

NATURAL GAS DEMAND : A REVIEW OF THE INTERNATIONAL ENERGY AGENCY PROJECTIONS

This first issue of "CEDIGAZ insights" is devoted to a review of **energy demand forecasts** delivered in November by the International Energy Agency (IEA) in their annual "World Energy Outlook-2009".

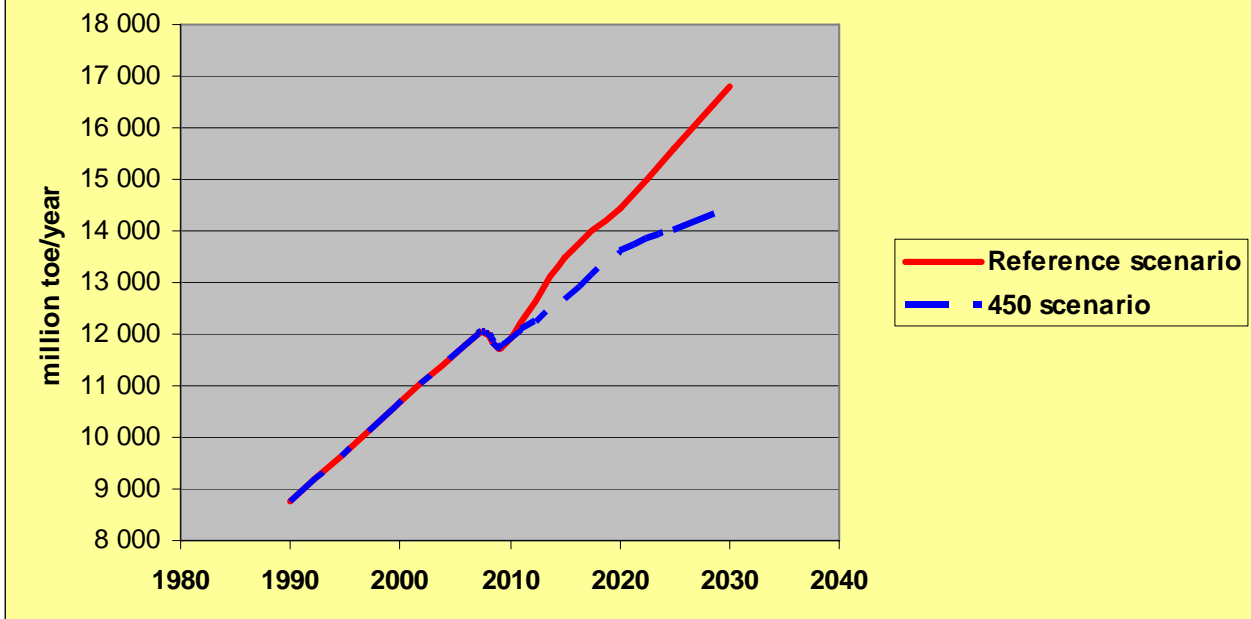
The purpose is not to summarize the study but to highlight and illustrate some of the key findings regarding the demand and more specifically the natural gas demand. In a first part, we review the projections of energy demand and energy mix to the horizon 2030. The purpose is then to focus on the gas sector and we illustrate the outcomes with the examples of five countries or regions of interest: USA, EU, Russia, China and India. At the end we compare the findings to those of the Department of Energy (USA) in their latest International Energy Outlook (march 2009).

Further CEDIGAZ reports or dedicated "CEDIGAZ Insights" will address the perspectives on reserves, production and trade of natural gas. For that reason, these subjects are not covered in this review of the IEA report.

The IEA emphasizes the need to adopt cost-effective solutions to avoid severe climate change and also enhance energy security. Therefore and similarly to 2008 the IEA proposes two scenarios:

- a "business-as usual"-type scenario which reflects the growing world energy needs but which takes into account the climate change policies who have been enacted up to the end of 2008 and which also takes into account the effects of the current economic crisis. It is the IEA "Reference Scenario" where the energy demand increases by 40% between now and 2030.
- a "450 scenario" which aims to limit the long-term concentration of greenhouse gases in the atmosphere to 450 parts per million of carbon-dioxide equivalent. The purpose of this limitation is to keep the global temperature rise to around 2°C (compared to a projected rise of up to 6°C before the end of the century in the business-as usual case). The "450 scenario" aims to demonstrate that a deep transformation of the energy usage including the development of energy efficiency policies and measures, low-carbon technologies, transportation solutions makes possible the containing of the climate change.

Figure 1: Projected primary energy demand
drafted from IEA scenarios



Energy demand and energy mix

In the "Reference Scenario", world energy demand is projected to increase by 40% between 2007 and 2030 to reach 16.8 billion tonnes of oil equivalent (toe), an average growth rate of 1.5% per year (which is very dissimilar between OECD and non-OECD countries). The economic crisis is reflected through the drop in energy demand in 2009 (around 2%). But economic recovery would possibly be underway in 2010. Demand will rebound thereafter with a projected growth of 2.5% over the 2010-2015 period followed by a less steep growth after 2015. (Figure 1)

Who will drive the demand?

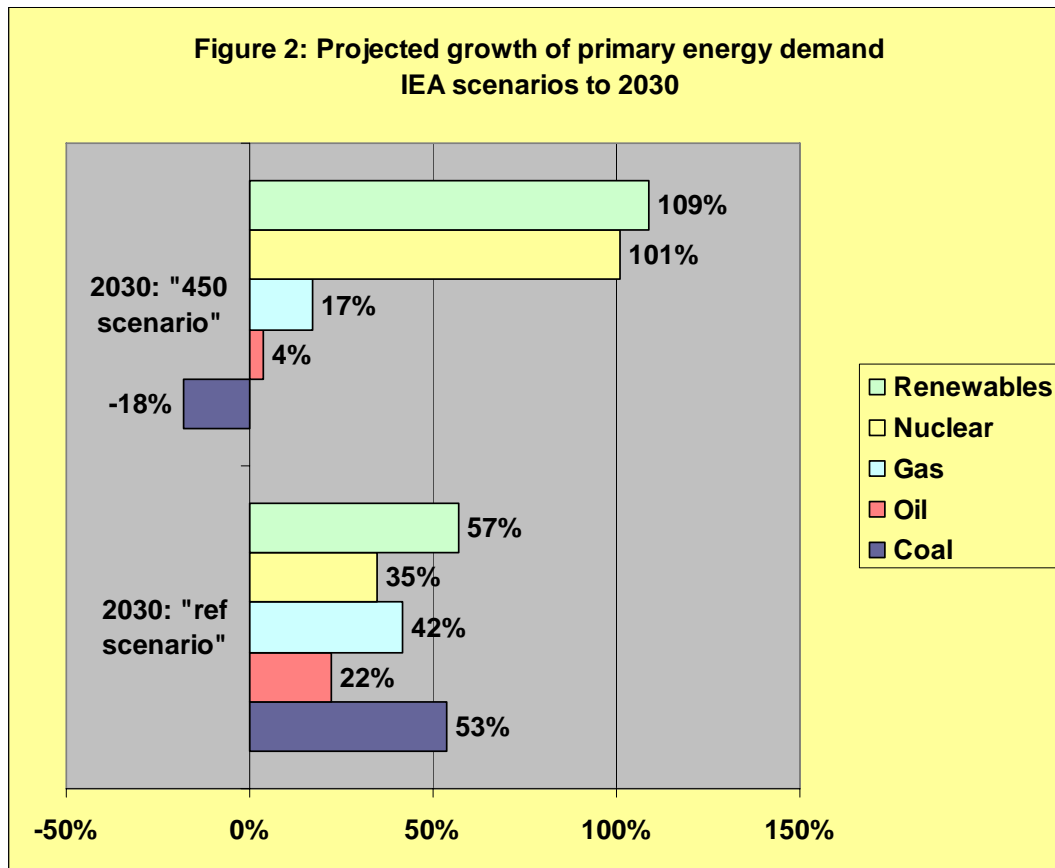
Asia and also Middle East (+89 %) are the main drivers of demand (China + 116%, India +82%). Conversely European Union (+1%), USA (+3%) experience a low increase of demand over the whole period or even a decrease (case of Japan, -5%) .

Which sectors to drive the demand ?

Regarding demand sectors, power generation is the essential driver for coal and natural gas with 80% of the growth taking place in non-OECD countries. In the "Reference Scenario", coal will grow to a share of about 44% and gas will slightly decrease (in relative terms) to about 21% of primary energy for power generation.

What is the projected energy mix in 2030 ?

In the "Reference Scenario", fossil fuels account for more than 75% of the global increase of energy demand between 2007 and 2030. In relative terms, renewables will increase by 57%, following the policies already enacted. But also in relative terms, coal will increase by 53%, natural gas by 42% and oil by 22% (Figure 2)



In particular oil is projected to grow from 85 million barrels per day in 2008 to 105 mbd in 2030 (excluding biofuels), mainly due to the demand in the transportation sector. From various sources, it is not clear whether this level of oil production can be reached. Conventional oil from non-OPEC producers is peaking around 2010, so that the increase will have to come from OPEC countries.

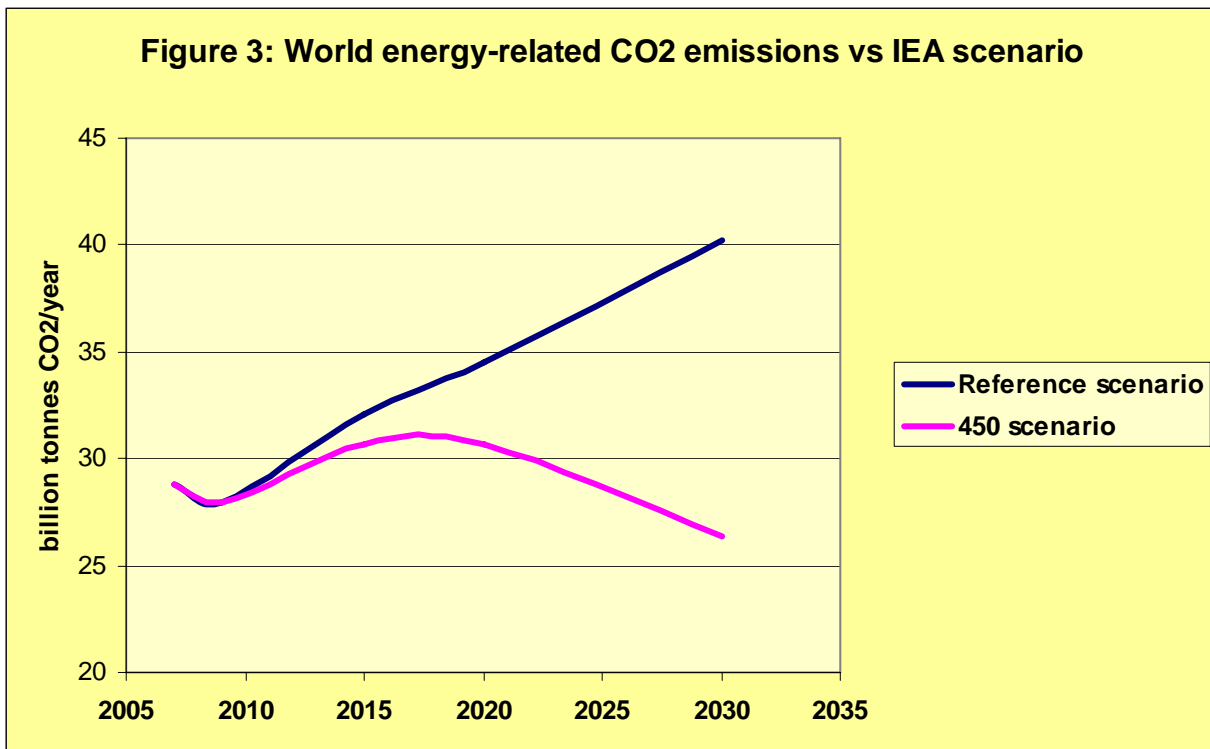
In the "Reference Scenario", the share of coal in the energy mix is projected to grow to 29% (Table-1). The natural gas is slightly increasing to 21% and the oil is decreasing from 34% to about 30% (although in absolute terms it will increase by 20 mbd).

Table-1: Projected primary energy mix

	2007	2030 "reference scenario"	2030 "450 scenario"
Coal	26,5%	29,1%	18,2%
Oil	34,1%	29,8%	29,5%
Gas	20,9%	21,2%	20,4%
Nuclear	5,9%	5,7%	9,9%
Renewables	12,6%	14,2%	22,0%
Total primary energy demand	100,0%	100,0%	100,0%

According to the IEA the "Reference Scenario" is not sustainable:

The rapid rise in energy-related CO₂ emissions (40.2 Gt in 2030, increase of 40% from 2007) is leading to long-term concentration in the atmosphere above 1000 ppm CO₂-eq and average temperature rising of about 6°C (Figure 3).



In addition, there appears an important issue regarding the security of energy supplies: massive imports of oil in non-OECD countries (China, India) but also significant rise of gas imports in Europe and developing Asia. This dependence involves a high level of spending on energy imports.

What are the fundamentals of the "450 scenario" ?

The IEA has adopted a consensus which advocates the need to limit the global temperature increase to 2°C. And this objective involves to stabilize greenhouse gases emissions at a level around 450 ppm CO₂-equivalent.

Consequently, according to the IEA, global energy-related CO₂ emissions could peak at a maximum 30.9 billion tonnes (Gt) in 2020 and decline to 26.4 Gt in 2030: 13.8 Gt below the emission level projected in the "Reference Scenario" (34% less in relative terms).

This objective entails drastic changes in the projected growth of primary energy demand which are reflected in the above figures:

- OECD countries will have to significantly decrease the primary energy demand and other countries will have to seriously limit the rate of growth of energy inputs (Figure 1): energy efficiency policies and measures are the key elements in all sectors of the economies.
- the energy mix will have to be significantly altered. Over the whole period 2007-2030:
 - o coal demand to be reduced by 18% at the end of the period after peaking (+10%) around 2020
 - o oil demand to increase by 4% only
 - o natural gas demand to increase by 17% (instead of 42%)
 - o nuclear power to double to reach about 10% of total energy demand
 - o renewables more than double to reach a share of about 22% in the energy mix

We shall not develop here the various solutions, steps and conditions that are listed by the IEA to reach the objective. In Cedigaz we feel it is a **tremendous challenge** to reach the objectives set out in the

scenario, including the intermediate objectives which are highlighted to the horizon 2020, in a 10 year period only, from now. It is like a revolution as qualified by the IEA itself.

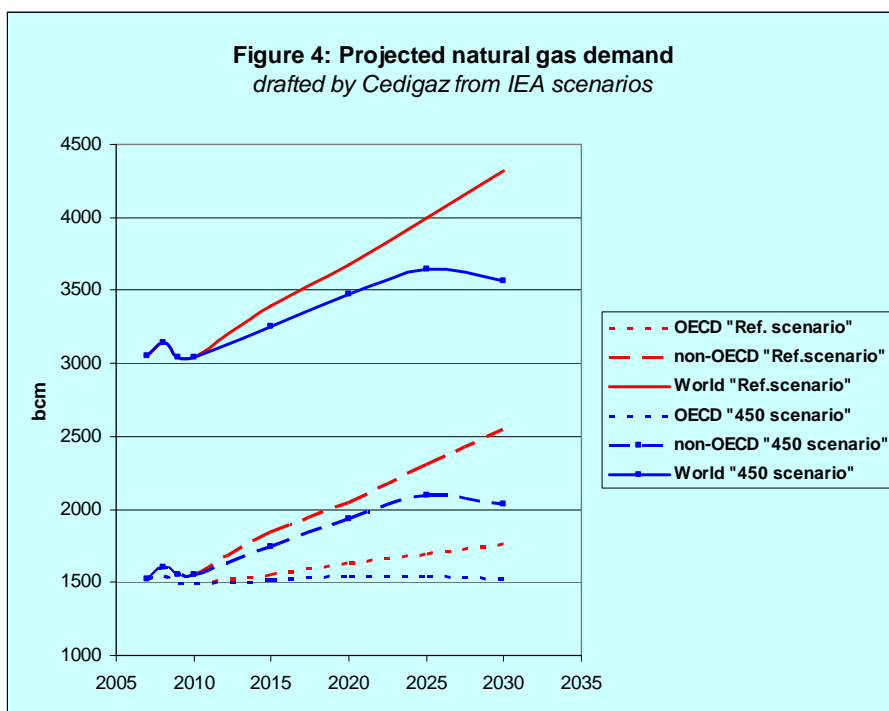
Then, considering the proposed scenarios, what are the long term projections for natural gas ?

Natural Gas demand

It is expected that from 2010 natural gas will resume the long-term upwards trend. The demand is set to grow whatever the scenario and it is expected that the share of natural gas will remain at the level of 20 to 21% in the global energy mix

In the "Reference Scenario", global gas demand will grow by 42% from 3.0 trillion cubic metres (tcm) in 2007 to 4.3 tcm in 2030, an average rate of increase of 1.5% per year. Due to the economic crisis, it is expected that worldwide, primary gas demand is falling in 2009 –IEA estimates a possible decline of 3%. But the economy is assumed to start recover by 2010, so that total gas demand will likely rebound at an estimated rate of 2.1% per year between 2010 and 2015.

Non-OECD countries account for more than 2.5 tcm in 2030 and for more than 81% of total demand growth over the period. Middle East has the highest absolute growth, with consumption rising from 294 bcm in 2007 to 602 bcm in 2030. China and India show the highest rate of growth over the period (their consumption is multiplied by about 3).



In the 450 Scenario, world primary gas demand grows by 17% between 2007 and 2030 (plus 510 bcm), but is 17% lower in 2030 compared with the "Reference Scenario". A peak in gas demand is projected around 2025 (Figure 4).

Non-OECD regions increase their demand over the period. Asia and Middle East have a continuous growth up to 2030. Other regions are projected to experience a peak in demand around 2020-2025 and then decline slightly to 2030. At the end of the period, 100% of the world gas demand growth is due to non-OECD countries.

How can we explain the reduction in demand compared to the "Reference Scenario" ?

Natural gas demonstrates a higher competitiveness than other fossil fuels due to higher carbon prices and application of emissions regulations. Nevertheless it is expected in the "450 Scenario" a large development of energy savings and low-carbon technologies which reduce the growth of natural gas demand, particularly at the end of the period.

**Table-2a: Change in gas demand 2007-2030
derived from IEA "Reference scenario"**

	total growth of demand, bcm	gas in power generation, % growth	gas in industry, % growth	gas in other sectors, % growth	%gas in total energy demand in 2030
World	1264	48%	35%	39%	21%
USA	-6	1%	-12%	2%	22%
EU	93	36%	3%	11%	29%
Russia	47	-5%	37%	30%	50%
China	169	360%	163%	231%	5%
India	93	323%	186%	192%	9%

**Table-2b: Change in gas demand 2007-2030
derived from IEA "450 Scenario"**

	total growth of demand, bcm	gas in power generation, % growth	gas in industry, % growth	gas in other sectors, % growth	%gas in total energy demand in 2030
World	511	17%	18%	17%	20%
USA	-29	25%	-25%	-15%	25%
EU	-17	-5%	-3%	-2%	25%
Russia	-48	-23%	7%	6%	48%
China	125	250%	100%	191%	6%
India	93	385%	171%	138%	10%

Looking to Table 2a and 2b, it appears that the biggest reductions in gas demand compared to the "Reference Scenario" are achieved in power generation (minus 21% in 2030). Total generated power is less than in the "Reference Scenario" by 13%. In addition, it is expected in the "450 Scenario" that in most regions, the power sector is subject to carbon pricing under a CO₂ cap-and-trade scheme, favoring nuclear power and/or renewables. The share of gas in power generation remains around 20% (a world average in all scenarios).

Industry and other sectors are also significantly affected by the reduction in gas demand compared to the "Reference Scenario". In particular significant savings of natural gas are projected in buildings due to improved insulation and more efficient heating and cooling. In industry efficiency gains reduce the gas demand by 13% (compared to the "Reference Scenario")

Compared to the "Reference Scenario", projected reductions in gas demand in 2030 can be figured as follows on a regional basis:

- OECD countries: minus 234 bcm (minus 15%)
- non OECD countries : minus 520 bcm (minus 20%)

The total projected reduction (754 bcm) is split between OECD countries (31%) and non-OECD countries (69%)

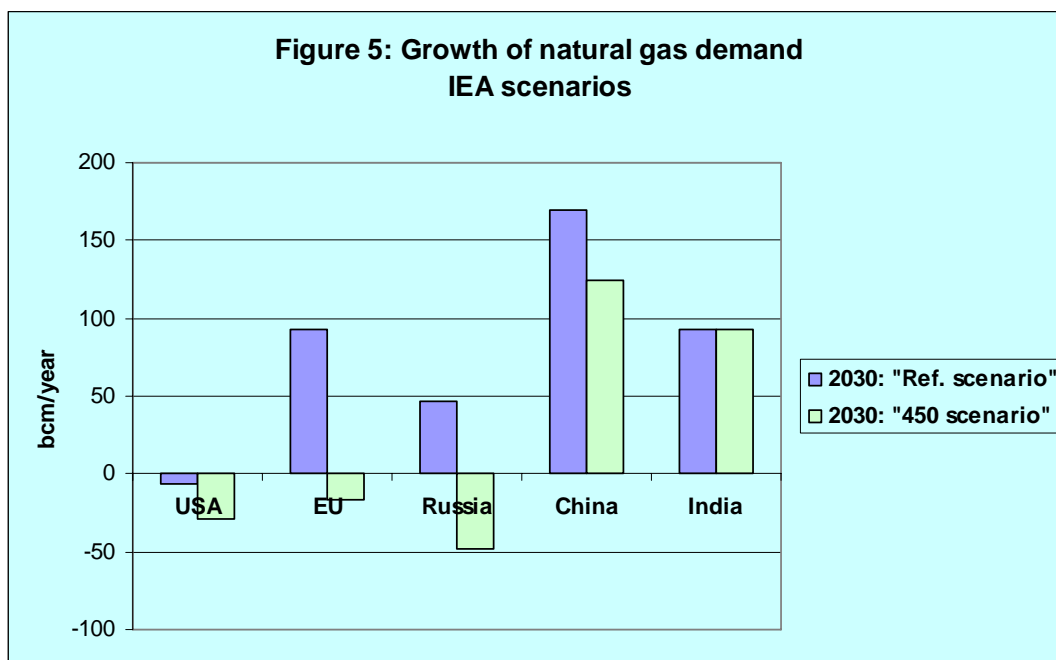
Regional examples

USA

In the "Reference Scenario" the United States experience a marginal decline of gas demand to the horizon 2030. In the power sector, older plant are retired and replaced by more efficient combined-cycle gas plants (CCGTs) and open-cycle plants.

In addition, residential demand for gas rises only very slowly while industrial demand falls slightly over the projection period.

The 450 Scenario shows a significant decrease in gas demand (-4%) compared to 2007. It is projected that electricity generation although higher than in 2007 will be much lower than in the "Reference Scenario" (-9%). Then, the lower electricity demand, combined with the effect of carbon pricing, strongly influences the composition of the pool of electricity generating plants over the projection period. As carbon prices increase, coal-fired plants are retired in greater numbers, to be replaced by gas plants, more renewables and nuclear power.



European Union: Gas demand in Europe has been severely affected by the economic slowdown with lower industrial and electricity demand and it will take time before demand recovers to the levels seen in 2007-2008. Nevertheless, the fundamental drivers continue to favour gas demand in Europe throughout the projection period, particularly the use of gas for electricity generation in efficient combined-cycle gas turbines. Clear signals for carbon prices coming from the EU Emission Trading System can also improve the position of gas versus coal, since coal-fired generation produces around twice the amount of CO₂ per unit of electricity generated.

In the "Reference Scenario", gas demand is projected to recover the 2008 level around 2015 and then it is projected to rise steadily to 619 bcm in 2030 (a growth of 93 bcm or + 18% compared to 2007). Gas demand for power generation increases more quickly than in other sectors (growth of 51 bcm, i.e. 55% of total gas growth over the period).

In the 450 Scenario, it is assumed that the EU adopts stringent targets to reduce greenhouse-gas emissions by 2020 that affect both industry and power generation, and that these are intensified in the period to 2030. Total electricity generation is projected to be lower than in the "Reference Scenario" (minus 3.6%) but the share of gas is estimated much lower (only 18% of total electricity generation). In this scenario, nuclear is taking 30% and renewables (including hydro) are taking 44% of total electricity generation. At the horizon 2030, the total demand of natural gas is projected to 509 bcm, a reduction of 110 bcm compared to the "Reference Scenario", and a reduction of 17 bcm compare to 2007 level.

Russia: natural gas represents a very important part of the primary energy demand (55% in 2007 with 453 bcm). But further to the recession and taking into account significant improvements in efficiency those levels of demand will not be reached before 2020. Nevertheless, the "**Reference Scenario**" anticipates a total consumption of 500 bcm in 2030 (a growth of 10% compared to 2007). Power generation is projected to 50% of total gas demand.

In the **"450 Scenario"**, gas demand in Russia does not return to 2007 levels. A peak of demand is anticipated before 2020 (about 450 bcm) and consumption falls slowly back to 405 bcm in 2030. According to the IEA: "While this appears to be a dramatic change in the pattern of gas use in Russia, such a scenario is consistent with some of Russia's own ambitions with regard to efficiency and gas saving". In this scenario, power generation represents 43% of total gas demand.

China: Natural gas plays a very small part of energy demand with only 3% in 2007 with 73 bcm. The energy market is dominated by coal (66% of energy demand in 2007). In the **"Reference Scenario"** the annual growth rate of gas demand is estimated to 5.3% over the period. But the share of gas is to reach about 5% only of total energy demand in 2030 with 242 bcm. Power generation is projected to take 26% of total gas demand growth and industry 22%.

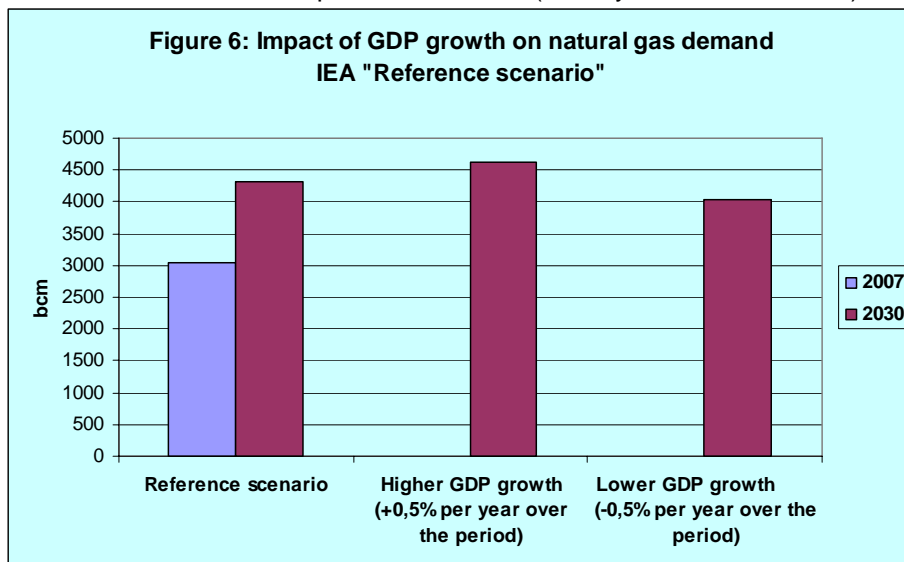
In the **"450 Scenario"** coal remains the dominating resource with 47% of total primary demand. Nuclear and renewables are projected to displace a large share of coal in the power sector. Electricity generation itself is projected lower (minus 21%) than in the "Reference Scenario". The growth of natural gas is lower with 4.4% per year over the period and a total demand of 198 bcm in 2030

India: As in China, natural gas plays a limited role in the current energy mix (5.5% with 39 bcm in 2007). But consumption is to double to 2015 (major new gas fields are brought on stream). Natural gas is used mainly in the power sector (40%), for non-energy use (fertilizers, chemicals) and in the industry (21%). In the **"Reference Scenario"** natural gas consumption is to grow 5.4% per year to reach 132 bcm in 2030. Main uses are projected in the Power sector (49% of gas demand and 52% of demand growth). In the **"450 Scenario"**, the total gas demand is set equal to the "Reference Scenario" in 2030 with power sector taking 56% of gas demand and 79% of demand growth.

Natural Gas demand & GDP growth

Energy projections are very sensitive to GDP growth. As many uncertainties remain regarding the pace of economic recovery and exchange rates, the IEA has worked out a sensitivity analysis:

- a higher GDP Sensitivity Case with a world GDP growing by an average 0.5% per year more than in the "Reference Scenario" over the period 2007-2030 (namely 3.6% versus 3.1%)
- a lower GDP Sensitivity Case with a world GDP growing by an average 0.5% per year less than in the "Reference Scenario" over the period 2007-2030 (namely 2.6% versus 3.1%)



Impact to the demand of natural gas are shown on Figure 6. In the higher GDP growth, natural gas demand is increased by 52% in 2030 in the "Reference Scenario" instead of 41%. In the lower GDP growth, natural gas demand is growing by 33% in 2030. Global differences are highly significant.

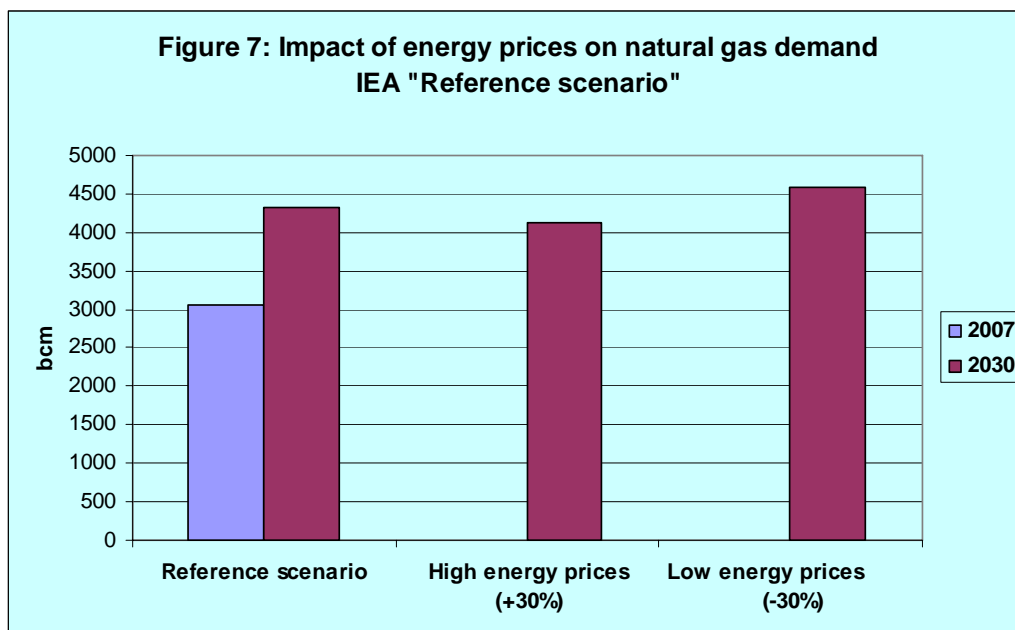
Natural Gas demand & energy prices

In the "Reference Scenario" the IEA has worked out assumptions for the evolution of gas prices in 2030 (in constant 2008 dollars):

- 11.4 \$/Mbtu for US imports
- 14 \$/Mbtu for European imports
- 15.9 \$/Mbtu for Japan LNG imports

These assumptions are deemed consistent with an evolution of average IEA crude oil import price to 115 \$/bbl in 2030.

Energy demand is sensitive to the price of energy. That is why the IEA has developed a "Higher Prices Sensitivity Case" and a "Lower Prices Sensitivity Case" assuming that the average IEA crude oil import price is 30% higher and lower, respectively, than in the "Reference Scenario" in 2030 . Similarly, prices for coal in 2030 are 30% higher and lower, as are natural gas prices (which are indexed to oil) in Europe and the Pacific. Natural gas prices in North America change by a more modest 20%, as prices in this market are driven directly by supply/demand fundamentals.



Impact to the global gas demand are illustrated on Figure 7.

In the higher price case, natural gas demand grows only by 35% over the period (instead of 41% in the "Reference Scenario" (total energy demand decreases and natural gas loses ground against renewables and nuclear in power generation) On the contrary, in the lower price case, gas demand grows by 50% over the period (total energy demand increases and the share of natural gas increases).

Comparing the IEA and US (DOE) projections

In may 2009, the Energy Information Administration have produced their "International Energy Outlook 2009" covering energy markets to the horizon 2030. At the date of issue it was difficult to assume the fall in energy demand likely to occur in 2009 and the probability of economic recovery in 2010 or 2011. The EIA have not issued a specific scenario taking into account reinforced measures to limit the emissions of greenhouse gas, but a "Reference Case" which is a likely scenario in their opinion. The "Reference Case" has been completed with alternative studies to account for major uncertainties:

- the High Economic Growth Case Projections which assumes a 4% GDP average world annual growth compared to 3.5% for the "Reference Case". This case shows a 10% increase in gas demand in 2030.
- the Low Economic Growth Case Projections, assuming a 3% GDP average annual growth. The projected impact is a reduction of 9% of gas demand in 2030.
- the High Oil Price Case Projections assuming the "world oil price" reach 200 \$/bbl instead of 130 \$/bbl in the "Reference Case". As a consequence, the gas demand is estimated 6% higher than in the "Reference Case". This result is in contradiction with the IEA "Higher Prices Sensitivity Case" which estimates significant reduction in gas demand with higher energy prices. In the DOE scenario, total energy demand decreases by more than 3% but the share of gas in the energy mix grows from 23% ("Reference Case") to more than 25%. It may be that gas prices are not so much coupled to crude oil prices in the DOE model.

- the Low Oil Price Case Projections assuming the "world oil price" to decline to 50\$/bbl around 2015 and remain at that level through 2030. But this case has practically no effect on the gas demand in 2030, according to DOE.

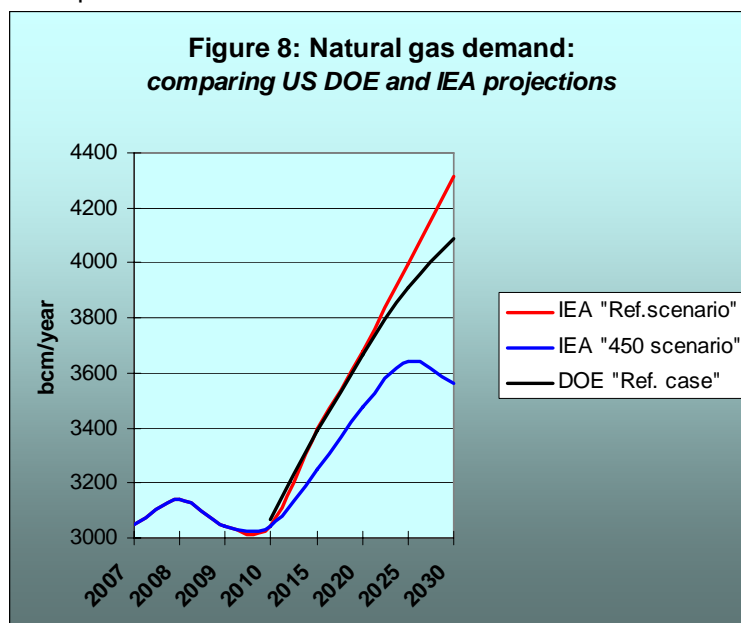
The basis for both IEA and DOE "Reference" case or scenario differs mainly on the assumption of GDP growth: 3.1% for IEA against 3.5% for DOE. One reason may have been the difficulty to assess the impact of the economic crisis and the pace of recovery at the beginning of 2009 (DOE). The price level of energy are not too dissimilar in both cases: the average price of crude oil is assumed to grow to 115 \$/bbl in 2030 for the IEA and to 130\$/bbl for the DOE.

Regarding CO₂-emissions, the outputs of IEA and DOE are similar with energy-related emissions of 40 Gt in 2030 for their reference case.

Figure 8 illustrates the natural gas demand in both cases. Global (world) consumption is similar up to 2020 and differs there after. The reason may be the level of energy prices as demonstrated by the sensitivity analyses. It may be also that the DOE "Reference Case" introduces a greater impact of energy savings and low-carbon technologies after 2020 (but less than the IEA "450 Scenario").

In both cases, OECD countries show approximately the same demand. The main difference is for non-OECD countries where the demand in 2030 is projected to be about 400 bcm lower in the case of DOE (minus 16%), with Middle East showing the main difference (minus 160 bcm in absolute terms or minus 26%). For the Middle East, the IEA has estimated an annual growth rate of gas demand of 3.2%; instead DOE is predicting 2%. DOE notes the limitation of intra-regional infrastructure in the Middle East.

Nevertheless the general key findings are similar: The share of natural gas in the energy mix is estimated to a range 21% (IEA) to 23% in 2030 (DOE). For the DOE "in the non-OECD countries natural gas demand grows more than twice as fast as in the OECD countries". In 2030 the non-OECD countries will account for 58% of consumption.



Conclusions

Both the IEA "Reference Scenario" and US DOE "Reference Case" are not judged sustainable by the IEA from the point of view of CO₂ emissions. The new "450 Scenario" proposed by the IEA involves tremendous changes in the use of energy and the structure of the energy sectors. The "450 Scenario" emphasizes that "end-use efficiency is the largest contributor to CO₂ emissions abatement in 2030, accounting for more than half of total savings in the "450 Scenario" compared with the "Reference Scenario". According to the IEA, "The cost of the additional investments (*estimated to 10.5 trillion \$ more than in the "Reference Scenario"*) needed to put the world onto a 450-ppm path is at least partly offset by economic, health and energy-security benefits. Due to the lower carbon content of gas relative to coal and oil **"Natural gas will play a key role whatever the policy landscape"**.