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GECF Global Gas Outlook
2040

SYNOPSIS

GAS EXPORTING COUNTRIES FORUM

The Gas Exporting Countries Forum (GECF) is an international, governmental organisation, established in 2001. It became a full-fledged organisation in 2008 with its permanent secretariat based in Doha, Qatar.

The GECF provides the framework for exchanging experience and information among its Member Countries. The GECF is a gathering of the world's leading gas producers whose objective is to increase the level of co-ordination and to strengthen collaboration among Member Countries.

In accordance with the GECF Statute, the organisation aims to support the sovereign rights of its Member Countries over their natural gas resources and their abilities to develop, preserve and use such resources for the benefit of their peoples, through the exchange of experience, views, information and co-ordination in gas-related matters.

The Member Countries of the Forum are: Algeria, Bolivia, Egypt, Equatorial Guinea, Iran, Libya, Nigeria, Qatar, Russia, Trinidad and Tobago, the United Arab Emirates and Venezuela. Azerbaijan, Iraq, Kazakhstan, the Netherlands, Norway, Oman and Peru have the status of Observer Members.

**Tornado Tower, 47th & 48th Floors, West Bay
Doha, Qatar
P.O. Box 23753
www.gecf.org**

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Tornado Tower, 47th & 48th Floors, West Bay

Doha, Qatar

P.O. Box 23753

www.gecf.org

FOREWORD

This the first edition of the *GECF Global Gas Outlook 2040* was prepared by the Secretariat of the Gas Exporting Countries Forum (GECF) based on the discussions and recommendations of the four GECF Technical & Economic Council (TEC) Meetings held in 2015-2016 as well as the previous six meetings of the GECF Steering Committee that convened during the years 2012-2014. The analysis is built on the GECF's Global Gas Model, which integrates existing and future gas supply by type and cost, energy demand forecasting modules, and the pipeline and LNG infrastructure that link demand and supply. The output is brought together in an analysis of long-term import and export of natural gas. It presents least-cost solutions based on contractual flows, cost curves and other constraints influencing world gas markets.

This document represents the first Global Gas *Outlook* to be published by the GECF, and the first and unique worldwide to be focused only on the natural gas value chain, aiming to be a reliable source and reference of insights to the gas industry.

This document reflects the GECF *Outlook* central scenario and highlights the current situation and evolution of the gas market and energy trends in terms of the 2040 perspective. It is based on the global energy demand (by region/sector/fuel) and the global gas supply (conventional and unconventional) for GECF and non-GECF countries. This perspective reflects current energy policies and introduces those new policies that are likely to happen in the forecast period as per our assessment.

The global economy is changing rapidly, influenced by such economic and geopolitical factors, energy demand, supply, and prices that are evolving. The GECF modelling team constantly reviews the assumptions of the GECF *Outlook* to ensure its relevance and update it accordingly. The current revised edition of the *Outlook* incorporates many updates including reviewed macroeconomic projections, migration dynamics, energy prices (gas, coal, nuclear, renewables), historical energy demand data, and downstream, midstream as well as the latest upstream data.

This document provides an analysis of developments in the gas market and its long-term perspectives. Additionally, it aims to stimulate discussion between the GECF member countries regarding the global energy and gas outlook, as well as the major uncertainties and challenges that lie ahead. Its long-term objective is to clarify these views to the wider public as a GECF yearly publication format.

Furthermore, this *Outlook* attempts to address the key challenges that face the GECF today and in the future. Those challenges include the macroeconomic context, competition from the non-GECF countries in terms of natural gas resources, production capacity and costs, as well as the uncertainty over the evolution of the LNG market and contractual versus spot market dynamics, also in the framework of the lower oil prices.

I would like to express my thanks to the many experts in the GECF countries who participated in preparing this *Outlook* and all the people in the GECF Secretariat. We all believe that natural gas will be the fuel of choice in the decades to come.

HE. Seyed Mohammad Hossein Adeli
Secretary General
Gas Exporting Countries Forum (GECF)

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PROJECT LEADER

Dmitry Sokolov

MODELLING TEAM

Sofiane Ghezali (Supply and Trade)
Es-hagh Mansourkiaee (Demand and Policies)
Alexander Sergeev (Economic and Prices)

LEAD AUTHORS

Sofiane Ghezali
Es-hagh Mansourkiaee

CONTRIBUTORS

Seyed Mohsen Razavi
Sid-Ahmed Hamdani
Hussein Moghaddam

ADMINISTRATIVE SUPPORT

Isabel Arrieta - AFD - DISD - SG Office

GECF EXECUTIVE BOARD MEMBERS

GECF Countries Representatives

GECF TEC MEMBERS

GECF Countries Representatives

PEER REVIEW SUPPORT

IHS Global SAS

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EXECUTIVE SUMMARY

This *Global Gas Outlook 2040*, prepared by the Gas Exporting Countries Forum, highlights the key challenges that major gas exporting countries will face in the development of their natural gas resources in the next two decades.

The gas industry in all countries will require significant investments in order to deliver new gas to domestic and to export markets. The coming 20 year period is expected to see a relatively strong growth for gas demand, as customers throughout the world seek energy to support economic development while treating environmental concerns in a responsible manner.

This *Outlook* emphasizes the importance of maintaining contractual relationships between the buyers and sellers in international gas trade that will support the needed investments. Sellers and buyers will require that the risks in both volume and price can and will be effectively managed.

A key message of this *Outlook* is that gas resources in GECF countries are abundant. So much so, that the GECF member countries expect to be willing and able to contribute, with new exports, **significant volumes** to the growing **international trade** in gas. At the same time, the **domestic markets** for gas in many GECF countries will also **grow substantially**. By 2040, the *Outlook* projects that global demand for gas will be about 5,200 billion cubic meters (bcm). This compares with demand of about 3,500 bcm in 2015. In other words, demand is likely to increase by about **50% in 25 years**, a similar growth to that experienced over the past 16 years. And in the GECF countries (members and observers) domestic demand (excluding gas used for reinjection) is forecast to grow from 1,000 bcm to 1,300 bcm. In the GECF countries, Iran is likely to see the strongest growth, followed by Russia, Egypt, Iraq and Nigeria.

Gas demand will play a key role in helping to meet future energy requirements. The global economy is expected to double over the next quarter of a century and energy demand to increase by almost 30% over the same time. The gas market share will increase from just over 21% to 25% over the outlook period, as it gains market share in power sector generation. As the world economy continues to electrify - global electricity demand increases by 70% between 2015 and 2040 - the generation requirement correspondingly increases and gas offers a least cost source of power in many countries. The longer-term risk is that deeper decarbonisation of the power sector could undermine the position of gas in the absence of offsetting carbon capture

and storage technologies. In the short-to-medium term, however, gas can displace coal as the global source of incremental power supply.

International trade in gas will grow at a faster rate than the overall growth in gas demand. The *Outlook* sees **gas trade increasing by 66%** over the period, from about 1,000 bcm in 2015 to almost 1,700 bcm in 2040, and even more of this trade will be carried by sea, in the form of liquefied natural gas (LNG), than it is today. By 2040, LNG carriers may be moving the equivalent of about 660 bcm per year, compared with just over 320 bcm in 2015. In other words, **LNG trade will more than double**. The volume of gas traded through international pipelines will also grow significantly, from almost 700 bcm in 2015 to about 1,000 bcm. The share of LNG in international trade will increase therefore from 30% today, to between 40 and 45% from 2020 to 2040. Most of this dramatic increase will take place in the first 10 to 15 years of the projection period.

The modelling work that underpins this *Outlook* simulates and calculates the way in which future international trade in gas can develop in a cost-effective way. The work shows that GECF members are in a position to maintain, throughout the period to 2040, **the share** in international trade that is implied by the **least-cost solutions** of our modelling and forecasting exercise. The share of GECF members in global trade is forecast to be 47% in 2040 compared with 43% in 2015, and very close to the average share of 46% for GECF member countries over the last twenty years.

Yet there are sufficient gas resources in GECF countries for our members to be in a position to **meet future expected calls from international buyers**, while at the same time continuing to support the long-term growth in the role of gas in our members' domestic energy economies. In 1990, gas represented 37% of GECF members' **domestic primary energy**; it is expected to reach a share of 51% by 2040. This increase will allow a reduction in coal and oil use, and a corresponding **reduction in CO₂ emissions**, in line with our members' various INDC commitments under the 2015 Paris Agreement.

Thus, in their responsible use of gas resources to fulfil export and domestic needs, GECF members can deliver on both the **economic and environmental fronts** within the international community.

While delivering on these obligations, GECF members expect to face **challenges** in three areas over the period, which the GECF *Outlook* highlights:

• **Dramatic build up in the global trade in LNG.** As the LNG trade builds up to its expected 40 to 45% of global gas trade, the terms and conditions of the LNG business (whether short-term or long-term contract obligations, whether spot or indexed price references) may become **more influential** in the overall trade in gas.

• **Upstream investment.** Investment in the upstream will continue to require the lion's share of capital available for the gas business. The Investment section of the document points to an expected global need for US \$8 trillion (real 2015 dollars) over the period, of which 85% will be needed in the upstream. This level of investment spending is equivalent to over 10% of today's global GDP (gross domestic product). GECF countries' investment needs are likely to be lower than those of other countries, reflecting the lower-cost nature of much of the GECF resource base, and illustrating the economic efficiency benefits of international trade in gas. Nevertheless, investment in GECF countries between now and 2040 will be equivalent to over 25% of the combined 2015 GDP. **Changing market rules or contracting practices should not be allowed to disrupt efficient investment, nor should access to finance,** that may threaten the future availability or stability of gas supplies.

• **Conventional versus unconventional gas.** Uncertainties surround the **comparative economics** of different gas resources. New conventional gas supplies usually have long lead times, high upfront capital needs, but low unit costs of production. For unconventional gas, development economics can be subject to very different criteria, with many small projects opening and closing quickly in response to short-term price movements and to the value of associated natural gas liquids.

In facing these challenges of the future, the GECF will continue to support its members both in dialogue in the international community and with analytical support such as that contained in this *Global Gas Outlook* to 2040.

I. INTRODUCTION AND SCOPE

This document provides the Gas Exporting Countries Forum views on energy and gas market developments, based on a proprietary assessment of the evolution of gas market fundamentals to a horizon of the year 2040. The GECF *Global Gas Outlook* was developed by the GECF Secretariat, supported by a framework of specialized committees created within the Forum to guide and monitor the Secretariat's extensive research on world gas markets.

The GECF *Global Gas Outlook* is unique. It is the only energy outlook worldwide to focus solely on natural gas; as such it aims to be a global reference for insights on gas markets. The document offers a view on gas market evolution by describing and assessing the developments that are most likely to occur in the medium and the long-term. To this end, it presents the GECF reference case scenario which has been developed based on certain strategic scenario axes (security of gas demand and energy prices) and GECF's key internal and external challenges.

The GECF reference case scenario highlights the current situation and the evolution of the gas market and energy trends to 2040, in terms of global energy demand (by region/sector/fuel) and global gas supply (conventional and unconventional) for GECF and non-GECF countries. It also reflects both current energy policies and the introduction of possible new policies which, in accordance with our assessment, are likely to materialize throughout the forecast period.

In addition the document explores the subject of competition from alternative sources of energy (mainly coal and renewables), as well as technological developments and their eventual impact on the energy mix and on the gas market share. There is a focus on power generation as strategic sector for gas demand growth. Moreover energy efficiency, environmental policies and other regulations have been considered in the reference case scenario to study their impact on the penetration of gas in key markets/sectors and to enable GECF views on these subjects to be further developed.

It is not possible to cover all future uncertainties with one single scenario; multiple scenarios are needed in order to have a broader mapping of uncertainties shaping the development of gas markets. In this context, alternative scenarios are envisaged, and will be included in further versions of the document.

The outcomes of the GECF reference case scenario, nevertheless, will serve as a basis to support the formulation of a consistent long-term strategy for the Forum. This will allow progress in the agreed objectives included in the GECF statute and in various GECF summit declarations.

Key Messages:

II. THE GLOBAL CONTEXT FOR GAS MARKETS

- In the long-term, it is estimated that global economic growth will average 2.9% per year in the outlook period, similar to the historical rate of growth since 1990.
- Key contributing factors are the impact of low commodity prices, tighter financing conditions, and the rebalancing measures in China; these result in weak investment and slower trade growth worldwide.
- Policy supports to renewables and to natural gas will be key drivers in the post COP21 era.

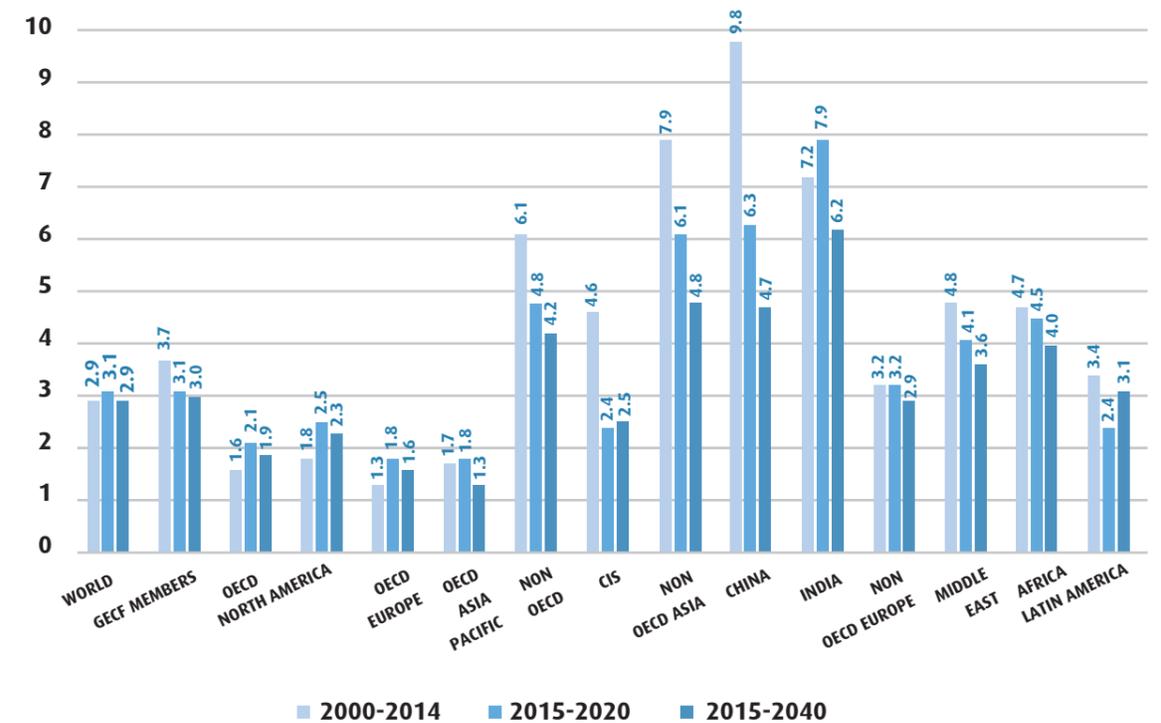
II. THE GLOBAL CONTEXT FOR GAS MARKETS

Future market conditions for gas will be shaped by global economic developments, by demographic trends, by oil market developments and by the implementation of national and international energy and environmental policies. This section examines each of these in turn.

THE GLOBAL ECONOMY IS EXPECTED TO GROW ON AVERAGE BY 2.9% PER ANNUM IN THE LONG-TERM

The trend of potential GDP growth is slower than previously expected, especially for non-OECD countries. An aging population, a lower rate of productivity growth, and slower rates of capital accumulation all weigh negatively on the global long-term GDP growth forecast. We estimate long-term global growth will average 2.9% per year in the *Outlook* period. This is very close to the historical average rate of growth since 1990. Two countervailing trends are observed: “the speed limit” of the economy set by an aging population and diminishing capital returns; and technological innovation and higher educational levels enhancing total factor productivity. Global growth is expected to be stronger between 2015 and 2020, at 3.1% per year, but starts to slow down to 2.9% after 2020 as non-OECD Asia, including China and some other major emerging but maturing economies, slow to a more sustainable long-term rate.

Real GDP growth assumptions (Market Exchange Rates – Share)



GLOBAL POPULATION GROWS BY 1.6 BILLION AND URBANIZATION RATE INCREASES TO 63%

Population growth is a primary driver of future energy trends, reinforced by the process of urbanization. This *Outlook*, and the GECF Global Gas Model on which is based, use UN statistical projections which estimate global population rising from 7.3 billion in 2015 to 8.9 billion in 2040 under a median scenario. However, population growth slows over the projection period, in line with the trends of the last three decades: from 1.0% per year in 2015-2020 to 0.7% per year from 2020 to 2040.

It is important to mention that the overall increase in population will take place in urban areas and, as a result, this tendency will affect the growth in energy consumption as the facilities for energy use are more readily available in urban settings. The population is shifting to cities, with a greater number of homes but fewer people per household. This also tends to increase the amount of energy used per head of population.

A continued urbanization trend is envisaged over the outlook period, particularly in the African regions where the average annual growth rate of urbanization is 3%, in Middle East where it is 1.8%, and in the non-OECD Asia region where it is 1.6%. Despite the fact that these are lower growth rates than in previous decades, overall the urbanization trend is laying foundation for a tremendous increase in the need for energy, not just in terms of the manufacturing base linked to these urban settlements, but also to fuel the domestic sector of the growing cities.

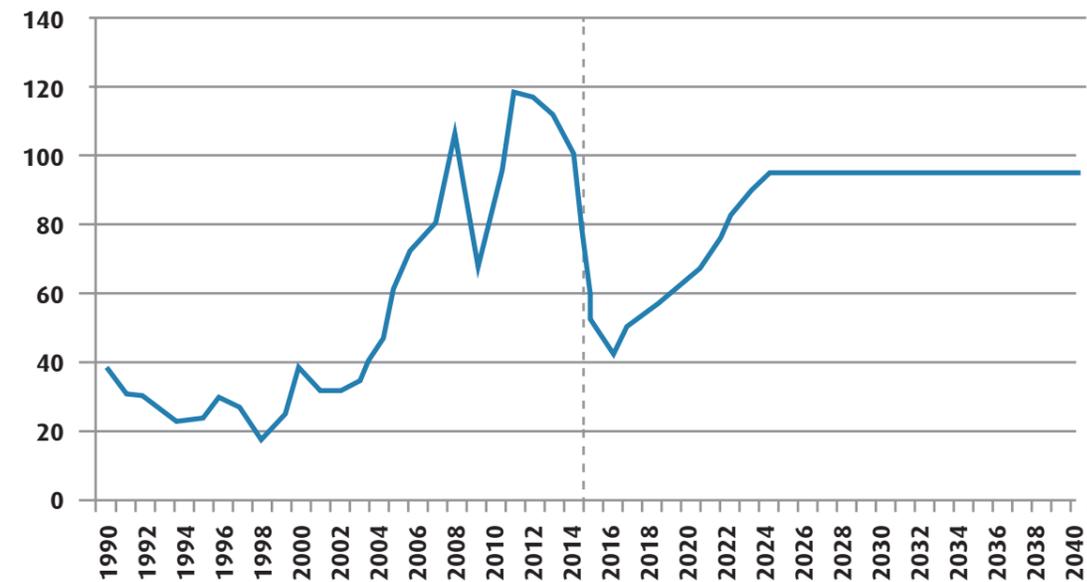
OIL PRICES CONTINUE TO BE PREDICATED ON THE SAME DETERMINING FACTORS THAT SHAPE TODAY’S OIL PRICES

Oil price forecasts are predicated on the same determining factors that shape today’s oil prices including: economic growth, the interplay between global oil supply and demand, Organization of the Petroleum Exporting Countries (OPEC)’s behavior, movement in oil inventory levels, financial market dynamics, industry production costs, and geopolitical events - particularly those that have the potential to disrupt supply. In the short term, we expect prices to remain weak due to a more pessimistic economic perspective than previously anticipated and to the absence of a strong decline in non-OPEC output.

In the medium term, the cost of producing the most expensive (marginal) barrel is an important component for oil price projections. Although the cost of producing oil varies significantly depending on the geology of the producing basin, the technology employed, and the fiscal terms applied to producers by host governments.

Our projections of 2040 oil prices show that over the medium to long-term, prices will likely range from \$70 to \$95 per barrel in constant (2015) dollars. This reflects the rising cost of supply needed to meet growth in demand, meaning that an expected pickup in the global economy would sustain the new levels. These price levels will support the most expensive sources of production, such as Canadian oil sands, Venezuelan heavy crude, and offshore deep-water African projects.

Brent oil price (2015 U.S. dollars per barrel)



NUMBER OF CARS TRAVELLING ON THE ROADS SURPASSES 2.2 BILLION BY 2040

Increasing the number of the cars on the road has huge implication for the transport sector and is widely expected to increase the demand for energy. Over the outlook period, more than 1 billion cars will be added to the global car fleets causing the number of the cars to surpass 2.2 billion by 2040. This also represents a significant opportunity for natural gas, especially as climate change policies and emission controls are tightening across the globe and therefore gas is seen as part of the solution to mitigate transport sector greenhouse gas (GHG) emissions by many countries.

Between 2005 and 2015, the number of vehicles fueled by compressed natural gas (CNG) has grown almost fivefold, increasing by over 7 million cars. Over the projection period, the global CNG vehicle fleet is expected to increase strongly by almost 9% annually and to reach over 73 million by 2040. China, Iran and India are the leading countries. This would increase the use of gas in global road transport to over 200 bcm in 2040.

NATIONAL CARBON MARKETS ARE MORE COMMON THAN EVER BUT STILL A LONG WAY TO GO

Carbon can be priced in various ways including carbon taxes, price references from emission trading systems (CO₂ markets), or a combination of both. Carbon prices allow internalisation of the external cost of climate change by increasing fuel costs for producers and consumers, making low-carbon fuels attractive at the expense of high carbon ones. Pricing of CO₂, for instance, will be translated in higher prices for coal relative to gas.

There are many countries in which carbon pricing instruments (carbon taxes and emission trading schemes) are under consideration or scheduled to be implemented. Australia, Brazil, Canada, Chile, Japan, Mexico, Turkey, New Zealand, Ukraine, South Korea, and South Africa are some examples. However, many uncertainties exist with regards to the progress of these carbon instruments, particularly regarding carbon market development and the effectiveness with which they signal relevant investment decisions.

The GECF *Outlook* considers that, in addition to the United States (US), European Union (EU) and China, other countries will implement national carbon markets over the period to 2040, including Australia, Canada, Hong Kong, South Korea, Mexico, and Turkey. However, the year of implementation will vary by country. While China and Hong Kong expect to establish national markets by 2017, the others are expected to join not earlier than 2020.

COP21 APPEARED AS A TURNING POINT IN ENERGY POLICY DEVELOPMENTS, BUT MANY CHALLENGES AND UNCERTAINTIES REGARDING THE ACHIEVEMENT OF ANNOUNCED COMMITMENTS AND TARGETS ARE OBSERVED

The agreement at COP21, reached in Paris in December 2015, was a turning point because it involved almost all the countries emitting GHG's in the world, including those who have been most reluctant in relation to climate policies. The Intended Nationally Determined Contributions (INDCs) submitted by many countries are a central mechanism in the COP21 agreement, reflecting the new bottom up approach which has been adopted to deal with the climate change challenge.

Policies aiming to mitigate GHG emissions in line with the countries' INDCs objectives will mainly look to increase the share of less carbon-intensive technologies and energy sources in the primary energy mix, and to enhance energy efficiency. These

policies are likely to be a combination of initiatives and measures in several policy domains, including renewable, non-renewable, energy efficiency, and other specific GHG mitigation measures such as emissions standards and carbon pricing.

Despite the objectives and measures announced by countries in the framework of their energy policies and submitted INDCs, many uncertainties and challenges still exist which can lead to mismatches between the policies' ambitions and the real outcomes of the implemented measures. Among the main uncertainties and challenges can be noted: political issues and support for climate ambitions; lobbying and resistance to change; security of supply priorities; growing energy needs to sustain economic and social developments; funding issues and affordability of energy supply; economic viability of green projects; non-binding and conditional commitments in the framework of the COP21 agreement; and the efficiency and level of implementation of the detailed agreement mechanisms.

The participants in the COP22 meeting held just recently in Marrakesh reaffirmed their commitments to the Paris accord which won a vote of confidence, and the momentum for GHG emission reduction was called as "irreversible". The meeting mainly concluded to the Marrakesh Action Proclamation which is a reinforcement of the Paris Agreement.

POLICY SUPPORTS TO RENEWABLES AND TO NATURAL GAS WILL BE KEY DRIVERS IN THE POST COP21 ERA

The main policy orientation in the GECF reference case is that the progress of renewables will still be driven by relatively strong policy support, especially in power generation. However, it is expected that many renewable support schemes will be impeded by constraints which are already becoming visible, particularly funding large amounts of subsidies, and integrating intermittent renewables in power systems.

The primary challenge for renewable power generation support schemes in the key markets is the adjustment of policies from renewable development to the integration of a large renewable share.

Policy support for gas infrastructure development, network integration and upstream projects, associated with other measures promoting demand for efficient and clean energy sources, encourage the progress of gas in the primary energy mix. Gas is also

promoted as an efficient back up to intermittent renewable energy. The overall direction of energy policies is to constrain coal consumption in many key markets by setting air pollutant emission standards, and introducing carbon taxes and caps on coal use.

Mandatory energy performance standards are the main policy drivers for improving energy efficiency in buildings, industry and transport. Policies which encourage a structural industrial shift in emerging countries will also be a key determinant in reducing energy intensity. Removal of energy price subsidies can also have an important part to play.

Carbon pricing policies will lead to relative increase in carbon as a cost component, but the extent of this increase is expected to be exceeded by the expected reduction of subsidies on fossil fuels. At the same time, emission trading systems are likely to experience difficulties in developing market relevant reference carbon prices.

Key Messages:

III. Trends In Energy Demand

- Global primary energy demand growth continued to slow down in 2015, for the third consecutive year. Weaker global economic growth combined with lower than expected demand from China has mainly contributed to this slowdown. All fuel types have experienced a slowing growth rate in 2015 except gas and renewables.
- World primary energy consumption is projected to grow by 1% per annum between 2015 and 2040, climbing from 13.8 Gtoe to 17.7 Gtoe.
- Natural gas will be the largest contributor to the increase in total primary energy consumption, with a share of almost 40%, followed by non-hydro renewables, which account for almost 30% of additional primary energy demand over the projection period.
- Over two-thirds of the global energy increase between 2015 and 2040 is expected to come from non-OECD Asia where strong population growth, higher economic activity, and improving living standards will drive an increase in energy demand.
- The power sector alone will contribute to 59% of the total increment in energy demand, while the sectoral contribution of industry will fall sharply indicating a global transition from heavy to light industry and to a more service-based economy.

III. TRENDS IN ENERGY DEMAND

Gas competes with other energy sources in all regions of the world and in all sectors of energy consumption, but the mix of energy in the power generation sector will be especially important for the overall energy balance and for gas demand. Although worldwide energy demand and carbon emissions from energy are expected to grow more slowly than in the past, the pathway to the internationally-agreed atmospheric GHG limit of 450 parts per million is not clear. Greater penetration of gas and renewables would be required to meet climate protection targets.

GLOBAL PRIMARY ENERGY DEMAND CONTINUED TO SLOW DOWN IN 2015, FOR THE THIRD CONSECUTIVE YEAR

The increase in global primary energy demand in 2015 was the most modest growth rate since 2010. All fuel types experienced slower growth in 2015, except gas and renewables. Global primary energy demand increased by around 137 Mtoe (million tonnes oil equivalent) in 2015, reaching 13.8 Gtoe (giga tonnes of oil equivalent). For comparison, this increase was only one fifth of the increase seen in the year 2010.

The fastest-growing regional markets were non-OECD Europe, Middle East, and non-OECD Asia with 3.1%, 3.3%, and 2.3% annual growth rates respectively. In terms of volume, however, non-OECD Asia was the largest contributor, accounting for over 80% of the total global increment in 2015.

GECF member and observer countries accounted for 13% of the total world primary energy demand in 2015. Demand growth rate increased marginally by almost 0.1% in 2015. This minor increase, however, interrupted a declining trend which began in 2010. Political instability in some GECF countries and consequently lower economic performance has kept energy consumption low in these regions. In terms of their share of the world energy market, GECF countries collectively ranked third following non-OECD Asia (36%) and North America (20%) on par with OECD Europe (13%) and ahead of CIS (7%), OECD Asia-Pacific (6%), Africa (6%), Middle East (6%), Latin America (5%) and non-OECD Europe (1%).

World energy demand trends by region (2010-2015) (Mtoe)

	2010	2011	2012	2013	2014	2015	Growth 2014-15
World	12855	13140	13309	13557	13710	13847	1.0%
of which GECF	1699	1761	1786	1796	1802	1810	0.4%
Latin America	641	654	676	692	702	698	-0.6%
North America	2706	2701	2628	2695	2757	2748	-0.3%
Non-OECD Asia	4144	4406	4595	4756	4876	4988	2.3%
OECD Asia-Pacific	922	898	894	899	894	893	0.0%
Non-OECD Europe	111	114	110	104	106	109	3.3%
OECD Europe	1904	1844	1835	1821	1775	1803	1.6%
Africa	710	733	753	768	777	791	1.8%
CIS	1045	1087	1082	1058	1048	1016	-3.0%
Middle East	673	703	737	763	776	801	3.1%

IRAN AND RUSSIA ARE AMONG THE TOP10- PRIMARY ENERGY CONSUMING COUNTRIES IN 2015

The ten largest energy consuming countries account for about two-thirds of the world's primary energy use, a proportion which stayed broadly stable in 2015. The two largest consuming markets, China and the US, held respective shares of 22% and 17% of the total global energy consumption in 2015, far ahead of India (6%) and Russia (5%). Russia and Iran are the two GECF members in the top 10 primary energy consuming club. In 2015, Iran took over tenth position from France, which highlights this country's potential to become an emerging energy consumer.

Top 10 energy consuming countries in 2015 (Mtoe)

	2010	2011	2012	2013	2014	2015	Growth 2014-15
China	2524	2754	2884	2989	3048	3098	1.7%
United States	2279	2257	2188	2251	2300	2285	-0.6%
India	695	721	757	782	833	868	4.2%
Russia	736	766	759	742	735	720	-2.0%
Japan	510	474	465	468	457	449	-1.7%
Germany	337	321	323	329	318	321	0.9%
Brazil	272	276	288	299	211	305	-2.0%
South Korea	262	272	275	276	281	286	1.8%
Canada	248	257	249	251	268	270	0.7%
Iran	209	215	222	231	243	254	4.5%
Total Top-10	8072	8313	8419	8618	8793	8856	0.7%

NON-OECD ASIA ACCOUNTS FOR OVER 65% OF THE PROJECTED INCREASE IN WORLD PRIMARY ENERGY DEMAND

World primary energy consumption is projected to grow by 1.0% per annum between 2015 and 2040, climbing from 13.8 Gtoe to 17.7 Gtoe, with an average addition of 155 Mtoe per year. There is a shift in the geographic focus of long-term energy demand growth over the forecast period from the OECD countries to the non-OECD countries. Non-OECD demand grows at an average rate of 1.5% between 2015 and 2040. The OECD countries, by contrast, barely grow at all, on average only 0.2% per year. Non-OECD energy demand first surpassed OECD energy consumption in 2005. Total energy consumption in the non-OECD countries is expected to be more than twice that of the OECD countries by 2040.

Indeed, a regional breakdown of primary energy demand shows that over two-thirds of the global energy increase between 2015 and 2040 is expected to come from non-OECD Asia, where strong population growth, higher economic activity, and improving living standards drive an increase in energy demand. Other regions show far less significant increases in demand than non-OECD Asia. The Middle East, the next largest source of incremental energy demand, contributes almost 11% of the increase by 2040, followed by Africa, which accounts for nearly 10% over the projection period.

Primary energy demand by region (Mtoe)

	Historical				Forecast					
	1990	2000	2015	CAAGR* 1990-2015	2020	2025	2035	2040	CAAGR	2015-2040 DELTA
World	8797	10111	13847	1.8%	14964	15801	17186	17733	1.0%	3886
of which GECF	1410	1278	1810	1.0%	1872	1978	2125	2180	0.7%	371
OECD	4668	5473	5505	0.7%	5663	5699	5734	5743	0.2%	237
America	2331	2768	2784	0.7%	2894	2947	2999	3022	0.3%	238
United States	1981	2339	2285	0.6%	2363	2406	2425	2423	0.2%	138
Europe	1679	1827	1803	0.3%	1806	1795	1785	1787	0.0%	-15
Asia-Pacific	656	859	893	1.3%	936	926	916	898	0.0%	5
Japan	449	531	449	0.0%	457	443	422	405	-0.4%	-44
Non-OECD	4130	4639	8341	2.9%	9301	10103	11452	11991	1.5%	3649
CIS	1388	916	1016	-1.2%	1014	1022	1024	1023	0.0%	7
Asia	1605	2276	4988	4.6%	5783	6356	7280	7626	1.7%	2639
China	874	1176	2098	5.2%	3564	3826	4134	4176	1.2%	1078
India	308	444	868	4.2%	1046	1231	1599	1780	2.9%	912
Europe	160	103	109	-1.5%	110	112	115	118	0.3%	9
Middle East	231	383	776	5.0%	880	990	1143	1189	1.7%	414
Africa	400	512	791	2.8%	857	920	1075	1158	1.5%	368
Americas	345	448	662	2.6%	655	703	816	875	1.1%	213
Brazil	141	191	305	3.1%	294	321	378	408	1.2%	103

*CAAGR - Compound Average Annual Growth Rate

PRIMARY ENERGY DEMAND GROWS 1% ANNUALLY OVER THE OUTLOOK PERIOD, WELL BELOW OF GROWTH RATE IT POSTED IN THE PAST 25 YEARS (1.8%)

For the last 25 years, energy demand in non-OECD countries, mainly non-OECD Asia and the Middle East, grew at a very fast rate of around 5.0% yearly. Over the projection period (2015-2040) energy demand growth is expected to slow considerably. In the non-OECD countries, energy demand would increase annually by almost half of the level recorded in 1990-2015; while in the OECD, the projected demand growth also slows to less than half of the rate it posted over the past 25 years. Over the outlook period, none of the regions surpass 2.0% average annual demand growth, indicating that the phase of rapid energy demand growth has come to an end, and the world is not likely to replicate the preceding high paces of energy demand growth.

GECF COUNTRIES ENERGY MIX DOMINATED BY GAS AND WILL REMAIN SO BY 2040

In the *Outlook*, GECF countries' energy demand is expected to increase by 370 Mtoe between 2015 and 2040 and to reach 2,180 Mtoe by the end of the outlook period.

Within the period 2015-2040, GECF primary energy consumption is expected to grow by an average of 0.7% per year, slower than global energy demand. This demand growth rate is also below the rate which the GECF countries experienced over the past 25 years. Future growth will reflect the impact of policies which aim at higher efficiency measures and the reduction of fossil fuel subsidies in some countries. In 2040, the overall GECF energy mix is not expected to change dramatically, although variations are likely to be observed in some individual countries. Natural gas is projected to be the fuel that benefits most, increasing its share to 51% in 2040 from 48% today.

GECF primary energy demand by fuel (Mtoe)

	Historical			Forecast					
	1990	2015	Share	2020	2025	2030	2035	2040	Share
Primary Energy Consumption	1410	1810	100%	1872	1978	2070	2125	2180	100%
Oil	514	576	32%	611	660	698	703	697	32%
Natural Gas*	516	861	48%	903	947	1004	1058	1119	51%
Coal	244	156	9%	136	122	108	94	82	4%
Nuclear	33	46	2%	41	60	63	65	65	3%
Renewables	72	129	7%	137	143	150	158	173	8%
Hydro	32	41	2%	44	46	46	46	45	2%
GECF Share of Global Consumption	16%	13%	-	13%	13%	12%	12%	12%	-

*Gas demand excludes gas used for enhanced oil recovery or other produced gas like Gas Works.

GECF COUNTRIES PROVE SUCCESSFUL IN REDUCING ENERGY INTENSITY

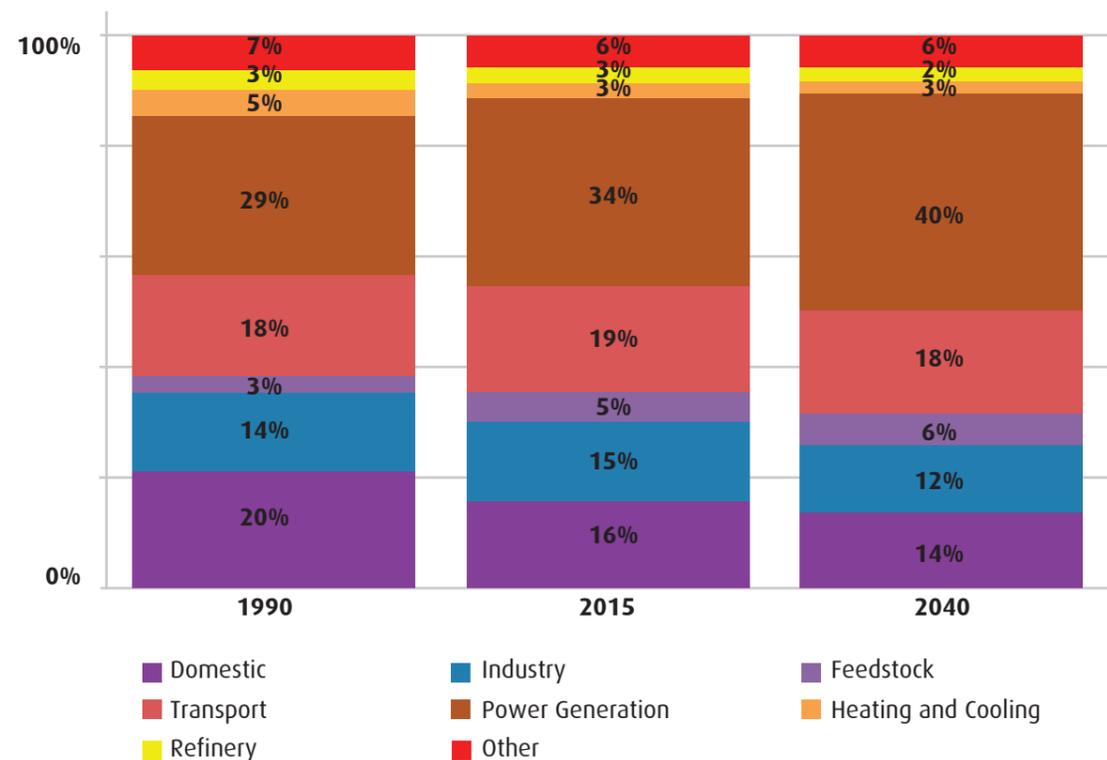
Over the next 25 years, the GECF urban population share is expected to increase to 70%. During the same period, the number of households in GECF countries is also projected to increase by about 72 millions. GECF real GDP is expected to rise by 100% between 2015 and 2040, implying an average growth rate of 2.8% per year. Despite these bullish factors, the energy intensity of GDP in the GECF countries will decline sharply over the outlook period. In 2015, 319.9 toe of energy were used to produce one million US dollars of GDP. In 2040, this will drop by 40% to 191.8 toe, mainly under the impetus of stronger efficiency measures and subsidy phase-out.

THE POWER SECTOR WILL SHAPE THE FUTURE OF PRIMARY ENERGY DEMAND

Over the past 25 years, from 1990 to 2015, total primary consumption increased by 5 Gtoe. Demand from the power sector, transport, and industry, as the three leading

sectors, contributed almost 80% of this increase. The power sector alone accounted for 44% of the additional demand followed by transport and industry with 20% and 15%, respectively. Over the next 25 years, these three sectors will still account for 76% of the total increase in primary demand; however, the share of the power sector will increase significantly at the expense of the other two sectors. The power sector alone contributes 59% of the total increment while industry's contribution falls sharply (2%), indicating that the world will see a transition in sectoral consumption from a heavy industrial sector to light industry and a more service-based economy. This transition will accelerate the decline in energy intensity but it will increase demand for electricity. Growing power consumption will also be driven by wider electrification, as the global index of access to electricity increases from 0.84 to 0.90, an increase in electricity access which mainly occurs in non-OECD countries.

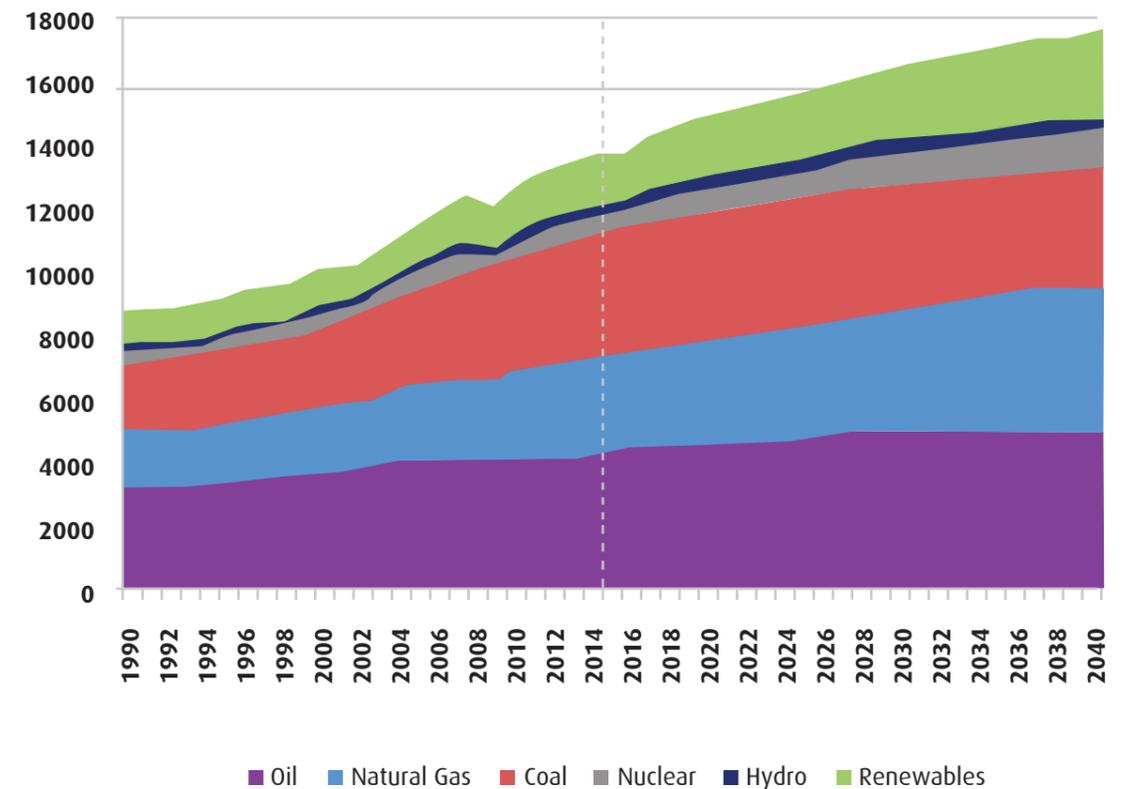
Primary energy demand by sector - market share



ENERGY CONSUMPTION INCREASES BY 30% BY 2040, GAS IS THE LARGEST CONTRIBUTOR

Natural gas, with almost 40% share from the increment in the primary energy, is the largest contributor to the increase in the total primary consumption. It is followed by non-hydro renewables, which account for almost 30% of the additional primary energy demand; oil and nuclear are the next largest contributors. Coal is the single energy source that sees no increase in its consumption in our GECF Outlook.

World energy demand by fuel (Mtoe)



FOSSIL FUELS REMAIN THE MAIN SOURCE OF ENERGY MIX WITH OVER 75% SHARE IN 2040

In 2015, fossil fuels (oil, gas and coal) contributed to over 81% of world fuel mix. In 2040, they are still likely to account for 75% of the total energy demand, making up the main bulk of the world energy mix and dominating the energy landscape. The significant share of these fuels, which are required to meet the global future energy needs, highlights the importance of changing the direction and energy mix in a favour of lower carbon content fossil fuels that will contribute to reduce pollution and to deliver climate change policies without completely precluding their use.

World energy demand in the reference case (Mtoe)

	Historical				Forecast					
	1990	2000	2015	Share	2020	2025	2030	2035	2040	Share
Total Primary Consumption	8797	10111	13847	100%	14964	15801	16574	17186	17733	100%
Oil	3243	3690	4406	32%	4670	4869	5007	5048	5043	28%
Gas	1679	2092	2988	21%	3298	3555	3864	4191	4496	25%
Coal	2221	2342	3852	28%	3985	3989	3949	3857	3792	21%
Renewables	942	1084	1697	12%	1855	2094	2308	2532	2762	16%
Nuclear	528	677	663	5%	783	889	1020	1122	1195	7%
Hydro	185	226	330	2%	374	406	426	436	446	3%

Note: Due to rounding, numbers may not add up to the totals provided and percentages may not precisely reflect the absolute figures.

GAS IS THE FASTEST GROWING FOSSIL FUEL, MAINLY UNDER THE IMPETUS OF RISING ELECTRICITY DEMAND

Gas grows faster than other carbon-based fuels, at an average of 1.6% per year, and gains the most market share among all energy types except the non-hydro renewables. Indeed, under the *Outlook*, the share of gas in global energy demand increases from 21% in 2015 to over 25% in 2040. The use of gas in the power sector, under the impetus of rising electricity demand, is the main driver behind this growth. However, policies that support environmental objectives, including carbon pricing mechanisms, will also support that growth significantly.

Non-hydro renewables are also growing strongly over the projection period. Although the majority of renewables still comes from biomass, solar and onshore wind have made significant gains in recent years, benefiting from preferential government rates as well as from cost reductions due to technological advances. Natural gas plays a complementary role for the variability of renewable sources in power generation and therefore, given their currently expected market penetration renewables do not diminish the position of natural gas in the *Outlook*. While this is the general worldwide picture, it will not be the same in every country, especially those countries that set more political targets for renewable deployment in the power sector.

COAL WILL PLAY A ROLE IN FUTURE ENERGY MIX BUT IN A LESS INFLUENTIAL MANNER

In the *Outlook*, coal is the most slowly growing fuel. Coal demand is expected to peak around 2025 and start to decline thereafter. This can be compared with a growth rate of 2.2% per year on average for the period from 1990 to 2015. After more than a decade of strong growth in coal demand, coal use is expected to be limited mainly by environmental policies. Today, more than ever, the future of coal is dependent on the development of clean technologies such as carbon capture and storage (CCS). While OECD countries move away from coal, global coal consumption increase is expected to come from non-OECD Asian countries, where India and China dominate and account for 70% of consumption by 2040.

Question marks hang over coal's future, especially in the bulwark non-OECD Asia markets. Chinese demand is coming under pressure as growing public demand for stronger air quality regulations has lowered expectations for future Chinese coal demand and therefore undermined the feasibility of numerous coal projects across the world. The future track of coal consumption and production in the United States may be influenced by significant changes in Federal government policy, following the election of Donald John Trump as the 45th US President, taking office from January 20th 2017, who may be seen as favourable to fossil fuels in general and to coal as well. However, in most of the US, we consider that state-level regulations and market developments are likely to constrain the use of coal.

OIL DEMAND GROWS BUT MORE MODERATELY THAN WITNESSED IN THE PAST 25 YEARS

In the *Outlook*, global demand for oil and other liquids increases from almost 93 million b/d in 2015 to over 98 million b/d in 2020. Oil demand continues to rise until it peaks at 106.5 million b/d in 2035 and then stabilizes around 106 million b/d through 2040. Compared with the past 25 year period from 1990 to 2015, during which demand was growing at 1.2% on average annually, the consumption of oil and other liquids will grow more moderately over the projection period at 0.5% per annum or in terms of volume with a yearly average increase of 25 Mtoe. The largest decline in the demand for oil and other liquids is expected to occur in the power sector where it faces strong competition from other fuels including natural gas, renewables, and nuclear.

DESPITE THE FUKUSHIMA INCIDENT, NUCLEAR IS EXPECTED TO GROW STRONGLY

While over the short-term nuclear is expected to be affected adversely by the Fukushima nuclear incident in Japan in 2011, over the long-term, it is still projected to grow significantly, by an average of 2.4% annually over the outlook period.

Under the *Outlook*, nuclear energy continues to develop mainly in the non-OECD countries, where it is expected to surpass the OECD by 2035-40 in absolute terms. China alone accounts for over 60% of the total additional nuclear demand by 2040, increasing rapidly at an average annual rate of 8.6% over the outlook period. India is the next largest contributor to the increment in nuclear demand; however, it is expected to grow slightly more slowly at an average annual rate of 7.8%.

In our *Outlook*, Japan's nuclear industry is expected to revive over the next five years and reach around 70% of its level in 2010. However, there are some uncertainties related to the public opinion and governmental policy changes, which put a downward risk on Japan's nuclear demand prospects in the *Outlook*.

GLOBAL CARBON EMISSIONS ARE EXPECTED TO INCREASE MORE SLOWLY COMPARED WITH THE PAST 25 YEARS AT AN AVERAGE OF 0.5%

In our *Outlook*, world energy related CO₂ emissions rise from 33.4 GtCO₂ in 2015 to 37.6 GtCO₂ in 2040. Annual emissions by 2040 are thus 13% above the level witnessed in 2015. However, the rate of increase in global carbon emissions is expected to slow down compared with the past 25 years, to an average of 0.5% per year over the outlook period.

Globally, implementing better energy efficiency measures and shifting the economic structure of the developing countries from high energy-intensity sectors to the low energy-intensity service sector is expected to result in lower global energy intensity per capita and per GDP. The rates of growth of economic activity and of energy consumption are therefore set to decouple over the outlook period. Furthermore, increasing the penetration of clean fuels, including gas and renewables in countries' fuel mix, will also widen the gap between growth in carbon dioxide emissions and growth in total primary energy consumption, a further decoupling.

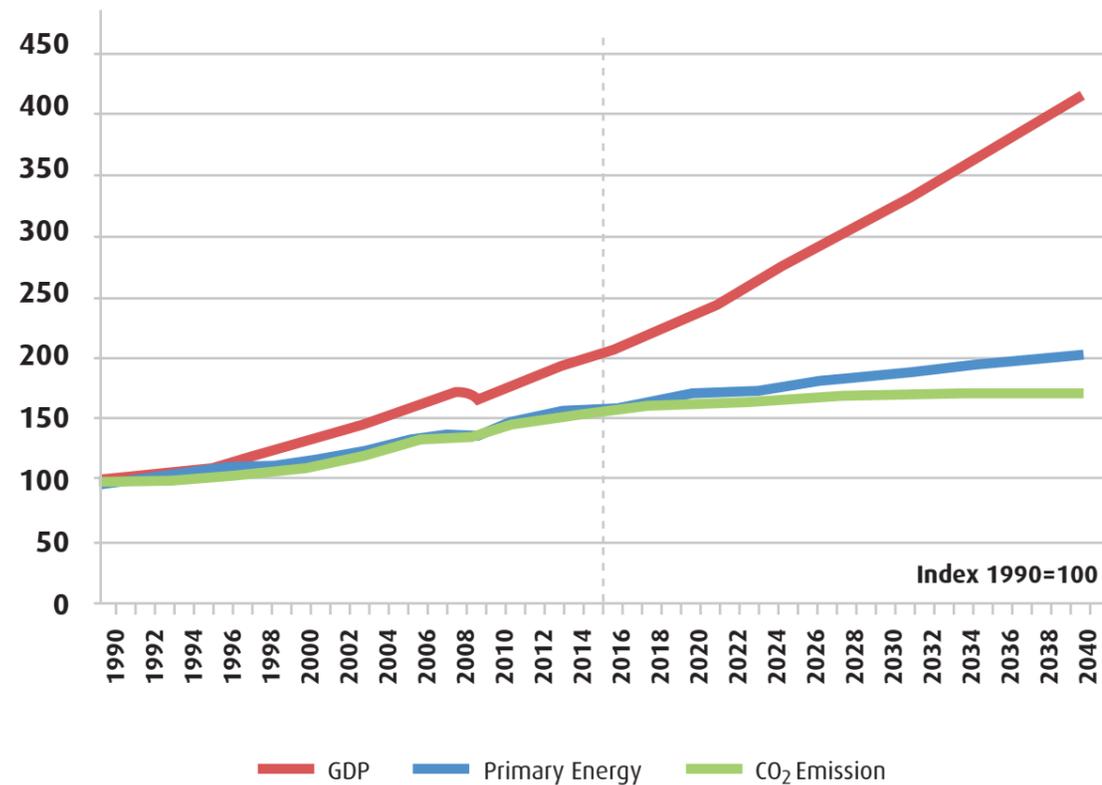
Despite this 'double decoupling' and the fact that in the GECF *Outlook*, gas is the fastest growing fossil fuel, and renewables are growing strongly, these developments are still not enough to keep the climate pathway in line with scientific recommendations, and existing political agreements, to limit the concentration of GHG's in the atmosphere to below 450 parts per million. This suggests that greater penetration of gas and renewables is required to control total carbon dioxide emissions sufficiently and meet climate protection targets.

Key Messages:

IV. The Global Future For Gas Demand and Supply

- Over the period 2015-2040, global gas demand grows by 1.6% per year in the Outlook, where the market share of gas increases from 21% in 2015 to over 25% in 2040.
- Gas demand is set to increase in every region in the *Outlook*. The bulk of the additional gas demand comes from non-OECD Asia, North America and the Middle East.
- Power sector gas intake grows by 2.2% per year over the outlook period and remains the largest contributor to gas demand growth.
- The world holds plenty of natural gas resources (total 532 trillion cubic metres (Tcm)), of which almost 178 Tcm are identified proven conventional reserves and 354 Tcm are other gas resources.
- The development of pipeline gas projects towards Asia and Europe will complement the development of LNG in future international trade.
- In the coming twenty-five years, the average global production growth rate from 2015 to 2040 is expected to be at around 1.6% (2.1% average annual growth by 2020). Thus, global gas production is expected to almost double compared with 1990, or increase by almost 50% above today's gas output, increasing to around 5,400 bcm by 2040.
- The share of unconventional gas is expected almost to double from around 15% currently to almost 30% by 2040.
- The share of the GECF member countries in global marketed gas production is expected to average 38% during the outlook period, while the historical average starting from 1990 was about 37%.
- Total cumulative investment in the upstream and gas transportation system is estimated at USD 8.0 trillion for the period 2015 to 2040 (real 2015 US\$).

Global CO₂ emissions, GDP and energy consumption



IV. THE GLOBAL FUTURE FOR GAS DEMAND AND SUPPLY

Gas demand is growing, and it is expected to continue to grow for the next 25 years. Growth is expected to be strong in the well-established power sector, but also in the emerging transport sector. There are plenty of resources to supply a growing demand, but significant investment will be needed to unlock them, with investment especially focused on upstream development. GECF countries will continue to play a major role in increasing supply, and there will be strong growth in production from unconventional geological sources, such as shales.

GLOBAL PRIMARY GAS CONSUMPTION PICKED UP BY 66 BCM IN 2015 MAINLY BOOSTED BY THE US

Global primary gas consumption¹ rose by 66 bcm in 2015 and approached 3,500 bcm. Consumption has grown strongly at 1.9% mainly driven by North America (3.3%), Middle East (5.1%), Africa (3.9%), OECD Europe (2.7%) and non-OECD Asia (2.1%). However, gas consumption in OECD Asia Pacific continued to decline in 2015 and registered its lowest annual rate of change (-3.6%) over the past couple of decades.

Gas consumption declined in the CIS, mainly due to a resurgence of political tensions as well as mild weather conditions.

North America saw most additional gas demand (31 bcm), mainly in the US (23 bcm). Gas demand in the US is mostly driven by the shale gas revolution that made gas abundant and more competitive with other fuels. The increased availability of gas put downward pressure on gas prices and made gas more attractive than coal in the US power sector. Cheap gas prices also displaced some nuclear energy and put non-economic nuclear plants at risk of closure.

In 2015, the Middle East was the second largest contributor to additional global gas demand, contributing an additional 22 bcm or one-third of the global increase. Total gas demand in this region reached 457 bcm in 2015 and for the first time in the past 25 years the Middle East equaled OECD Europe in gas usage. The GECF² countries' gas demand showed an increase year-on-year of 2.1% in 2015 and exceeded 1,000 bcm.

¹ Gas demand excludes gas used for enhanced oil recovery or other manufactured gas such as gas works gas, unless otherwise indicated.

² Including members and observers.

World energy demands trends by region (2010-2015) (Mtoe)

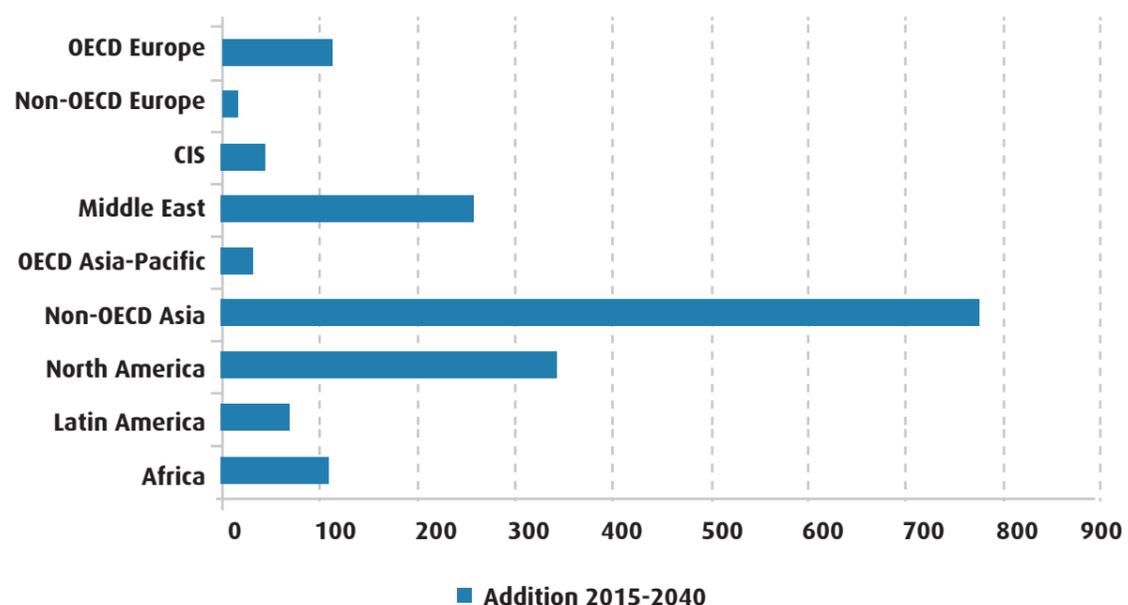
	2010	2011	2012	2013	2014	2015	Growth 2014-15
World	3212	3270	3347	3400	3428	3494	1.9%
of which GECF	927	957	968	979	987	1007	2.1%
North America	817	845	879	901	928	958	3.3%
CIS	623	631	628	621	626	611	-0.8%
Non-OECD Asia	391	410	425	447	470	480	2.1%
OECD Europe	548	501	490	486	445	457	2.7%
Middle East	370	390	408	420	435	457	5.1%
OECD Asia-Pacific	184	206	216	222	222	214	-3.6%
Latin America	146	146	155	158	163	161	-0.9%
Africa	107	115	121	121	127	132	3.9%
Non-OECD Europe	26	26	25	23	23	24	4.4%

LONG-TERM GAS DEMAND INCREASES BY 50%, SUPPORTED MAINLY BY THREE REGIONS: NON-OECD ASIA, NORTH AMERICA AND MIDDLE EAST

Over the period 2015-2040, global gas demand is expected to grow by 1.6% in the Outlook and to exceed 5,200 bcm by 2040. The market share of gas increases from 21% in 2015 to over 25% in 2040. In terms of growth rate, gas has the fastest growth among fossil fuels but ranks third behind nuclear and renewables when compared with all forms of energy. In fact, gas demand is expected to grow faster than global energy demand by 0.6% per annum.

Gas demand is expected to increase in every region, however, the bulk of the additional gas demand comes from non-OECD Asia, North America and the Middle East. Non-OECD Asia accounts for 43% of total additional gas demand over the forecast period, with China and India together contributing over 30% of the increase. In this region, Japan introduces uncertainty to the regional gas consumption. After the Fukushima accident, Japanese gas demand increased significantly through imports of LNG, which offset the loss of a large part of its nuclear capacity. Since then only five nuclear plants could obtain necessary permits and restart operation. While Japan's long-term nuclear policy is not clear, its future gas demand is highly susceptible to public attitudes to nuclear; it is assumed nuclear will return, but it is a risk to the outlook that may have an upside for gas.

Regional natural gas demand increment (bcm)



THE POWER SECTOR IS THE MOST DYNAMIC SECTOR FOR GAS DEMAND GROWTH

The power sector is expected to be by far the biggest source of additional gas demand. In the Outlook gas use in the power sector is projected to grow by 2.2% per year, which is faster than global gas demand growth of 1.6%. Thus, the power sector’s share of global gas demand increases from 35% in 2015 to 41% by 2040. Power sector gas demand rises strongly by 900 bcm between 2015 and 2040 and reaches over 2,100 bcm by the end of the outlook period.

The most notable point is that all fuels compete in the power sector, so the expansion of gas in the power sector is highly dependent on the prices of competing energy sources mainly coal, nuclear and renewables and to the extent that consuming countries’ policies, such as carbon prices, would act in favor of gas.

Gas has seen strong competition from non-hydro renewables, mainly solar and wind, in the power sector. The development of renewables can have a negative impact on the use of gas in this sector. It matters especially when the electricity demand is not

growing strongly. However, both solar and wind are intermittent energy sources, which means that they are not continuously available. They are predictable but are not directly controllable, so they need a combination of back up for the system, adequate storage to provide reliable energy, and sophisticated system controls in electricity dispatching and demand management. In this context, renewables development can have a positive impact on gas demand as a source of back-up capacity, given that gas-fired power plants have lower investment costs compared to other alternatives. However, the downside risk for gas demand as a backup system is any breakthroughs in electric storage technologies and batteries.

PROSPECT FOR UTILIZATION OF GAS IN THE TRANSPORT SECTOR IS PROMISING

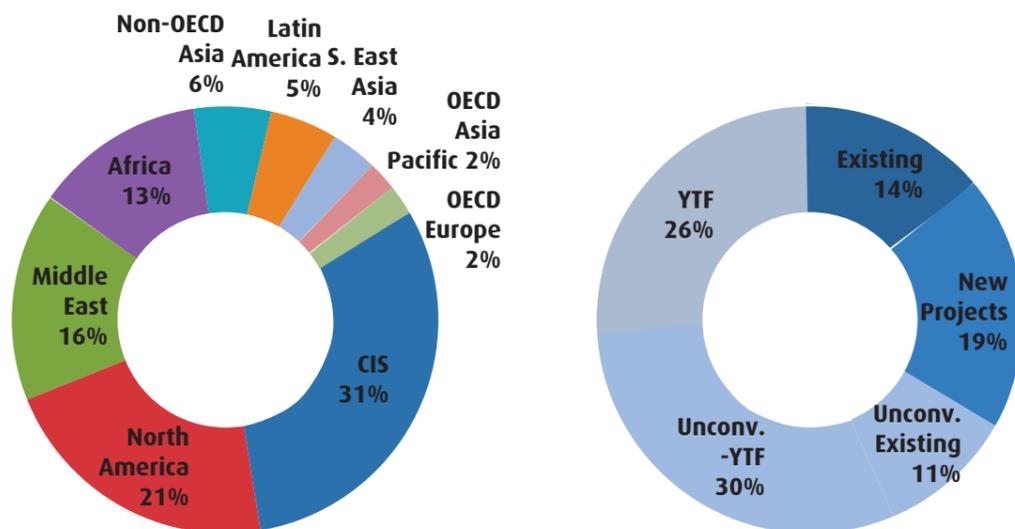
Natural gas can be used in different ways in the transport sector. In addition to use of gas in CNG vehicles, for which there is long precedent, today natural gas can also be employed in large trucks, ships, bunker fuels, buses and trains thanks to the development of small-scale LNG.

One factor that could have a significant impact on natural gas use in the transport sector is local environmental policies which aim at reducing air pollution and other harmful emissions. From 1st January 2015, ships trading in Emission Control Areas in Europe, the US and Canada are restricted to use fuel oil with a maximum Sulphur content of 0.1%. Consequently, ships have to switch to more expensive types of oil or install equipment like scrubbers to clean the exhaust gases. A larger gain for gas is expected if additional emission limits are introduced later in the 2020s for fuel oils used outside these emission control areas. However, the main challenge for gas penetration in the transport sector is the lack of adequate fueling stations. So market penetration may be limited to those where the price advantage is very significant (such as North America), and infrastructure is available, or it is promoted by government policy to displace oil due to environmental concerns (such as China).

THE WORLD HOLDS PLENTY OF NATURAL GAS RESOURCES

The world’s identifiable natural gas resources exceed 532 Tcm. Almost 178 Tcm are identified as proven conventional reserves and 354 Tcm are other gas resources including unconventional reserves (shale gas, coal bed methane, and tight gas) and undiscovered resources (conventional and unconventional Yet-To-Find or YTF).

Distribution of total natural gas resources by region and type (532 Tcm)



The total unconventional gas resources (40% of the total resources), and especially shale gas, are expected to be a major driver of global gas supply growth, due to their potential availability in many regions of the world (mainly Russia, North America, Africa, Non-OECD Asia and Latin America). Although the North American shale gas experience has been a relative success, its duplication with the same level of achievement in other regions of the world will not be possible as the conditions below and above ground are not the same elsewhere.

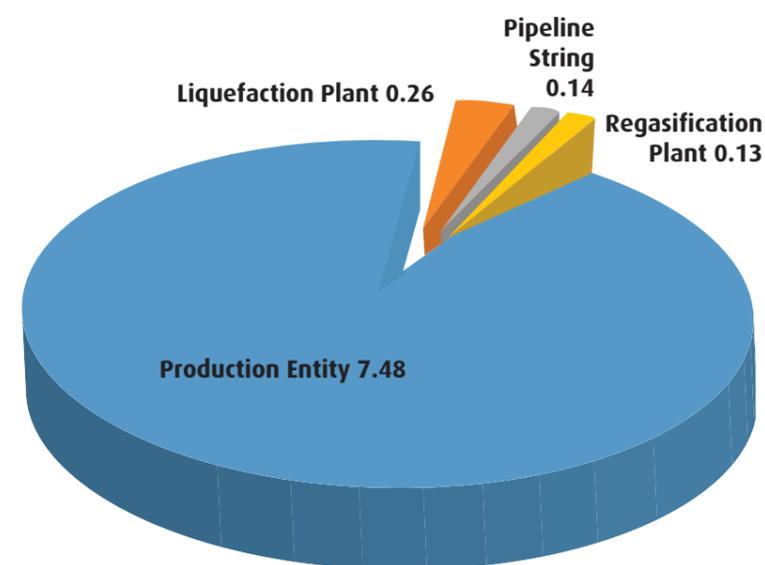
The current resource to production ratio is around 140 years for the complete resource base (Existing, New Projects, Conventional Yet-To-Find and Unconventionals), or around 60 years for just the existing and known new projects. There is, therefore, a considerable amount of natural gas that could be produced, with a large swath of it already having been proved (45%).

THE INVESTMENT CHALLENGE

In order to develop these resources, significant investment will be required. Total cumulative investment needs for the period 2015 to 2040, for both the upstream and gas transportation systems, are estimated at 8.0 trillion USD.

The upstream part is likely to need the biggest part of this investment, with more than 90% or almost 7.5 trillion USD (real 2015 USD). Other segments liquefaction, regasification and pipeline projects) will represent the remaining 7-8%. Since many gas projects will be developed on an integrated basis with the upstream, pipelines and liquefaction facilities developed altogether as one single project, the distinction is sometimes unclear.

Investment costs by segment of the gas supply chain (2015 Trillion USD)

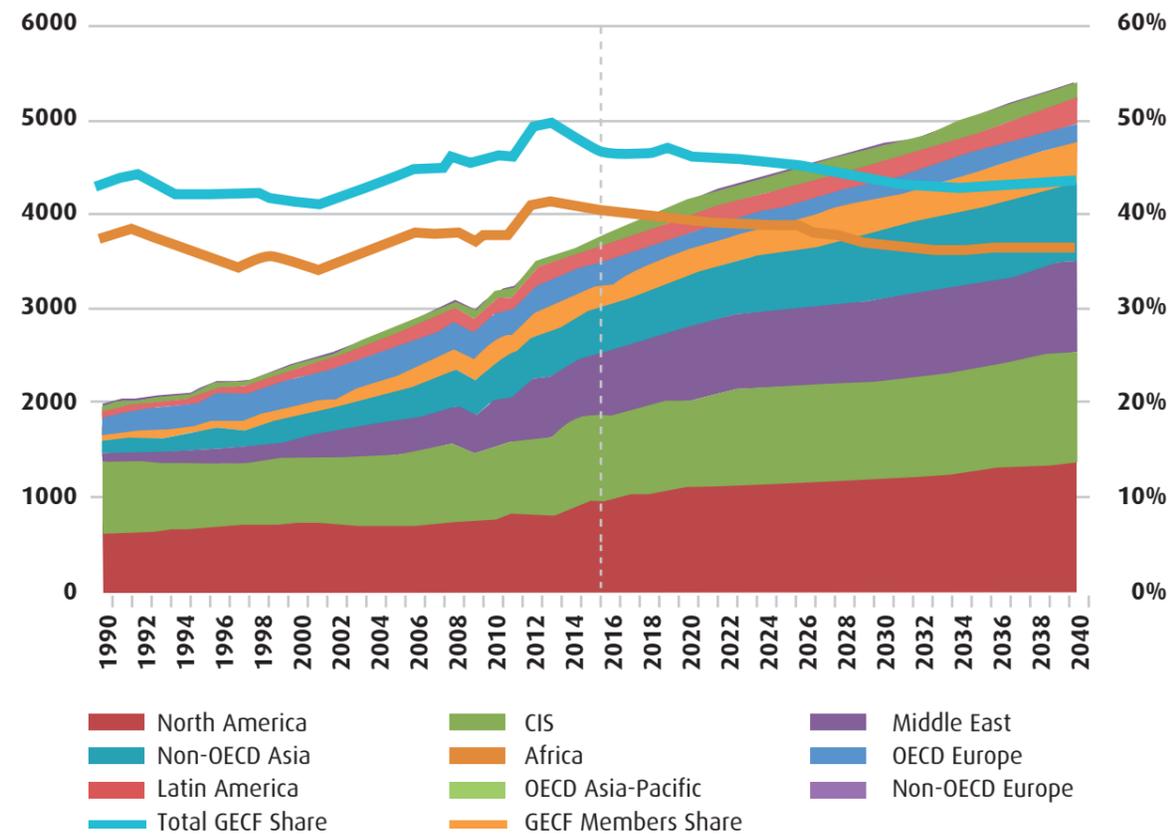


Almost \$1.7 trillion is associated with the GECF group of countries. Around 85% on average is associated with the upstream, with 15% for pipelines, LNG, shipping, and regasification combined. The GECF countries account, on average, for around 40% of the conventional upstream gas investments, 44% of the pipeline projects, and 30% of the LNG, while they account for only around 20% of the undiscovered unconventional gas.

GLOBAL GAS PRODUCTION GROWING WITH GECF SUPPORT

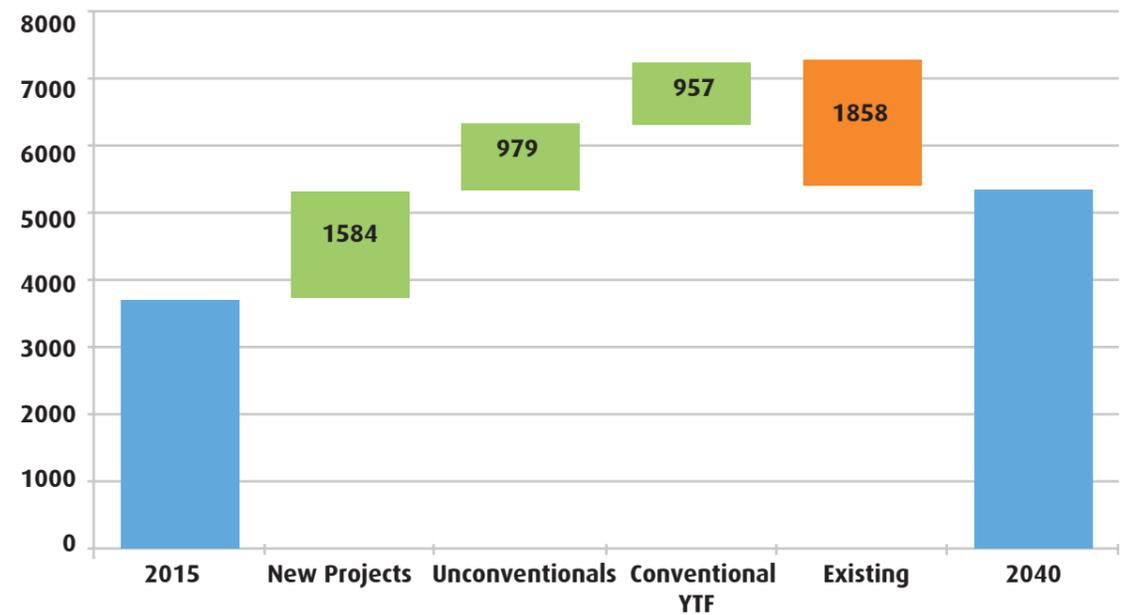
Global gas marketed production increased since 1990 at an annual average 2.5% growth rate up to the end of 2015. As long as the required investment is made, in the coming years, the average global production growth rate (from 2015 to 2020) is expected to be around 2.1%, slowing to 1.6% average annual growth up to 2040 as it adjusts to the developments and prospects of global gas demand and the associated worldwide uncertainties. Thus, global gas production is expected to increase by almost 50% above today's output of around 3,700 bcm (including gas used for enhanced oil recovery for some countries), increasing to around 5,400 bcm by 2040. The cumulative production (2015-2040) would then be almost 120 Tcm, representing around a quarter of the remaining total known resources in 2015.

Global gas production by region (bcm)



If we look at the growth of global gas production from 2015 to 2040 the new projects, the unconventional and the conventional YTF combined will contribute an additional 3,520 bcm of production, which is almost equivalent to the level of existing annual production. This would allow global gas production to virtually double by 2040, taking into account of the decline of the production of all existing fields, then the global gas production is expected to hit a level close to 5,400 Tcm by 2040.

Global gas production by type (bcm)



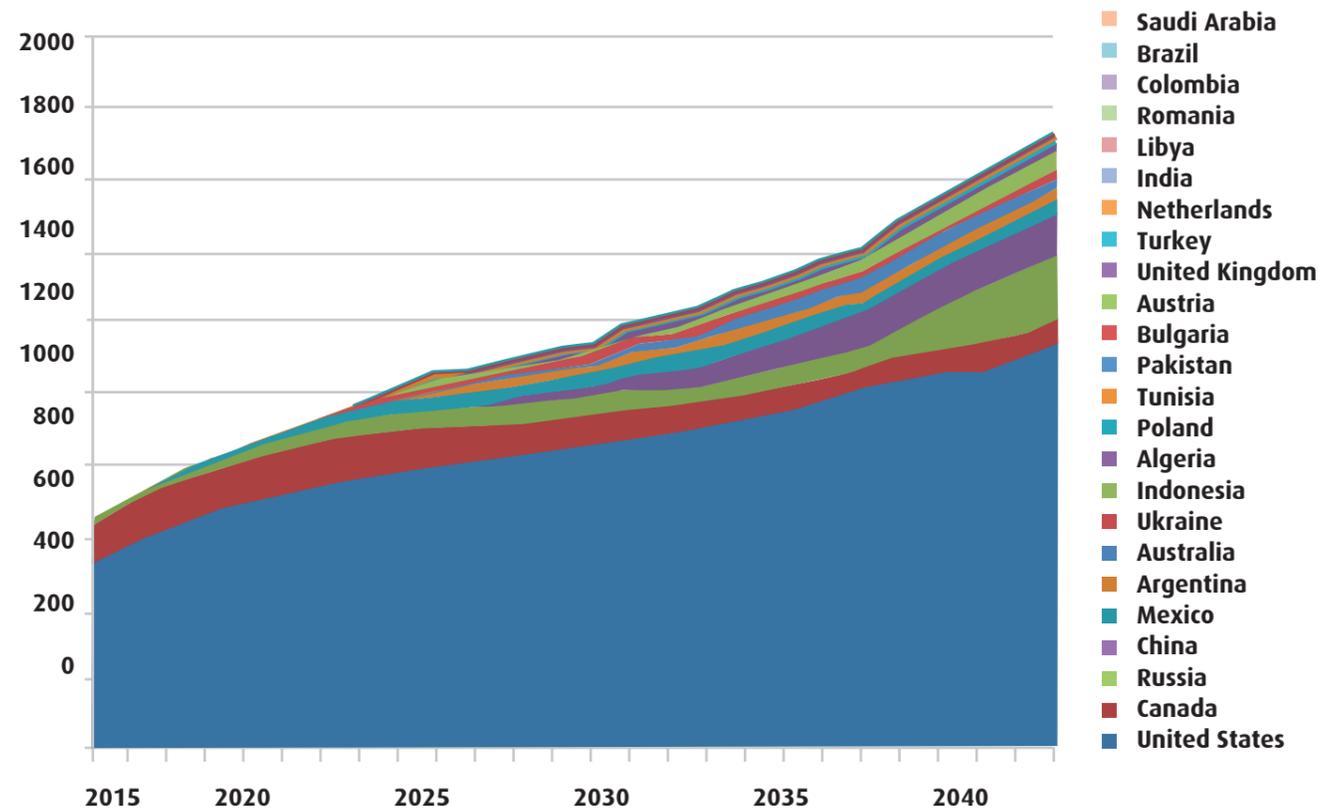
The GECF group of member countries (excluding observers) accounts currently for around 1,500 bcm of output (40% of the world gas output), having increased from 850 bcm (35% of the global total) in 2000, while it was around 750 bcm (38%) in 1990. GECF Members' gas output is expected to rise to around 1,630 bcm in 2020 (39% of the world total), and to almost 2,000 bcm (39%) in 2040. Thus, the share of the GECF member countries in global marketed gas production is expected to remain relatively stable at an average of 39% during the outlook period, while the historical average starting from 1990 was about 37%.

UNCONVENTIONAL GAS PRODUCTION

Unconventional gas production is dominated currently by the US. We do not expect that this dominance will be challenged, but it will be accompanied by other regional developments, mainly in China, and also to a lesser extent in Russia, North Africa, Asia Pacific, and in Latin America.

The unconventional gas production, mainly driven by shale gas, is expected to more than double in twenty-five years' time. Consequently, it is one of the main determinants of natural gas production growth, with an average annual growth of more than 3.6%, double the global gas production growth rate. It represents approximately half of the net growth of global gas production between 2015 and 2040.

Global unconventional gas production by country (bcm)



Key Messages:

V. Global Gas Trade

- It is estimated that currently global gas trade represents around 30% of global gas marketed production. This share is expected to remain at that level by 2040, although the global gas trade is expected to expand in absolute levels by 60%, growing by 2.1% annually on average.
- GECF members averaged a market share of 46% in the last twenty years in global gas trade; it is expected that this share will remain so by 2040.
- By the mid-2020s international gas trade is expected to exceed 1,250 bcm, of which potentially 43% will be associated with LNG. After that, LNG trade slows and stabilizes in the 40-45% range, when combined with the growth of piped gas by 2030, especially from CIS to non-OECD Asia, making LNG trade to grow annually by an average of 2.8%.
- The unconstrained international gas trade that can be contracted either through spot or potentially other long-term deals, will grow significantly at about 6% per year, and from around 12% share of total gas trade, it will represent roughly 30% by the end of the outlook period in 2040.

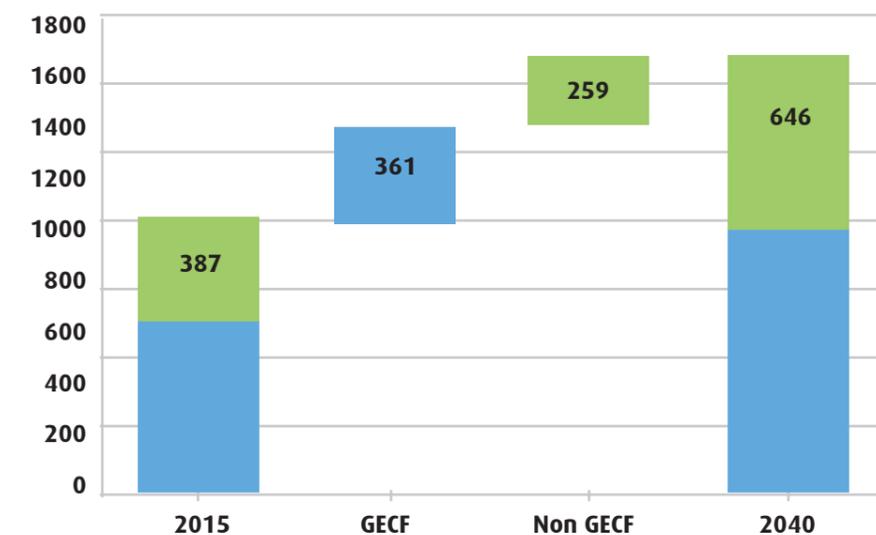
V. GLOBAL GAS TRADE

The pattern of global gas trade that will result from the demand and supply trends described above has been figured out by the least-cost optimization exercise undertaken by GECF. International trade in gas will certainly increase, and will require the expansion both of liquefaction capacity and of major international pipelines. New export deals, and the renewal of existing deals, will be required. The terms on which these are done will reflect both the traditional contracting practices in the gas industry, and new approaches to marketing gas. The nature of these terms will be determined by three factors: the balance of LNG and pipeline gas, the regional location and pattern of the trade, and the extent to which renewal of existing contracts takes place.

GLOBAL GAS TRADE TRENDS

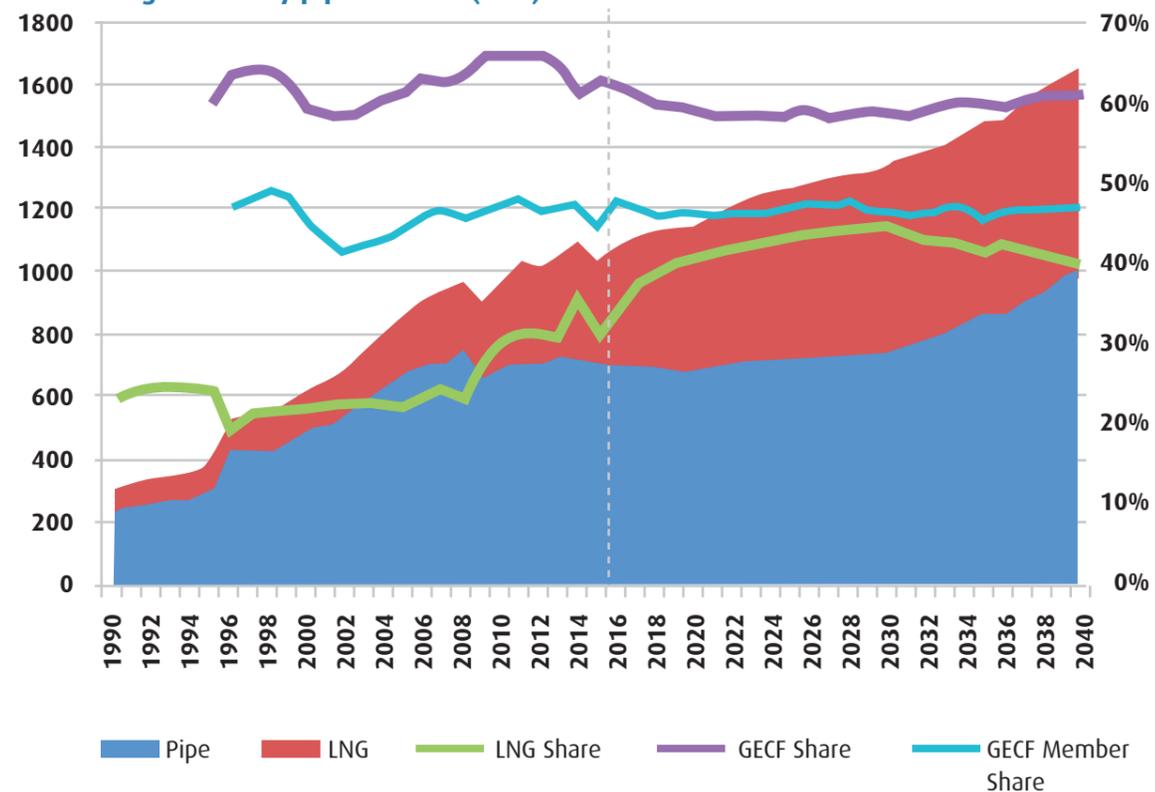
The volume of global gas trade is expected to increase from 2015 levels by 60% by 2040 reaching a level of 1,650 bcm; growth of almost 2.1% annually on average. GECF members averaged a market share of 46% in the last twenty years in global gas trade; we expect this share to remain close to this level by 2040.

Global gas trade GECF/non-GECF (bcm)



A little more than 1,000 bcm of gas was traded globally in 2015, of which almost 300 bcm was LNG (30%) and the remaining piped. By the mid 2020's, international gas trade is expected to exceed 1,250 bcm, with potentially 43% associated with LNG. After that point, LNG trade slows and stabilizes in the 40-45% range, because of the parallel growth in piped gas by 2030, especially from CIS to non-OECD Asia. On an annual average basis, LNG trade is expected to grow by 2.8% in the long run.

Global gas trade by pipe and LNG (bcm)



Global gas trade by pipeline and LNG (bcm)

	Historical				Forecast		
	2000	2005	2010	2015	2020	2030	2040
Pipeline	493	671	693	714	680	745	998
LNG	137	191	296	322	468	599	658
Trade	630	862	989	1,036	1,148	1,344	1,656
LNG share	26%	26%	31%	31%	41%	45%	40%

Source: Cedigaz (history), GECF Secretariat 2016 (forecasts)

LIQUEFACTION CAPACITY TO INCREASE BY 40% IN THE MEDIUM TERM

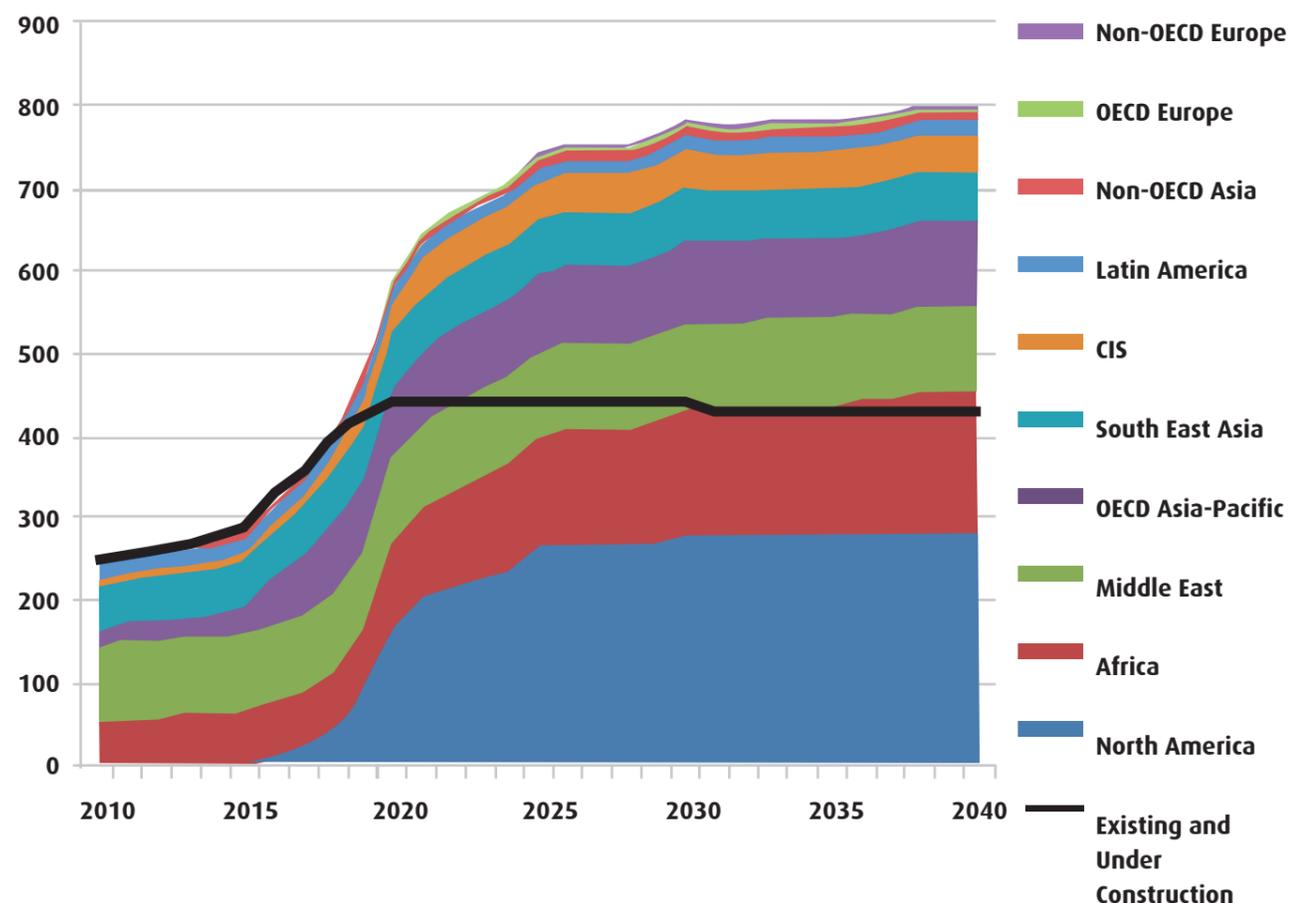
In order to support this growth, new liquefaction capacity will be built in many parts of the world. New international pipelines will also be needed.

More than 300 million tonnes of LNG capacity exists worldwide, most of it located in the Middle East (centred in Qatar), Africa (Algeria and Nigeria), South East Asia (Indonesia and Malaysia), and Australasia, which is starting to play an increasing role in Asian gas markets.

Most of the potential GECF LNG projects are located in Russia, Iran, and Venezuela. These countries have the ambition to increase the share of LNG in their export mix, diversify their client portfolio and expand their geographical coverage. For non-GECF LNG projects, there is currently around 100 mtpa of LNG capacity under construction, leading consequently to an increase of almost 40% in the medium term of the total operating LNG capacity.

Australia is ramping up, with about 55 mtpa LNG capacity already in operation, taking account of the recently commissioned projects in 2015 (Gladstone, Curtis Island), and in 2016 (Australia Pacific and Gorgon). A further 30 mtpa is expected in 2017 and 2018 (other trains in Gorgon, Prelude, Ichthys and Wheatstone). The United States started exporting LNG in early 2016 with its two new commissioned trains located in Sabine Pass, thus becoming a net LNG exporter and has more than 50 mtpa of capacity currently under construction. East Africa may also enter the market after 2020 with some projects in the later stages towards taking FID (final investment decision), making it a serious wild card to be taken into consideration, however, it may be disadvantaged by its expensive cost base.

Total projected LNG capacity per region (bcm)



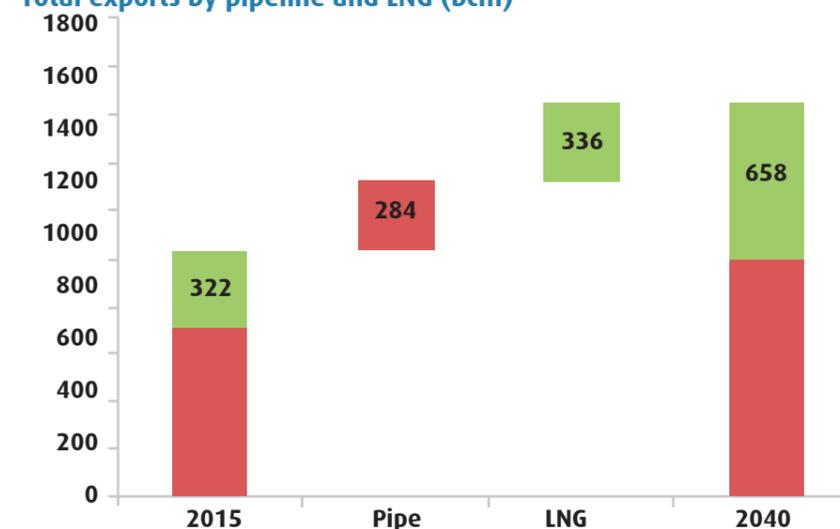
International trade in gas is undertaken by long-distance pipelines as well as by LNG. Most of the existing international pipeline network is concentrated on Europe which is the main pipeline gas market, with most of the gas export corridors oriented towards it, notably those from Russia, North Africa and the Caspian. Non-OECD Asia is also an evolving gas pipeline market with some projects already completed (from Turkmenistan and Myanmar), and many projects under development, from Russia, the Caspian, and Iran.

PIPELINE AND LNG TRADE

The OECD Pacific market is 100% dependent on LNG trade and is expected to remain so in the foreseeable future. OECD Europe and non-OECD Asia have a mix of pipe and LNG. OECD Europe's LNG imports will reach a level of 20% of its total imports throughout the outlook period, while non-OECD Asia will import 55-60% of its gas via LNG. In both cases, the share of LNG is expected to decline from its expected medium term peak towards the end of the outlook with the assumption that more pipeline projects will be implemented especially to non-OECD Asia. Success in the development of domestic gas resources may take time, but it is expected to happen to some extent later in the outlook.

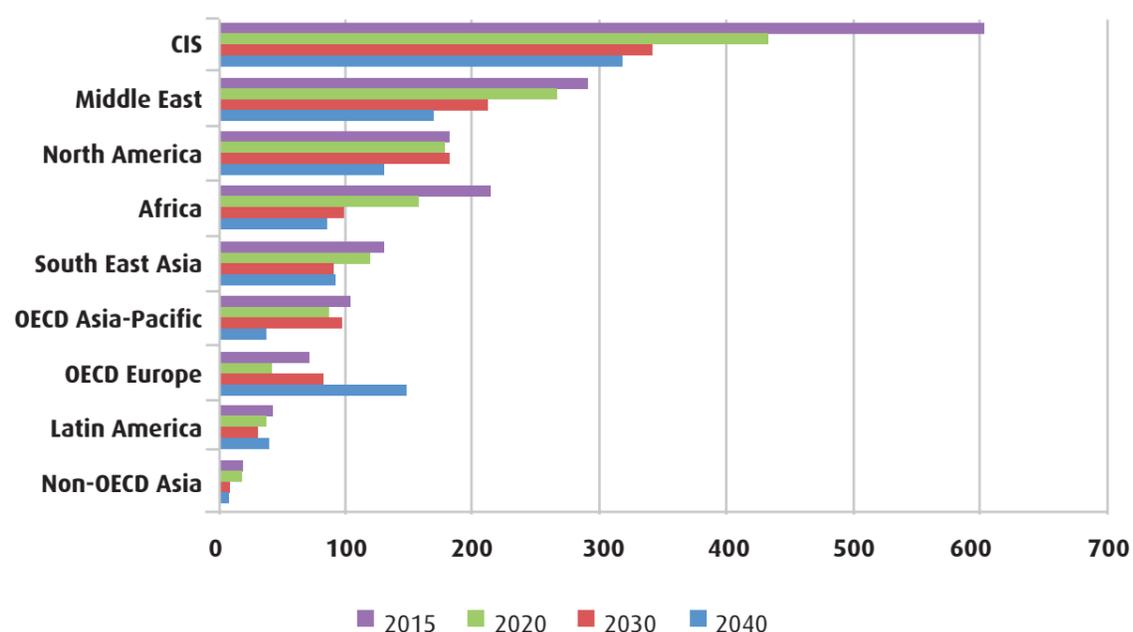
In OECD Europe, piped gas arrives externally from Russia and North Africa, as well as from the Southern corridor that will bring gas from the Caspian region and eventually from the Middle East in the future if geopolitical and security hurdles are resolved. In non-OECD Asia, LNG trade increases up to 2020, but there is a large leap in pipeline trade from Russia and Turkmenistan in particular. Gas demand in this region increases beyond the capability of domestic unconventional and conventional gas to meet the additional demand, and increased imports are required and are likely to be met via piped gas.

Total exports by pipeline and LNG (bcm)



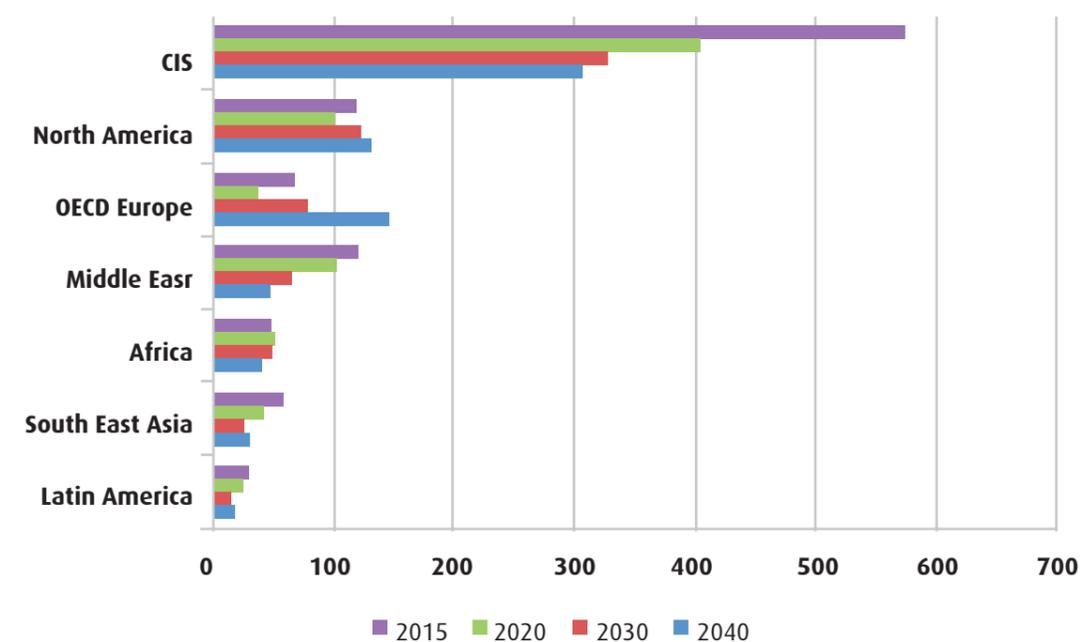
Total exports by pipeline and LNG by region highlight the important role of the CIS region, primarily based on Russian exports. However, CIS exports are dominated by the pipeline trade, while the Middle East and Africa have the leading role in long-term future LNG trade.

Total natural gas exports by source region (bcm)



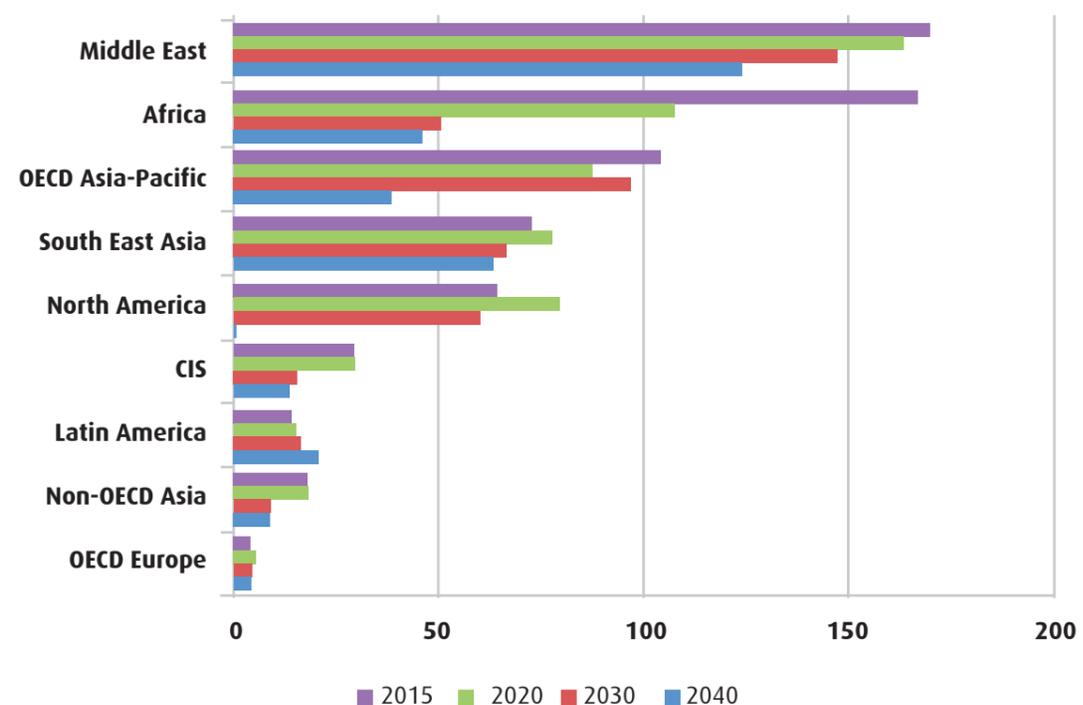
Russia and the Caspian are set to continue to predominate in the piped gas trade, with Russia already the major player. Norway and Algeria are also currently significant piped gas exporters, but Norway's exports decline over the outlook, while Algeria's exports are expected to increase from current levels during the outlook, based on the assumed success of current and upcoming developments. For North America, the trade in pipeline gas takes place essentially within the same region, while Iran is expected to emerge as an important pipeline gas exporter, especially after 2020.

Piped natural gas exports by source region (bcm)



In the LNG export market, it is Qatar, South East Asia (Indonesia and Malaysia), OECD Pacific (Australia) and North America that take the leading role, or are set to predominate in the medium-term (by 2020). Algeria and Nigeria are expected to remain significant LNG exporters in the early part of the period to 2040, whereas, Iran and Venezuela will enter the club of LNG exporters in the years to follow.

LNG exports by region (bcm)



Russia and the CIS are expected to remain the number one gas exporting region throughout the period to 2040, with the pipe trade as the major part of the export portfolio, but with LNG gaining market share gradually, especially until 2030. However, the main gas export growth will be supported by pipeline routes that are set to be completed either to Europe (Nordstream expansion and Turkstream), or China (Power of Siberia 1-2, Altai, Turkmenistan to China and Turkmenistan to India) by 2030. The growth after 2030 is mainly due to additional deals that we are assuming to take place between the two regions due to the combined effect of rising gas demand and insufficient domestic resources in non-OECD Asia, and the attractiveness from a cost perspective of the CIS gas supplies into this region.

The Middle East is the next largest exporter after Russia, headed by Qatar (already the largest LNG exporter worldwide) and Iran (starting from 2020). Export volumes from the region are expected to increase over the outlook. LNG is the dominant export mode from this region, with the Middle East being the world's largest LNG export region. The Middle East will maintain this position until 2040, even though its dominance will be contested by the emergence of important competitors from OECD Pacific, North America, and in the long-term from East Africa.

North America is expected to be the third largest gas exporting region thanks to its shale gas boom. The intra-regional trade, both between the United States and Mexico and between Canada and the United States is set to increase throughout the outlook. The region is emerging as a significant LNG exporter, up from small levels today to more than 50 bcm by 2020 and further increases to around 80-90 bcm by 2040.

Africa is another major export region that is expected to grow over the outlook. Again, these exports are predominantly via LNG, with East African LNG expected to take off by 2025 and increase significantly after 2030. African LNG exports are expected to overtake the current second largest LNG exporter, South East Asia by 2020, and compete with OECD Asia Pacific to take second place after 2030.

OECD Asia-Pacific (Australian) LNG exports will also increase to a similar extent, such that it remains in the top three of the world's largest LNG exporters by 2040.

South East Asian exports are also LNG dominated, and the export volumes are expected to remain at more or less the same level over the outlook.

Other regions, like Latin America, will be characterised by intra-regional trade. Latin America is expected to record an expansion of its domestic resources that will allow it to reduce its imports from sources outside the region. Bolivia will ramp up its exports to Argentina and Brazil, while Venezuela will be a new country to emerge as an international gas exporter. OECD Europe export potential will decline over time as the Netherlands' production is fading drastically and Norway will gradually adjust its gas exports according to its production profile.

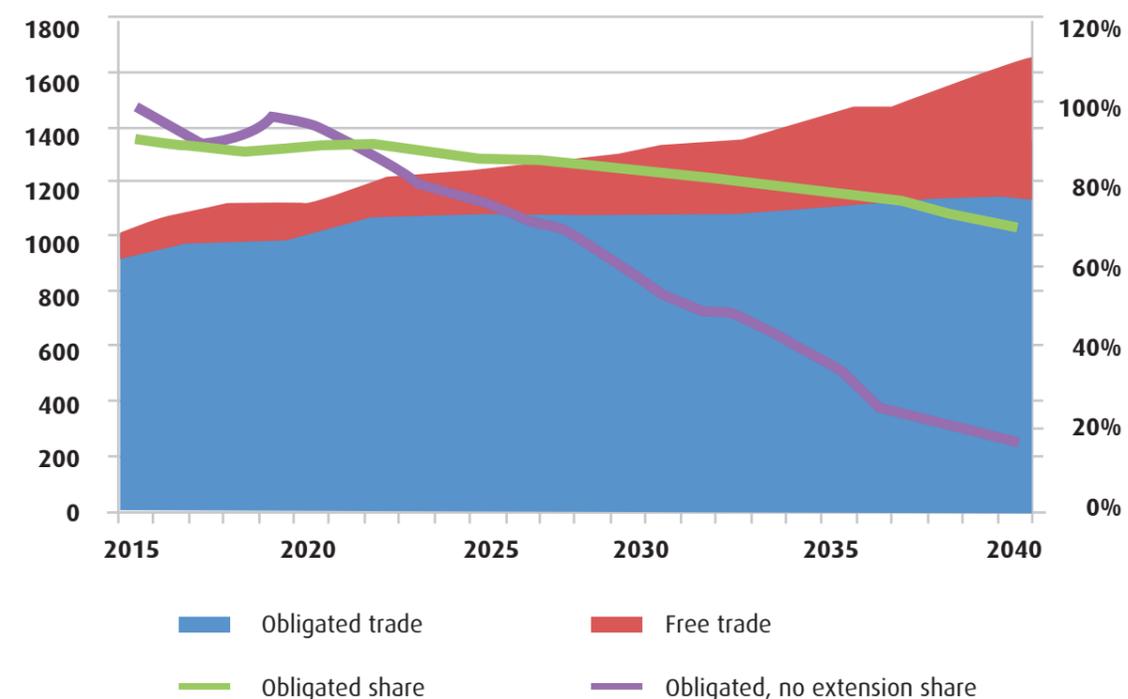
CONTRACTED VERSUS NON-CONTRACTED TRADE

The decline of domestic gas production in many gas consuming countries and the significant increase of gas demand imports from developing and emerging economies, such as in non-OECD Asia, will call for more international gas trade. At the same time, it will create pressure either for new import/export gas deals or for the renewal of existing long-term agreements, or both.

The international gas trade is currently exercised through medium/long-term contracts that are mainly oil-indexed and, to a lesser extent, hub-based. A second format of international gas trade is through short spot transactions that can also be either oil-indexed or hub-based. Currently, the oil indexation is predominant throughout the world, except partially in North Western Europe and in North America where it is only a local market for the time being.

We assume that the renewal of many medium/long-term gas export deals will take place, whenever these are consistent with trade needs and where the projects are competitive. Thus, globally we conclude that the currently contracted volume level will be at least maintained, thanks mainly to the new long-term deals between Russia and China and other predominantly pipeline export projects.

Contracted trade vs. spot trade (bcm)



Given the overall growth in international gas trade, it follows that the unconstrained trade where options remain open for gas to be contracted either through spot or other potential long-term deals, will grow significantly—at a rate of about 6% per year.

This would mean that such uncontracted gas trade, which we estimate around 12% share of total international trade today, would represent globally around 30% by the end of the outlook period in 2040 (see previous figure). However, if no extensions or adjustments are made to the currently contracted volumes, then the share of unconstrained trade may increase substantially and the projected annual contract quantities (ACQ) in long-term deals may represent as little as 20% or less of total gas trade by 2040, which of course is not a realistic scenario.

VI. DEFINITIONS OF REGIONS

Africa: Algeria, Angola, Central Africa (Democratic Republic of Congo, Gabon, Cameroon, Congo), Eastern Africa (Eritrea, Sao Tome and Principe, Sierra Leone, Mauritania, Seychelles, Lesotho, Liberia, Somalia, Cape Verde, Sudan, Central African Republic, Kenya, Djibouti, Chad, Burkina Faso, Burundi, Gambia, Niger, Rwanda, Mali, Guinea-Bissau, Ethiopia, Guinea, Uganda, Mauritius, Madagascar, Malawi, South Sudan, Comoros, Swaziland, Reunion, Tanzania), Egypt, Equatorial Guinea, Libya, Morocco, Nigeria, South Africa, Southern Africa (Mozambique, Africa (Senegal, Cote d'Ivoire, Ghana, Togo, Benin).

Commonwealth of Independent States (CIS): Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

Latin America: Argentina, Bolivia, Brazil, Central America (Guatemala, El Salvador, Nicaragua, Costa Rica, Panama, Honduras), Chile, Colombia, Ecuador, Other Caribbean (Aruba, British Virgin Islands, Saint Vincent and the Grenadines, Saint Pierre and Miquelon, Suriname, Antigua and Barbuda, Bermuda, Jamaica, Belize, Barbados, Grenada, Cuba, Dominican Republic, Cayman Islands, Saint Lucia, Saint Kitts and Nevis, Dominica, Falkland Islands, Bahamas, Montserrat Antilles, Guadeloupe, Martinique, Guyana, Haiti), Paraguay, Peru, Puerto Rico, Trinidad and Tobago, Uruguay, Venezuela.

Middle East: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates (UAE), Yemen.

Non-OECD Asia: Bangladesh, China, Hong Kong, India, Nepal, Other Asia (Maldives, Vanuatu, Laos, Afghanistan, Mongolia, Bhutan, Macau, Fiji, Cook Islands, North Korea, Tonga, Samoa, New Caledonia, East Timor, Kiribati, Solomon Islands, Papua New Guinea, French Polynesia), Pakistan, Sri Lanka, Taiwan and South East Asia (Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam).

Non-OECD Europe: Albania, Bosnia, Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Macedonia, Malta, Romania, Serbia and Montenegro.

North America: Canada, Greenland, Mexico, United States.

OECD Asia-Pacific: Australia, Japan, New Zealand, South Korea.

OECD Europe: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Other Regional Groupings:

GECF Member Countries: Algeria, Bolivia, Egypt, Equatorial Guinea, Libya, Islamic Republic of Iran, Nigeria, Qatar, Russia, Trinidad and Tobago, UAE, Venezuela.

GECF Observer Countries: Azerbaijan, Iraq, Kazakhstan, Netherlands, Norway, Oman, Peru.

European Union: Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, and United Kingdom.

G20: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, United Kingdom, United States, the European Union (EU).