SGT-A35 USER GROUP 2020 MEETING

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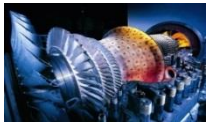
RWG REPAIR & OVERHAUL EXPERTISE

TRANSCANADA TURBINES

ETN Global 2020

A User Driven Global Gas Turbine Association






Membership-based, non-profit association
Coverage: Gas Turbine and Turbomachinery Technology

110 Member organisations
23 countries: Europe, Asia, North America
+800 persons from member companies involved in different ETN activities

President: Pedro Lopez, Uniper
Vice President: Hege Rognø, Equinor


Platform for Information exchange, R&D cooperation and technology development

Vision

Safe, secure and affordable carbon-neutral turbomachinery-based energy solutions by 2030, implemented widely and globally by 2050

Mission

Encourage and facilitate information exchange and cooperation to accelerate research, development, demonstration, and deployment of energy solutions in line with our vision.

Strategy

Three key pillars around Turbomachinery

Market Trends, Policy, Legislation

ISO

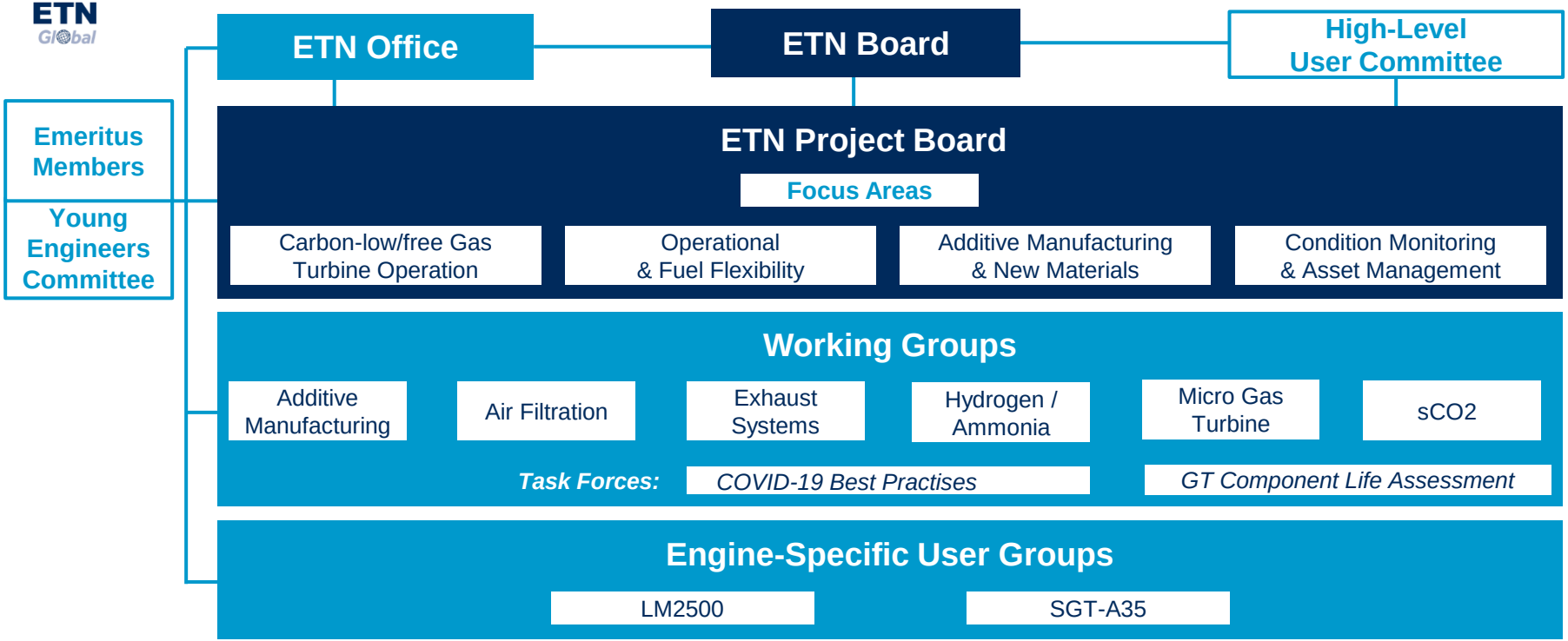
COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

Technical issues and optimised operations

Research and Development

Working Groups and Projects

Organisational Structure



High-Level User Meeting

13 October 2020

Yearly strategic meeting in October for coordination of priorities and to review progress

Discussions

- Topics of strategic importance
  - Operational issues and needs for the current fleets
  - Requirements for the next generation GT fleets
  - Highlight engines with a high amount of issues
- Outcome reported to the ETN Community

ETN Key R&I topics of interest

etn.global/RDRR

Legend:
Short-term
Long-term

Energy Efficiency and Emissions
- Load Flexibility
- Reliability
- Bottoming cycle

Decarbonisation
- Blend of H2, Biogas
- Full fuel flexibility (from 0 to 100%) H_2, ammonia

Advanced Cycles
- Integration with storage solutions (battery, CAES, LAES, thermal)
- Supercritical CO_2

Cost Optimisation
- CAPEX & OPEX
- Overhaul cost

Digitalisation
- Condition monitoring
- Unmanned plant

Material
- Hot-Corrosion
- Additive Manufacturing

Engine-specific User Groups

SGT-A35 USER GROUP 2020 MEETING

SGT-A35 Siemens

LM2500 USER GROUP 2020 MEETING

LM2500 General Electric

Process

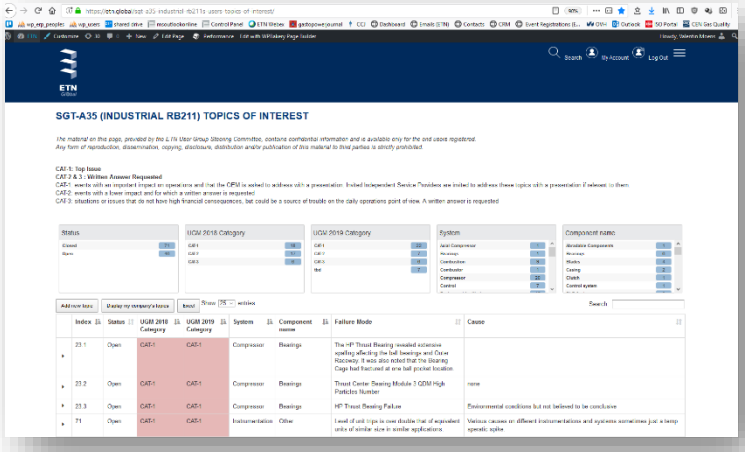
1. **Collect** and select most critical technical issues
2. **Exchange** experiences among the users
3. **Trigger** dedicated responses from OEM's, ISP's and R&D community

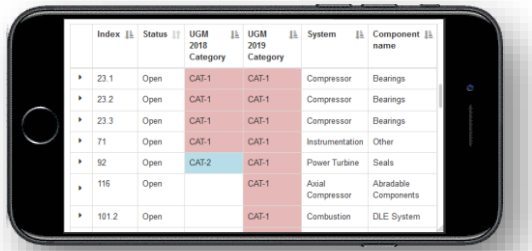
Content

- ✓ 100+ topics in each engine database
- ✓ Answers from the OEM and ISP's
- ✓ Individual reports for each top issue
- ✓ Questions from Users to OEM

Online platform for Users

Online platforms and databases developed by the ETN Office to gather topics of interest on LM2500 and SGT-A35 (RB211) gas turbines
https://etn.global/sgt-a35-industrial-rb211s-users-topics-of-interest/





Prioritised topics - 2020

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IP turbine blade failures, and risk for the fleet	103
HPT blade failure event (2018), and risk for the fleet	123
Potential risk associated to abradable Metco coating in the HP compressor coming out in chunks	116
Mitigate/reduce the effects of hot corrosion	109
Feedback on the FMV design released in March 2019	66
Center bearing failure (2018)	125
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Power Turbine disk & rotor inspection and life extension criteria	115
Lack of alternatives for RT Power Turbines overhaul (RT61)	110
Status of Siemens' alarms and trips rationalisation programme initiated in 2017	71
HP Thrust Bearing material review update	23
Water mist on hot engine external casings, turning to steam and burning electrical cables	111
Hexavalent Chromium	121
Procedure to commission a DLE engine after overhaul: FT-110/125 controls & STI187	128
Different designs developed during manufacturing phase	107

Vision and Strategy 2020

ETN Global

Pillar 1

Market Trends, Policy, Legislation

- Promotion of low carbon turbomachinery technologies in future energy and industrial markets
- Influence energy and research policy
- Monitor market trends and emission regulations
- Monitor development and contributions to standards

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

Pillar 2
Technical issues and optimised operations

- Risk mitigation and technical solutions:
  - To improve energy efficiency and performance
  - To improve operational flexibility
  - To improve reliability and availability
- To reduce emissions
- Digitalisation/Condition Monitoring/Life Assessment
- Standardisation
- Exchange of best practices

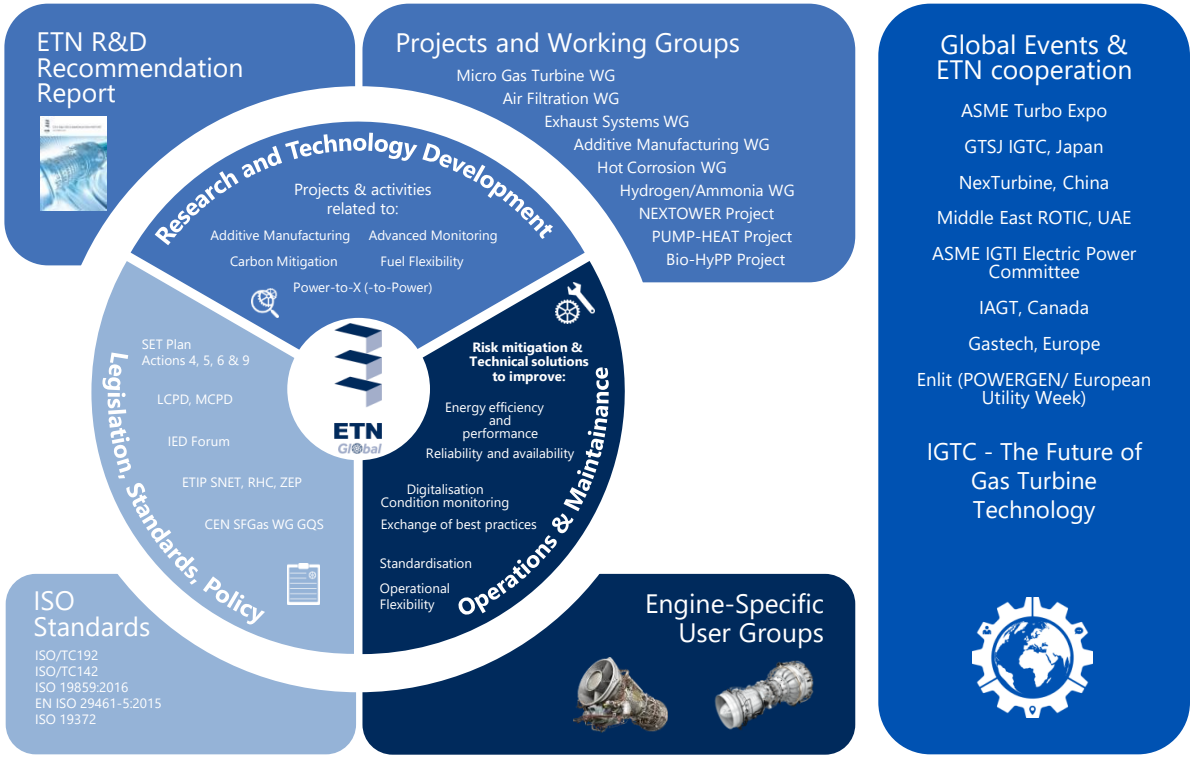
Pillar 3
Research and Technology Development

Development of turbomachinery systems to meet future low carbon market needs

- Fuel flexibility: hydrogen, ammonia, widen the operability of different fuel compositions
- Carbon mitigation: CCUS, CSP, Advanced Cycles
- Storage
- Digitalisation, Additive Manufacturing
- Advanced monitoring, component life management

Details in ETN's R&D Recommendation Report

Summary of Activities



High-Level User Meeting

Yearly strategic October meeting for GT users

Needs and requirements of strategic importance
and coordination of priorities

30 September 2019, Florence

Energy Efficiency and Emissions

- Part load
- Minimum load
- Maximum load
- Reliability
- Bottoming cycles
- Regulatory compliance

Decarbonisation

- H_2
- Ammonia
- Mixing/blends

Advanced Cycles

- Supercritical CO_2
- Integration with renewables and batteries/thermal storage

Cost Optimisation

- CAPEX & OPEX
- Overhaul cost

Digitalisation

- Condition monitoring
- Data management
- Optimisation of maintenance intervals
- Life predictive modelling
- Unmanned plant

Flexibility

- Start – ramp – min/max load
- Transients/Stabilisation
- Ancillary services
- Biofuels

Additive Manufacturing

Knowledge and experience transfer

- Attracting and training new talents (OEM, SPs and Users)

Operation in harsh environment

- Water wash
- Filtration
- Materials selection
- Coatings
- Hot corrosion

User Groups, Working Groups, Projects and other activities

ETN Global

Hydrogen Working Group

Objective: Accelerating the development and use of hydrogen-based gas turbine technology by:

- Identifying potential barriers and exploring:
  - Research needs
  - Operational issues/effects on GT components
  - Retrofit solutions for high hydrogen-content fuel
  - Safety aspects
- Exploring cooperation opportunities to ensure safe, reliable and cost-efficient solutions for existing and future fleets

Participation
- Users
- OEMs
- ISPs
- Academia

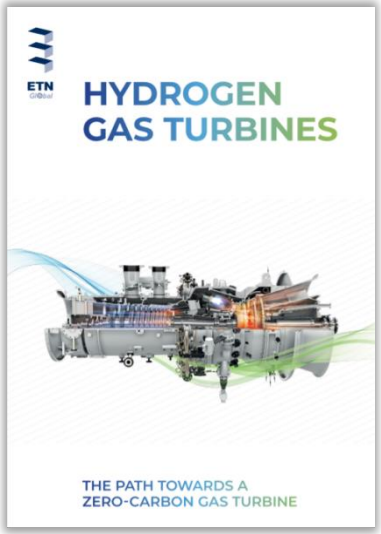
ETN Hydrogen Gas Turbine Report

The path towards a Zero-Carbon Gas Turbine

Working Group

Report to raise the awareness on

- Advantages of hydrogen gas turbines
- Pre-conditions of a hydrogen power plant
- Hydrogen Combustion
- Current hydrogen capabilities of gas turbines
- Retrofit opportunities of existing gas turbines



Download at
etn.global/hydrogen-report

Additive Manufacturing Working Group

Working Group

Objective: Exchange knowledge and experiences focusing on the added value of AM

Activities

- Equipment and process market overview
  - AM Equipment and Suppliers database – beta online
- Product quality and control
  - ✓ ETN best practices booklet
  - Case study on AM product quality and control
- Influence future EU R&I Programme to include relevant proposals for the turbomachinery sector
  - ETN AM Research roadmap

Working Group

Air Filtration Working Group

Objective: Improvements of quality and flexibility of Air Filtration systems

ETN liaison member of the ISO/TC142

- Comments on ISO 29461 - Particulate Air Filters intake systems for rotary machinery
- Revison of the "*Water/Salt test procedure for Gas Turbine/Compressor Air Inlet Filter Systems*" to be part of ISO 29461 – Part 5: *"Test Methods for static filter systems in marine and offshore environments"*

Testing activities

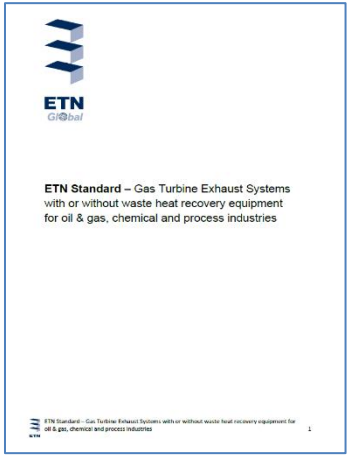
- Aging effect of the filters
- Performance of the single filter in a multi-stage system
- Independent air filtration test on a model-scale test rig
  Test of filters in close-to-real GT operation conditions

Exhaust System WHRES Working Group

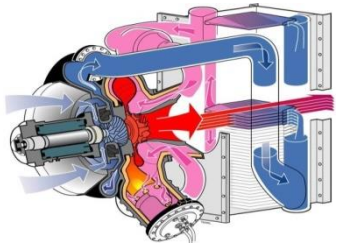
Objective: Create an ISO standard on exhaust system designs for gas turbines

ETN liaison member of ISO/TC192

- ETN WHRES standard available on ETN website for members
- Draft ISO standard under review, publication scheduled by mid 2020
- Published in March 2020



Micro Gas Turbine Working Group



Explore markets opportunities and solutions

Pave the way for funding opportunities by highlighting the importance of the MGT technology development, contributing to the achievement of the 2030 climate and energy targets set by the European Commission

Initiate R&D projects

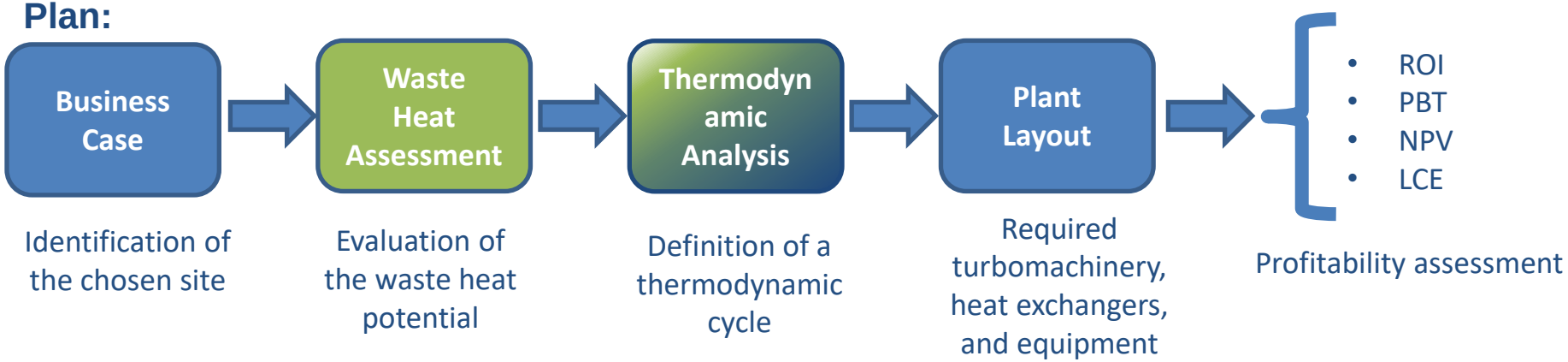
Activities

- MGT Technology Summary
- ISO 19372 - Microturbines applications – Safety
- Meetings

sCO2 Working Group

Objectives: The aim of the project is to investigate the technical and economic feasibility of a sCO2 waste heat recovery system for power generation in heavy industry.

Plan:



Activities: 3 business case identified: Cement, Iron, Steel Industries.
Waste Heat Assessment done for the 3 business cases – report shared with ETN members
Thermodynamic analysis in progress.

ETN Collaboration towards Emissions Reduction

- **Industrial Emission Directive (IED) Forum Member**

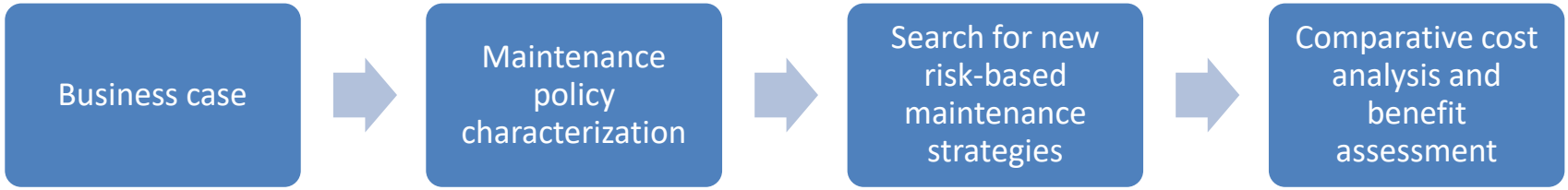
  ETN is a recognised member of the IED Forum and a collection point for inputs from the User Community

  - Large Combustion Plant Directive BREF
  - Medium Combustion Plant Directive

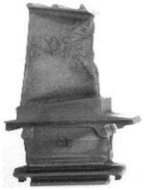
GT Components Life Assessent Task Force

Objective: to verify the feasibility of extending the life of GT components through risk analysis and the assessment of the related costs and benefits.

Advantages: A risk-based (data-driven) approach is easier to use, time-efficient and less costly than a modelling approach = significant economic benefits.



Hot Corrosion Task Force



Objective: To understand the likely causes of hot corrosion and address hot corrosion damages on the hot gas path parts of the gas turbine

Best practices, metallurgical analysis

Survey

Find Users with Hot Corrosion issues and Collection of details on their issues (Type of engine, Location, fuel, …)

Collection of parts

Analysis of the damaged parts

Investigation for solutions

Page & Survey available online

https://etn.global/hot-corrosion

Includes Documentation for ETN Members

Research and Technology Development Priorities for Gas Turbines

- Extended fuel spectrum: hydrogen, ammonia, biogas…
- Increased operational flexibility within emission regulation
- Power-to-X
- Future concepts/cycles (sCO_2 cycles…)
- Future materials and Additive Manufacturing
- Digitalisation, condition monitoring and lifing

Details in ETN's R&D Recommendation Report
etn.global/RDRR

External Involvement

Participation to European Technology and Innovation Platforms

Highlighting GT R&D development opportunities

Smart Networks for Energy Transition

Governing Board - Rob Versteirt (ENGIE)

WG3 Flexible Generation: Peter Jansohn (PSI),

Olaf Bernstrauch (Siemens), Yiguang Li (Cranfield University)

Renewable Heating and Cooling

Biomass panel representative: Peter Kutne (DLR)

Zero Emission Platform

Key priorities

1. Deployment and commercialisation of CCUS; 2. CCU; 3. Engagement with EU and MS; 4. Influence stronger policy support; 5. CCUS financing.

Involvement in the Strategic Energy Technology (SET) Plan

- SET-Plan Action 4 – Increase the resilience, security and smartness of the energy system
- SET-Plan Action 5 – New materials and technologies for buildings
  Increase efficiency of heating and cooling technologies for buildings
- SET-Plan Action 6 – Energy efficiency for industry
- SET-Plan Action 9 – Carbon Capture Utilisation and Storage

EU Projects

NEXTOWER aims at demonstrating high-performance durable materials for the next generation of CSP air-based tower systems, making them com-mercially competitive in the energy market beyond 2020.

- **Dissemination**
- **Market analysis of GTs in CSP ongoing**

PUMP-HEAT project proposes the demonstration of an innovative concept based on the coupling of a fast-cycling highly efficient heat pump (HP) with CCs. The integrated system features thermal storage and advanced control concept

Dissemination

FLEXnCONFU (FLExibilize combined cycle power plant through power-to-X solutions using non-CONventional FUels)

April 2020-April 2024

Dissemination and communication

Young Engineers Committee (YEC)

Vision To bring together the future generation of engineers and leaders of ETN members and the wider energy sector, who are able to sketch pathways for a successful energy transition towards a carbon-neutral society

Objectives

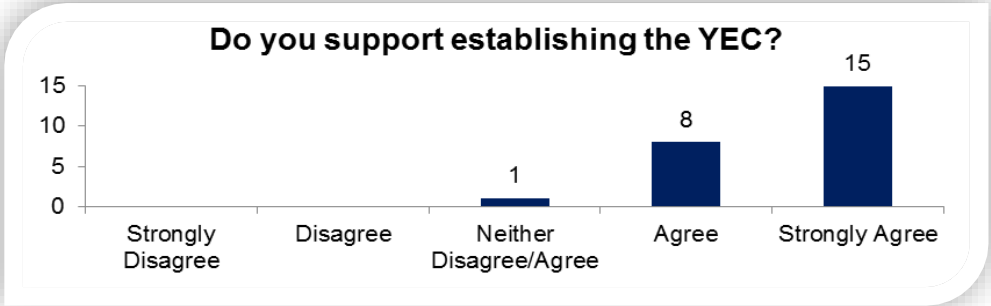
- Develop future leaders in the sector
- Enhance the ETN network
- Pass on experience
- Provide valuable contributions
- Promote low-carbon technologies

Contact:
Valentin Moens (vm@etn.global)

LinkedIn:
ETN Young Engineers Committee

Current member organisations

Baker Hughes, Solar Turbines A Caterpillar Company, uniper, SESTA LAB, Infosys, Cardiff University Prifysgol Caerdydd, FRAZER-NASH CONSULTANCY, Università di Genova, EDF



Gas Turbines in a Carbon-Neutral Society

10th International Gas Turbine Conference

12-13 October 2021, Brussels Belgium

IGTC
International
Gas Turbine Conference

5 keynote sessions
6 technical sessions
30 technical papers to be presented

Communications

www.etn.global website

- Main communications platform and database for member information
- New features: a new support platform: https://etn.global/members-area/questions-answers/

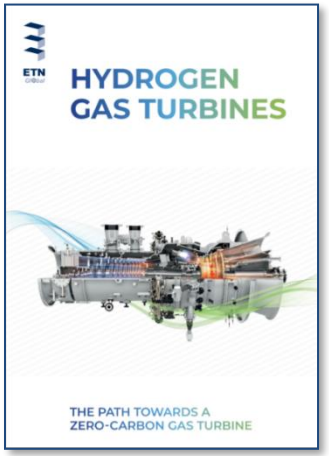
Social media

- ETN accounts on Twitter (@etngasturbine) and Linkedin (ETN Global)

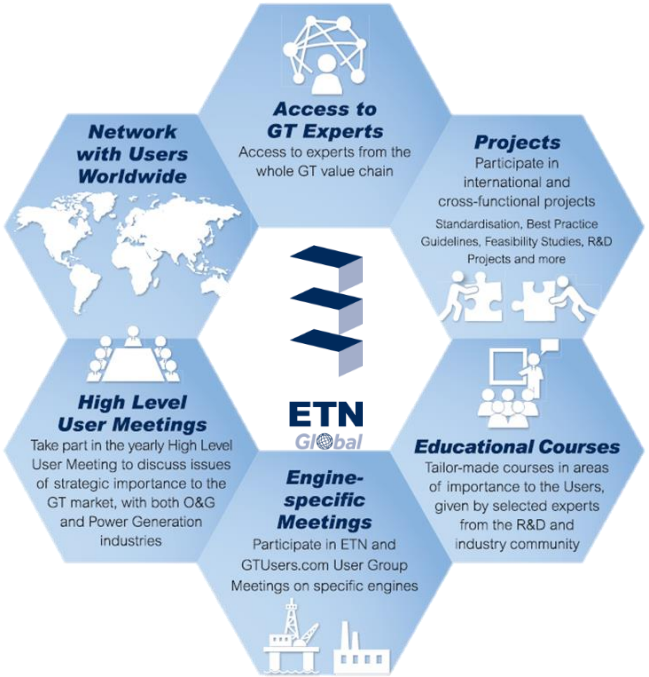
ETN publications

- Monthly News Summary: distributed internally to ETN members every month (700 subscribers)
- Quarterly Newsletter: sent to more than 1500 contacts (members and external contacts) four times a year

Recent Publications



ISO 21905 – Gas turbine applications – Requirements for exhaust and heat recovery unit



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