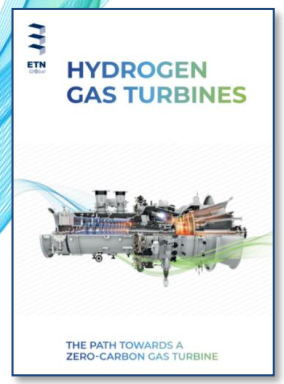
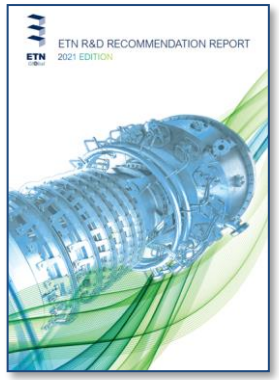
Decarbonisation Pathways for Gas Turbines

Peter Jansohn, Head of Project,
PSI/ETN Project Board





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GAS TURBINE APPLICATIONS IN A CARBON-NEUTRAL SOCIETY

ETN GLOBAL'S VISION
Safe, secure, affordable and dispatchable carbon-neutral energy solutions by 2030, implemented globally by 2050

2020

2030

2050 AND BEYOND

H_2 PIPELINE
Compressor station

POWER PLANT
- Gas turbines as electric power generation units
- Power-to-X solutions

GAS TERMINAL
Gas turbines for compression transport and storage

HYDROGEN STORAGE

H_2 pipeline

H_2 pipeline

ENERGY INTENSIVE INDUSTRIES
- Gas turbines as mechanical drives
- Power-to-X solutions
- Co/tri-generation

HARBOUR
Gas turbine providing Combined Heat & Power for industrial hubs

SEA TRANSPORT
Gas turbines for ship propulsion

MOBILITY
Gas turbines for aviation, hybrid electric heavy-duty vehicles and for e-charging stations

BUILDINGS & RESIDENTIAL
- Gas turbines for distributed generation and microgrids
- Combined Heat & Power and district heating

GAS TURBINE ENERGY SYSTEM SOLUTIONS OF THE FUTURE:

COMPACT POWER DENSITY | DISPATCHABLE | FLEXIBLE | RENEWABLE FUELS | ENERGY STORAGE | COST COMPETITIVE | NET-ZERO SOLUTIONS

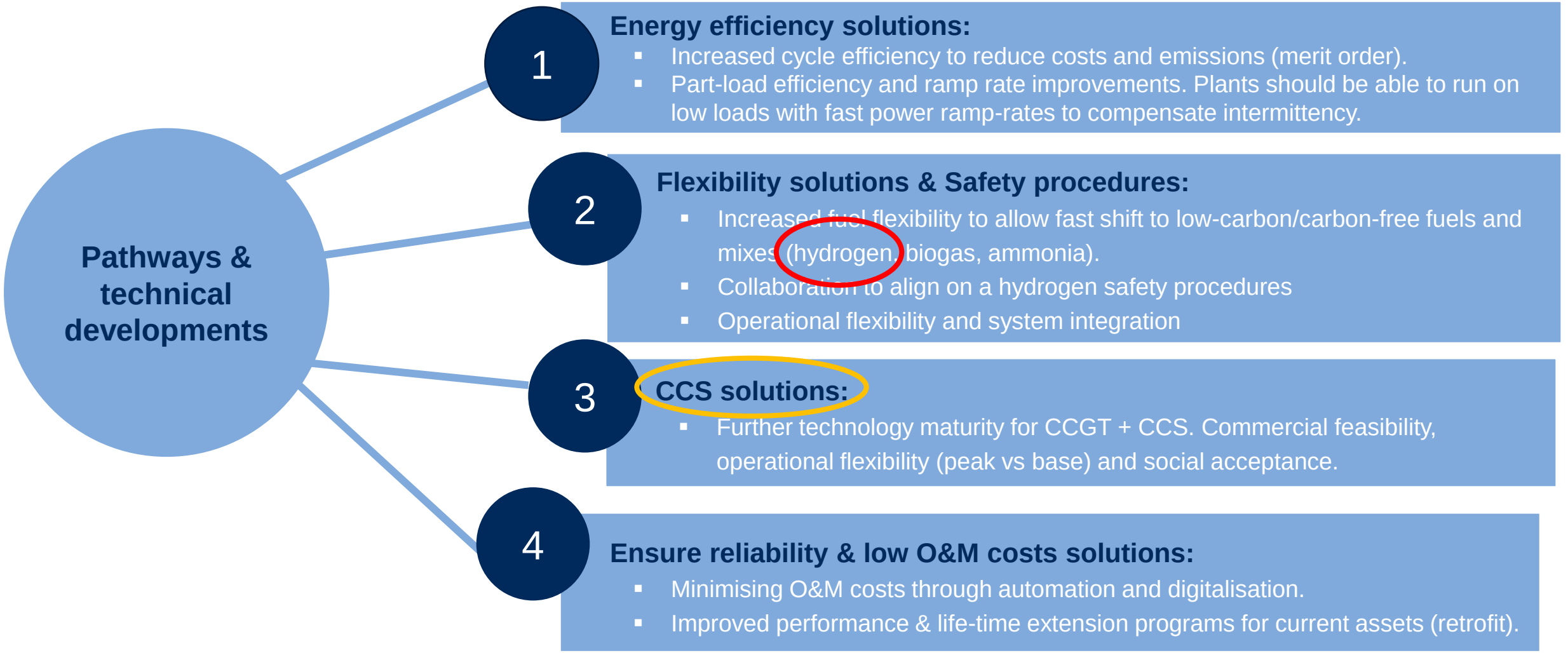
Strategy

To Expedite the GT Technology Transition

- **Portfolio Development:** Create promising pathways by gathering user demands, consulting technology experts, and fostering market demand.
- **Pathway Exploration:** Delve into selected pathways in specialized working groups, identify barriers and opportunities, and conduct feasibility studies.
- **Collaborative Projects and Activities:** Execute joint research and demo projects, and advocate for market incentives and regulatory support.

Pathways & Technical development needs

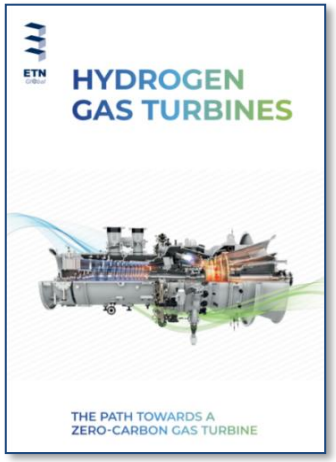
Input from the GT user communities

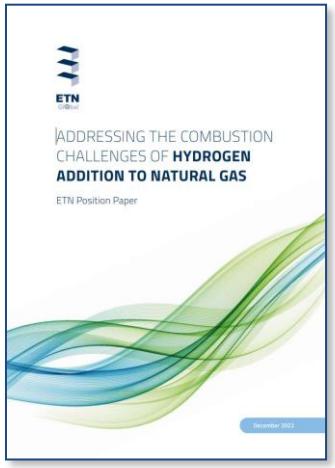


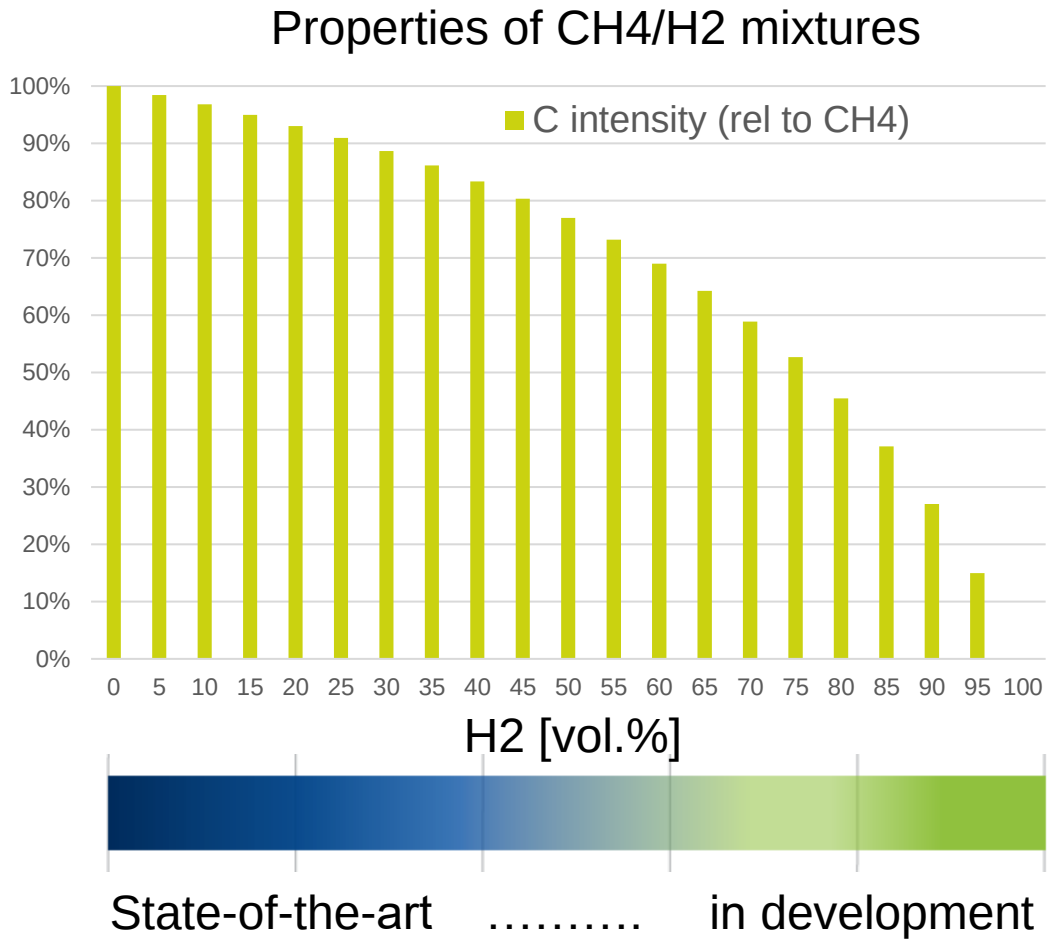
Hydrogen

Challenges

- Flame flashback
- NOx emissions
- Flow rates (energy density)
- Materials degradation
- …. and even more



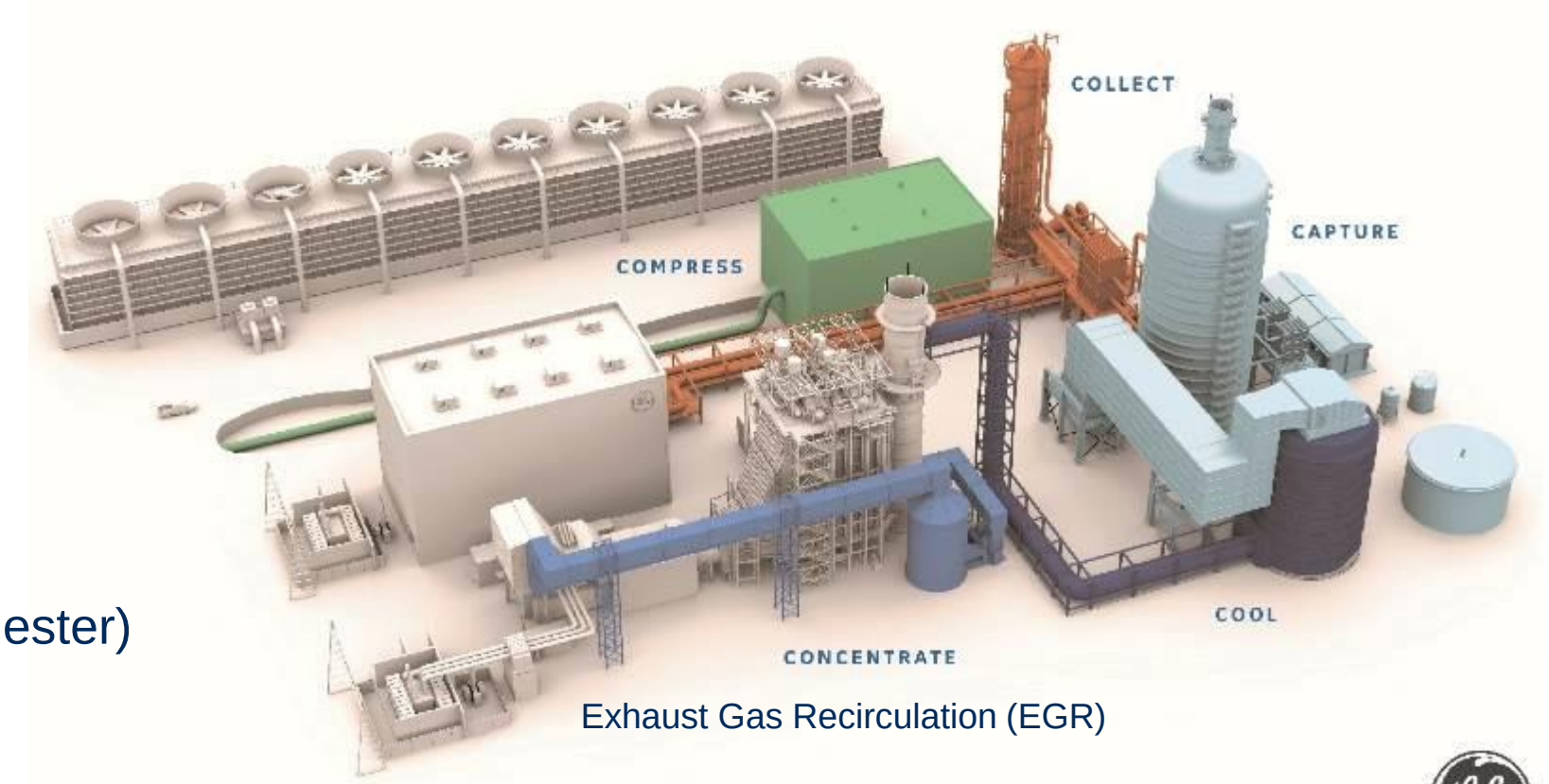




GTs with CO_2 capture

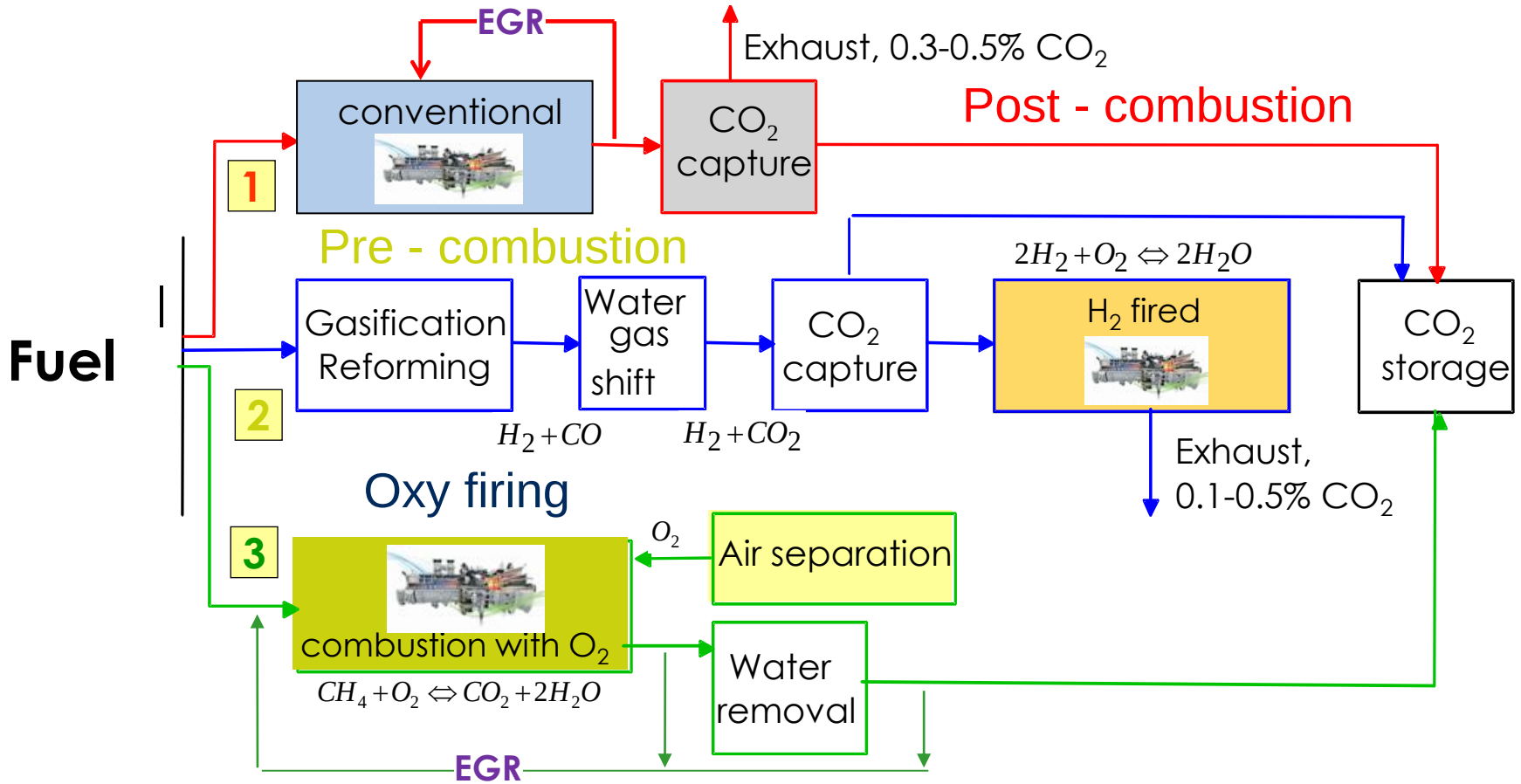
Issues

- with or w/o EGR
- dynamic operation
- minimum capacity
- CO2 (re-use or sequester)
- …. to be continued



Exhaust Gas Recirculation (EGR)

(low carbon) Gas Turbine solutions



R&D Recommendation Report 2023

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- Operational Flexibility
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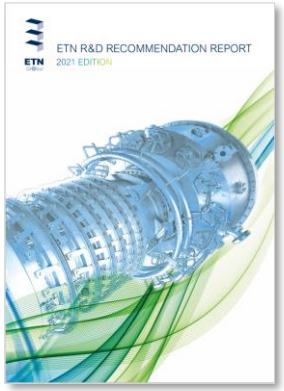
- Digitalisation
- Sensors & Instrumentation
- Condition Monitoring & Lifing

Technology Transitions Pathways

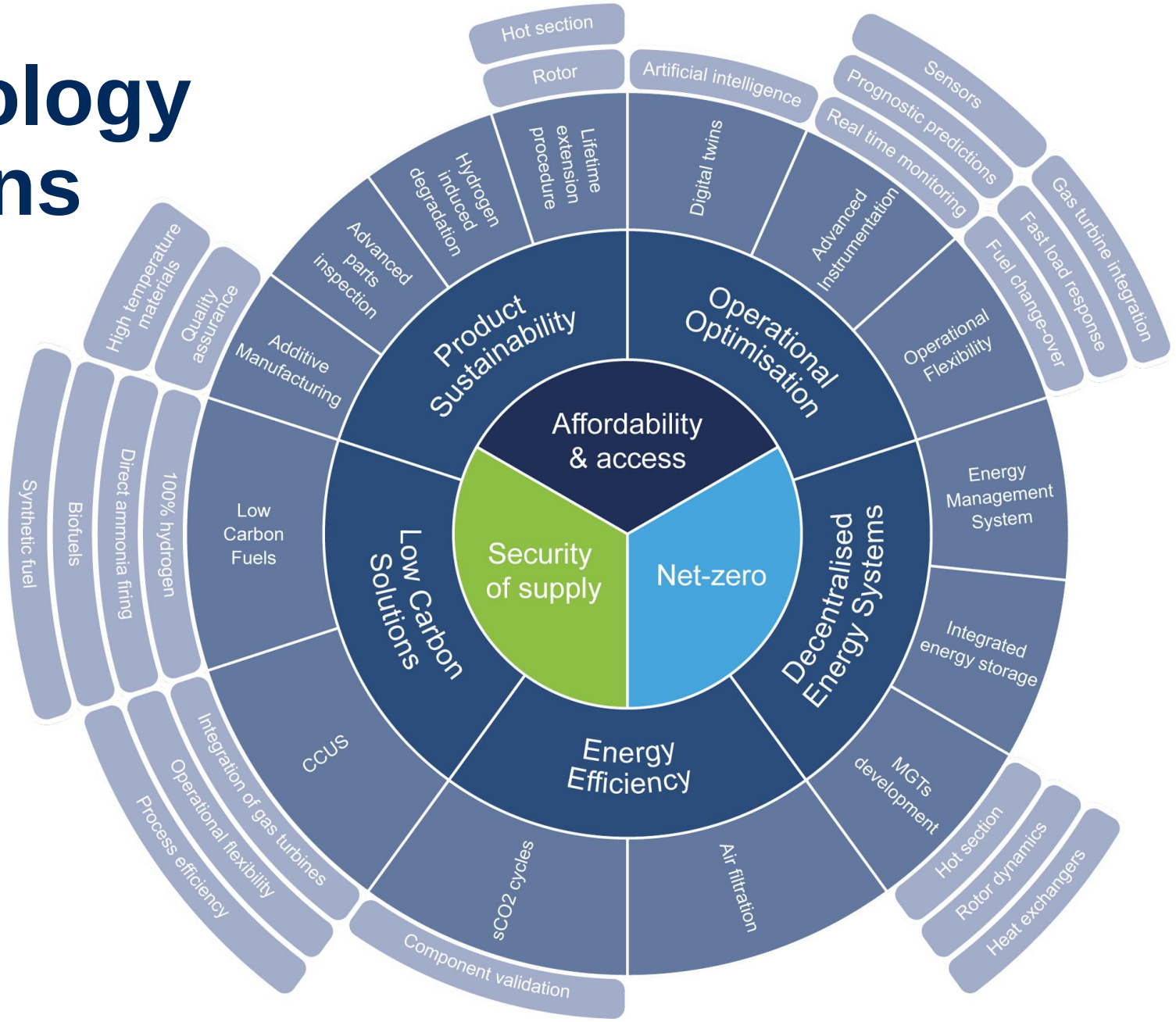


Key objectives

Key topics

Tech. solutions

Specific solutions



2030 Technology development requirements

1. **Engine specific retrofit solutions** to enable safe, flexible and reliable operation at **up to 30% hydrogen** with upgrade option to **up to 100% H_2** before 2030 without significant increase in the NOx emissions and maintaining the plant's performance.

2. **GT specific CCS solutions** and other **integrated energy system solutions** (storage, waste recovery, and other hybrid solutions)

3. **Gas turbine specific upgrade packages enabling part-load efficiency and ramp rate improvements**

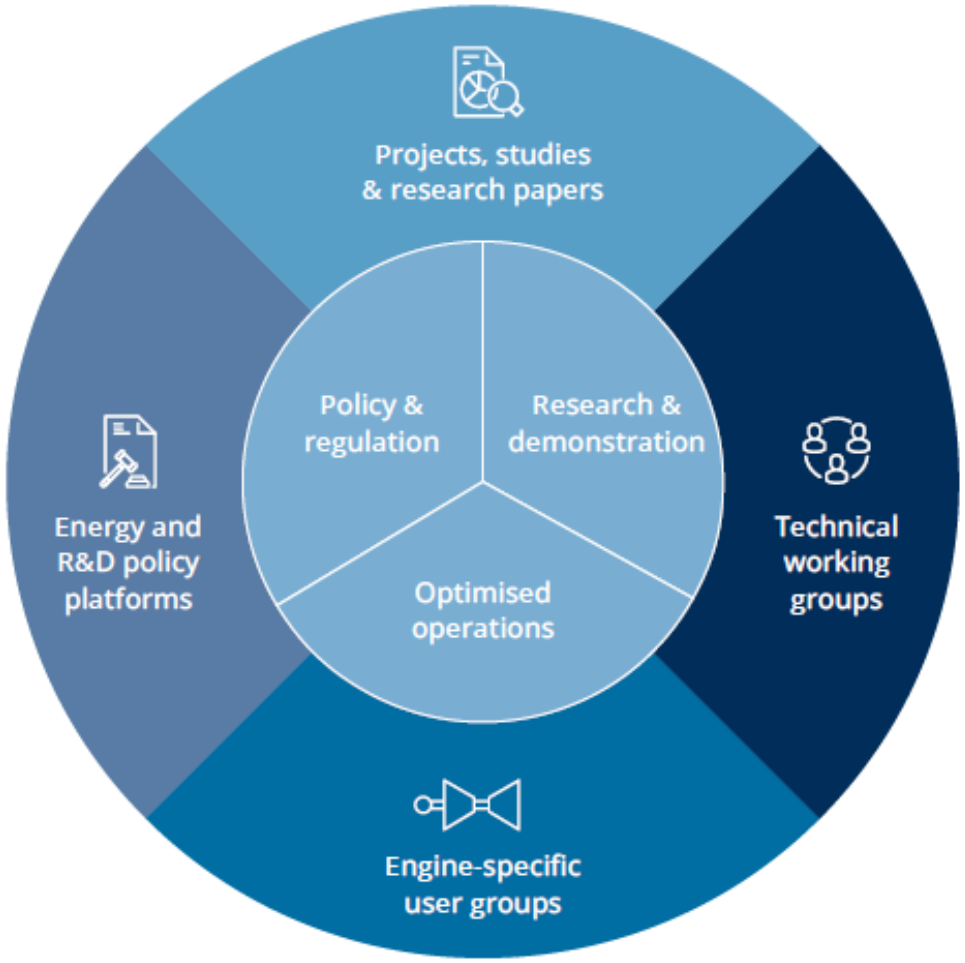
4. **Life assessment and extension programmes** for plant specific gas turbines **for cycle behaviour and alternative fuels** guaranteeing safe operation and optimised performance. Including advanced component repair to reduce material resources and costs of ownership.

5. **Optimise power plant operation and maintenance through better use of digitisation and analytics**. Combine analytics with engineering knowledge to reduce the operational costs and increase of plant's overall performance.

6. **System integration and storage solutions**

ETN Global

Energy & Turbomachinery Network



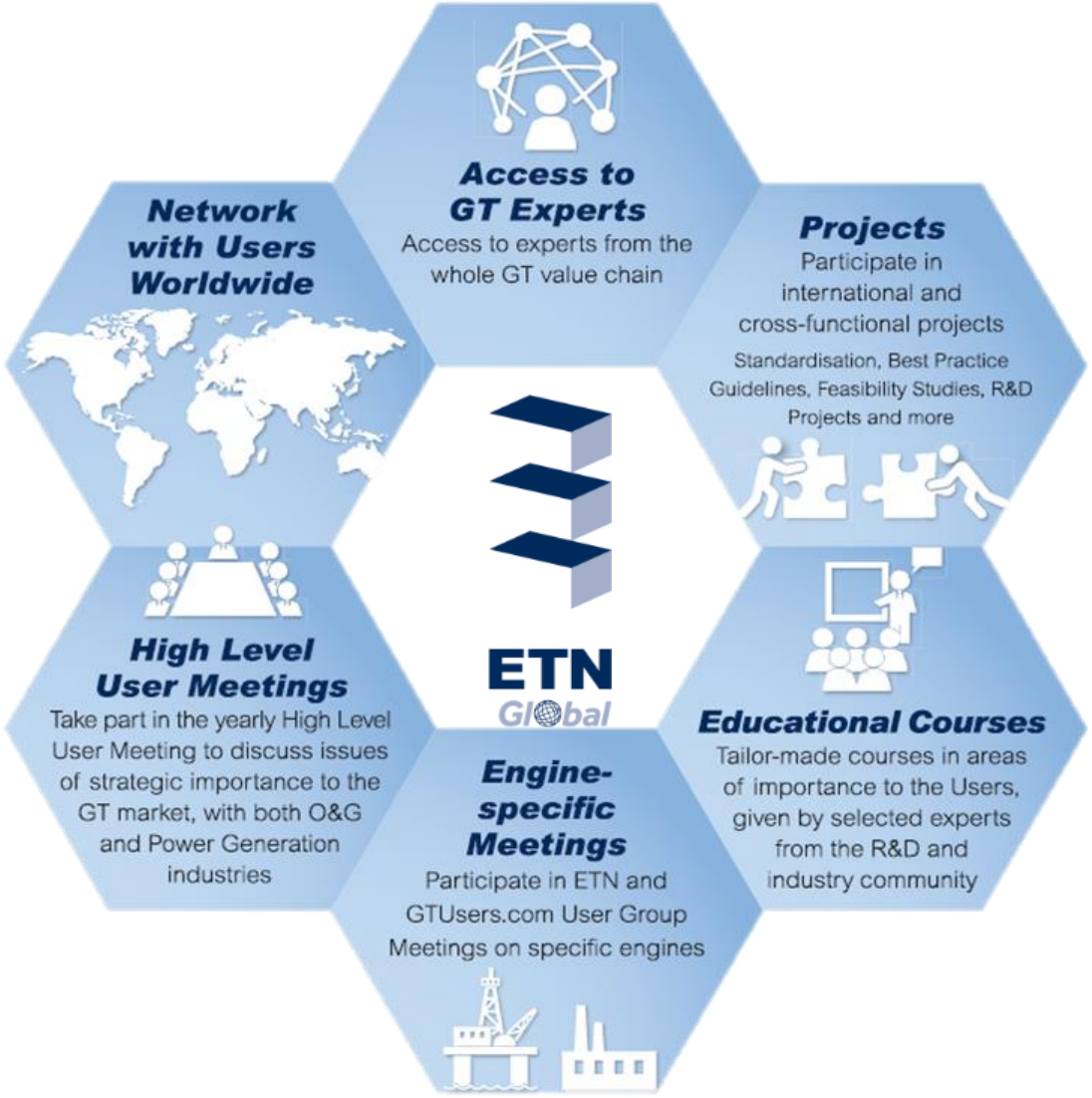
Global cooperation for dispatchable, safe, affordable and sustainable energy solutions

Non-profit association with 130 organisation members:

- ✓ Utilities, gas companies, industrial users, gas distribution companies
- ✓ Gas turbines OEMs
- ✓ suppliers and service providers
- ✓ consultancies
- ✓ research institutes and universities

22 countries: Europe, Asia, & North America

Cooperation for a successful energy transition!



ETN NEWS

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ETN Global is a non-profit association bringing together the entire value chain of the gas turbine technology community. Through cooperative efforts and by initiating common activities and projects, ETN encourages and facilitates information exchange and cooperation to accelerate research, development, demonstration, and deployment of safe, secure and affordable carbon-neutral energy solutions by 2030.

In this issue

A lifetime opportunity to accelerate the transition to a sustainable society

Christer Björkqvist
Managing Director

The recent natural disasters with the unprecedented flooding in Europe and China as the latest example have reinforced beliefs of the urgency to address climate change. Parallel the pandemic has ripped through countries with the force of a universal tidal wave, leaving behind profound socio-economic destruction. This provides an opportunity for both a sustainable recovery and an acceleration of the energy transition. The European Union is planning to use this occasion and recently announced its largest recovery and stimulus package ever financed in Europe, with a budget of over €2.0 trillion sealed with sustainable conditions.

From a research and cooperation point of view, the successful developments of vaccines in an unprecedented speed demonstrate what can be achieved when there is a true global emergency, an aligned research community and sufficient resources. There are parallels to be made with our sector and we should be inspired by the power of coordinated global research collaboration. ETN is providing a platform for such a development, and the increased active involvement by our members and commitment to our vision is very encouraging. ETN's ongoing projects and activities show the determination by our members to accelerate the gas turbine transition. Parallel to the FLEXnCONFU and ROBINSON projects, a new CO2OLHEAT project kicked off in June focusing on industrial waste heat valorisation and its conversion into electrical energy via a supercritical CO_2 cycle. With 21 partners from 11 countries, the objective is to develop a cutting-edge supercritical CO_2 technology that will contribute to both energy efficiency targets and GHG emissions reduction. The solution will be demonstrated in a real industrial environment in the EU-first-of-its-kind sCO_2-plant.

Over the last months ETN has also been involved in several webinars where our members have had the opportunity to highlight development needs and cooperation opportunities. This input is transmitted to our Working Groups, in key technology fields, where technology development and cooperation opportunities are constantly explored. These virtual events and activities are crucial, as information exchange, coordination, alignment, and commitment are key in accelerating the transformation of gas turbine technology that will open for continuous dynamic developments and contributions from our sector in the energy transition and beyond.

To be fully successful in our strategy, we also need to demonstrate to policy makers and the society that gas turbine is an enabling technology in the energy mix for a timely achievement of a carbon-neutral society. Being a flexible conversion technology with low-emission credentials that can be further developed to provide carbon-free energy and heat with seasonal and medium-term storage solutions, gas turbine is a vital element in a successful carbon-neutral energy strategy. These attributes offer important decarbonisation opportunities, as well as a clear path towards a dispatchable zero-carbon technology, suitable for a wide variety of applications. You can read more about this in our newly produced document "Gas turbines: an enabling technology for a carbon-neutral society" and our "Research and Development Recommendation Report".

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