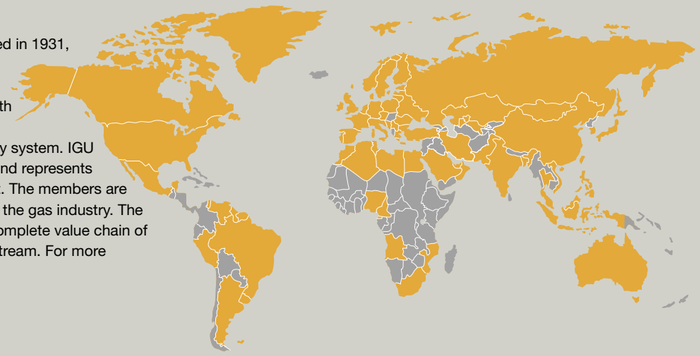
IGU

The International Gas Union (IGU), founded in 1931, is a worldwide non-profit organisation promoting the political, technical and economic progress of the gas industry with the mission to advocate for gas as an integral part of a sustainable global energy system. IGU has more than 110 members worldwide and represents more than 95% of the world's gas market. The members are national associations and corporations of the gas industry. The working organization of IGU covers the complete value chain of the gas industry from upstream to downstream. For more information, please visit www.igu.org.



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NATURAL GAS INDUSTRY STUDY TO 2030: AN UPDATE ON SUPPLY, DEMAND AND TRADE

25TH WORLD GAS CONFERENCE

25th world gas conference
“Gas: Sustaining Future Global Growth”
Kuala Lumpur, Malaysia
4 - 8 June 2012

natural gas industry study to 2030:

an update on supply, demand and trade

2009 – 2012 Triennium Work Report

June 2012

Natural Gas Industry Study to 2030

- New Horizons for Supply, Demand and Trade

Produced by:

PROGRAM COMMITTEE B: STRATEGY

International Gas Union

Chair: Dr Colin Lyle, United Kingdom

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Foreword

This summary report presents work carried out during the Malaysian Presidency of the International Gas Union, culminating in the World Gas Conference in Kuala Lumpur in June 2012. The purpose is to update the supply, demand and gas trade data that was used in the comprehensive global gas industry analysis to 2030 presented at the last World Gas Conference in Buenos Aires in October 2009.

IGU Strategy Committee (PGCB) has re-analysed the regional projections of gas supply, demand and trade at a time of unprecedented global gas price arbitrage and with a background of economic and political turmoil and uncertainty in many parts of the world. The results not only confirm the key conclusions from the 2009 report, but show that a substantial increase in the world gas market during the next two decades would provide policymakers, business leaders and citizens with an energy platform for sustaining global growth.

Despite the economic downturn of the last few years, our experts grew in confidence that the global demand for natural gas will increase at a faster rate than was foreseen in 2009 and with abundant gas supplies able to maintain this growth. They also challenged and re-analysed the IGU Green scenario, discovering that green policies could play out quite differently in different regions. But overall, the new IGU sustainability scenario requires a significant increase in natural gas to enable politically and economically acceptable energy solutions to be implemented in each region.

This report shows that by 2030 the world will need to increase its global gas supply and demand by some 50% and to support this will require enhanced international pipeline and LNG trade. Challenging indeed! But the good news for investors is that this should be a 'no regrets' solution, if we seize the opportunity.

Colin Lyle
Chair, IGU Strategy Committee

Ho Sook Wah
Chair, IGU Coordination Committee

Acknowledgements

This report this is based entirely on work carried out by the IGU Strategy Committee. This committee comprises more than 130 experts from gas companies and related institutions throughout the world. The main results presented are the work of our study group on world gas supply and demand to 2030 that was expertly led by Jaap Hoogakker of GasTerra, The Netherlands. Jaap drew on the wider experience of our global network to coordinate the input and analysis from the eight IGU regions:

- Blaise Poole for North America,
- Carlos Eduardo de Freitas for Latin America & Caribbean,
- Thomas Dirksmeyer for Europe,
- Anne-Sophie Corbeau and Saeed Ghavampour for The Middle-East,
- Fethi Arabi for Africa,
- Tatiana Mitrova for CIS,
- Anne-Sophie Corbeau for Asia,
- Hiroshi Hashimoto for Asia Pacific.

I would like to pay particular tribute to this international team for supporting each other through unforeseen difficulties, challenging our internal information and analysis to ensure consistency and delivering a comprehensive dataset on which this summary report is based.

To gain better insight into supply, demand and trade patterns, it is important to understand the economic and political drivers. Whilst our focus in this report is to update supply and demand, we must take account of the crucial role that the price of gas has in determining longer-term investment decisions and the trading patterns that will ultimately occur. This report therefore starts by presenting some fundamental observations from the exhaustive work of our study group on wholesale gas price formation led by Mike Fulwood of Nexant UK Ltd. Mike's IGU Study Group has not only analysed gas price formation trends throughout the world, but through colleagues in the Strategy Committee they have obtained global coverage of actual wholesale gas prices to ensure that there is a solid basis for their results.

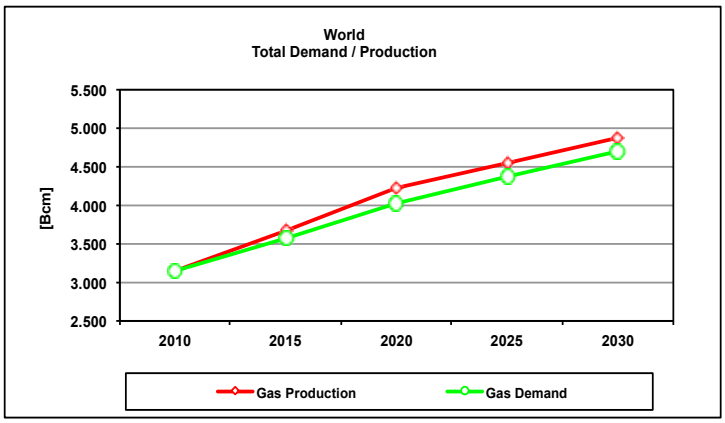
Many people have contributed the various data used in this report and I would like to thank them all. Unless otherwise attributed in the report, any views expressed are collectively those of the IGU Strategy Committee and are usually explained further in the full PGCB Strategy Committee Report that is also being presented at the World Gas Conference in Kuala Lumpur in June 2012.

Finally, I would like to pay tribute to Mr. Ho Sook Wah, Chairman of IGU Coordination Committee for his support and encouragement to complete this work.

Colin Lyle
Chair, IGU Strategy Committee

Executive Summary

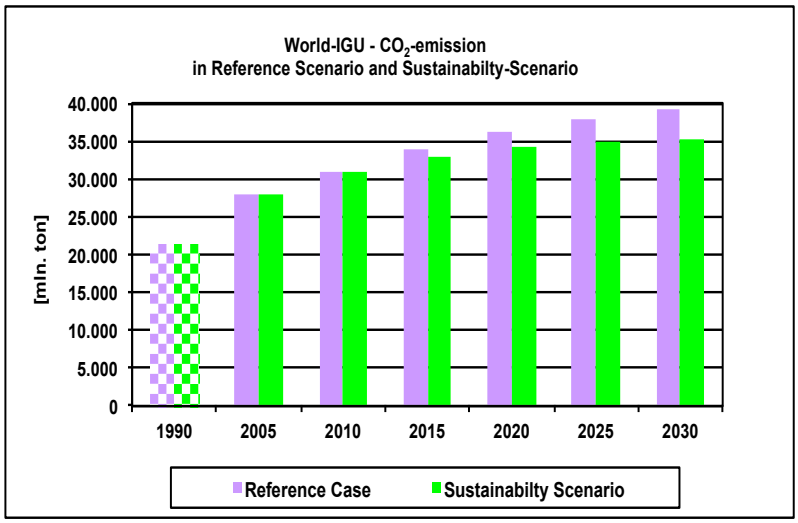
Global gas demand is expected to expand towards 4700bcm by 2030, supported by an increase of gas production potential and international trade that will sustain this growth over the next two decades. This 1.4% average annual growth rate is slightly higher than was anticipated in the 2009 IGU analysis.



The gas share of primary energy demand would rise from 22% in 2010 to almost 25% in 2030. Gas market growth should occur, albeit to very different extents, in every sector of every region throughout the globe. The most significant market sector growth should occur in power generation which could account for 1900bcm (40%) of the total gas market in 2030. The region with most significant growth in gas demand is Asia, driven by the continuing rise of the Chinese gas market.

Overall, commercial and regulatory trends suggest that 'gas-on-gas' prices will become the dominant global gas price formation mechanism well before 2030. Regulated gas prices will increasingly allow recovery of full economically incurred costs and some form of indexation to oil or oil products will still be of fundamental importance in several parts of the world.

Regarding climate change mitigation, the world is not currently on course for a reduction in CO_2 emissions, but there are practical and viable solutions that would level off CO_2 emissions well before 2030.



A Sustainability Scenario would enable Global Primary Energy Consumption to reduce slightly and the gas market share would increase from 22% today to 27% in 2030; gas market growth helping to stabilise global CO_2 emissions.

In addition to other balanced measures, a realistic and pragmatic view of 'Sustainability' is seen to require a further increase in global gas demand, to nearly 4.9 tcm by 2030.

Overall, this new update of gas supply, demand and trade strongly supports the key conclusions from the 2009 report:

- **Natural gas is an abundant fuel**
  In addition to extensive conventional gas reserves, technological developments for exploiting unconventional gas are further raising the prospect of ample, commercially viable gas resources. Unlike oil, gas resource potential is not a concern on a global basis.

- **Natural gas will continue to play a substantial role in global energy demand for many decades**
  Demand from traditional sectors and uses (such as power generation, heating/cooling, feedstock, etc.) will continue to increase, thereby contributing to environmental improvements through increased efficiency and low carbon content. In addition, natural gas will also play a new role as a complementary fuel to renewables by enabling increased deployment of energy supply from intermittent renewable technologies.

- **Through these two roles, natural gas will play a key role in helping to meet environmental targets**
  This is related to both local pollution reduction and climate change mitigation. Gas is an essential part of a sustainable global solution.

- **Market conditions are right for international trade of natural gas—and especially of liquefied natural gas (LNG)—to expand**, linking additional resources to fast growing markets. However, the growth will depend critically on the support for trade and investments from national and international policies and regulations.

- **The natural gas industry can and must invest through the current economic cycle** if it is to reach its full potential and bring economic and environmental benefits to humankind.

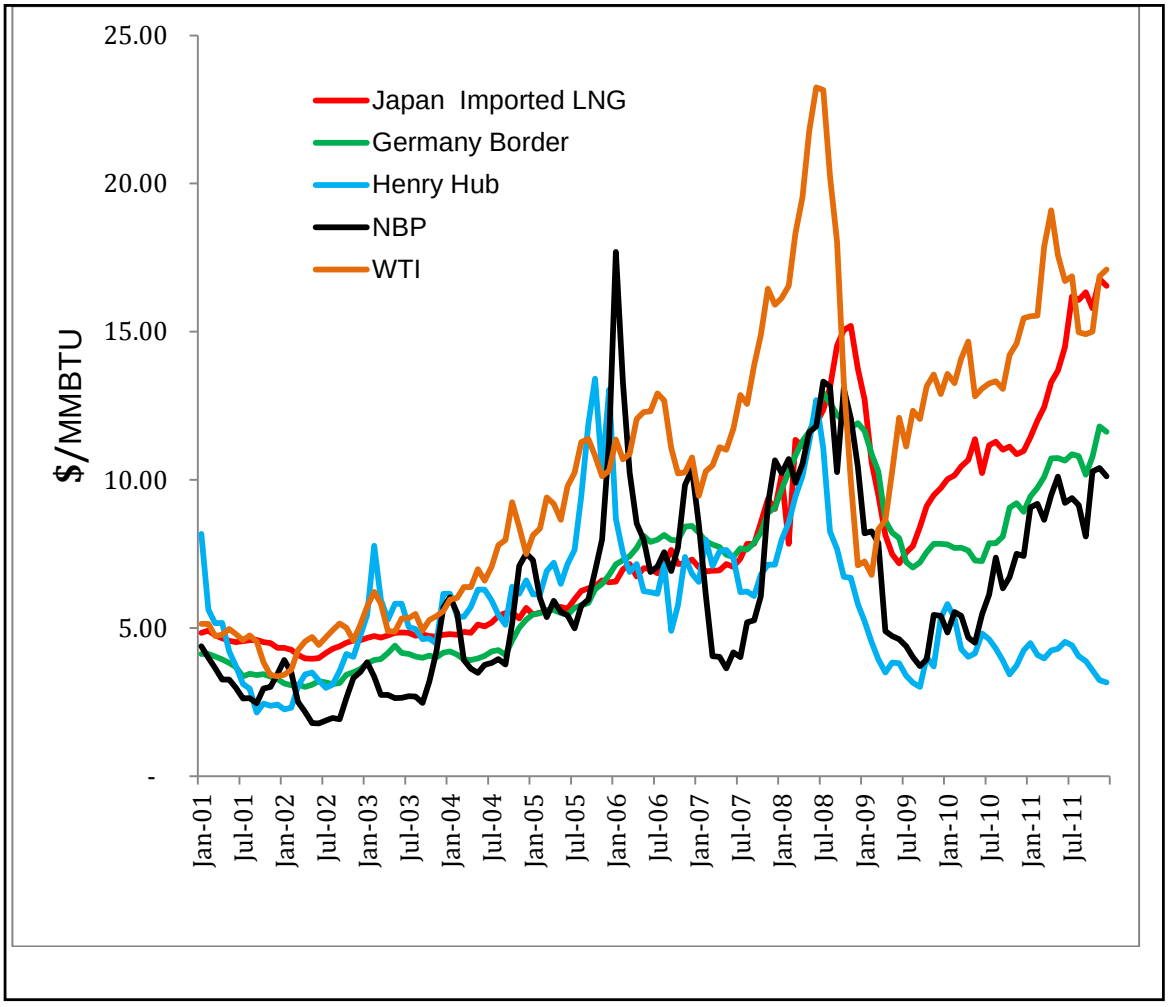
- **Political and geopolitical issues can threaten the continuous optimum economic development of the gas industry.** International agreements and solutions are needed to ensure that required investments in key parts of the gas chain are not delayed or impeded.

We can conclude that investing in natural gas should be a 'no regrets' solution. Whether or not action on climate change is a globally agreed policy objective, a growing global gas market should be an increasingly important part of our sustainable energy future.

1.0 Global gas price trends

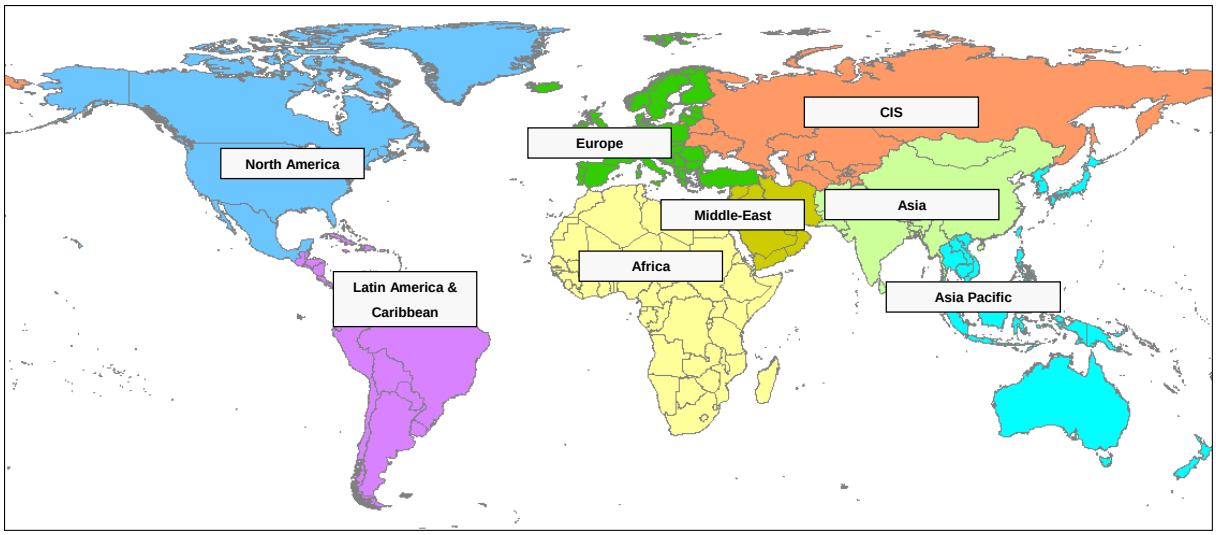
Whenever we look at the 21st century energy world, it appears to be in transition. It is clear that mankind will require more energy, but beyond that there seems to be a bewildering range of uncertainties in energy supply, demand and prices. Gas is no exception. During the last decade the world of natural gas has become physically more interconnected, with major international pipelines and outstanding growth of LNG trade, but despite this the price of gas has diverged throughout the world.

Figure 1. Since 2000 gas prices diverged and traded gas prices decoupled from oil



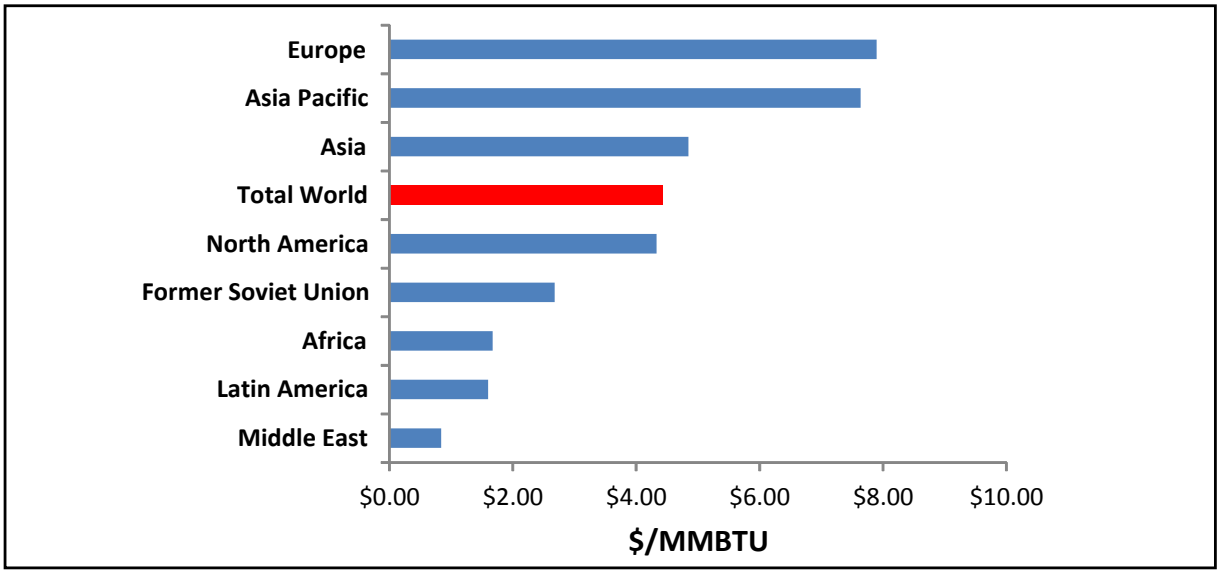
This gas price divergence has occurred not only in the traded gas markets, but is even more evident where different gas price formation mechanisms are used. The IGU Strategy Committee has gathered worldwide data on wholesale gas prices and gas price formation mechanisms for the eight IGU regions from 2005 to 2010.

Figure 2. Analysis is based on the eight IGU regions



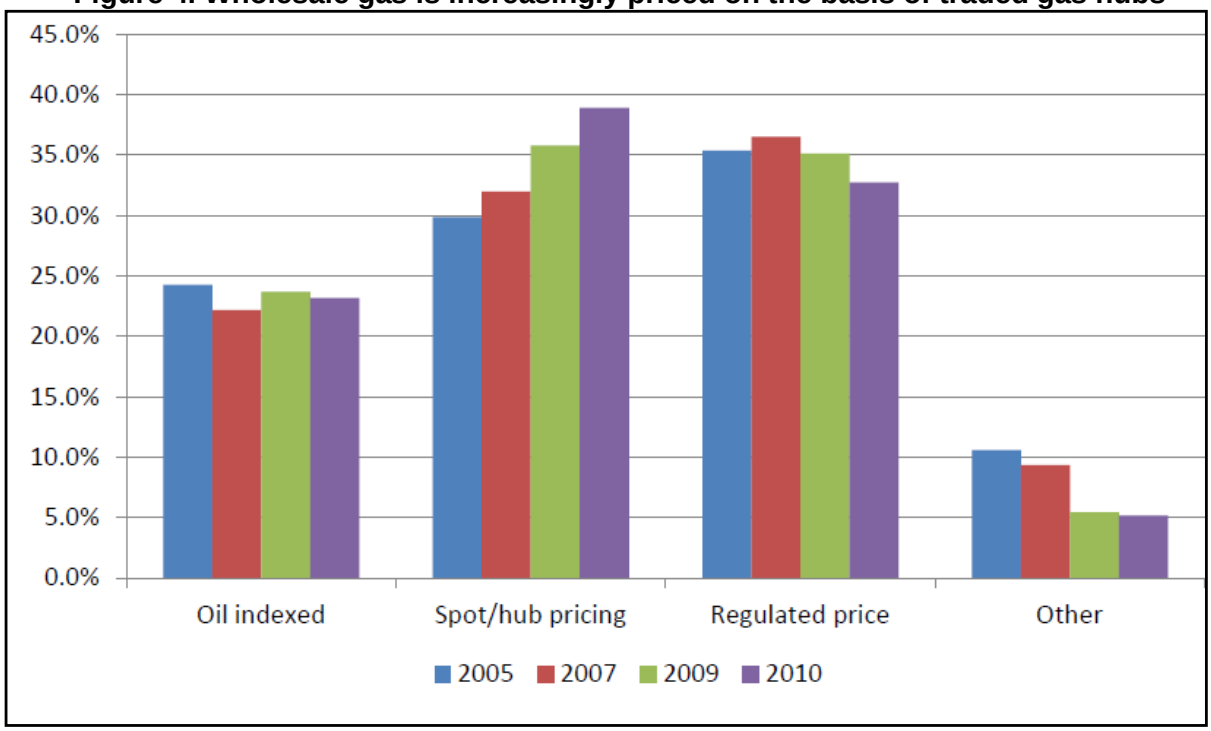
In 2010, for example, the average regional gas prices varied throughout the world as shown in the following diagram. Despite the averaging effects that dampen the results over each region, there is still a factor of ten between the regions with lowest wholesale gas prices and the regions with the highest. Individual country price data (see IGU PGCB report) shows differences of twenty times or more, and if the data were available for 2012 we would expect that the difference might be even greater.

Figure 3. Average wholesale gas prices in each IGU region in 2010



The tension that results from such diverse wholesale gas prices across the globe leads to enhanced international trade (to exploit the arbitrage opportunities) and it also leads to pressure to change wholesale gas price formation mechanisms. In particular, customers and retail suppliers in competitive markets are compelled to align their gas costs with the traded market. This effect has led to a trend of wholesale gas prices being linked increasingly to traded natural gas prices. The trend is summarised in Figure 3, and for more details and explanation of the various gas price formation mechanisms, the reader is referred to the full IGU PGCB report.

Figure 4. Wholesale gas is increasingly priced on the basis of traded gas hubs



There is, however, considerable uncertainty about the future gas price formation mechanisms and the extent to which global price differences will persist. The overall trend that we have seen since 2005 suggests, however, that 'gas-on-gas' price formation will be the dominant global mechanism well before 2030, that regulated gas prices will increasingly allow recovery of full cost (provided these are economically incurred) and that some form of indexation to oil or oil products will still be of fundamental importance in parts of the world where the local gas markets is not open to competition or trading in natural gas is not sufficiently liquid.

2.0 Global perspectives of regional gas demand

An ever increasing world population and expected GDP growth in major developing countries have a huge impact on energy consumption and more specifically an impact both on gas demand and gas supply. Environmental issues and also technical developments like advances in shale gas production and cost reduction of renewable energy sources are playing a main role in the future fuel mix. Analysing the main trends in natural gas demand and supply against a background of political and economic uncertainty is therefore a challenging job.

3.0 IGU Scenarios - IGU Expert View and the Sustainability Scenario

The analysis of gas demand and supply presented in this report is based on a regional analysis of country data aggregated at regional level by a team of experts in the IGU Strategy Committee. Our experts performed both a local 'bottom-up' analysis and a top-down consistency check on the collected data to establish regional expectations of indigenous supply and indigenous demand. This **IGU Expert View** then results in a

Reference Scenario in which each of the eight IGU regions can have some additional export potential, or may exhibit a supply shortfall that will need to be satisfied by imports from another region.

The information from our experts shows clearly that, in the Reference Scenario, a global objective of decreasing CO_2 emission will not be met. Therefore, in addition to this Reference Scenario, a **Sustainable Scenario** has been designed. Whilst this sustainability scenario does not assume (as had been the case in the 2009 IGU Green Scenario) that there would be a global agreement on the need for a high 'cost of carbon' to find the best economic solution to combat climate change, this new approach may still be regarded as a "stretched" green scenario from a regional perspective. Current "green ambitions" in the various regions and countries are stretched where our experts believe that it is both economic and practical to do so. The resulting Sustainability Scenario, which may be regarded as 'greener' than the Reference Scenario, is in our view achievable and arguably more realistic than the politically ambitious global IGU green case presented in Buenos Aires in October 2009. For details of the regional impact on CO_2-emissions, primary energy consumption and gas consumption, please refer to the PGCB Report as just a summary of the results will be provided below.

3.1 Primary Energy Demand

To frame gas supply into a wider energy context, an assessment has been made of the development of the total primary energy consumption (PEC) in each of the eight IGU regions and the sectors within those regions.

Figure 5. World - Primary Energy Consumption by Region – IGU Expert View

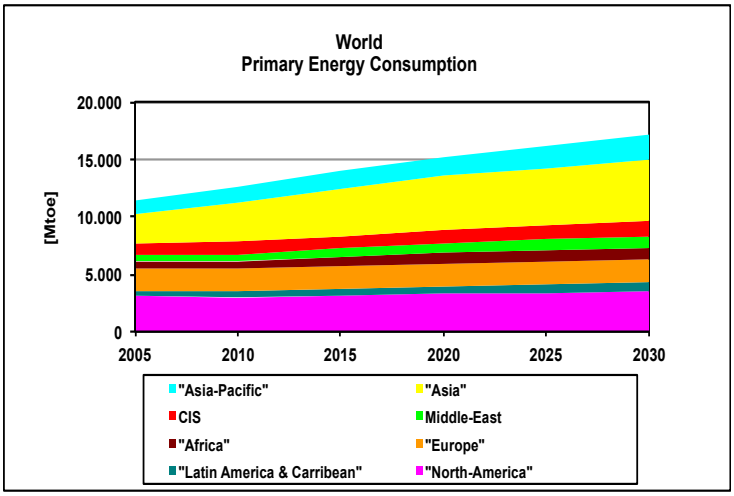
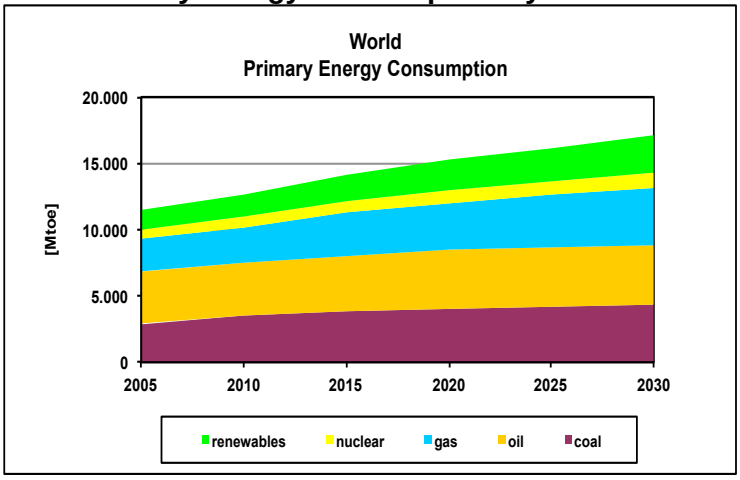
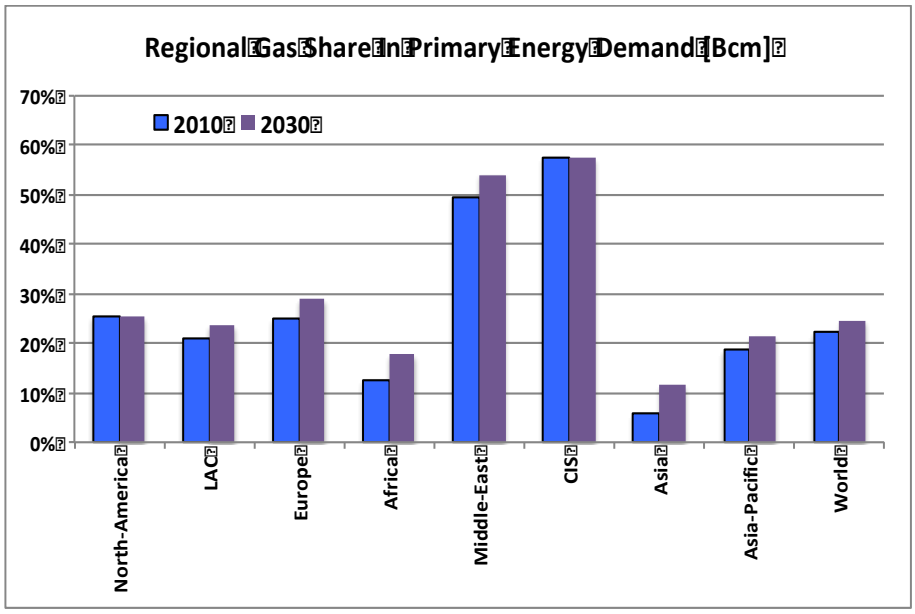


Figure 6. World - Primary Energy Consumption by Sector – IGU Expert View



Primary energy demand is expected to increase with an average annual growth of 1.3% from 2010 to 2030. The gas share of primary energy demand would rise from 22% in 2010 to almost 25% in 2030. The relative share of natural gas is quite different at regional level. The gas share in primary energy demand is expected to grow in all regions, except for the giant North America and CIS markets where the share stays relatively stable.

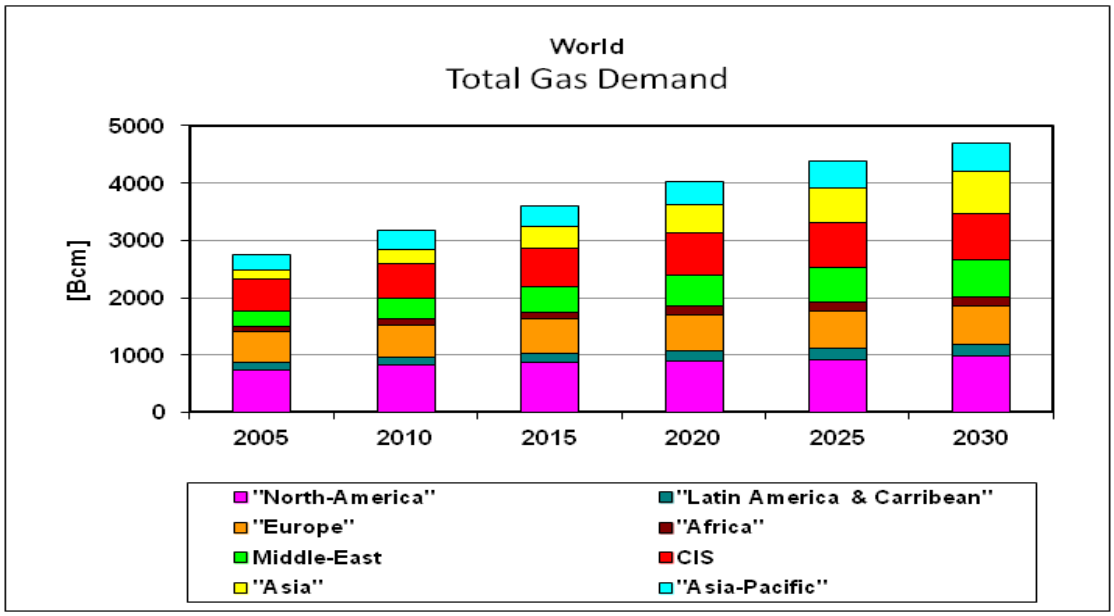
Figure 7. Changing regional gas share of primary energy – IGU Expert View



3.2 Natural Gas Demand by Region – IGU Expert View (Reference Scenario)

Natural Gas demand is projected to increase by 1.4% per year between 2010 and 2030 to a total of 4.7 tcm. Despite the effects of the recent global economic downturn, when compared with the IGU report of 2009, this new projection is about 300 bcm higher by the year 2030. The increase is spread across the globe, and includes the major production and consumption regions of North America, CIS as well as some increase in Europe. The most dynamic regions in terms of percentage growth are Asia (driven by China), Africa and the Middle-East.

Figure 8. World - Natural Gas Demand by Region – IGU Expert View

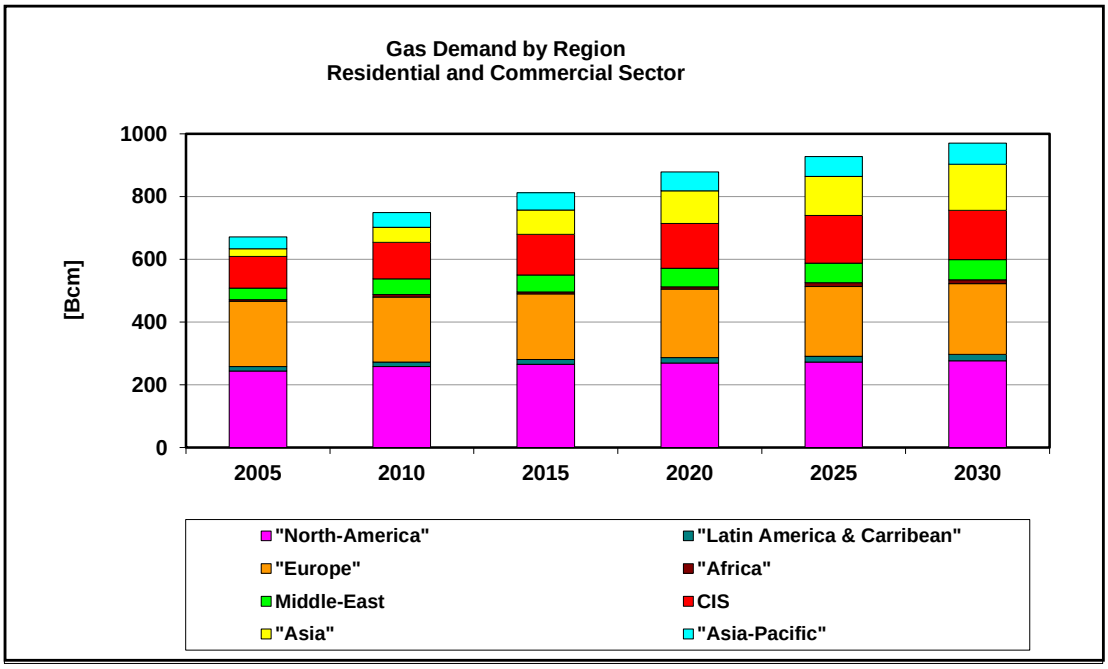


3.3 Natural gas demand by market sector – IGU Expert View (Reference Scernario)

3.3.1 Residential and Commercial Sector

In the residential and commercial sector a moderate growth is expected from 0.7 tcm now to well over 0.9 tcm in 2030.

Figure 9. Residential and Commercial gas sector growth to 2030 – IGU Expert View



Although all regions show some growth in this sector, a significant increase is foreseen in Asia mainly driven by the increased number of homes expected to be connected to the gas supply grid.

The strongest driver for gas consumption is the number of households. In developing countries this is mainly determined by population growth and in developed countries by the decreasing number of persons per dwelling. Furthermore, comfort levels and lifestyle are driving factors.

On the other hand, gas demand is reduced by energy conservation and efficient use of resources, both measures which are strongly encouraged by IGU. New, well-insulated houses with low heat demand, however, may increasingly turn to electricity for space heating, often in combination with heat pumps.

Even in our reference case, renewable energy sources are expected to provide a larger share of the future energy demand in dwellings. The number of photo voltaic power generation systems as well as boilers for solar heat will grow significantly. Germany is an example where the penetration of photo voltaic power in households is growing strongly.

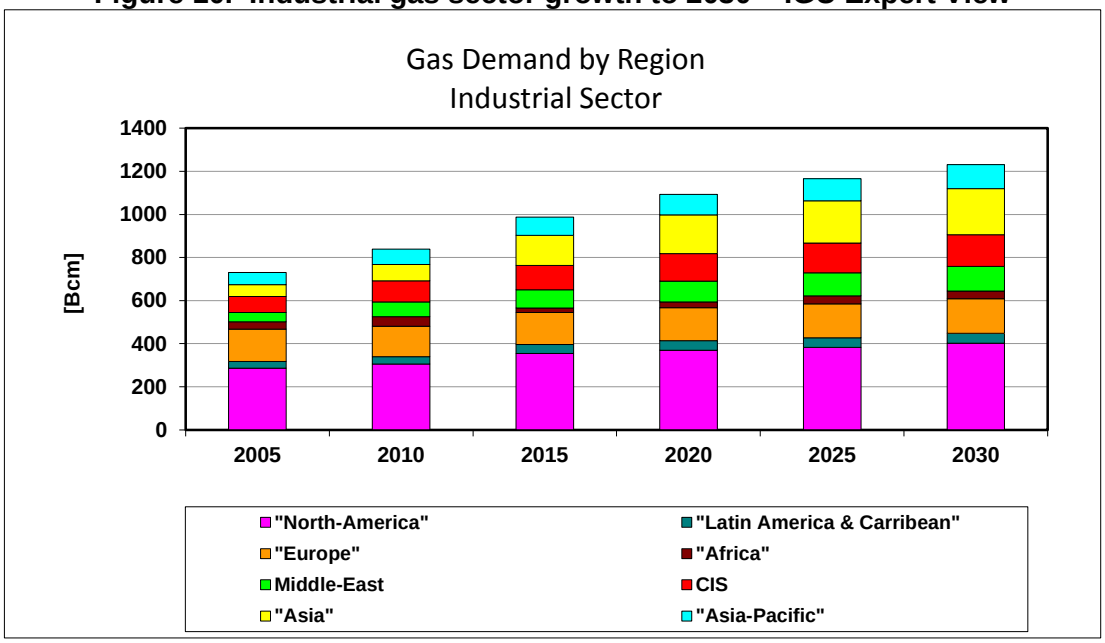
3.3.2 Industrial Sector

The industrial sector is expected to benefit significantly from the environmental and high efficiency advantages of natural gas and gas appliance technology. Lower

emissions for CO_2 and better combustibility should result in gas being able to increase its market share. Although gas demand in industry is expected to grow strongly, the increase from 800 bcm in 2010 to 1200 bcm in 2030 is somewhat lower than in the 2009 IGU Study as industrial output is more constrained in the OECD countries and better energy efficiency is achieved on average.

From a relative point of view, Asia has the highest growth figures. Industrial gas consumption could more than double within two decades, mainly driven by developments in the Chinese and Indian economies. Combined heat and power (CHP) will most probably expand in almost all regions.

Figure 10. Industrial gas sector growth to 2030 – IGU Expert View



3.3.3 Power sector

The increase of total global gas demand in the past two decades was driven, above all, by the need for clean, efficient and competitively priced power generation. With billions of people needing electricity supplies, this sector is set for continuing growth in the coming decades.

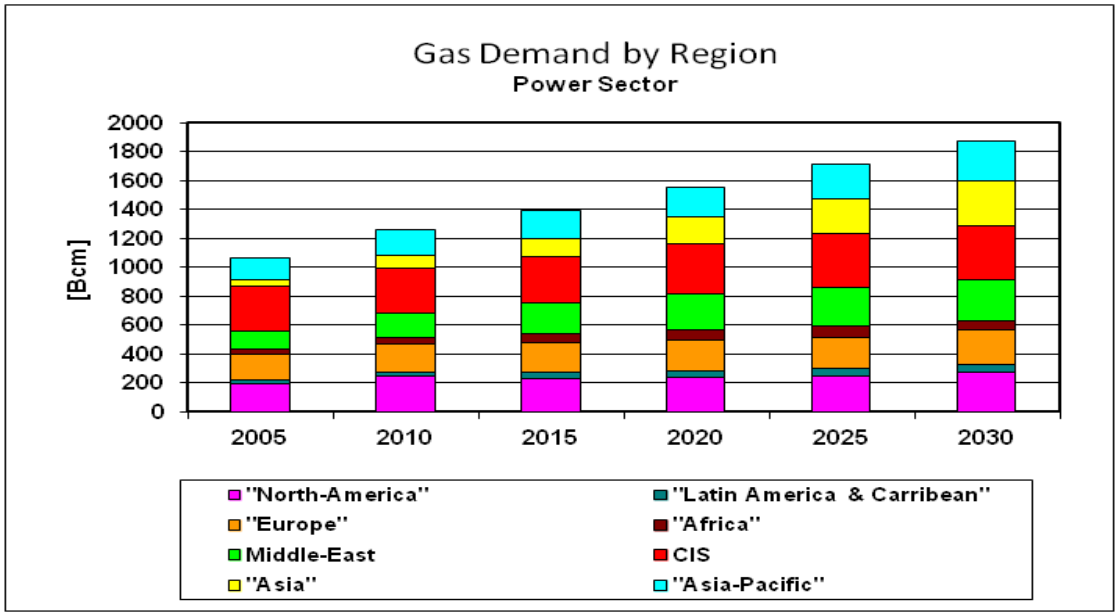
The advantages of gas for power generation are evident: high efficiency, low pollutant emissions (including lower CO_2 than for other thermal plant), flexibility in electricity generation; low investment costs and short lead times. Furthermore, the expanding gas network and diversification of supply through long distance pipelines and LNG shipping are helping the availability of natural gas. The way gas is priced, however, can present some difficult challenges to the economics of power generation projects. In particular, if, as hoped by some producing countries, there were a return to some form of 'oil-parity' in Europe or a full continuation of oil indexation in Asia, then that would reduce the demand for gas-fired power generation below the expectations shown below. Furthermore, if the gas price for power generation were held unduly low in North Africa and the Middle East, then that would reduce the likelihood of approval for investment in major renewable energy projects and may prevent their successful implementation. This would make global climate change goals more difficult to achieve despite the increased use of natural gas.

Overall, the global power sector is expected to grow to almost 1600 bcm in 2020 and around 1900 bcm in 2030. The regions with the largest percentage increases are Latin America, Europe, Middle-East and Asia. The power sector in Latin America will show strong growth to around 50 bcm in 2030, up from 35 bcm now mainly driven by GDP growth. Power demand in Europe is expected to rise, and even though renewable energy is politically and economically favoured as the most desired primary source, gas-fired capacities will also increase. The final result in terms of natural gas consumption in the power sector, however, is extremely dependent on the policies concerning renewable energy, which in turn are subject to economic and social pressures.

We see some growth in gas-fired power generation in North America, but despite the shale gas revolution, coal is likely to remain the main fuel source for electric generation through 2030 and possibly beyond. However, coal is projected to lose market share to natural gas and renewable energy sources. The growth of natural gas in the power sector will be driven by a combination of economic imperatives and environmental legislation, particularly in the US and Canada.

In the Middle-East, gas in power will almost double within the time frame. This reflects the strong increase of electricity demand driven by the growth of population, and GDP as well as rising needs for air conditioning and desalination projects.

Figure 11. Gas-fired power sector to 2030 – IGU Expert View



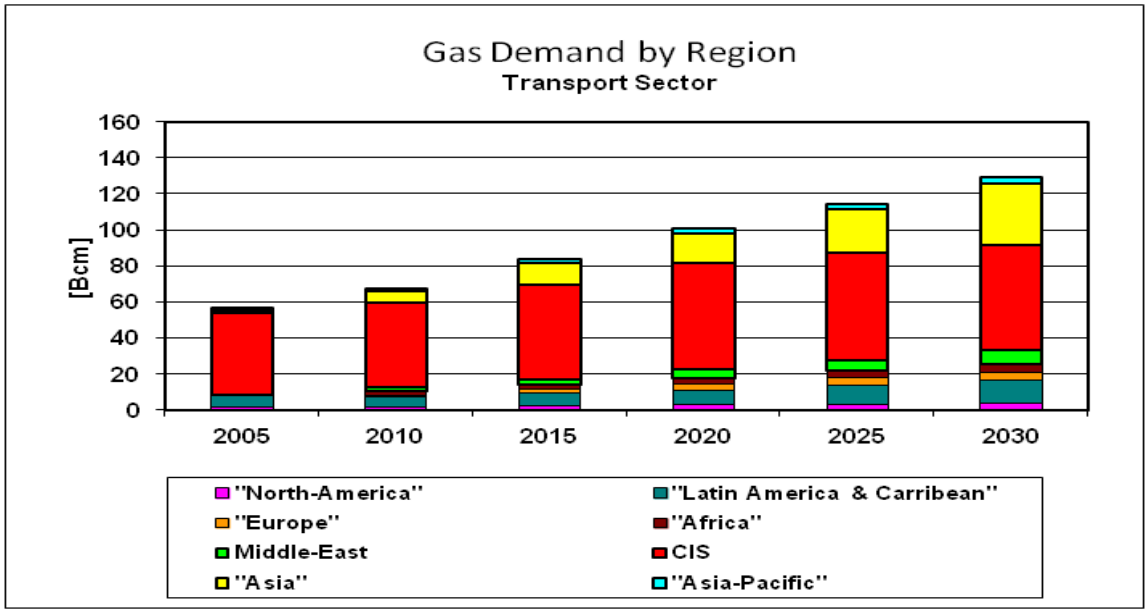
With a total projected volume of 1900 bcm in 2030, the prospects for gas for power generation are impressive. However, at the same time a lot of uncertainties arise. How will renewable energy sources develop and will they take over part of the electricity market? What will be the influence of CO_2? A correctly implemented emission-trading scheme for CO_2 costs or taxes based on the CO_2 content would benefit natural gas in relation to other fossil fuels. Uncertainty in the price of CO_2, however, creates an additional risk for investment. What will be the impact of CCS plants (Carbon Capture and Storage) on gas demand in the power sector?

The expected gas demand is large, but is also very uncertain when considered against the background of these complex issues.

3.3.4 Transport sector

Gas consumption in the transport sector (mainly Natural Gas Vehicles- NGVs) is expected to become more important, growing from around 90 bcm now to 150 bcm in 2030. Main users are CIS, Middle-East and Asia.

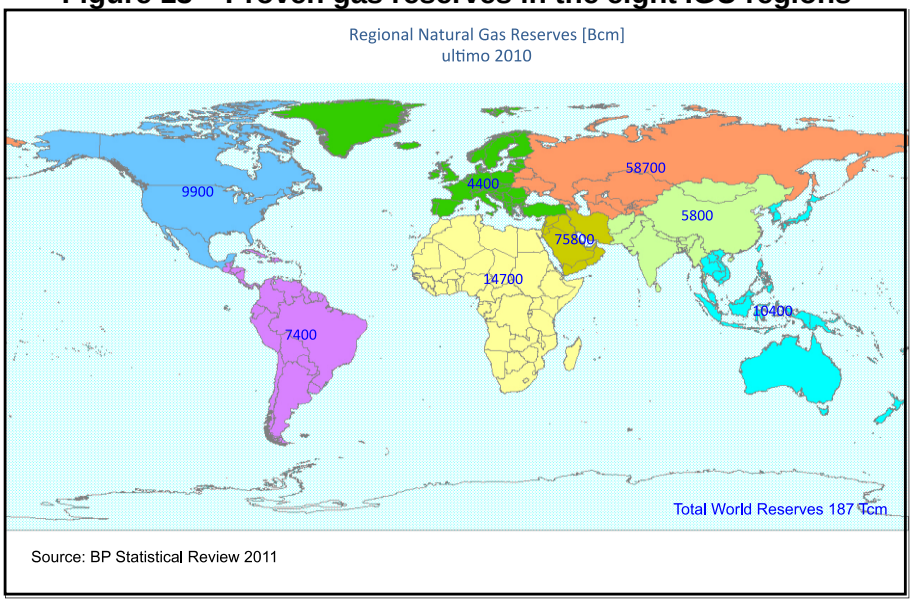
Figure 12. Gas transport sector to 2030 – IGU Expert View



3.4 Gas production and supply

In parallel with this analysis of future gas demand summarised in the above pages, our experts studied the available information on gas reserves and projects to establish expected regional supply levels. It is well known that natural gas reserves are sufficiently abundant to cover the global gas demand for many decades, and the inclusion of some unconventional gas in the reserve base has clearly enhanced economically recoverable reserves in the last few years. Moreover, technological developments and higher energy prices in some regions have increased the economic reserves locally as well as the diversification of sources and routes to bring these reserves to market.

Figure 13 – Proven gas reserves in the eight IGU regions



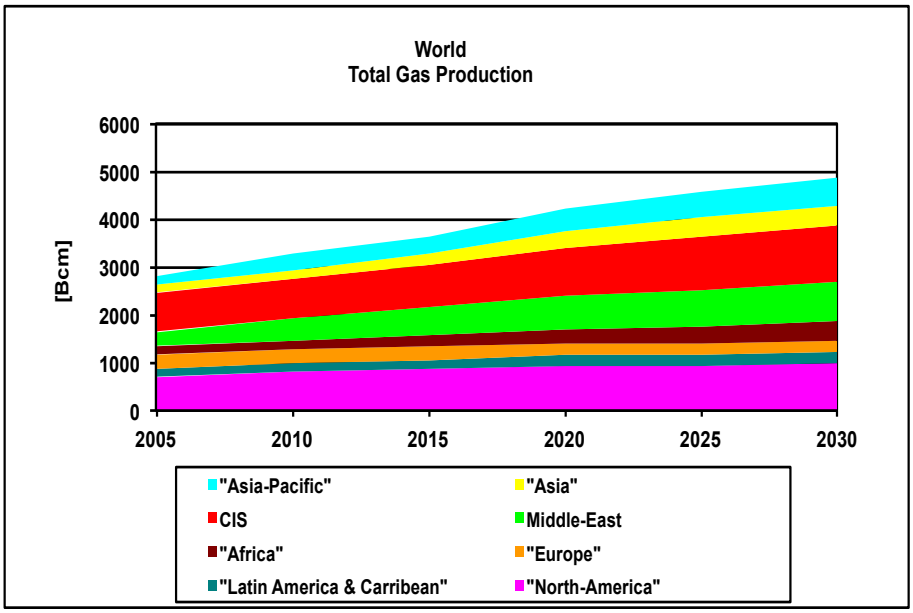
The current developments on unconventional gas, especially shale gas in the United States, are spectacular and have led to upward revisions for the prospects in North America. The potential for unconventional gas in some other regions is also significant. At several places around the globe, like Poland and China, the opportunities for shale gas are being actively investigated.

3.4.1 Regional gas supply potential

For all the regions, the expected gas supplies were not forced to balance with gas demand but rather were intended to be what industry experts in every region think will be developed under the common set of assumptions of the Reference Scenario. The difference between demand and supply indicates possible over or under supply for that region, and hence the likely need for imports or the possibility of export potential.

Overall, increased production will enable world gas supplies (in terms 'pipeline quality' gas) increase to over 4.8 tcm by 2030, with the CIS (dominated by Russia) consolidating its position as the region with largest gas production.

Figure 14. Regional gas production to 2030



The natural gas supply outlook for **North America** has changed significantly over the last three years. The key change is the economic development and production from natural gas bearing shale resources and the implications that this has had. Total North American gas production is projected to increase from 810 bcm in 2010 to almost 1000 bcm by 2030. The share of unconventional gas in the US will grow from 60% to over 73% by 2030.

In **Latin America,** natural gas production both onshore and offshore is expected to grow from 150 bcm now to 250 bcm in 2030.

In **Europe,** indigenous resources currently satisfy about half of the gas demand. The largest European producers are Norway (105 bcm), the Netherlands (88 bcm) and the UK (60 bcm). In the period from 2010 to 2030, most of this production will decline with only Norway expected to maintain its production level. Several geological plays in Europe are being explored for "unconventional gas", mainly shale gas reserves. However, this development is currently at an early stage and the economics do not match up with new imports if these are

available at competitive (gas hub) prices. The result is that no significant indigenous unconventional gas is included in the European regional supply forecast.

Gas production in **Africa** is expected to more than double between now and 2030, growing to 400 bcm/year with Algeria and Nigeria as the main suppliers. Half of the production could be exported to other regions, enabling Africa potentially to benefit from international prices whilst contributing significantly to diversification in global gas supply.

The **Middle East** is endowed with a wealth of gas resources, but capital investments remain the main concern due to geopolitical issues and higher capital costs. The largest gas producing countries are, and will remain by far, Iran and Qatar, followed by Saudi Arabia. Iraq holds promising resources and could become a significant gas producer (and exporter). The Middle East total gas production is expected to increase from 480 bcm in 2010 to 840 bcm in 2030. In 2030, around 200 bcm will be exported mainly to Europe and Asia.

In the **CIS,** Turkmenistan, Kazakhstan, Uzbekistan, and Azerbaijan together with **Russia** are the main gas producing countries and should remain in this position in 2030. Together, Russia and the CIS countries account for around 25% of the world's total gas production. Gas production in the region is expected to increase by 45% from 2010 to 2030 when it should reach 1150 bcm.

In **Asia,** gas production has more than doubled in the last decade up to around 210 bcm and the question is whether or not this astounding increase could occur again? Despite substantial proven and potential gas reserves, Asian natural gas production is not keeping pace with demand. Over the next 20 years, IGU experts expect production to reach 460 bcm, but the gap between supply and demand will increase almost seven-fold.

The key challenges to increase gas production are the development of adequate transport infrastructure as new resources are far away from markets, in particular in China and India, and relatively low prices are a constraint in some countries. Additionally, the development of unconventional gas requires appropriate expertise to be developed or acquired. From a regional point of view, China appears as the leading country. By 2011, China was already a relatively large producer – it produced more than Saudi Arabia, and most of its production is conventional gas. Our forecasts assume a strong growth in China, where production reaches 250 bcm by 2030 and the successful development of both CBM and in a later stage, shale gas.

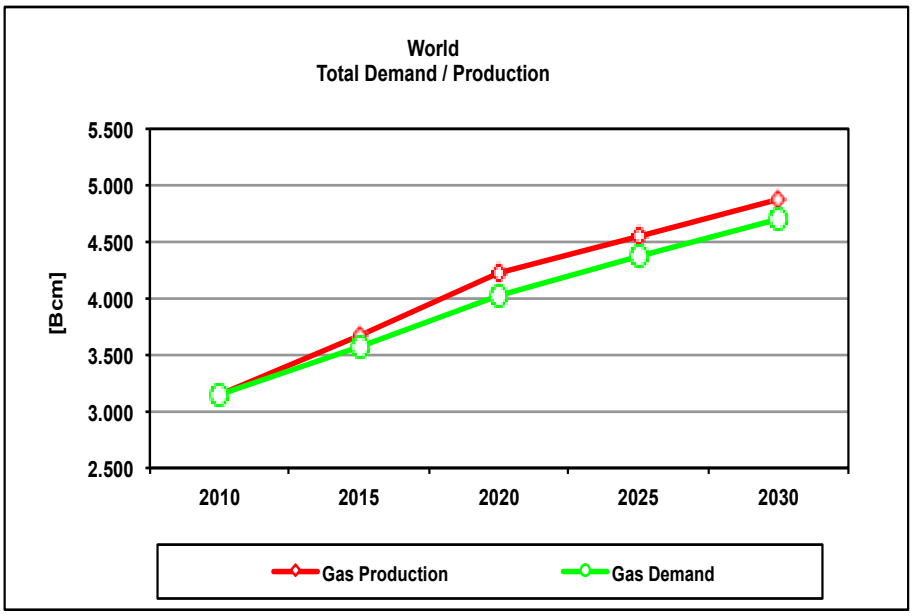
In India gas production will increase markedly reaching around 100 bcm by 2035.

Production in **Asia Pacific** will grow substantially to 570 bcm in 2030. The region includes big LNG exporters, Indonesia, Malaysia, Australia and Brunei accounting for about 33% of the total world LNG production, but the picture is increasingly complex, with intra-regional trade increasing and Australia becoming a major gas producer and LNG exporter in Asia Pacific as well as a potential global rival to Qatar.

3.5 The changing global gas balance

If natural gas demand is increasing from 3130 bcm in 2010 to 4700 bcm in 2030, will there be sufficient gas supply to satisfy this growth? At a global level, the answer is yes. The following figure plots global gas demand and gas supply up to 2030, suggesting that if the projects went ahead and supplies could reach the markets, then there would be a healthy gas supply surplus through to 2030.

Figure 15. The global gas supply and demand balance – IGU expert view



Gasification and production projects can of course be delayed or occasionally advanced, and we all know that the economic cycle can give us a bumpy ride, but there is a clear message that natural gas has a global potential for sustained growth during the coming decades. Whilst in practice there may well be periods when it is more a buyers' or sellers' market, we have a clear expectation that supply can continue to satisfy demand in the long run. But, this is predicated on growing international and indeed inter-regional trade.

3.5.1 Inter-regional gas trade

Our global natural gas balance is the outcome of the different regional analyses. For each region, gas demand has been taken as given, while supply has been seen more as a production capability which could be constrained if demand is not there or infrastructure projects such as pipeline and LNG plants and export terminals are not built. For each region, the distinction between LNG and pipeline imports, as well as between LNG and pipeline exports, was been made. The imperative was that, for each region, "total demand" (demand + exports) must be equal to "total supply" (production + imports). Demand must also balance with sufficient supply on a global level.

LNG exports were combined into a global LNG pool, from which LNG imports were redistributed between all LNG importing regions so that global LNG trade itself would also be balanced. The split between LNG imports and pipeline imports (or exports) at the regional level was based on global as well as on regional considerations. Existing infrastructure, including the relationships between buyers and sellers (such as long-term contracts), represented the basis of this analysis. To this, we added the infrastructure projects which are already either under construction or planned. The details concerning this infrastructure can be found in the individual regional chapters of the IGU Strategy Report.

In terms of net importers, three regions stand out:

1. **Europe** is, and will remain, by far the largest net importer; European import dependency will go up as demand increases and domestic production continues on its relentless decline despite innovative production techniques and new exploration plays. Net imports exceed 440 bcm by 2030, a 58% increase compared to 2010 levels. Europe exports only small amounts of LNG from Snøvhit in Norway.

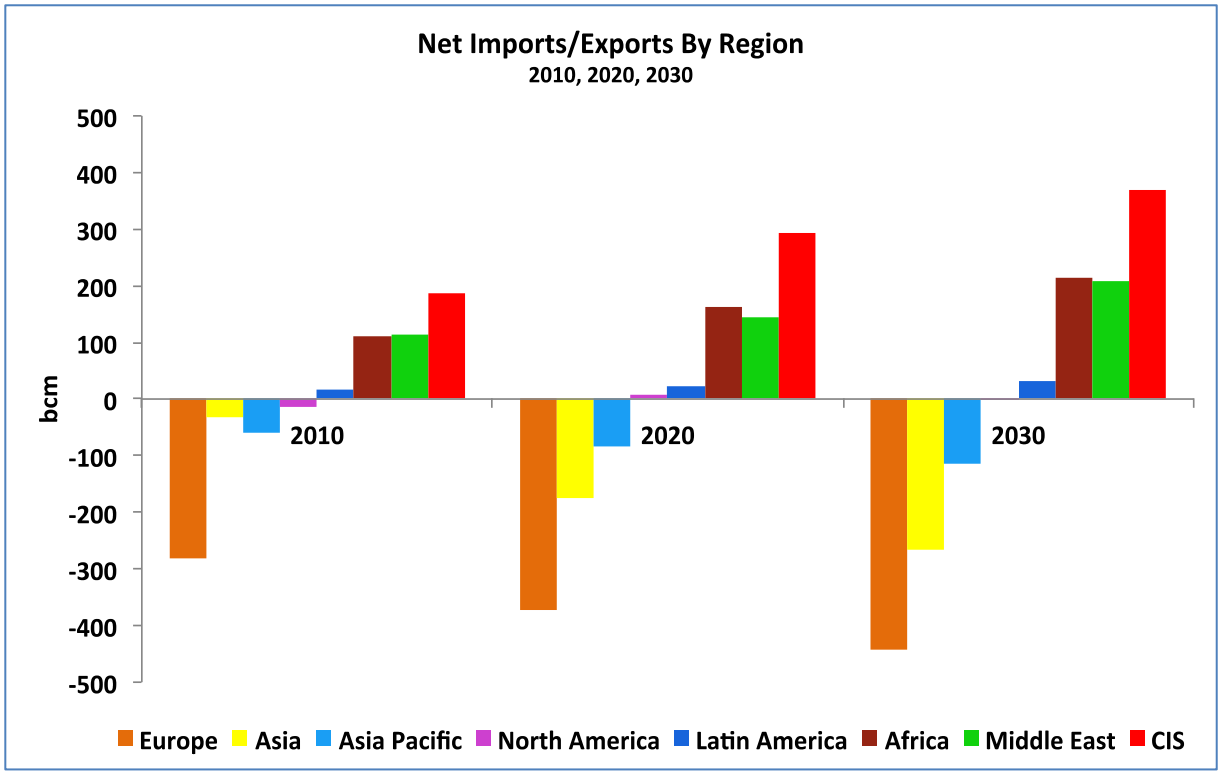
2. Continental **Asia** is set to become the second largest importing region by 2030, driven by the growing energy requirements of China and India. This is a radical evolution from the present situation as imports are multiplied eightfold, with around 270 bcm needed by 2030, compared to around 30 bcm in 2010. We can envisage some exports by pipeline from Myanmar to Asia Pacific.

3. In third position in terms of imports stands **Asia Pacific.** This diverse area will continue to be a net importer, but the rapidly increasing demand for imports in Japan, Korea and the South-East Asian region is partially compensated by the surge in Australian LNG exports. Net imports will almost double to around 80 bcm by 2030. The region both imports and exports LNG, and a large share of LNG is increasingly traded internally, notably between Australia and Japan/Korea.

The American continent is a slight net exporting area: The **North American** region is almost balanced towards the end of the projection period, while **Latin America** exports around 30 bcm of LNG. In terms of direct trade, the whole of the Americas will remain only physically linked to the rest of the global gas market through LNG imports and exports.

Africa and the **Middle East** have a similar growth in terms of exports, reaching close to 200 bcm of net exports by 2030. The largest exporter is and remains the **CIS** region, with a doubling of its gas exports compared to 2010 reaching 370 bcm. These three regions export both LNG and pipeline gas, but only Africa and CIS do not import any gas from the other regions, while the Middle East may continue to remain an LNG importer.

Figure 16. Changing imports and exports by region



3.5.2 LNG Trade

Global LNG trade is expected to more than double over the coming 20 years, increasing from 300 bcm in 2010 to 660 bcm by 2030. This requires a rapid build up of liquefaction capacity around the world. There was already a first wave of new LNG capacity that arrived over 2009-11 with over 100 bcm of new LNG capacity coming on line, notably 63 bcm of LNG capacity from Qatar. The next wave will be coming mostly from Australia, Papua New Guinea and Indonesia with some 95 bcm of LNG export capacity having reached FID and expected to start over 2012-17.

Currently, there is a lot of attention on whether or not **North America** will export LNG, and if it does, then will there be a political limit? North American LNG exports are part of our scenario, but never in very high volumes. Indeed, on a regional basis, the annual supply and demand are very much balanced, and the region continues to import some LNG (Mexico, Quebec) at the same time as it exports LNG (Western Canada, United States). The US LNG terminals may well also have a seasonal role; exporting when prices are sufficiently high in other parts of the world, but importing when the local gas supply/demand is tight and Henry Hub prices are high.

Africa will also see an expansion of its LNG capacity; some is already on track with Angola and Skikda (Algeria) starting in 2012 and Gassi Touil in 2013, but more could be expected from Sub Saharan Africa – Nigeria, Equatorial Guinea, Angola, Cameroon, and the region which has recently awaken on a gold mine of gas: Eastern Africa (Mozambique and Tanzania).

The **Middle East** will also see LNG export capacity being expanded based on the two countries with the largest reserves – Iran and Qatar, as well as on smaller countries – Iraq and Israel.

Several LNG projects are currently considered in **Russia** – either in the North of the country (Yamal, Shtokman) or in the East (Vladivostok and Sakhalin). We expect several of these projects to move forward, tripling Russia's LNG exports by 2030. European LNG export capacity will remain limited to the existing facility in **Norway**.

Figure 17 Global LNG Exports by Region

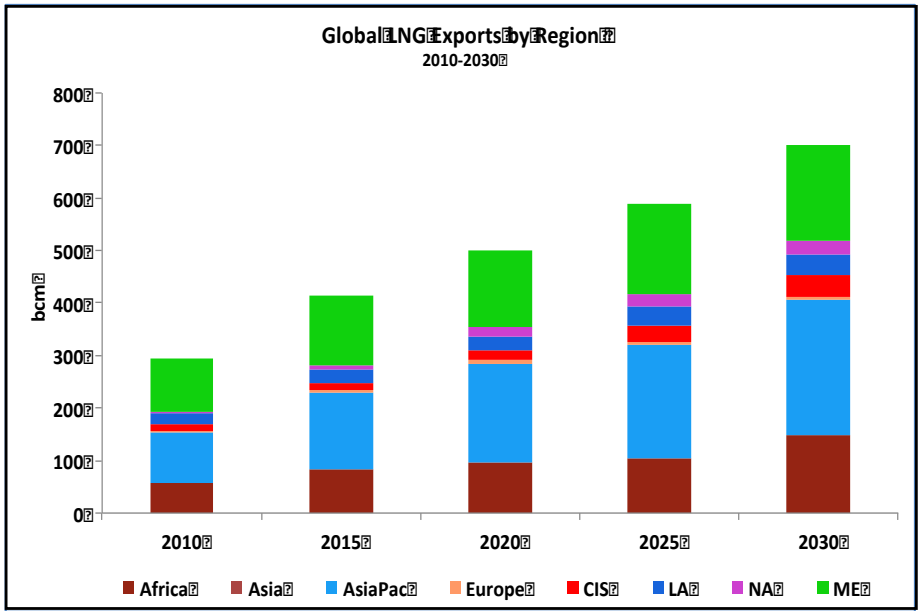
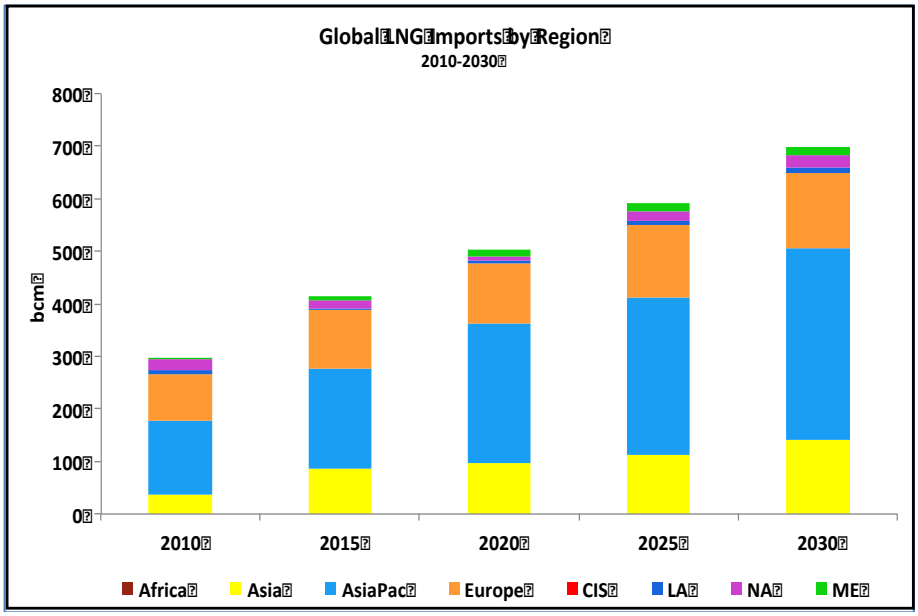


Figure 18 Global LNG Imports by Region



On the import side, **Asia Pacific** remains by far the largest LNG importer, representing around half of total LNG imports by 2030. Europe and Continental Asia follow but the two regions' combined LNG imports are still below that of Asia Pacific (around 140 bcm by 2030). Three other regions also import LNG, but in smaller quantities (below 20 bcm): North America, Latin America and the Middle East.

3.5.3 Overall Regional import/export balances

Despite its increasing import dependency, **Europe** keeps a relatively diversified supply mix. Pipeline imports increase by a half, and account for twice as much as LNG imports. Pipeline imports are based on imports from North Africa, the CIS region as well as the Middle East. Russia and CIS are by far the largest sources of gas supplies, with gas coming from Russia as well as from the Caspian region. By the end of the coming decade, Europe starts receiving additional pipeline supplies from Azerbaijan. Europe will also see imports coming from the Middle Eastern region, building up on the existing imports from Iran to Turkey, but their share will remain limited to 4% of total imports.

Continental **Asia** will also rely on a relatively diversified supply, with gas coming from CIS (Turkmenistan in a first stage before moving to Russia later), the Middle East and LNG. LNG and pipeline imports have relatively similar shares in total imports. The region exports only limited amounts of pipeline gas to Asia Pacific.

Asia Pacific is the most reliant on LNG imports due to the geographic specificities of some countries – Japan, Korea as well as new countries that in the period 2012-2015 are becoming LNG importers – Thailand (already importing), Malaysia, Indonesia, Singapore, and Vietnam. The region will become the largest LNG exporter, overtaking the Middle East as soon as 2015. Historically, it was already a major LNG exporter with countries such as Malaysia, Indonesia, Brunei, and Australia. During the coming decade, Australia will emerge as the largest LNG exporter while Papua New Guinea will start exporting by 2014.

North America is expected to remain both an exporter and importer of LNG. During the coming decade, the United States is expected to start exporting LNG, but LNG exports will remain relatively limited compared to the current planned projects (see section on North America in the full PGCB report). LNG imports are still necessary due to regional disparities and infrastructure bottlenecks. By contrast, Latin America remains a net LNG exporter over the period 2010-30. Besides the export LNG facilities in Trinidad and Tobago and Peru, new export plants will start in Brazil and Venezuela.

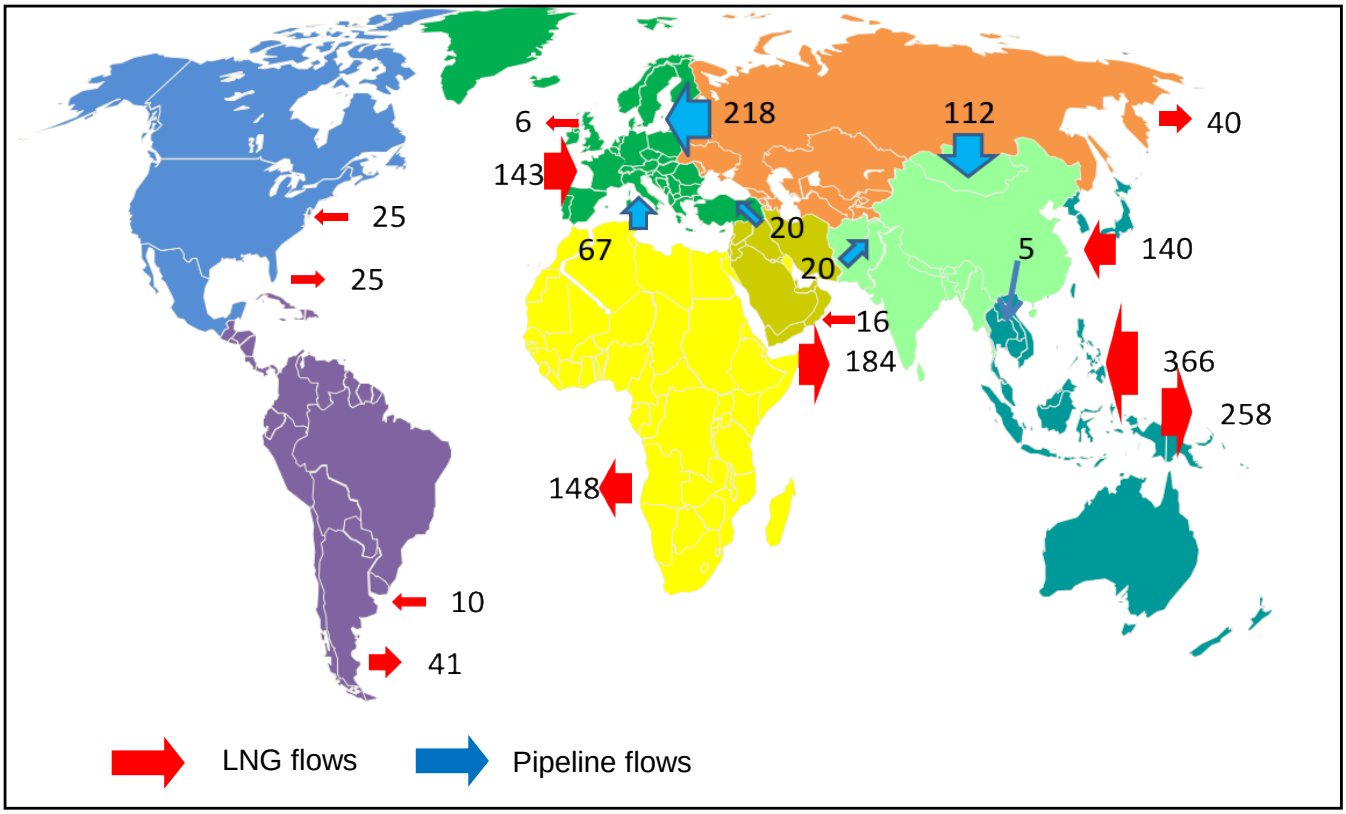
The Middle East is, like Africa and the CIS region, both an LNG and pipeline exporter. LNG exports are expected to remain relatively flat between 2011 and 2015, as no new capacity will be coming online. Post 2015 raises the question of new LNG export facilities from Qatar, Iran, Iraq or Israel. We expect their development to take time and to face competition from a rapidly increasing gas demand as well as pipeline export projects. LNG exports are expected to increase by two thirds between 2010 and 2030. Meanwhile, gas supplies from the Middle East will contribute to the Southern Corridor to Europe as well as to Asia.

Africa will remain a key contributor to European gas supplies, but the increase will be limited by the bottlenecks in the European gas infrastructure, notably the ability to move gas from the Iberian Peninsula to the wider European gas market. Meanwhile, the current exports to the Middle East are expected to drop over the coming decade following the recent attacks on the Arab Gas Pipeline and the fact that Israel will require less imported gas after the development of Tamar and Leviathan. LNG export capacity will continue to increase based notably on projects in Nigeria, Angola, and East Africa.

The CIS region is ideally located to supply Asia as well as Europe and even the Middle East and Asia Pacific by pipeline. Additionally, Russia has several plans to develop LNG export capacity to have more flexibility in supplying the different regional gas markets. By 2030, 31% of CIS gas production will be exported, either by LNG or by pipeline. Exports to the European gas market will represent two thirds of pipeline exports, with the rest going to Asia. New LNG export plans are also developed during the projection period.

The following figure summarises these developments in global inter-regional gas trade in 2030. Only the main pipeline routes between IGU regions are shown. There are also many international trade routes within each region, for example by high pressure pipeline from Canada to USA, which are not included on this map.

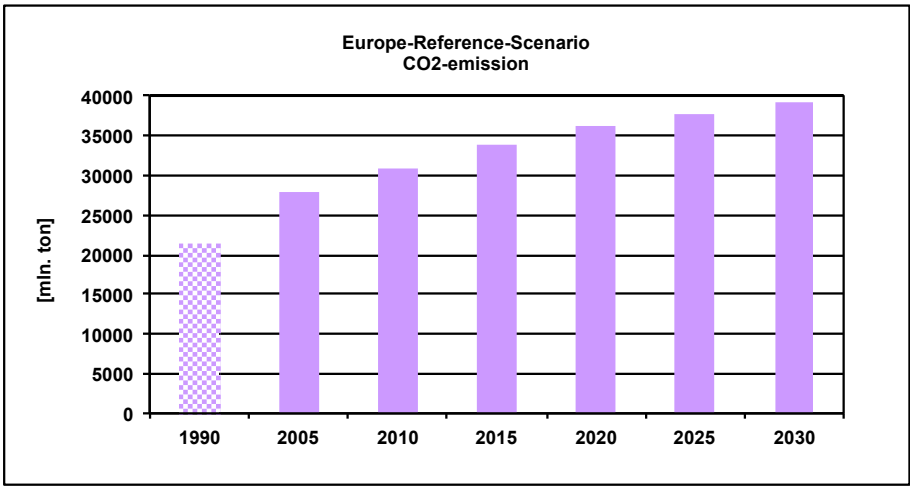
Figure 19 Global LNG and Inter-regional Pipeline Imports and Exports in 2030 (bcm)



3.6 The environmental imperative – Sustainability

Due to the increasing energy demand and the dominant role of fossil fuels, the CO_2-emissions in our experts' reference case continue to increase during the whole period to 2030. The Kyoto constraints are not met, there is no chance to constrain the increase in atmospheric temperatures to 2 deg C and there is no indication that emission levels could go into decline. Overall the outcome is similar to the IGU Expert view scenario in October 2009.

Figure 20. Global CO_2 emissions continue to rise in the reference case



The sustainability scenario sought to reverse this trend or at least put a brake on the relentless increase in annual CO_2 emissions.

The policy measures to do this are described in the IGU Strategy Committee report, where it is evident that the approach would vary widely throughout the world. Renewable energy sources and nuclear energy both offer almost zero CO_2 emissions, but neither can solve the global CO_2 problem in the coming decades, not least because of long lead-times and economic and social constraints.

The attitude towards nuclear energy is somewhat ambivalent after the Fukushima disaster and questions still remain. Some countries, like Germany have started to abandon nuclear energy, while others like China are still building new plants. In Japan, at the time of writing this report, only one of the country's fifty four nuclear generation units is operating.

Full scale "Carbon Capture and Storage" (CCS) is not yet technically and commercially available, and would require a large increase in CO_2 prices to make it economically attractive. Such an increase in 'the cost of carbon' would of course affect the economics of other projects and fuel sources too, so should not be considered alone in relation to CCS. Furthermore, building CCS plant needs time too, although it can contribute to the decarbonisation in the longer term and could be an add-on for gas-fired plant post 2030.

The best economic and politically acceptable answer for the next few decades might come from natural gas and renewable energy sources forming the ideal partnership.

From this point of view a 'sustainability scenario' was designed by adapting the fuel mix to take into account the regional "green ambitions". This included current policies on encouraging specific fuel sources or market sector applications (for example renewable energy sources, nuclear energy, NGVs or electric vehicles etc.). Furthermore, additional policies to enhance energy efficiency were assumed to be applied to the extent considered the best practical in each region given the local circumstances. The resulting scenario may be regarded as a "stretch", but at the same time is, in our view, achievable and realistic.

Figure 21 shows the primary energy consumption in this sustainability case. Increased use of renewable energy particularly for power generation as well as moving to high efficiency natural gas applications will both help to reduce the overall primary energy consumption compared with our reference case. The overall result for the future CO_2-emission curve is shown in Figure 22.

Figure 21 World Primary Energy Consumption in the sustainability scenario

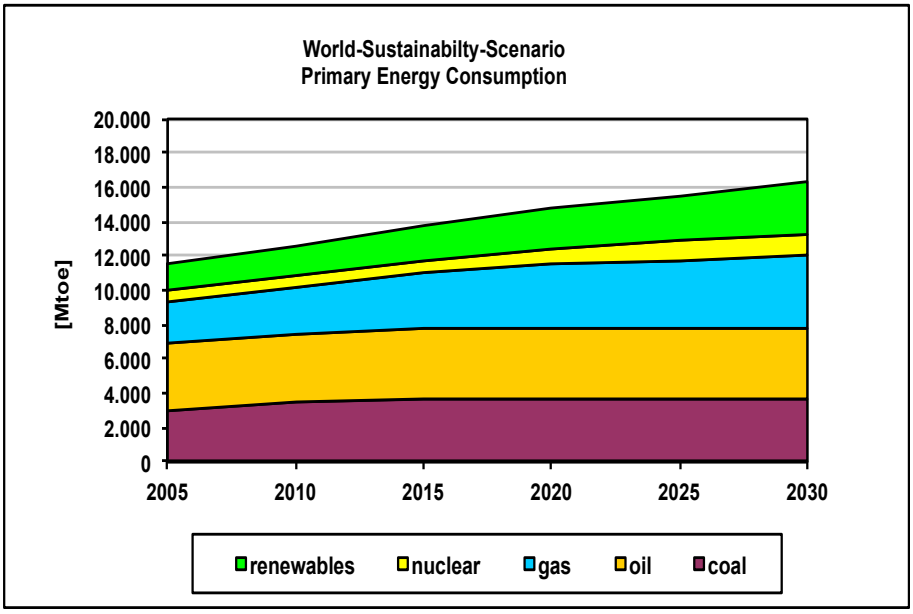
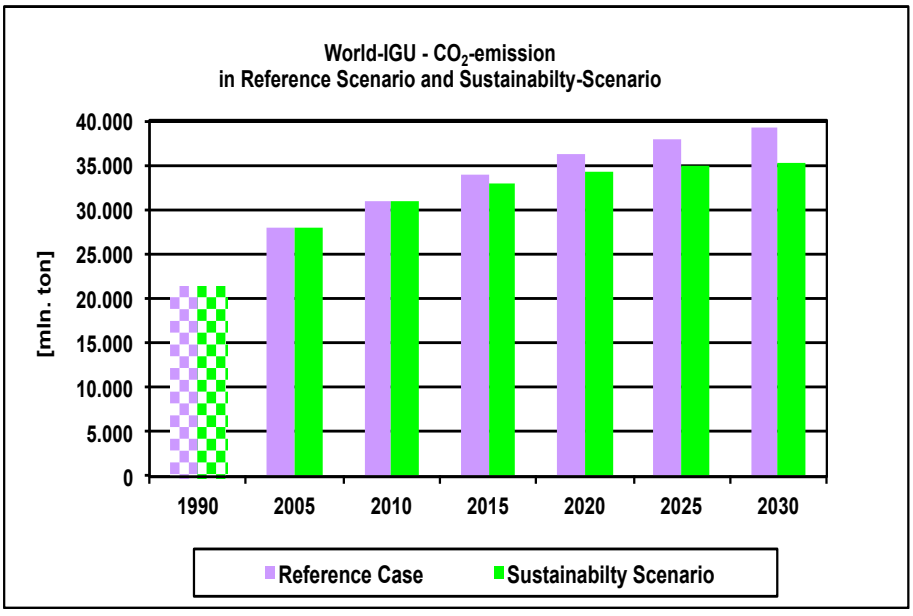


Figure 22 World CO_2 emissions level-off in the sustainability scenario



To achieve this sustainability scenario actually requires an increase in global gas demand. The effect is not the same in each region, but overall the global gas market will need to increase to nearly 4.9 tcm by 2030. This will also be challenging for gas production, but the difference between our expert view of future gas supply and what is needed to realise the sustainability case is relatively small.

The Sustainability scenario, with higher gas demand, will require about 70 tcm of gas by 2030, which would correspond to somewhat less than 40% of the currently proven gas reserves. Since gas reserves can be expected to move into the proven category as knowledge and technology both continue to advance, the impact on the reserve base will be entirely sustainable. Furthermore, the production in Africa and the Middle-East will grow

substantially in the sustainability scenario, while all other regions, except for Europe where production would decline, will enjoy slightly increasing gas production.

If the sustainability scenario is to be attained, then, despite regional variations, the global gas market as a whole needs to grow at least as much as in the reference case over the coming decades. Whilst the results in terms of climate change are less dramatic than in the 2009 study, the world's CO_2 emissions are stabilised from around 2025 onwards in this balanced and pragmatic regional approach. Overall, global Primary Energy Consumption reduces slightly and the gas market share increases from 22% today to 27% in 2030; a gas market growth of 1700 BCM helps to stabilise global CO_2 emissions.

We can conclude that investing in natural gas should be a 'no regrets' solution. Whether or not action on climate change is a globally agreed policy objective, a growing global gas market should be an increasingly important part of our sustainable energy future.

Appendix
Key Regional Messages on Gas Supply and Gas Demand

North America

- Gas demand will grow from 800 Bcm now to 940 Bcm in 2030
- Bright future for gas due to shale gas developments
- Shale gas reserves estimated at 13-30 Tcm
- Gas demand has significant upside potential; competitive priced energy in industry and power
- Coal will however stay the dominant fuel for power, but coal faces considerable environmental challenges
- North America becomes a net exporter, but net volumes will be small

Europe

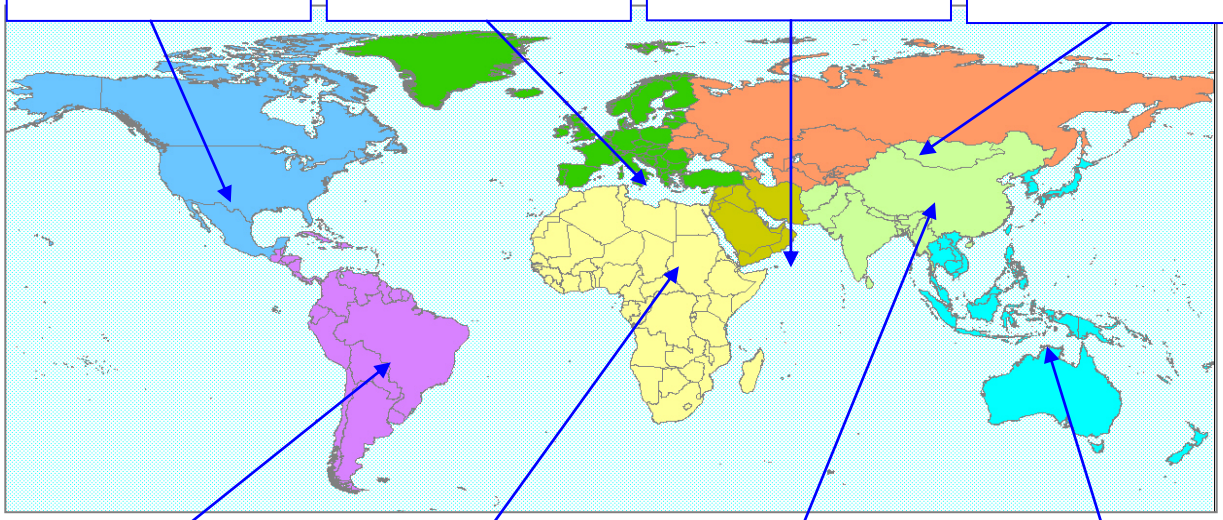
- Gas demand will grow from 570 Bcm now to 660 Bcm in 2030
- Power is the main driver
- Big uncertainty around power share due climate discussions
- Residential and Commercial sector as well as Industry show a small increase of 40 Bcm totally in 2030
- Renewables are growing fast. In 2030 the share might be slightly above 20%
- Indigenous production in sharp decline
- Shale gas opportunities under investigation

Middle-East

- Gas demand will grow from 370 Bcm now to 630 Bcm in 2030
- Power sector and industry are main consumers
- The Middle-East is endowed with more than 40% of the global proven gas reserves
- Gas production will grow from 480 Bcm now to 840 Bcm in 2030
- The Middle East is expected to remain a key exporter with over 200 Bcm exported by 2030.
- Capital Investment is the main concern due to numerous infrastructure projects

CIS

- Gas demand will grow from 620 Bcm now to 800 Bcm in 2030
- Power and Industrial sectors are the main drivers
- CIS is running on oil and gas
- Coal is at most spots not competitive due to its transportation cost
- Nuclear units cannot be built within the necessary timeframe
- By 2030 demand from the power sector in the CIS will increase to 380 Bcm
- Gas reserves increased to 60 Tcm
- Supply in the CIS can grow to around 1150 Bcm in 2030



LAC

- Gas demand will grow from 130 Bcm now to 210 Bcm in 2030
- Power sector is driver
- Biomass and other renewables are competitive
- Renewables grow strongly; Hydro is dominant
- Gas production will increase from 60 Bcm to 250 Bcm
- Indigenous natural gas production in LAC can keep up with gas demand

Africa

- Gas demand will grow from 110 Bcm now to 170 Bcm in 2030
- Main driver is population growth and GDP
- Gas production will grow from 220 Bcm now to 390 Bcm in 2030
- Africa's role as global gas supplier will getting more and more important
- Gas export will grow to over 200 Bcm in 2030
- High shale gas opportunities (i.e. Algeria)
- Foreign Domestic Investment is crucial factor for supply

Asia

- Gas demand will grow from 250 Bcm now to 730 Bcm in 2030
- China is THE DRIVER
- The share of natural gas is expected to double to 12% within the time frame regarded
- Environmental issues (especially pollution of cities, not CO2) are playing an important role
- Asia faces a growing dependency in gas supply from other regions
- Huge shale gas opportunities (China) but water might be a show stopper

Asia Pacific

- Gas demand will grow from 330 Bcm now to 550 Bcm in 2030
- Japan is the main consumer
- Oil price is the main driver for gas demand in Japan
- Region is highly dependent on LNG
- Gas production will grow from 340 Bcm now to 570 Bcm in 2030
- Asia Pacific provides one third of global LNG supply