



# LM2500 USER GROUP 2019 MEETING



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BHGE

*5-6 June 2019, Stavanger, Norway*

**BAKER  
HUGHES**  
a GE company



# ETN Global 2019

## A User Driven Global Gas Turbine Association



Membership-based, non-profit association

Coverage: Gas Turbine and Turbomachinery Technology

110 member organisations

23 countries: Europe, Middle East  
Asia, North America

+700 persons from our member companies  
involved in different ETN activities



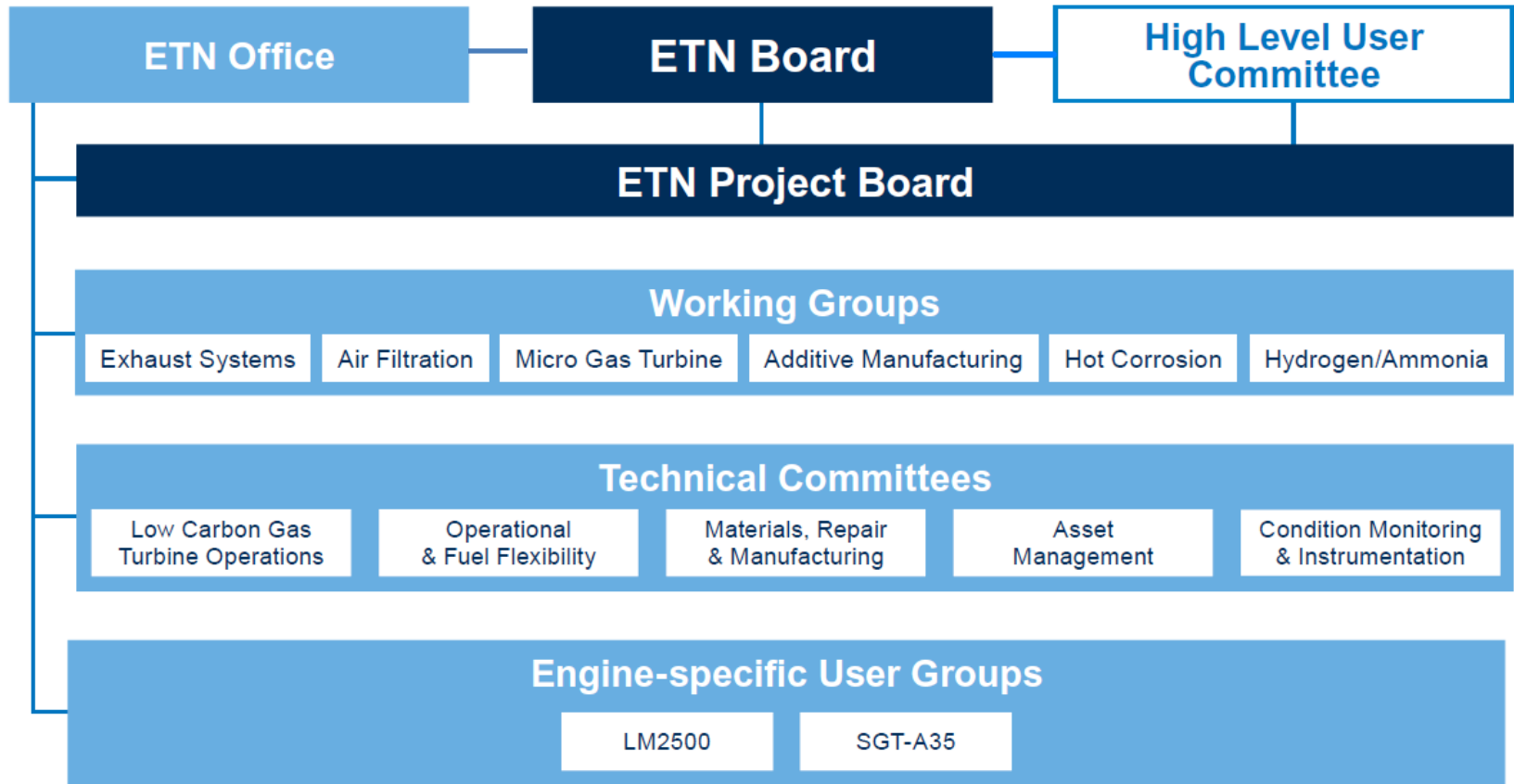
President: Bernard Quoix, Total

Vice President: Catherine Goy, Uniper

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



# Organisational Structure



# ETN Strategy Vision and Mission



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# Vision



To promote the operation of  
environmentally sound turbomachinery technology  
with high reliability and low cost

# Mission

Encourage and facilitate information exchange, research  
and technology developments in key areas

A successful implementation will  
ensure a prosperous user community  
beneficial to the whole turbomachinery value chain



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# Strategy

## Three Key Pillars

Technical issues  
and optimised operations

Market Trends,  
Policy, Legislation

Research and  
Development



ETN Meetings & Events and Dissemination Activities

# Pillar 1

## 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







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# Pillar 2

## 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





# 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 Activities





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# High-Level User Meeting

**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
  - Engines with a high amount of issues
- ❖ Outcome reported to the ETN Community

## **Operation in harsh environment**

'Cold' corrosion

- Coatings
- Water wash
- Materials selection

Hot corrosion

- Coatings
- Materials selection

Filtration

## **Flexibility**

Start ; ramp ; min/max load

Transients/Stabilisation

Ancillaries services

## **Digitalisation**

Condition monitoring

Data management

Optimisation of maintenance intervals

Life predictive modelling

## **Energy Efficiency and Emissions**

Part load

Minimum load

Maximum load

Reliability

## **Reliability of the total system**

## **Cost Optimisation**

CAPEX & OPEX

## **Control Systems Obsolescence**

## **Preservation of GTs & Plant**

## **Advanced Cycles**

## **(Green) Hydrogen**

H<sub>2</sub>

Ammonia

Mixing/blends





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# Engine-specific User Groups



## Process

1. **Collect** and select the 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



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# New online platform for Users

The ETN office has developed new online platforms and databases to gather topics of interest on LM2500 and SGT-A35 (RB211) gas turbines

<https://etn.global/lm2500topics/>

Screenshot of the ETN Global online platform interface showing the SGT-A35 (INDUSTRIAL RB211) TOPICS OF INTEREST page.

The page displays a table of topics of interest, categorized by UGM 2018 and UGM 2019 categories, System, Component name, and Failure Mode. The table includes columns for Index, Status, UGM 2018 Category, UGM 2019 Category, System, Component name, Failure Mode, and Cause.

Key data points from the table:

Index	Status	UGM 2018 Category	UGM 2019 Category	System	Component name	Failure Mode	Cause
23.1	Open	CAT-1	CAT-1	Compressor	Bearings	The HP Thrust Bearing revealed extensive spalling affecting the ball bearings and Outer Raceway. It was also noted that the Bearing Cage had fractured at one ball pocket location.	
23.2	Open	CAT-1	CAT-1	Compressor	Bearings	Thrust Center Bearing Module 3 QDM High Particles Number	none
23.3	Open	CAT-1	CAT-1	Compressor	Bearings	HP Thrust Bearing Failure	Environmental conditions but not believed to be conclusive
71	Open	CAT-1	CAT-1	Instrumentation	Other	Level of unit trips is over double that of equivalent units of similar size in similar applications.	Various causes on different instrumentations and systems sometimes just a temp speratic spike.

Smartphone displaying the ETN Global online platform interface, showing a table of topics of interest.

Index	Status	UGM 2018 Category	UGM 2019 Category	System	Component name
23.1	Open	CAT-1	CAT-1	Compressor	Bearings
23.2	Open	CAT-1	CAT-1	Compressor	Bearings
23.3	Open	CAT-1	CAT-1	Compressor	Bearings
71	Open	CAT-1	CAT-1	Instrumentation	Other
92	Open	CAT-2	CAT-1	Power Turbine	Seals
116	Open		CAT-1	Axial Compressor	Abradable Components
101.2	Open		CAT-1	Combustion	DLE System



CAT-1				
Blisk blade ductile deformation	Compressor pitting corrosion on st.2 disk	HPC st.16 blade failure : tip and platform damage and/or release	HPC st.15 blade failure : liberation/ Platform loss/ Tip release	DLE engine feeder tube cracking
IGB duplex	4B Bearing	5R Bearing	TMF scavenge return tube wear	HPT Stage 1 TBC degradation/separation
CRF B-sump oil supply cracking	3R Bearing spline corrosion	4B failure at low load		

CAT-2				
DLE engine high NOx emissions at full load	Combustor TBC wear	Flame detector signal faults	Compressor rotor air duct vespel wear	Pipe cracking on st.13 cooling air manifold
HPC St.8 bleed corrosion	Ruggedized compressor improvement for HPC st.12 &14 failure	VSV Torque Shaft Bearing Support improvements SB248 & 249	VSV bearing block mechanical rub	Fuel manifolds valves stuck in position
T48 thermocouple probe missing sleeves	Damaged cables and erratic instrument readings	PX36 pulsation probe erratic reading	T54 probe support failure	6-oclock position O-rings degradation under high temperature
CDP valve cabling and high temperature issue	FMV command VS feedback mismatch	Premixers check valves prohibitive repair cost		

CAT-3				
CDP Position error				



# Working Groups, Projects and other activities



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# 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 carriers (such as ammonia)
- ❖ Address issues related to ammonia combustion in gas turbines



# 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:

- ❖ **ETN AM equipment and process database;**
- ❖ **AM product quality and control**
  - ✓ ETN best practices booklet: “Best practices for defects detection in additive manufactured components in the energy sector”;
  - ✓ Case study on AM product quality and control;
- ❖ **AM research roadmap**
  - ✓ ETN Roadmap
  - ✓ Cooperation with the AM European Forum





# Air Filtration Working Group



**26 Member organisations**

## **Objectives:**

Improvements of quality and flexibility of Air Filtration system

ETN liaison member of the ISO/TC142

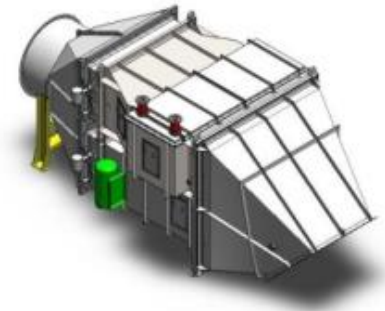
- ❖ Comments on ISO 29461 - Particulate Air Filters intake systems for rotary machinery
- ❖ Drafting of a *“Water/Salt test procedure for Gas Turbine/Compressor Air Inlet Filter Systems”* to be part of ISO 29461 – Part 5: *“Test Methods for static filter systems in marine and offshore environments.”*

## **Testing activities:**

- ❖ To evaluate the aging effect of the filters
- ❖ To evaluate the performance of the single filter in a multi-stage system
- ❖ To perform an independent air filtration test on a model scale test rig to test filters in close-to-real GT operation conditions



# Exhaust System WHRES Working Group



## 19 Member organisations

### Objectives:

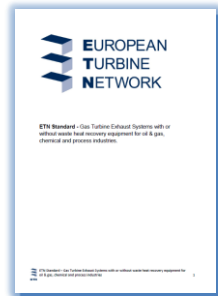
Create an ISO standard on exhaust system designs for gas turbines

ETN liaison member of ISO/TC192

- ❖ ETN WHRES standard submitted to ISO/TC192 in February 2016

### Activities

- ❖ New Work Item in ISO/TC 192 to draft an ISO standard scheduled to be published in 2019.
- ❖ 3 ETN members actively involved in the ISO/TC 192 Working Group
- ❖ ETN Exhaust System WG members will be invited to submit comments on the draft ISO standard.



# Hot Corrosion Working Group



## Objectives:

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

## Page & Survey available online

<https://etn.global/hot-corrosion>

Includes Documentation for ETN Members

### 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



# 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

## ❖ Methane Emission

ETN approached by GIE and Marcogaz, who leads a Joint Task Force with the objective to explore ways to reduce Methane emissions.

Report to be presented at the Madrid Forum 5-6 June 2019



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# CEN SFGas Working Group

“Pre-normative study on H-Gas Quality Parameters”

The Sector Forum Gas Working Group (SFGas WG) is a joint working group between Sector Forum Gas Infrastructure and Sector Forum Gas Utilization.

## Objective:

To try to define a Wobbe Index range to be used within a revised version of EN 16726:2015 “**Gas Infrastructure – Quality of Gas – Group H**”.

Uniper and ETN office attend and represent ETN during these meetings.

Input from members welcomed!

# Activities to pave the way for R&D funding

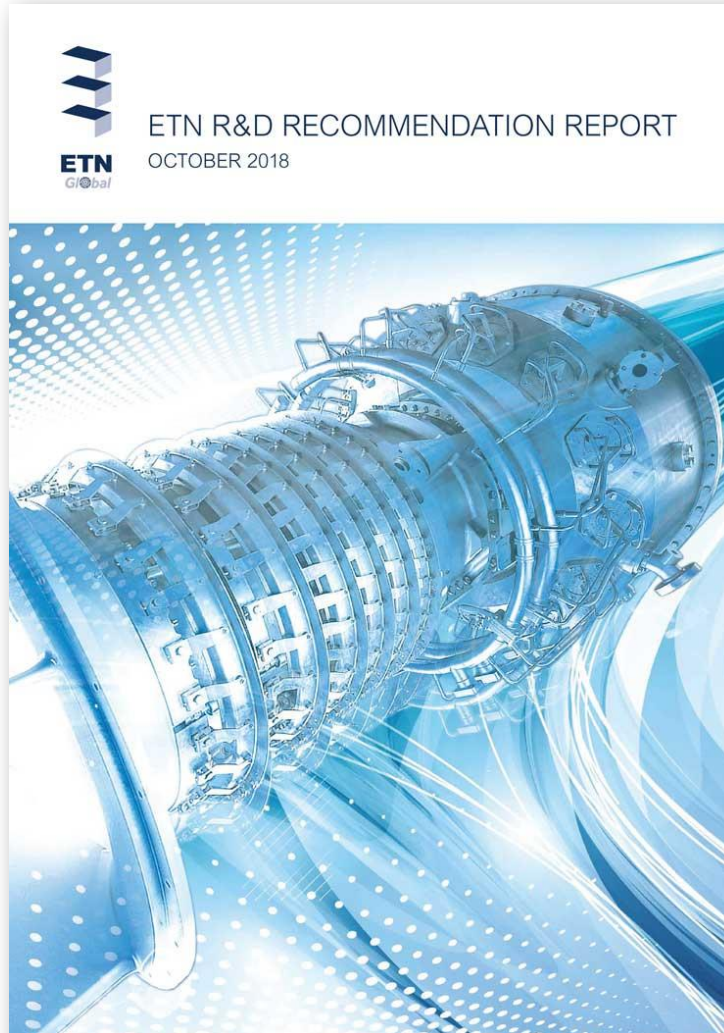


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# Involvement in the EU Technology and Innovation Platforms

- ❖ Renewable Heating and Cooling Platform (RHC)
- ❖ Smart Networks for Energy Transition (SNET)
- ❖ Zero Emission Platform (ZEP)
- ❖ Comments and input to the Strategic Energy Technology Plan





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# Publications and databases

## **R&D Recommendation Report**

ETN Project Board published a new edition of ETN's R&D Recommendation Report in early October 2018, ahead of the International Gas Turbine Conference (IGTC-18).

## **White Paper on digitalisation**

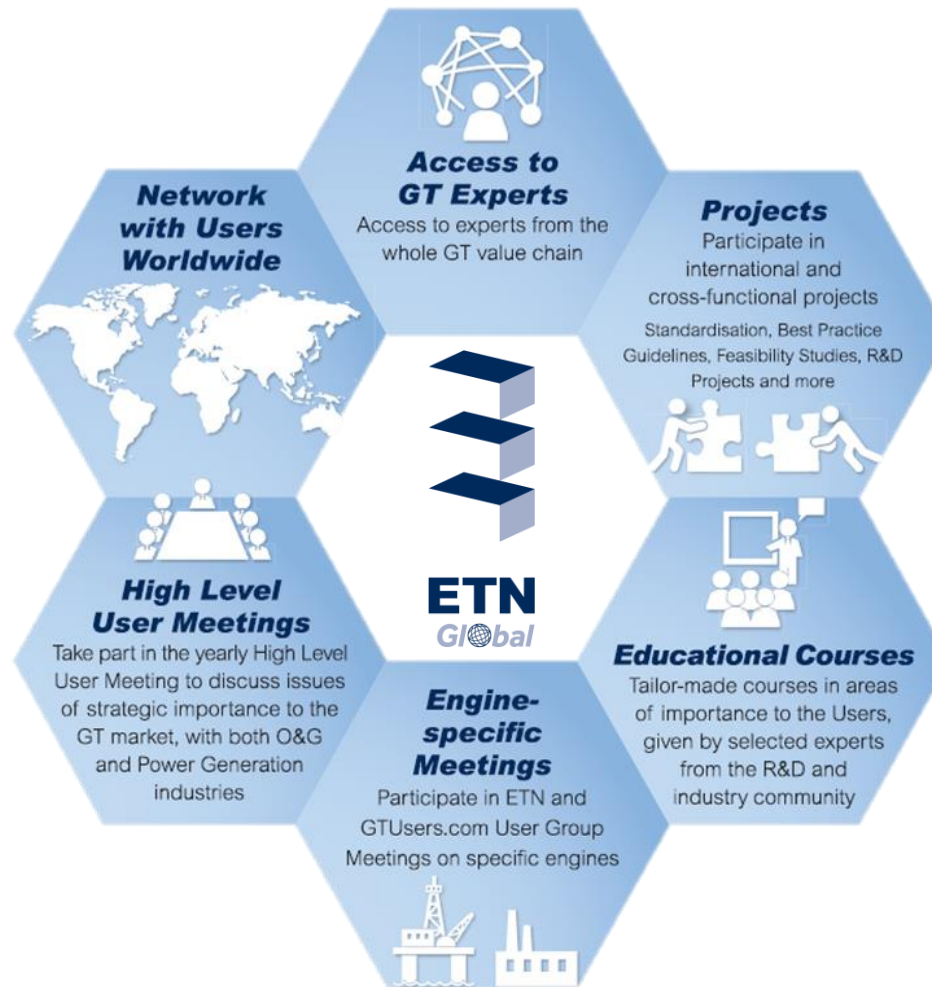
ETN's White Paper Industrial Internet: the next age of productivity for European GT based plants is to provide support and guidance to the ETN members on Industry 4.0 and the Industrial Internet.

## **ETN booklet on additive manufacturing**

The booklet "Best practices for defects detection in additively manufactured components in the energy sector" is now available for ETN members.

## **New online platform for users**

The ETN office has developed new online platforms and databases to gather topics of interest on LM2500 and SGT-A35 (RB211) gas turbines.



# Questions?

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