Chapter IV

Geopolitical impact of the development of unconventional hydrocarbons

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Abstract

Unconventional oil and gas resources are abundant and their production is economically viable. In addition, the geographical distribution of these resources helps to diversify the traditional sources of supply currently highly concentrated in the Middle East and Russia. Stagnation and imminent fall in production of crude oil will make unconventional oil to gain prominence in the future. Over the next decade, its increasing extraction, particularly in the United States and Canada, will help to temporarily weaken the hegemony of the OPEC which nevertheless will regain control of the market shortly after the mid-1920s. Meanwhile, the production of unconventional gas will extend in the future from North America to other parts of the world, consolidating its contribution to the global supply of gas on a long-term basis. The change in the geography of demand, whose centre is moving towards Asia, along with the changes introduced by the unconventional hydrocarbons production in the current balance between exporting and importing countries, will incur a reorganization of the trade flows of oil and natural gas, with implications upon the security of the global supply routes. The United States, which thanks to unconventional oil, achieves the auto-sufficiency in the case of natural gas as well as a low degree of dependence on crude oil imports, is the big beneficiary in the medium term of the so-called unconventional revolution. The European Union, by contrast, will see an increase on its imports and external dependence.

Key words

Unconventional hydrocarbons, OPEC, Energy Self-sufficiency, Energy Dependence

Introduction

The objective is to analyse the geopolitical impact of the development of unconventional oil and natural gas resources.

To do this, as a preliminary step, after clarifying the meaning of the expression unconventional and going on to define and list the main categories of these types of hydrocarbons, an estimate of resources at the global level, at the same time as the potential production costs that are evaluated.

Once their abundance and the economic viability of extracting them have been recorded (without internalising the costs associated with the C02 emissions generated) the analysis focuses on the geographical distribution of unconventional oil and gas resources, with the aim of finding out whether their geographical location could represent a counterbalance to the current concentration of conventional resources in certain parts of the planet.

Later on, it is possible to analyse the production prospects during the next two decades, identifying the main players and evaluating the possibility the possibility of that the unconventional resources constitute a genuine and lasting alternative to the current hegemony of OPEC and the Middle East, in the case of oil and this latter region and Russia in the case of gas.

Finally, the changes that the production of unconventional hydrocarbons that could be inserted into the current exporter-importer balance sheet of the main countries and regions, so in this way to try to recognise changes of direction in the commercial flow of oil and natural gas, as well as the possible trends in reorganisation of the current map of world trade and the potential implications that said reorganisation could have on the security of global supply routes are valued.

The methodology used to cover the objectives mentioned above basically consisted of a detailed study and summarising of the data and conclusions presented in several recent reports published by the International Energy Agency[1].

[1] We should recognise that this is an autonomous body, with its HQ in Paris, as a consequence of the 1973 oil shock, within the context of the Organisation for Cooperation and Economic Development (OECD). Its objective is to design and carry into practice an international energy programme. THE IEA is made up of the following countries: Germany, Australia, Austria, Belgium, Canada, South Korea, Denmark, Spain, the United States of America, Finland, France, Greece, Hungary, Ireland, Iceland, Italy, Japan, Luxembourg, New Zealand, Norway, the Netherlands, Poland, Portugal, the United Kingdom, the Czech Republic, the Slovak Republic, Sweden, Switzerland and Turkey. The Euro Commission also takes part in the IEA work.

It is opportune to highlight the fact that, as happens in any study in which prospecting issues and the estimating of sub-soil resources are dealt with, the figures set out during the course of this paper, although they come entirely from sources of recognised standing, they should not be taken to be exact values, but rather more as orientations that make it possible to identify certain trends.

Unconventional oil

Preliminary technical considerations

What does unconventional mean?

There is no universally accepted definition of what may be understood by conventional or unconventional in the oil and gas industry. In general, at a determinate time, this latter term is applied to any accumulation of oil and gas that requires production technologies that are significantly different from those that have mostly been used until now. Doubtless, this acceptance is imprecise and to associated with the time factor. In the long run, as a result of technological evaluation, unconventional takes on the category of being conventional from the time at which an extractive technology stops being an exception to become the norm.

Main types of unconventional oil

According to the International Energy Agency (IEA), unconventional oil includes the following categories (figure 1):

I. Kerogen shales or oil shales[2]. This is a type of fine-grained sedimentary rocks (mainly made up of clay or silt-size particles) and with very low permeability that contain a mixture of solid organic components known as kerogen. On the basis of this, by means of heating (up to some 500º C), hydrocarbon liquids (kerogen oil) can be obtained. Kerogen shales are immature source rocks that have not managed to produce oil because, during their burial, they have not been subject to the minimum temperature conditions required for the genesis of oil or gas.

[2] In the original Spanish version of this paper, the term shale was not translated. The reason for that lies is that the two Spanish terms used designate metamorphic rocks which, by definition, do not contain organic or hydrocarbons materials. Shales are fine-grained sedimentary rocks that are preferably stated in the original to be a sedimentalogical word (*lutitas – lutites*) that is not well known but that is technically the most correct one. *[Note: This is translator's comment that does not strictly correspond to the original].*

II. Light tight oil or LTO. This refers to light crude trapped in sedimentary rocks with low levels of permeability and porosity (lutites, sandstones and limestones). These are mature hydrocarbons rocks, rich in organic materials, which after undergoing a suitable thermal maturing process have generated oil. Part of this is still in the rock, although another part of it may have migrated vertically, being accumulated in conventional reservoirs. Since the fluids cannot move easily via low-permeability rocks, commercial oil production that it contains require advanced techniques such as hydraulic fracturation (or "fracking") and the drilling of multi-lateral horizontal wells.

III. Oil sands or tar sands.These are sedimentary rocks that are unconsolidated and mostly made up of sand-sized particles, melded by a dense and extremely viscous variety of oil, technically known as bitumen. There are several technologies of extracting the bitumen from the sands. When these are near the surface, they are exploited using mining, huge shovels and dumper trucks. The bitumen is then extracted using hot water and caustic soda, and it is finally treated using a process ("upgrading") that gives rise to a synthetic crude that is sent to a refinery. When the tar sands are at greater depth (over 75 m) in the subsurface, it is necessary to drill horizontal and vertical wells, and inject hot water. Most reserves and resources of tar sands are concentrated in Canada, mainly in Alberta.

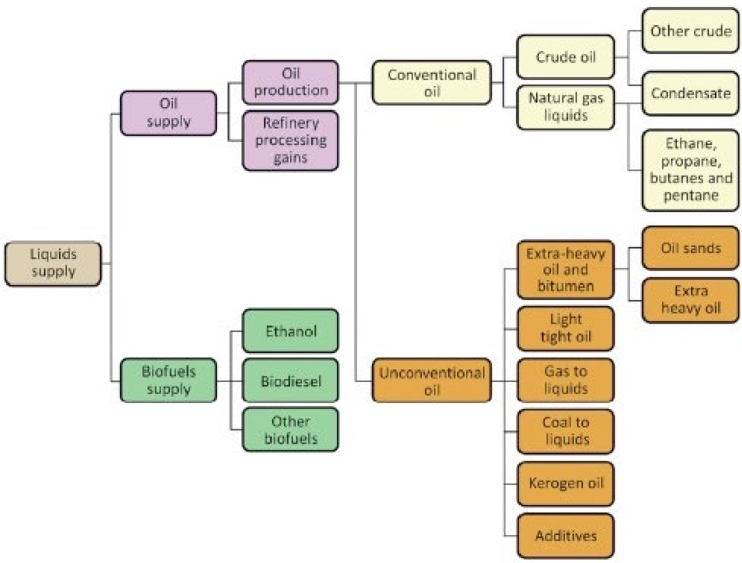


Figure 1. The supply of liquid fuels and the classification diagram of these are used by the International Energy Agency (IEA, WEO 2013).

IV. Some experts use oil density criteria, or API gravity, so as to differentiate conventional from unconventional oils. Thus, all of the oils with API gravity below 20 °, that is, with a density of greater than 0,934 grammes per cubic centimetre, are considered to be unconventional. This category –besides the tar sands mentioned before– would include the so-called extra-heavy oils. Diverse advanced drilling techniques are used that manage to reduce viscosity enough so that the oil can flow to the surface. The greater accumulation of extra-heavy oil is concentrated in the Orinoco Belt in Venezuela.

V. Coal and natural gas liquids (coal-to-liquids or CTL and gas-to-liquids or GTL). This includes synthetic fuels (synfuels) derived from the conversion of the coal or the gas using the Fisher-Tropsch reaction.

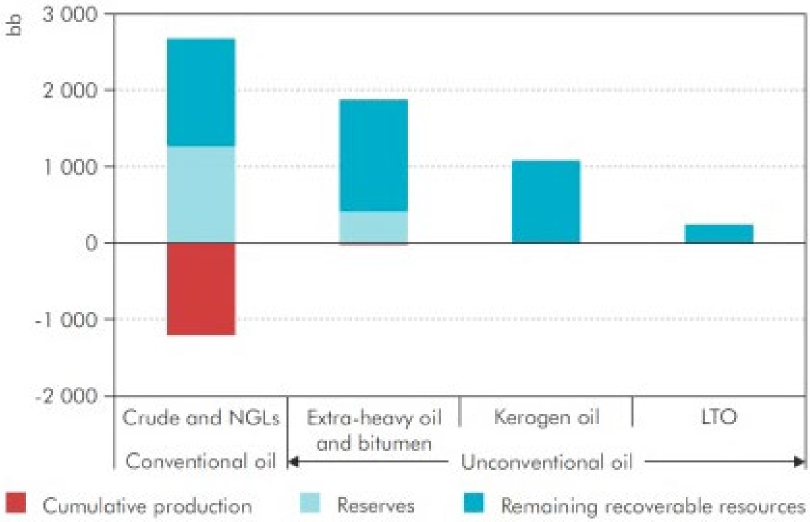


Figure 2. Accumulated production, reserves and resources of oil to be exploited that can be recovered, both conventional and unconventional, at the end of 2011 and on a global scale. Figures in billions of barrels (bb). (IEA, WEO 2012).

Estimate of resources and their production costs (without internalising the CO_2.costs)

At the end of 2011, without including the coal and natural gas liquids (CTL and GTL), the estimates of reserves and resources[3] of unconventional oil that can be recovered were, in general terms, at about 3.2 x 1012 barrels

[3] The proven reserves are those ready to be extracted in a profitable way with the existing ethnology and prices on one particular date, while recoverable resources are estimated volumes that are based upon different hypotheses, waiting for confirmation

(figure 2, table 1). A volume that slightly exceeds that of the conventional oil reserves and resources, although the calculations about unconventional oils are less reliable than that because, in general, the latter have been studied and explored less intensely and there is less experience about how to exploit them. In addition, it is worth being aware that the commercial production of this requires going beyond considerable technical, environmental, political and economic barriers.

	Conventional			Unconventional				Total
	Crude oil	NGLs	Total	EHOB	Kerogen oil	Light tight oil	Total	
OECD	318	99	417	812	1 016	101	1 929	2 345
Americas	253	57	310	809	1 000	70	1 878	2 188
Europe	59	31	91	3	4	18	25	116
Asia Oceania	5	11	16	0	12	13	25	41
Non-OECD	1 928	334	2 261	1 069	57	139	1 264	3 526
E. Europe/Eurasia	352	81	433	552	20	14	586	1 019
Asia	95	26	121	3	4	50	57	178
Middle East	982	142	1 124	14	30	4	48	1 172
Africa	255	52	306	2	0	33	35	341
Latin America	245	32	277	498	3	37	538	815
World	2 245	433	2 678	1 880	1 073	240	3 193	5 871

Note: EHOB = extra-heavy oil and bitumen.

Table 1. Technically recoverable resources of oil to be exploited, by types and regions, at the end of 2011. Figures in billions of barrels (bb). (IEA, WEO 2012).

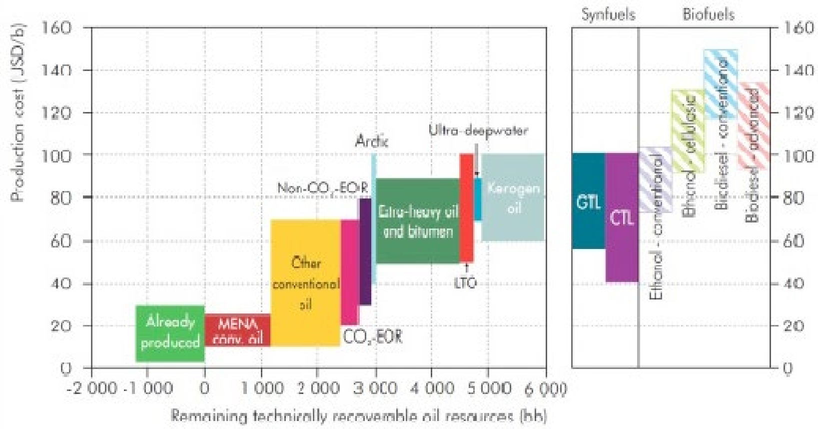
According to the International Energy Agency (IEA, "Resources to Reserves", 2013) the production costs of the nearly 1.2 x 1012 barrels of conventional oil extracted up to now have not exceed 30 dollars. What could be the production costs of other categories of oil resources that are technically recoverable waiting to be exploited?

Figure 3 tries to answer this question in summary form. The potential volume of technically recoverable resources is represented in the horizontal axis[4] as these being exploited in the long-term, other than in the case of synthetic fuels derived from bio-fuels and coal (CTL) and natural gas (GTL), because the former come from the transformation of renewable resources, while the two latter ones are summarised on the basis of

by probes and production tests. This means that the estimates of resources always, by definition, display a high degree of uncertainty.

4 Technically recoverable resources are estimated volumes on the basis of different hypotheses (waiting for confirmation using probes and production tests) and they could be extracted from the subsoil with current technology, leaving aside considerations of an economic nature.

raw materials, coal and gas, which are very plentiful and it is considered that only a small fraction of these will be actually used in the conversion process. The vertical axis informs us about the ranges of costs estimated for the production (exploration, extraction and upgrading) of the end liquid hydrocarbon on the basis of the different categories of resources. It is worth stressing that these costs do not internalise the costs of the CO_2. emissions associated with the production process.



Notes: unless otherwise indicated, all material in figures and tables derives from IEA data and analysis. CO_2 = carbon dioxide; MENA = Middle East and North Africa. "Other conventional oil" includes deepwater. No carbon pricing included. Synfuel resources are difficult to assess due to competition with other natural gas and coal uses. Biofuels are renewable and, in theory, not resource constrained. Biofuels production costs have been credited with a "refiner's margin", using the ratio of gasoline and diesel spot prices in the United States compared to the West Texas Intermediate crude oil price. The ratio was, on average, 1.3 for gasoline and 1.35 for diesel between 2007 and 2012.

Figure 3. Production costs of liquid fuels (in dollars per barrel) and volumes that are technically recoverable in the long-term for some resources of oil, conventional or unconventional (in billions of barrels). (IEA, Resources to Reserves, 2013).

In the case of the conventional oil resources, the IEA study cited (IEA, Resources to Reserves, 2013) makes the following considerations:

I. The entirety of the conventional oil resources and reserves of the Middle East and North Africa can be produced at relatively cheaper costs than in other regions, although the increase in the investments in exploration and production necessary for the development and improving of field that are already mature and these are being translated into certain more expensive production costs than in the past. Conventional oil resources in the Middle East and North Africa amount to 1.12 x 1012 barrels and the production costs are estimated at between 10 and 25 dollars per barrel.

II. Production costs of the resources and reserves of conventional oil from other regions are highly variable. From a technical standpoint, some Russian fields are as easy to exploit as the deposits from the Middle East and North Africa, being placed at the bottom of the production costs band. The top of this would be represented by fields on land or in sea waters (excluding ultra-deep ones) that are technically more complex. Oil resources in this category amounted to 1.22 x 1012 and production costs were between 10 and 70 dollars per barrel.

III. The use of enhanced oil recovery techniques or EOR can achieve up to 0.5 x 1012 barrels of which 0.3 x 1012 barrels could come from techniques based on CO_2.injection and other thermal stimulation techniques (such as steam injection) or chemical ones. The estimated costs for the production using these techniques are highly variable and depend on the specific parameters of each field. These costs range from $ 20 to $ 80 per barrel. The cheapest are those related to CO_2.injection techniques that would be even more competitive if production costs incorporated a price for CO_2. emissions since this technique would benefit from the carbon credits obtained by the net sequestration of CO_2.in the sub-soil.

IV. The recoverable conventional oil in ultra-deep water (more than 1.500 m of water depth) could represent some 0.16 x 1012 additional barrels, with a production cost of 70-90 dollars per barrel.

V. According to the latest estimates from the U.S. Geological Survey, the region north of the Arctic Circle could 90.000 x 106 barrels of crude and further 44.000 x 106 barrels of natural gas liquids, with certain production costs of the order of 40 to 100 dollars per barrel.

In the case of the unconventional resources, the International Energy Agency in its study, assumes the following points:

VI. There is great potential resource of extra-heavy oil and oil sands, with about 1.88 x 1012 barrels, mainly concentrated in Venezuela and Canada, but also in other countries such as Russia and Kazakhstan. Production costs in the new facility, including the "upgrading" of the oil and mitigating the environmental impacts, although no mitigating CO_2.emissions are between the 50 to 90 dollars per barrel mark.

VII. Oil production from kerogen shales and light tight oil or LTO, is still in an early stage of development, except in the U.S. where LTO production has progressed dramatically (see *the LTO revolution started in the U.S. spread to other countries but loses steam from the early thirties*). The estimated cost of future large-scale production is not easy to ascertain. In the case of kerogen oil, such costs could be around 40-100 dollars per barrel and technically recoverable resources could reach 1.07 x 1012 barrels. The technically recoverable LTO resources are at the figure of around 0.24 x 1012 barrels and production costs are at between 60 and 100 dollars per barrel.

VIII. The technologies for the production of synthetic fuels from coal (CTL) and natural gas (GTL) are based primarily on the Fischer-Tropsch reaction, so this means that the main costs to consider are those associated with the construction of the installation and the costs of the raw material used in the conversion process. It is estimated that the production costs of CTL range from $ 45 to $ 105 per barrel of oil equivalent (boe). If only 10% of the world's resources of coal and lignite was used in this process, up to 4.5 x 1012 barrels could be obtained, which is the equivalent of synthetic fuel oil. In the case of GTL production costs in the most modern plants, these range from $ 60 to $ 105 per boe and if 20% of the global resources of natural gas are used as a raw material, this could result in obtaining up to 1,7 x 1012 barrels of synthetic fuel oil equivalents.

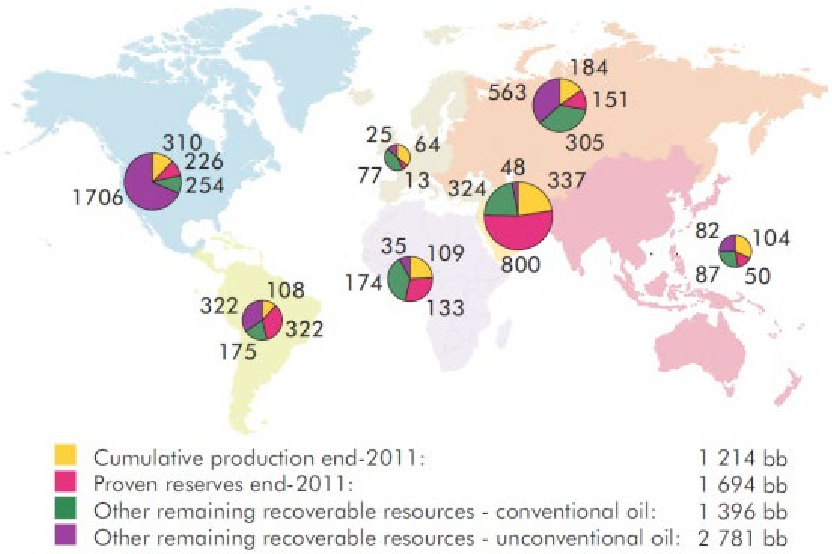


Figure 4. The oil in the world in 2012. Regional distribution of cumulative production, proven reserves and recoverable resources by exploiting both conventional and unconventional.Figures in billions of barrels (bb). (IEA, Resources to Reserves, 2013).

Geographical distribution of the resources. The unconventional ones as a counterbalance to the Middle East

As shown in table 1, without accounting for resources of coal derived liquids (CTL) and natural gas (GTL), the industrialized countries of the OECD, only hoard 15.6% of the total resources of technically recoverable oil and natural gas liquids, containing 62% of unconventional oil resources. The figures also show that unconventional resources that are recoverable as recorded in late 2011 (table 1, figures 4 and 5) are preferably located in North America, Eastern Europe-Eurasia and Latin America, thereby counteracting the importance of the geopolitics of the Middle East, a region that accounts for 42 % of the reserves and resources of conventional oil The production and development of unconventional oils is more advanced in North America, which may be explained in part because current estimates attribute the highest volume of resources to this region. However, it is possible that in the future other, regions that have so far received little attention for their large conventional resources such as the Middle East and Africa, will look in the future to significantly increase their estimates of unconventional resources.

I. Extra–heavy oil and tar sands: these categories of unconventional oil are preferably located in Venezuela (in the so-called Orinoco Belt) and Canada, respectively. The amount of in-situ oil of the oil sands of Canada is estimated at 1.845 x 1012 barrels of which 0.8 x 1012 barrels could be recovered (IEA, WEO 2010).

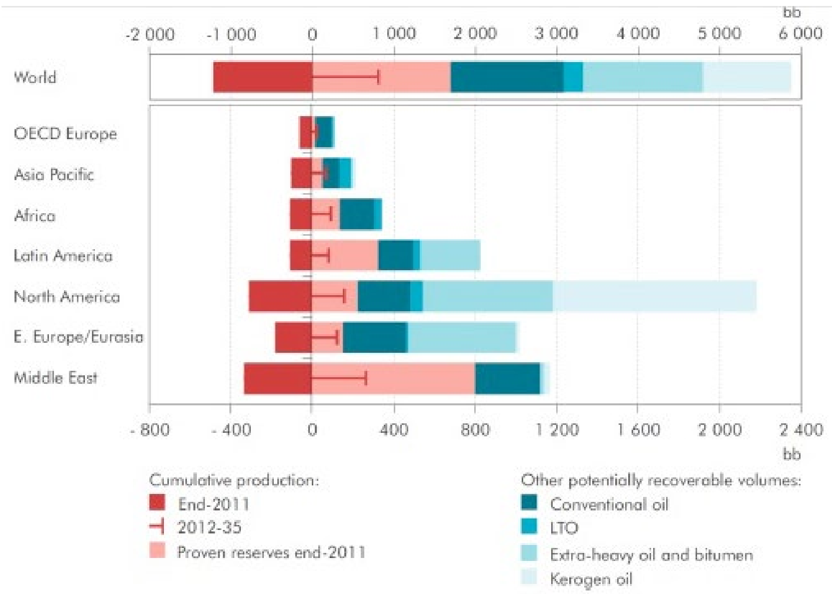


Figure 5. Cumulative production, proved reserves and potentially recoverable oil resources by type and by region, in the New Policies Scenario (IEA, WEO 2012).Figures in billions of barrels (bb).Note the different scales for the world (above) and regions (bottom).

With regard to extra-heavy oil, we would be talking about around 1.36 x 1012 barrels in situ, with nearly 0.5 x 1012 recoverable barrels (USGS, 2009). In addition to Venezuela and Canada, it is believed that there are significant resources of the two types of unconventional oil analysed in Russia and Kazakhstan, as well as more modest volumes in Angola, Azerbaijan, China, Madagascar, Middle East, UK and the U.S, which taken together could mean a further 0.6 x 1012 recoverable barrels. Apart from Canada and Venezuela, the forecasts of the International Energy Agency (WEO 2013) the horizon 2035, including some production only in Russia (Tatarstan) and China, countries in which production projects or plans are already well advanced.

II. Light tigh oil or LTO: in recent years the exploitation of such unconventional oil has reached a commercially significant scale, particularly in the prospecting parts of Bakken and Eagle Ford in the U.S. In this country, the government agency Energy Information Administration (U.S. IEA) recently estimated the resources at some 58.000 x 106 LTO barrels, well above that estimated in 2012, which is 32.000 x 106 barrels (U.S. IEA, 2013B). And as more data become available, this review might not be the last one. The IEA (IEA, WEO 2012) estimated that nearly 240.000 x 106 barrels of the world's resources in LTO are technically recoverable and other private consultants talk about a figure of between 100,000 and 600,000 x 106 barrels. In June 2013, the USIEA published a study (U.S. IEA, 2013a) on a large number of sedimentary basins in the world, estimating that the technically recoverable resources of LTO could approximate 350.000 x 106 barrels, distributed mainly among Russia, USA, China, Argentina, Libya, Australia, Venezuela, Mexico, Pakistan and Canada (see table 2 for details).

Country	Areas assessed	Technical recoverable LTO resources
Russia	Bazhenov shale	76
United States	Bakken, Bone Springs, Eagle Ford, Granite Wash, Niobrara, Spraberry, Wolfcamp, Monterey and Woodford shales	58
China	Sichuan, Yangtze, Jianghan, Greater Subei, Tarim, Junggar and Songlia basins	32
Argentina	Neuquen, San Jorge, Magallanes and Parana basins	27
Libya	Ghadames, Sirte, and Murzuq basins	26
Australia	Cooper, Maryborough, Perth, Canning, Georgina, and Beetaloo basins	18
Venezuela	Maracaibo basin	13
Mexico	Burgos, Sabinas, Tampico, Tuxpan and Veracruz basins	13
Pakistan	lower Indus basin	9
Canada	Horn River, Cordova, Liard, Deep, Alberta, Windsor basins, Duvernay, Bakken, Utica shales	9

Source: US EIA (2013a).

Table 2. Top ten countries in light oil resources of compact rocks. (Light tight oil or LTO). Figures in billions of barrels. (IEA, WEO 2013).

III. Kerogen shales or oil shales currently, oil from kerogen (kerogen oil) is produced in very small quantities in Estonia, China and Brazil. Kkerogen shale is easier to exploit through mining techniques are those that are near the surface, but deeper accumulations by injecting hot water into the subsurface can also be exploited. The first type of resources are enormous. The largest known to date are located in parts of Utah, Colorado and Wyoming in the U.S. These, which have been studied in detail by the U.S. Geological Survey (USGS), could contain some resources equal to 4.285 x 1012 barrels oil, of which just under a quarter corresponds to deposits that most likely to be commercially exploitable (USGS, 2012). Worldwide, the existing resources in geological formations of kerogen shales near the surface could reach at least a minimum of 1.1 x 1012 barrels. Apart from the USA, other resources are found in Jordan (30.000 x 106 barrels), Australia (12.000 x 106 barrels), Estonia and China (4.000 x 106 barrels each) and Israel, Morocco and Brazil (with nearly 3.000 x 106 barrels each). Australia had planned to undertake a big project in "the Stuart Shale" training in the 90's, but this was abandoned, mainly due to environmental considerations. This same country has recently approved a new pilot scheme with the initial goal of producing 40.000 barrels a day. Currently, Jordan, Israel and Morocco have a number of projects under consideration at the study phase.

IV. Coal-to-liquids or CTL: coal resources that are the raw material for this process are very broad and, in fact, using only 10% of proven reserves in the world would obtain 275.000 x 106 barrels of liquid hydrocarbons. Clearly, the coal resources available do not constitute any limitation on the development of the CTL techniques. In all likelihood, countries like China and India with large coal resources that are extractable at a relatively low cost, and they are highly dependent on oil imports will lead the investments in this technology, which already has extensive operational experience in South Africa. China has announced plans to produce to 600.000 barrels a day of synthesized fuels using CTL technology in 2020. However, environmental concerns, including emissions and access to water, together with spiralling costs, have led the Chinese government to impose stricter standards for the construction and operation of CTL plants. In the U.S., they have announced several CTL projects totalling more than 300.000 barrels a day, but these projects are still under study. Australia and Indonesia are also interested in developing this industry

V. Gas-to-liquids or GTL: untapped resources of recoverable natural gas, the raw material capable of being transformed into liquid hydrocarbons by GTL technology are around 810 x 1012 cubic metres (see the section on *Estimating resources and production* *costs (without internalizing the costs of CO_2..* The transformation of 10% of this volume by GTL technology could yield 280,000 x 106 barrels liquid hydrocarbons. Currently, three countries, Qatar, South Africa and Malaysia, monopolize most of the existing production capacity in the world from the GTL technology. These could be joined by the U.S. and Nigeria.

Oil production between 2012 and 2035. Non-conventional as a temporary alternative to the hegemony of OPEC and the Middle East

Oil production has already peaked. Unconventional oil gains prominence

In his scenario New Policies (IEA, WEO 2013) the International Energy Agency (IEA) forecasts that world oil supply will increase gradually from 89.2 x 106 barrels per day (bd) in 2012 to 101.4 x 106 bd in 2035. The aim of this growth in supply is to cope with increased demand that focuses exclusively on the transport sector in countries outside the OECD, with China itself grabbing about half of the increase commented on.

Moreover, the IEA expects total conventional oil production will fall slightly over the period 2012-2035, from about 69 x 106 to 65 x 106 bd [5]. This means that the share of total conventional crude oil production will fall from 80% today to 65% in 2035 (figure 6). That is to say, the growth in production necessary to meet the demand must come from other sources.

Among these, the forecasts are that the production of natural gas liquids is to grow about 40% to about 18 m db in 2035, so this date would represent around 20% of global oil production.

Another source of production growth is unconventional oil, whose contribution would increase from 5 x 106 bd in 2012 to 15 x 106 bd in 2035 (figure 7). These mainly come from unconventional supplies of light oil from compact light tight oil or LTO in the U.S., the oil sands of Canada and the extra-heavy oil of Venezuela. Between 2020 and 2035, rapid growth, mainly in Qatar and North America, the production of synthetic fuels deriving from natural gas (gas-to liquids or GTL) is also expected, as well as the production of liquid hydrocarbons from coal (coal-to liquids or CTL), mainly in China, but also to a lesser extent in South Africa, Australia, Indonesia and the U.S. With respect to oil deriving from kerogen shales or oil shales, despite the broad base of resources available, their production would remain marginal due to their high costs and environmental impacts.

5 A projection that should not go unnoticed because it is equivalent to saying that conventional crude oil production has practically reached its peak (“peak oil”).

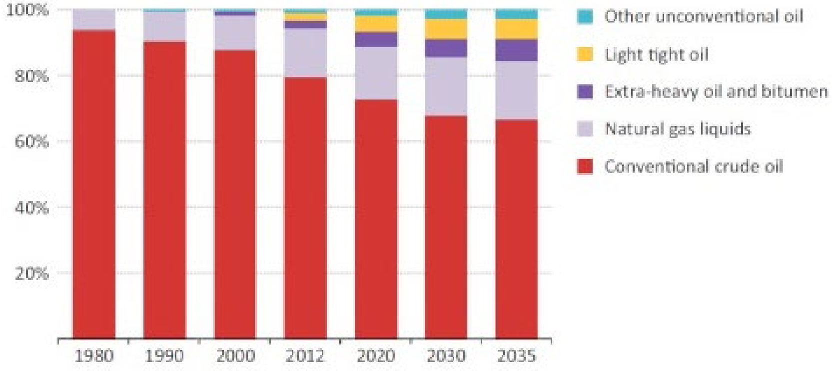


Figure 6. Percentage share of different types of oil, conventional and unconventional, in global production. New Policies Scenario (IEA, WEO 2013).

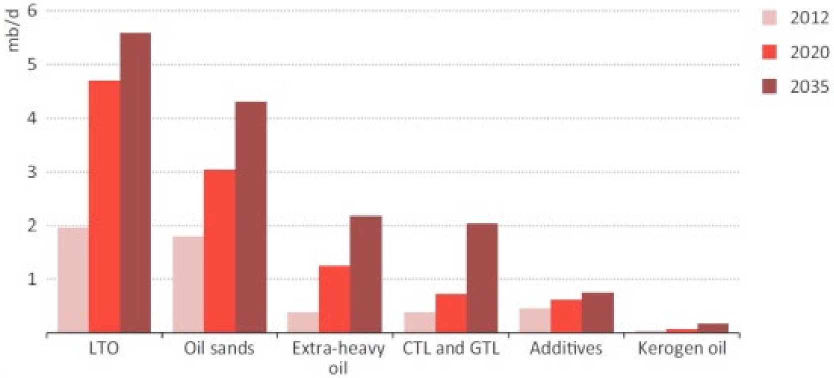


Figure 7. Projected growth in the production of various types of non-conventional oil. Figures in millions of barrels per day (mb / d). New Policies Scenario (IEA, WEO 2013).

The production from the non-OPEC countries increases until the late twenties and it then stagnates and declines.

In the New Policies Scenario of the IEA (IEA, WEO 2013) the oil production of all non-OPEC countries will maintain its upward trend experienced in recent years. It will then stagnate and subsequently start to decline in the late twenties, but in 2035, the production of this group of countries still exceeded that for 2012 by some 3.5 x 106 barrels per day (bd). In percentage terms, the share of the countries outside the cartel in global oil production would increase from 57% in 2012 to 59% in 2020, and lose ground gradually until 54% in 2035 (table 3).

During the first half of the period 2012-2035, both the production of conventional oil and the unconventional one, will increase, but the first peaks shortly before 2020, and it then declines a few years after that in such a way that even the increased production of non-conventional oil cannot reverse the downward trend. In fact, the total oil production between 2012 and 2035 falls in most countries non-OPEC, with the exception of Brazil, Canada, Kazakhstan and the U.S., although the production of the latter goes into decline by 2035. Table 3 summarizes the details of the report remarked upon.

	1990	2012	2020	2025	2030	2035	2012-2035	
							Delta	CAAGR*
OECD	**19.0**	**19.9**	**23.2**	**23.1**	**22.8**	**22.4**	**2.5**	**0.5%**
Americas	13.9	15.9	19.3	19.8	19.9	19.6	3.8	0.9%
Canada	2.0	3.8	5.0	5.3	5.7	6.1	2.3	2.1%
Mexico	3.0	2.9	2.7	2.6	2.6	2.6	-0.3	-0.4%
United States	8.9	9.2	11.6	11.8	11.5	10.9	1.7	0.7%
Europe	4.3	3.5	3.1	2.6	2.2	2.0	-1.5	-2.3%
Asia Oceania	0.7	0.6	0.7	0.7	0.7	0.7	0.2	1.1%
Non-OECD	**22.7**	**29.5**	**31.9**	**32.0**	**31.4**	**30.6**	**1.0**	**0.2%**
E. Europe/Eurasia	11.7	13.8	13.7	13.7	13.9	14.2	0.4	0.1%
Kazakhstan	0.5	1.6	1.9	2.5	3.2	3.7	2.1	3.6%
Russia	10.4	10.7	10.4	9.9	9.6	9.4	-1.3	-0.6%
Asia	6.0	7.8	7.7	7.4	6.8	6.0	-1.8	-1.1%
China	2.8	4.2	4.4	4.3	4.1	3.4	-0.8	-0.9%
India	0.7	0.9	0.8	0.7	0.7	0.6	-0.3	-1.7%
Middle East	1.3	1.5	1.3	1.1	1.0	0.9	-0.6	-2.2%
Africa	1.7	2.3	2.9	2.6	2.3	2.1	-0.2	-0.4%
Latin America	2.0	4.2	6.2	7.2	7.4	7.4	3.2	2.5%
Brazil	0.7	2.2	4.1	5.4	5.8	6.0	3.8	4.5%
Total non-OPEC	**41.7**	**49.4**	**55.0**	**55.1**	**54.2**	**52.9**	**3.5**	**0.3%**
Non-OPEC market share	*64%*	*57%*	*59%*	*58%*	*56%*	*54%*	*n.a.*	*n.a.*
Conventional	**41.3**	**45.0**	**46.2**	**44.6**	**42.6**	**40.7**	**-4.3**	**-0.4%**
Crude oil	37.6	38.4	38.3	36.4	34.3	32.3	-6.1	-0.7%
Natural gas liquids	3.6	6.6	8.0	8.1	8.3	8.3	1.7	1.0%
Unconventional	**0.4**	**4.4**	**8.8**	**10.5**	**11.7**	**12.3**	**7.9**	**4.6%**
of which:								
Canada oil sands	0.2	1.8	3.0	3.3	3.8	4.3	2.5	3.9%
Light tight oil	0.0	2.0	4.7	5.7	5.8	5.5	3.6	4.6%
Coal-to-liquids	0.1	0.2	0.4	0.7	0.9	1.2	1.0	8.3%
Gas-to-liquids	0.0	0.1	0.1	0.2	0.3	0.4	0.4	9.9%

* Compound average annual growth rate.

Table 3. Oil production in non-OPEC countries. Figures in millions of barrels per day. New Policies Scenario (IEA, WEO 2013).

Within this overall picture, it is of particular interest to note that the decline in oil production in Europe started long ago, continued during the 2012-2035 period. In 2012, the countries in the old continent that had been integrated into the OECD experienced a drop in oil production of some 300.000 bd, reaching a total of around 3.5 x 106 bd. The latter volume is that which shows itself to be 3.3 x 106 bd lower than the peak reached in the year 2000.

The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties

In the U.S., oil production from light tight oil or LTO by hydraulic fracturing fracking techniques has gone from almost non-existent in 2005 to 2.3 x 106 barrels per day bd up to mid-2013. This is a complete success for the industry of the country, coupled with the increased production of shale gas (see the sections on: *Geographical Distribution of Unconventional gas resources as a counterweight to the Middle East and Russia* and *Natural gas production between 2012 and 2035. The unconventional gas revolution expands beyond the U.S. and Canada)*, is having a profound impact internationally. Given this, reality we can ask about the prospects for the success we remarked on to continue, as well as the production potential of LTO in other parts of the world, particularly in countries for which the U.S. Energy Information (U.S. IEA, 2013a) estimated there would be great potential, such as Canada, Russia, Argentina, China and Australia, among others (see Table 2).

According to the IEA (IEA, WEO 2013), it appears that America, i.e., the USA, with a small degree of participation from Canada will continue to dominate global LTO production (figure 8). Elsewhere in the world, the IEA also predicts that many countries are seeking to replicate U.S. success, so that in 2035 production in Russia could reach 450.000 barrels per day (bd), while in Argentina it could reach about 220.000 bd and 210.000 bd in China. However, most likely, in other countries production will barely be the order of several tens of thousands of barrels a day, reflecting the regulatory barriers and the absence of an innovative and competitive atmosphere in its exploration and production sector, which would keep the extraction costs above conducive towards attracting significant investment levels.

The IEA forecasts (IEA, WEO 2013) show that the LTO production in all the areas in use in the U.S. will maintain their upward trends until 2025, and then thereafter, in the following five years, stabilise at around 4.3 x 106 bd, before starting a gentle descent which runs until 2035 and beyond (Figure 8). This decline would be the result of the increasing difficulty in identifying new drilling opportunities in the most prolific reservoir zones, thereby shifting the activity to the less productive areas and also due to increased competition in terms of cost of the LTO production in other parts of the world.

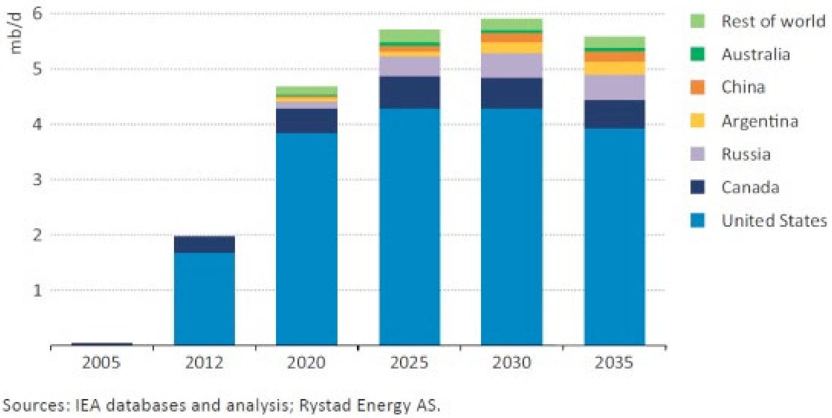


Figure 8. Light oil production light tight oil or LTO in several key countries (see Table 3). Figures in millions of barrels per day (mb / d). New Policies Scenario (IEA, WEO 2013).

The IEA warns that, in reality, it is still too early to reliably predict the course of the LTO production curve LTO in the U.S., a country that is used to overcoming its challenges in production and which could still discover more resources that will help to keep production at higher levels and for longer than is expected. This is one possibility that does not seem to be remote if oil prices remain high, technological advances continue at the same rate as they have done to date and environmental concerns dissipate.

In any case, neither does the IEA hide a number of risks that could vary its forecast for U.S. LTO production downwards. Firstly, extraction might be more difficult in some of the new prospecting areas, and more expensive than was experienced in other areas such as prolific the Bakken (North Dakota) or Eagle Ford (Texas). For example, the shales deposits of Utica (Ohio) which were initially considered to be very promising, turned out to be good for the extraction of gas but not for LTO (possibly because the oil trapped in the rock does not move). The production could also be affected by limitations in the supply chain or refining infrastructure, although both factors would bring about a delay rather than a complete shutdown of the process. Moreover, it must be remembered that there, as in the case of the exploitation of shale gas, there are widespread social and environmental concerns regarding the use of the hydraulic fracturing (or fracking) technique and if we would like to avoid problems in the exploration and production business, these concerns should be properly addressed and resolved. Finally, it cannot completely rule out the possibility of a fall in oil prices adversely affecting the economic viability of extraction. Most estimates range between 60 and 80 dollars per barrel, which is the equilibrium price for LTO production in the U.S., so that it would be enough for there to be a relatively modest drop as compared to today's prices that brings it near to the upper limit of that range.

							2012-2035	
	1990	2012	2020	2025	2030	2035	Delta	CAAGR*
Middle East	16.4	26.7	27.3	29.2	31.1	33.6	6.9	1.0%
Iran	3.1	3.5	3.3	3.6	3.8	4.2	0.7	0.8%
Iraq	2.0	3.0	5.8	6.7	7.3	7.9	4.9	4.3%
Kuwait	1.3	3.0	2.4	2.5	2.7	2.9	-0.1	-0.1%
Qatar	0.4	2.0	2.0	2.2	2.4	2.6	0.6	1.1%
Saudi Arabia	7.1	11.7	10.6	10.9	11.4	12.2	0.5	0.2%
United Arab Emirates	2.4	3.5	3.3	3.3	3.5	3.7	0.3	0.3%
Non-Middle East	7.5	11.0	10.5	10.7	11.2	11.6	0.6	0.2%
Algeria	1.3	1.8	1.7	1.7	1.7	1.8	0.1	0.1%
Angola	0.5	1.9	1.6	1.5	1.4	1.4	-0.4	-1.2%
Ecuador	0.3	0.5	0.4	0.3	0.3	0.3	-0.2	-2.3%
Libya	1.4	1.5	1.6	1.7	1.8	1.9	0.4	1.1%
Nigeria	1.8	2.6	2.4	2.5	2.6	2.8	0.2	0.3%
Venezuela	2.3	2.7	2.8	3.0	3.3	3.3	0.6	0.9%
Total OPEC	23.9	37.6	37.8	39.9	42.2	45.2	7.5	0.8%
OPEC market share	*36%*	*43%*	*41%*	*42%*	*44%*	*46%*	*n.a.*	*n.a.*
Conventional	23.9	37.0	36.2	37.9	39.7	42.4	5.3	0.6%
Crude oil	21.9	30.9	29.4	30.1	31.2	33.0	2.1	0.3%
Natural gas liquids	2.0	6.1	6.8	7.8	8.5	9.3	3.2	1.9%
Unconventional	0.0	0.6	1.6	2.0	2.5	2.8	2.2	6.9%
of which:								
Venezuela extra-heavy	0.0	0.4	1.2	1.5	1.9	2.1	1.7	7.5%
Gas-to-liquids	0.0	0.1	0.2	0.3	0.4	0.4	0.3	5.1%

* Compound average annual growth rate. Notes: Data for Saudi Arabia and Kuwait include 50% each of production from the Neutral Zone.

Table 4. Oil production in OPEC countries. Figures in millions of barrels per day.New Policies Scenario (IEA, WEO 2013).

Middle East grows in significance in OPEC. Venezuela maintains its position thanks to extra-heavy oils.

As regards OPEC (table 4 and figure 9), the New Policies Scenario of the IEA (IEA, WEO 2013) concludes that most of the increased production will come from the Middle East (Saudi Arabia, Iran, Iraq, Kuwait, Qatar and the United Arab Emirates) which together in 2035, have experienced an increase that contrasts with the 7 x 106 barrels per day (bd) as compared to the 2012 levels. This is an increase that contrasts with the roughly 0.6 x 106 bd for all of the other countries of the cartel (Algeria, Angola, Ecuador, Libya, Nigeria and Venezuela). The subsurface of the Middle

East hosts the largest number of conventional resources and, usually, it involves the development of the lowest costs in the world due to its favourable geology and existing infrastructure.

The WEO 2013 considers (table 4 and figure 9) that natural gas liquids are the major contributor to the growth in OPEC production, accounting for nearly 3 x 106 db, a volume that widely outstrips the 2.1 x 106 bd provided by conventional crude. From the point of view of non-conventional oil, we should stress the role envisaged by the extra-heavy oil in Venezuela, whose production would increase by about 1.7 x 106 bd during the 2012 to 2035 period. Also, within the field of non-conventional products, the IEA estimates a growth in the contribution of liquids derived from natural gas (GTL) near to 0.3 x 106 bd from the Qatar and Nigeria plants.

Ten-years ahead, OPEC will again occupy a key position and the Middle East will stand as the only source of cheap oil.

From the discussion in the preceding paragraphs, it is clear that until the early twenties, the global oil market could be seen to be less dependent on OPEC, to the extent that the production from some countries outside the cartel would be sufficient to deal with much of the increased demand expected for the 2012-2020 period.

Note: Share of OPEC is for the end of the interval shown, *i.e.* for 2012 in the first column, for 2015 in the second, and so on.

Figure 9. Changes in global oil production and participation percentages: OPEC vs. non-OPEC. The figures on the left in millions of barrels per day (mb/d).New Policies Scenario (IEA, WEO 2013).

This is a fact that can be explained by the new resources made commercially viable by means of the technological innovation undergone in the field of exploration and production. Two prominent examples of this trend are unconventional oil production and the expansion of the production of conventional oil in deep ocean waters. Thus, the blurring of OPEC's role that is expected in the medium term, would be based on the rapid growth of oil production in low permeability rocks (LTO) in the U.S., increasing the contribution of oil sands in Canada, in the oil extraction from off the Atlantic coast of Brazil and in obtaining natural gas liquids (GTL) in various parts of the world.

In any case, the IEA warns that the situation discussed will be a temporary phenomenon and that, from the mid-twenties onwards, OPEC will occupy a key position in the global oil supply. From that date to 2035, the production in the ultra-deep waters of Brazil and of LTO in the U.S. will lose steam, and the Middle East will stand as the only source of relatively cheap oil in the world and Iraq will become the largest contributor to overall output growth.

In summary, as shown in Figure 9, the IEA (IEA, WEO 2013) finds that OPEC's percentage share in world oil production will fall by an average of 43% in 2012, to something a little over than 40% in 2015. Then, after five years of relative stability, this will climb up to 44% on average in 2030 and eventually reach 46% in 2035.

Certainly, in the light of these data, it would be unwise to send wrong messages to the producing countries of the Middle East, in the sense that, given the expected increase in the production of unconventional oil in some countries outside OPEC (see table 3 and figure 10), the industrialized countries will increasingly need their oil. This is a statement that, as well as being false, could encourage the investor passivity of those countries, which may neglect its efforts to increase their production capacity, which would have very negative consequences for global oil supply in the medium term.

Iraq, Brazil, Canada, Kazakhstan, USA and Venezuela will be key in ensuring global supplies

The developments in oil production (conventional and unconventional) provided by the IEA for some of the major producing countries during the period 2012 to 2035 (New Policies Scenario, IEA, WEO 2013) are summarized in Figure 10.

With regard to conventional oil, we can highlight the large increases in daily oil production that are expected in the case of Iraq, Brazil and Kazakhstan, as well as increased the production of natural gas liquids in Russia, Qatar, Saudi Arabia Kazakhstan, United Arab, Brazil, Iraq, Azerbaijan, Kuwait, Venezuela, Argentina and Oman. From a negative perspective, we should emphasise the large declines in oil production in Russia, China, Venezuela and the U.S., with more moderate declines in Norway, the UK, Oman, Canada, Azerbaijan, Argentina, Kuwait, Saudi Arabia and Qatar. In the case of the production of natural gas liquids, the falls in production falls are confined to OECD countries such as Canada, the USA, the UK and Norway.

As for unconventional oil, the IEA forecasts huge growth in the production of light tight oil or LTO in the U.S. and to a much lesser extent, in Russia, China, Canada and Argentina. The Canadian oil sands and the extra-heavy oil in Venezuela also contribute significantly towards the growth in world production of unconventional oil, which likewise would be further supplemented by other, less significant contributions from China, Saudi Arabia and Qatar.

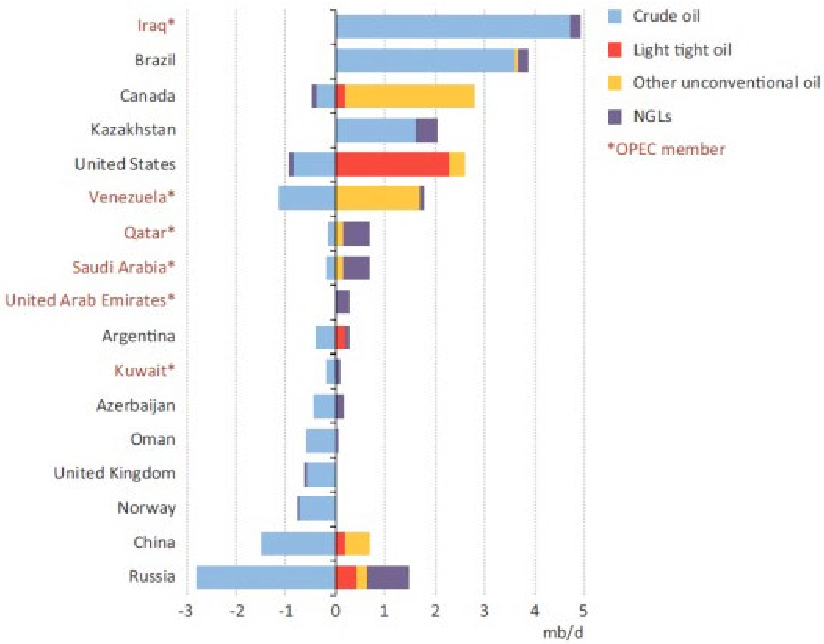


Figure 10. Changes in oil production, by types, in some key countries in the 2012-2035 period. Figures in millions of barrels per day (mb/d).New Policies Scenario (IEA, WEO 2013).

Overall, considering both conventional and non-conventional oils, the balance of production during the period 2012-2035, is clearly favourable to Iraq, Brazil, Canada, Kazakhstan and the U.S., while at the opposite end would be located Russia, China, Norway, UK, Oman, Azerbaijan, followed distantly by Argentina and Kuwait. Moreover, Venezuela, Qatar, Saudi Arabia and the United Arab Emirates would remain at an equilibrium position.

Uncertainties. The case of Iraq as an example.

From the discussion in the preceding paragraph and from looking a figure 10, which shows the evolution of the production during the 2012 to 2035 period for a number of key countries in the oil market, we can see the huge importance that the IEA (IEA, WEO 2013) grants to Iraq, Brazil and Kazakhstan in the conventional crude oil production, as well as Canada, USA and Venezuela in unconventional oil. However, we must not forget the great uncertainties underlying this forecast. These have already been briefly discussed in section: *"The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties",* regarding the future production of light tight oil or LTO in the U.S. Another interesting example to consider is the case of Iraq.

According to the IEA (IEA, WEO 2012) Iraq, the world's seventh largest exporter and the fifth largest OPEC producer in 2011 - could double production by the end of this decade, reaching 6.1 x 106 barrels per day (bd), and then go on to reach 8.3 x 106 bd in 2035. In the less optimistic case (Central Scenario) that the said report provides, another scenario (Optimum Case) is contemplated, in which the previous two figures become 9 x 106 and 10.5 x 106 bd in 2020 and 2035, respectively. We are talking about certain volumes at the end of the period considered would allow Iraq to contest and even in the most favourable scenario, make sure that it is the second-ranked producer, ahead of Russia and immediately behind Saudi Arabia.

The main uncertainties that could mean that the IEA forecasts are not met have nothing to do with sub-soil or geology, but with so-called "surface factors." Apart from the chronic political instability in the Middle East and the sectarian conflict, often violent, between the Shia and Sunni communities, such factors include: tensions over the exploitation of existing oil resources between Baghdad and the Kurdistan Regional Government, the corruption and bureaucracy that make it hard for foreign oil companies operating in the country to achieve their targets and finally the OPEC quotas system- which Iraq is currently exempt from- ends up being applied, which would limit production.

The world does not care about expectations about Iraq being frustrated. The increased oil production expected in this country between 2012 and 2035 could, depending on the scenario considered, cover about 40-57% of the growth in world demand during the same period. Without such action, the global oil market would go through a very complicated situation, with supply constraints, high prices and extreme volatility that would harm the global economy. In the Central Scenario, the IEA (IEA, WEO 2012) predicted that a price of a barrel of oil would stand at around $ 125 (2011) in 2035. If Iraq fails, this amount would have to add at least $ 15 more, as a minimum.

The reorganization of the global trade in oil between 2012 and 2035. Its implications for the security of global supply

The new geography of demand. Decline in the OECD, growth in Asia and the Middle East

In the New Policies Scenario of the IEA (IEA, WEO 2013) oil demand grows from 87.4 x 106 of barrels per day (bd) in 2012 to 101.4 x 106 bd in 2035, although the rate of increase gradually slows, from an average annual increase of 1 x 106 bd during the 2012-2020 period, to another one of 0.4 x 106 bd in the course of the 2020-2035 period. This slowdown mainly follows the new efficiency policies and changing types of fuels in the industrialized countries of the OECD, which would experience a significant decline in oil demand (figure 11, table 5). As a result, in 2035, the percentage share of OECD countries in global oil demand falls to about 32%, as compared to 46.6% in 2012.

In China, however, the use of oil suffers an increase of nearly 6 x 106 bd, reaching 15.6 x 106. This means that, from 2030, the country will moved ahead of the U.S. as the chief global consumer. India also emerges as a key oil consumption centre, especially between 2020 and 2035, during which the country will experience the highest growth in global demand.

A relevant issue from a geopolitical perspective is that the Middle East (figure 11, table 5) will become the third largest centre of oil demand, reaching approximately 10 x 106 bd in 2035. According to the IEA (IEA, WEO 2013) this increase in consumption is going to be driven by a rapid increase in its population and the generous oil subsidy policy applied by its governments (about $ 520 per person in 2012). By sector, the growth demand is concentrated in transportation and petrochemicals, while the use of oil for electricity generation falls to the extent that the high cost ($ 200 per megawatt hour) of this makes other technologies competitive.

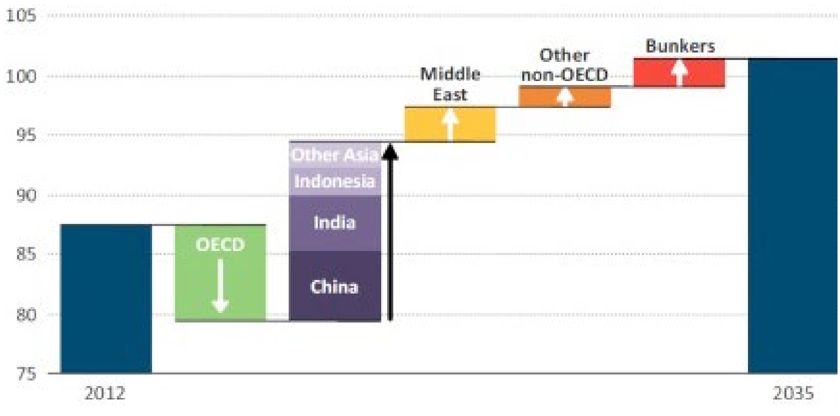


Figure 11. Growth in global oil demand by region. Figures in millions of barrels per day (mb/d): New Policies Scenario (IEA, WEO 2013).

Globally, the IEA expects that oil consumption is going to be concentrated in two sectors during the 2012-2035 period: transport, where the use of oil grows by nearly 12 x 106 bd up to a volume of about 60 x 106 bd in 2035, and that for petrochemicals, which for the same date would have experienced growth of about the 3 x 106 bd, standing at around 14 x 106 bd. According to the WEO 2013, improvements in efficiency would contribute significantly towards reducing the growth in oil demand, while the alternative fuels to this would gain some ground, particularly in the sea and road transport, in which the percentage share of natural gas as a fuel would reach 5.6%, as compared to 3.8% today.

The balance between production and demand. Imports move from the OECD to Asia. Unconventional fuels make North America a net exporter

According to the IEA (WEO 2013), in the next two decades, the changing geography of oil production and consumption (see the sections on *Oil production between 2012 and 2035. Unconventional fuels as a temporary alternative to the hegemony of the OPEC and the Middle East* and *the New Geography of demand. Decline in the OECD, growth in Asia and the Middle East*). Will lead to a dramatic reorganization of global trade, with implications in international cooperation as regards supply security. In this sense, the figures for net oil imports by region for the 2012-2035 period (figure 12) are very illustrative of how the fate of the global oil trade is shifting its centre of gravity from the OECD countries to the large emerging economies of Asia.

	2000	2012	2020	2025	2030	2035	2012-2035	
							Delta	CAAGR*
OECD	44.6	40.8	39.4	37.3	34.9	32.8	-8.0	-0.9%
Americas	22.7	21.3	21.9	20.8	19.6	18.4	-2.9	-0.6%
United States	18.7	17.1	17.5	16.4	15.1	14.0	-3.1	-0.9%
Europe	13.7	11.7	10.9	10.2	9.4	8.9	-2.9	-1.2%
Asia Oceania	8.2	7.8	6.7	6.3	5.9	5.5	-2.2	-1.5%
Japan	5.3	4.7	3.6	3.3	3.0	2.8	-1.8	-2.2%
Non-OECD	26.5	39.6	48.3	52.3	55.8	59.2	19.6	1.8%
E. Europe/Eurasia	4.2	4.7	5.1	5.2	5.3	5.4	0.7	0.6%
Russia	2.6	2.9	3.1	3.1	3.2	3.2	0.3	0.4%
Asia	11.5	19.3	24.8	27.6	30.1	32.5	13.2	2.3%
China	4.7	9.6	12.9	14.1	15.0	15.6	6.0	2.1%
India	2.3	3.6	4.7	5.7	6.9	8.1	4.5	3.6%
Middle East	4.3	6.9	8.2	8.7	9.3	9.9	2.9	1.6%
Africa	2.2	3.4	4.0	4.2	4.4	4.6	1.2	1.3%
Latin America	4.2	5.3	6.2	6.5	6.7	6.9	1.5	1.1%
Brazil	1.8	2.4	2.9	3.1	3.3	3.4	1.0	1.6%
Bunkers**	5.2	7.0	7.8	8.3	8.8	9.3	2.4	1.3%
World oil	76.3	87.4	95.4	97.8	99.5	101.4	14.0	0.6%
European Union	n.a.	10.9	9.9	9.1	8.3	7.7	-3.2	-1.5%
World biofuels***	0.2	1.3	2.1	2.7	3.4	4.1	2.8	5.0%
World total liquids	76.5	88.7	97.6	100.5	102.9	105.5	16.8	0.8%

* Compound average annual growth rate. ** Includes international marine and aviation fuels. *** Expressed in energy-equivalent volumes of gasoline and diesel.

Table 5. Oil demand by region. Figures in millions of barrels per day.New Policies Scenario (IEA, WEO 2013).

Thus, the net import requirements of the Asian countries that are not members of the OECD will grow by almost 15 x 106 barrels per day (bd) between 2012 and 2035, reaching approximately 15 x 106 bd on the latter date, representing over half of all inter-regional trade. The increase most remarked upon is attributable to China (the country's imports will grow by almost 7 x 106 bd), India (4.8 x 106 bd) and the ASEAN (3 x106 bd). China is poised to overtake the U.S. as the top net importer as the world, and it seems that, by 2020 imports will also exceed those of the entire European Union.

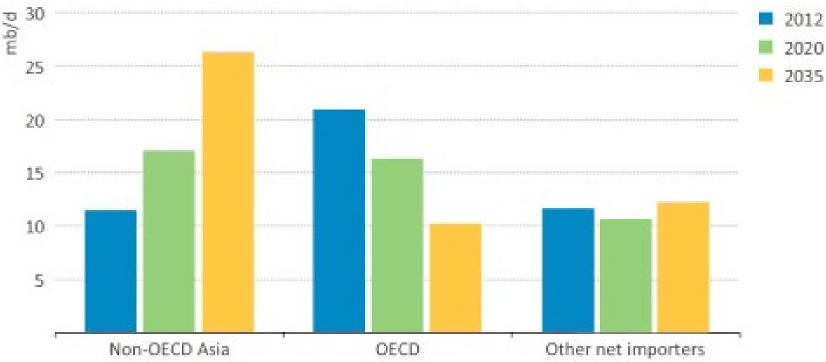


Figure 12. Net oil imports in the OECD, Non-OECD Asian countries not members of the OECD and elsewhere, during the period 2012-2035 period.Figures in millions of barrels per day (mb / d). New Policies Scenario (IEA, WEO 2013).

As regards the OECD countries (which have traditionally been the major importers of oil), the IEA (IEA, WEO 2013) predicts that all of them will reduce their imports. Overall, the percentage of participation in the inter-regional trade will fall from about 50% today, to only 20% in 2035. The decline in imports is relatively gentle in the Asian and European OECD countries, but it is very pronounced in North America, which happens to be a net importer region now, with 5.1 x 106 bd in 2012, to it becoming a net exporter, with 1.7 x 106 bd in 2035 (figure 13).

This shift of 6.8 x 106 bd is attributable in part to an increase of 3.8 x 106 bd in oil production, which comes almost entirely from unconventional sources (see the sections entitled *Crude oil production has already peaked. Unconventional oil gains prominence*, *The production of non-OPEC countries will increase until the late twenties and then stagnate and decline* and *LTO revolution started in the U.S. will spread to other countries but loses steam from the early thirties*, as well as a reduction in consumption, which decreases by 3 x 106 bd. Interestingly, the decline in imports in North America increased almost equals the same figures in China.

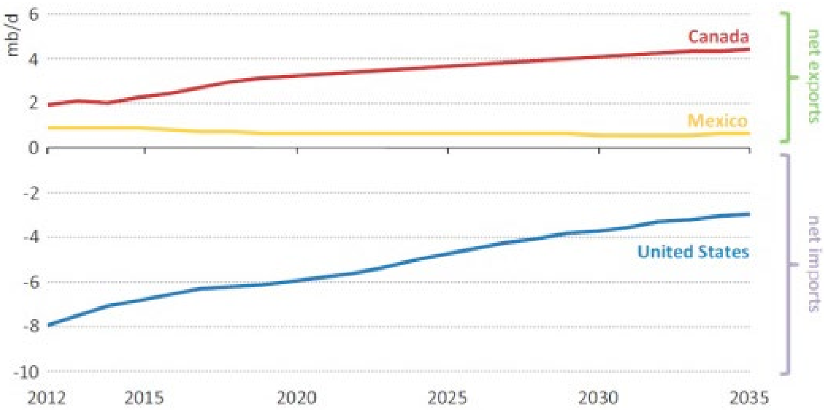


Figure 13. Net imports and exports in North America's trade balance. Figures in millions of barrels per day (mb/d). New Policies Scenario (IEA, WEO 2013).

The overall flow of oil veers from the Atlantic basin, with the exception of Europe, towards the east of Suez, particularly to China and India.

One analysis of inter-regional trade that is exclusively focused on crude (which accounts for the majority of global trade) shows a form of evolution that is similar to what has been discussed in the preceding two sections. According to the IEA (IEA, WEO 2013), the commercial flow of oil veers significantly from the Atlantic basin in the next two decades, whereby Europe remains the sole importer market. This flow moves to the region to the East of Suez, the name by which the Middle East and Asia is best known to commercial oil analysts.

The east of Suez region, as a whole, has come to be the major exporter of oil to the world, mainly from the Middle East to Europe and North America. For example, in 2000, the east of Suez region exported 7 x 106 barrels per day (bd).

However, since that date, increased refining capacity in the region, reflecting a growth in domestic demand for petroleum-derived products has been translated into a decrease in the exporter flow to the world. This meant that in 2012, the export balance in the east of Suez region was practically nil, because net exports of crude oil from the Middle East were equivalent to the net importing needs of Asia. Obviously, the Middle East also exports crude to other regions such as Europe and North America, which makes Asia need to import roughly equivalent volumes from other sources, such as Russia, the Caspian region and West Africa.

Looking ahead, from here to 2035, the IEA expects that oil exports from the Middle East will only increase only, because the increase in refining capacity that is scheduled in this region absorbs most of the production growth. Furthermore, while increased import requirements are expected in Asia, as a result of the growth in refining capacity and a fall in production, it seems that the east of Suez region will experience a growing deficit the export-import balance sheet of crude.

This is a completely different situation to that expected for North America where a sharp decline in crude oil imports, as a result of falling demand (see *The New Geography of demand. Decline in the OECD, growth in Asia and the Middle East*) and an increased level of production in light oil from compact rocks (light tight oil or LTO) and hydrocarbons deriving from Canadian oil sands (see *oil production between 2012 and 2035. Unconventional fuel as a temporary alternative to the hegemony of OPEC and Middle East*).

The consequence of this is that oil from other exporting regions will flow, on an unprecedented scale to the east of Suez region, which in 2035 will have to cover net import needs of near of 8 x 106 bd.

Since some exports from the Middle East will still have to go to the West, mainly to Europe (although at a lower rates than today's volumes), the flow of crude from the rest of the world to the east of Suez region should be even higher than the figure above, exceeding 9 x 106 bd in 2035. In this context, the IEA (IEA, WEO 2013) predicts that imports from the Asian markets, or sea or gas pipeline from Russia and Kazakhstan, will increase to 2.3 x 106 bd. This still leaves a volume of 7 x 106 db that must be transported by tankers from the ports of European Russia, West Africa, Latin America and Canada (figure 14).

Overall, the IEA forecasts indicate that during the 2012-2035 period, the inter-regional trade in crude oil will increased by 3.9 x 106 bd, representing a percentage close to 10%, although the volume traded by sea and oil tankers will increase by 18%, since the sea supply routes is longer on average.

Security implications of the global oil supply

The IEA projections discussed require a re-assessment of the security policies regarding oil supply. In this regard, it is appropriate to note that in 2035, the world's two largest oil importers will be China (with 11,7 x 106 bd) and India (6,8 x 106 bd), while the percentage of U.S. involvement in inter-regional trade in crude declines from 27% now, to 15%. This situation means that the Asian countries mentioned should get more involved in anticipating and managing the effects of potential supply disruptions.

Also, changes in the global flow of oil will have implications for the relative importance of some strategic steps ("choke points") in the maritime supply system. For example, according to projections by the IEA (IEA, WEO 2013), the flow of oil through the Straits of Malacca will increase from 13 x 106 barrels per day bd in 2012 to 17,5 x 106 db in 2035. Undoubtedly, the most import-dependent Asian countries should be actively involved and increase their efforts to strengthen the security of this waterway. This is a task which, in any case, requires international cooperation because all of these countries are interested in importing so as to mitigate the possible effects of a disruption in their oil supply, given the potential impact that such an event could have on oil prices and the global economy.

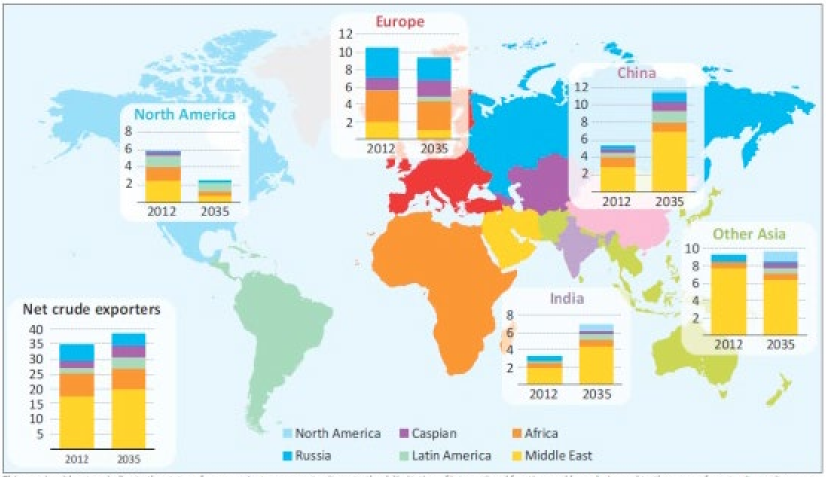


Figure 14. Crude imports by region and source.Figures in millions of barrels per day (mb/d). New Policies Scenario (IEA, WEO 2013).

Unconventional gas

Preliminary technical considerations

What does unconventional mean?

In the case of natural gas, industry classified as unconventional as being that gas which is present in rocks or in unusual crystalline substances, from which it is difficult to extract the gas, either due to the low level of permeability and porosity of the rocks or the manner in which the gas is kept. It is also defined as a gas that could be extracted in an economically profitable way by commonly used technology and whose production requires the use of special technical drilling techniques and stimulation technology. This represents an additional cost and, in general terms, the production of unconventional gas becomes very much dependent on gas prices in the market.

Main types of unconventional gas

According to the International Energy Agency (IEA), unconventional gas includes the following five categories:

I. Tight gas. This is natural gas trapped in sedimentary rocks (sandstones and limestone) with very low levels of permeability (typically less than 0.1 millidarcys) and low porosity. Practically speaking, this gas can also be defined as one that cannot be extracted profitably from its reservoir rock using conventional vertical wells. This type of unconventional gas may contain condensates (gaseous hydrocarbons in conditions of pressure and sub-surface temperature but that condense to liquids at the surface).

II. Shale gas. This is natural gas trapped in sedimentary fine-grained rocks (mainly consisting of clay or silt sized particles) of low permeability and rich in organic matter. Because it very low in permeability and because of the porosity of these rocks, some authors consider them to be a subcategory of tight gas. These are hydrocarbons source rocks after being subject to a maturation process will generate convenient thermal gas. Part of this is still in the rock. However, another part may have migrated vertically and this is accumulated in conventional reservoirs. As the fluid cannot move them easily through low-permeability rocks, the commercial gas production requires advanced techniques such as the hydraulic fracturing (the fracking) and the drilling of horizontal multilateral wells.

III. Coalbed methane. This is the absorbed methane within coal seams in the rock matrix. Most of the coal reserves in the world are at the depths at which mining work is impossible. The CBM is the methane contained in coal beds, due to its depth or poor quality, which cannot be exploited by mining. In the exploitation of coal mines, the associated methane gas is considered to be a hazard or a source of environmental problems if it is vented into the atmosphere. However, the CBM can be exploited using technologies similar to those used in the search and exploitation of conventional oil drilling, although production may be very difficult if the formations containing it are very compacted and have low permeability levels, in which case, then various techniques are to be used such as hydraulic fracturing to improve well productivity. In this case, the injected water that goes into the pore spaces has to be removed prior to gas extraction, which complicates the production process, increasing costs and creating environmental problems.

IV. Methane hydrates or gas hydrates. These are natural solids, with a snow-frosted appearance, characterized by a “clathrate” (or cages) structure formed by a crystalline lattice of water molecules trapped inside molecules, mainly methane gaseous hydrocarbon. Within the “ice cage”, methane molecules are compressed by a factor of about 164, so that atmospheric pressure and temperature to one cubic metre of gas hydrate releases 164 cubic metres of gas for 0.8 cubic metres of water. This concentration factor gives special importance to the sediments containing gas hydrates, both from the point of view of its energy potential, as well as from the perspective of the geological hazards and climate change. Gas hydrates are stable under high-pressure conditions and moderately low temperatures. These conditions, along with the presence of the water and gas necessary for the genesis of gas hydrate are provided both on land, in the permafrost of the Arctic regions, and in the sediments located in the deep ocean and other large bodies under water.

Estimation of resources and production costs (without internalizing the CO_2.costs)

Knowing the amount of in-situ gas that is hosted by the unconventional reservoir rocks is a difficult task, due to the heterogeneous structure of these rocks as the production profiles differ significantly from those observed in conventional wells.

With these cautions in mind, regardless of gas hydrates, it is estimated that the reserves and recoverable resources[6] of unconventional gas are around 343 x 1012 cubic meters (cm), compared to approximately 468 x 1012 cm of conventional gas (figure 15, table 6), representing an approximate total amount of 811 x 1012 cm, equivalent to over 230 years of production at current rates.

The potential contribution to the overall supply of natural gas that each of the different types of conventional and unconventional gas (excluding gas hydrates) could provide in the long term is summarised in figure 16. This figure also illustrates production costs (box on the left) and transport (box on the right) in 2008 (IEA, WEO 2009). Gas hydrates are not included because there is still no commercial gas production from these compounds and they are not expected to occur in the immediate future.

The total long-term potential of all commercially exploitable gas resources as of today is approximately 811 x 1012 cubic meters (cm). The volume extracted and partially-burned (flared) or vented directly into the atmosphere, is situated around 100 x 1012 cm with top production costs of $ 8 per million BTU (MBTU)[7]. For comparison, on the basis of the same energy content, these costs with oil (see *Estimating resources and pro-*

6 See note at end of page two

7 $ 1 per million BTU ("British Thermal Units") equals approx. $ 0.035 per m3.

duction costs (no internalize CO_2.costs) should know that $ 8 per MBTU is equivalent to about the equivalent of $ 46 per barrel of oil.[8]

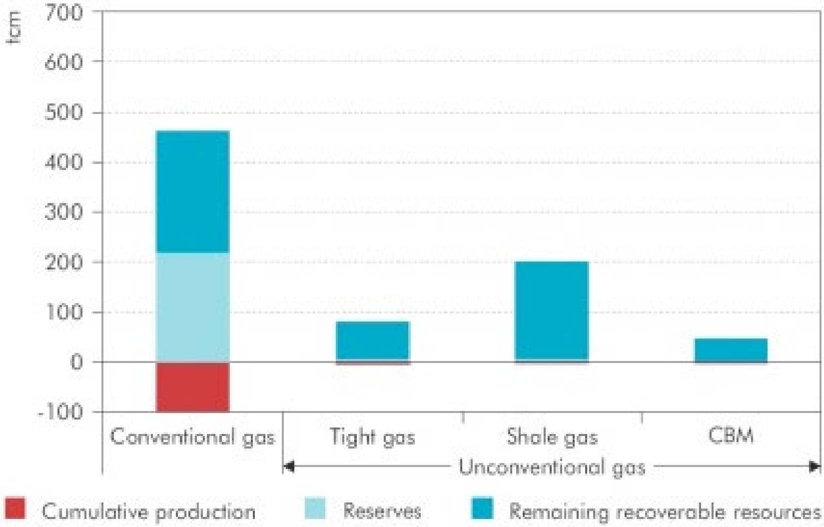


Figure 15. Cumulative production, reserves and recoverable natural gas resources by exploiting both conventional and unconventional fuel, in late 2011 and globally.Figures in billions of cubic meters (bcm). (IEA, WEO 2012).

Production costs for the associated gas (gas that occurs in an oil exploitation operation) are generally lower than those of non-associated gas (the one extracted from a natural gas field). This applies most particularly in those areas where the infrastructure to extract oil existed before the intention to exploit the gas resource did. However, even today, significant amounts of gas are burned because to treatment and subsequent transport of the gas to market is not economically viable. Thus, only in the last decade, have burned more than 1.5 x 1012 cm. of gas worldwide, a volume equivalent to more than 5% of the marketed production.

The most accessible portion of conventional gas resources to be exploited are around 220 x 1012 cm, with production costs that range between 0.20 to $ 9 per MBTU. Other conventional resources include those from the Arctic or deep water. Firstly, this could reach 30 x 1012 cm. and production costs would be between $ 4 to $ 12 per MBTU. The latter could represent a 50 x 1012 cm with a production cost of between $ 5 to $ 11 per MBTU[9].

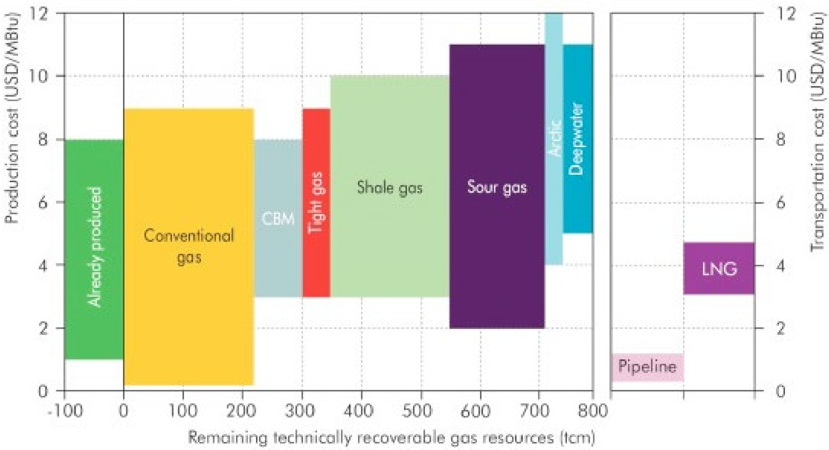
[8] $ 1 per million BTU ("British Thermal Units") equals $ 5.8 per barrel of oil equivalent

[9] There is a clear discrepancy in the numbers of volumes of technically recoverable conventional natural gas between (table 8) and figure 20. Probably, this is because in the latter end of 2008 the data is tabulated, while the table shows data from late 2012.

	Conventional	Unconventional				Total
		Tight gas	Shale gas	Coalbed methane	Sub-total	
E. Europe/Eurasia	143	11	15	20	46	190
Middle East	124	9	4	-	13	137
Asia-Pacific	44	21	53	21	95	138
OECD Americas	46	11	48	7	66	112
Africa	52	10	39	0	49	101
Latin America	32	15	40	-	55	86
OECD Europe	26	4	13	2	19	46
World	468	81	212	50	343	810

Notes: Remaining resources comprise known reserves, reserves growth and undiscovered resources. Unconventional gas resources in regions that are richly endowed with conventional gas, such as Eurasia or the Middle East, are often poorly known and could be much larger. Sources: BGR (2012); US EIA (2013); USGS (2000); USGS (2012a and 2012b); IEA databases and analysis.

Table 6. Technically recoverable natural gas resources to be exploited, by types and regions, in late 2012. Figures in billions of cubic meters (bcm). (IEA, WEO 2013).



Notes: CBM = coal-bed methane; LNG = liquefied natural gas; Pipeline costs refer to costs per 1 000 km; MBtu = million British thermal units; tcm = trillion cubic metres.

Figure 16. Production costs in 2008 (in dollars per million of BTU) and long term technically recoverable different resource categories of natural, conventional and unconventional gas (billions of cubic metres) in volume. The box on the right shows the costs for natural gas in dollars per million of BTU (and 1000 km in the case of transport by pipeline). (IEA, Resources to Reserves, 2013).

Commercially exploitable unconventional resources now total 343 x 1012 cubic meters (cm.), which correspond to 212 x 1012 cm of shale gas), 81 x 109 cm of tight gas and 50 x 10 cm of coal bed methane or CBM - with production costs of between 3 and 10 dollars per MBTU. The resources of sour gas and lean gas that some authors include within the category of unconventional gas (see the section on *Main types of unconventional gas* would provide additional 160 x 1012 cm with a cost production of between $ 2 to $ 11 per MBTU.

One key factor to consider in the cost of natural gas is transportation. In the case of gas pipelines this is $ 0.30 to $ 1.2 MBTU every 1000 miles, depending on whether the segments are on land or under the sea and depending on pipeline capacity and the age of the facility. For liquefied natural gas (natural liquefied gas or LNG) the total cost of liquefaction, transportation and regasification vary from $ 3.10 to $ 4.70 per MBTU, depending on plant size and the distance involved in transportation.

The estimation of the global volume of gas hydrates is about 2.1 x 1016 cm. Other more conservative estimates lower the previous figure by an order of magnitude, but even these reveal the existence of a planet in the huge volume of gas that is "caged" in hydrates. We are talking about between 3.4 x 1018 cm and 3 x 1017 cm mc gas contrasted with the 811 x 1012 cm discussed in the second paragraph of this section.

Geographical distribution of resources. The unconventional gas as a counterweight to the Middle East and Russia

From the number of unconventional gas resources mentioned in the second paragraph of section "*Estimation of resources and production costs (without internalizing the CO_2.costs)*" (343 x 1012 cubic meters) approximately 27.7% are located in the Asia-Pacific, 19.2% in the USA and Canada, 16% in Latin America, 13.4% in Eastern Europe-Eurasia, 14.2% in Africa, 5.5% in European countries integrated into the OECD, and only 3.8 % in the Middle East (table 6 and figures 17 and 18).

This geographical distribution helps to balance the excessive concentration of conventional reserves and resources in Eastern Europe-Eurasia (mainly in Russia) and in the Middle East. Both regions respectively recorded about 30.6% and 26.5% of the reserves and the technically recoverable[10] resources of the conventional natural gas in the world. However, it is possible that, in the future, the Middle East and other regions, such as countries bordering the Caspian, which so far have received little attention due to their large conventional resources, will see a substantial increase in their estimates of unconventional resources.

Figure 19 summarizes the volume of recoverable resources of unconventional gas for different countries, breaking it down into three categories: gas from compact rock tight gas, shale gas and coal-bed methane "or CBM. It follows, without any doubt, the geopolitical importance of shale gas resources. In late 2012, these accounted for approximately 61.8% of the total of the outstanding operating resources, as compared to 23.6% of

[10] See footnote on page no. 4.

low permeable rock-gas and 14.6% of coalbed methane that is technically recoverable from unconventional resources (table 6).

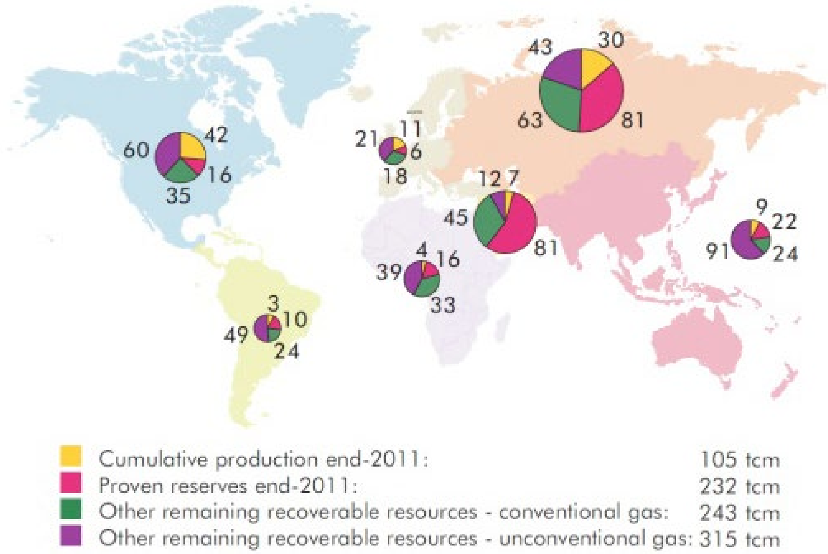


Figure 17. The natural gas in the world in 2012. Regional distribution of cumulative production, proved reserves and recoverable resources by exploiting both conventional and unconventional fuel. Figures in billions of cubic metres (bmc). (IEA, Resources to Reserves, 2013).

The case of shale gas

In a report published in early June 2013 (*Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States, 2013*), the Energy Information Administration (IEA) of the Government of U.S. had increased by 10% as compared to the previous estimate (U.S. IEA 2011), on a global scale of the technically recoverable shale gas resources. The new estimate is about 204.4 x 1012 cubic meters (cm). This figure far exceeds the 185.2 x 1012 cm. according to the latest report from BP (*Statistical Review of World Energy, June 2013*) formed in late 2012. This proved the reserves of natural gas in the world and that the rate of extraction of the same year, ensure the availability of this fuel for nearly 56 years.

Of the 204.4 x 1012 cm. cited, 31.2 x 1012 would correspond to China, which is ranked first in a list of 42 countries analysed in the report, followed by Argentina, Algeria and the U.S., with 22.5 x 1012 19.8 x 1012 and 18.6 x 1012 cubic meters (cm), respectively. The other countries that occupy the top ten rankings are Canada (16 x 1012 cm), Mexico (15.3 x 1012 cm), Australia (12.2 x 1012 cm), South Africa (10.9 x 1012 cm), Russia (8 x 1012 cm) and Brazil (6.9 x 1012 cm).

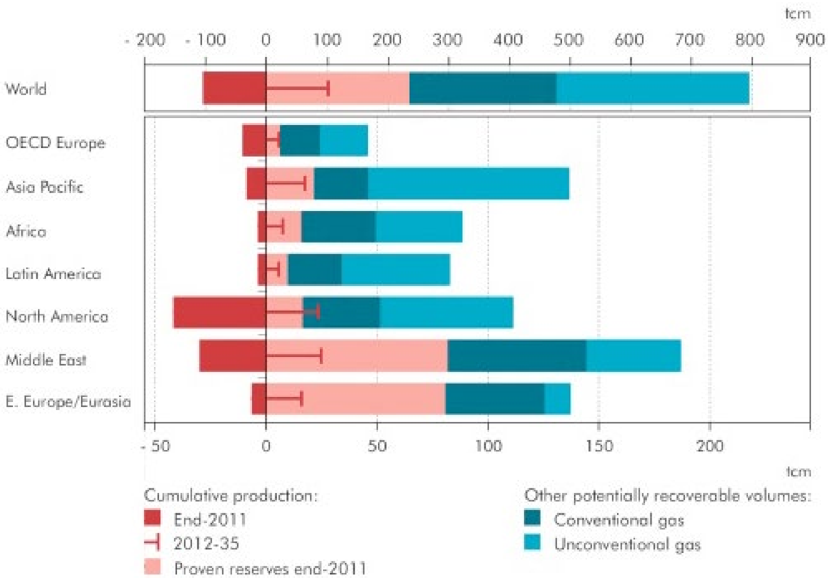


Figure 18. Cumulative production, proven reserves and potentially recoverable gas in the New Policies Scenario (IEA, WEO 2012). Figures in billions of cubic meters (bcm). Note the different scales for the world (above) and regions (below). The figure contains an error: the length of the light blue bar for the unconventional gas in Eastern Europe-Eurasia actually corresponds to the Middle East and vice versa (compare with table 8). (IEA, WEO 2013).

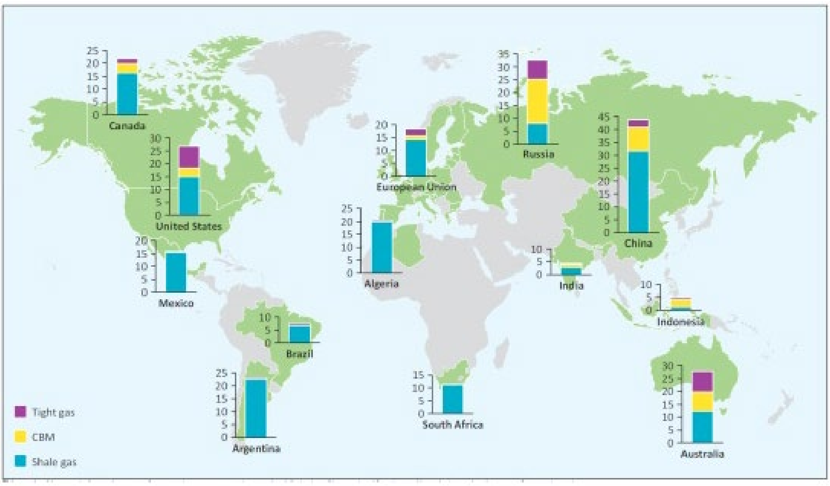


Figure 19. Recoverable unconventional gas resources by type and country in late 2012.Figures in billions of cubic meters (bcm). (IEA, WEO 2013).

The report (U.S. IEA, 2013a) finds that more than half of the global shale gas resources located outside the U.S. focus on China, Argentina, Algeria, Canada and Mexico. Without doubt, the new figures produced are of great economic and geopolitical interest, given the enormous potential of the resources located beyond U.S. borders, but it remains to be seen whether these resources can be economically exploited as being feasible, such as the U.S. That is a country in which the production of gas from shale has grown so much that today, this already represents 40% of all natural gas extracted.

With respect to Europe, the estimates of technically recoverable shale gas resources in 11 countries conducted throw together a rough figure of 13.2 x 1012 cm representing 6.4% of the estimated total for the 42 countries analysed. This overall figure puts Europe in seventh place in the world rankings, behind Mexico and ahead of Australia. 60% of the total amount of resources from the old continent would be located in Poland and France, with 4.1 x 1012 and 3.8 x 1012 cm, respectively, leading the European ranking. These are followed far behind by Romania (1.4 x 1012 cm) Denmark (0.9 x 1012 cm), the Netherlands and the UK (with 0.7 x 1012 cm each). Spain[11], with 0.22 x 1012 cm occupies tenth place, behind Bulgaria and Germany (0.48 x 1012 cm each) and Sweden (0.3 x 1012 cm. According to data from BP (its Statistical Review of World Energy, June 2013), the consumption of natural gas in the European Union was about 0.44 x 1012 cm in 2012, so technically recoverable shale gas resources could cover up to 30 years of consumption multiplied by a factor of 7.6 as compared to the current proven gas reserves in the EU.

The IEA (IEA 2013a U.S.) also report some decline in their previous estimates, such as Norway, Poland, South Africa, China and Mexico. What happened in the case of the two European countries clearly illustrates some of the reasons behind such sales, underlining the precautionary step that must be handled with any resource estimate. In this connection, we must not forget that the U.S. and Canada are the only countries in the world

[11] The AIE report (US AIE, *2013a*) shows the new development of including for the first time an estimate of the technically-recoverable resources of shale gas for Spain. Specifically, the Basque-Cantabrian and Ebro basins are analysed. In the first case, for technical reasons, the study only considers some shale formations from the Jurassic Age to be potentially beneficial. For these, an in-situ accumulation of 1.18 x 1012 cu.m. is calculated, of which only around 0.22 x1012 cu.m. could be recovered. The report does not quantify the possible technically-recoverable resources from the Ebro basin, because it considers that the existing Palaeozoic and Eocene shale formations in the subsoil of that basin do not meet one of the basic geo-chemical requirements to generate appreciable quantities of hydrocarbons: the organic matter (TOC) in those formations is low. For all of these reasons, whilst awaiting new studies, the AIE report concludes that the technically-recoverable reserves of shale gas in Spain are 0.22 x 1012 cu.m. This figure is very below other estimates recently made public, would make it possible to cover the natural gas combustion of Spain for rather more than 7 years, assuming the consumption figures published by BP (*Statistical Review of World Energy,* June 2013).

that currently produce shale gas and oil shale in commercial quantities. For Norway the technically recoverable shale gas resources of 2.3 x 1012 cm fell to zero in 2011, due to the disappointing results obtained after Shell drilled three wells in The Alum Shale formation. These three wells were drilled in Sweden in 2011 in part of the less complex formation cited from the geological point of view, which drastically reduces the prospects of success in Norway where the geology is much more complicated.

	1990	2011	2020	2025	2030	2035	2011-2035	
							Delta	CAAGR*
OECD	881	1 195	1 358	1 403	1 410	1 483	288	0.9%
Americas	643	859	1 000	1 041	1 063	1 114	255	1.1%
Canada	109	160	184	189	186	194	34	0.8%
Mexico	26	49	50	58	68	81	32	2.1%
United States	507	649	764	792	807	837	188	1.1%
Europe	211	277	249	237	225	215	-62	-1.1%
Norway	28	101	121	118	115	111	10	0.4%
Asia Oceania	28	59	109	125	143	155	95	4.1%
Australia	20	51	103	120	139	152	101	4.6%
Non-OECD	1 178	2 188	2 599	2 919	3 216	3 492	1 304	2.0%
E. Europe/Eurasia	831	882	911	986	1 094	1 164	282	1.2%
Azerbaijan	10	16	23	33	43	47	30	4.5%
Russia	629	673	667	692	757	808	135	0.8%
Turkmenistan	85	67	83	100	117	132	66	2.9%
Asia	130	419	566	625	694	769	350	2.6%
China	15	103	178	218	266	317	214	4.8%
India	13	46	62	73	85	98	52	3.2%
Indonesia	48	81	108	118	129	139	57	2.3%
Middle East	92	519	624	720	766	823	304	1.9%
Iran	23	150	143	165	180	207	56	1.3%
Iraq	4	6	39	71	79	83	77	11.5%
Qatar	6	151	187	214	227	237	86	1.9%
Saudi Arabia	26	86	112	121	128	136	50	1.9%
UAE	20	52	58	61	62	65	13	0.9%
Africa	64	200	280	333	378	428	228	3.2%
Algeria	43	77	106	115	123	132	55	2.3%
Libya	6	8	17	21	24	30	22	5.7%
Nigeria	4	36	42	55	70	83	47	3.6%
Latin America	60	168	218	255	285	308	140	2.6%
Argentina	20	42	49	65	80	91	49	3.3%
Brazil	4	17	38	60	78	92	76	7.4%
Venezuela	22	25	36	43	52	63	38	3.9%
World	2 059	3 384	3 957	4 322	4 646	4 976	1 592	1.6%
European Union	213	185	135	122	114	104	-80	-2.3%

* Compound average annual growth rate.

Table 7. Natural gas production by region. Figures in billions of cubic metresNew Policies Scenario (IEA, WEO 2013).

In Poland, the technically recoverable gas from the Lublin Shale formation resources declined from 1.23 x 1212 cm. in 2011, to 0.25x1012 cm. in the report of 2013, as a result of the application by the IEA of more stringent criteria to define the quality of the formations that contain the gas. This review involves the estimation of shale gas resources for the whole of Poland, with falls of 5.2 x 1012 cm. in 2011 to 4.1x1012 cm. in 2013.

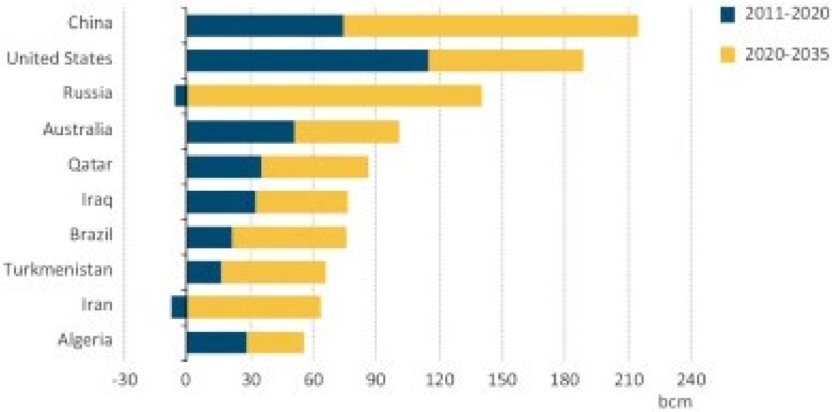


Figure 20. Changes in the production of natural gas in key countries for the period 2011-2035 period. Figures in billion cubic meters (bcm). New Policies Scenario (IEA, WEO 2013).

It should be stressed that in any case, the report commented on (U.S. IEA 2013a) cannot be regarded to be complete as it excludes many shale formations of prospective interest, such as those that underlie the major oil fields of the Middle East and the Caspian region.

Production of natural gas between 2012 and 2035. The unconventional gas revolution expands beyond the U.S. and Canada

In just over two decades unconventional gas could represent more than a quarter of the global production of natural gas

The IEA predicted in its New Policies Scenario (IEA, WEO 2013), the consumption of natural gas in the world will grow from about 3.4 x 1012 cubic metres (cm) in 2011 to just under 2035, 5 x 1012 cm, with 40% of this increase being attributable to the electricity generation sector. We are talking about an average annual growth rate of 1.6%, although this rate has varied widely by region, so that would be three times faster than in countries outside the OECD than in more mature markets of the industrialized countries that are integrated into this organization.

In the discussed scenario, the IEA projected that between 2011 and 2035, natural gas production will grow in all regions, with the exception of Europe (with a fall of 22.4%) and the increase in production in Norway (10%), which will not be enough to offset the decline in other mature fields in the North Sea and the Netherlands. As shown in table 7 and in figure 20, China, the USA, Russia and Australia (in that order), followed by Qatar, Iraq, Brazil, Turkmenistan, Iran and Algeria, are the countries that would experience a greater increased production. Although the U.S. and Australia would account for significant increases in its production (29% and 198%, respectively), with both becoming net exporters, the non-OECD countries would account for about 81.75% of production growth.

The IEA (IEA, WEO 2013) considers that the total increase in production expected in the New Policies Scenario (1.5 x 1012 cm., approximately) 52% would be contributed by unconventional gas, while the remaining 48% come from unconventional sources (table 8). Forecasts are that from 2020, the development of unconventional gas production extends beyond North America (U.S. and Canada), thus making China and Australia the largest contributors to global output growth followed by other countries such as Argentina, India, Algeria, Mexico and Indonesia and the European Union set slightly above the latter three countries (figure 21).

	2011	2020	2025	2030	2035	2011-2035	
						Delta	CAAGR*
Shale gas	232	402	513	627	745	513	5.0%
Coalbed methane	78	148	202	261	315	237	6.0%
Tight gas	250	281	285	276	269	18	0.3%
Total	560	832	999	1 165	1 328	769	3.7%

* Compound average annual growth rate.

Table 8. Production of unconventional natural gas by type. Figures in billions of cubic metres.New Policies Scenario (IEA, WEO 2013).

For the IEA (IEA, WEO, 2013), unconventional gas, which in 2011 accounted for about 17% of the total world production of natural gas, could reach 27% in 2035, with about 1.3 x 1012 cm. The historical development of unconventional gas production from 2000 to 2035 is summarised in Figure 22. It follows from the observation of this figure, which the revolution that began with the shale gas in the U.S.A. and Canada, expands beyond the borders of these countries, maintaining an average growth rate of 3.7% between 2011 and 2035.

In any case, it noted that the IEA warns that its predictions about the global production of unconventional gas are uncertain and they depend, to a large extent, on governments and industry being able to develop a regulatory framework and good practices enabling them to obtain a "social license" to operate, thus satisfying the existing great public concern about the environmental and social impacts that are associated with such operations.

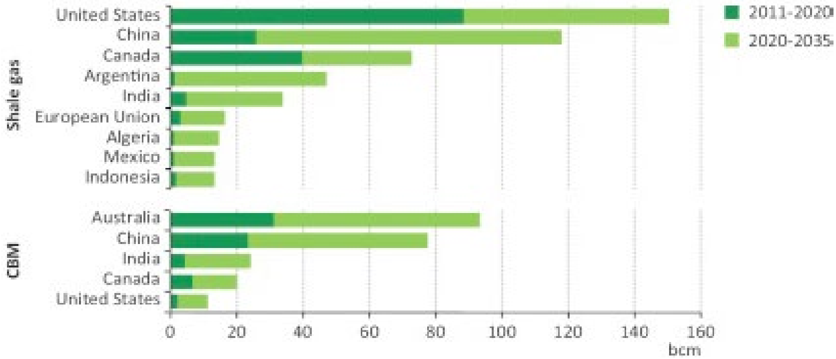


Figure 21. Growth in unconventional gas production by type in some key countries and regions during the 2011-2035 period. Figures in billions of cubic metres (bcm). New Policies Scenario (IEA, WEO 2013).

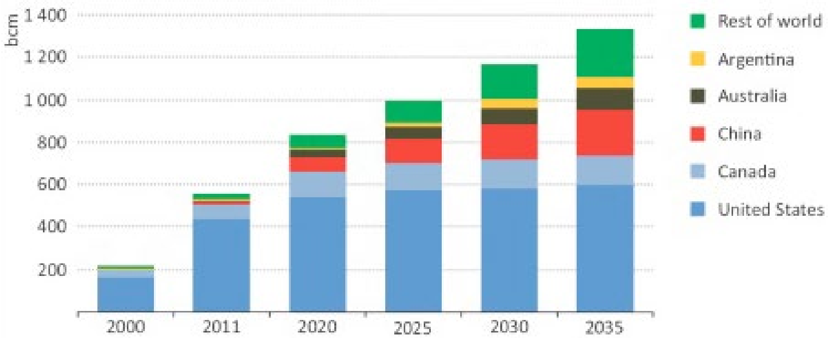


Figure 22. Production of unconventional gas in key countries for the 2011-2035 period. Figures in billions of cubic meters (bcm)) New Policies Scenario (IEA, WEO 2013).

U.S. production and Canadian production continues to grow in the next decade and it is then stabilised. Mexico comes onto the scene

In the New Policies Scenario of the IEA (IEA, WEO 2013), until 2020, more than half of the growth in global unconventional gas production comes from two major current producers, USA and Canada, which in 2011 accounted for about 90% of the total. Towards the end of this decade it is expected that this latter percentage will to 80% decay, reflecting the start-up of production in China and Australia, which will be added to later on by Argentina and other countries (figures 21 and 22).

The increased production of unconventional gas, especially shale gas in the U.S. has slowed slightly in 2012, to the extent that the very low gas prices have caused a decline in drilling activity. However, the IEA projections assume that, over time, the gas price will increase in such a way that total production in the U.S. of unconventional gas could reach 600.000 x 106 cubic meters (cm.) in 2035, although there is no indication of a similar decline discussed in section "*The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties*", (figure 8) as regards light tight oil or LTO decline.

In Canada, the current production of unconventional gas, gas that is mainly composed of tight gas together with minor amounts of shale gas and coal-bed methane or CBM, is around the 70.000 x 106 cm. However, forecasts suggest that this figure could increase to 2035. 140.000 x 106 cm. that is basically driven by shale gas.

In the long term, in North America, it seems that Mexico will join U.S. and Canada as an unconventional gas producer country. In the New Policies Scenario, the IEA (IEA, WEO 2013) estimates that extraction could reach 30.000 x 106 cm, in 2035. Pemex, the state oil and gas company in the country, has launched a program to invest $ 200 million over three years in the exploration of gas shale, starting with the extension in the northern part of Mexico of the Eagle Ford geological formation, currently in production in neighbouring Texas, and in the U.S., and it is believed that these could hold about half of the total resources. However, commercial production could be limited by the scarcity of water in some resource-rich regions so the priority is accorded to Pemex projects generating export earnings and the difficulties in keeping development costs to levels capable of competing with gas imports from the U.S. Anyway, the power sector reform adopted in Mexico could mean a big boost for the exploitation of unconventional gas resources in the country, to the extent of opening up the oil and gas sector to foreign companies would provide the technology necessary and large capital investments.

China and Australia burst onto the world stage in the production of unconventional gas

In Australia, the IEA (IEA, WEO 2013) points out that the production of coal-bed methane has been so far the main source of unconventional gas production and this may increase rapidly after the completion of three liquefied natural gas (LNG) in Gladstone (Queensland) that will be powered by unconventional natural gas from coal beds in the Surat basin. The projections of the New Policies Scenario (figure 21) provide for the production of coalbed methane in Australia increase of about 6000 x 106 cubic meters (cm.) in 2011 to almost 100.000 x 106 cm. in 2035. To achieve these goals, operators should pay special attention to water management, given the general scarcity and the high dependence of some the regions of groundwater and artesian water on farming and grazing. In this regard, the decision of New South Wales in early 2013, to prohibit the development of coal-bed methane within a radius of two kilometres in residential areas and some rural areas is a wake-up call for the industry.

According to the IEA (IEA, WEO 2013) in China, the commercial production of coal-bed methane reached the 10.000 x 106 cm. in 2011. But production is growing less rapidly than expected, so that it will be difficult to achieve the objective of 30.000x106 cm. set for 2015. The projections of the New Policies Scenario contemplate that this target will be delayed to 2020 (figure 21).

As regards shale gas, China's potential is immense (see *The case of shale gas resources*) but production projects are mostly at an early stage of exploration, particularly in the region of Sichuan. Foreign companies can participate in exploratory activities as minority partners of Chinese companies and, in some cases, such as operators, with the important implications of this for technology transfer. Anyway, it seems unlikely that the commercial production of shale gas in China will reach the government targets set at just under 6.500 x 106 cm. in 2015. The projections of the New Policies Scenario of the IEA (IEA, WEO 2013) envisage the production of shale gas in China to rise slowly until 2020, then accelerate and reach nearly 120.000 x 106 cm. in 2035 (figure 21). The main uncertainties in this regard are geological (e.g. in many cases, the rock formations of interest are deeper than in the U.S., thus increasing development costs) and accessibility (the most promising resources are in mountainous areas). Also, the limited availability of water, particularly in the Tarim and Ordos basins, together with the absence of pipelines, processing capacity and other infrastructure are factors that could hinder the development of shale gas resources in China.

The potential of Argentina

In a recent U.S. government report (U.S. IEA 2013a), Argentina ranks second in the world rankings in shale gas resources (see section on *The case of shale gas resources)*. The most interesting geological formation is Vaca Muerta in the northern Patagonia. According to the IEA (WEO 2013 IEA) from a geological point of view of production prospects are positive, but, in practice, fiscal, contractual and political obstacles could slow their development. Apart from that, it is expected that companies will focus their activity preferably in areas that are rich in oil and liquids rather than those containing dry gas resources. One factor that has so far been delayed investments has been offering low prices for production. YPF, the new state company, has approved an investment programme of $ 6,500 million, which is intended to increase gas production by 8% during 2013-2017, with about 60% of the increase coming from gas production from tight gas and shale gas. Also, YPF has announced partnerships with foreign companies to develop unconventional resources such as Vaca Muerta. In the New Policies Scenario, the IEA (IEA, WEO 2013) assumes that if these partnerships fructify the production of unconventional gas in Argentina in 2035 could reach a volume to 50.000 x 106 cm. (figure 21), to which must be added other 40.000 x 106 cm. of conventional gas.

The incognita of Europe

As discussed in the sections *The production of natural gas between 2012 and 2035,* The unconventional gas revolution expands beyond the U.S. and Canada and *In just over two decades unconventional gas could represent more than a quarter of the global production of natural gas.* Europe has substantial resources of the three types of unconventional gas analysed (figure 19), but large-scale development must overcome a series of geological constraints (the complexity is higher than in North America) as well as the public and political exploitation of unconventional gas opposition in many countries, particularly in Western Europe. At the moment, it is uncertain to what extent such forecasting social and environmental concerns will condition a tightening of the regulations at the European level. Therefore, in the New Policies Scenario, the IEA (IEA, WEO 2013) adopts a conservative position when making forecasts on production during the period 2011-2035 period, which could reach just under the 20.000 x 106 cm. (figure 21)

In this volume, the highest percentage corresponds to Poland (8.000 x 106 cm.), which is the country that has been considered to be the most promising one in Europe for the production of unconventional gas. However, until September 2013, after more than 50 wells have been drilled, the results have not lived up to initial expectations of the industry, although it is still early to judge the extent and quality of the exploitable resources since they still have to drill more wells around 200 between now and 2016.

The IEA also believes that by 2035 the UK will be able to produce 3,000 x 106 cm. of unconventional gas. In June 2013, the British Geological Survey revised the potential of this country upwards, doubling the previous resource estimate made for the main prospect domain of the United Kingdom (Bowland Shale).

Outside the European Union, the IEA expects that in 2035, the production of unconventional gas in Ukraine to increase to levels similar to those of neighbouring Poland, although the outlook for the troubled political situation in the country is clouded and the associated investment climate is uncertain.

The reorganization of the global trade in natural gas between 2011 and 2035. New pipelines and new players in the market of LNG

The new geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market

The International Energy Agency (IEA) predicts in its New Policies Scenario (IEA, WEO 2013) that the markets for natural gas between 2011 and 2035 will experience the fastest growth levels that are located outside the OECD (table 9). Countries outside the organization will be responsible for over three quarters of the growth in demand during that period, with the highest growth in absolute terms focusing on China and the Middle East. In the new geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market.

By contrast, in OECD countries, although consumption is increasing, the growth rates are lower due to market saturation and the effects of penetration of renewables in the electricity sector in Europe. However, the OECD markets remain comparatively large, so that, for example, in 2035, demand in the U.S., which continue to be the world's largest consumer, will be 50% higher than China.

	1990	2011	2020	2025	2030	2035	2011-2035	
							Delta	CAAGR*
OECD	1 036	1 597	1 707	1 778	1 827	1 885	289	0.7%
Americas	628	869	957	988	1 016	1 044	175	0.8%
United States	533	696	749	769	781	789	93	0.5%
Europe	325	525	537	568	584	605	80	0.6%
Asia Oceania	82	202	214	222	227	236	34	0.6%
Japan	57	120	119	123	122	124	3	0.1%
Non-OECD	1 003	1 773	2 249	2 541	2 815	3 086	1 313	2.3%
E. Europe/Eurasia	738	703	732	756	785	817	114	0.6%
Caspian	100	117	127	134	139	144	27	0.9%
Russia	447	476	493	504	523	544	68	0.6%
Asia	84	410	669	816	949	1 088	678	4.2%
China	15	132	307	396	470	529	397	6.0%
India	13	61	87	114	140	172	111	4.4%
Middle East	87	399	504	577	645	700	301	2.4%
Africa	35	111	153	170	187	204	93	2.6%
Latin America	60	149	190	221	248	277	128	2.6%
Brazil	4	27	45	61	75	90	63	5.2%
World**	2 039	3 370	3 957	4 322	4 646	4 976	1 606	1.6%
European Union	371	492	494	523	537	554	62	0.5%

* Compound average annual growth rate. ** The world numbers include gas use as an international marine fuel.

Table 9 Demand for natural gas by region. Figures in billions of cubic metersNew Policies Scenario (IEA, WEO 2013).

According to the IEA (IEA, WEO 2013), despite relatively low prices, the maturity of the gas market in the U.S. and Canada, will limit the possibility of rapid demand growth in North America, even though the price difference with other fuels could stimulate the expansion of the use of gas to new sectors, such as transport. Forecasts of the New Policies Scenario of the IEA (IEA, WEO 2013) for the entire region (including Mexico experiencing rapid growth) is for the demand to increase by over 0.86 x 1012 cubic metres (cm.) in 2011, rather less than 1.04 x 1012 cm. in 2035. A particularly interesting fact is that the IEA forecasts suggest that in the U.S., as a result of abundant supply and low prices, natural gas surpassed oil in the energy mix of the country, thus becoming the first primary energy source.

In all European OECD countries, the demand for natural gas fell to just over 0.5 x 1012 cm. in 2012- marking the second consecutive year of decline, down 10% compared to 2010) reaching 2003 levels. The situation is similar in the EU, mainly because of the weak economy and high gas prices, but also to a lesser degree, to a combination of low coal prices, the collapse in the price of CO_2.in the emissions market, the great expansion experienced by renewables and the implementation of cost saving measures and efficiency. In the New Policies Scenario, the IEA (IEA, WEO 2013) predicts that the demand in European OECD countries will recover very slowly, returning in 2025 to the levels of 2010, and then, in 2035, to slightly above 0.6 x 1012 cm.

Russia, the world's second largest consumer of gas, faces an uncertain future regarding its domestic demand resulting from structural inefficiencies and doubts about the speed and the direction in which the prices reform scenario will evolve. The "New Policies Scenario" predicts growth from just over 0.47 x 1012 m^3 in 2011, to near the 0.54 x 1012 m^3 in 2035.

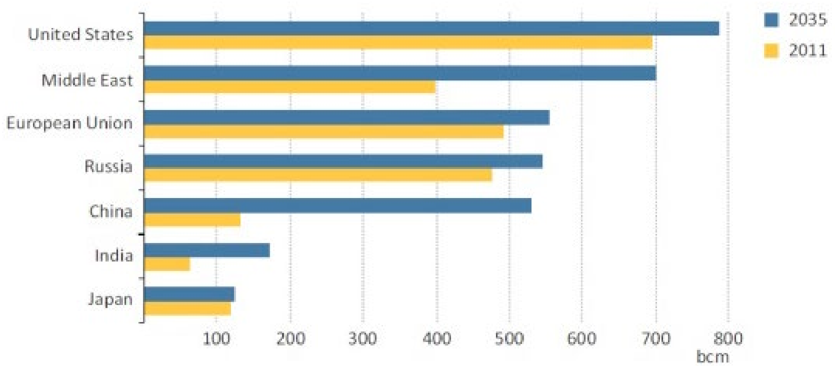


Figure 23. Development of demand naturally in some countries and regions during the period 2011-2035 period. Figures in billions of cubic meters (bcm) New Policies Scenario (IEA, WEO 2013).

According to the IEA (IEA, WEO 2013) China will be the country that will experience the greatest increase in the demand for gas, quadruplicating to spend 0.13x1012 cm in 2011 to 0.53x1012 cm in 2035, while the Middle East and India also experienced a significant increase, rising during the same period, from 0.4 x 1012 to 0.7 x 1012 cm. and 0.06 x 1012 cm to 0.17 x 102 cm respectively. Interestingly (figure 23) shows that if the demand for these forecasts comes true then, in 2035, this will mean much higher demand in the Middle East than that of China and the whole of the European countries integrated into the OECD and the EU, ranking second place in the world rankings, just behind the U.S. In fact, the forecasts suggest that demand for gas in the Middle East will exceed the EU from 2020.

Electricity generation will be the main driver of gas consumption worldwide, although consumption trends will be very sensitive to the impact of the energy policies enacted by governments as well as the competitive pressure from coal and renewables. In the New Policies Scenario the use of gas for electricity generation grows at around 42% during the 2011-2035 period. This increase is especially noticeable in the Middle East (which doubles), China (where it multiplies by six) and India (where it is multiplied by more than three).

Balance between production and demand. Unconventional gas makes Australia and the USA and Canada net exporters. Imports are moving from the Atlantic basin (except Europe) towards the Asia-Pacific

The inter-regional natural gas trade has increased by 80% in the past two decades and in the New Policies Scenario the IEA (IEA, WEO 2013) projects that it will continue to grow, increasing by about 0.4 x 102 cubic meters (cm) during the 2011-2035 period, to achieve slightly less than 1.1 x 102 cm. in 2035 (table 10). This means that this is a very dynamic period in the international gas trade market, during which increasing relevance collected some new players, such as Australia, the USA, Canada and some countries of East Africa, which together posed a competitive challenge classical exporters like Russia and Qatar.

According to the IEA, during the 2011-2035 period, we will also see a continued shift in the direction of the international trade of natural gas importers whose focus will move from the Atlantic basin (with the notable exception of Europe that will remain the main importing region in the world) to the Asia-Pacific, which raised new dilemmas for farmers dependent on the Eurasian pipeline infrastructure to access markets. IEA also glimpsed signs that these terms that will govern international trade, particularly in the case of liquefied natural gas (LNG) will be much more sensitive to the conditions in the short-term market, with innovative pricing mechanisms and fewer destination clauses, which will favour the interconnections between different regional markets and that will facilitate worldwide changes in pricing mechanisms.

	2011		2020		2035	
	Trade (bcm)	Share of demand or output (%)*	Trade (bcm)	Share of demand or output (%)*	Trade (bcm)	Share of demand or output (%)*
OECD	-402	25%	-349	21%	-402	27%
Americas	-11	1%	43	4%	69	6%
United States	-47	7%	15	2%	48	6%
Europe	-248	47%	-288	56%	-390	87%
Asia Oceania	-143	71%	-105	52%	-81	40%
Japan	-117	97%	-117	108%	-123	125%
Non-OECD	415	19%	351	13%	407	12%
E. Europe/Eurasia	179	20%	179	20%	347	30%
Caspian	58	33%	76	37%	143	50%
Russia	197	29%	174	26%	263	33%
Asia	9	2%	-103	16%	-319	31%
China	-29	22%	-130	41%	-212	40%
India	-14	24%	-25	28%	-74	39%
Middle East	120	23%	119	19%	123	15%
Africa	89	44%	127	45%	224	52%
Latin America	19	11%	29	13%	32	10%
Brazil	-10	38%	-7	20%	2	2%
World**	685	20%	804	20%	1 092	22%
European Union	-308	63%	-360	77%	-450	107%

* Imports as a share of primary demand for importing countries; exports as a share of production (output) for exporting regions/countries. ** Total net exports for all *WEO* regions, not including trade within *WEO* regions. Notes: Positive numbers denote exports; negative numbers imports. The difference between OECD and non-OECD totals in 2011 is due to stock change and statistical discrepancies.

Table 10. Net trade in natural gas, pipeline and liquefied natural gas (LNG) by region. Figures in billions of cubic meters New Policies Scenario (IEA, WEO 2013).

Europe increases its dependence on imports

Despite a relatively modest increase in demand over the 2011-2035 period (see *The New Geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market*, Table 9, European import requirements of natural gas are growing strongly Table 10, due to the generalised fall (except Norway) in production on the continent (see *in just over two decades unconventional gas could represent more than a quarter of the global production of natural gas*, Table 9. In the case of the European Union, the New Policies Scenario of the IEA (IEA, WEO 2013) provides that import requirements of gas increase of just over 0.3 x 1012 cm in 2011 to 0.45 x 1012 cm. in 2035 (Table 10, figure 24).

The IEA believes that Europe is well placed to ensure this supply from diverse backgrounds. In addition to the countries that supply the international market for liquefied natural gas (LNG), the suppliers include both some traditional exporters such as Norway (which in 2012, became the main supplier of natural gas to the EU), Russia and Algeria, as new shippers looking to connect to Europe by pipeline, such as Azerbaijan and perhaps Iraq, through Turkey and the rest of south-eastern Europe, via the "southern corridor" (see *Transportation by watertight pipeline from Russia to Europe redirected to China. Azerbaijan and Turkmenistan take centre stage).*

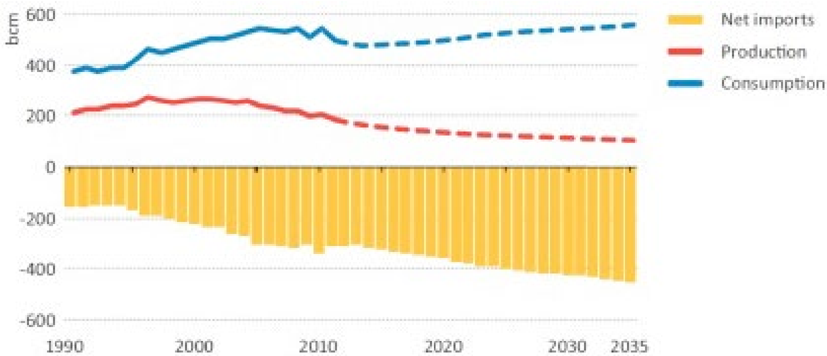


Figure 24. Balance of demand-production and net imports of natural gas into the European Union. Figures in billions of cubic meters (bcm). New Policies Scenario (IEA, WEO 2013).

The increased production in China and India is not enough to offset the increased demand

According to the IEA (WEO 2013), the Asia - Pacific region will be called upon in the next two decades, to undergo the most profound changes in the global natural gas markets, although the rate and extent of these changes are subject to a high degree of uncertainty. Apart from Japan and Korea, which can currently be considered to be mature markets, the IEA said that the region has great potential to increase its gas consumption, especially in those countries seeking to diversify their energy mix and address the issues of air quality and local pollution that are associated with coal combustion. However, the Asia - Pacific region is currently paying higher prices for internationally traded gas prices (a situation that according to forecasts by the IEA, shows few signs of changing in the future). This raises questions about its ability to purchase and whether it will be possible for the policy objectives to be imposed on economic factors, at least in some countries.

Japan, Korea and Taiwan, the traditional LNG importers in Asia, have been joined by China, India, Indonesia, Thailand and more recently, by Malaysia and Singapore. The IEA's forecasts suggest that increases in gas imports will be targeted at these new consumers, led by China (Table 10, figure 25), with certain import requirements that go from about 30.000 x 106 cubic metres (cm) in 2011 to 212,000 x 106 cm. in 2035, followed by India during that particular period, which will increase its imports by 60,000 x 106 cm. (Table 10). Part of these imports will be transported by pipeline to China, but most of it will be sent via tanker, as happens with LNG.

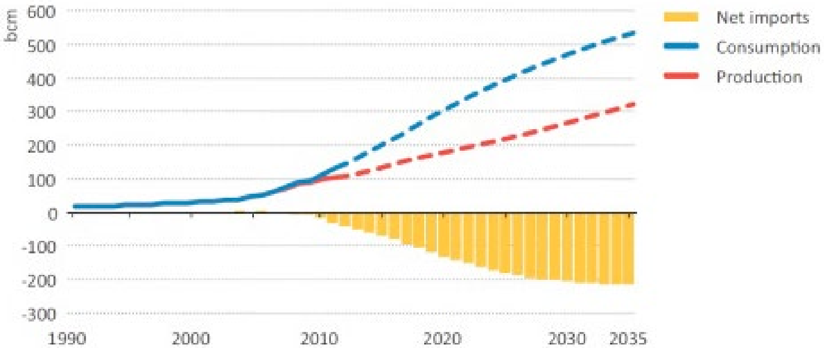


Figure 25. Balance-demand production and net imports of natural gas in China. Figures in billion cubic meters (bcm) New Policies Scenario (IEA, WEO 2013).

Transport by pipeline from Russia to Europe stagnates and it is to be redirected toward China. Azerbaijan and Turkmenistan take centre stage.

In the New Policies Scenario, the IEA (IEA, WEO 2013) thinks that the increase in the international trade in gas expected for the 2011 to 2035 period (close to 0,4 x 1012 cubic meters, see Table 10), just under half of which will be shipped via pipeline. This flow will not be affected by the developments in producing unconventional gas that were commented on in "Production of natural gas between 2012 and 2035. The unconventional gas revolution expands beyond U.S. and Canada."

In the field of exports by gas pipeline, the IEA predicts that the major developments will be focused on Eurasia. For European markets, it is relevant to take note of the announcement made by the consortium involved in the second phase of development of the Shah Deniz field in Azerbaijan, as regards the chosen route to market. The preferred option is that after crossing Turkey via the "Trans-Anatolian Gas Pipeline" (or TANAP), the exports from Azerbaijan should be routed towards Greece and Albania, and then it will go to southern Italy via the "Trans-Adriatic Pipeline" (or TAP). It will have a possible diversion from Albania towards Montenegro, Bosnia, Herzegovina and Croatia. Once the pipeline has completed, by 2020, it is expected to channel a flow of close to 10.000 x 106 cubic metres (cm) towards the south of Europe, with the possibility of this later on to be able to expand to the 20.000 x 106 cm. per year. The opening of this "southern corridor" for the 2011-2035 period enables an expansion of the exports from Azerbaijan, whose production could increase from its current 17.000 x 106 cm. to 47.000 x 106 cm. in 2035, and perhaps those from other countries, the most notable of which Iraq. The volumes channelled through the "southern corridor" are still very small compared to the European natural gas demand, but in any case, this is a step forward in the goal of the diversification and security of supply.

As regards the exports by pipeline from Russia, the IEA (IEA, WEO 2013) provides for the New Policies Scenario to increase only modestly during the 2011-2020 period, despite the potential increase in its export capacity which would result from the so-called "South Stream" and "North Stream" pipelines. The IEA believes that export growth via pipeline will be constrained by Russia's position with regard to the pricing mechanism in Europe, as the stubborn defence of a price indexed to oil could mean a loss of its market for Russia. However, from 2020 onwards and up to 2035, the IEA predicted a further expansion of Russian exports by pipeline, to the extent that trade changes orientation in this easterly direction and new connections between the gas fields of Eastern Siberia and China are opened up.

The latter, could also increase its imports via pipeline from Central Asia, where the current connection with Turkmenistan could be expanded to reach an annual capacity that is close to 60.000 x 106 cm and from Myanmar, a country with which China inaugurated a connection with an approximate capacity of 12.000 x 106 cm. per year in 2013.

The trade in liquefied natural gas (LNG) is reorganized due to the increasing domestic consumption in the Middle East and the emergence of new sources of supply from Australia, U.S. and Canada.

The IEA (IEA, WEO 2013) found that while the natural gas trade by pipeline will still be dominated by a few producers, located mainly in Eurasia (see preceding paragraph), the group of LNG exporting countries will undergo a major reorganization.

According to the IEA, some existing LNG exporters are already experiencing rapid growth in their domestic demand, which places limits on the annual turnover that they have available for exports. This trend is particularly noticeable in the Middle East, where Oman, the United Arab Emirates and Abu Dhabi could leave the ranks of LNG exporters, so that by 2020 there would only be Qatar and Yemen left, which could perhaps be joined by Iraq). Other countries that, for the same reason, may no longer be exporters are Egypt and Trinidad and Tobago.

Conversely, the market will see new players emerge and some of the existing ones will increase their market share. According to the IEA, globally, there are currently twelve LNG export plants under construction with a combined capacity of close to 130.000 x 106 cubic meters (cm) per year.

The plans are that this new capability will be ready for operation between 2015 and 2018, although the final date is highly conditional on what happens in Australia where seven of the twelve terminals mentioned and construction projects are located and these have been subject to delays and significant increases in costs.

Besides Australia, the new source of supply of LNG could be North America. According to the projections made by the IEA (IEA, WEO 2013), in the U.S. production is being called on to exceed domestic consumption, so that by 2035, the net exports from this country would reach almost 50.000 x 106 (cm) (table 10). If we add to these volumes, the ones that come from Canada, this would mean that North America would be in a position to export a volume of LNG that will be close to 50.000 x 106 cm. in 2020 and 75.000 x 106 cm. in 2035. In any event, the IEA noted that these projections are very sensitive to small changes in the forecasts of production and demand, so that small changes in these could have a major impact on the final balance of trade.

Along with the increase in exports of LNG from Australia and North America, the IEA projections included several new projects in East Africa, as well as expansions in capacity in some of the existing LNG exporters, among which Russia is included. The expansion of capacity in the latter country could have a special meaning if, as seems possible, the Rosneft and Novatek companies manage to get the rights to export LNG to Asian markets assured. This would constitute the first breach in the export monopoly that Gazprom has. During the 2011-2035 period, the IEA assumes the largest LNG import prices will be in the markets of the Asia-Pacific region, so this would be the most sought-after destination for most of the exporters of LNG, which would leave Europe in the role of the region that acts as the market balance.

Conclusions

Key conclusions regarding unconventional oil

I. At the end of 2011- excluding liquid fuels derived from coal and natural gas (CTL and GTL) - the estimates of the reserves and recoverable resources of unconventional oil that are available globally slightly exceeded the volume of conventional oil reserves and resources.

II. Without counting CTL and GTL resources, the industrialized OECD countries, only hold 15.6% of the technically recoverable oil and natural gas liquid global resources, which contain 62% of non-conventional oil resources. In late 2011, these were preferably located in North America, Eastern Europe, Eurasia and Latin America, counteracting the geopolitical importance of the

Middle East. This is a region that accounts for 42% of the reserves and resources of conventional oil. In any case, it should be noted that the potential of the conventional resources of the latter region remains unexplored.

III. During the 2012-2035 period, the share of total conventional crude oil production is to fall from 80% to 65%. Therefore, the increase in the level of production needed to meet the demand must come from other sources. These, along with natural gas liquids, include unconventional oil, whose contribution could multiply threefold in that period. These mainly come from the unconventional supplies of light tight oil in the U.S., the oil sands of Canada and the extra-heavy oil of Venezuela.

IV. The oil production levels of all of the countries outside OPEC will be maintained until approximately 2020, which represents an upward trend. Both the production of conventional oil as well as unconventional oil will increase, but the first peaks shortly before 2020. But then a few years later, these will decline in such a way that even the increased production in unconventional oil will fail to reverse the downward trend. The total oil production between 2012 and 2035 will fall in most of the countries outside OPEC, with the exception of Brazil, Canada, Kazakhstan and the U.S., although the latter's production level will go into decline before 2035.

V. From the mid-twenties onwards, OPEC will again occupy a key position in the global oil supply. From that date until 2035, light tigh oil production in the ultra-deep waters of Brazil and the U.S. will lose steam, the countries of the Middle East will assert themselves as the only source of relatively cheap oil in the world and Iraq will be developed on the largest contributor to overall production output growth.

VI. With regard to both conventional and unconventional oil, the balance of production during the 2012-2035 period, is clearly favourable to Iraq, Brazil, Canada, Kazakhstan and the U.S., while Russia, China, Norway, UK, Oman and Azerbaijan would be found at the opposite end, followed distantly by Argentina and Kuwait. Moreover, Venezuela, Qatar, Saudi Arabia and the United Arab Emirates would remain in a position of equilibrium position.

VII. In 2035, the percentage share of OECD countries in terms of global oil demand will fall to about 32%, as compared to 46.6% in 2012. In China, however, oil use has been increasing rapidly, so that, from 2030 onwards, that country will displace the U.S. as the main global consumer. India will also have emerged as a key centre for oil consumption, especially between 2020 and 2035, during which the country will experience the highest growth in global demand. Another relevant issue is that the Middle East will become the third largest centre of oil demand.

VIII. In the next two decades, the changing geography of the production and consumption of oil will lead to a major reorganization of global trade. The fate of the oil flow moves from the OECD area, where Europe will remain as the sole importer market, to Asia. In 2035 the world's two largest oil importers will be China and India, while the percentage of U.S. involvement in inter-regional trade in crude will decline from the 27% now to 15%. This reorganization of trade flows will require a re-assessment of the security policies for the oil supply. The big Asian countries should engage more in preventing and managing the effects of any potential disruptions in global crude supplies.

Key conclusions relating to unconventional gas

I. Regardless of gas hydrates, it is estimated that the reserves and recoverable resources of unconventional gas are equivalent to about three quarters of that of conventional gas. In late 2012, shale gas was representing approximately 61.8% of the total technically recoverable unconventional resources pending of explotation, as compared to 23.6% for tight gas and 14.6% for coal-bed methane.

II. Approximately 27.7% of unconventional gas resources are located in the Asia-Pacific region, 19.2% in the U.S. and Canada, 16% in Latin America, 13.4% in Eastern Europe, Eurasia, 14.2% in Africa, 5.5% in European countries integrated into the OECD, and only 3.8 % in the Middle East. This distribution helps to balance out the excessive concentration of conventional reserves and resources in the Eastern Europe-Eurasia region (mainly in Russia) and the Middle East, which accounted, respectively, about 30.6% and 26.5% of the reserves and technically recoverable resources of conventional natural gas in the world. However, the volume of unconventional gas resources in the Middle East has not yet been evaluated.

III. Between 2011 and 2035 natural gas production will grow in all regions, with the exception of Europe, where the increase in production in Norway will not be enough to offset the decline in other mature fields. China, USA, Russia and Australia (in that order), followed by Qatar, Iraq, Brazil, Turkmenistan, Iran and Algeria, are the countries will experience a greater increase in their production levels. Although the U.S. and Australia accounted for significant increases in production thanks to their unconventional gas resources, with both of them becoming net exporters. Thus, the countries outside the OECD would be responsible for about 81.75% of production growth.

IV. Regarding the increase in natural gas production that is expected in the world between 2011 and 2035, 52% would be contributed by unconventional gas while the remaining 48% would come from conventional sources. The forecasts are that from 2020 onwards, the development of unconventional gas production extends beyond North America (U.S. and Canada), turning China and Australia into the largest contributors to global output growth followed by other countries such as Argentina, India, Algeria, Mexico and Indonesia and the European Union, which is placed slightly above the latter three countries. Unconventional gas, which in 2011 accounted for about 17% of total world production of natural gas, could reach 27% in 2035.

V. The natural gas markets between 2011 and 2035 that will experience the fastest growth rates are located outside the OECD. Countries outside the organization will be responsible for over three quarters of the growth in demand during that period, with the highest growth in absolute terms being focused on China and the Middle East. In the OECD countries, although consumption will increase, the growth rates will be lower due to market saturation and the effects of the penetration of renewables in the electricity sector in Europe. However, the OECD markets will remain comparatively large, so that, for example, in 2035, demand in the U.S., -which continue to be the world's largest consumer- will be 50% higher than that of China.

VI. The inter-regional natural gas trade will continue to grow over the 2011-2035 period. During that period, on the basis of the exploitation of unconventional resources, some new exporters such as Australia, USA and Canada will take on greater relevance, and these will pose a certain degree of competitive challenge to the classical exporters like Russia and Qatar. During the 2011-2035 period, we will also see a continued shift in the direction of international trade in natural gas. The importer focus of this will move from the Atlantic basin (with the notable exception of Europe, which will remain the main importing region in the world) to the Asia-Pacific region.

VII. The increase in international trade in gas that is expected for the period 2011-2035 period will see just under half of it carried out via pipeline. This flow will not be substantially affected by advances in the production of unconventional gas and the major developments there will focus on Eurasia.

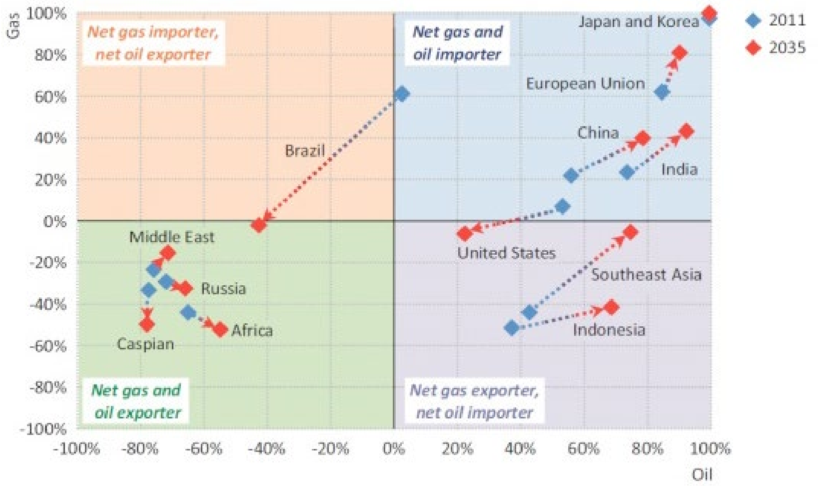
VIII. While the trade in natural gas via pipeline will continue to dominated by a few producers, located mainly in Eurasia (Russia, Azerbaijan and Turkmenistan), the group of exporting liquefied natural gas (LNG) will undergo a major reorganization. Some of the current LNG exporters are already experiencing some rapid growth in their domestic demand which sets limits on the volume they have that is available for export. This trend is evident in the Middle East, so that by 2020, only Qatar and Yemen (which could perhaps be joined by Iraq), will remain as exporters Other countries which, for the same reason, may no longer be exporters are Egypt and Trinidad and Tobago. Moreover, the market will see the emergence of new players, among them Australia, the USA and Canada, as the major producers of unconventional gas. Likewise, Russia could expand its share of the market, targeting leading LNG exports to Asia.

A final thought. Unconventional hydrocarbons and energy dependence: The divergent paths of the U.S. and Europe

Future changes in the New Policies Scenario of the IEA (IEA, WEO 2013) about the exports-imports balance of oil and gas in various countries and regions during the 2011-2035 period are summarized in Figure 26.

It clearly follows from this that one of the consequences of the rise of oil and unconventional gas in the U.S. is that during the period referred to, this country could achieve self-sufficiency and become a net exporter of gas, while potentially reducing its dependence on oil imports to 20% of its total consumption. This is completely opposite to the trend of other countries and regions, with the exception of Brazil, which is also experiencing a net positive development that is based on the exploitation of unconventional hydrocarbon resources.

In contrast to the United States, the European Union is undergoing particularly negative development, as its dependence on gas imports will increase from 60% in 2011 to 80% in 2035, while the dependence on oil imports during the same evolutionary period will go up from 80% to nearly 90%. Apart from the implications for the security of supply, these data imply an energy price in the European Union that is much more expensive. This undoubtedly will be a heavy burden for the competitiveness of their industries and a serious loss of purchasing power of their citizens.



Notes: Import shares for each fuel are calculated as net imports divided by primary demand. Export shares are calculated as net exports divided by production. A negative number indicates net exports. Southeast Asia, *i.e.* the ASEAN region, includes Indonesia.

Figure 26. Evolution over the 2011-2035 period in the percentages of net exports and net imports of oil and gas in some countries and regions. New Policies Scenario (IEA, WEO 2013).

China and India and other Asian countries and regions show something similar to the trend of the European Union in their degree of dependence on imported oil, although theirs is less dramatic, while the large conventional hydrocarbons producing countries of the Middle East, Russia, Africa and the Caspian region, barely vary their places.

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