



GLOBAL NATURAL GAS INSIGHTS • 2017 EDITION

NATURAL GAS: The energy for today and the future



90 Charter members, 10 Premium Associate Members and 51 Associate members in **90 countries**. The member countries are marked in blue below.



A message from...

The International Gas Union is pleased to release the first edition of Global Natural Gas Insights.

This handy publication is essential to understanding the significant contribution natural gas can make in meeting the global energy challenges. Natural gas helps meet economic, environmental, and energy security goals.

The 2017 edition contains the latest information on natural gas and its role in enhancing the quality of life around the world, delivering a cleaner environment, meeting vital human needs, creating economic opportunity, and driving innovation.



DAVID C. CARROLL
President, International Gas Union



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Secretary General, International Gas Union

Fuelling the Future

Global energy consumption is expected to double in the next 50 years, driven by increasing population and economic development.

The immediate challenge facing policy makers and the global energy industry is cooperating in the development of energy systems that meet this demand growth.

This must be done in an economically efficient way that offers the best path tackling both, climate change and the detrimental health impacts of poor air quality, while fuelling economic growth.

Natural gas is clean, abundant, and accessible virtually anywhere in the world.

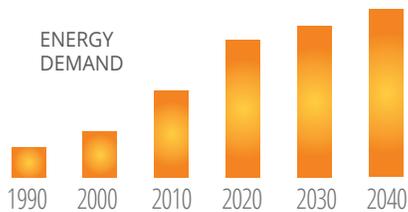
New sources of natural gas from conventional and unconventional deposits, in combination with new and existing pipelines, and the rapid growth of Liquefied Natural Gas (LNG) infrastructure, are greatly enhancing supply security, flexibility, and affordability.

Natural gas is the fuel for today and for the future.

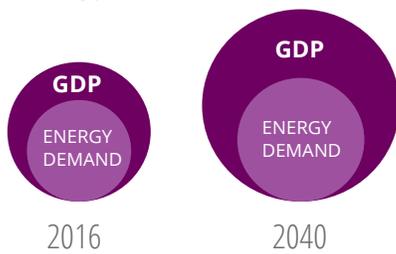
The world will need more energy to fuel future growth.

Large and rapid efficiency improvements will be necessary to achieve sustainability.

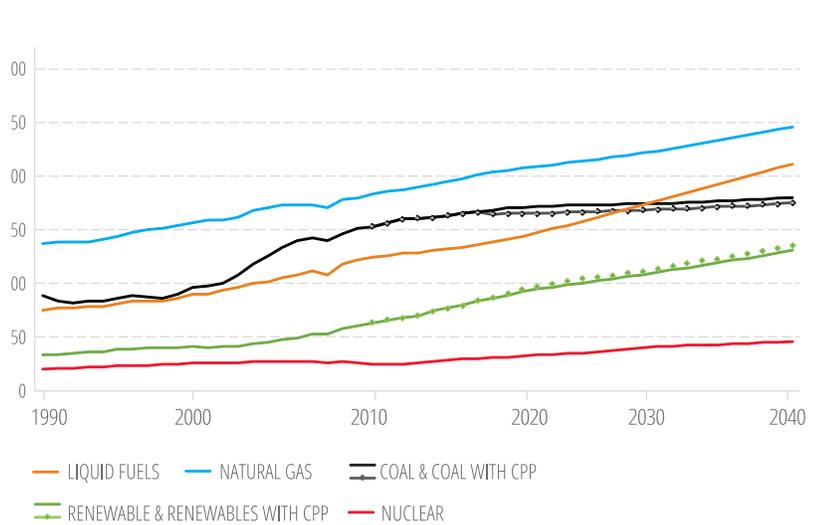
Natural gas will play an important role in enabling a timely meeting of environmental and climate goals. Investments are needed to offset production declines in some regions, in order to avoid a global production gap in the future.



...But will become more energy efficient



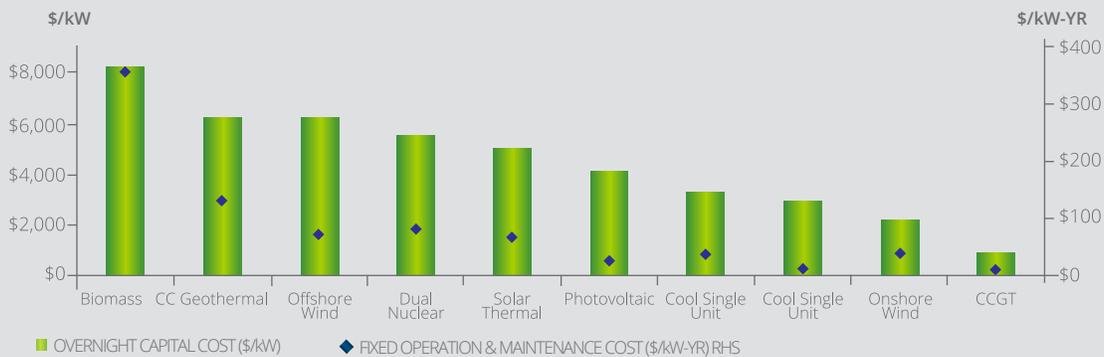
World Energy Consumption by Fuel, Quads (EIA, 2016)



The Value of Gas

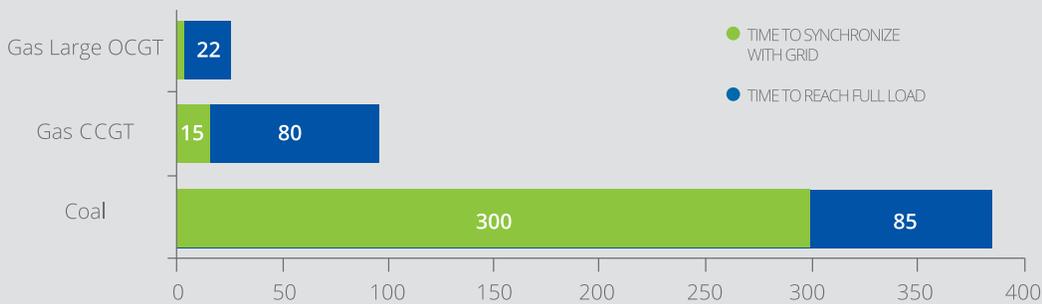
Gas plants are cheaper to build & operate

Capital Cost of Power Plants KW/yr



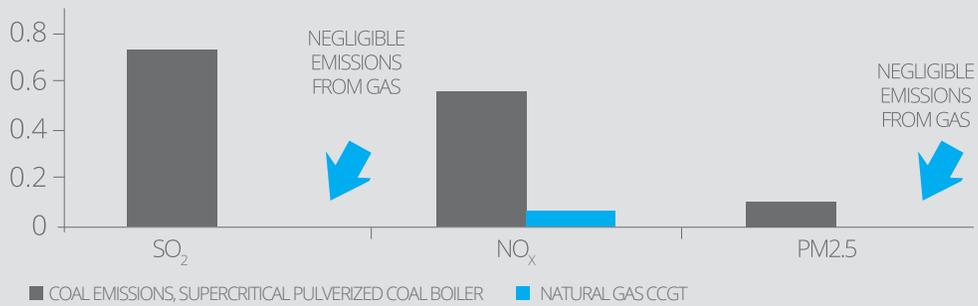
Supporting renewable generation growth

Average Time Required to Come Online, Minutes



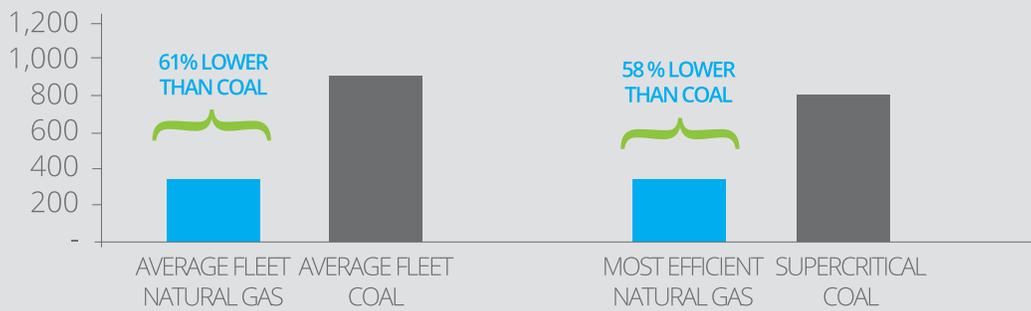
Addressing local air quality concerns

lb/MWh gross



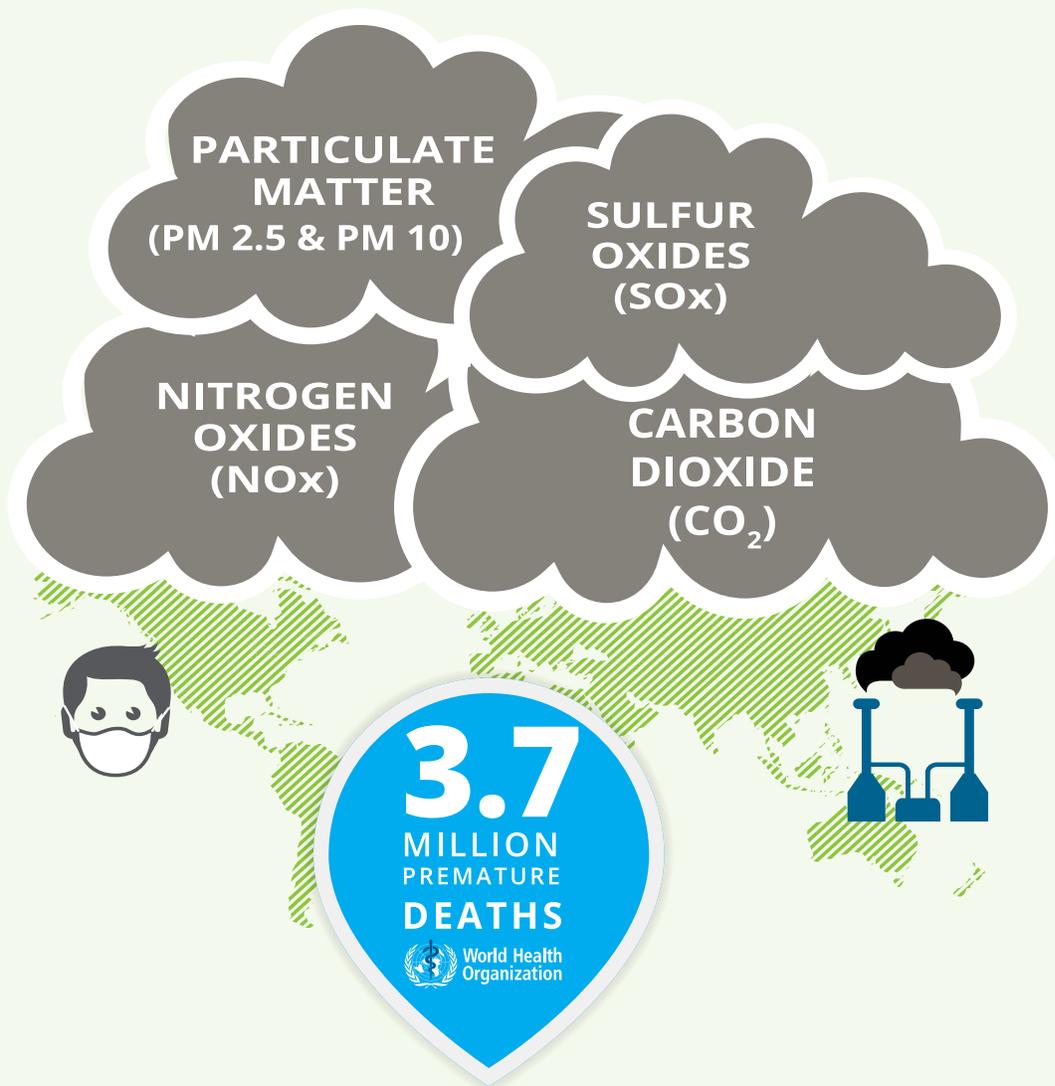
Facilitating climate change objectives

kg CO₂e/MWh, 100 year Global Warming Potential





Natural Gas
Delivers a
Cleaner
Environment



NEW YORK



69% SOx ↓

NYC Converted 30% of heavy fuel burning buildings to natural gas & achieved 69% reduction in SOx concentration within 4 years.

TORONTO



90% PM & SOx ↓

Removal of coal from power generation resulted in reductions in PM10, SOx & NOx of 90%, 91%, & 65% from 2004 levels, and reductions in premature deaths and hospitalization by 76% & 60%.

DUBLIN



90% PM ↓

Severe pollution problem existed in the 1980's due to coal use. Increased use of natural gas (75% of residential demand) resulted in 80-90% reduction in PM emissions.

ISTANBUL



98% SO₂ ↓

Banning lignite coal and gradually replacing it with natural gas for residential heating resulted in reduction of PM concentration levels by 50% and SO₂ by 98% (from 220 µg/m³ to 5) in under a decade.

BERLIN



95% SOx ↓
83% PM ↓

1990-2012 share of natural gas in city's primary energy grew from 17% to 41% resulting in reductions in SOx, NOx, and PM10 by 95%, 76%, and 83% from 1989 levels.

Accelerating the use of natural gas supports two elements of a 'clean and sustainable energy system'.

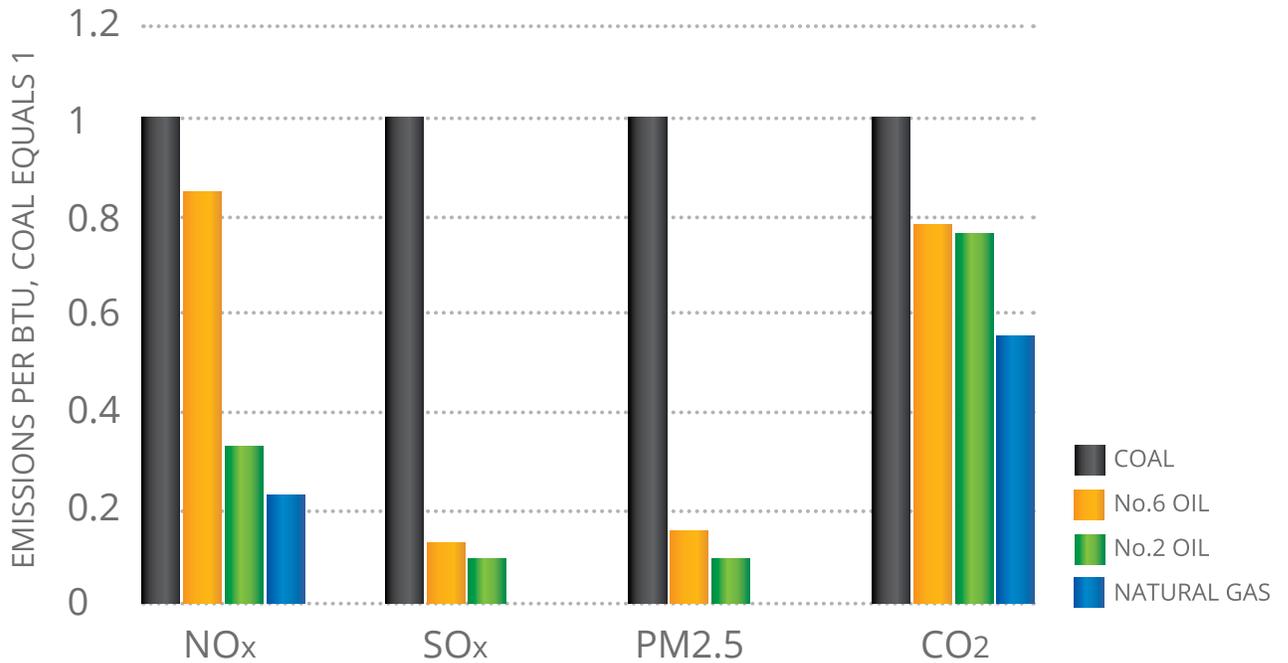
It allows the global economy to begin to reduce harmful air emissions and carbon today, while complementing the development of renewables, and other innovative low-carbon energy technologies.

In generating electricity, from production through to use, natural gas produces around half of the Greenhouse Gas Emissions (GHGs), compared to coal.

Air pollutants, such as PM2.5, NO_x, and SO_x, are detrimental to human health. Greater use of natural gas in power generation and transportation sectors will help to significantly reduce these harmful emissions.

Comparison of Combustion Emissions from Fossil Fuels

(Emissions per Btu)



Enables Clean Air

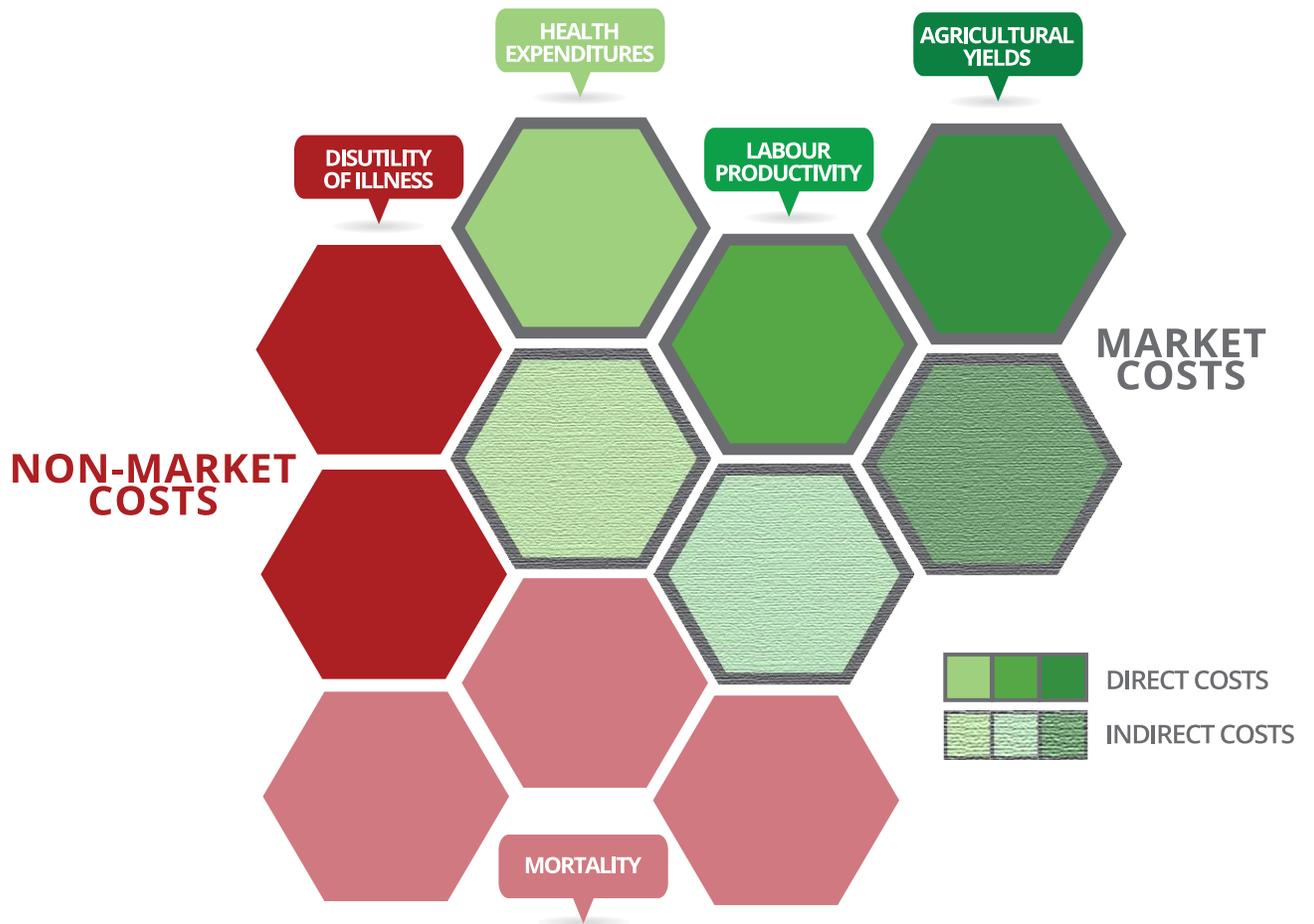
Outdoor air pollution is amongst the most significant threats to human health.



Air pollution also has real economic costs:

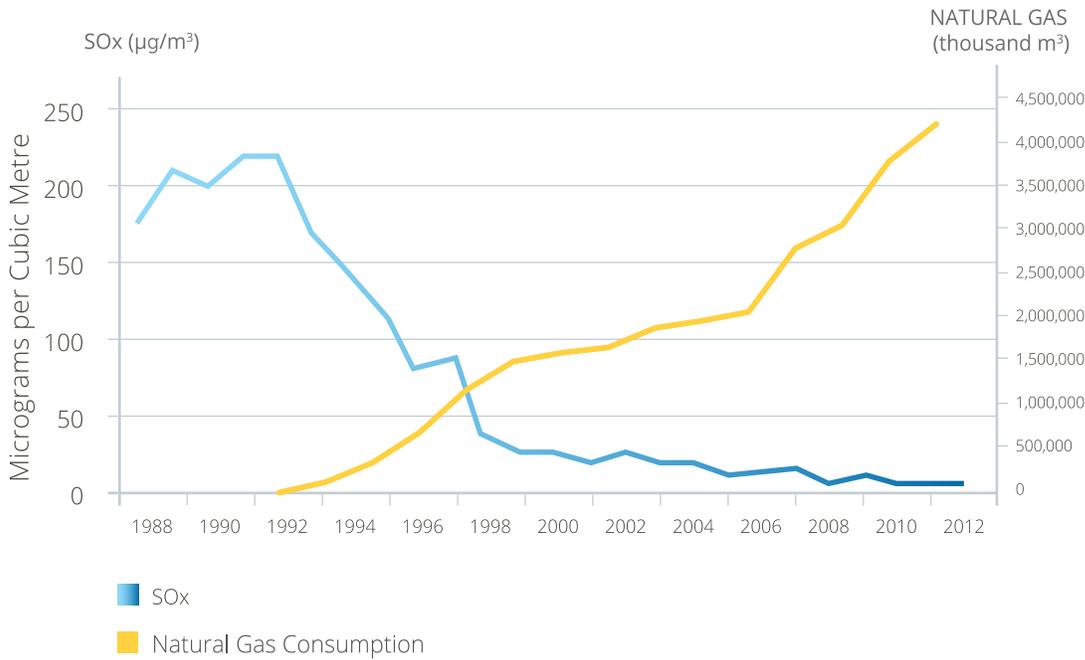
The annual cost of air pollution globally was estimated at USD 3.8 trillion in 2015 and is projected to grow up to USD 30 trillion per year in 2060, with the cost being disproportionately born by the non-OECD countries.

Breakdown of Air Pollution Costs



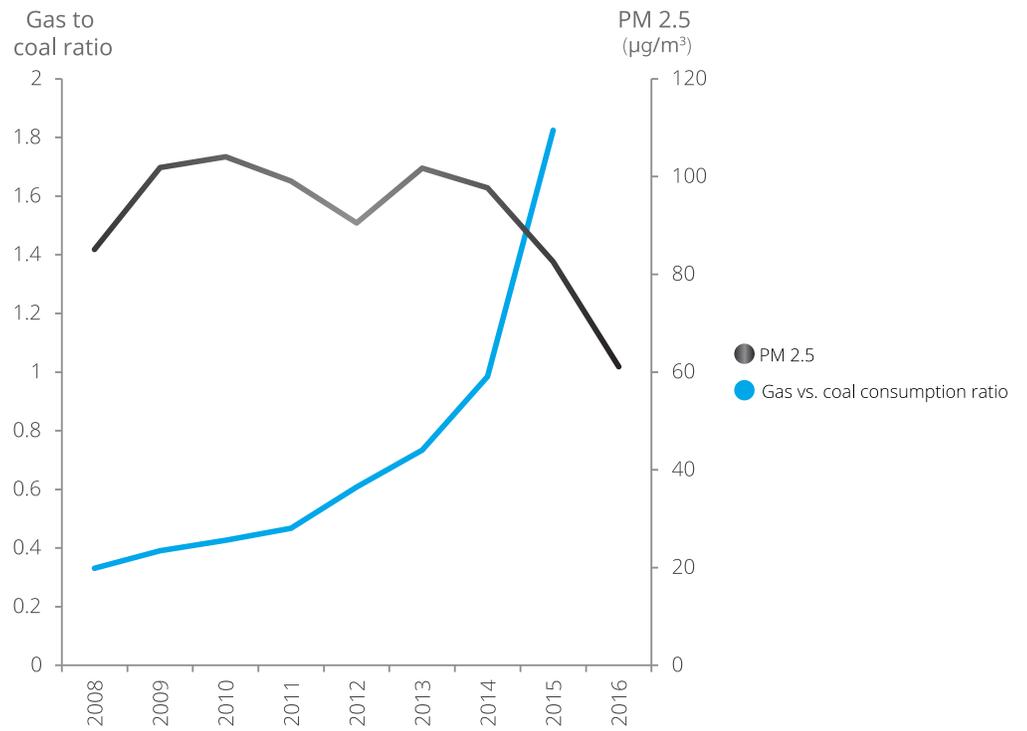
Istanbul

Improving Air Quality





Beijing Improving Air Quality



A **Low Carbon** Option Today

Realizing the full benefits of natural gas will require robust predictable policies and regulatory structures.

For many governments, policy frameworks that support switching from coal to natural gas in power generation and industry offers a fast, affordable way to meet demand, while reducing carbon dioxide emissions that contribute to climate change.

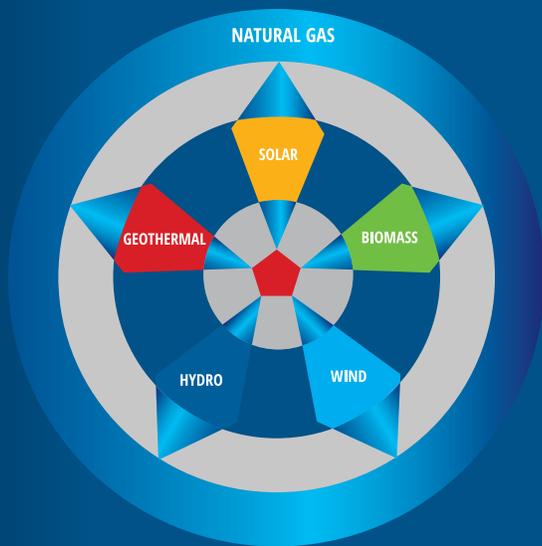
Well-designed emission regulations and carbon pricing systems help to accelerate a shift from coal to natural gas, promote low-carbon technologies, including Carbon Capture and Storage (CCS), and encourage greater energy efficiency.



Global Carbon Pricing Initiatives



CARBON PRICING PRINCIPLES: ECONOMY WIDE • TRANSPARENT • REVENUE NEUTRAL



Enables **Clean** Energies

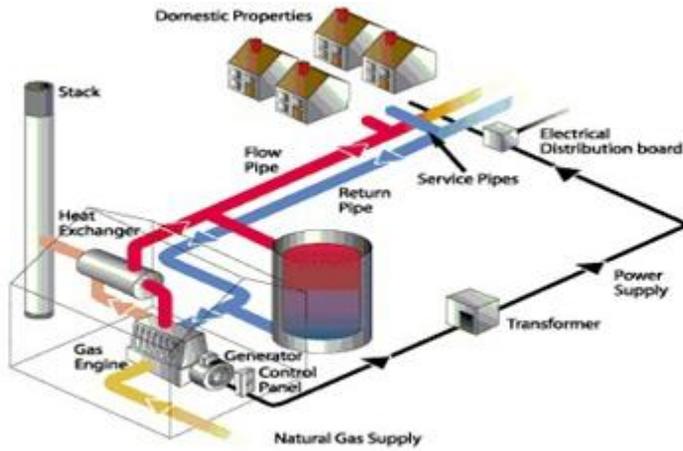
The flexibility, price & performance characteristics of **natural gas** make it the best fuel to partner with clean energy sources in multiple ways.

Natural gas can help address the challenge of seasonal and daily output variability of wind, solar, and hydro generation.

Distributed natural gas-based energy systems can be integrated with renewable thermal and electric generating systems to offer clean, efficient, and reliable hybrid systems.

The natural gas infrastructure can also act as a storage medium for renewably generated hydrogen, or synthetic natural gas.

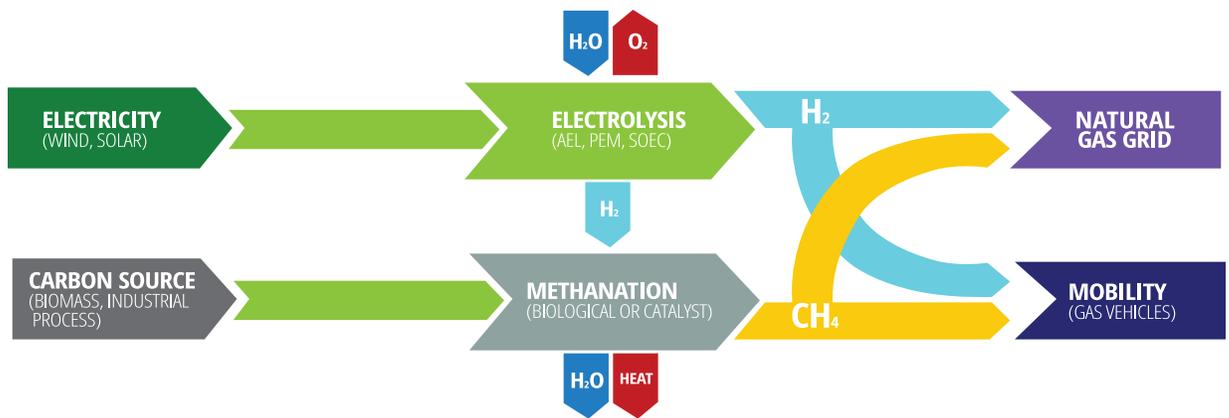
This maximizes the use of renewable generation.



DISTRIBUTED ENERGY SYSTEM



THERMO SOLAR COMBINED CYCLE POWER PLANT



RENEWABLY GENERATED HYDROGEN

Enables Clean Transport

Natural Gas in the transportation sector enables cleaner mobility.

Compressed Natural Gas and Liquefied Natural Gas mobility can deliver cost-effective solutions to reduce the emissions of pollutants in applications related to short, medium, and long distance transport of persons and goods.

Proven and commercially available technologies exist for passenger, return-to-base commercial, heavier transport vehicles, rail and marine transport applications.



Reducing emissions from road transport

The use of natural gas in transportation is seeing exponential growth, offering significant long-term cost savings, while greatly improving air-quality.

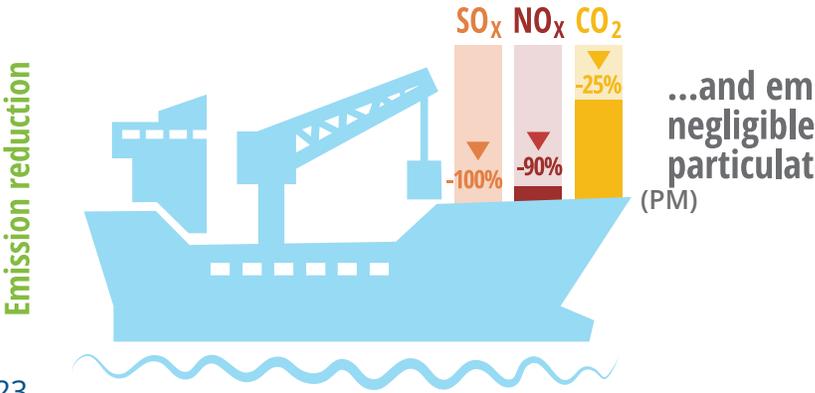
Natural gas is the cleanest hydrocarbon fuel available. As a transportation fuel, natural gas can reduce greenhouse gas emissions by 20-30%, when compared with diesel and gasoline.

The exhaust emissions of natural gas vehicles, offer reductions of common urban pollutants.



Delivering clean marine transport

LNG is a low emissions marine fuel allowing operators to meet their sulphur and nitrogen oxides reduction obligations under the International Maritime Organization regulations.



Natural Gas
Meets
Vital
Human
Needs

Natural gas is a clean, reliable, efficient, and economical energy source for electricity generation, heating and hot water supply, cooking and motor fuel.

A key feedstock in industry across a range of sectors, from agriculture to chemicals, natural gas facilitates a wide range of life-enhancing products.

From healthcare, to construction, to transport.

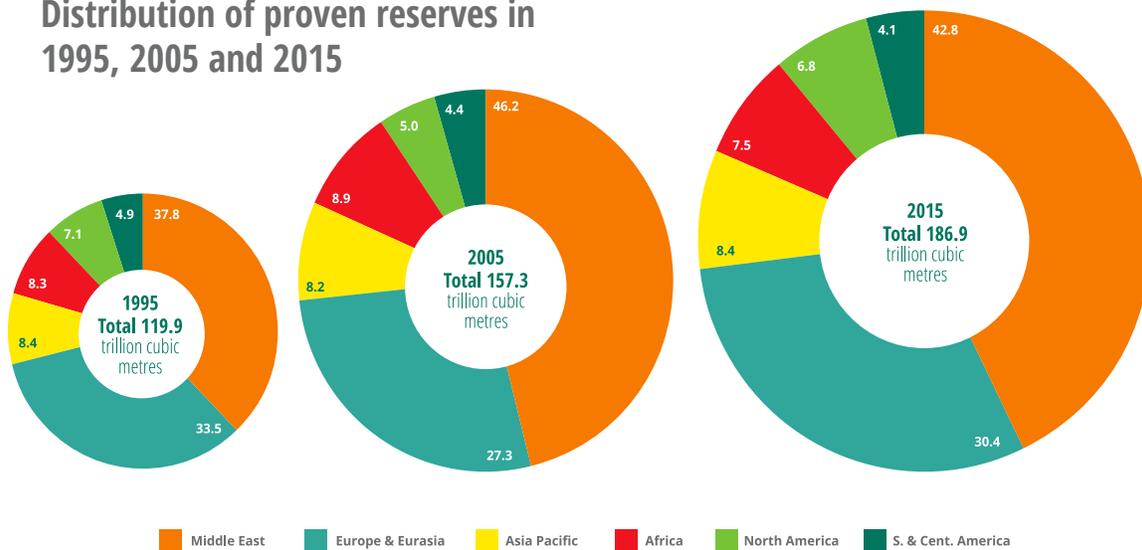
Natural gas plays an increasingly important and positive role in people's daily lives.



Abundant **Global** Supplies of Natural Gas

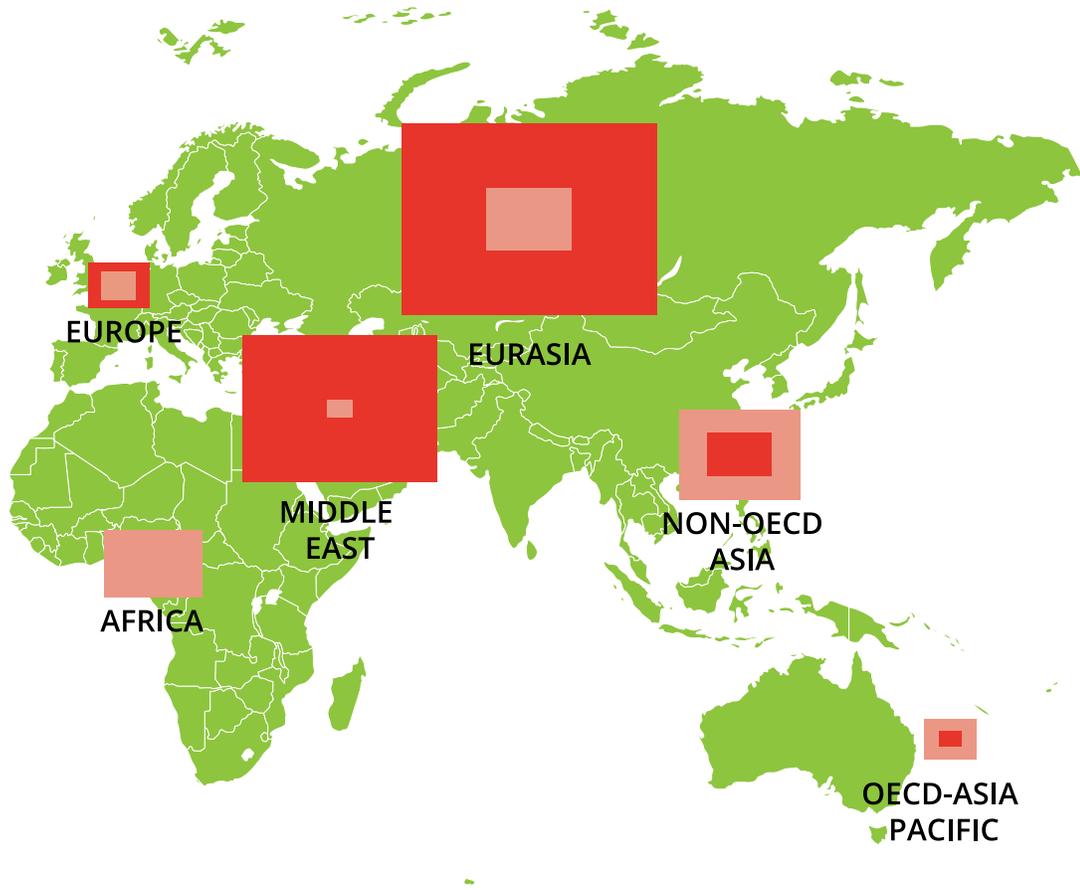
Global natural gas resources are growing and are increasingly geographically diverse. There are sufficient technically recoverable natural gas resources to last for at least the next 235 years at current production levels.

Distribution of proven reserves in 1995, 2005 and 2015



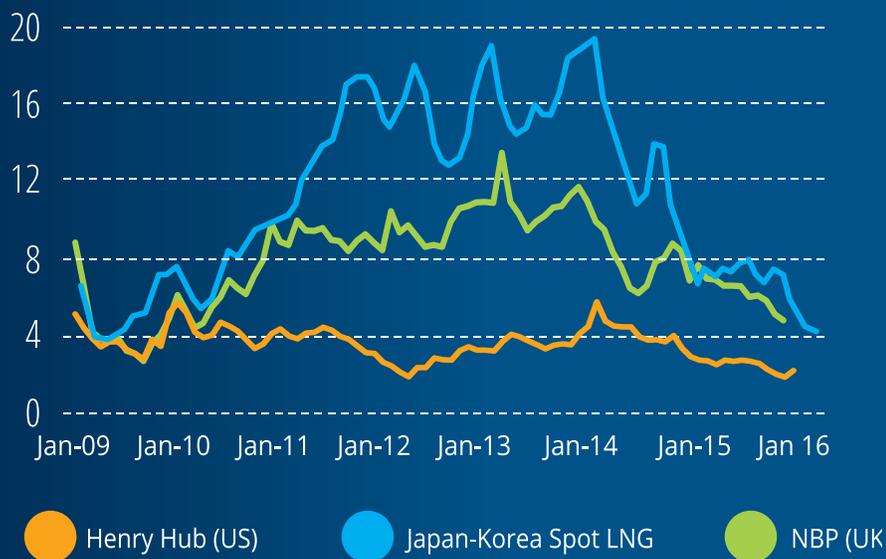
Global Conventional & Unconventional Natural Gas Resources





Competitively Priced

REGIONAL GAS PRICE MARKETS January 2009 - April 2016 USD/MMBtu



The price of natural gas has declined due to the unprecedented growth in new supply and LNG volumes.

This resulted in a significant global price convergence.

Globally, gas-on-gas competition has continued to increase its market share.

Best Option for New Flexible Generating Capacity

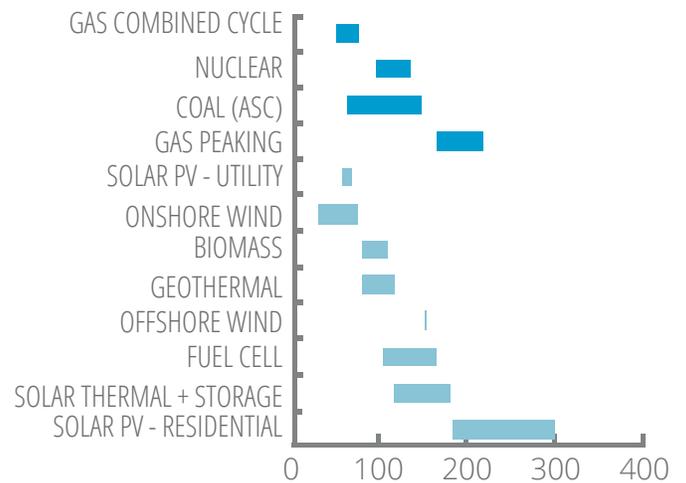
Natural gas provides an economic, energy efficient, and stable option to generate electricity. It is particularly suitable for the developing economies, which require significant new capacity investments.

The high pollution costs associated with coal make it a more expensive option, despite its lower marginal cost.

The welfare costs of outdoor pollution in non-OECD countries exceeded USD 500 per capita in 2015 and are projected to rise to between USD 2,000 and USD 3,000 per capita by 2060.

LEVELIZED COST OF ELECTRICITY USD/MWh

(Excluding pollution externalities)





Over 2.8 million km of transmission pipelines globally

A highly developed network of natural gas pipeline infrastructure already exists today, with more being built. This vast network of pipeline and gas storage infrastructure allows natural gas to be easily moved from production regions to consumer markets.

Highly Accessible

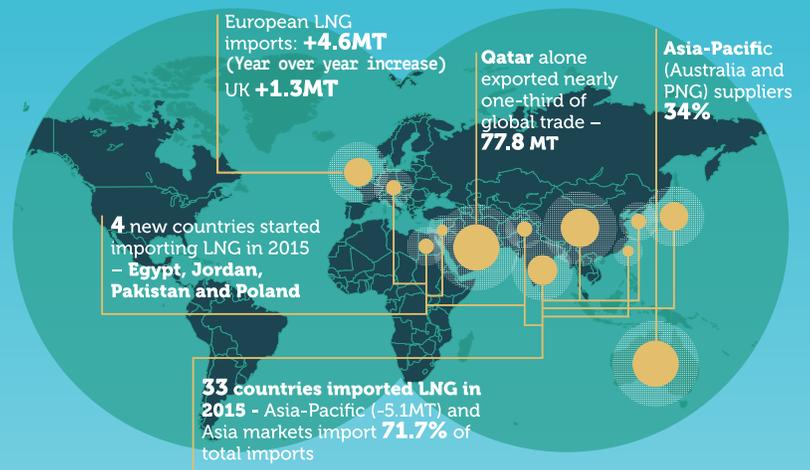
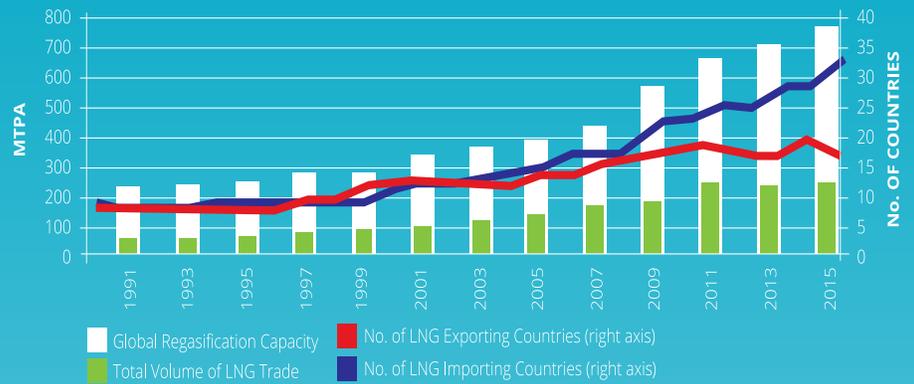
**Dependable
Pipeline & Storage
Infrastructure**

LNG

Liquefied Natural Gas (LNG) bridges the distance between supply and demand, allowing markets to increase flexibility and mitigate security of supply concerns.

Technology cost reductions and unlocking of new supplies resulted in a tremendous growth in the global LNG market, at 6.6% per annum, since 2000.

Today LNG already accounts for 9.8% of total global supply, and this share will continue to increase, providing secure and flexible supplies.



Global Natural Gas Flows (2015)

(billion m³) | Year-over-year change

Net pipeline exports:

Russia (+7.7%)
Norway (+7%)

Net pipeline imports:

Mexico (+44.9%)
France (+28.8%)

Global LNG trade increased by 1.8%.

Net LNG Exports:

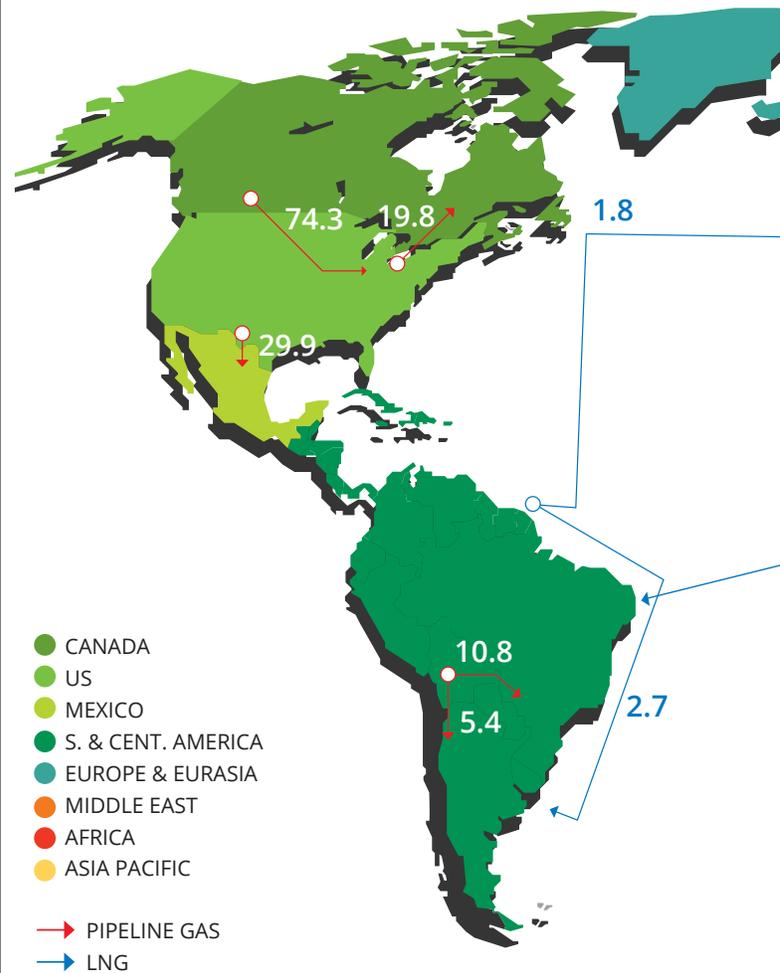
Australia (+25.3%)
Papua New Guinea (+104.8%)

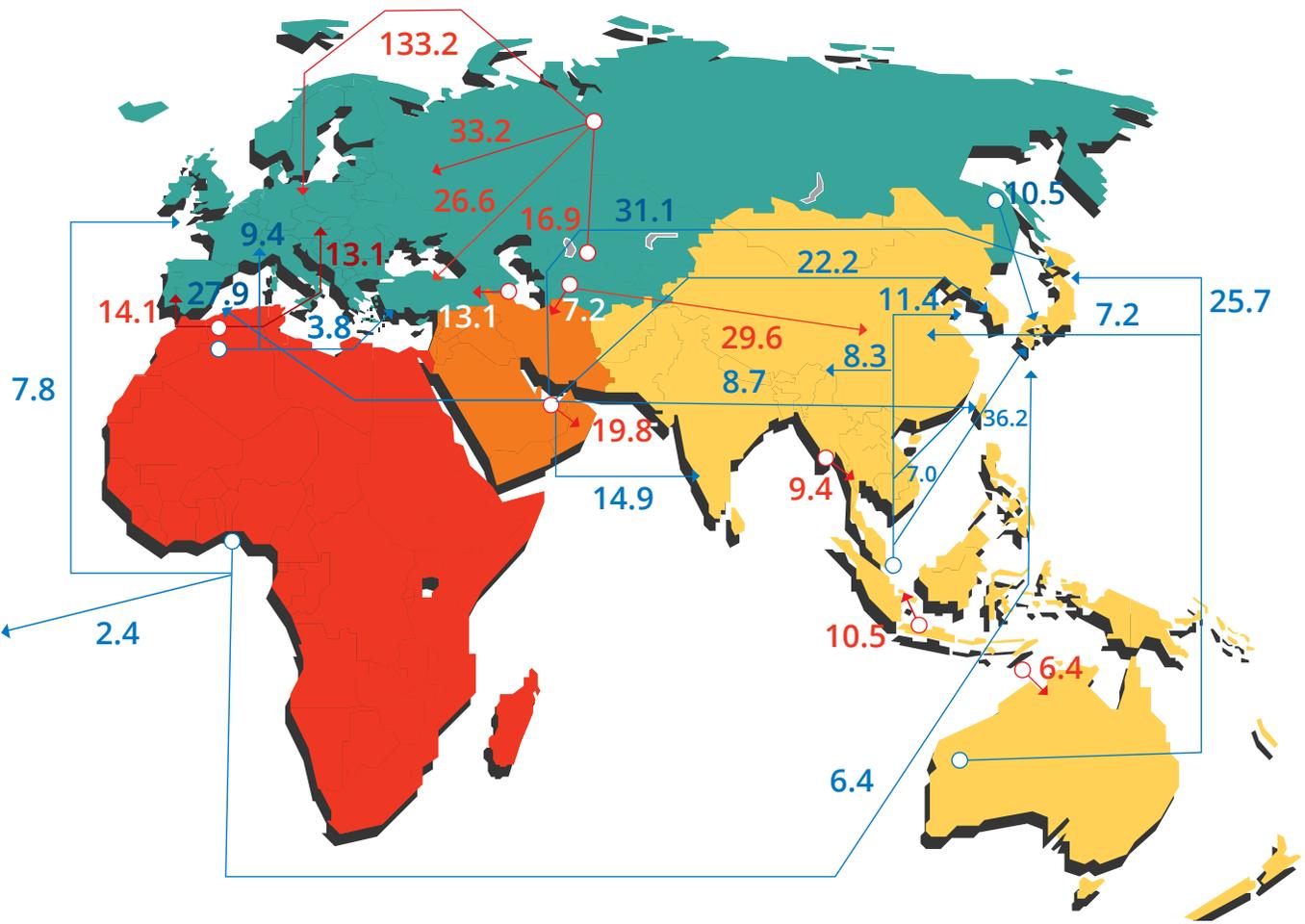
Yemen (-77.2%)

Net LNG Imports:

Europe (+15.9%)
Middle Eastern (+93.8%)
South Korea (-10.4%)
Japan (-4%)

International natural gas trade accounted for 30.1% of global consumption.







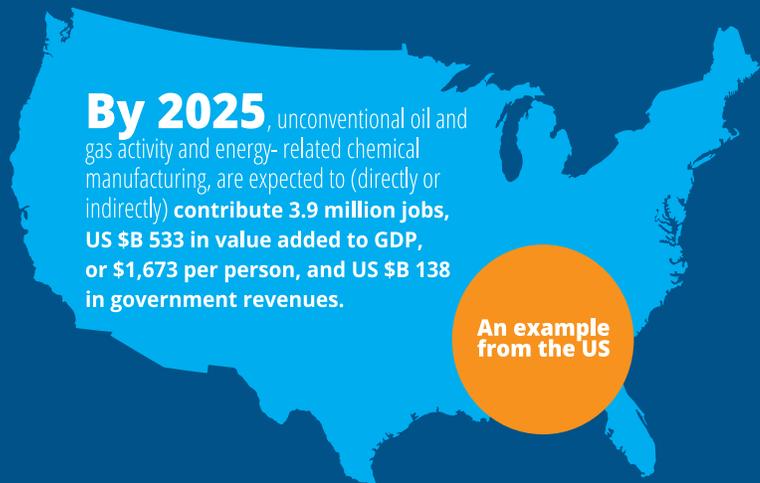
Natural Gas
Creates
Economic
Growth

Natural Gas Drives Industrial Competitiveness

The employment multiplier of the oil and gas industry is greater than 3. That means that for every job in the natural gas sector, 3 or more are created elsewhere in the economy.

In developed markets, with the greater focus on climate change mitigation, gas can drive continued competitiveness. In light of more stringent emissions legislation, gas remains more cost effective than renewables, yet more sustainable than coal.

Gas is not only the backbone for industrial competitiveness, it also supports the faster deployment of clean energies.

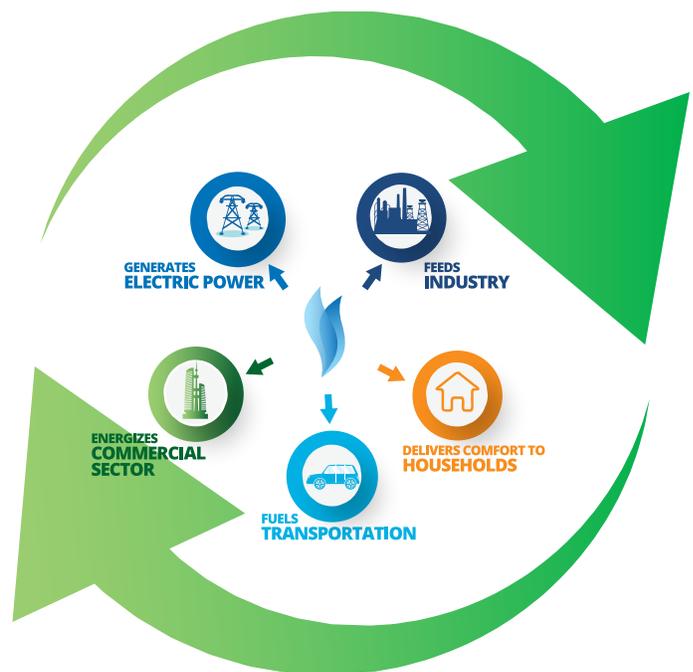


Creates Economic Opportunity

Natural gas can fuel the engine of the entire economy while keeping to the path of immediate climate change action.

Gasification can open access to energy for millions of people – one that won't add environmental stress to cities and would free populations from labour-intensive energy generation to focus on value creation.

These conditions would allow emerging markets to continue to develop in a sustainable way.



A Commercial Opportunity for Governments

39

For countries with large domestic natural gas resources, the impact of developing and bringing substantial additional volumes of natural gas on stream can be economically transformational.

In addition to the positive impacts from direct sector employment and the related economic multipliers, natural gas is also a key feedstock material for a number of lucrative manufacturing industries, such as fertilizers and petrochemical products.

Unlocking the value of natural gas resources can significantly improve the prosperity of a developing economy.



HEALTHCARE

All specialized medical gasses and much of the pharmaceutical industry rely on natural gas as either feedstock or as a key part of the lifecycle.



CHEMICALS

Ammonia-based fertilizers that keep the food we eat growing start with natural gas. Many plastics can only be affordably created through using natural gas.



CONSTRUCTION

Natural gas is a vital component in the creation of cement mixes. Natural gas has replaced coal as a much cleaner, but also far more efficient heating agent, which results in a more effective product. Modern safety and ultra-thick / thin glasses would be impossible to create without high-tech, gas-fired forges.



Energizing Remote Communities

Globally over 1.2 billion people do not have access to electricity, and 2.7 billion (38% of world population) people do not have clean cooking facilities.

3.5 million premature deaths can be attributed to household air pollution from the use of solid fuels such as firewood and charcoal.

Sub-Saharan Africa and developing Asia represent over 95% of these underserved communities.

Access to clean energy is a basic human necessity. Natural gas is perfectly suited to address this vital human need.

Advancements in small scale LNG and distributed energy technologies are unlocking new opportunities for energizing communities where no existing energy delivery infrastructure is in place.

Natural gas can help communities gain access to safe, reliable, and affordable energy, which can spur economic development and improve healthcare, education, and lives.

Natural Gas
Drives
Higher Energy
Efficiency

Driving Higher Energy Efficiency

Through highly efficient delivery and end-use

By facilitating effective integration of energy end uses for homes and businesses

By delivering carbon-neutral emissions using natural gas like biomethane

Providing an energy storage option for excess renewable generation



Efficiency in energy delivery

NATURAL GAS

SOURCE ENERGY

100
MMBtu

EXTRACTION, PROCESSING
& TRANSPORTATION

▼ 7% ENERGY LOSS

93 MMTu



GENERATION

No energy conversion
necessary, therefore
no energy is lost

DISTRIBUTION

▼ 1% ENERGY LOSS

92 MMTu



DELIVERED
TO CUSTOMER

92
MMBtu



ELECTRICITY

SOURCE ENERGY

100
MMBtu

EXTRACTION, PROCESSING
& TRANSPORTATION

▼ 5% ENERGY LOSS

95 MMTu



GENERATION

▼ 64% ENERGY LOSS

34 MMTu



DISTRIBUTION

▼ 6% ENERGY LOSS

32 MMTu



DELIVERED
TO CUSTOMER

32
MMBtu



Smarter Infrastructure

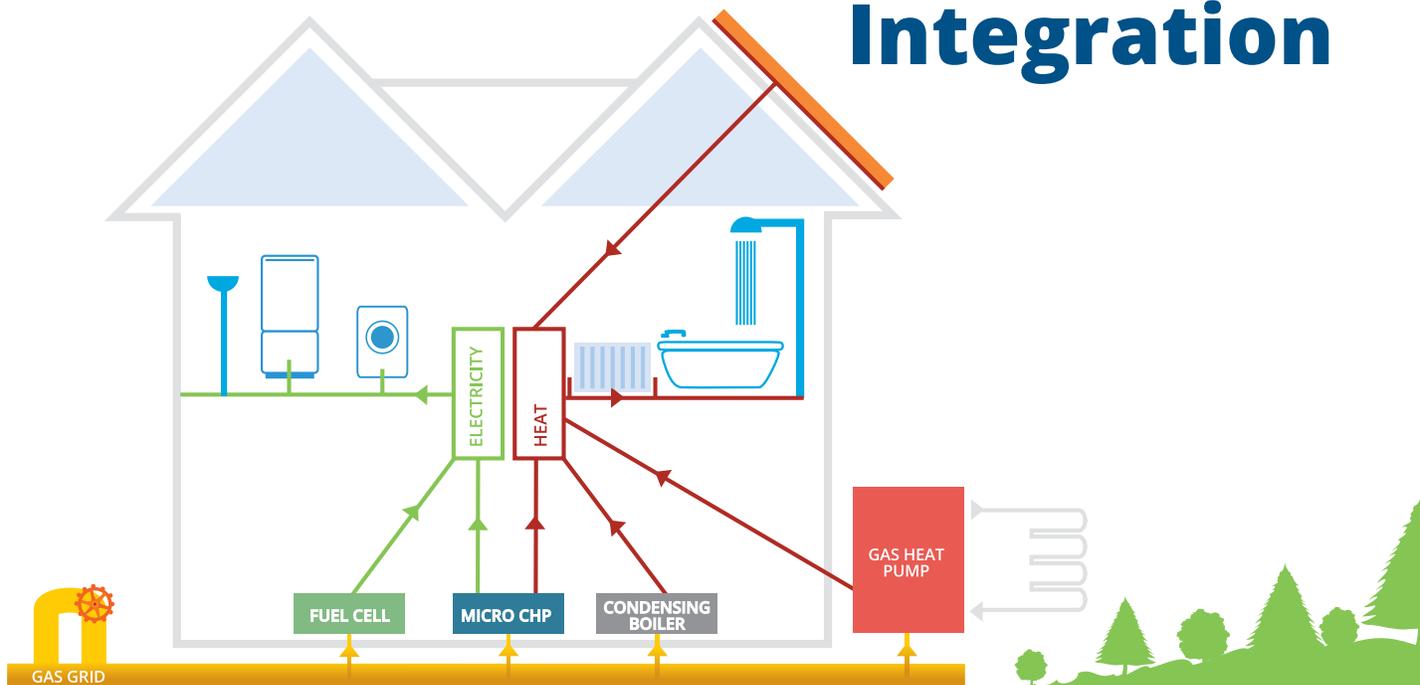
With the development of natural gas infrastructure that is connected to industrial, commercial, and residential sectors, natural gas can be applied in Combined Heating and Power systems (CHP) and Combined Cooling and Heating Power systems (CCHP).

CHP generates electricity while also capturing usable heat in one single, highly efficient process.

Smarter city planning that incorporates infrastructure to accommodate distributed gas heat with power generation (CHP) offers significant gains in efficiency and helps to reduce air pollution and greenhouse gas emissions associated with coal-fired power. CHPs can also help improve the resilience of a city in times of crisis and keep the lights on, when the main electric grid is down.



Smarter Integration

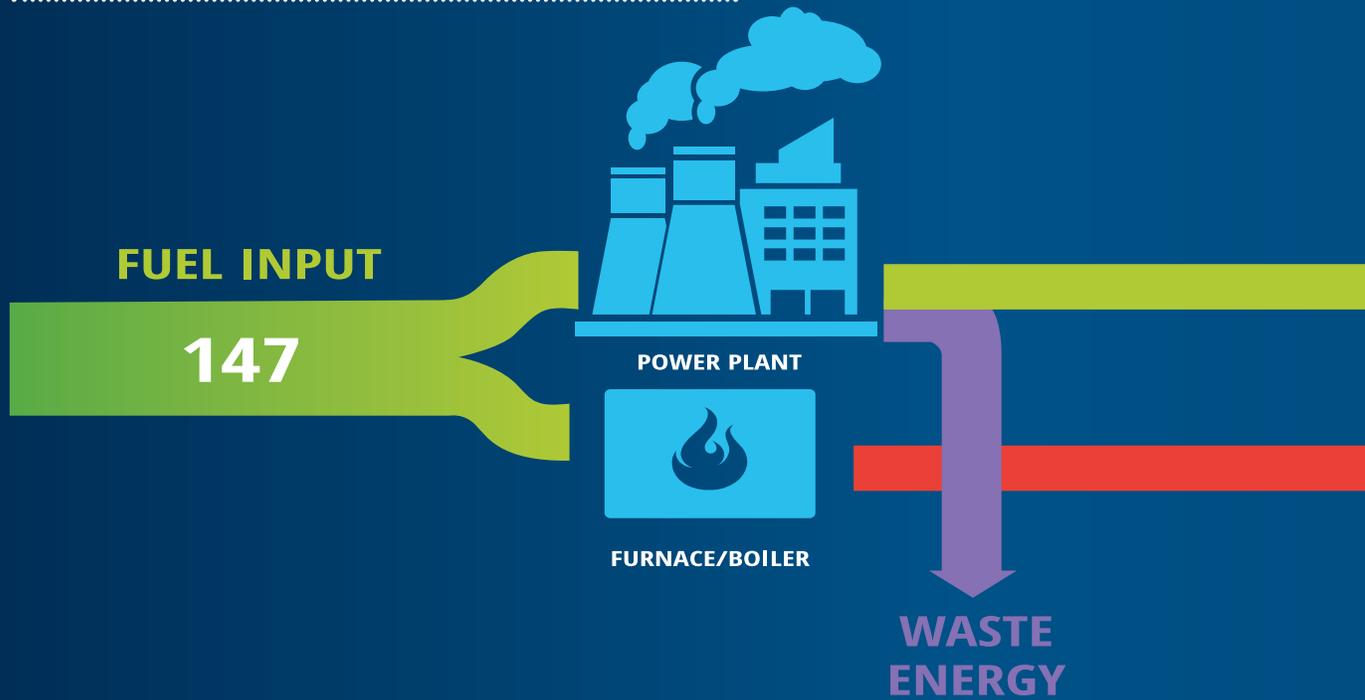


Natural Gas can drive higher efficiencies in the residential and commercial sectors through the intelligent use of new technologies, such as micro-chp, condensing boilers, gas heat pumps, and hybrid solar/gas water heating.

These flexible and responsive technologies can provide cost-effective energy solutions, be integrated with renewable energy via the internet of things, and ensure high energy performance and comfort.

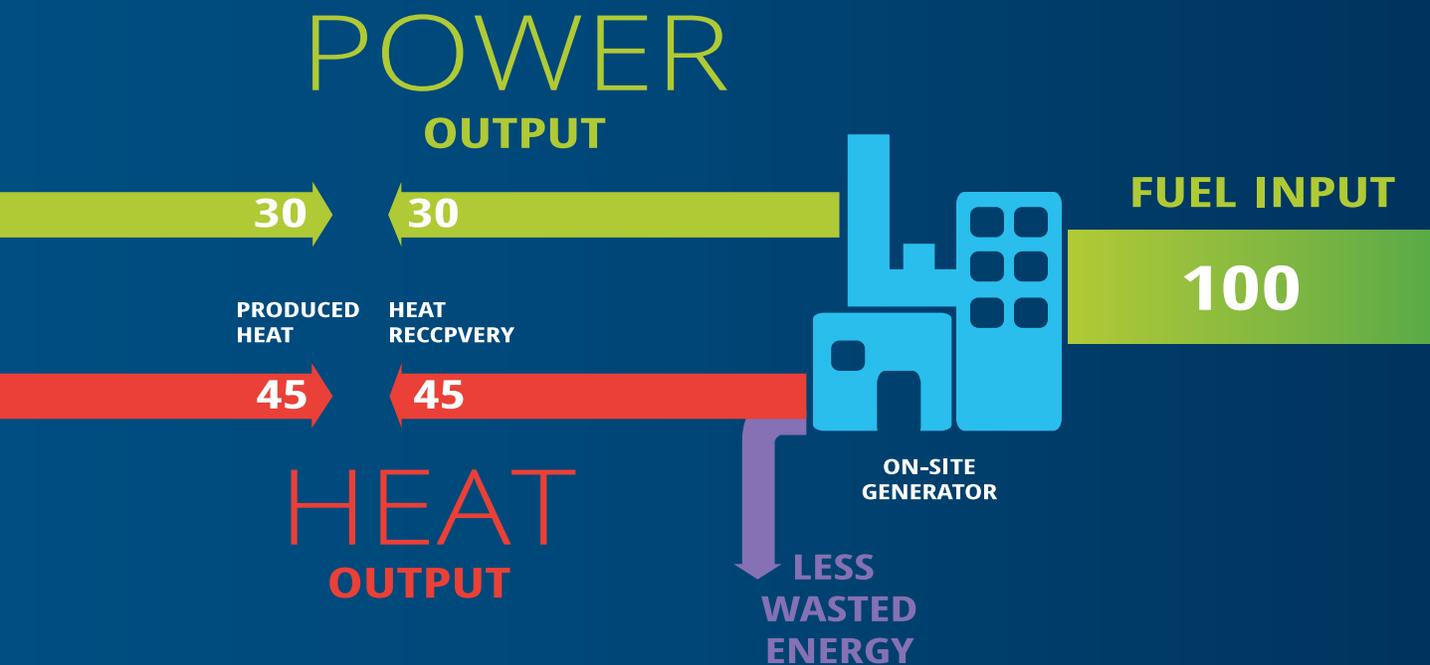
Separate Production of Electricity & Heat

TOTAL EFFICIENCY: 51%



Combined Heat & Power Systems

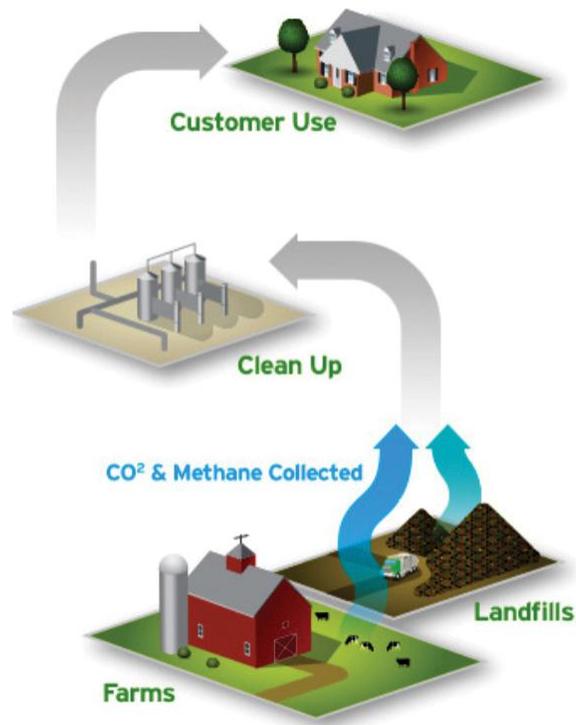
TOTAL EFFICIENCY: 75%

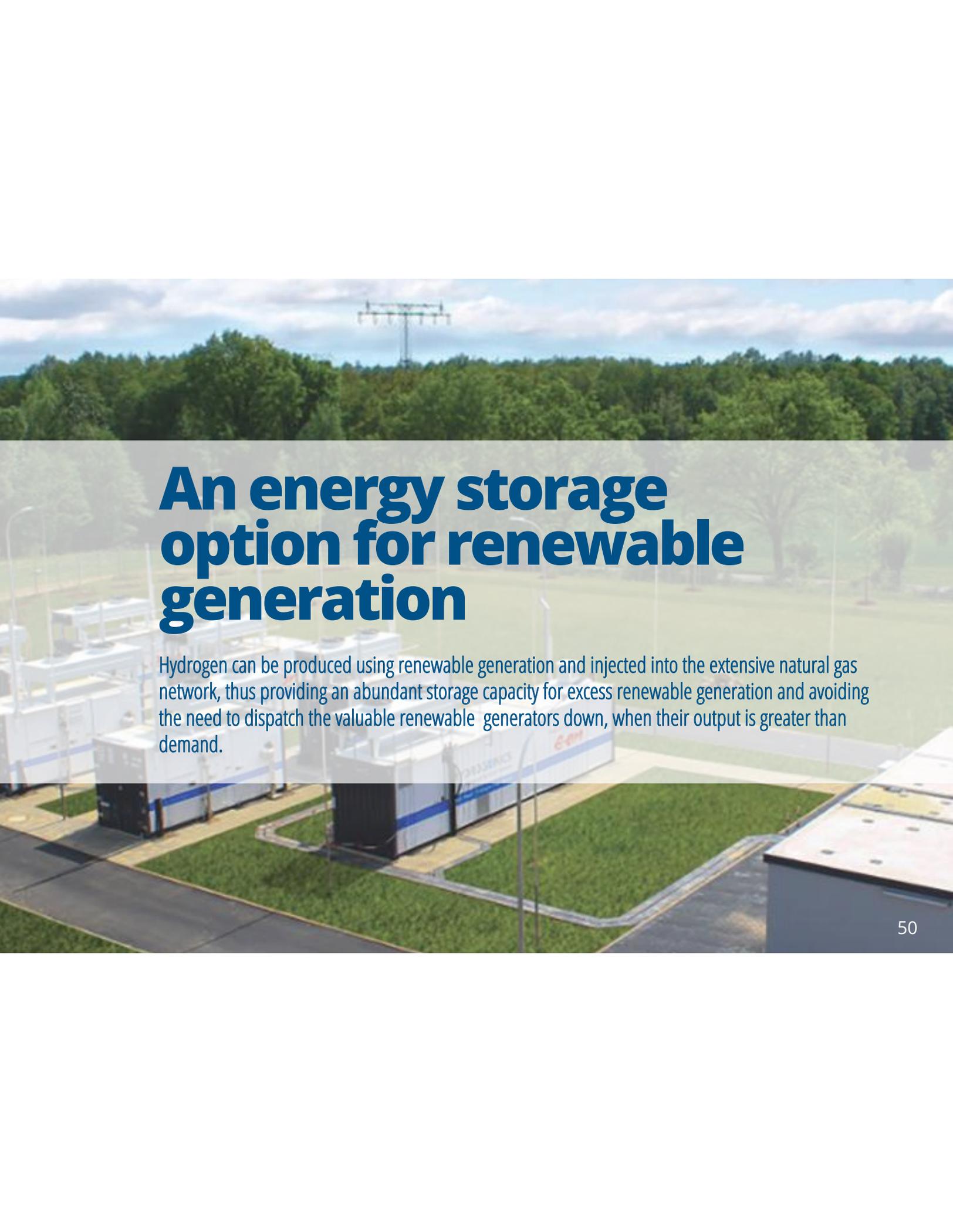


Natural Gas It's Renewable, Too

Renewable gas is natural gas, or biomethane produced from existing waste streams and a variety of renewable biomass sources, including animal waste, landfills, crop residues, and food waste. Once processed, it is interchangeable with traditional pipeline-quality natural gas.

It is carbon neutral, extremely versatile, and compatible with existing pipeline infrastructure.



An aerial photograph of an industrial facility, likely a hydrogen production or storage site. The facility features several large, white, cylindrical storage tanks or processing units arranged in a row. The ground is a mix of green grass and paved areas. In the background, a dense line of green trees is visible, with a tall power line tower standing prominently against a blue sky with scattered white clouds. The overall scene is well-lit, suggesting a clear day.

An energy storage option for renewable generation

Hydrogen can be produced using renewable generation and injected into the extensive natural gas network, thus providing an abundant storage capacity for excess renewable generation and avoiding the need to dispatch the valuable renewable generators down, when their output is greater than demand.

SOURCES

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Left: Adapted from Statoil (Energy Perspectives 2016)
Right: Energy Information Agency, 2016

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Adapted from Royal Dutch Shell (Global LNG Outlook, 2017)

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IGU Clean Air Report, 2015; World Health Organisation

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IGU Clean Air Reports, 2015 & 2016

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IGU Clean Air Report, 2015

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OECD (The Economic Consequences of Outdoor Air Pollution, 2016)

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OECD (The Economic Consequences of Outdoor Air Pollution, 2016)

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IGU Clean Air Report, 2015;
iGDAS 2015 Annual Report

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Royal Dutch Shell 2017 LNG Outlook

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Adapted from Statoil

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Image courtesy of Gas Natural Fenosa

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Infographic courtesy of The American Gas Association

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Images courtesy of GasNaturally, and Gas Natural Fenosa

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Courtesy of BP (Natural Gas Statistical Review, 2016)

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Adapted from Statoil (Energy Perspectives, 2016)

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Adapted from Statoil (Energy Perspectives, 2016)

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Image courtesy of Gazprom

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Top: Image courtesy of Royal Dutch Shell
Bottom: IGU Infographic

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Adapted from BP (Natural Gas Statistical Review, 2016)

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Infographic courtesy of the American Gas Association

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Image courtesy Eurogas (Gas: the right choice for Europe)

PAGES 47-48

Graphic courtesy of the American Gas Association

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The International Gas Union (IGU) was founded in 1931. It is a worldwide non-profit organisation registered in Vevey, Switzerland with the Secretariat currently located in Barcelona, Spain.

The mission of IGU is to advocate for natural gas as an integral part of a sustainable global energy system and to promote political, technical, and economic progress of the natural gas industry.

More than 150 IGU members are associations and corporations representing over 97% of the global natural gas market. IGU covers the entire natural gas value chain, from exploration and production, to transmission via pipelines and liquefied natural gas (LNG), through to distribution and combustion at the point of use.

IGU encourages international natural gas trade by supporting non-discriminatory policies and sound contracting principles. IGU also promotes the development of new technologies, which enhance the environmental benefits of natural gas, as well as the industry's continued excellence in safety of production, transmission, distribution, and efficient utilisation of the product.

The IGU vision is to be the most influential and independent non-profit organization serving as the global voice of the natural gas industry worldwide.

igu.org