All you always wanted to know on gas

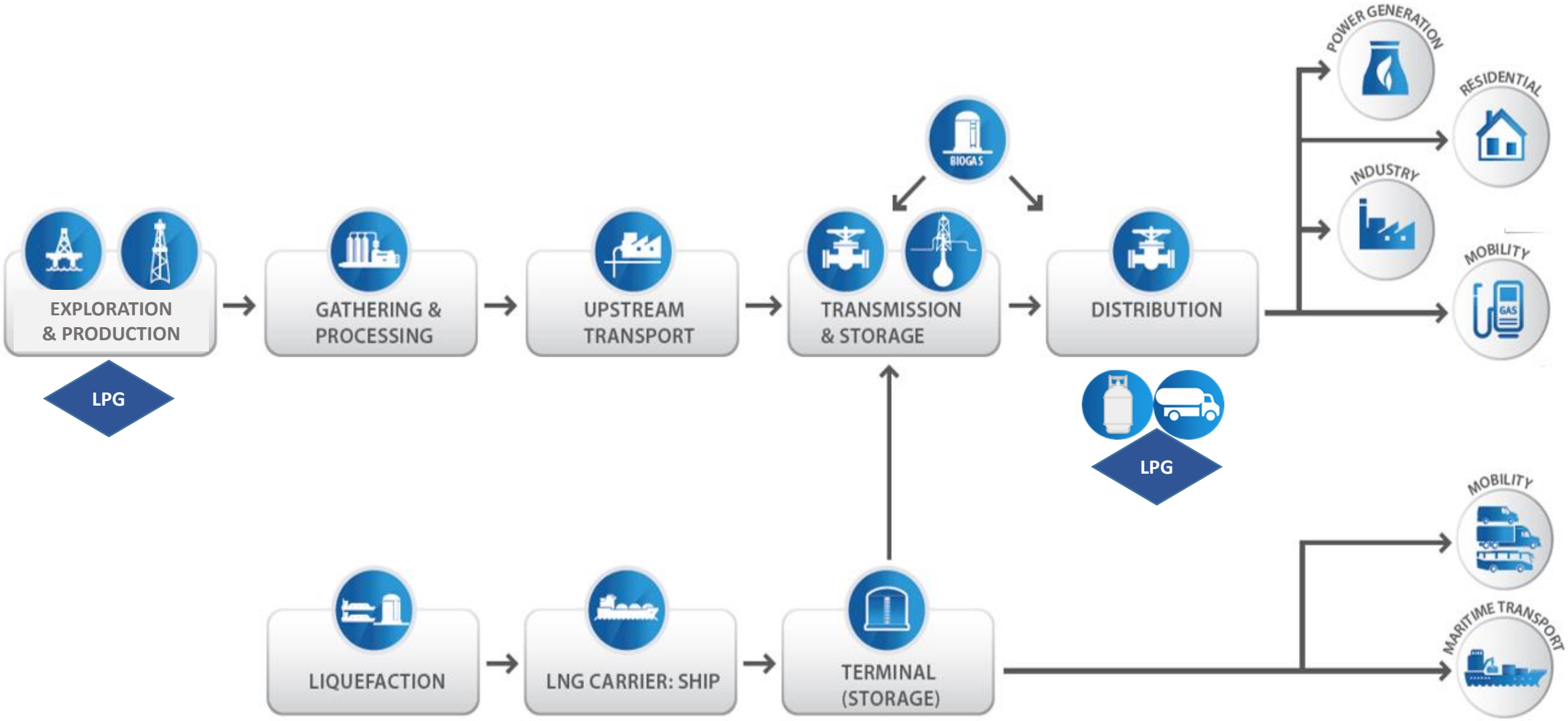
EEF Briefing for MEPs Advisers and Assistants

Thursday, 30 January 2020 – European Parliament, Brussels

Gas Production

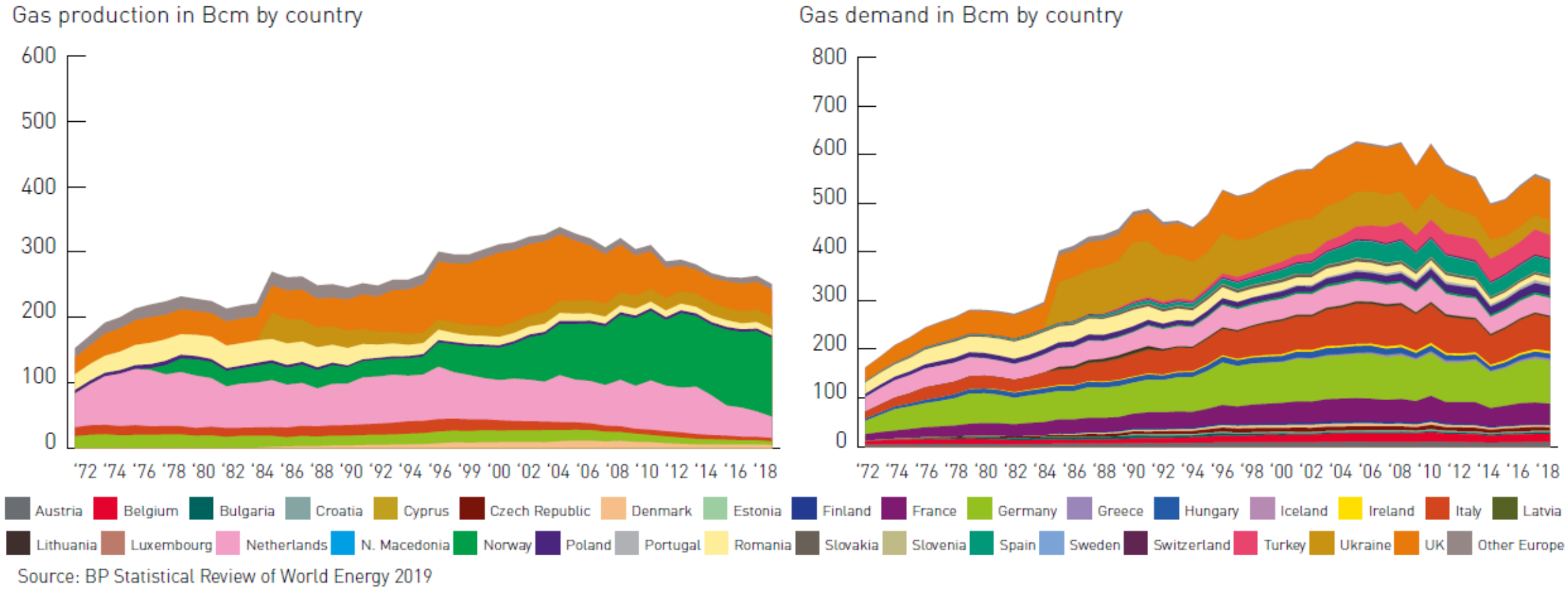
Lucie Boost, Vice-chair of IOGP Energy Markets Sub-committee
Caterina de Matteis, Policy Officer, IOGP

Gas value chain



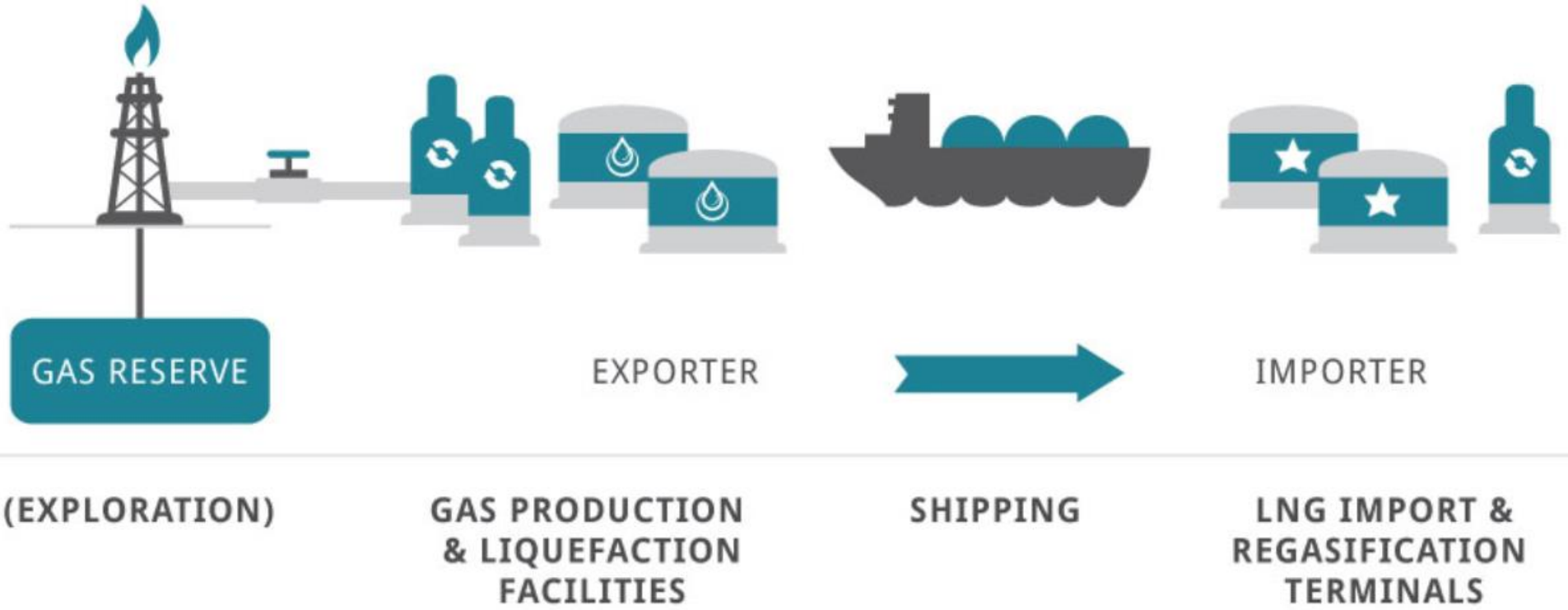
Courtesy of GIE & Marcogaz

Where is natural gas produced in Europe?



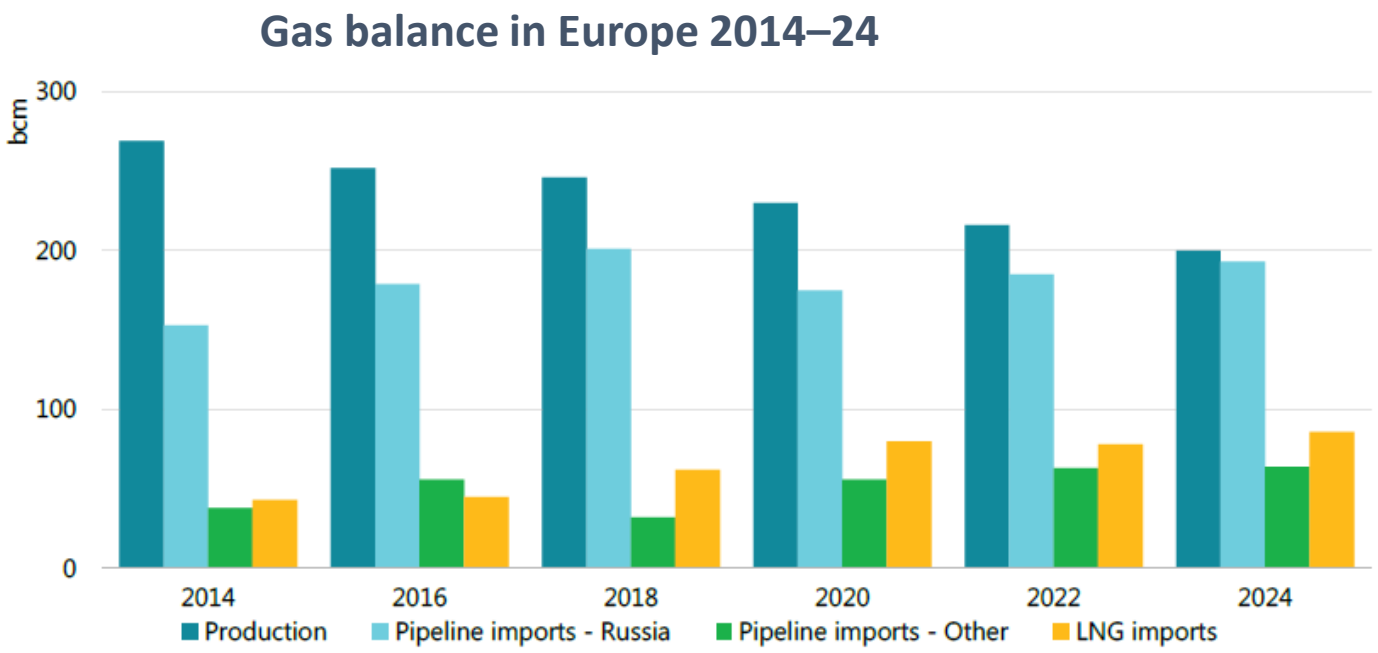
Source: BP Statistical Review of World Energy 2019

What is LNG (Liquefied Natural Gas)?



Liquefied natural gas (LNG) is simply natural gas which has been reduced to a liquid state by cooling it to **minus 162°C**. LNG has a volume about 600 times less than natural gas.

What is the role of LNG in Europe?



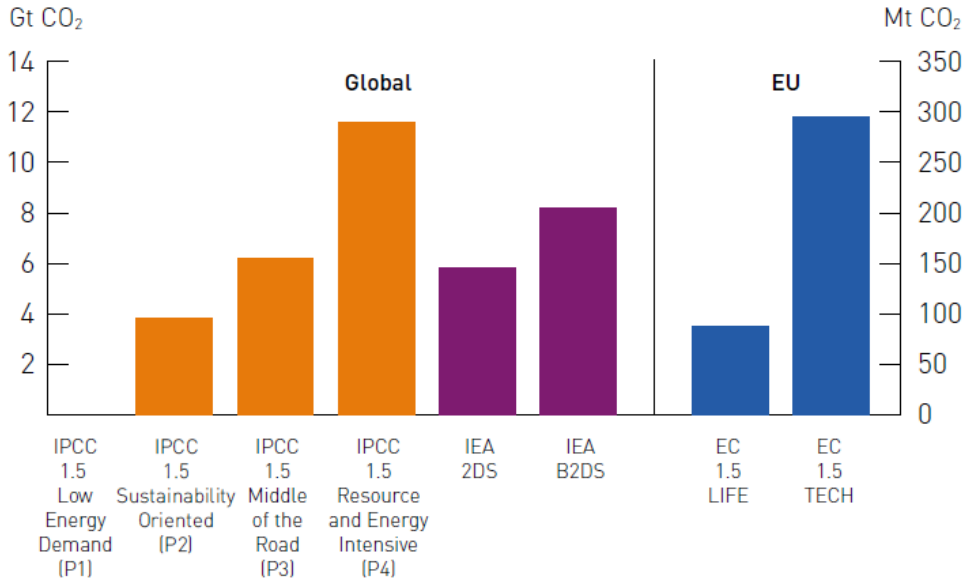
Source: IEA Gas Market 2019

- **European natural gas imports** are expected to increase as indigenous production decreases.
- **Import requirements** will be met by pipeline gas & additional LNG volumes:
  - 6% increase in pipe flows and
  - ~ 50% increase in LNG flows (McKinsey, 2018).
- **Main LNG suppliers to the EU:**
  - Qatar (41%), Nigeria (19%), Algeria (17%)
  - Peru (7%), Norway (7%)
  - US (4%), Trinidad & Tobago (3%)

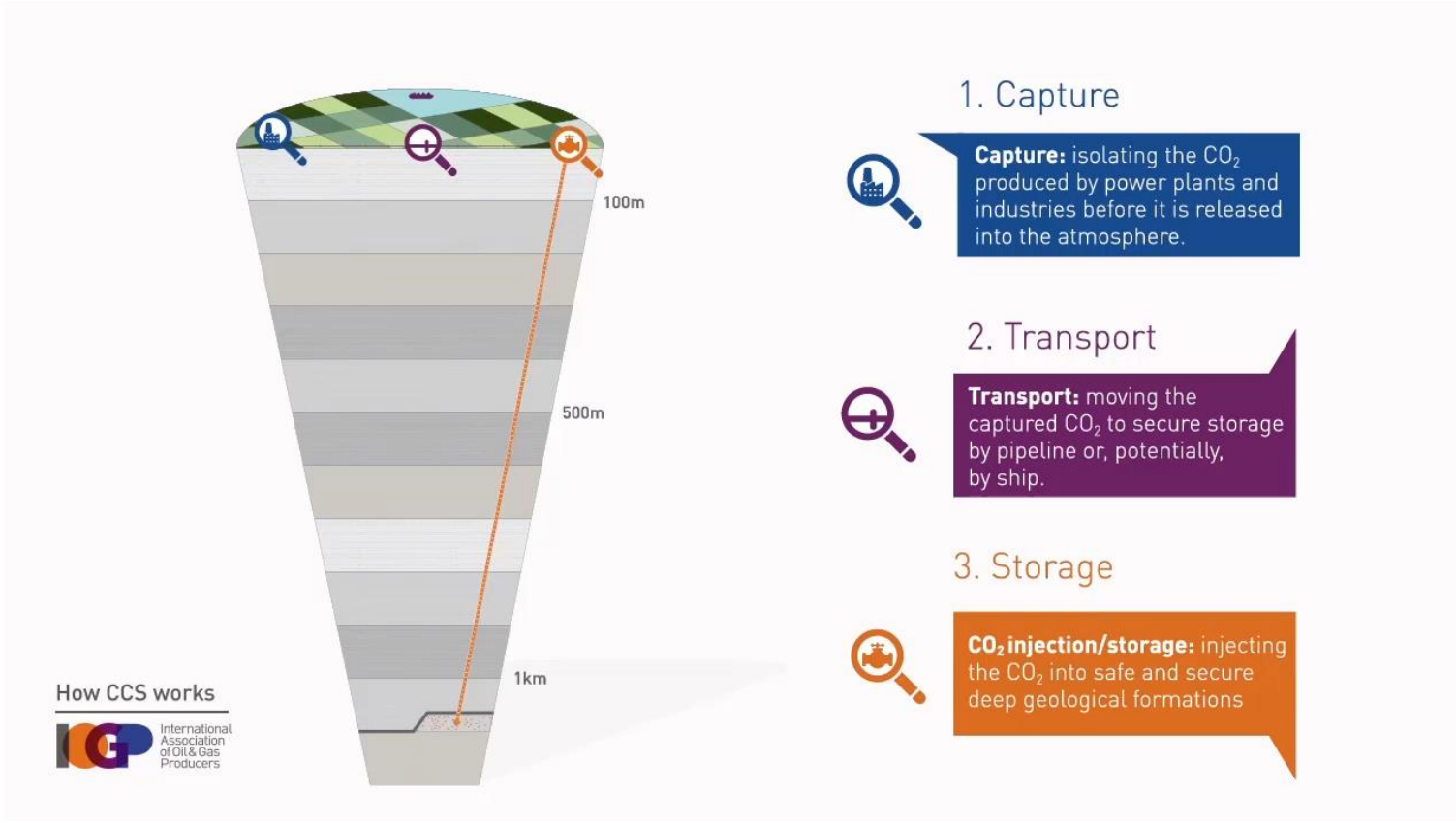
An influx of LNG guarantees market liquidity

How can we decarbonise natural gas? Carbon Capture and Storage

The role of CCS in global and EU 2°C and 1.5°C scenarios CO_2 stored in 2050



Source: data from IPCC (2018), IEA (2017), GCCSI (2018).



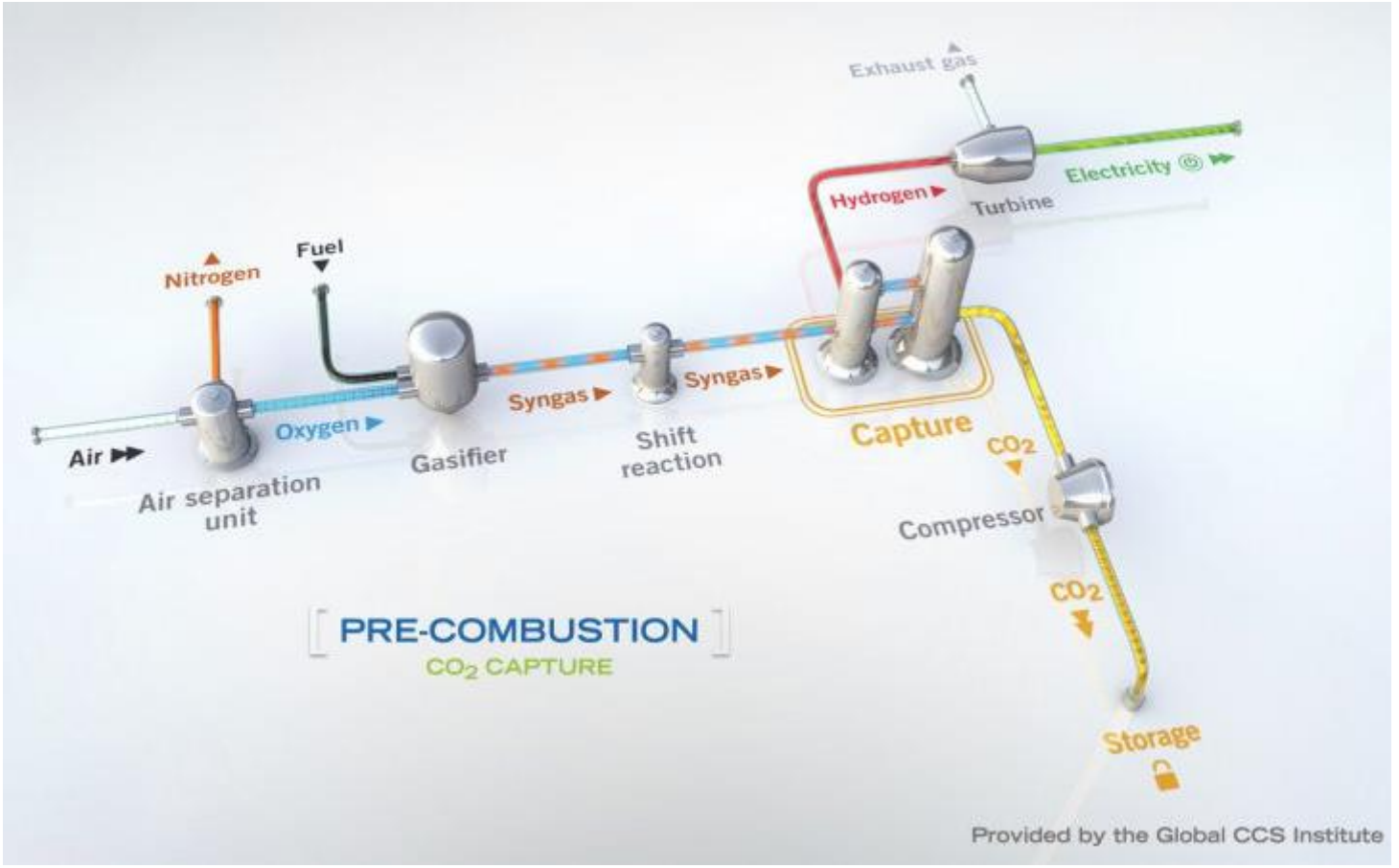
The IPCC, IEA and European Commission foresee a crucial role for CCS in meeting the Paris Agreement temperature targets.

CCUS – capturing technologies

1

Pre-combustion capture:

- Converts fuel into a gaseous mixture of hydrogen and CO_2 using one of a number of processes such as '**gasification**' or '**reforming**'(before fuel is burned).
- Hydrogen is separated, and can be burnt without emissions via **CO_2 capture**.
- **CO_2** can then be compressed for **transport and use or storage**.
- **CO_2** capture and storage is **already used in industrial processes** (such as natural gas processing [1,2]), while its application in power generation will be via new-build projects [3].



[1, 2] See the Sleipner and Snøhvit CCS facilities in Norway

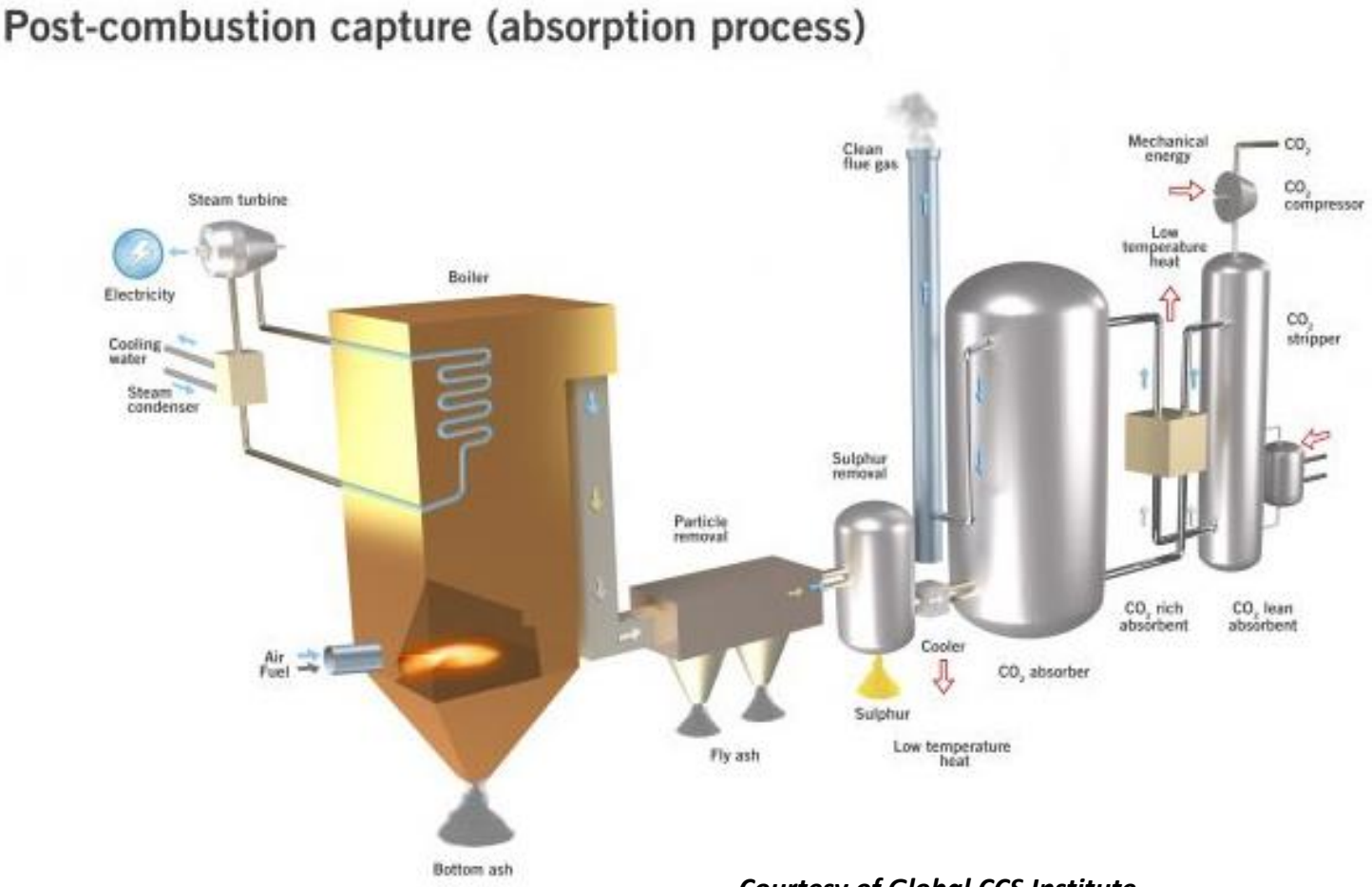
[3] See the Magnum project to convert a gas-fired powerplant to hydrogen with CCS in the Netherlands

CCUS – capturing technologies

2

Post-combustion capture:

- Separates CO_2 from **combustion exhaust gases** (after fuel is burned).
- CO_2 can be captured using a **liquid solvent** or other separation methods.
- In an **absorption-based approach**, once absorbed by the solvent, the CO_2 is released by heating to form a high purity CO_2 stream.
- This technology is **widely used** to capture CO_2 for use in the food and beverage industry.



Courtesy of Global CCS Institute

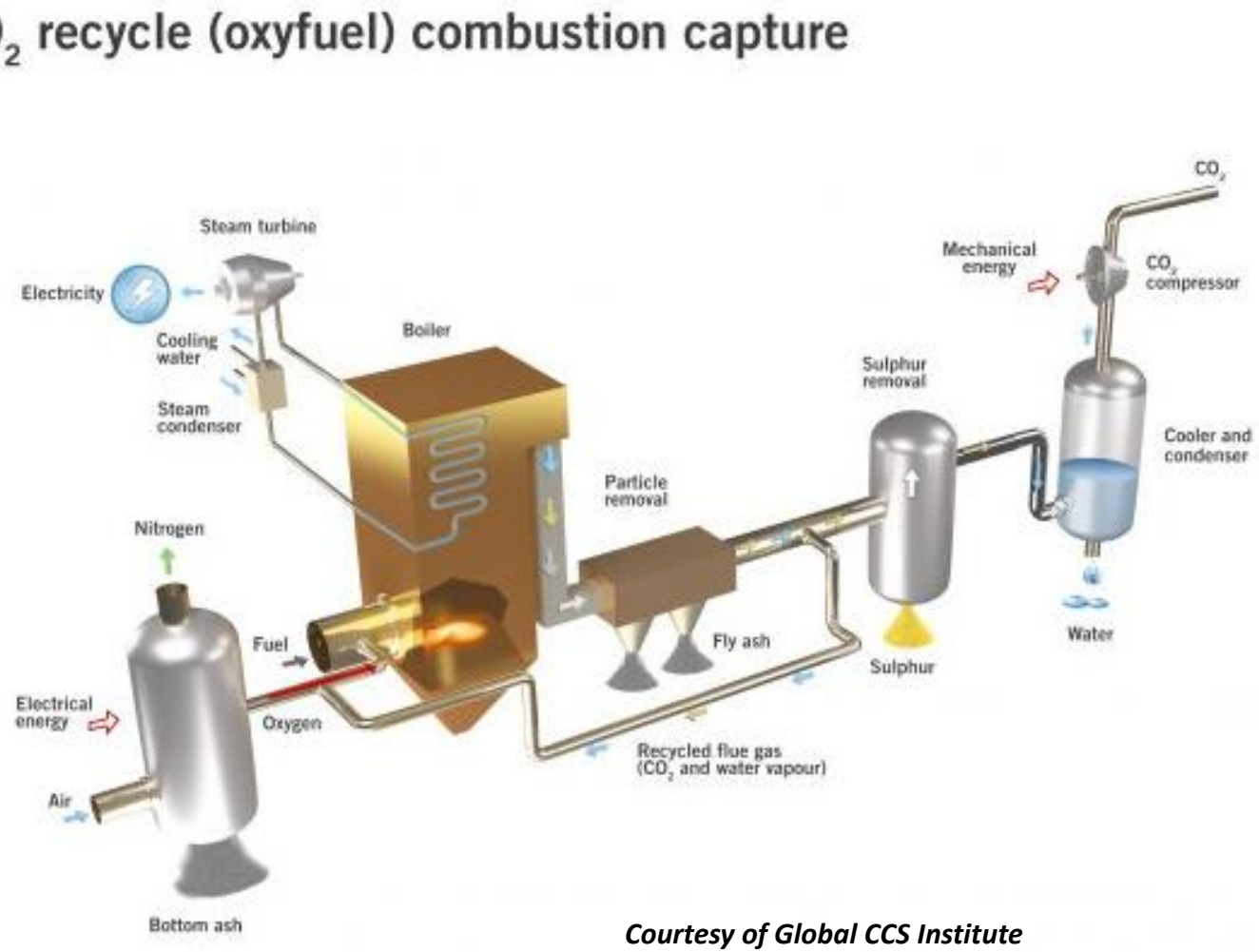
CCUS – capturing technologies

3

Oxyfuel combustion:

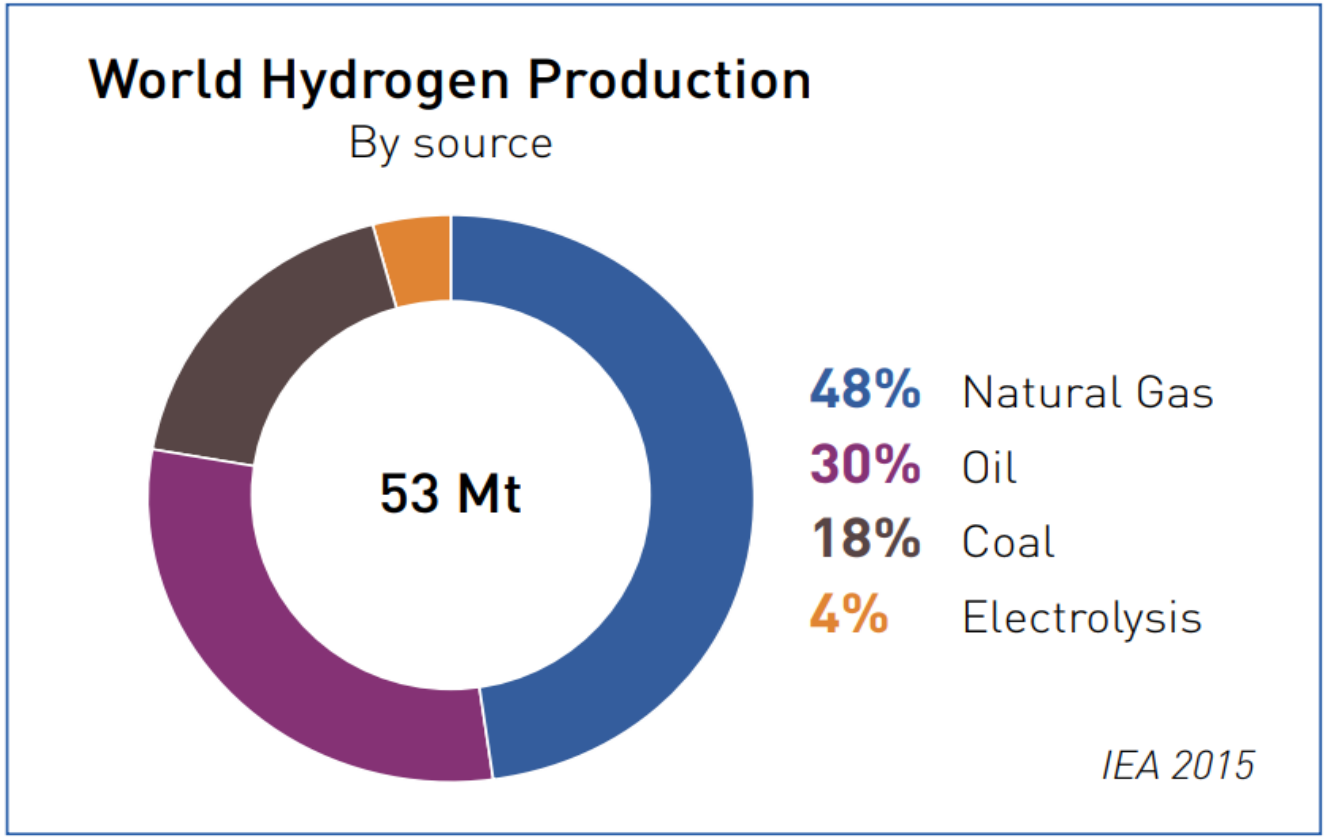
- In this process, **oxygen** is separated from air prior to combustion and the fuel is combusted in oxygen diluted with recycled flue-gas rather than by air.

- This oxygen-rich, nitrogen-free atmosphere results in final flue-gases consisting mainly of CO_2 and H_2O (water), so **producing a more concentrated CO_2 stream** for easier purification.



Courtesy of Global CCS Institute

How can we decarbonise natural gas? Hydrogen H_2



- The main source of hydrogen production today is natural gas reforming: a process which produces hydrogen and CO_2.
- Gas reformers can be fitted with CCS technology to capture and store CO_2 emissions from this process.
- Hydrogen can be produced from natural gas with CCS or from renewable electricity.

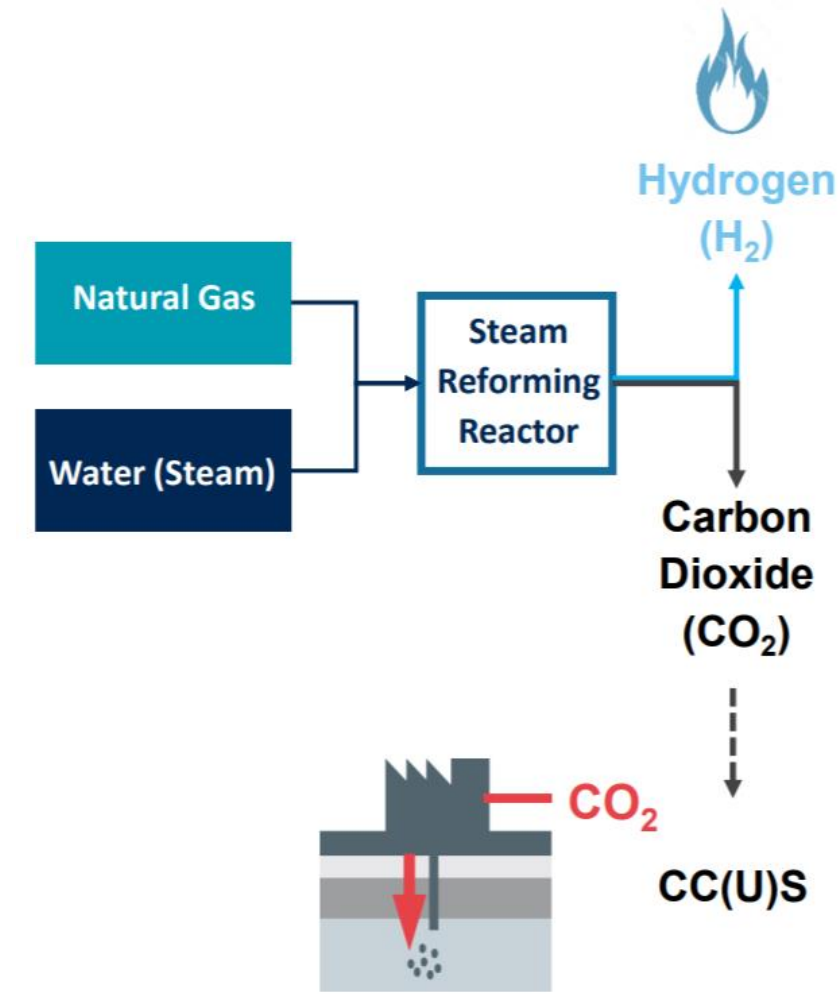
How can we decarbonise natural gas?

1

Steam reforming:

- **DESCRIPTION:** Conversion of natural gas and water into Hydrogen and Carbon Dioxide (CO_2).

- **Characteristics:**
  - Well-known and mature technology
  - Produces large volumes of clean hydrogen
  - Application of Carbon Capture technology in combination with carbon usage and/or storage



Courtesy of Wintershall Dea

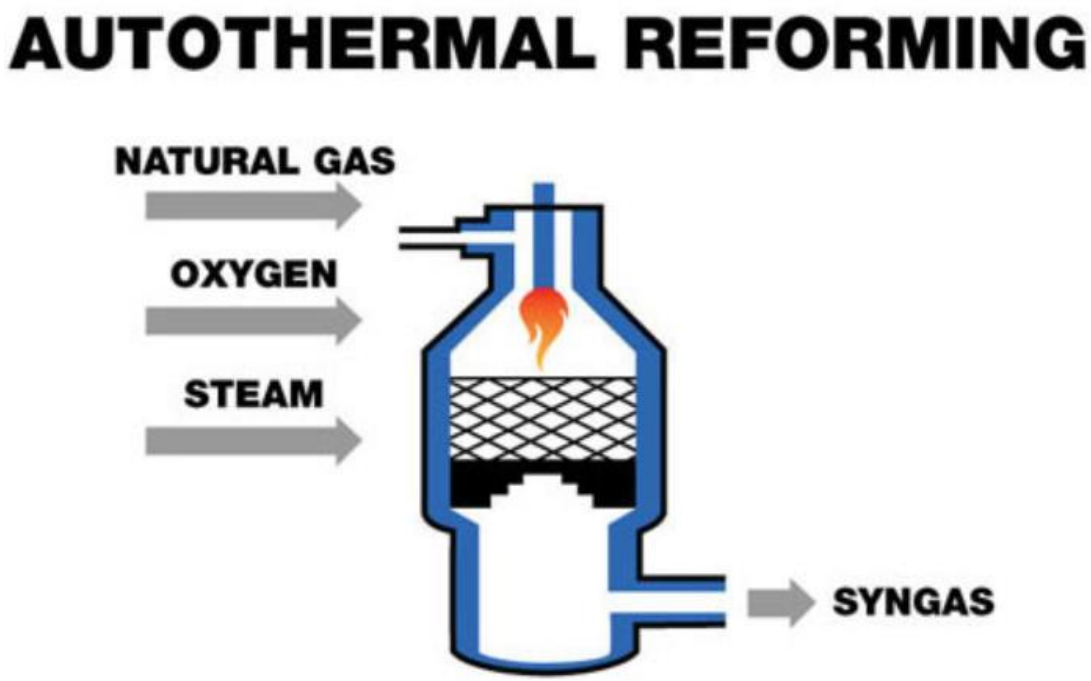
How can we decarbonise natural gas?

2

Authothermal reforming:

- **DESCRIPTION:** uses oxygen or steam in a reaction with methane to form syngas.

- **Characteristics :**
  - Suitable technology for large plants using natural gas
  - Syngas is adjustable to downstream usage, offering a wide field of application
  - Limited commercial experience
  - Requires air or oxygen



Courtesy of Global Syngas Technology Council

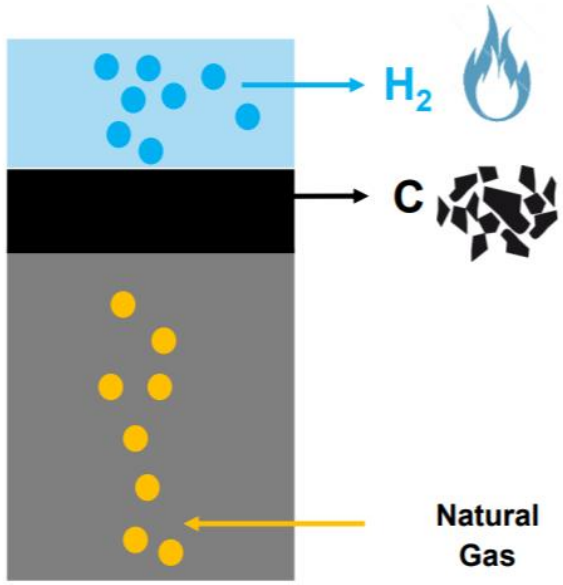
How can we decarbonise natural gas?

3

Methane pyrolysis:

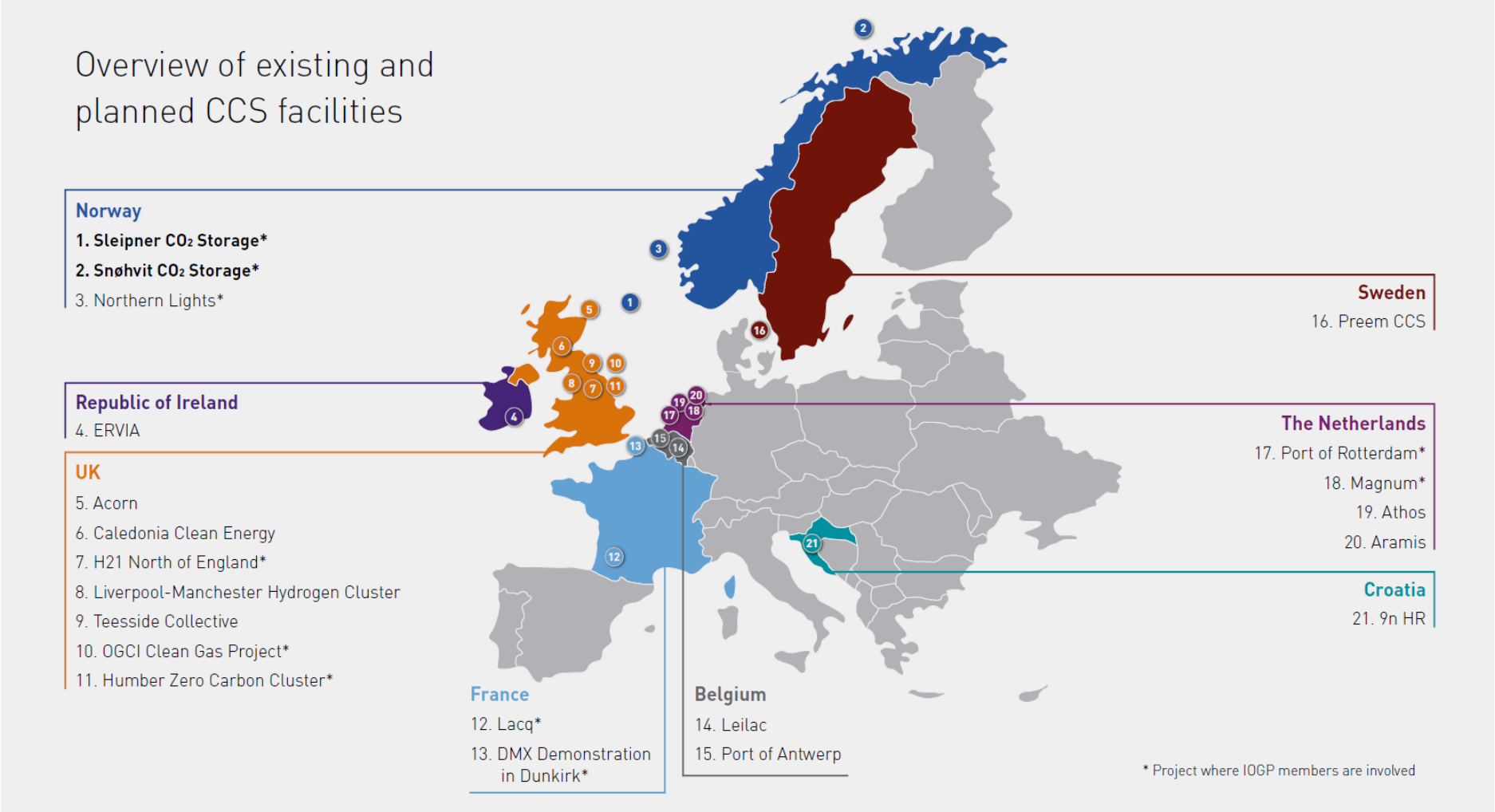
- **DESCRIPTION:** natural gas is split into gaseous hydrogen and fixed carbon. As a pure substance, the carbon can be stored in solid form and used in a multitude of industrial areas.

- **Characteristics:**
  - Carbon is separated in solid state – no need to store CO_2
  - More energy efficient than electrolysis
  - Cost similar to steam methane reforming
  - Need for more basic R&D and new reactor design
  - High-temperature materials required



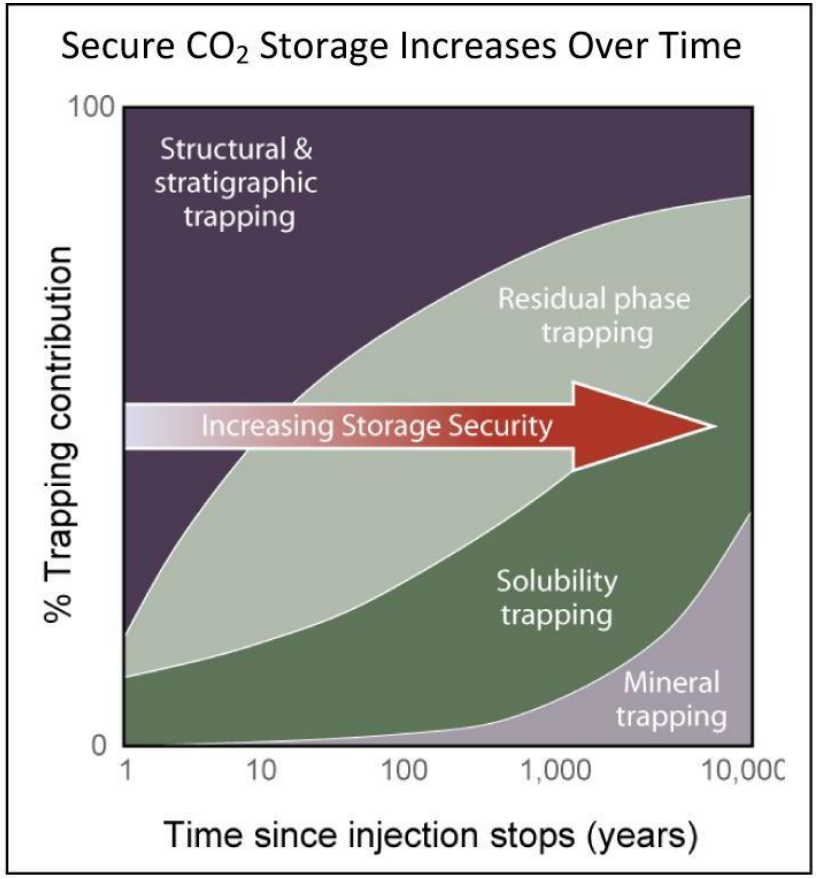
Courtesy of Wintershall Dea

CCS, CCU, H_2 Projects in Europe

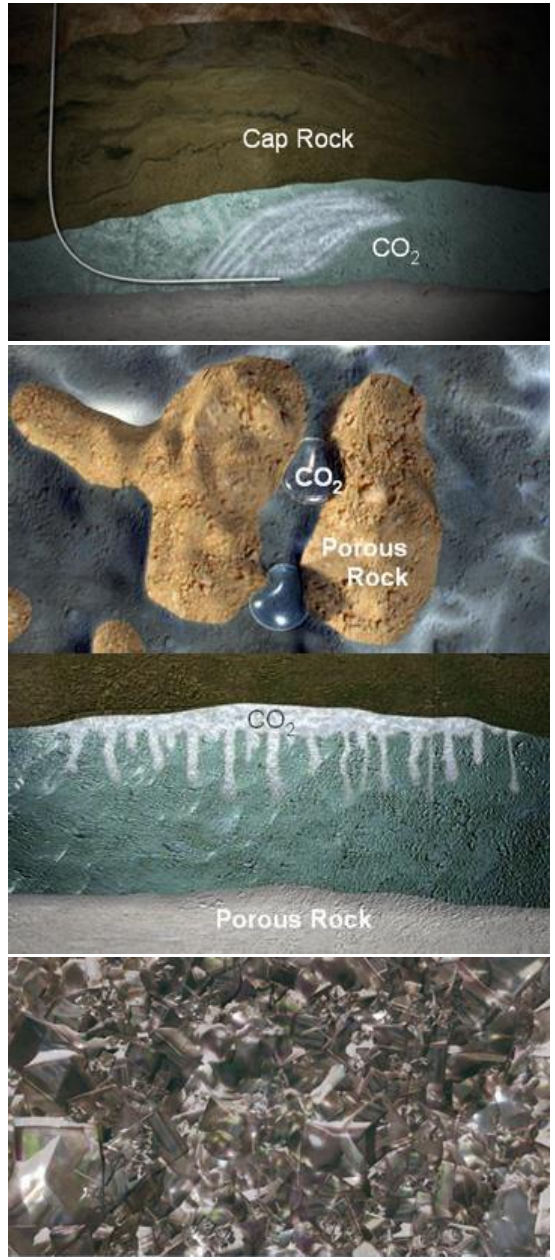


Source: IOGP

Storage mechanisms – increasing safety over time



After IPCC (2005): Carbon Dioxide Capture and Storage



http://www.co2captureproject.org/co2_trapping.html

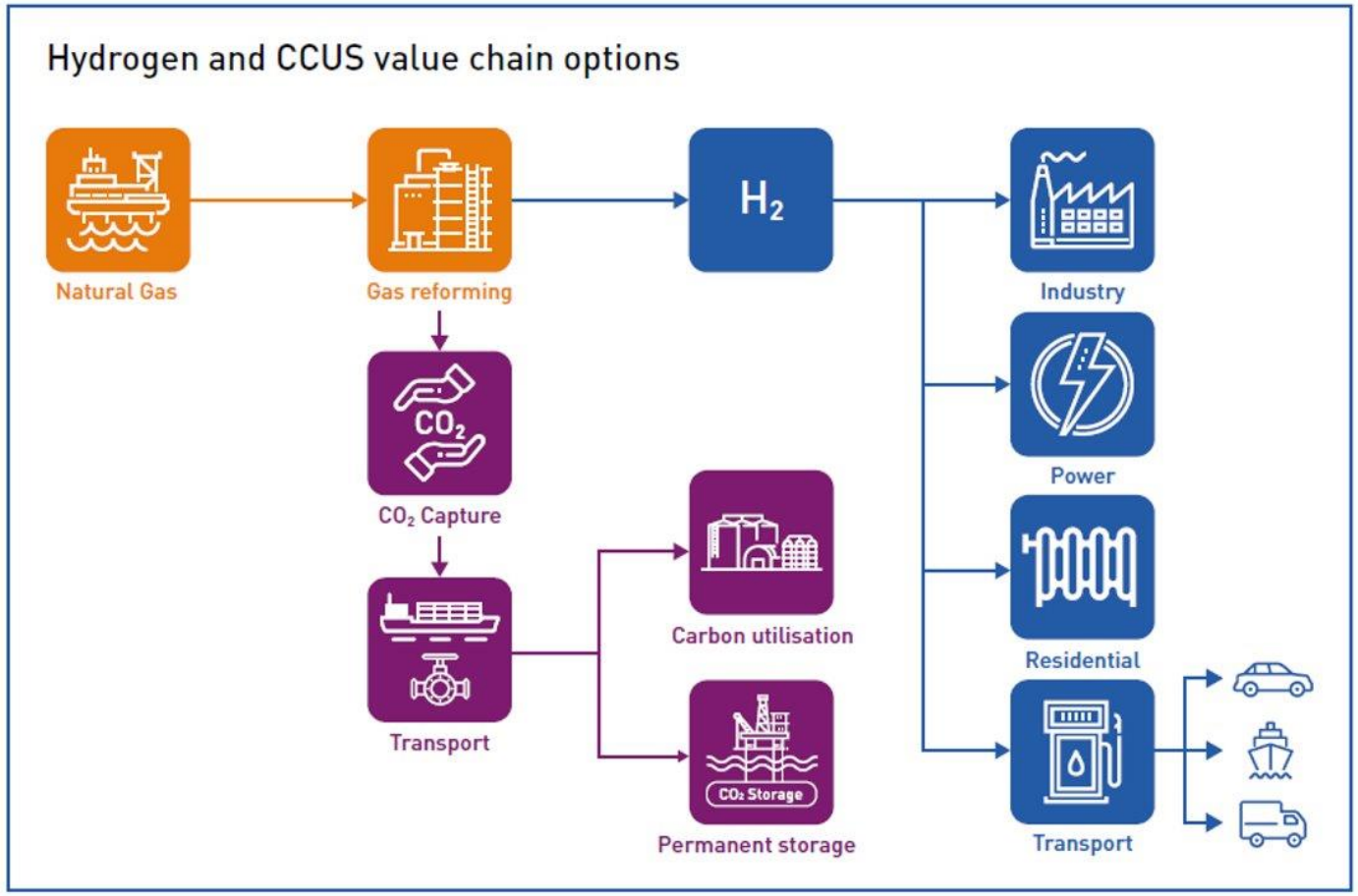
Where can CCUS and hydrogen make a difference?

Emission cuts in **industrial processes** where mitigation potential is high, like steel, cement/lime, chemicals, and refining

Low-carbon, flexible **electricity from gas-fired power plants with CCS** to complement an energy system with a growing share of variable renewables

Large-scale production of **hydrogen from natural gas with CCS**, providing clean energy for industry, power, transport and heating

Removal of CO_2 from the atmosphere by combining **CCS with bioenergy (BECCS)**



Gas transmission

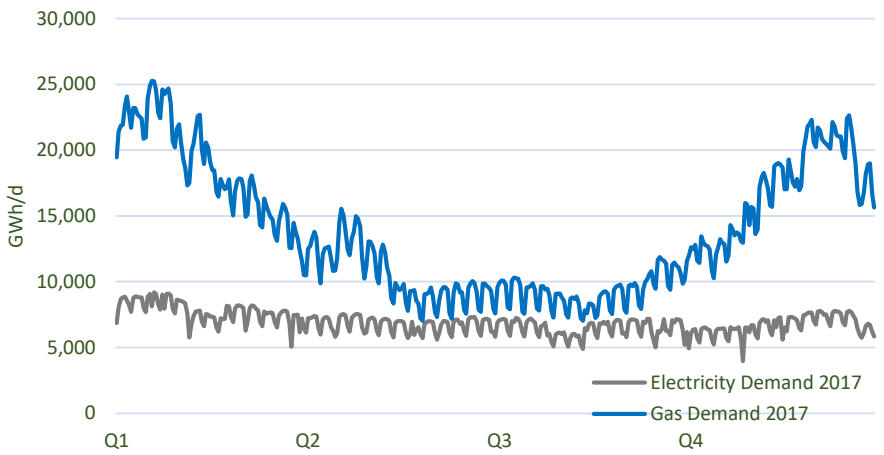
Sara Piskor, Director of Strategy, Policy and Communication of ENTSOG
Louis Watine, Deputy Director of System Development of ENTSOG

Gas Import & Transmission Capacity Map 2018

Gas infrastructure is around **225 000 km transmission** & **2 m km distribution** system

Gas Infrastructure's Role to Consumers

Peak demand for Gas Grids (1)



Always safe

Reliability

- Gas grids can cope with blackouts and excess of electricity and provide gas to over **192 m** EU households (2)
- Gas TSOs provide over **50 000** jobs (3)
- **46%** gas in heating & cooling (4)

Gas share in electricity

- **24%** gas in EU energy mix
- **20%** gas in EU electricity mix (6)

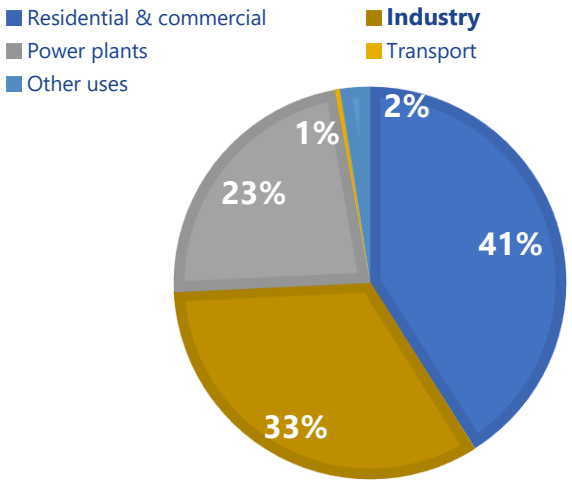
Sustainability

- TSOs aim to transport decarbonised gas: **1710 TWh hydrogen** & **1170 TWh biomethane** in the gas infrastructure (7)
- **Coal to gas switch** in the power sector, can save **150 MtCO2/y** or cut by **30%** CO2 emissions (8)
- **65** TSOs innovative projects promoting sustainable solutions (9)

1 ENTSOG TYNDP 2017
2 AEGPL Europe, "Beyond the Gas Grid" based of data from 2010
3 ENTSOG Activity Report 2015
4 SETIS, Low-carbon heating & cooling
5 ACER 2019 Market Monitoring Report, Gas Wholesale Volume based on NRA input, Eurostat Comext, BAFA, Platts
6 Source: BP Statistical Review, 2018
7 Navigant Study "Gas for Climate" 2019
8 Joint TYNDP 2020 Scenarios; 8 IEA, The Role of Gas in Today's Energy Transitions
9 ENTSOG, Innovative Projects Platform

Gas Infrastructure's Role to Industry

GAS USE BY SECTOR (1)



Competitiveness

Cost-effectiveness

- Flexible generation with natural gas makes the energy transition more affordable
- Evidence of cost-efficiency with gas infrastructure: **€138B/y** estimate of savings with an EU hybrid energy system (2)

Resilience

- Gas has a higher energy density and can transport energy cheaper than electricity (factor **>6**) (3)
- **90%** of the gas used in Europe has physically crossed at least one border (4)
- Gas storage provides high flexibility - **1130 TWh** (5)

Sustainability

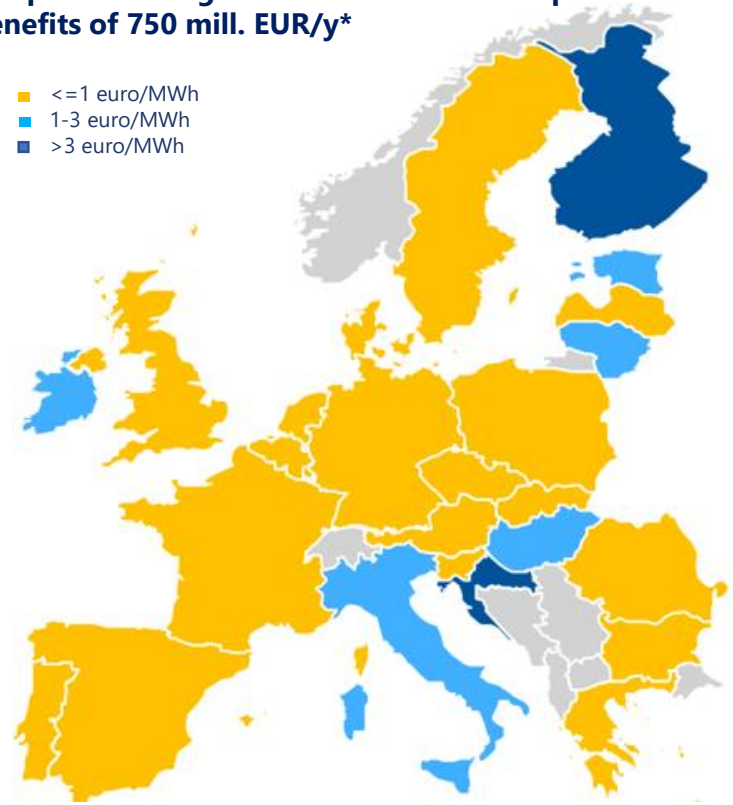
- **Coal to gas switch** could **replace up to half of the EU's coal-fired power** saving around **220 Mt CO2** (6)
- Replacing an old coal-fired power plant with a CCGT plant can reduce CO2 emissions by up to **70%** (7)
- **16 CCUS** projects in Europe that are built or planned

1 Eurogas statistical report, 2015
2 Ecofys, "Gas for Climate", 2018
3 EWI, "The underrated long-term relevance of gas in the decarbonizing German energy space", October 2018
4 ENTSOG Annual Report, 2015
5 TYNDP, 2018
6 IEA Study "The Role of Gas in Today's Energy Transitions" 2019
7 ENTSOG Annual Report 2015

From ENTSOG's Objectives to its Achievements

Internal Energy Market

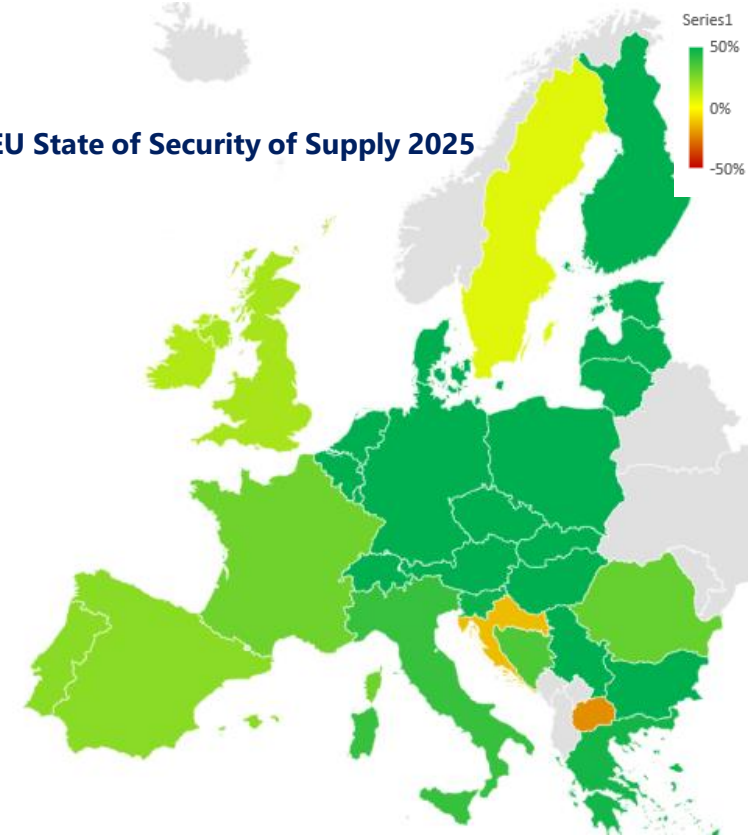
Gas price convergence from 2014 to 2018 provided benefits of 750 mill. EUR/y*



Wholesale gas; prices of Title Transfer Facility.
Source: ACER 2019 Market Monitoring Report, Gas Wholesale Volume based on NRA input, Eurostat Comext, BAFA, Platts

Security of Supply

EU State of Security of Supply 2025

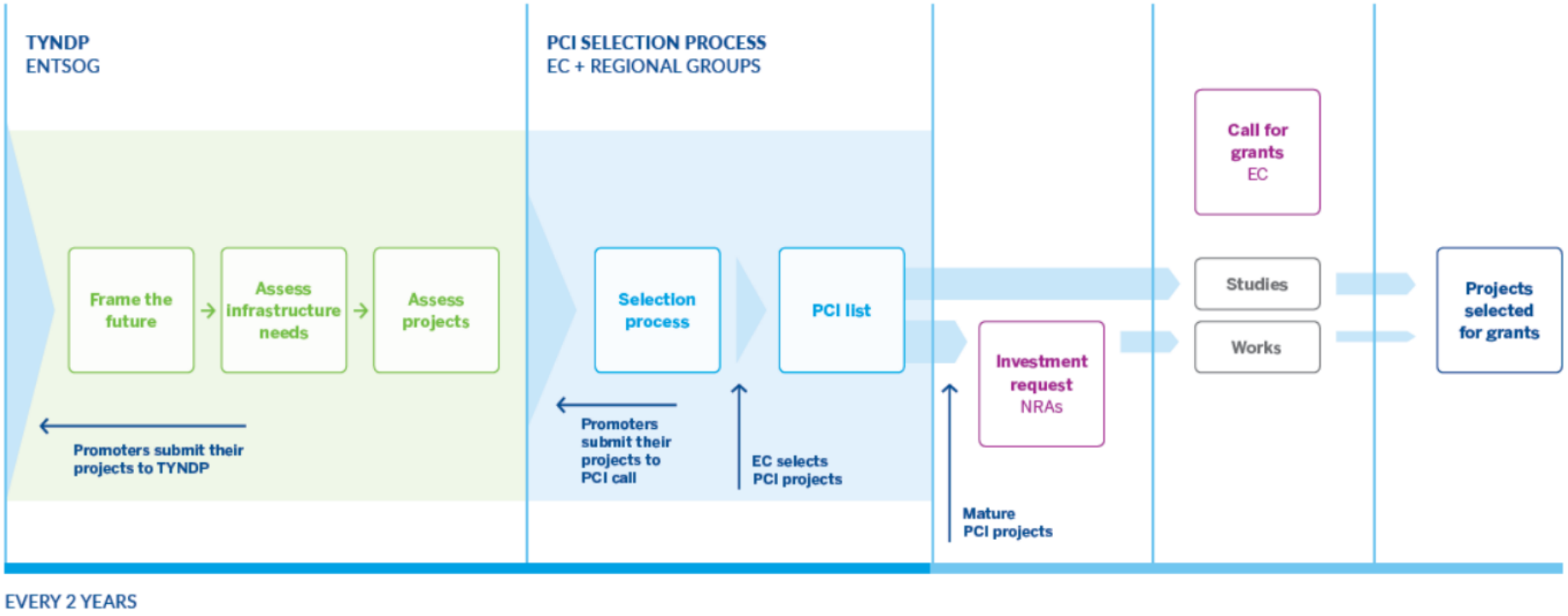


Source: ENTSOG 2018

Sustainability

Gas TSOs have contributed to the integration of **Internal Energy Market**, improved **SoS** and now support the uptake of **sustainable gas-related infrastructure projects** in TYNDP 2020 and onwards

Ten-Year Network Development Plan (TYNDP)



- TYNDP provides an overview of the gas infrastructure and its future developments, mapping the integrated gas network according to scenarios
- TYNDP to include the assessment of **renewable & decarbonisation** projects (methane, H2, CCUS)
- TYNDP scenarios comprise the **NECPs** and 2 additional scenarios

ENTSOG Roadmap 2050
Co-existing Pathways for Decarbonisation of Gas Grids

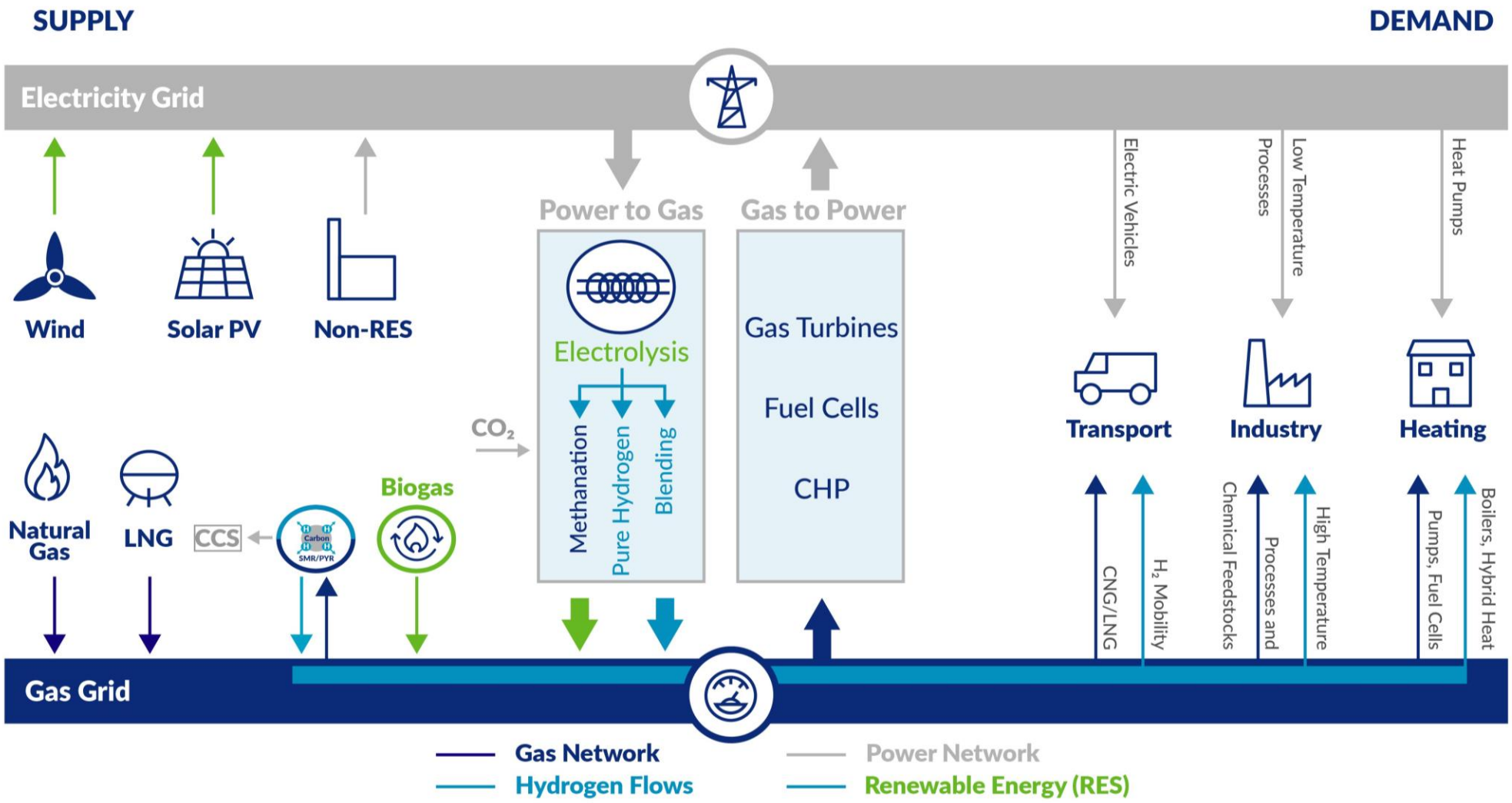
Methane – increasingly renewable, decarbonised & Low-carbon gases		**Blending Methane and Hydrogen**		**Hydrogen**
Biogas	**Synthetic methane**	**Hydrogen - SMR and Pyrolysis**	**Power to Gas**	**Hydrogen**
Biogas produced via anaerobic digestion	Biomass converted to H2 & methanation applied	• Steam Methane Reforming (SMR) converts methane to H2 & CO_2 is stored • Pyrolysis converts methane to H2 & solid carbon	Power to Gas converts electricity to H2	H2 (RES or natural gas) transported via adapted gas grids or dedicated systems

The aim of the Roadmap is to provide ENTSOG's Recommendations & Actions, as well as a Stakeholder Process, contributing to the upcoming discussions on the European Green Deal

Common Enablers:

R&D + scalability, CCUS, Gas Quality Handling Services and combining different solutions between the MS.

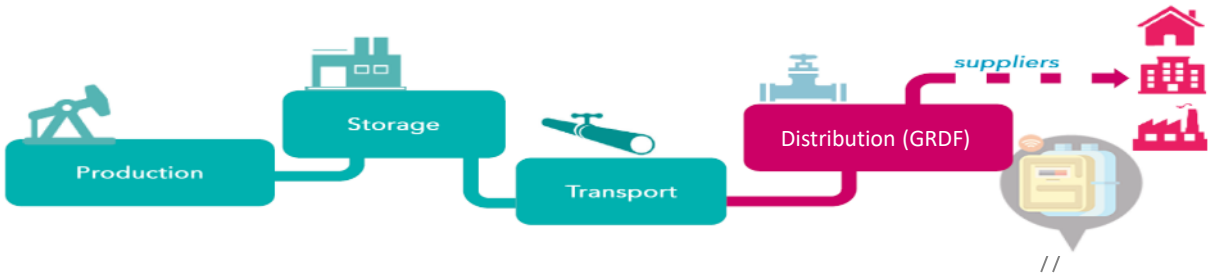
Hybrid Energy System



Gas distribution

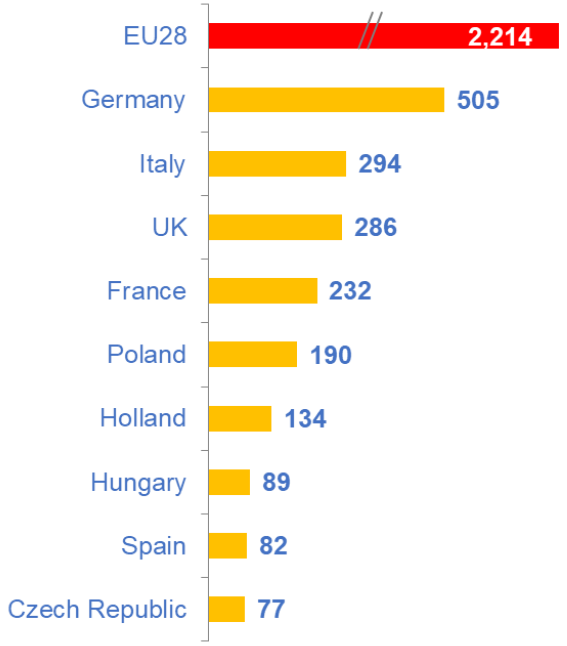
Jean-Marie Gauthey, Head of European Affairs of GRDF

Gas distribution in Europe



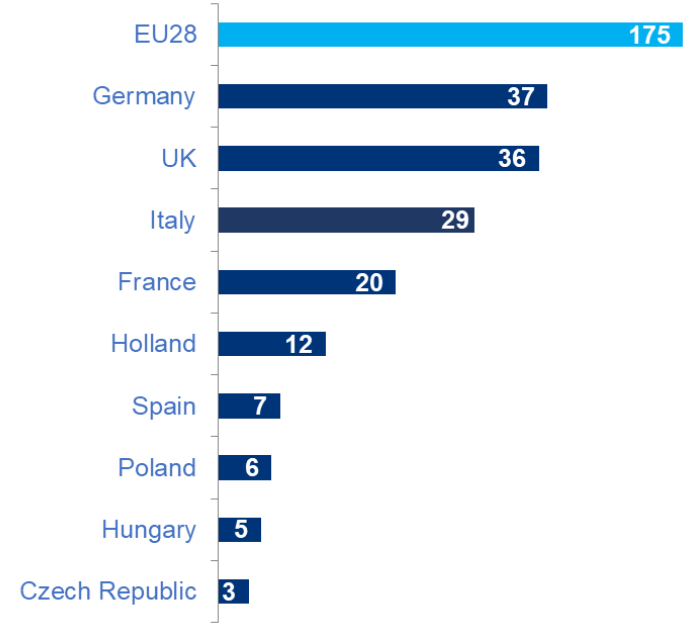
KM DISTRIBUTION NETWORK

(Thousands[2])



VOLUMES OF DISTRIBUTED GAS TO RES&COM

(Billions mc per year[3])



From one EU Member State to the other, the landscape of DSOs can be very different

- **1,293 DSOs**
- **90 unbundled DSOs**

- **27 DSOs**
- **3 unbundled DSOs**
- **GRDF with 95% of the market**

- **222 DSOs (30 with more than 100,000 RDP)**
- **Top 5 count for 2/3 of the market**
- **Italgas with 34% of the market**

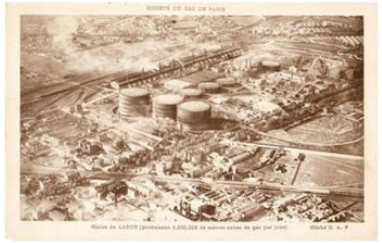
- **724 DSOs**
- **26 unbundled DSOs**
- **Often not delivering only gas**

Note: (1) for comparison only volumes distrubuted to the segment RES&COM (residential and commercial) are shown. Data relating to small enterprise segment connected to the distribution network are not included
Source: Eurostat. (2) data 2014. (3) data 2015

The on-going renewable gas revolution

Manufactured gas
Local production and distribution

Lighting .... Cooking

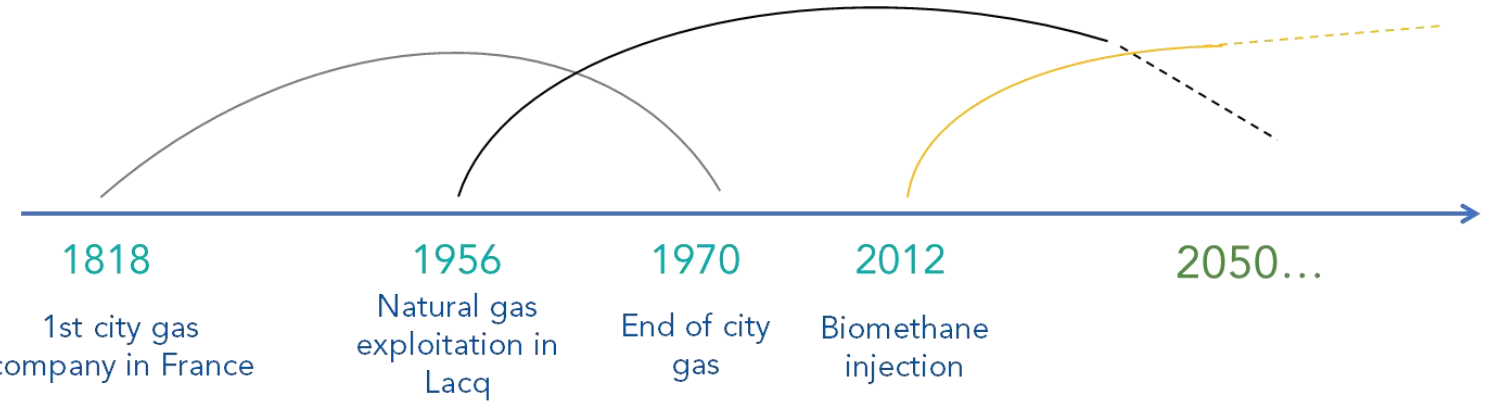


Natural gas
Centralised infrastructures

... Heating, Hot water...

Renewable gas
Decentralised and interconnected infrastructures

... Mobility, Power to gas, Fuel Cells...



Source: GRDF

How to produce renewable gas?

3 technologies are currently used to produce renewable (biomethane and synthetic methane) gas with different stages of maturity

Anaerobic digestion:

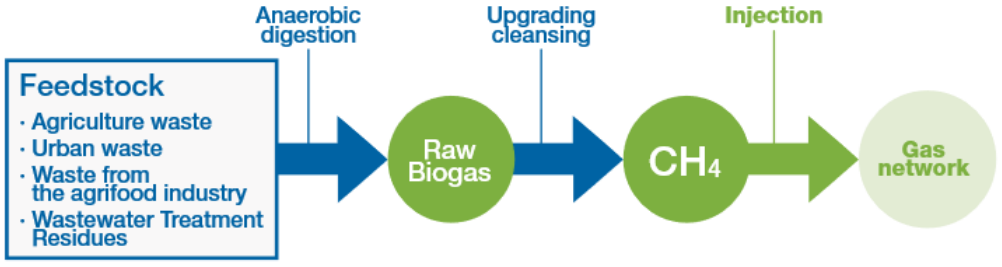
- fermentation of organic material
- a natural process (bacteria)
- mature and deployed technology
- cost reduction trend
- biomethane, CO_2 and digestate as co-products

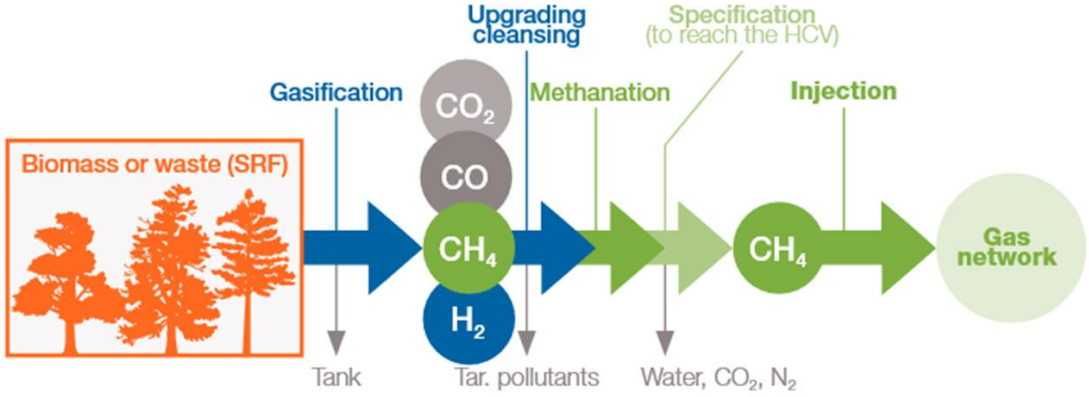
Gasification of biomass:

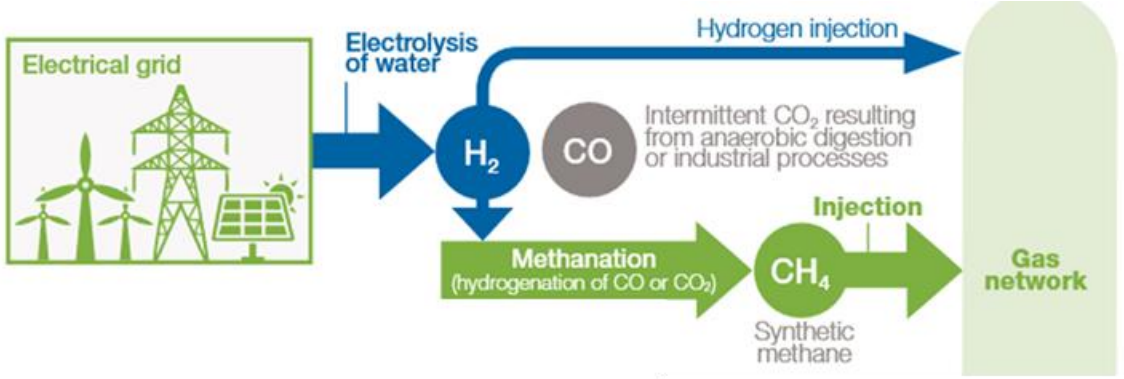
-combustion of organic material
- a different feedstock than A.D.
- demonstrators

Power to gas:

- hydrogen production from water and electricity (renewable)
- direct injection to the grid or combination with CO_2 to produce methane (synthetic methane) through methanation





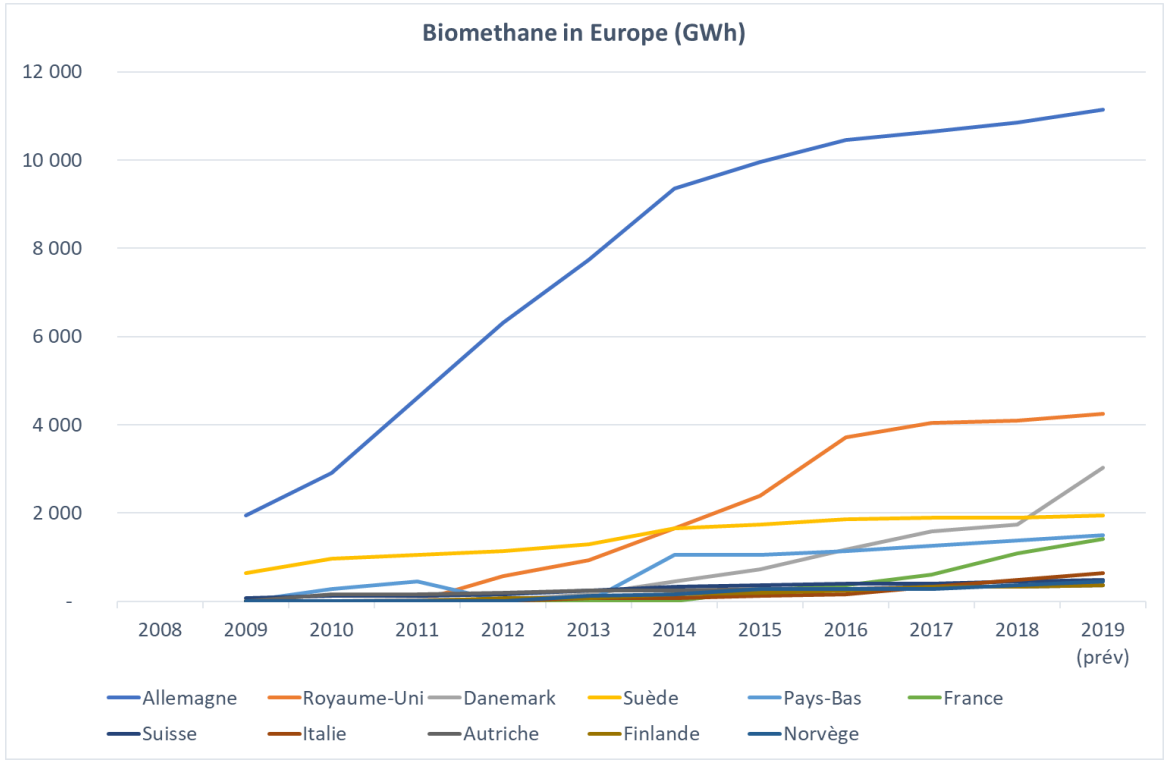


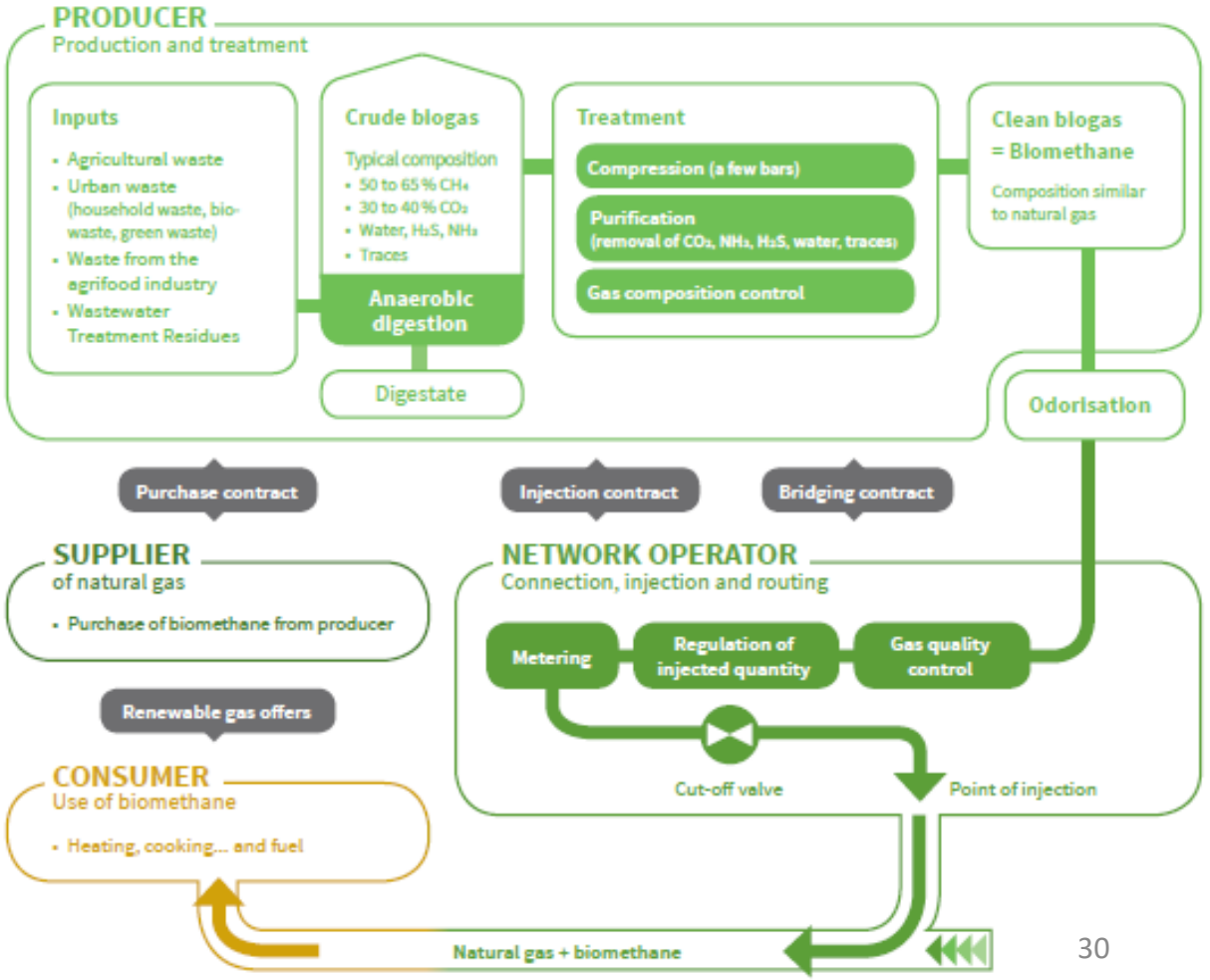
Biomethane and synthetic methane can substitute natural gas: using existing infrastructure and appliances

Hydrogen is limited to max. 20% blending

Source: GD4S

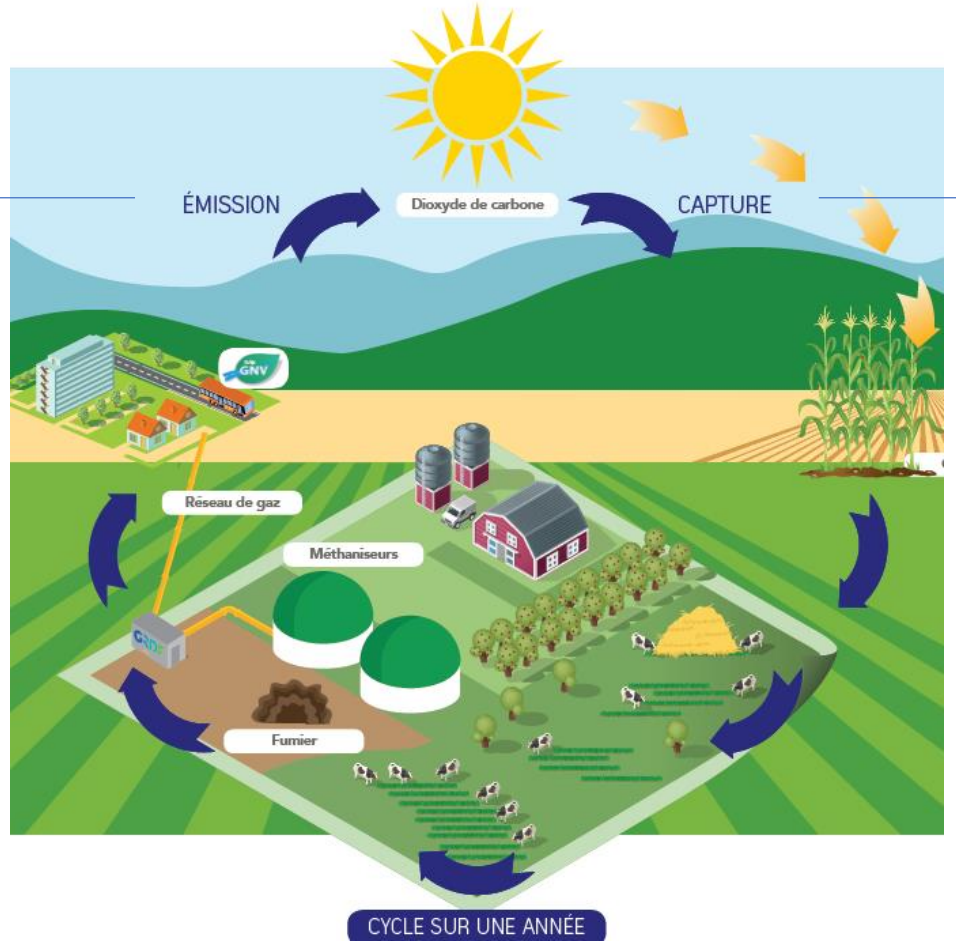
Biomethane production from anaerobic digestion:





Biomethane is sustainable

Combustion of biomethane in boiler or vehicle produces « biogenic » CO_2 meaning coming from renewable organic material, not fossil



Organic material used for biomethane production has captured an equivalent amount of CO_2 to grow

This balance between emissions and capture is considered as Climate Neutral by the IPCC and ADEME

Source Base Carbone ®
http://www.bilans-ges.ademe.fr/documentation/UPLOAD_DOC_FR/index.htm?co2_biogenique.htm

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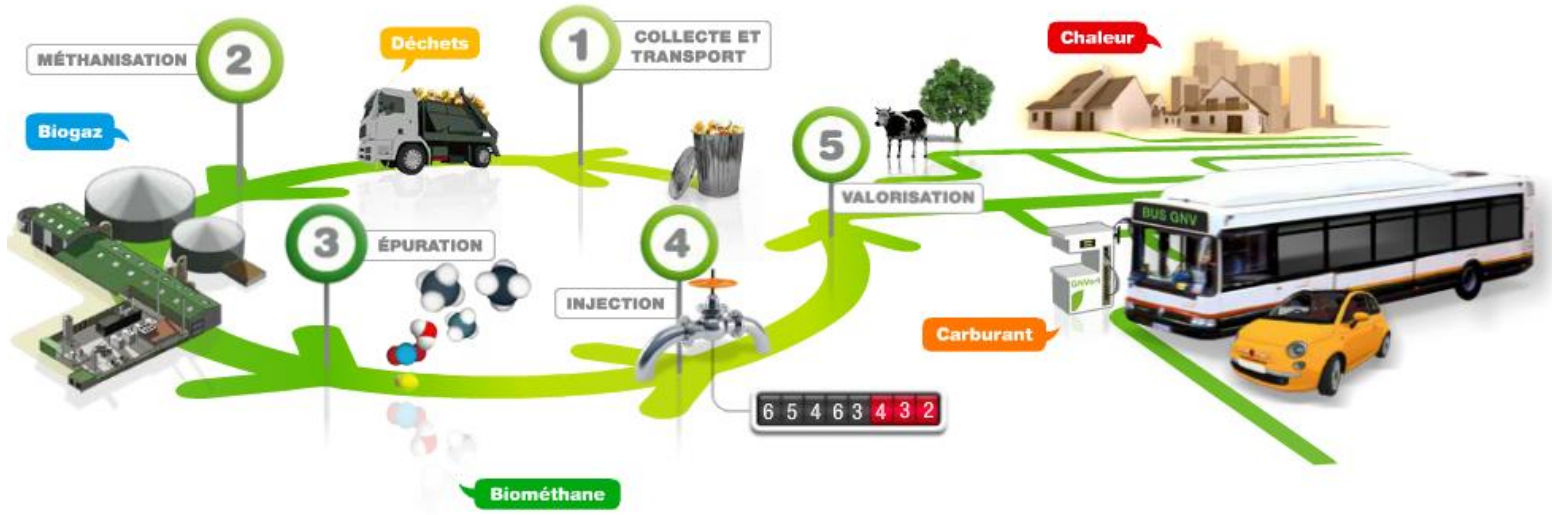
Advantages of renewable gas

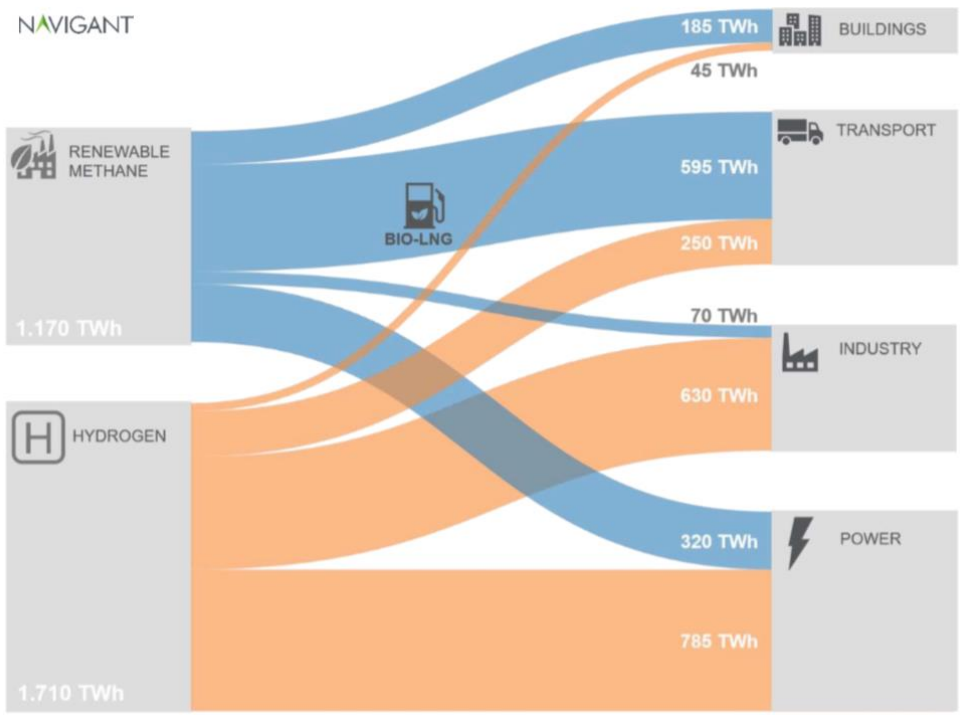
- Renewable gas participate to:
  - ✓ A **circular economy** with waste treatment and valorisation of co-products as energy, fuel and organic fertiliser (digestate)
  - ✓ A **local activity** with short loop of distribution for a local production (reduction of imports) and creating jobs
  - ✓ **Synergies with the agriculture**: carbon footprint reduction, diversified income for farmers
  - ✓ **Clean mobility** Natural Gas Vehicle (NGV) can be fueled with biomethane (bioNGV) ; BioNGV could present lower carbon emissions than EV in full Life Cycle Analysis (LCA)



How much renewable gas?

Estimation at **EU level** from several studies:

Navigant's 2019 Gas for Climate study



Renewable and low-carbon gas supply demand in the « optimised gas » scenario

EU 2050 LT Strategy EC (2018)
Biomethane 1,000 TWh/year
Renewable hydrogen 300 TWh/year
Syngas 1,200 TWh/year

International Council for Clean Transportation (ICCT)
Biomethane 635 TWh/year

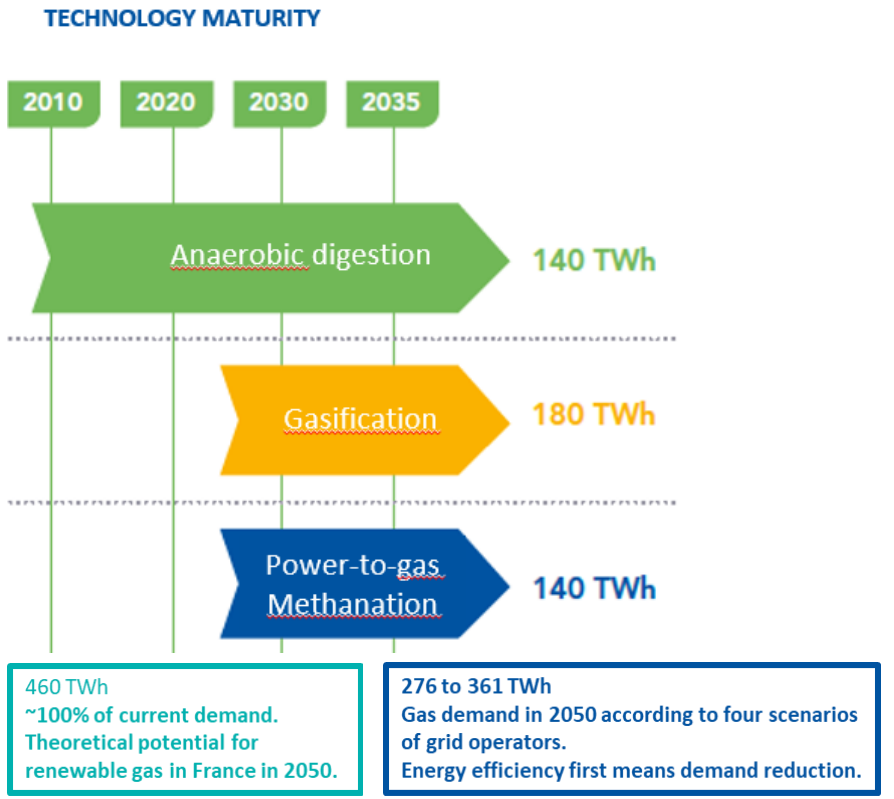
ENTSOs (TYNDP)
Biomethane 950 TWh/year
Renewable hydrogen 500 TWh/year
Syngas 500 TWh/year

Center for Regulation in Europe
(CERRE 2019)
Biomethane 1,211 TWh/year
Renewable hydrogen 200 TWh/year (only RES surplus)

Trinomics for the EC (2019)
Biomethane 1,422 TWh/year
Renewable hydrogen 495 TWh/year
Syngas 1,443 TWh/year

Assessment of potential of production for **France**

French Environment & Energy Management Agency (ADEME)



Study « Un mix de gaz 100% renouvelable en 2050 ? », ADEME, 2018

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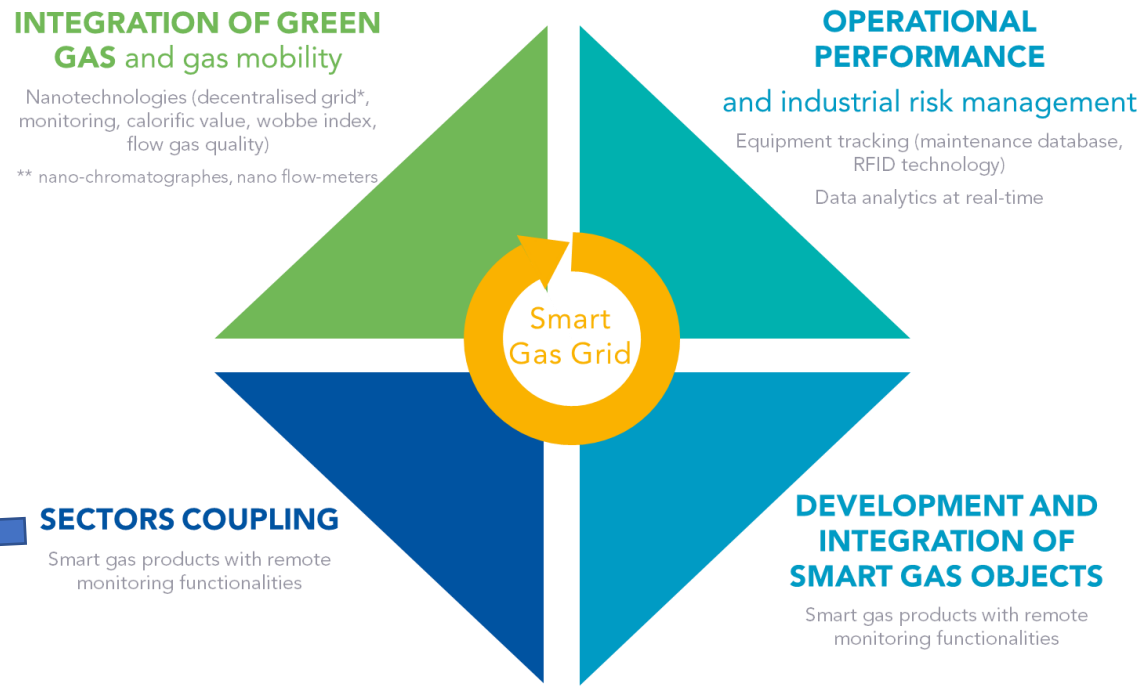
Evolution - adaptation

- The distribution grid has not been built for decentralised production and therefore needs to adapt to receive always more renewable gas until 100% and to gain in efficiency
- **Smart Gas Grid** is an answer to increasing complexity of grid management with higher penetration of renewable.
- **Gas Smart-meters - a requirement for Smart Gas Grid:** The roll-out of communicating meters in France is the biggest gas smart meter project globally



A **joint approach of renewable gases and electricity** will optimise the delivery of energy to consumers and increase the capacity to use renewable energy efficiently and effectively.

Grid digitalization: why?

Safety
Less Leaks
Early Detection
Emergencies
Containment

Efficiency
Focused Maintenance
Less False Alarms

Sustainability
Less Emissions
Energetic Efficiency

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Closer to the consumer: gas off the grid

Samuel Maubanc, General Manager of Liquid Gas Europe

Rural decarbonisation challenge

114 million EU citizens live in rural areas

40.7 million European households
located in rural areas are not connected to the gas grid

45% of rural heat comes from heating oil and coal in off the gas grid areas

How is gas distributed?

Gas is widely available, as it can be provided to end customers even beyond the coverage of the existing (pipeline) infrastructure

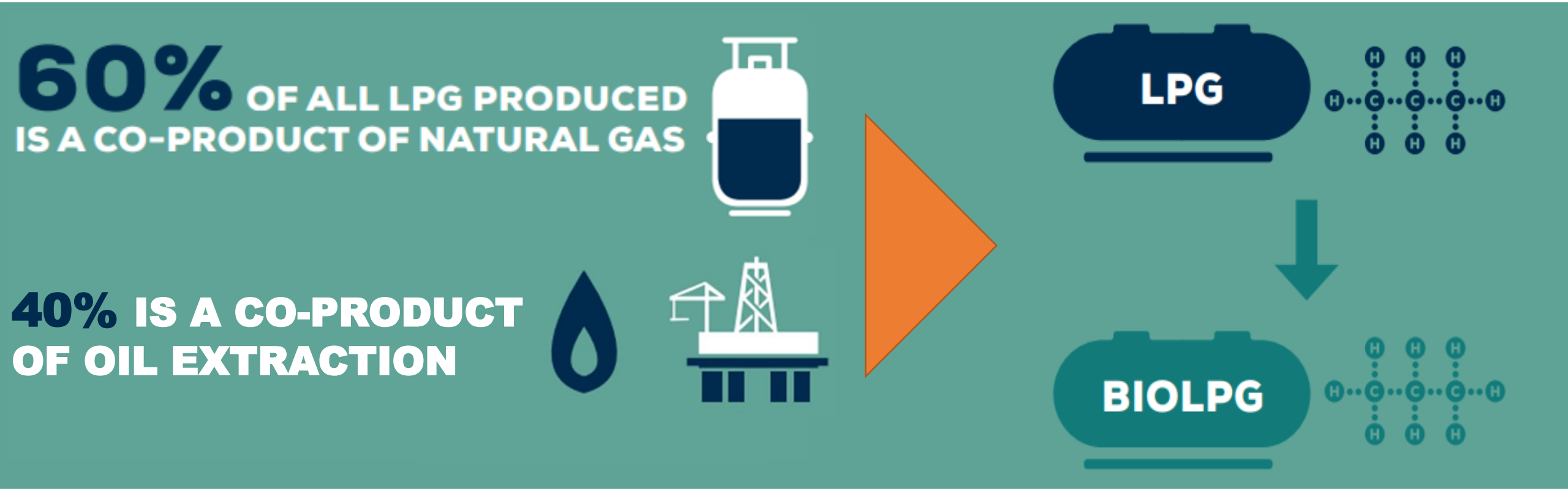
Gas infrastructure (pipelines)

Natural gas

Off the gas grid:

LPG (butane and propane)

What is LPG (Liquified Petroleum Gas)?



LPG: molecules of **propane and/or butane** liquified under pressure

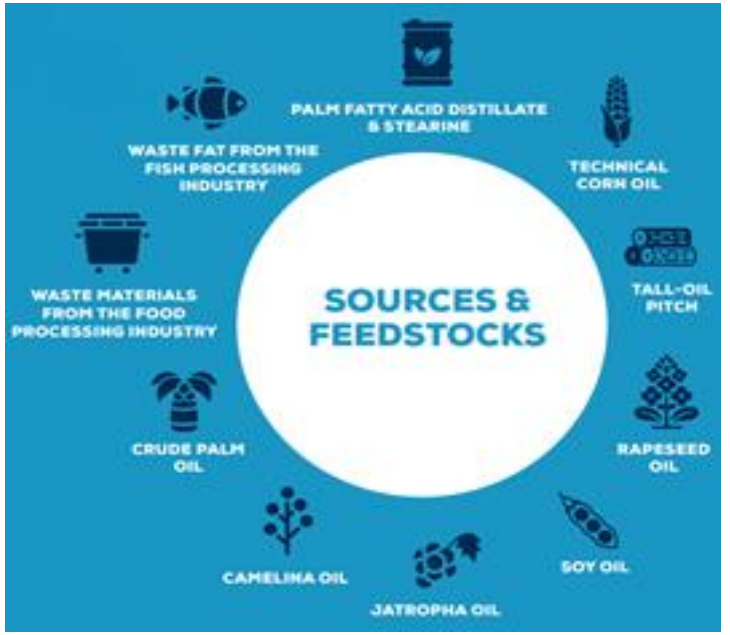
Renewable LPG: chemically identical to conventional **propane**, it is produced from renewable and organic feedstocks

Renewable LPG – readily available alternative

A DROP-IN ALTERNATIVE

BIOLPG IS CHEMICALLY **IDENTICAL TO CONVENTIONAL LPG.** IT CAN REPLACE CONVENTIONAL LPG BUT **THE TWO CAN ALSO BE BLENDED** AND USED BY EXISTING APPLIANCES SUITABLE FOR USE WITH LPG, WITHOUT HAVING TO CHANGE OR UPGRADE EQUIPMENT OR APPLIANCES.

BIOLPG CAN BE COMBUSTED IN EXISTING **LPG BOILERS** SAVING BOTH THE **HOUSEHOLD BUDGET, AND HASSLE** FROM SWITCHING TO A NEW HEATING SYSTEM.



HOW IS BIOLPG PRODUCED?

BIO-REFINING

CONVERSION OF BIOMASS TO PRODUCE FUEL, HEAT, POWER AND CHEMICALS. A LARGE NUMBER OF TRADITIONAL OIL REFINERIES IN THE EU HAVE REFINERY TECHNOLOGY SUITABLE FOR HVO (RENEWABLE DIESEL) CONVERSION. AS SUCH, THE GLOBAL INSTALLED CAPACITY OF HVO-BIODIESEL IS EXPECTED TO INCREASE FROM 4.7 MILLION TONNES (MT) TODAY TO UP TO 20MT IN 2025.

POWER TO GAS (P2G)

A TECHNOLOGY WHICH CONVERTS ELECTRICAL POWER TO A GAS FUEL. COMBINING THE ELECTRICITY AND GAS SYSTEM (KNOWN AS SECTOR COUPLING) CAN INCREASE EFFICIENCY AND FLEXIBILITY OF THE ENERGY SYSTEM AND ULTIMATELY LOWER THE COST OF DECARBONISATION.

ANAEROBIC DIGESTION (AD)

THE BREAKDOWN OF ORGANIC MATERIAL BY MICRO-ORGANISMS, IN THE ABSENCE OF OXYGEN. THIS PROCESS PRODUCES BIOGAS (SUCH AS BIOLPG). AD IS A KEY PROCESS FOR DEVELOPING A CIRCULAR ECONOMY AS IT ELIMINATES WASTE AND REGENERATES NATURAL SYSTEMS.

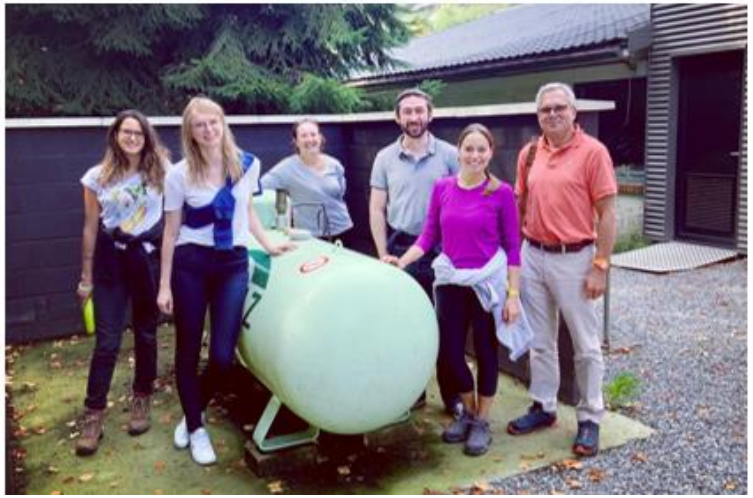
GASIFICATION AND PYROLYSIS

A PROCESS THAT USES HEAT, PRESSURE AND STEAM TO CONVERT BIOMASS MATERIALS SUCH AS FOREST AND AGRICULTURE WASTE INTO GASEOUS COMPONENTS THAT CAN BE USED IN VARIOUS APPLICATIONS. GASIFICATION IS ANOTHER SOLUTION THAT COMPLIMENTS AND SUPPORTS THE CIRCULAR ECONOMY.

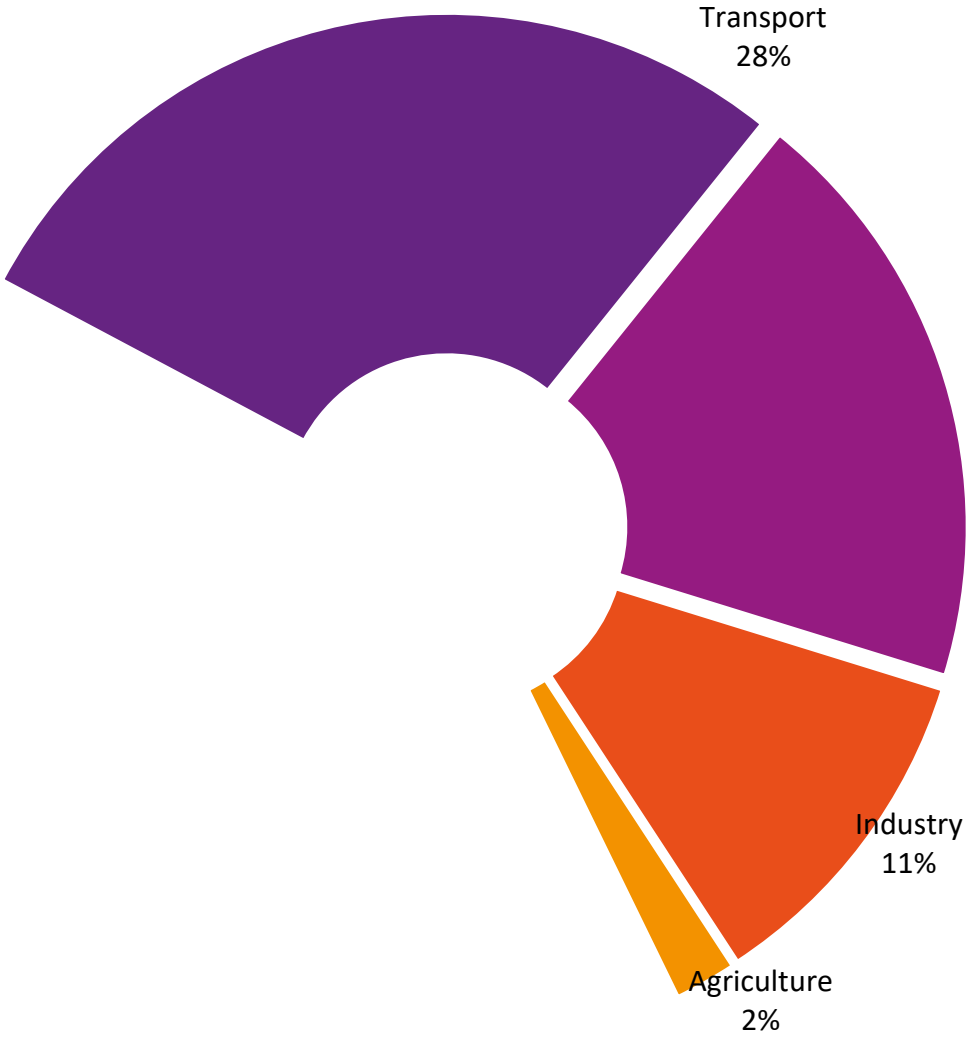
LPG – gas everywhere you need it





LPG in European economy and our daily lives



Total LPG demand in the EU in 2018

= 31,4 million tonnes

+ 200 kt/y global growing production of bioLPG

Road and marine transport

Heating

Power and heat generation

* 40% of LPG is used as feedstock by chemical industry

LPG in European economy and our daily lives

Road and marine transport

- Autogas, LPG used in the transport sector, is Europe's most widely used alternative fuel
- LPG supports a complete range of vehicles from passenger cars to vans, buses and trucks, as well as in the maritime sector
- It is used by over 8,000,000 vehicles in the EU and it is present in more than 31,000 filling stations
- Key Autogas markets in Europe are Poland, Italy, Germany
- LPG is becoming a technically and economically feasible option as an alternative fuel for shipping. It produces low levels of PM and SOx

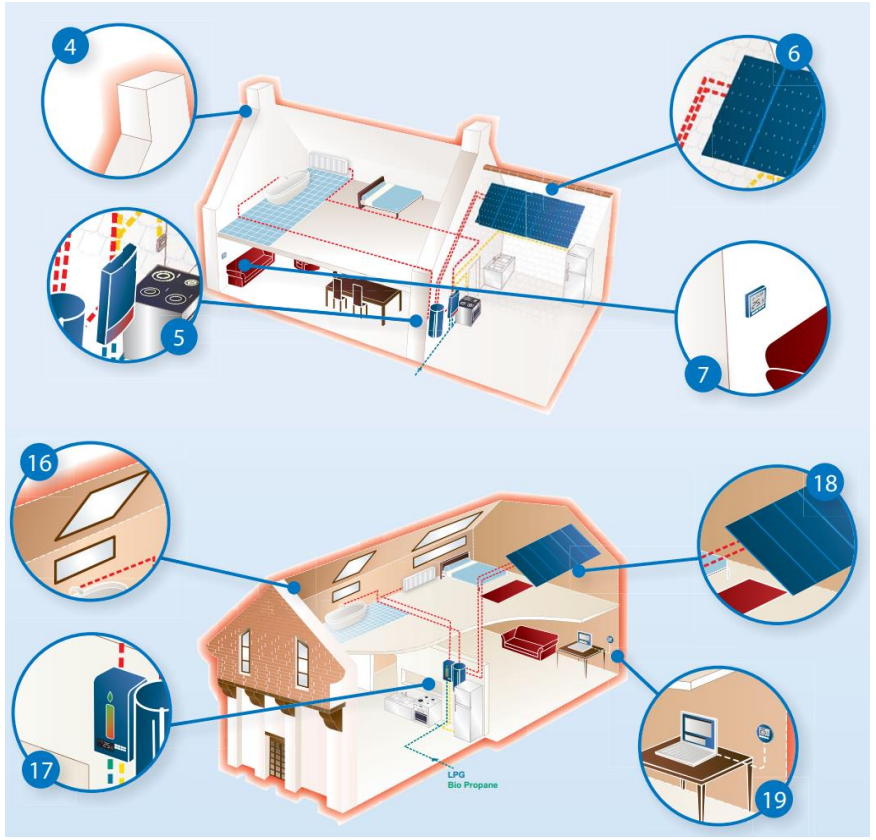
LPG in European economy and our daily lives

Heating

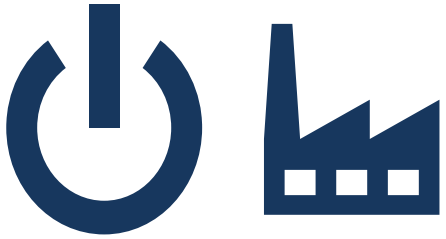
- LPG meets heating needs of millions of homes beyond the gas grid across Europe
- Currently almost 6 million tonnes of LPG is used in European households as a heating source
- LPG boilers have the added advantage of emitting almost no particulate matter into the air
- Additional emissions reduction can be achieved by installing higher efficiency appliances like gas heat pumps, micro-combined heat and power systems (CHPs) or fuel cells

LPG and renewable electricity in heating

- Several hybrid technologies are available to end-users to decarbonise the energy demand for heating and increase its efficiency
- Such technologies combine the environmental benefits of renewable energy with the reliability of LPG
- Possibilities to integrate a mix of decentralised technologies are for example solar-thermal installations or hybrid heat pumps, fueled by (renewable) LPG



LPG in European economy and our daily lives



Power and heat generation

- In Europe 11% of LPG is used by industry
- LPG is for instance used in:
  - Process heating, including metal and glass high temperature treatment
  - Space heating in large commercial buildings
  - Food industry and textile
  - Agriculture, e.g. for crop drying and as non-chemical weed killer
  - Small and mid-sized power generation
  - Building sector
  - Manufacturing of aerosol products

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Thank you for your attention!