

Panel session: The Future of Gas Turbine Systems

ASME Turbo Expo, Phoenix, 17 June 2019



ETN
Global



ETN
Global



Christer Björkqvist
Managing Director
ETN Global



ETN
Global

ETN Global 2019

Turbomachinery Association

111 member organisations from 23 Countries



Technical issues
and optimised operations

Market Trends,
Policy, Legislation

Research and
Development



ETN Working Groups and Projects



ETN
Global

Climate Change Situation

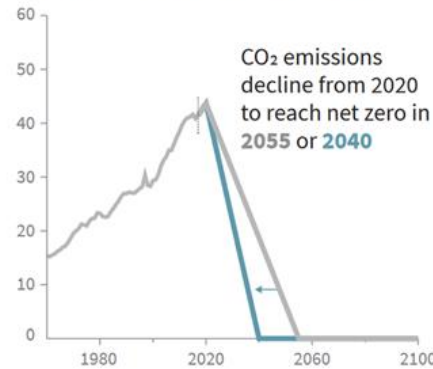
Increasing gap with Paris Agreement



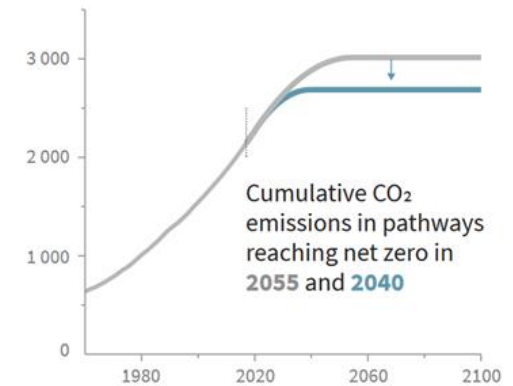
Paris Agreement



b) Stylized net global CO₂ emission pathways
Billion tonnes CO₂ per year (GtCO₂/yr)

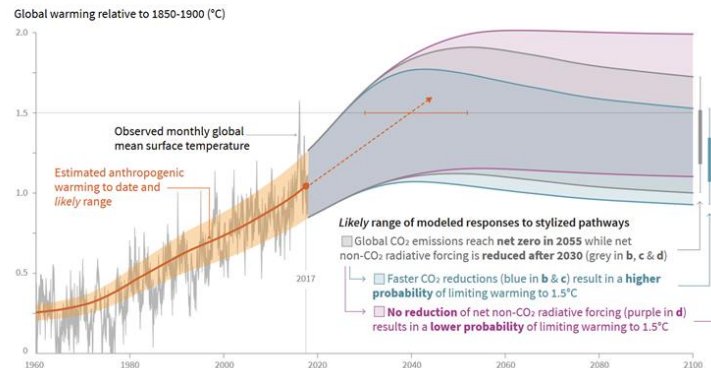


c) Cumulative net CO₂ emissions
Billion tonnes CO₂ (GtCO₂)



Faster immediate CO₂ emission reductions

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways



Source: IPCC 2018 Report
8 October 2018 Incheon, Republic of Korea



ETN
Global

G20 Key Energy figures 2018

Fossil Fuels Represent **80%**
of Primary Energy Mix



Strong increase in LNG
flows **(+8.5%)**



Gas demand strongly
accelerates **(+4.8%)**



+3.8%

Economic growth

At purchasing power parity

2017 : + 3.8%
2005-16 : + 3.4%



+2.1%

11.2 Gtoe
Rising energy
consumption

2017 : + 2.2%
2005-16 : + 1.5%



+1.7%

27 GtCO₂
New record in CO₂
emissions**

2017 : + 2.2%
2005-16 : + 1.4%

* G20 countries account for 80% of global energy consumption

** Energy-related CO₂ emissions from energy combustion (> 80% of CO₂ emissions)

Source: *Global Energy Trends - 2019 Edition - 6*



ETN
Global

Raising global concern about Climate Change



Worst flooding in a century, India



Wildfires in CA, USA



Snow storms,





ETN
Global

Demonstrations around the World by Students

Pressure to decarbonise is increasing



Bangkok



Lagos



Greta
Thunberg



Berlin



Delhi



EU Energy & Climate Policy



ETN
Global





ETN
Global

Energy Union Strategy



Energy Strategy and Energy Union

Secure, competitive, and sustainable energy



1. Building the Energy Union => SET Plan



2. Governance of the Energy Union (NECP)



3. Clean Energy for all Europeans (legal framework)



4. Energy Security Strategy



5. 2050 Long-term Strategy



6. Clean Energy for EU islands

The New Legislative Framework for Climate and Energy in EU



Greenhouse Gas Emissions

2020	2030
-20%	≥-40%



Renewable Energy

2020	2030
20%	≥32%



Energy Efficiency

2020	2030
20%	≥32.5%



Climate in EU-funded programmes 2014-2020

2020	2030
20%	25%



Interconnection

2020	2030
10%	15%

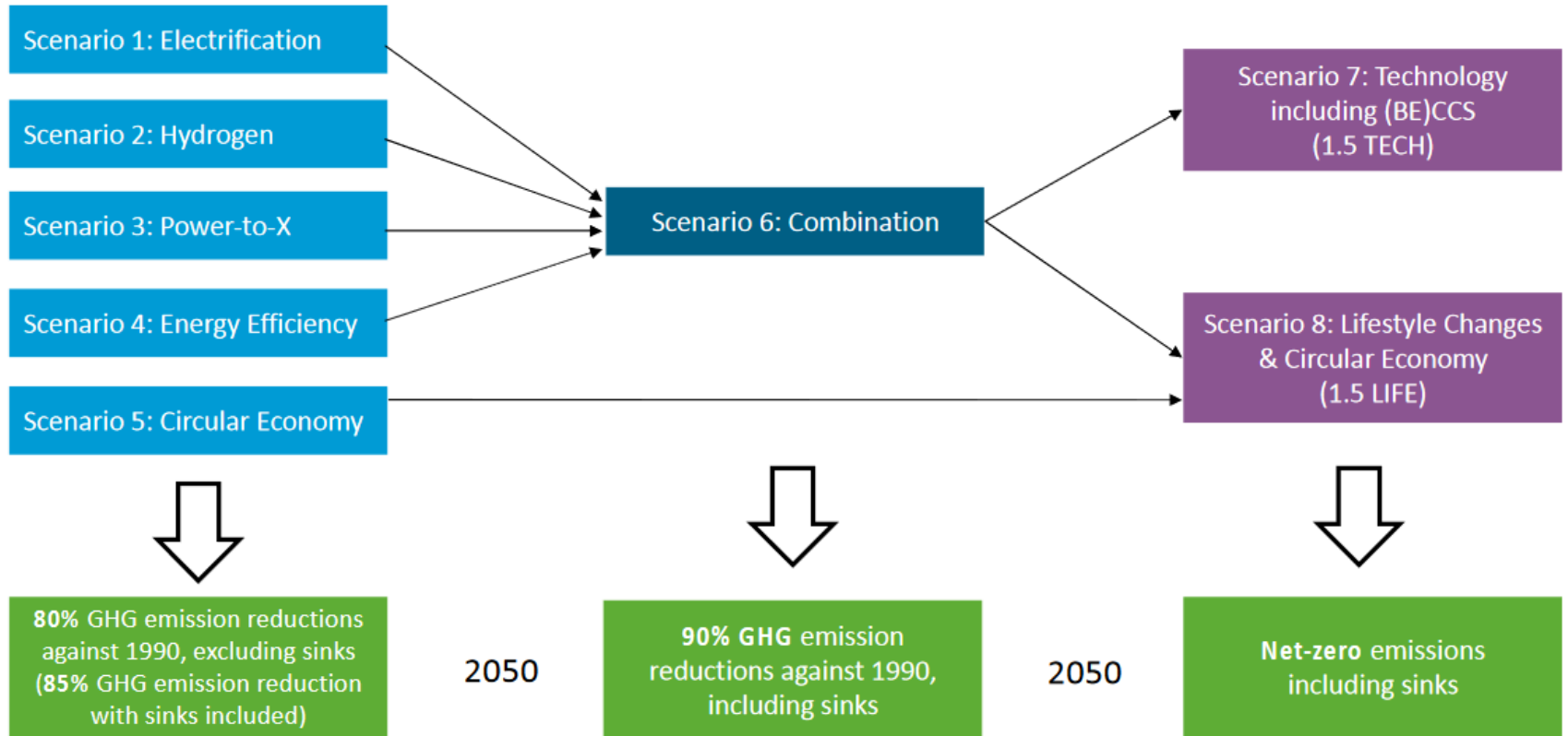


CO2 from :

Cars	Vans	Lorries
2030		
-37.5%	-31%	-30%

EC net-zero strategy proposal

Long-term strategy



Source: visualization by Ecologic Institute, drawing on the EC In-Depth Analysis document



Market trends



ETN
Global

Decarbonisation, Decentralisation, Digitalisation



EU Emission Trading System

Price of Carbon now trigger Coal to Gas Switch

ETN
Global

CO₂ taxes

Norway: 58 /tCO₂

Sweden: 124 /tCO₂

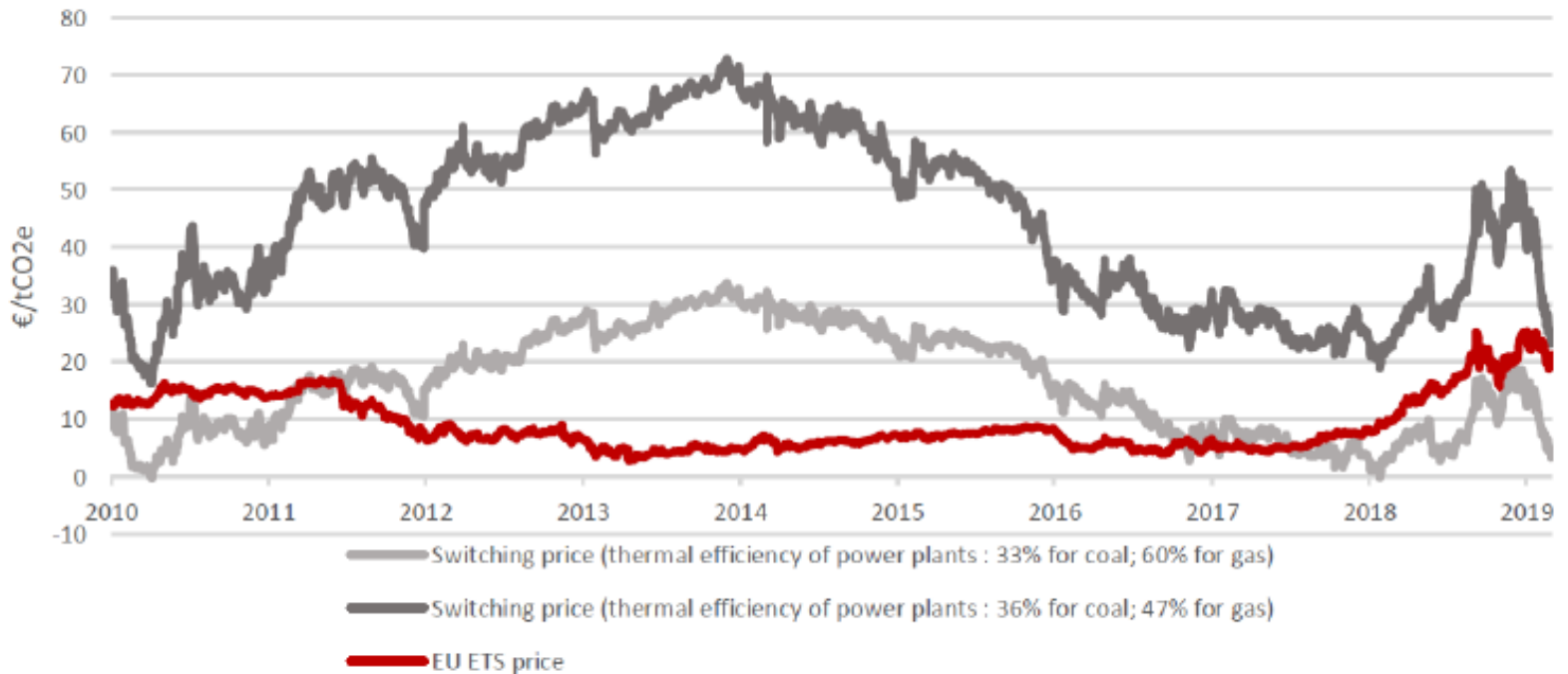
Finland: 70 /tCO₂

France: 51 /tCO₂

Switzerland: 96 /tCO₂

UK: 24 /tCO₂

CO₂ Switching Price for Different Coal and Gas Power Plants Efficiencies



Source: I4CE

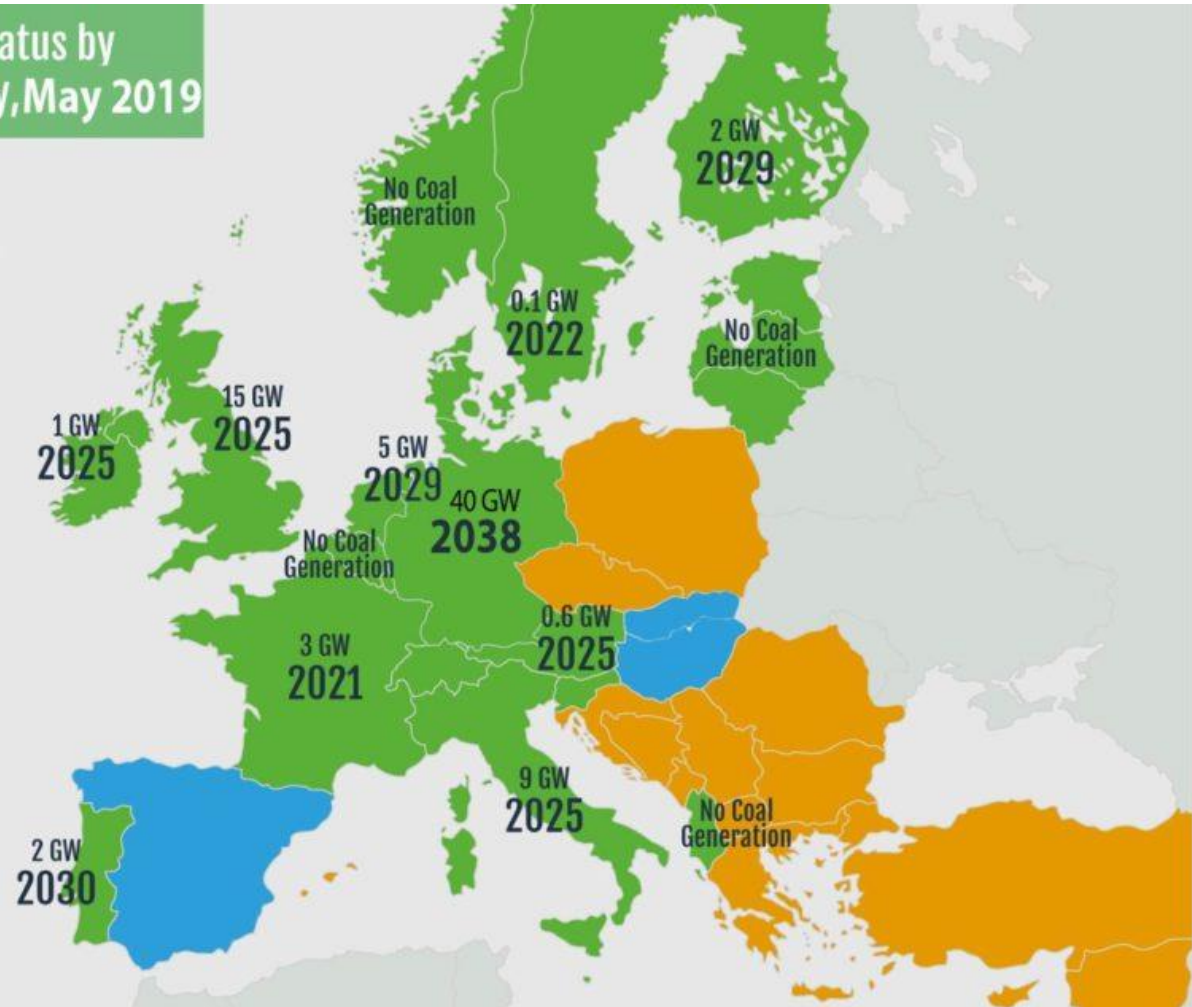


Coal Phase Out

Fig 2.

Coal phase out status by European country, May 2019

- Green**
No coal, or commitment to phase-out coal
 - Blue**
Phase-out being actively discussed
 - Orange**
Phase-out yet to be decided
- GW is the gigawatts coal capacity currently operational



EU Clean Energy Package:
New regulation on internal market for electricity - No capacity payment for carbon intensive generation >550gr CO₂/kWh

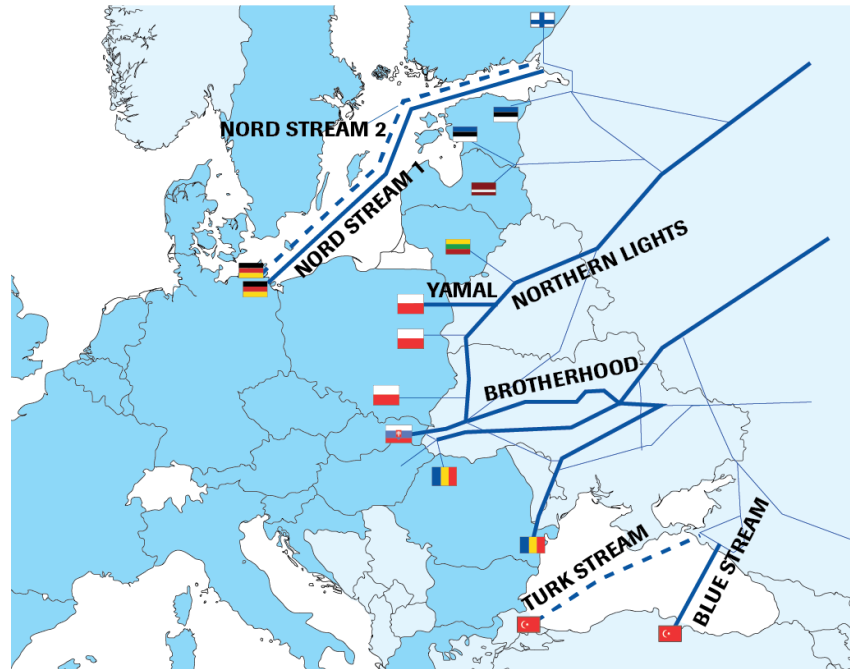


Geopolitical positioning for export of natural gas

ETN
Global



7.9 bcm
in 2018 (181% increase
since July 2018)



201 bcm
in 2018



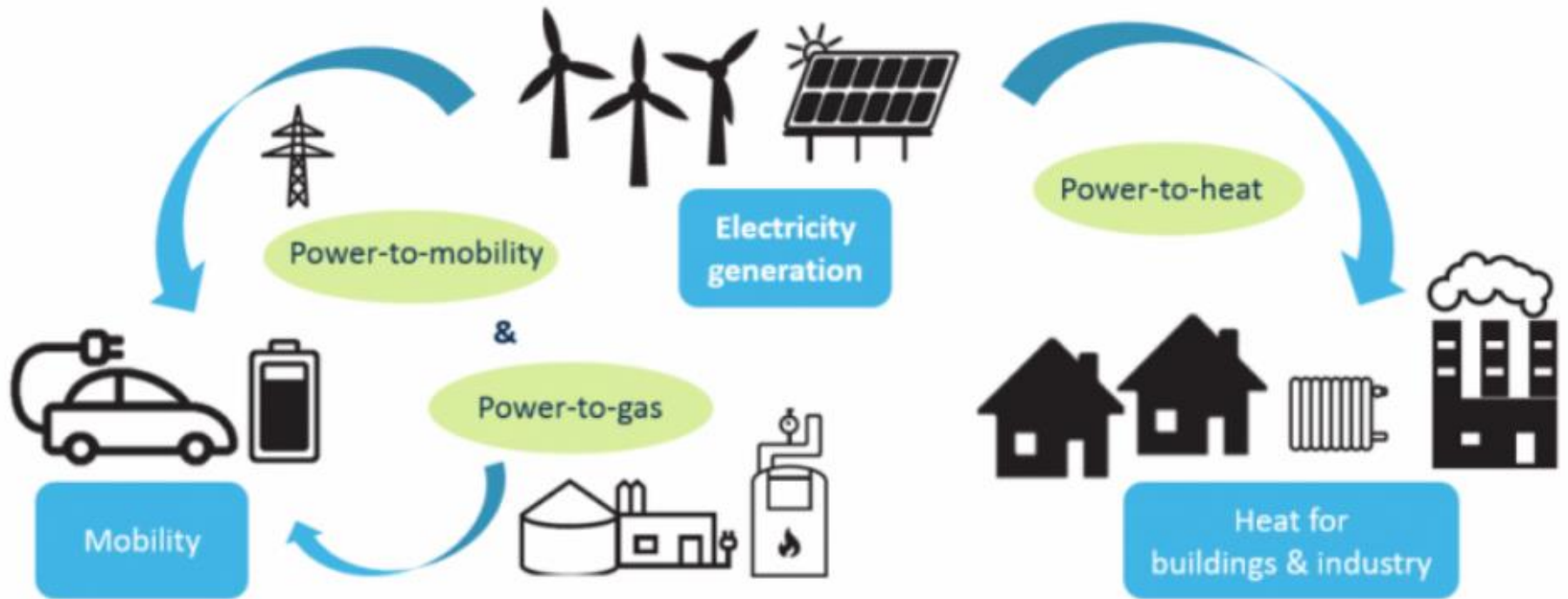
Big investments!



ETN
Global

Sector Coupling

Creating an integrated carbon-neutral energy system



Power-to-X

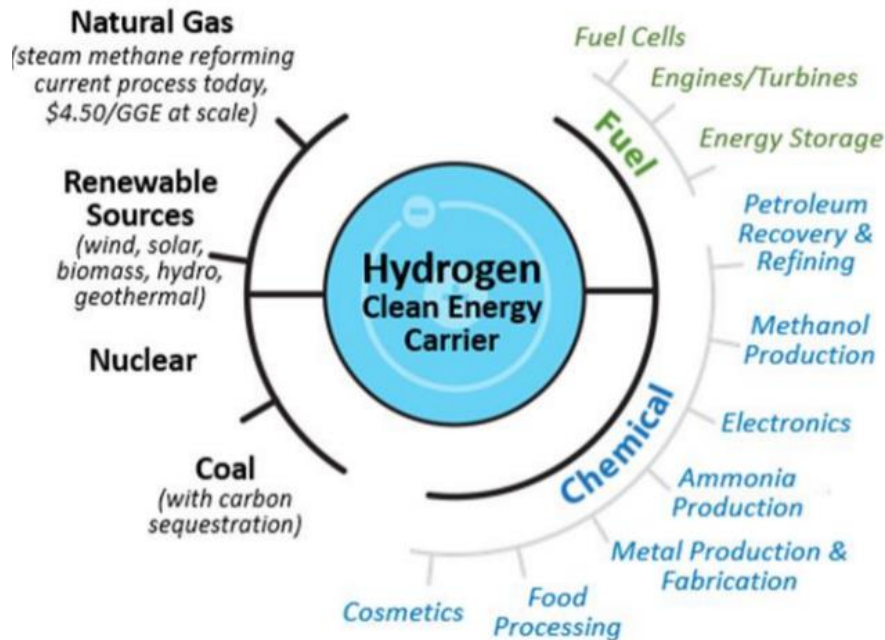


ETN
Global

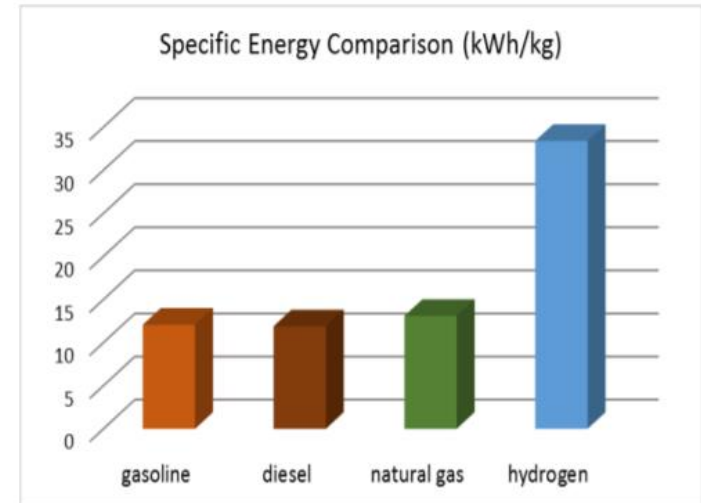
Hydrogen as an energy carrier

A multitude of sources can be used to produce H₂

Many applications rely on or could benefit from H₂



Very High Specific Energy



About *three times* more energy by mass than most other fuels!

Source: U.S. Department of Energy



ETN
Global

Market Trends and Opportunities for Gas turbine technology

1. **Stricter climate legislation in place to prevent high polluting solutions** - Accelerated phase out of coal plants and in some countries also phase out of nuclear - **replacement capacity opportunities**
2. **Increasing CO₂ price trend** - ETS and CO₂ taxes – **Increasing interest in energy efficiency and low carbon energy solution**
3. **Fast growing intermittent renewable power** - **balancing and power-to-X opportunities**
4. **Energy demand increasing** **IEA estimates that global demand for gas will grow by 1.5% every year in the period to 2040**
5. **Large investments in new pipelines and LNG import facilities**
- **LNG export expected by DNV-GL to double by 2040**

Future Research & Development Needs



ETN
Global



ETN's R&D Recommendation Report 2019

ETN
Global



ETN
Global

Research and Technology Development Priorities for Gas Turbines



- ❖ Extended fuel spectrum: hydrogen, ammonia, biomass,...
- ❖ Power-to-X
- ❖ Future concepts/cycles (sCO₂ cycles, wet cycles...)
- ❖ Future materials and Additive Manufacturing
- ❖ Digitalisation, condition monitoring and lifing



Details in ETN's R&D Recommendation Report



Hydrogen Working Group



Explore, enable and optimize the use of hydrogen in gas turbines by:

- ❖ Highlighting potential use, applications and benefits
- ❖ Identifying potential barriers
 - Research needs
 - Operational issues/effects on GT components
 - Explore retrofit solutions for high hydrogen-content fuel
 - Explore the safety aspects
- ❖ Supporting the use of hydrogen as an energy carrier

www.etn.global



Additive Manufacturing Working Group



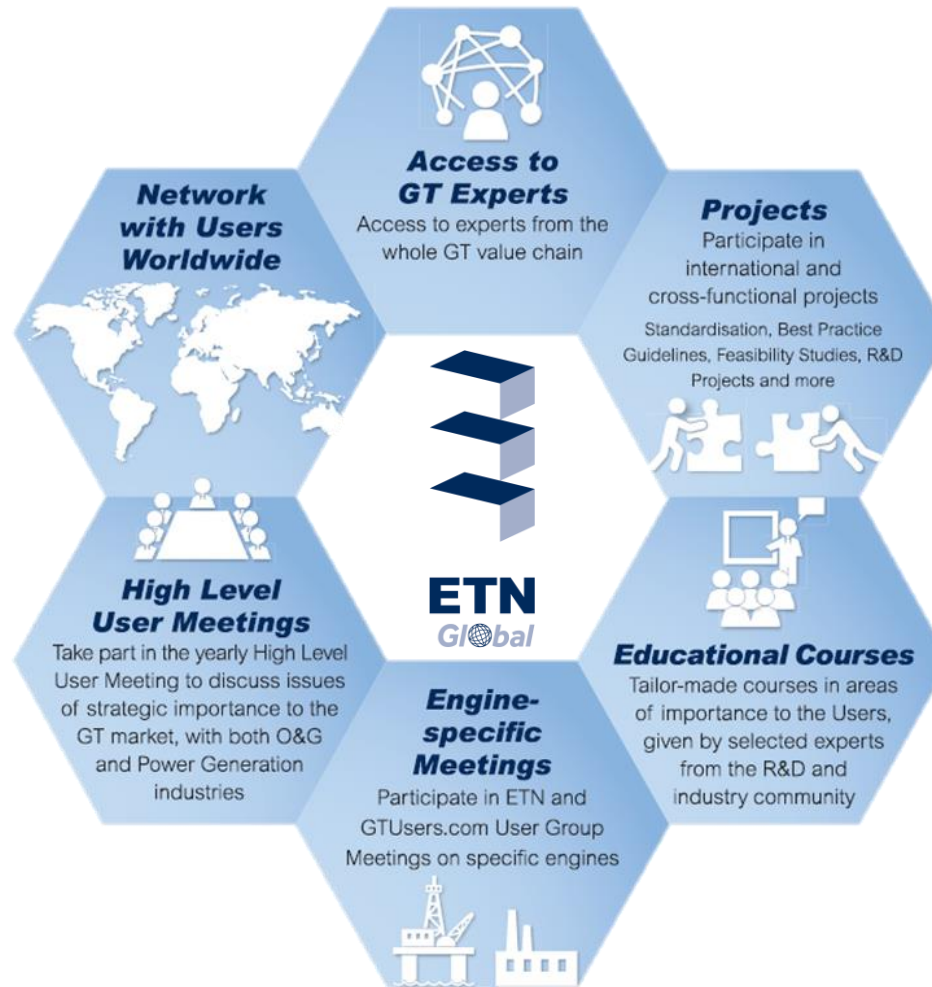
Objectives:

- ❖ Exchange knowledge and experiences focusing on the added value that AM could generate
 - ✓ short delivery time
 - ✓ efficiency increase by optimized design
 - ✓ delivery of obsolete or “urgent” parts to shorten maintenance outages and overhauls
- ❖ Cooperate on additive manufacturing practices

Activities:

- ❖ AM equipment and process database;
- ❖ AM product quality and control
 - ✓ ETN best practices booklet
 - ✓ Case study on AM product quality and control;
- ❖ AM research roadmap





Questions?

ETN Global
 Chaussée de Charleroi 146-148, 1060 Brussels, Belgium
 Tel: +32 (0)2 646 15 77, info@etn.global