*18.1%*	-	*2.0%*	*15.1%*	-
Total Middle East	65.4%	56.2%	28.7%	29.1%	36.0%	19.8%
Africa	7.4%	6.3%	13.3%	5.5%	7.6%	11.1%
Asia Pacific	3.7%	3.2%	-	2.9%	8.1%	9.6%
Others			9.3%	24.6%		6.0%
Total World*	**1048**	**1221**	**939**	**939**	**156**	**145**

* Oil measured as thousand million barrels; Gas measured as trillion cubic metres

Source: our elaborations on EIA-DOE (2003), IEA (2002), WETO (EC, 2003).

Gas

(a) From the historical trend of total natural gas reserves it emerges that total discoveries in the last three decades have doubled gas reserves (with a very strong increase in FSU and Middle East). Projections on future discoveries are also quite optimistic.

(b) The current situation shows a dominant role for the FSU, in particular the Russian Federation with 30% of proven reserves, and a strategic role of Iran, with 14.8% of world gas reserves. The two regions, however, present a major analytic problem because data both on oil and gas reserves of Caspian states, Central Asia, and Iran are very uncertain (Cordesman, 1998). North African gas reserves are not high relative to world reserves or future demand.

[4] IEA projection has an undistinguished "Others" group with a 24.6% share that could explain all differences with EIA undiscovered estimates.

(c) Comparing the USGS estimates used by EIA-DOE and IEA with cumulative discoveries assumed in the WETO scenario, a quite similar result emerges for natural gas *resources*, reaching a value around 300 Tcm (which is the sum of *proven* and *undiscovered* for EIA). Adding reserve growth and undiscovered resources to the previous data, as done in IEA WEO, total resources reach a value of about 500 Tcm. In *total resources*, the share of FSU and the Middle East is between 60% and 70% of world reserves, while Africa, Latin America and North America constitute respectively the 11%, 9% and 13% of resources (EIA, 2003).

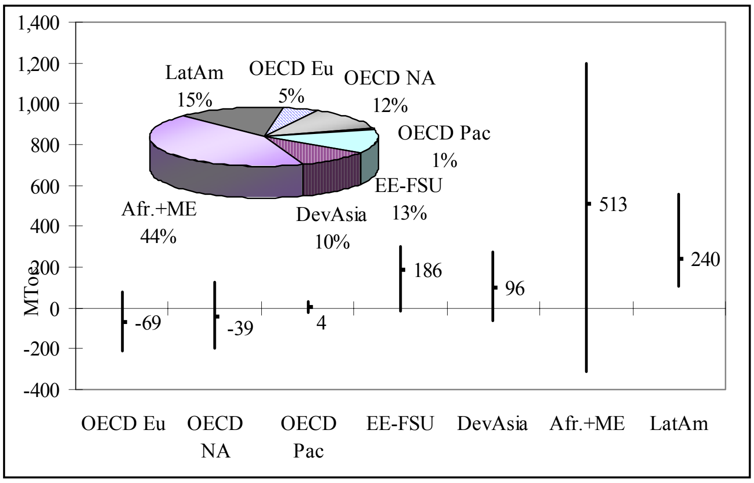
For gas the main constraining factor is its transportation. In the future, however, new gas liquefaction technologies might play a key role, and gas could substitute oil in many producing countries, by increasing its transformation into LNG (Liquefied Natural Gas). This would increase the export potential of gas producers considerably.

3.2 Distribution of oil and gas production

Oil

The distribution of oil during the period 1965-2002 has been characterized by a decreasing share of OPEC supply and a substantial increase in OECD share, mostly after the oil crisis in 1973. FSU production share fell during last decade, after a great increase in the period 1975-1985. Even allowing for these changes, however, Africa and Middle East remain the main producing regions, while OECD total production amounts for 29% of world production, with a major share of that going to North America. Furthermore, excess production capacity of OECD is quite low, while Middle East countries have higher margins subject to future new investments.

Figure 1 - Breakdown of oil production by Region in 2020 and change of oil production between 2000 and 2020



The bars represent the variability of oil production within the six scenarios, while the cake graph represents the average distribution of total production within the regions in 2020.

Comparing the current situation with results from the six scenarios adopted in this paper, concentration of oil supply would change substantially up to 2020, but there is less agreement about what changes will actually materialize.

(a) Oil production is projected to decrease on average in the OECD regions because, even with higher recovery rates thanks to better technology, reserves have reached the peak production point. Only the maximum expansion of Canadian oil sand production, as projected by EIA-DOE (an increase of more than 2 million barrels per day by 2020), could increase the North America's production. On the contrary, it is clear that production will increase in all non-OECD regions, with Middle East's countries probably accommodating any increase in oil demand, thanks to their large reserves and low costs for expanding production.

(b) As regards two other important areas, oil production is projected to increase significantly in Central and South America, and could have a significant role in reducing energy insecurity in North America, given the supply relationships with the U.S. The increase of oil production in FSU is only slightly less (on average) than in Latin America, confirming FSU as the second export region. However, despite the general optimism about its long-term potential, the Caspian Sea Basin does not seem to have a big role in the future evolution of the oil market, probably because of the great uncertainty about export routes from the region.

(c) But the main result of the comparison is the huge range of scenarios regarding Middle East (plus Africa): while there is considerable support for a continuing dominant role for the Middle East (and to some extent Africa), it is by no means shared by all scenarios. It is remarkable that the projections of the Reference scenarios (EIA-DOE, IEA and WETO) vary as much as they do from those of the IIASA-WEC scenarios (even the high-growth A1): according to the former, oil production, in 2020, in the Middle East (plus Africa) will reach 2,500 Mtoe, both because of the larger consumption and the lower production in importing regions, while oil production is well below 2,000 Mtoe in Scenario IIASA-WEC A1 (and slightly above 1,000 Mtoe in IIASA-WEC B and C1). This means that in the first case Middle East is by far the most important oil producers, becoming in fact the key supplier to whole market, while in the alternative case oil production is much more evenly distributed among different regions, with obvious consequences on security of supply.

Gas

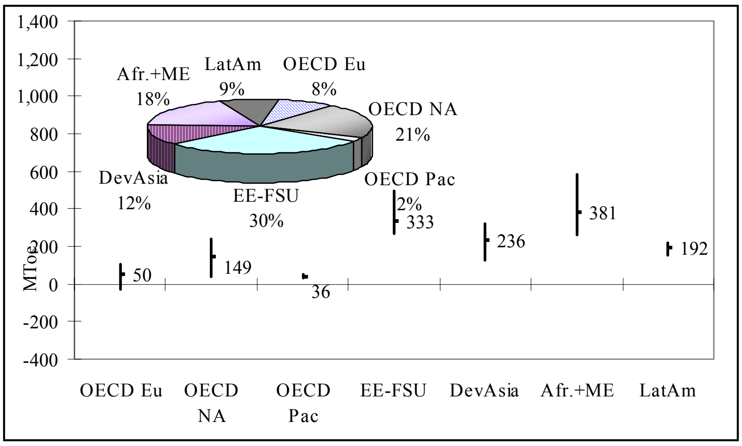
(a) The current situation for natural gas production and distribution is slightly different from oil, as it is concentrated within three main areas: North America, North Africa and Middle East (mostly Algeria, Saudi Arabia, and Iran), and the FSU, representing respectively 30.3%, 14.6% and 27.4% share of total world supply. OECD Europe provides 10.7% of world supply, concentrated in the Netherlands, Norway and United Kingdom.

(b) From an historical perspective, during the period 1970-2002 OECD countries have faced a consistent reduction in supply share (from 74.4% to 43.2% of world gas production at the end of 2002), mainly due to lower output from the U.S.. The Middle East and Africa have increased their production share from 2% to 17%, while FSU production has increased its share by around 10%, reaching 27% of total production at the end of 2002.

(c) Across all scenarios, the variation is substantially lower for gas than for oil. As demand for natural gas at world level will grow at least by 50%, there is obviously a need for a great increase of production, which is indeed expected in every region, with the only exception of OECD Europe, where gas production could slightly decrease (Figure 2). This lower level of uncertainty is also directly linked to the rigidity and the regionalization of the market, because characteristics of the gas system imply that future trends in regional gas production reflect the proximity of reserves to the larger markets (IEA, 2003).).

(d) The analysis shows that the major increases in absolute values in production will probably occur in EE/FSU and in Africa/Middle East, while very large increase in relative terms will also occur in Developing Asia and Latin America (up to four times the 2000 production level). In any event, the projected increase of about 1,500 Mtoe in production will inevitably require a huge amount of investment, firstly in production facilities, secondly in transport infrastructure.

Figure 2 - Breakdown of gas production by Region in 2020 and change of gas production between 2000 and 2020



(e) The largest increase in production should come from Africa/Middle East, where production in 2020 could be more than three times the 2000 level. Although gas reserves in this region are higher than those of EE/FSU, gas production currently lags far behind that of the EE/FSU region, mainly because there are few pipelines linking Middle East to areas of consumption. Hence a key factor determining the actual increase of gas production will be the effective realization of a number of pipeline options and/or a significant growth of LNG trade flows, which are both necessary to increase export capacity.

(f) For the EE/FSU, the projections also show a huge increase in production, with a variation range of projections clearly smaller than the one of Middle East. It reflects the expectation that natural gas will become more dominant in Russia's energy mix, and the role of Russia will become even more central in the gas system.

In conclusion, despite the differences among projected variations in regional gas production, it seems likely that the regional composition of world's production is not going to change significantly (at least until 2020). FSU will be the lead gas producer (over one-quarter of world gas production), followed by Africa/Middle East and North America. Production will be significant also in Developing Asia, Western Europe and Latin America, each one with a share of around 10%. So, unlike the oil market, the gas market will probably continue to be characterized by a more equal distribution.

3.3 Distribution of oil and gas consumption and consequent market structure

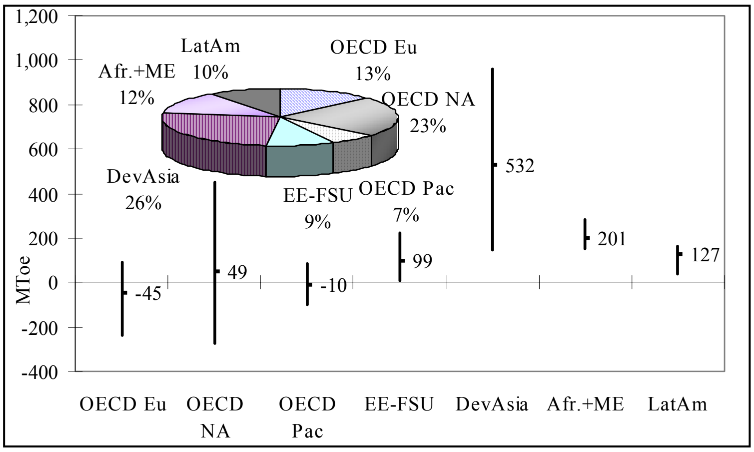
Oil

On average over the forecast period oil remains the fuel of choice in the transportation sector worldwide (the great part of the projected increase in oil demand comes from the transportation sector), particularly in developing countries, that currently have a lower proportion of transportation fuels in their energy mix. However, the six projections are significantly different: comparing the current situation with projections up to 2020, total oil consumption exceeds 100 mbd (about 4,900 Mtoe) in the three Reference scenarios, while it is slightly lower in IIASA-WEC A1 and substantially lower in the remaining scenarios (Figure 3). At regional level, the main features can be summarized as follows:

(a) The greatest uncertainty relates to North America, whose oil consumption will grow very sharply according to IEA and EIA scenarios, while it will remain constant for WETO and IIASA-WEC A1, and it will decrease in IIASA-WEC B and C1. As North America is the largest oil consumer (more than one-fourth of total demand in 2000), and consumption in the transportation sector currently represents 66% of its oil demand, policies adopted in this sector will have a great impact on the future oil market.

(b) The variation range for OECD Europe is relatively small, with consumption estimated not to be too far from current levels in 2020. This reflects the facts that transportation and other end-use infrastructures are mature and population growth is relatively slow. In addition, the ratification of the Kyoto Protocol by European Union is expected to act a force to reduce the use of oil, especially in the transportation sector.

Figure 3 - Breakdown of oil consumption by Region in 2020 and change of oil consumption between 2000 and 2020



(c) Apart from North America, the second source of uncertainty is the increasing demand from Developing Asia, with a variation in its share ranging from 17% to 26% up to 2020 of world oil consumption. Anyway, there is no perfect agreement among the six scenarios, where Developing Asia could play a decisive role for WETO projections, and a lower role for IIASA. Major factors for different estimates, are the increasing oil demand for transportation, the switching from coal due to new technologies and environmental standards, and finally accession to World Trade Organization (WTO) for China (Mitchell, 2002).

In terms of future market structure, the relative importance of different regions in the oil trade market is going to change, reflecting the overall geopolitical shift in energy use from North to South. The consequence IS that the current position of OECD countries as dominant buyers will be progressively eroded and import security concerns, traditionally strong in OECD Europe and Japan, will be shared by developing countries. As a matter of fact, in every scenario Developing Asia becomes by far the main importing region (its oil imports are half of Middle East export and in some scenarios more than half of oil trade is directed to Asia), while North America becomes the second import region, followed by the other OECD countries.

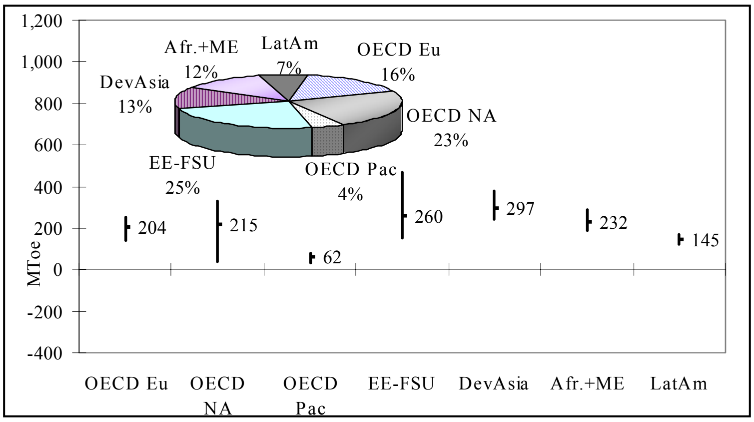
These data confirm that two geopolitical factors will determine whether the quest for Middle East oil could enhance global oil security or could lead to oil supply disruptions and instability and conflict in the Asia-Pacific region (Salameh, 2003): the United States' growing dependence on oil imports from the Middle East and the Asia-Pacific region's thirst for oil.

But, as the huge growth of US' oil demand is not inevitable, one of the main source of potential risks for the stability of the oil market could be reduced not only through free markets and investments (or by force), but also through more specific energy policies in the developed world (first of all in North America), i.e. through energy conservation, diversification of energy sources and promotion of alternative energy development and use. Together with an extended exploitation of Canadian oil, these conditions could indeed contribute to reduce the US pressure on Middle East oil and the growing competition with the Far East countries.

Gas

The situation for natural gas is substantially different from oil. At present, gas consumption is concentrated within OECD countries (54% of world gas consumption) and transition economies (23%), while Developing Asia has only a marginal role (3%). In the next twenty years, gas consumption is projected to expand in all regions (uncertainty is quite low): in absolute terms, it will almost double between 2000 and 2020 (from about 2,000 Mtoe to 3,500 Mtoe), and even in the lowest growth scenario it will increase by 50%. Also as a share of total energy consumption, natural gas will grow substantially, from 20% of total consumption to 25%. Among the factors explaining this trend, the main one is the diffusion of highly efficient and economically attractive conversion technologies, so that gas is becoming the fuel of choice for power generation, especially in industrialized countries(Nakicenovic et al., 1998). The regional developments of consumption can be synthesized as follows:

Figure 4 - Breakdown of gas consumption by Region in 2020 and change of gas consumption between 2000 and 2020



(a) The biggest source of uncertainty is North America, because of a number of factors that could have significant impacts on the development of the region’s integrated gas market, such as decisions about investments and the viability of developing conventional and unconventional Canadian gas resources. The other source of uncertainty relates to EE/FSU, mainly due to uncertainty about economic growth.

(b) The range of possible scenarios is far more limited for Western Europe, which is expected to expand strongly its use of natural gas, due to the increasing preference for gas in power generation (and the increasing penetration of electricity in the economies) and also thanks to the liberalization process, with the growing interconnection between gas and power industries and the progressive opening of gas infrastructures to third party access.

(c) The most robust growth is expected in the developing world, in particular in Developing Asia, where natural gas use is pushed not only by electricity generation but also by the goal of displacing polluting home heating and cooking fuels in major urban areas[5].

In conclusion, the general expectation is that the composition of gas demand will continue to be characterised by two main areas of consumption: North America and FSU. OECD

[5] For instance, in China, where currently gas accounts only for a modest 3 percent of total energy mix, the government has recently made several moves toward increasing the penetration of natural gas in the country, both exploring its own natural gas resources and constructing LNG re-gasification terminals and/or several gas pipelines (the Beijing’s natural gas infrastructure should be fully operational in time for the 2008 Olympic games).

Europe will remain the third area of consumption, while gas use in Developing Asia, even if increasing sharper than in other regions (both in absolute and in relative terms), will instead continue to account for a smaller share of the market.

This growing demand for gas in all regions, combined with the regional disparities in gas reserves and production costs, will, however, lead to the development of inter-regional gas trade, increasing the linkages between regional markets. Currently, inter-regional trade represents a quite marginal share of total world gas consumption. Gas trade by pipeline accounts for 58% of inter-regional flows (mainly Russian gas delivered to Europe), and the rest made up of LNG exports. By 2020, however, interregional gas trade is projected to increase by a factor to two to four. This inevitably will imply new investments in long distance pipelines and significantly increased LNG trade and investments in infrastructures (Feltham, 2002; Hawdon, 2003; Moraleda, 2002; Mouratoglu, 2002; OME, 2002). Therefore, key questions are if and when all these infrastructures, requiring a lot of time to be constructed, will be made available.

While the gas inter-regional trade flows are not expected to change much to 2020, there is is a marked difference of opinion between the WETO analysis and the IEA/WEO analysis as regards 2030. Table 3 shows that two different pictures are possible, depending on how gas is transported from the two regions with big margins for increasing production (FSU and Middle East) towards the two regions which will probably become more import-dependent (Europe and Developing Asia).[7]

The first possibility is an market characterized by two main importing regions with about the same level of gas import, OECD Europe and Developing Asia, each one served by a main production area and another less important area. This is the scenario depicted by WETO and IIASA-WEC, with OECD Europe and Developing Asia importing large amounts of gas from FSU (the main exporter for Europe) and from Africa/Middle East (the main exporter for Asia).This market structure lead to the key question of how the gas available to meet the world demand will be allocated between the regional consumption areas, that is “to what extent the rapid growth in gas demand in developing regions with limited gas reserves (e.g. Asia) will affect the long-term European gas supply pattern” (EC, 2003).

The second global option is an market characterized by a single main importing region, served by two main exporting areas, one of which (Middle East) is by far the key player on the market, exporting significant amounts of gas towards almost every other region with about the same level of export. This is the scenario depicted by IEA (and in the medium-term also by IIASA-WEC scenarios), in which the main importing region is by far OECD Europe that is served by FSU and Middle East, each with a share not far from 50% (of Europe’s imports). In this case, the structure of the gas market seems more favourable for Europe in geopolitical terms, giving it the possibility to enjoy a position partially similar to a monopsony with respect to any of the potential sources.

[7] Anyway, it must be underlined that more than 50% of the natural gas produced in the FSU and Africa/ Middle East will remain inside the regions.

Table 3 - Natural Gas: Trade movements in 2030 (bcm, pipeline and LNG)

To From	North Am.	OECD Europe	OECD Pacif.	EE/FSU	Dev. Asia	Africa/ ME	Latin Am.	Total Export	Total prod.
WETO 2003									
North Am.			4				16	20	886
OECD Europe								0	220
OECD Pacif.						1		1	91
EE/FSU		420			265			685	1,692
Dev. Asia			188			3		191	378
Africa/ME	1	114	8		378			501	1,107
Latin Am.	73				62			135	507
Total import	74	534	200	-	705	4	16	1,533	
Total cons.	940	754	290	1,007	892	610	388		4,881
IEA WEO 2002									
North Am.								-	960
OECD Europe								-	280
OECD Pacif.								-	123
EE/FSU		244	8		25			277	1,222
Dev. Asia	59		52					111	650
Africa/ME	201	362	60		40			663	1,340
Latin Am.	85	17						102	475
Total import	345	623	120	-	65	-	-	1,093	
Total cons.	1,305	901	243	945	615	666	373		5,047

Source: WETO (EC, 2003), WEO (IEA, 2002a).

4. Energy security for OECD Europe: dependence and vulnerability indicators

For a comprehensive assessment of the outlook for energy supply security for OECD Europe, dependence and vulnerability indicators based on the scenarios described above are needed. These are summarized in Table 4.

Main Observations on Oil Security

One of the main results regarding Europe is the great difference between the evolutions described by the three Reference scenarios (IEA, EIA, and WETO) and those of the IIASA-WEC. In the former oil consumption continues to increase, even if quite moderately, by about 10%. On the other hand, all IIASA-WEC scenarios describe, for OECD Europe, an orderly transition away from conventional fossil fuels, characterised by two parallel factors: a decrease in oil consumption and a more moderate decline of production. According to IIASA, a decline of production in the medium term is unlikely, as capital availability is not a major constraint in Europe. Therefore, oil net imports could even halve during the time horizon, (from current 8.5 mbd to 4 mbd). On the contrary, they substantially increase in the Reference scenarios by IEA, EIA, and WETO (up to 13 mbd), with a consequent divergence within import dependence values (50% for IIASA against more than 80% within the others).

Following from this, it is not surprising that IIASA-WEC scenarios produce more favourable forecasts of dependence and vulnerability than the three medium term reference scenarios (IEA 2002, EIA-DOE 2003 and WETO 2003). In all IIASA-WEC scenarios, even with carbon-intensive assumptions (scenario A1), OECD Europe is significantly less vulnerable, as both oil consumption per capita and the degree of supply concentration for production is much lesser than in WEO, IEO and WETO (Table 4).[8] Considering Net Imports

[8] Difference between EIA and IIASA about oil used per capita mainly depends on different assumption for population growth.

as percentage of Total Primary Energy Supply (TPES) for oil, IIASA projections remain at the 2000 level, while WETO and IEA estimate a substantial increase for import dependence (and consequently an increased risk of disruption).

Table 4 – Dependence and vulnerability indicators for OECD Europe, oil and natural gas

Security Issue	Scenarios / Physical Dimension	OIL 2000	OIL 2030 WETO	OIL 2030 IEA	OIL 2025 EIA	OIL 2030 IIASA A1	GAS 2000	GAS 2030 WETO	GAS 2030 IEA	GAS 2025 EIA	GAS 2030 IIASA A1
Dependence	Net Import % of TPES	0.72	0.89	0.84	0.67	0.50	34	0.67	0.70	0.60[c]	0.50
	Share of European oil/gas Imports on world oil/gas imports (%)	0.29	0.22	0.23	0.20	0.19	0.33	0.35	0.60	-	0.67
Vulnerability supply-side	Degree of supply concentration (trade)	0.25	-	0.51	0.48	-	0.12	0.32	0.40	n.a.	n.a.
	Degree of supply concentration (production)	0.21	0.35	0.29	0.28	0.22	0.12	0.23	0.20	n.a.	0.19
	Shannon-Weiner diversity index	1.29			1.82		0.99	0.67	1.02		
Vulnerability demand-side	Oil used in transportation (%) Share of electricity produced with gas (%)	59	-	68		-	16	24	39	-	-
	Oil/Gas used per capita (toe/ab)	1.57	1.54	1.51	2.07	1.18	0.64	1.15	1.37	1.73	1.25
	Economic Dimension										
Dependence	Value of oil/gas imports (bil$/€)	104	164 (€1999)	140 ($2000)	104 ($2001)	-	23.3	-	85.5 ($2000)	-	-
Vulnerability supply-side	Oil/Gas Cons. per $ of GDP (toe/mil 1995$PPP)	72	43.2	46.3	48.6	-	0.03	0.03	0.04	0.04	0.04

Notes.

(a) The degree of supply concentration is measured as a simple index built as the sum of the squares of the shares of different exporting countries on total world oil and gas imports (IEA, 2001). Formally it is defined as $CONC = \sum_i x_i^2$ where x_i is the market share of each country separately for oil and gas, assuming values in the range (low concentration) $0 \leq CONC \geq 1$ (high concentration).

(b) In a context of security of supply, the original formulation of the diversity index by Stirling (1994), can be reformulated as a Shannon-Weiner index $SW = -\sum_i x_i \ln x_i$, where x_i represents market share of the *i-th* supplier country. Such a measure of diversity places weight on smaller participants, and it assumes value in a range (low diversity) $0 \leq SW \leq 2$ (high diversity), increasing as the number of different suppliers increases.

The issue of import dependence, however, should not be considered alone, because it is part of the pattern of free trade and international cooperation. This means that import dependence of OECD Europe should be linked to the great amount of its non-energy exports, part of which go towards oil exporting partners like Middle East. "[S]uch regions would not be such good customers for European exports without the revenues they earn from their own energy exports. Energy trade therefore should not be considered in isolation from trade in other goods and services. Indeed trade and economic cooperation are important not only to economic growth, but also to international and regional security." (Nakicenovic et al., 1998, p. 190). In this context it is important to note that the analysis does indicate a possible scenario (IIASA-WEC C1, not shown in Table 4 – see Annex for details of the scenarios) with a moderate growth of oil demand (or even a reduction) by importing regions without affecting the possibility for exporting countries to increase their revenues, so reducing the (already large) dimension of necessary investments to increase capacity production and connections among energy system.

Finally, the analysis shows that a scenario (even if *high-growth* and *fossil-intensive*, like the IIASA-WEC A1) of improving "traditional" security indexes and simultaneously taking into account needs and interests of exporting countries is perfectly feasible. In our view this is probably the best way for Europe to control its concerns about security of oil supply and reduce its vulnerability. But this scenario implies a reduction of oil demand and effective actions in favour of the Middle East political stability, its openness to foreign investments and its integration and cooperation with the Western world (Mitchell, 2002; Peters, 2003).

Main Observations on Gas Security

Considering the natural gas sector, the evolution of dependence over time seems to be quite different from oil, for the following reasons:

- in the medium term, Europe's reliance on natural gas is expected to increase strongly, as in 2030 the dimension of gas imports will be between two to three times the current value (up to a maximum value of about 500 bcm);
- the share of gas imports in the region's total gas supply will also increase substantially, in all scenarios;
- as a consequence of the increase in physical imports, the monetary value of gas imports will also inevitably grow.

Even if import dependence is not a threat in itself, because security of gas supply covers a large number of aspects (Luciani, 2003; Müller, 2003), these data are significant and clearly indicate that a huge amount of additional gas supply must be mobilized and transported to the European market (Cayrade, 2003; Coffin, 2002; IEA, 2002b; Klaassen et al., 2001). At least up to 2010, transport capacities from the main gas region (Russia and Algeria) seem to be sufficient, as they currently exceed 140 bcm (IEA, 2003). The difference between this value and the possible dimension of gas import in 2020 and after generates the question of the huge investments in infrastructures that would be necessary to bring these imports to the market.

In order to understand if high levels of import dependence could have a relevant impact on security of supply, the vulnerability of the energy system must also be analyzed. The comparative analysis of the six scenarios gives some interesting insights on several inter-related aspects of European gas security, synthesised by the evolution of vulnerability indicators over time. First, while dependence will increase within all scenarios, a parallel increase of the diversification of gas imports is feasible; as shown by IEA projections, a strong increase of imports from Middle East could help Europe to diversify its supply routes or terminals, as indicated by the (even moderate) increase of the Shannon-Weiner diversity index (von Hirschhausen and Neumann, 2003). Furthermore, the supply-side indicators about the international gas market structure - share of gas imports on world total gas imports and the degree of supply concentration in trade and production - show a possible decrease of concentration in gas trade. As a consequence the European role among net importer regions could become very different, from a secondary position to a position of monopsony. Finally, the share of gas in the energy mix of the region will inevitably increase, even if more moderately in comparison to the increase observed during the last ten years. It is quite likely that this share will reach 30%, principally because of the growing role of gas in electricity generation switching from coal and fuel oil (Toh, 2002).

5. Emerging issues for oil and gas markets, risks and policy options

Oil

The main issues that arise concern the political instability of major suppliers, growing energy demand from developing countries, and oil price volatility.

a) Political instability of suppliers. The risk of collusion among oil exporters due to increasing concentration of oil reserves and production could distort export prices and delay new investments (by adopting 'wait-and-see' policies), with consequent growing market instability. To reduce such risks, expanding oil production from non-OPEC countries could be a first tool. Furthermore, collusion is probably limited by the different Reserves/Production ratios of exporting countries (especially within North Africa and Middle East), which provide different capabilities for expanding supply, as countries with less volume potential are interested in slower demand growth and higher prices than those that can increase revenues by expanding volumes at current prices (Mitchell, 2002).

Besides, because of the proximity of Canada and Venezuela to the US market, helping these countries to compete against lower-cost producers, and the increasing US demand for non-conventional sources could provide an opportunity to reduce oil imports from Middle East, so reducing the pressure on supply countries.

Another major issue affecting future supplies is whether the required investments in oil production will actually materialize. The amounts required are huge; even in the IIASA-WEC scenarios the amount of investment needed to increase production between 1990 and 2020 are is US$700 billion, that is between 2% of GDP (Nakicenovic et al., 1998, p. 182).

Considering in particular the consequences of future market structure on European Union, a key role will be played by FSU. Diversification of transport routes and increasing cooperation and international investments for enhancing new infrastructures will be the most effective policy actions. In order to achieve such goals, an international institutional framework will be necessary to promote incentives in building an oil network with exporting and transit countries. The Energy Charter Treaty could be a vehicle to promote Western investment and technology flows into the energy sector of the Eastern transition states of the Former Soviet Union and the flow of energy from the East to the West (Andrew-Speed, 1999; Papaioannou, 1995).

b) Growing demand of developing countries. The phenomenal economic growth of Developing Asia, and its steadily rising energy needs lends urgency to the question of how the region would meet its considerable energy challenges. By the end of the EIA-DOE forecast period (2025), OPEC exports to industrialized countries are estimated to be about 11 mbd higher than their 2002 level. Despite such increase, the share of total exports going to industrialized nations is projected to decrease, while OPEC exports to developing countries are expected to increase by about 17 mbd (three-fourths of the increase going to Asia). Such dependence on a volatile region like the Middle East and the perception of scarcer energy resources in the Asia-Pacific region have the potential to lead to conflict in both regions (Salameh, 2003).

From a strictly European point of view, this means that any reduced pressure on Middle East oil from US due to Canadian oil will be mostly compensated by the increase in oil demand from China and rest of Developing Asia. Projections on economic and demographic growth of the Asian continent imply that oil demand from there will constitute a great source of instability on the oil market. (Peters, 2003).

c) Oil price volatility. The structural inflexibility of oil market in the short term, both on supply, (due to high fixed production costs) and demand side (due to low price and substitution elasticities) explains the high volatility of oil prices. The slightest imbalance between supply and demand, or the expectation of such an imbalance, has a very profound impact on prices (witness the current high process in the oil markets).

It is well known that the oil price has a great influence on the economic system not only for its absolute value, but also due to its volatility. Volatility in the oil price, both in the short and long run, creates uncertainty, and therefore an unstable economy for both exporting and importing countries. Higher prices result in an increasing inflation and a subsequent recession in oil-consuming nations, as oil prices are negatively correlated to economic activities (IEA, 2001b).

Most post-war recessions were preceded by oil price shocks, i.e. the 1974, 1980 and 1990 economic recessions. Estimates show that an increase in the price of oil by $10 a barrel leads to a reduction in growth of 0.5 to 0.6% with a lag of 1-2 years that lasts for about a year (EC, 2002; IMF, 2001). Other effects include increased inflation and unemployment.

It is extremely difficult to predict price increases and fluctuations in the future, but some factors that should be given greater attention are the decline in spare crude oil production capacity in the supplier countries, the lower level of inventories and rapid decline in surplus capacity in the global refining industry. All these are undoubtedly contributing to increasing volatility in the price and supply of oil and will continue to do so. Particularly the last two factors influence supply security, because the resulting tightly balanced market has become more sensitive to actual or threatened supply disruptions, and swings in demand are increasingly met by price changes rather than delivery from storage. Liberalization of trading markets and development of transaction tools such as derivatives and information technology seem to intensify volatility (Yang et al., 2002).

This increasing uncertainty can push up risk premiums, and discourage oil companies' investment, which, in turn encourages refiners to minimize their crude oil inventories, and discourages crude processing since they are punished for hedging forward. Reduction of oil stocks in order to minimize production costs following just-in-time techniques could exacerbate such risks. In order to avoid dramatic consequences on the economic system due to lack of necessary stocks, a revision of IEA emergency response system with increasing strategic stocks will be needed. (EC, 2002).

A further – but not exhaustive – list of demand-side policies to reduce price volatility could be: enhancing energy saving and efficiency, reducing oil intensity for the economic system with investment in research and technology, reforming taxation of energy products, and reducing oil price inelasticity, especially for the transport sector (Fisk, 2003; Helm, 2002; Toman, 2002).

Finally we note that, while high oil prices clearly have negative consequences for the importers, very low prices, and high price volatility are equally harmful for the exporters. In 1998, for example, when oil prices declined to approximately $10 a barrel, the consequences were retarded economic development and even political instability and social unrest in some oil-producing countries. This in turn is harmful to energy security for all (Ferderer, 1996; Huntington, 1998).

Natural gas

In the medium to long-term, the main risks characterising the international gas market are the possibility of global crisis, of export cartel policies (risk of a "seller's market") due to the fragmentation of demand (in the face of an oligopolistic supply structure), of demand/supply imbalance due to difficulty of developing incremental supply projects and infrastructures, and finally of depletion of gas reserves/resources. Key factors which contribute to increasing these risks are the unavoidable growing dependence and insufficient diversification. Therefore, the main medium and long-term policies to address the risks underlined above can be grouped in the following two points (apart from the improvement of geopolitical relationships).

a) Reduction of dependency. Gas production is expected to increase in all regions according to almost all scenarios, but the viability of a long-term increase of domestic production in Europe is considered quite limited. According to all scenarios, a reduction of dependence through demand side measures is also very difficult, because the pressure for an increase in gas demand is very strong, while internal production for OECD Europe will not cover the gap.

b) Diversification. The possibility to increase the diversification of energy types is linked to the potential for fuel substitution. Problems arise here, because of the growing importance of gas in power generation. Between 2000 and 2010 electricity production will probably contribute to more than 50% of incremental gas demand, and gas will account for the largest share of the increase in electricity production. Equally limited is the scope for diversification of sources of gas imports, given the characteristics of the gas system, which is regional and rigid. In practice, flexibility with respect to the use of gas is limited, at least in Europe.

A key question in the future evolution of the gas market is whether it will continue to be regionally segmented or whether it will become more and more global? At present, there are few physical connections between the main regional markets, but these could significantly increase with rapid expansion in LNG trade (now becoming more flexible and responsive to price signals). If the development of such trade would imitate the evolution of the international oil market, this could have major implications for gas supply, as prices in connected regional markets could be expected to converge, depending on the ability of suppliers to switch volumes between supply routes and markets. In particular, LNG spot trading is a key factor for a more global (or less regional) gas market (IEA, 2002a). Should the latter prevail, the analysis of scenarios shows that ME supply would probably be larger, depending on demand for LNG in the North American and also European market.One of the key questions for Europe with regard to the international trade in gas is to what extent a rapid growth in gas demand in Asia will affect the long-term European gas supply pattern. (EC, 1998, Ekinci, 2002, Misiulin, 2002). It is clear that, if this development unfolds, Europe will have to compete with other gas markets and to offer competitive price terms. On the other hand, if gas consumption in Developing Asia grows more moderately (like in the IEA scenario), parallel to a significant increase in production, the need for import could be very limited, with the consequence that Asia could be not present at all in the international gas market (see table 3 fro a comparison of the two alternatives). In this case, the situation could be more favourable for Europe in geopolitical terms, as: a) the diversification index improves with respect to the current situation; b) Europe has the possibility to enjoy a position partially similar to a monopsony with respect to any of the potential sources.

Whether the market for imported gas will indeed develop in Asia depends not only on domestic production and demand but also on the capacity of Russia to expand production and delivery to Developing Asia. There is scepticism about the possibility of large increase of Russian production, because of the aging of the main fields in West Siberia (accounting for 80% of Russian output), and the technically difficult development of offshore fields in the Arctic North of Russia.

Apart from Russian production capacity, another issue will be the consequence of liberalisation on capacity development: will adequate and timely investments in upstream production be triggered by market signals as supply gaps develop? Competitive markets may not automatically deliver sufficient diversification, as they focus on price level, so that at each location it is the cheapest gas which is consumed. More short-term gas sales contracts and market uncertainties could increase risks and costs of large long-term investments (IEA, 2002b).

One of the worrying results coming from the analysis of scenarios regards the comparison between expected demand and projected infrastructures: transport capacities from the main gas regions to the European borders (67 bcm/y from Algeria and 75 from Russia, plus completion of Yamal I to Germany) appear not to be sufficient even in 2010, as net imports are projected to be in the range 160-320 bcm. For the longer-term, significant import capacity expansion could be needed, well beyond current plans and proposals, as imports are projected to be in the range 230-500 bcm, while total projected capacity (considering existing plus plans and proposals) is 280 bcm (320 bcm assuming that capacity has a lifetime of 40 years instead of 35 years (Klaassen et al., 2001). And it has to be underlined that adequate capacity is necessary for supplier to compete for market share: it is a prerequisite of effective competition.

Finally, LNG development and the dimension of the spot market are also factors affecting the flexibility of the market and the possibility of diversification of sources. The LNG market for short-term deliveries is expanding fast, creating more flexibility and diversity of supply, as the LNG chain is intrinsically more flexible than a pipeline: a European gas market with a larger share of LNG imports would therefore be more easily diversified and also more effectively integrated in the event of a crisis. Unfortunately, an increase in number of LNG terminals (liquefaction plant and re-gasification terminal including storage) across Europe is costly: construction costs for a plant with a capacity of liquefying 5 bcm per year are between US$ 1.4 to 2 billion, about US$ 2 billion for a 10 bcm plant, plus ships for transport and re-gasification terminals (IEA, 2002b). This means that sunk costs, i.e. irreversible investments, will rise above US$ 5 billion for a single working terminal, (von Hirschhausen and Neumann, 2003). Therefore, for LNG development to be justified, a case may have to be made on security of supply grounds, accepting the additional costs as a form of insurance.

6. Conclusions

This paper has reviewed the oil and gas supply and demand scenarios to 2030, including a regional breakdown in both supply and demand and its implications for regional trades. On the positive side we can say that there is agreement on global supply demand balance for most of this century. Total reserves of oil are found to be sufficient to around 2050, although even by that date some unconventional reserves will have to be developed. If we include resources as well as reserves, supply is sufficient in all thirteen long-term scenarios up to 2100. For gas the situation is slightly better: reserves are sufficient at least to 2045 and reserves and resources are sufficient to 2100.

Looking at the regional evolution and focusing over the next 20-30 years, there is less agreement among the scenarios. On the supply side, there is great uncertainty about oil supply from Middle East and Africa, while gas supply has less variability, as output is expected to grow by more than 50%, with all regions contributing to this, but especially the FSU and the Middle East and Africa. On the demand side, oil demand forecasts are divergent for North America and Developing Asia, in both cases reflecting different policy assumptions, including the implementation of the Kyoto Protocol. Demand for gas shows smaller variations, and a general expansion in all regions, but here too there is uncertainty about North America. The main feature about gas demand is its implications for gas trade, which is estimated to increase two to four fold between 2000 and 2020. This will imply huge investments in long distance pipelines, and it is not clear if the geopolitical situation will make that feasible in this time frame. The implications of all these development for Europe can be seen in terms of changes in measures of the region's dependence and vulnerability to the supply and demand for these fuels. Looking at oil, there is a wide variation in the forecast of the dependence indicators In terms of vulnerability, all scenarios show a decline, as the degree of supply concentration falls. An interesting result is that the scenarios also support the view that it is possible for demand for oil in Europe to moderate, or even fall, without the oil exporters suffering a fall in their real incomes. For gas, dependence is expected to increase in all scenarios, but vulnerability is expected to decline, with imports from the Middle East playing a major role in this.

The policy implications of these findings for Europe can be summarized as follows:

- Demand side measures such as energy efficiency, especially in transportation sector, together with technological investments on the supply-side, could reduce import dependence on oil, as underlined within IIASA-WEC results. (e.g. the EU SAVE Directive (1993) needs to be promoted more vigorously).

- Stability and development in the Middle/East and FSU, and cooperation in the development of energy resources in these regions will be key factors in ensuring that sufficient investment is made in infrastructure and in ensuring the security of transit routes (FSU) and cooperation for political stability in Middle/East. Measures such the Energy Charter Treaty, with the FSU, the Euro-Mediterranean Energy Partnership and INOGATE, with the countries of South East Europe are all deigned to promote such cooperation.
- Involving Developing Asia (in any case a key actor on energy market in the medium-term) in order to cooperate building infrastructures, reducing risk of conflicts will also contribute to European energy security.
- Considering natural gas, a reduction of dependence through increase of domestic production or through energy saving is not credible. Nor is the diversification of energy sources through fuel substitution a major possibility, given the growing use of gas in power generation.
- The situation is different with regard to diversification of the sources of gas, because Europe's position in the world market could be more favourable if Africa/Middle East's exports grow substantially, with significant volumes of LNG. This would make Europe more able to diversify its own sources, as it would increase the flexibility of the market.
- Finally, a critical factor is the transport capacity towards Europe, as it seems very likely that expected demand is higher than projected infrastructure. This will require access to the gas reserves, the opening of producing areas to international investments and measures to increase the stability of "transit countries".

References

Andrew-Speed P., The politics of petroleum and the Energy Charter Treaty as an effective investment regime, *Jnl of Energy Finance and Development* n. 4, pp. 117-135, 1999.

Bentley R.W., Global oil & gas depletion: an overview, *Energy Policy* n. 30, pp. 189–205, 2002.

Birol F., *Oil Price Changes and the Macroeconomy: A Brief Overview*, IEA paper, Paris, 1998.

Cayrade P., *Investments and gas pipelines and LNG infrastructure*, paper at INDES Workshop on Insuring against Disruptions of Energy Supply, Amsterdam 6-7 May, 2003.

Coffin B., *Overview of Cross-border trade and Transit Issues*, paper at Cross-Border Gas Trade Conference Paris, France 26-27 March, 2002.

Cordesman A.H., Hacatoryan S., *The Changing Geopolitics of Energy – Part II: Global Oil and Gas Production and Reserves*, CSIS Center for Strategic and International Studies, pp. 48, 1998.

EIA-DOE, *International Energy Outlook*, 2003.

European Commission (EC), *World Energy Technology and climate policy Outlook* (WETO 2030), 2003.

European Commission (EC), *The internal market in energy: Coordinated measures on the security of energy supply*, COM (2002) 488 final, Brussels, 2002.

European Commission (EC), *Green Paper Towards a European strategy for the security of energy supply*, COM(2000) 769 final, Brussels, 2000.

European Commission (EC), *Directive on Natural Gas*, Dir 98/30/EC, 1998.

Ekinci B., *The Role Of Turkey, Epicentre Of Energy Routes, In The European Energy Security*, paper at Conference On Natural Gas Transit And Storage In Southeast Europe, 31 May - 1 June, 2002.

Feltham J., *How Australia Successfully Develops LNG Projects*, paper at Cross-Border Gas Trade Conference Paris, France 26-27 March, 2002.

Ferderer J.P., Oil price volatility and the macroeconomy, *Jnl of Macroeconomy* n. 18, pp. 1-26, 1996.

Fisk D., *Transport Energy Security. The Unseen Risk?*, paper at INDES Workshop on Insuring against Disruptions of Energy Supply, Amsterdam 6-7 May, 2003.

Hawdon D., Efficiency, performance and regulation of the international gas industry—a bootstrap DEA approach, *Energy Policy* n. 31, pp. 1167–1178, 2003.
Helm D., Energy policy: security of supply, sustainability and competition, *Energy Policy* n. 30, pp. 173–184, 2002.
Huntington, H.G., Crude oil prices and US economic performance: where does the asymmetry reside?, *Economic Jnl.* Vol. 19 (4), pp. 107-132, 1998.
IEA, *Proceedings From Security Of Gas Supply Meeting Of The Governing Board At Ministerial Level*, 28-29 April, 2003.
IEA, *World Energy Outlook*, OECD, Paris, 2002a.
IEA, Caspian Oil & Gas, OECD, Paris, pp. 285, 2002b.
IEA, *Toward a Sustainable Energy Future*, OECD/IEA, Paris, 2001a.
IEA, *Energy price volatility: trends and consequences*, IEA paper, OECD, Paris, 2001b.
IMF, World Economic Outlook, IMF, Washington DC, 2001.
IPCC, *Emissions Scenarios*, Special report of IPCC Working Group III, 2000.
Kendell J.M., *Measures of Oil Import Dependence*, EIA-DOE, 1998.
Klaassen G., McDonald A., Zhao J., The future of gas infrastructures in Eurasia, *Energy Policy* n. 29, pp. 399-413, 2001.
Luciani G., *Security of supply risks related to energy import dependency – Natural Gas*, paper at INDES Workshop on Insuring against Disruptions of Energy Supply, Amsterdam 6-7 May, 2003.
Misiulin A.V., Matyushechkin V.N., *35 Years of Russian Gas Export and Transit*, paper at Cross-Border Gas Trade Conference Paris, France 26-27 March, 2002.
Mitchell J., *Renewing energy security*, The Royal Institute of International Affairs, Sustainable development Programme, London, 2002.
Moraleda P., *How the Major Barriers to Cross-Border Gas Trade were Overcome in the Case of the Maghreb Pipeline*, paper at Cross-Border Gas Trade Conference Paris, France 26-27 March, 2002.
Mouratoglu R.A., *Trilateral Agreements: Bakü-Tiflis-Ceyhan Pipeline Case Study*, paper at Conference On Natural Gas Transit And Storage In Southeast Europe, 31 May - 1 June, 2002.
Müller F., *Gas import dependence*, paper at INDES Workshop on Insuring against Disruptions of Energy Supply, Amsterdam 6-7 May, 2003.
Nakicenovic et al., *Global energy perspectives*, IIASA-WEC, 1998.
Odell P.R., *UK Security of Energy Supply*, UK House of Commons Trade and Industry Committee Second Report of Session n. 02, 2001.
OME (Observatoire Mediterraneen de L'Energie), *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*, paper for the IEA Conference on natural Gas transit and Storage in Southeast Europe: An Opportunity to diversify European Gas Supply?, Istanbul 31 May, 2002.
Papaioannou A., Security of energy supply: the approach of the European Union and the contribution of the Energy Charter Treaty, *Maastricht Journal of European and Comparative Law* Vol. 2 (1), pp. 34-62, 1995.
Peters S., *Courting future resource conflict: the shortcomings of Western response strategies to new energy vulnerabilities*, Political Science Department, Giessen University, 2003.
Popp. D.C., The effect of new technology on energy consumption, *Resource and Energy Economics* n. 23, pp. 215–239, 2001.
Salameh M.G., Quest for Middle East oil: the US versus the Asia-Pacific region, *Energy Policy* n. 31, pp. 1085–1091, 2003.
Stirling A., Diversity and Ignorance in electricity supply investment: addressing the solution rather than the problem, *Energy Policy* Vol. 22 (3), pp. 195-216, 1994.
Toh K.H., *The Impact of Convergence of the Gas and Electricity Industries: Trends and Policy Implications*, paper for the Cross-Border Gas Trade Conference, Paris, 26-27 March, 2002.
Toman M.A., International Oil Security: Problems and Policies, *Resources for the Future*, Issue Brief n. 02-04, 2002.
U.S. Geological Survey (USGS), *World Petroleum Assessment 2000*, U.S. Geological Survey World Energy Assessment Team, 2000.
von Hirschhausen C., Neumann A., *Security of 'Gas' Supply: Conceptual Issues, Contractual Arrangements, and the Current EU Situation*, paper at INDES Workshop on Insuring against Disruptions of Energy Supply, Amsterdam 6-7 May, 2003.
Yang C.W., Hwang M.J., Huang B.N., An analysis of factors affecting price volatility of the US oil market, *Energy Economics* n. 24, pp. 107-119, 2002.

Annex: Details of Demand Scenarios

Scenarios by IEA, EIA, and WETO are Reference or business as usual (BAU) scenarios. IIASA-WEC scenarios are divided into three cases: 1) Case A assumes a future of impressive technological improvements and high economic growth: in scenario A1, investments and technological progress focus on oil and gas, so that the dominance of oil and gas is perpetuated to the end of the 21st century; scenario A2 assumes that investments and technological progress will support a massive return to coal; scenario A3 is characterized by a phase-out of fossil fuels for economic reasons, i.e. the rapid technological change in nuclear and renewable energy technologies. 2) Case B describes a more realistic technological improvements and intermediate economic growth. 3) Case C presents a «rich and green» future, with technological progress and international cooperation, driven by explicit policies whose goals are environmental protection and international equity: in Scenario C1 nuclear power is a transient technology, eventually phased out by the end of the 21st century; in Scenario C2 a new generation of nuclear reactors is developed, inherently safe and small scale, so that it finds widespread social acceptability.

Table 5 - Demand forecasts for oil and gas in Europe for 2000-2100

		Years	Oil	Gas
HISTORICAL DATA		**1990**	**615**	**227**
		2000	**667**	**379**
IIASA-WEC	**A1**	1990	604	229
		2000	608	333
		2010	628	426
		2020	**561**	**576**
		2030	583	619
		2100	129	317
	B	1990	604	229
		2000	603	330
		2010	549	414
		2020	**424**	**543**
		2030	332	611
		2100	56	379
	C1	1990	604	229
		2000	559	308
		2010	468	360
		2020	**322**	**468**
		2030	249	507
		2100	15	134
IEA WEO 2002		2000	683	384
		2010	738	511
		2020	**773**	**638**
		2030	790	721
US EIA IEO 2003		2000	718	375
		2010	748	441
		2020	**771**	**590**
		2025	796	665
WETO 2003		1990	615	227
		2000	667	379
		2010	688	464
		2020	**716**	**521**
		2030	722	537

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