GECF Global Gas Outlook 2040

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Gas Exporting Countries Forum Secretariat

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- Scenario and assumptions
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- Impact of the environmental agenda
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GDP, population, urbanization and oil prices

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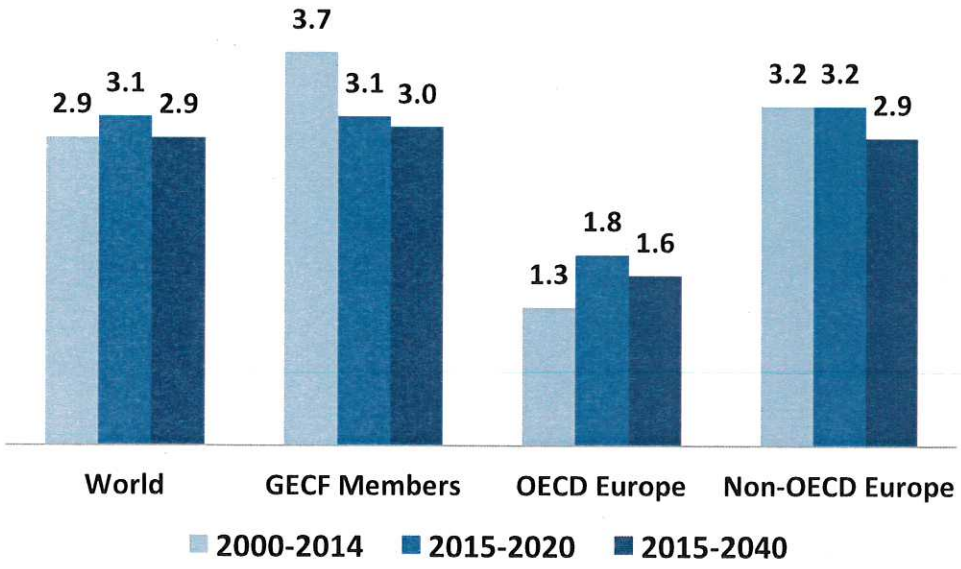
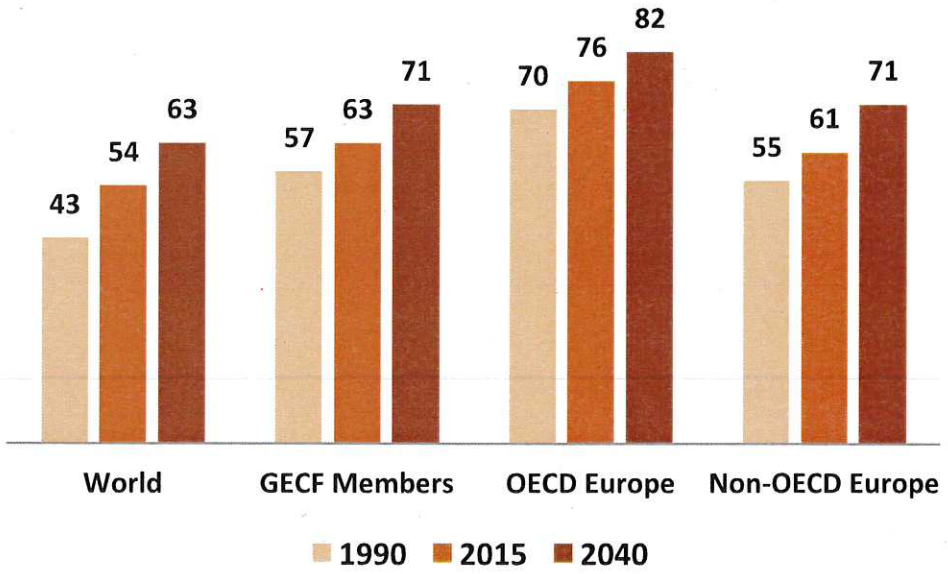
Real GDP growth assumptions (Market Exchange Rates- %)



Urban population share (%)



- Global GDP 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, slow to a more sustainable long-term rate.
- The world urban population rate will increase from 54% in 2015 to 63% in 2040.
- Around 82% of population of the EU will choose urban areas in 2040, as their place to live.
- Oil prices will gradually recover and likely range from $60 to $95 (2015 U.S. dollars per barrel) over the medium to long-term projection period.

Demand key figures

30% Primary energy demand is set to increase by 30% between 2015 and 2040.

1% Over the next 25 years, primary energy demand grows by 1% per annum showing an increase of 3.9 Gtoe from 13.8 in 2015 to 17.7 Gtoe by 2040.

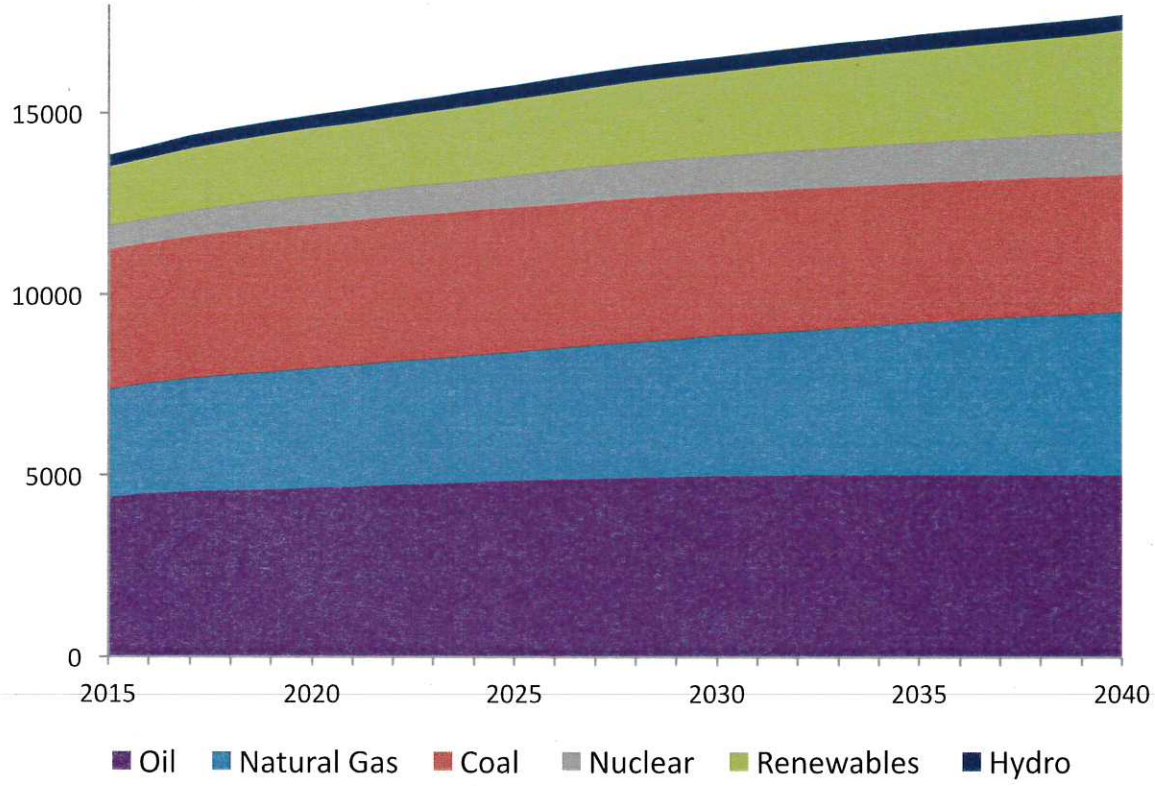
50% Gas demand will rise by 50% over the outlook period, increases from almost 3500 bcm in 2015 to over 5200 bcm by 2040.

25% Gas demand grows by 1.6% per year, stronger than growth in primary energy demand. Then gas share in primary energy mix increases from over 21% today to 25% in 2040.

2.2% Gas for power sector will grow by 2.2% over the outlook period, make power sector the main source of additional gas demand.

16% Non-hydro renewables are also growing strongly over the outlook period, increase their share from 12% today to 16% in 2040, still well below of that for gas (25%).

World primary energy demand by fuel (Mtoe)



- 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 (almost 30% increase).
  - ✓ *Natural gas will be the largest contributor to the increase in total primary energy consumption, with a share of almost 40% over the projection period.*

Gas demand and regional breakdown

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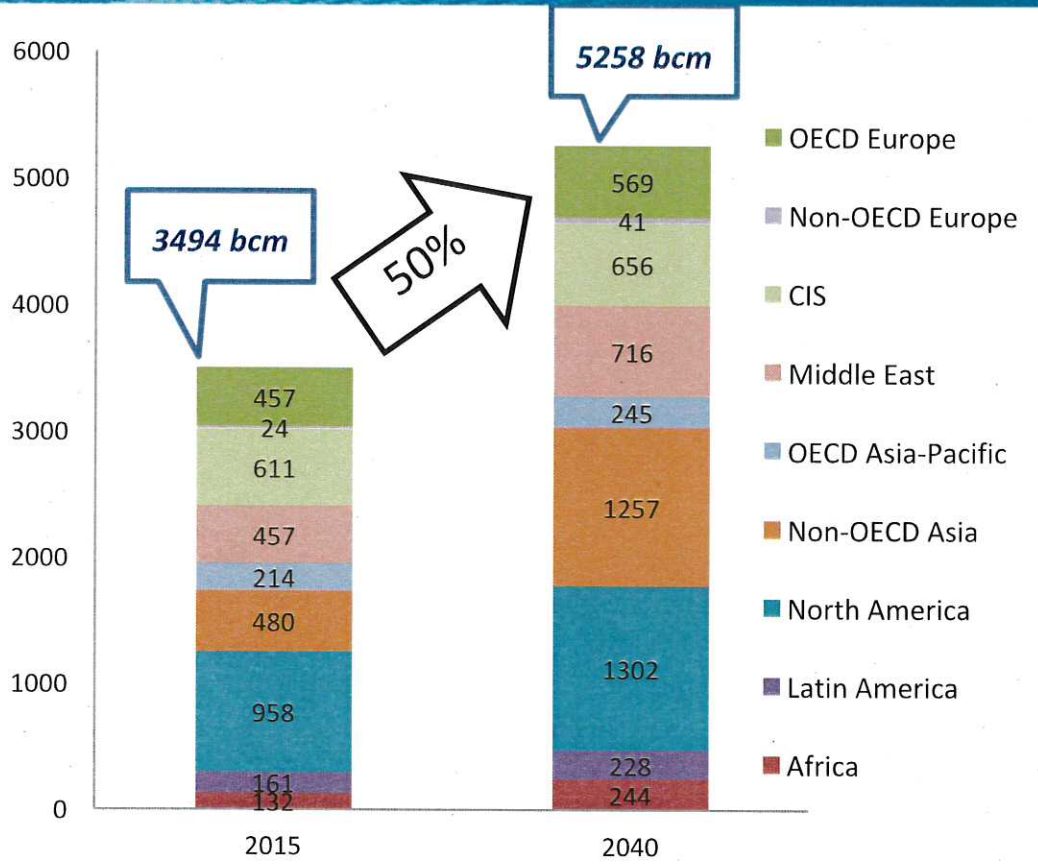

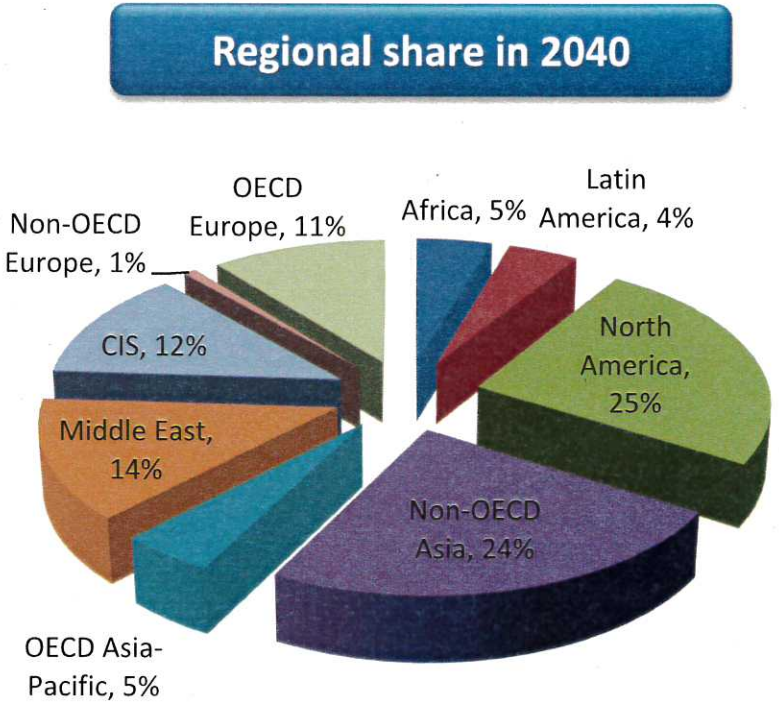

- Over the period 2015-2040, global gas demand is expected to increase to 5200 bcm.
- In the OECD region, the share of natural gas will in crease by 32% in primary energy.
- In non-OECD, natural gas remain third most-consumed fuel, still behind coal and oil, and reaching a share of around 22%.
- Non-OECD Asia accounts for 43% of additional gas demand mainly derived by China and India, while North America led by U.S., accounts for 19% and Middle East 15%.

Gas demand by sector in Europe (bcm)

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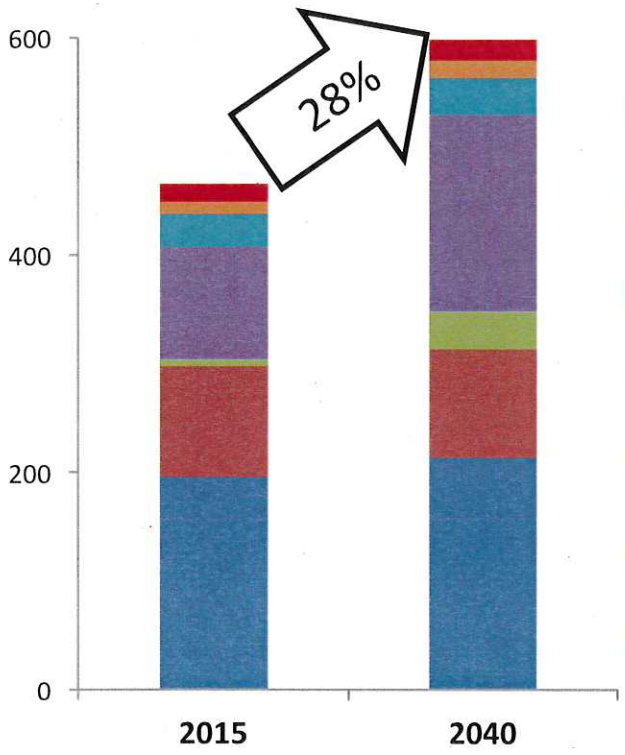
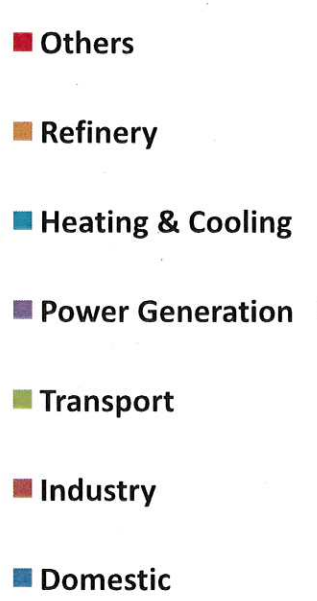
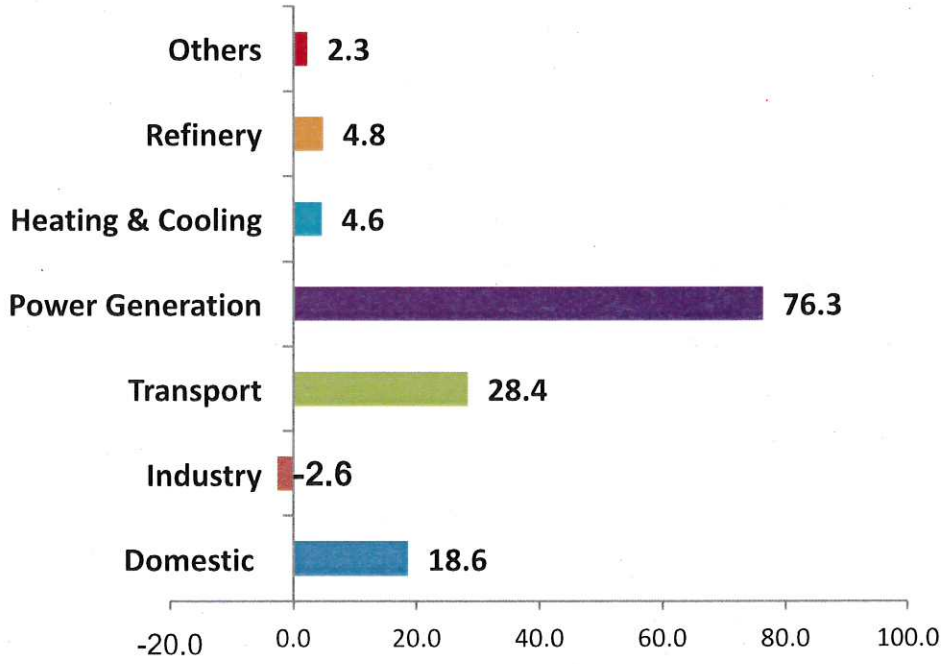




Incremental gas demand



- Highest gas use is set to increase in power, transport, and domestic sectors.
- Power sector is by far the biggest source of additional gas demand. Gas use in power sector is projected to grow from 22% today to 30% in 2040.
- Prospect for utilization of gas in the transport sector is promising.

Global gas supply key projections

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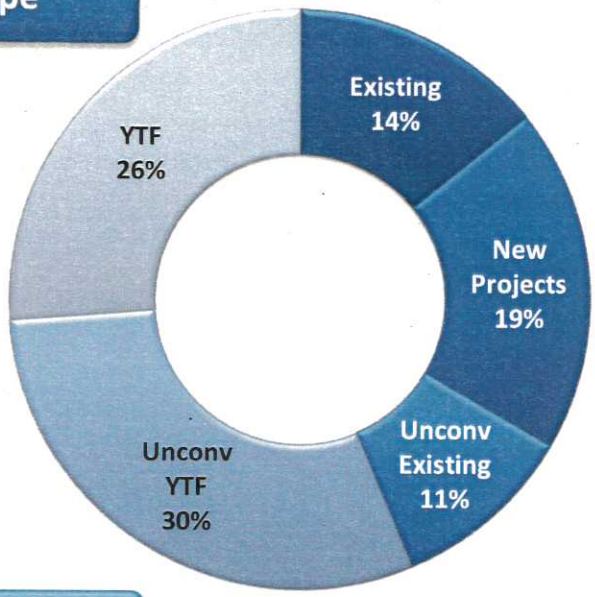
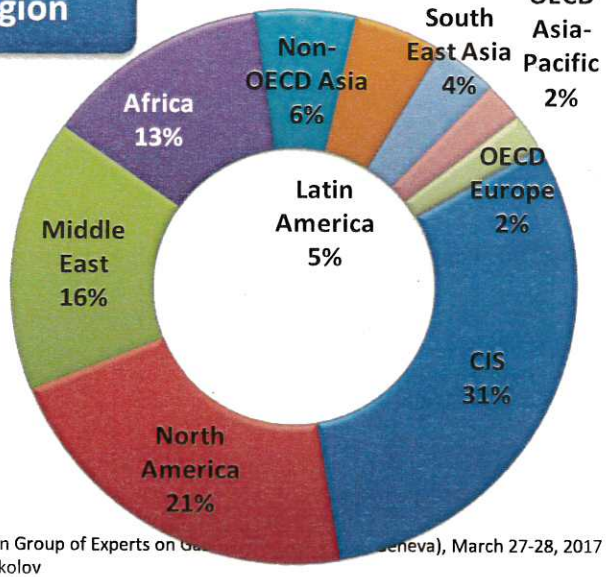
500+	532 trillion cubic meters is the total of natural gas resources worldwide including the proven reserves and the undiscovered resources
+50%	+50% increase (absolute levels) in global gas marketed production from 2015 to 2040
30%	Unconventional gas production to represent 30% of global gas production by 2040 (currently it represents around 18%)
+40%	+40% increase in liquefaction capacity worldwide in the medium term
+60%	+60% increase in global gas trade (absolute levels) from 2015 to 2040
+3%	LNG trade to increase annually on average by 2.8% in the long term

Abundant global natural gas resources (532 tcm)

By type



By region



- The world holds plenty of natural gas resources (532 tcm), of which almost 178 tcm are identified proven conventional reserves (33%) and 354 tcm are other gas resources including unconventional reserves (67%).
- CIS and North America represent almost half of worldwide gas resources, Middle East & Africa represent another 30%, and all the other regions represent the remaining 20%.
- The current resource to production ratio is around 140 years for the complete resource base or around 60 years for just the existing and known new projects.
- GECF countries (members & observers) account for almost 50% of the global resource base (by end of 2015), and represent almost two thirds of proven conventional reserves.

+50% in global natural gas production by 2040

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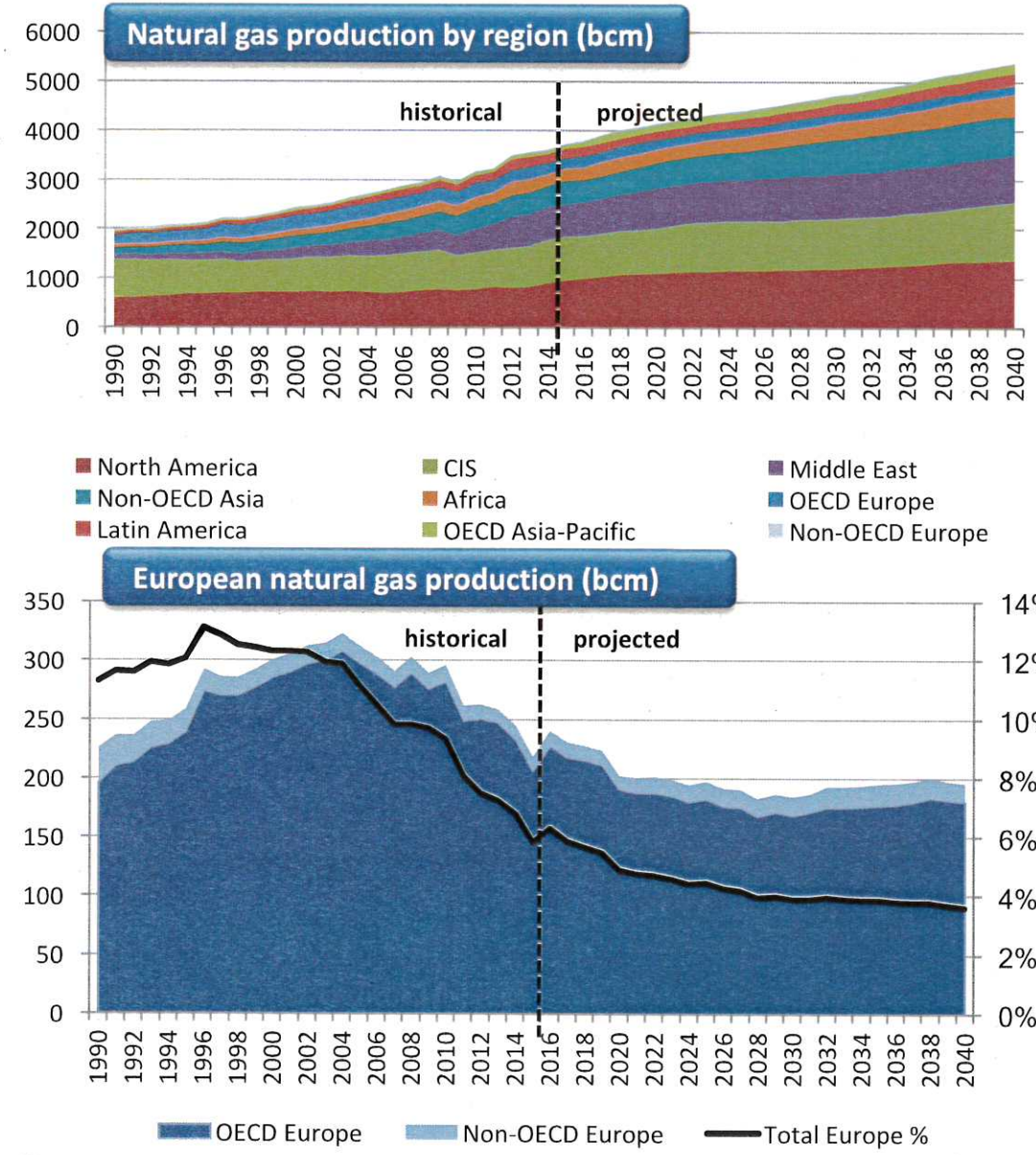

- Global gas marketed production increased since 1990 at 2.5% average growth rate until 2015. In the coming 25 years, the average global production growth rate is expected to be at 1.6% (2.1% up to 2020). Thus, global gas production is expected to increase by almost 50% on top of today's output.
- Five countries (Russia, USA, China, Iran & Australia) will represent more than two thirds of the total incremental production 2015-2040.
- European gas production will decline to 200 bcm and the share of European natural gas production is projected to be about 8% of Global in 2040

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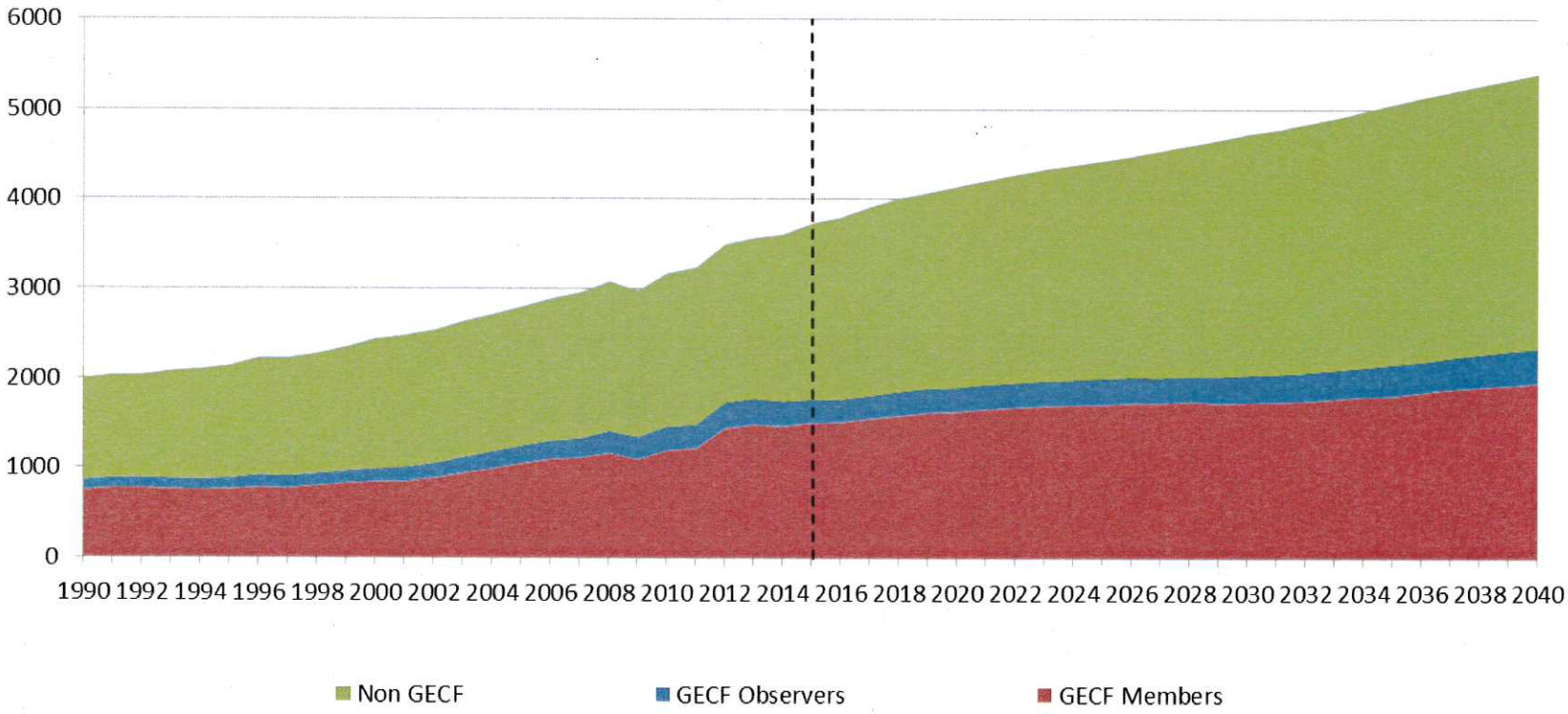
Global gas production by GECF and non-GECF countries (bcm)

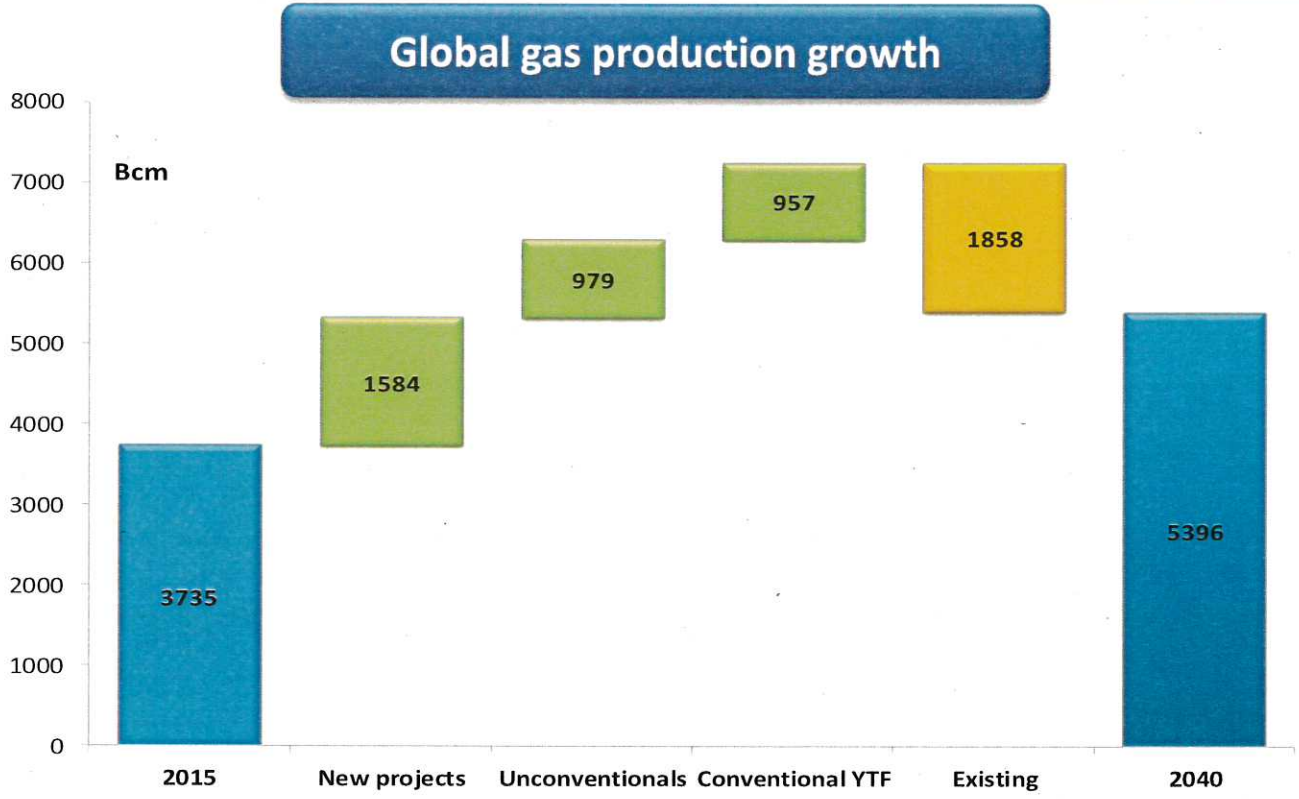
GECF Global Gas Outlook 2040



- GECF Members' gas output is expected to rise to around 1,630 bcm in 2020 (39% of the world total), to over 1,700 bcm (37%) in 2030, and to almost 2,000 bcm (39%) in 2040
- The share of the GECF member countries in global marketed gas production is expected to remain relatively stable at an average of 38% during the outlook period, while the historical average starting from 1990 was about 37%.

Unconventional gas production to represent 30% by 2040

GECF Global Gas Outlook 2040



- If we look at the growth of global gas production from the 2015 level to 2040, the new projects, the unconventionals and the conventional YTF combined will bring an additional production (3520 bcm) which is almost equivalent to the level of existing annual production.
- This would allow global gas production to virtually double by 2040, but as we have to consider the decline of the production of existing fields (1860 bcm) due to their natural decline, the global gas production is expected to hit a level close to 5400 bcm by 2040—an overall increase of about 50 percent compared to the present level.

+40% increase in liquefaction capacity in the medium-term

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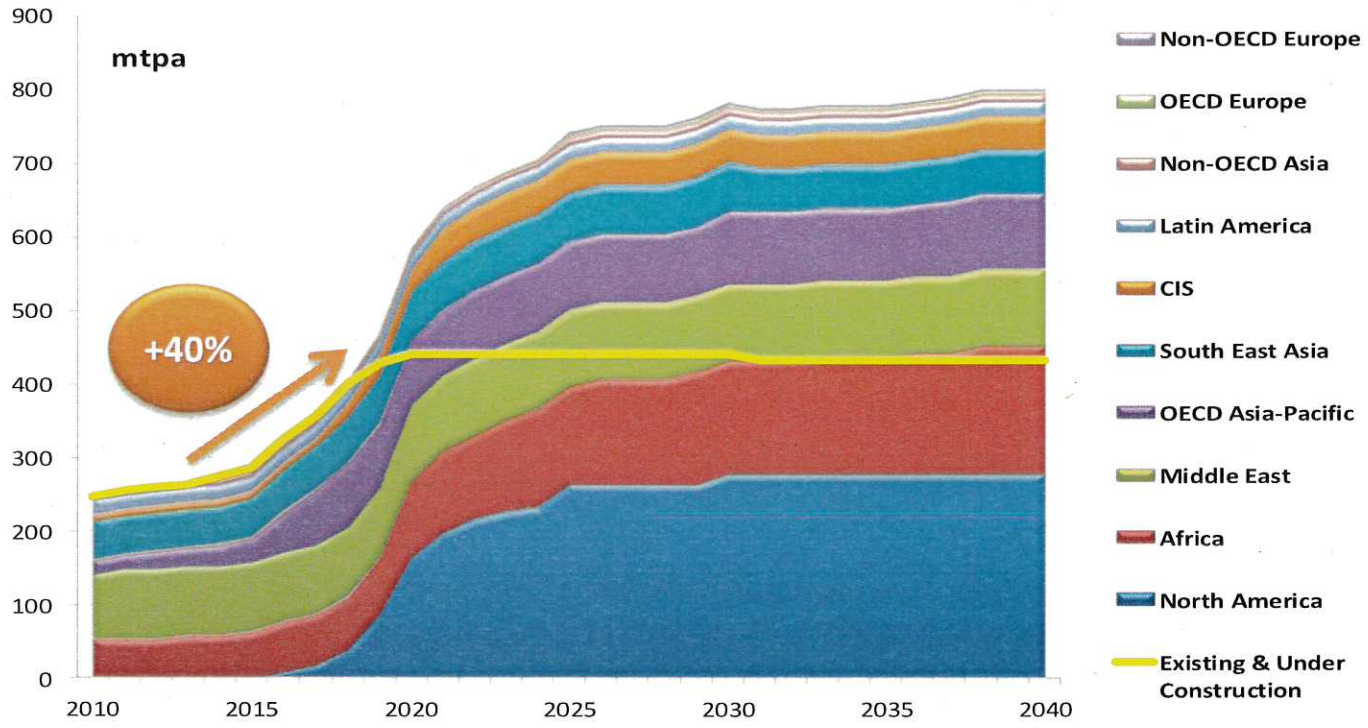

- There is a little more than 300 million tonnes of LNG capacity that exists worldwide (early 2016), most of it located in the Middle East (centered on Qatar), plus Africa (Algeria & Nigeria), South East Asia (Indonesia and Malaysia), and also Australasia which is already starting to play an increasing role in Asian gas markets.
- We estimate that there is 121 mtpa of LNG capacity that is currently under construction corresponding to almost 40% increase in global liquefaction capacity, of which 100 mtpa coming by 2017-2018.
- Beyond these projects there are potential projects being discussed with a total capacity of almost 350 mtpa. A large number are focused in non-GECF countries like in North America, Africa, and Australia. Russia, Iran and Venezuela have also plans that would allow them to become significant LNG players.

Source: GECF GGM October 2016

LNG trade to grow annually by 2.8%

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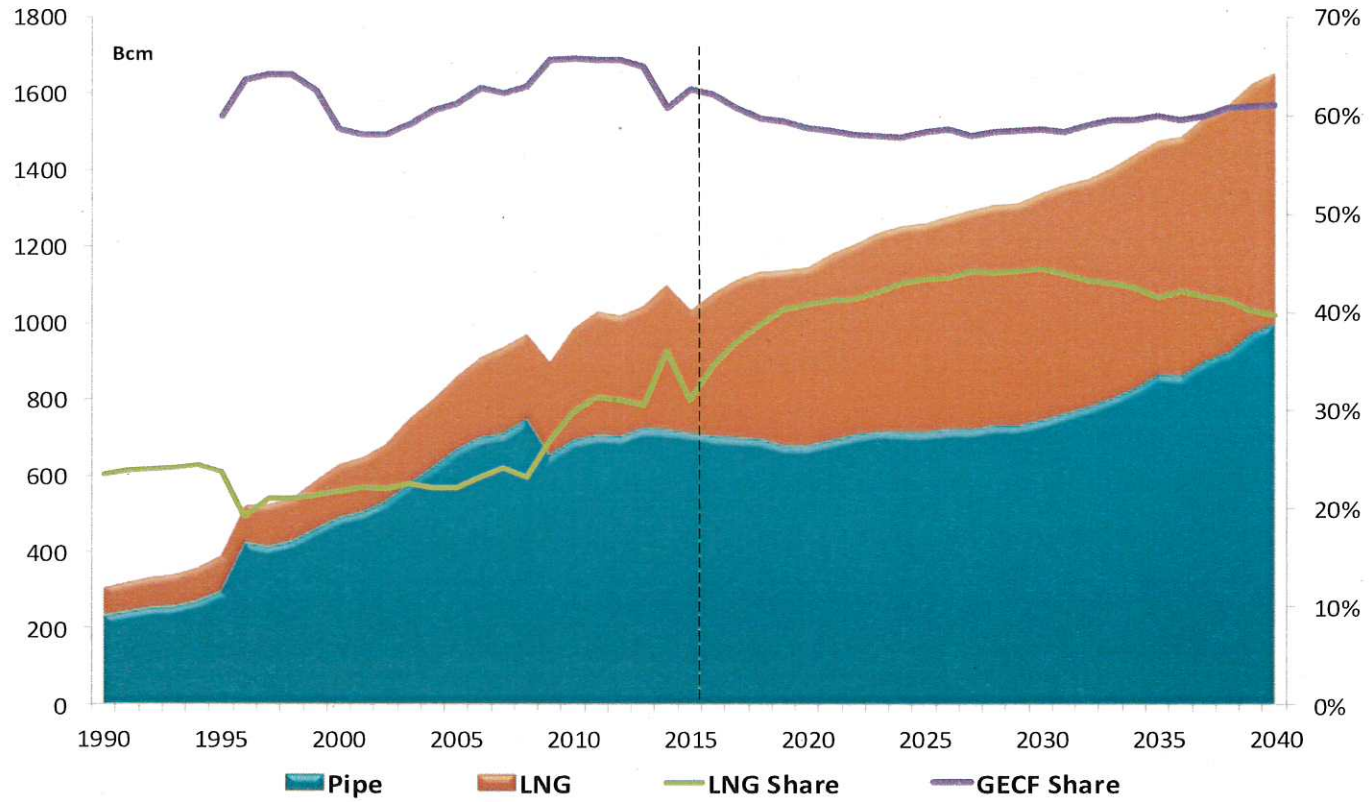

- A little more than 1,000 bcm of gas was traded globally in 2015, of which almost 300 bcm was LNG (30%) and the remaining piped.
- By the mid-2020s international gas trade is expected to exceed 1,250 bcm, with potentially 43% associated with LNG (green curve). After that, LNG trade slows and stabilizes 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 will grow by 2.8%.
- GECF will remain dominant in LNG trade and its share (purple curve) will represent an average above 60% of global LNG trade by 2040.

+60% global gas trade by 2040

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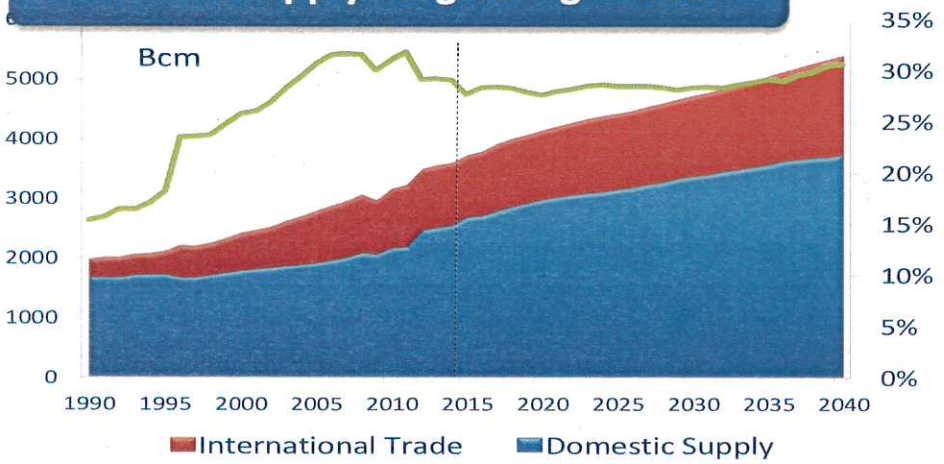
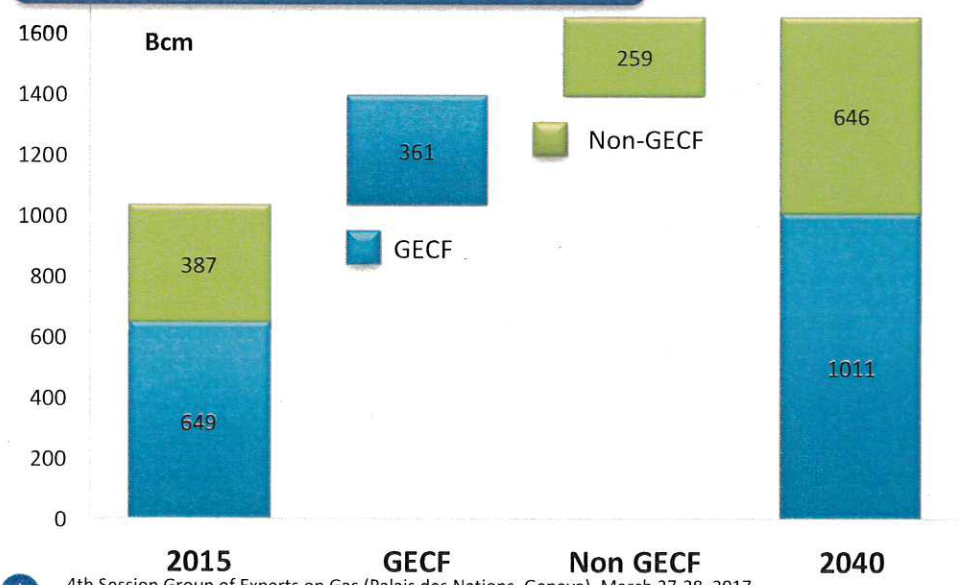
Domestic supply vs. global gas trade



Global gas trade evolution



- It is estimated that currently global gas trade represents around 30% of all global gas marketed production. This share is expected to remain at that level by 2040, due to many domestic developments that will happen in some key regions like non-OECD Asia and North & Latin America.
- Regionally and at country level the situation is somehow different, as the needs and the conditions of each region differ from the other, both regarding possibilities of domestic supply and also prospects of gas demand.

- The volume of the global gas trade is expected to increase, from 2015 levels, by 60% by 2040 reaching a level of 1,650 bcm, growing by 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 in this range by 2040, provided that the set of assumptions used in our outlook are confirmed.

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GECF Head of Energy Economics and Forecasting Department

Contracted trade vs. spot trade (bcm)

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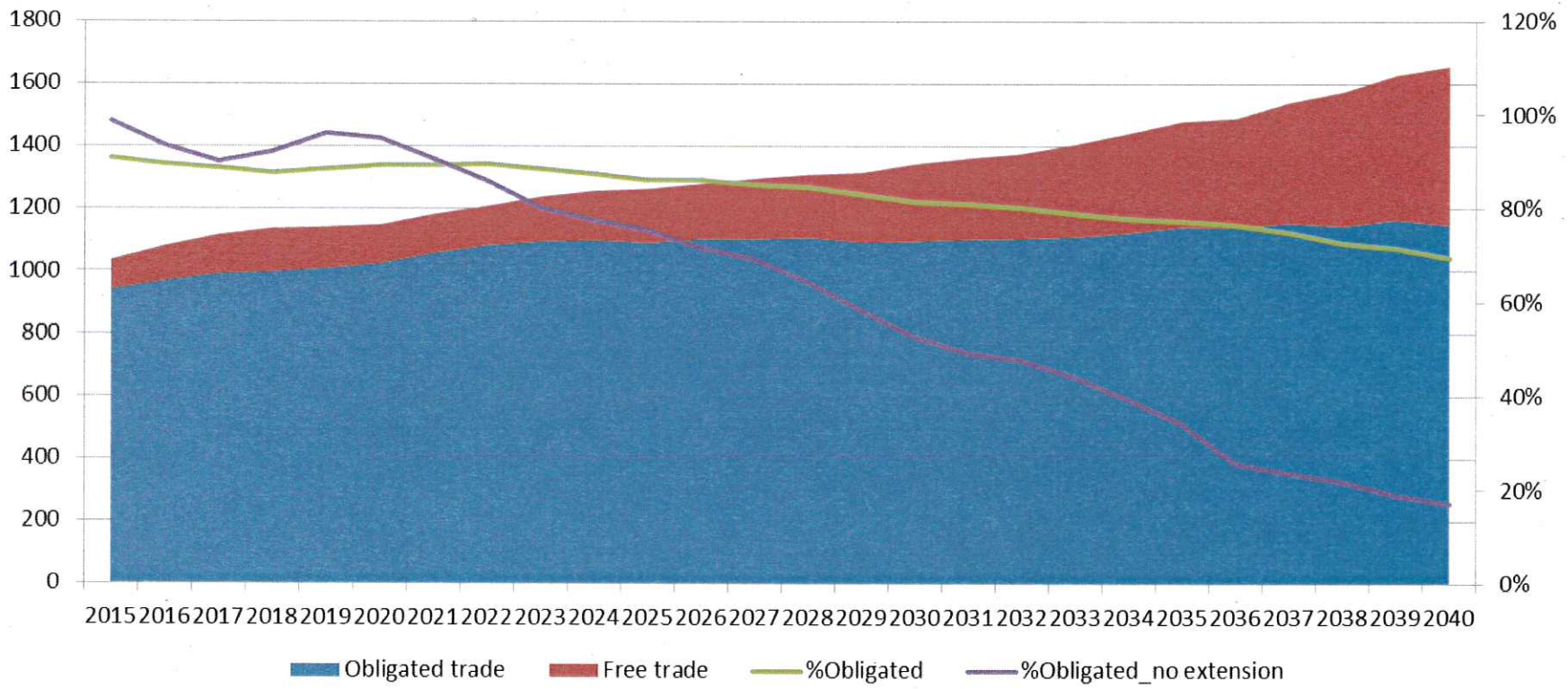

- The unconstrained international gas trade that can be contracted either through spot or potentially other long-term deals, will grow significantly at about 6% per year. From around 12% share of total gas trade, it will represent roughly 30% by the end of the outlook period in 2040.

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$8.0 trillion investments needed along 2015 - 2040

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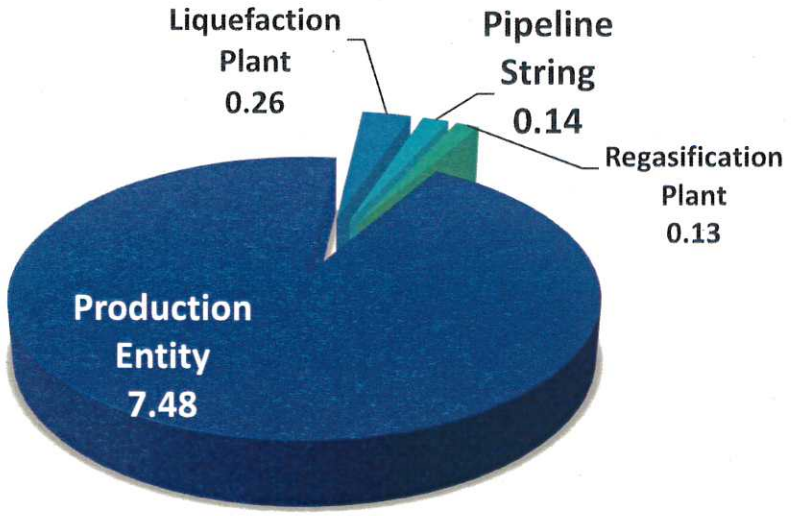
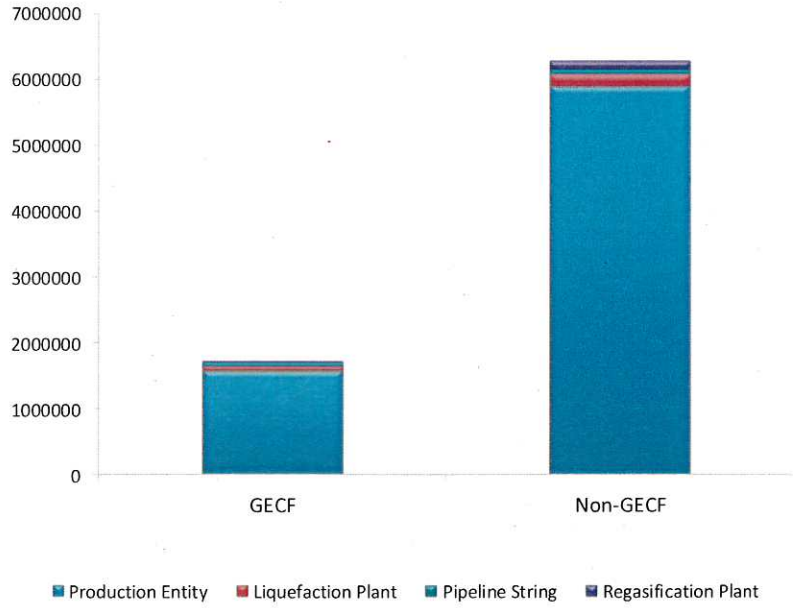
Investment costs by segment of the gas supply chain (2015 Trillion USD)



Cumulative investment 2015-2040 (thousands 2015 USD)



- Total cumulative investment in the upstream and gas transportation system is estimated at US$ 8.0 trillion for the period 2015 to 2040 (real 2015 US$).
- Almost US$ 1.7 trillion is associated with the GECF group of countries and the remaining (US$ 6.3 trillion) for the non-GECF countries, which are mainly planned in more complex and expensive projects (unconventional).
- Annually, investments are expected to average a level of about US$250 billion until 2030, while for the last ten years of the outlook period we are assuming a spike in investments to reach a level around US$ 400 billion.

Paris agreement appeared as a turning point in energy and climate policy developments...

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...BUT ACHIEVEMENT OF THE ANNOUNCED COMMITMENTS WILL FACE MANY CHALLENGES AND UNCERTAINTIES

NDCs emissions targets for 2030 Horizon ??

Dec. 2015 ***Nov. 4th, 2016*** ***Nov. 7-18th 2016***

COP 21: Adoption of Paris Agreement

- It involved more than 190 countries;
- Commitments to limit the temperature increase (Targets: **"< 2 ° C"** and continued efforts to reach **"< 1.5 ° C "**)
- Intended National Determined Contributions (INDCs) as main mechanism;

Entry into force

- Countries Ratification of PARIS AGREEMENT
- INDCs transformed into NDCs.

COP 22: strengthened political support

- Release of Marrakesh Action Proclamation
- GHGs reduction momentum was called as "irreversible"
- Announced initiatives for funding and supporting GHGs mitigation and adaptation

Main challenges and uncertainties to meet the targets:

- Political issues and support
- Lobbying and resistance to change;
- Security of supply priorities;
- Growing energy needs;
- Funding and affordability issues;
- Economic viability of green projects;
- Non-binding and conditional commitments;
- Implementation of the detailed agreement mechanisms.

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GHGs mitigation policies will be a combination of initiatives in several policy domains...

Main GHG mitigation levers according to NDCs...

- Promoting energy efficiency
- Switching to less carbon intensive fuels in different usages;
- Promoting GHGs free energy alternatives (Renewables, Nuclear);
- Promoting carbon sequestration and storage, and carbon sinks

... but gas as cleanest fossil fuel needs to play a key role in these mitigation policies

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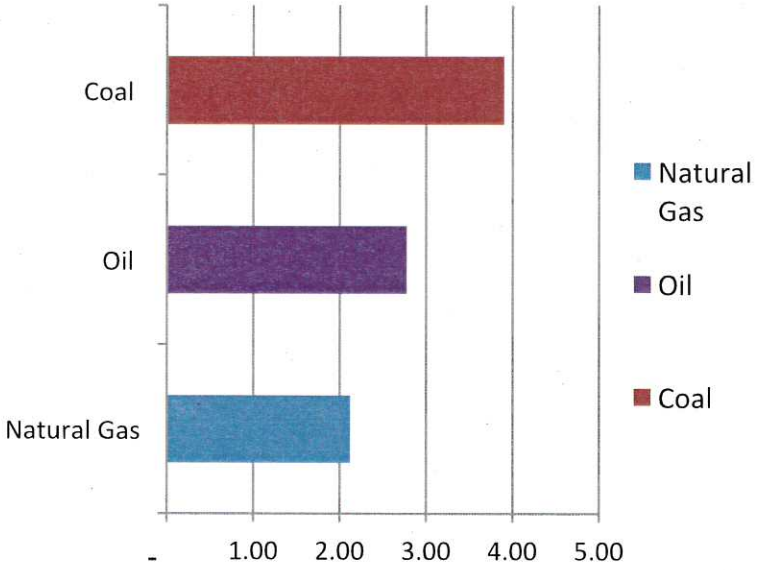
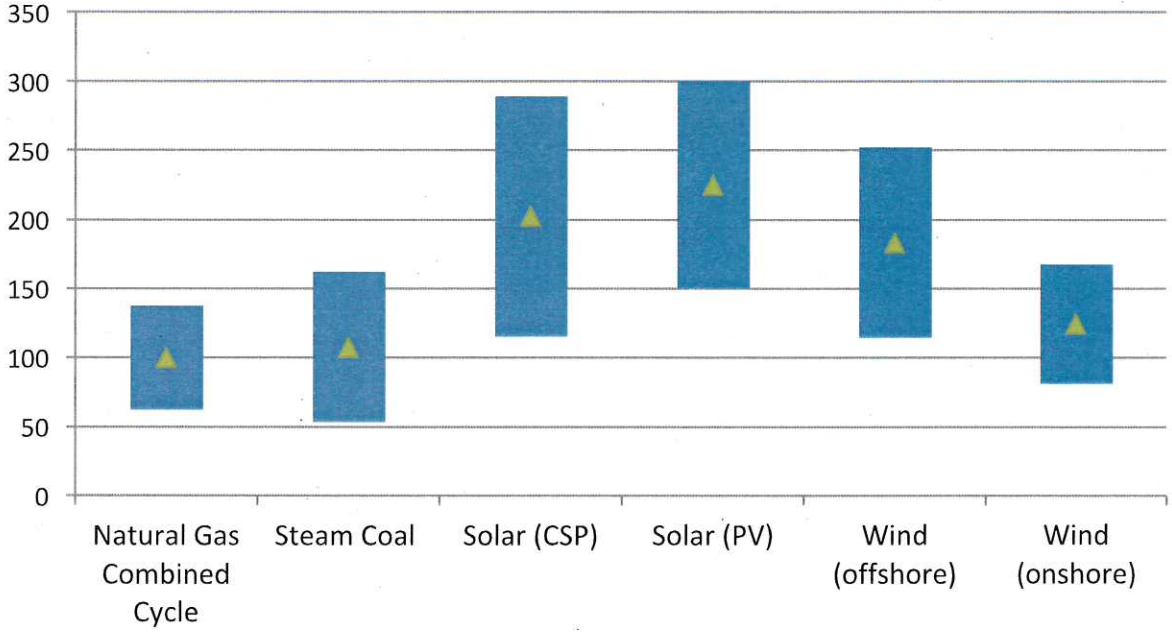
CO2 emission by unit of energy consumed (T.CO2/Toe)



Range of power generation costs for gas, coal and renewables in European countries (US$/Mwh)



Gas has many advantages

- Gas emits less CO2 and other harmful by-products (Particles, NOx, SO2...);
- Gas enjoys a good competitive position against renewables, and also coal in many countries, especially if environmental externalities are integrated
- Good complementarity between gas and renewables;
- Good energy performance of gas-based technologies and processes;
- Gas is clean, abundant, affordable and allows to improve energy accessibility.

Energy and climate policies will contribute in slowing down CO_2 emissions...

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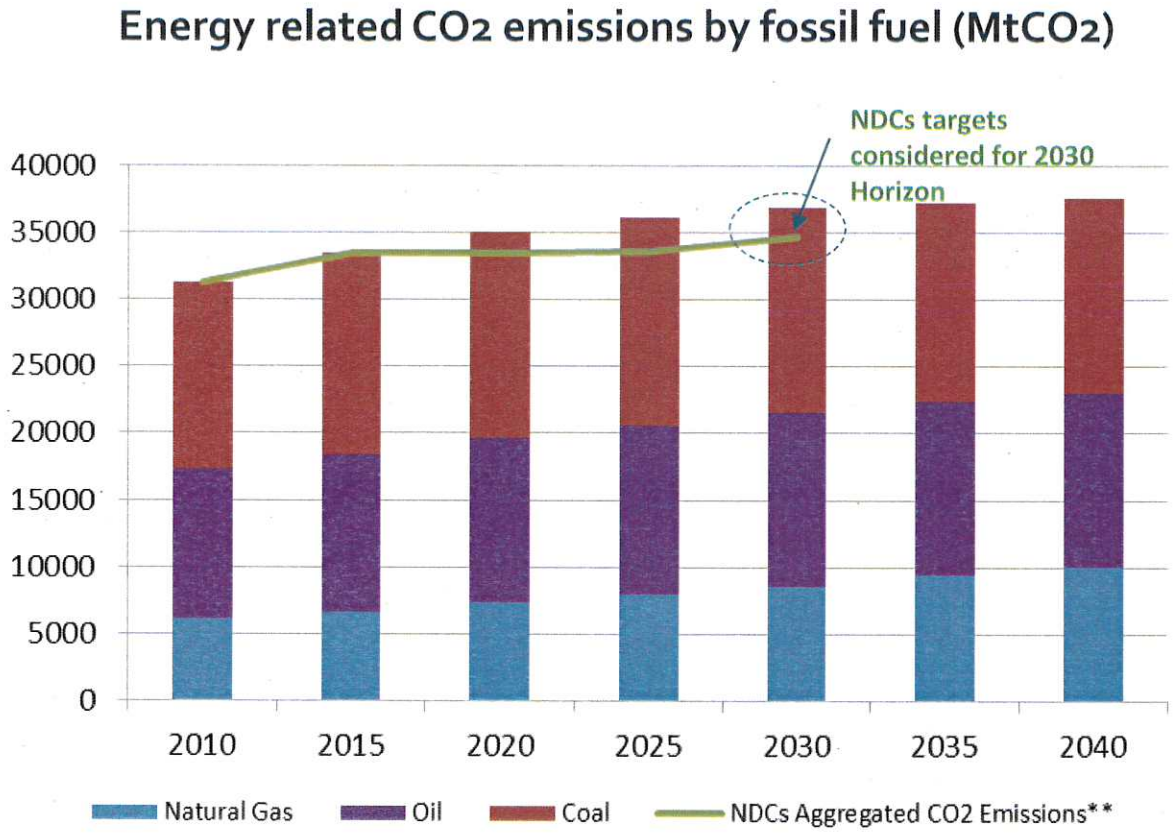
...BUT MISMATCHES ARE EXPECTED BETWEEN FORECASTED REFERENCE CASE EMISSIONS AND EMISSIONS RESULTING FROM AGGREGATED NDCS' TARGETS



- Energy related CO2 emissions expected to grow slowly at 0.5% average rate between 2015 and 2040.
- Oil and coal would represent more than ¾ of CO2 emissions over the long-term.
- Estimated gap between CO2 emission and aggregated NDCs targets is around 6% by 2030 (Around 35% of CO2 emissions in 2030 are expected to come from coal and 42 % from oil)
- More penetration of gas can further contribute in reducing CO2 and in achieving GHGs emissions targets.

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** Estimation of energy related CO2 emissions based on IPCC updated assessment for COP 22 Conference

Gas competitiveness advantages

- Lower investment costs and higher energy performance of gas power plants (the average efficiency of gas combined cycles can reach more than 60%), which support cost competitiveness of electricity produced by gas fired power plants.
- The environmental advantages of gas, especially the lower carbon content, which support lower carbon costs of this fuel
- The technical advantages and flexibility of gas power plants which allow them to work both in baseload and peak load regimes and to contribute efficiently in backing intermittent renewables.

Conclusions

- Gas demand and supply remain coordinated during the Outlook period, even though some short periods of disequilibrium might occur, and long-term contracts act as the tool to manage the volume and price risks.
- The gas industry in all countries will require significant investments in order to deliver new gas to domestic and to export markets. The Outlook emphasizes the importance of maintaining contractual relationships between the buyers and sellers in international gas trade that will support the needed investment. Sellers and buyers will require that the risks in both volume and price can and will be effectively managed.
- 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 role of natural gas in the battle with greenhouse gas emissions gains momentum especially after the ratification of the COP21 agreement.
- The GECF Secretariat will continue to support GECF members both in dialogue in the international community and with analytical support such as that contained in this edition of GECF Global Gas Outlook to 2040.

Thank you very much for your attention!

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