

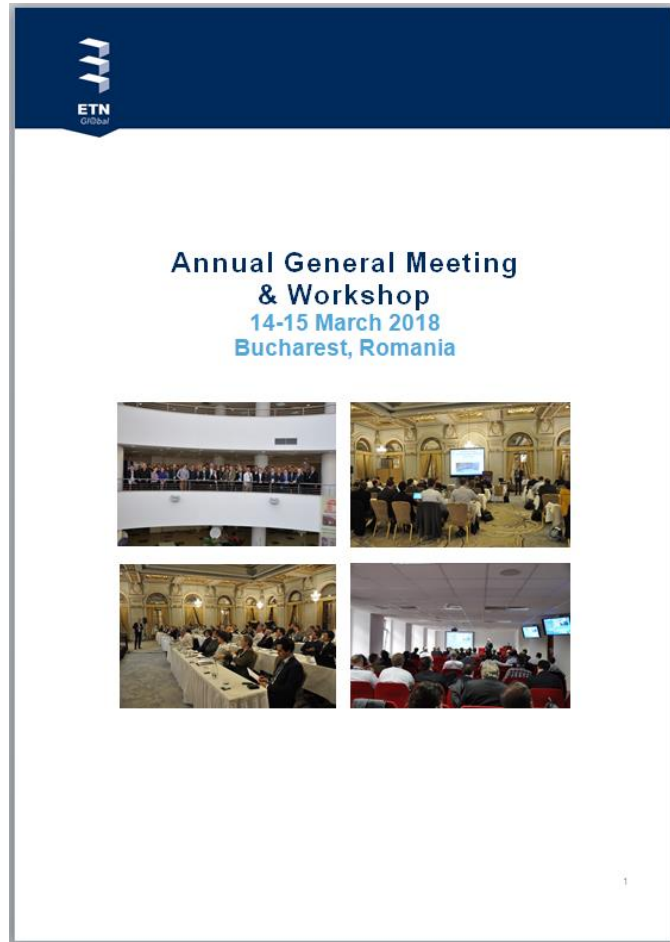


# Welcome to ETN's 15<sup>th</sup> Annual General Meeting & Workshop

27-28 March 2019  
Pau, France



# Approval of the AGM-2018 Meeting report



# Activity report

Annual General Meeting, 27 March 2019



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**Christer Björkqvist**  
**Managing Director**  
ETN Global

# ETN Activity report

## April 2018- March 2019



1. ETN 2019 and New Members
2. ETN Governance
3. Energy & Climate Policy and Market
4. ETN Meetings
5. WG, Projects and other Activities
6. Publications
7. Collaborative Conferences
8. Communication





# ETN 2019 and New Members



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# 9 new members since last AGM



**Members in 2019**

# 108

1. Fiatec Filter & Aerosol Technologie (Germany)
2. Maharatna Oil and Natural Gas Corporation (India)
3. Gastops (Canada)
4. Mechanical Field Support (Netherlands)
5. Masood John Brown International (UK)
6. Braden Europe (Netherlands)
7. Vattenfall (Netherlands)
8. Enipower (Italy)
9. Staffordshire University (UK)

# ETN Global 2019



**Coverage: Gas Turbine and Turbomachinery Technology**

**108 member organisations**

**23 countries: Europe, Middle East, Asia, North America**

**+700 persons from our member companies are following/involved in ETN activities**

**+1500 persons registered for our Quarterly Newsletter**

International Cooperation with associations from Japan (GTSJ); USA (DOE, GTA and ASME); Canada (GTEN), China (NRC-GT, NexTurbine); UAE (ME Rotating Machinery Technology & Innovation conf.)



# Governance



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# ETN Board of Directors

## 2018-2020



**Bernard Quoix**  
Total  
ETN President



**Catherine Goy**  
Uniper  
ETN Vice President



**Bram van Cauwenberge**  
Engie



**Walt Steimel**  
Shell



**Gary Lock**  
Frazer-Nash Consultancy



**Andy Williams**  
Chromalloy, ETN Treasurer



**Mick Conway**  
RWG Repair & Overhauls



**John Oakey**  
Cranfield University



**Manfred Aigner**  
DLR



**Aristide Massardo**  
University of Genoa



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# ETN Project Board

## 2018-2020



**Peter Jansohn (chair)**  
Paul Scherrer Institute, CH



**Abdalnaser Sayma**  
City, University of London, UK



**Peter Breuhaus**  
NORCE, NO



**Peter Kutne**  
DLR, DE



**Yiguang Li**  
Cranfield University, UK



**Dominique Orhan**  
Total, FR



**Olaf Brekke**  
Equinor, NO



**Nicola Rossi**  
Enel, IT



**Marco Ruggiero**  
BHGE, IT



**Olaf Bernstrauch**  
Siemens, DE



**Grant Terzer**  
Capstone, US



**Chris Dagnall**  
DNV-GL, UK



**Rene Vijgen**  
Sulzer, NL



# Energy & Climate Policy and Market



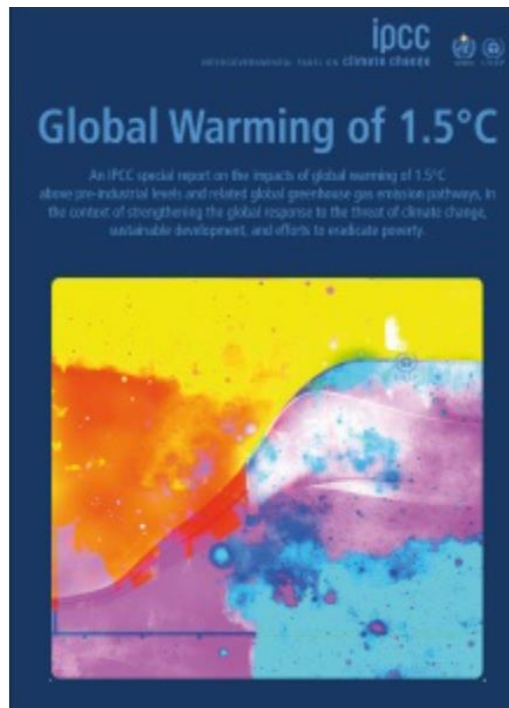
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# IPCC 2018 Report

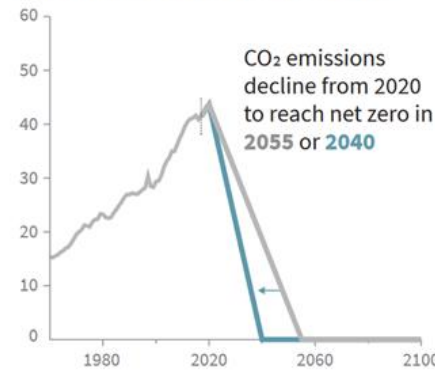
8 October 2018 Incheon, Republic of Korea



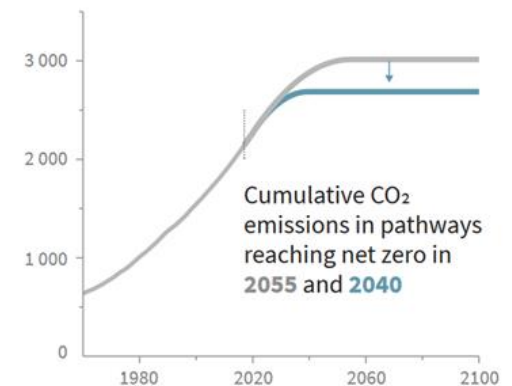
Paris Agreement



**b) Stylized net global CO<sub>2</sub> emission pathways**  
Billion tonnes CO<sub>2</sub> per year (GtCO<sub>2</sub>/yr)

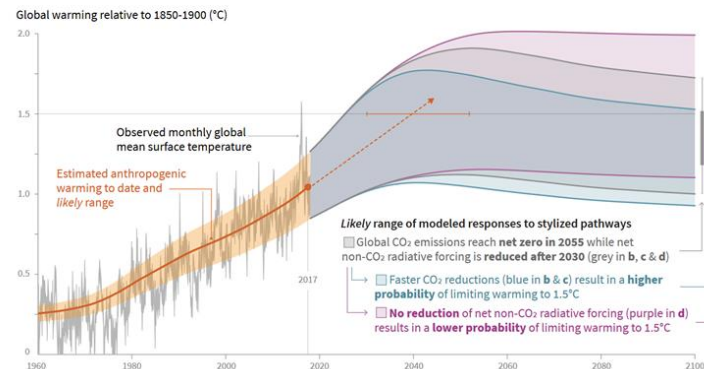


**c) Cumulative net CO<sub>2</sub> emissions**  
Billion tonnes CO<sub>2</sub> (GtCO<sub>2</sub>)



Faster immediate CO<sub>2</sub> emission reductions

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



## Wake up call

# 2°C Not enough!

## IPCC 2018 Report

### 5 Steps to a 1.5 °c Change

1. Global emissions of CO<sub>2</sub> need to decline by **45%** from 2010 levels by 2030
2. Renewables (carbon-free energy) to provide up to 85% of global electricity by 2050
3. Coal is expected to reduce to close to zero
4. Up to seven million sq km of land needed for energy crops (a bit less than the size of Australia)
5. Global net zero emissions by 2050





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# Demonstrations around the World by Students

Pressure to decarbonise is increasing



Bangkok



Greta  
Thunberg

Lagos



Berlin



Delhi

# Raising concern about Climate Change in US

Ambitious Climate Goals, California,  
Zero-carbon electricity by 2040 and  
**Carbon neutrality no later than 2045**



California Gov. Jerry Brown



Wildfires in CA

# 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



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# Energy Union



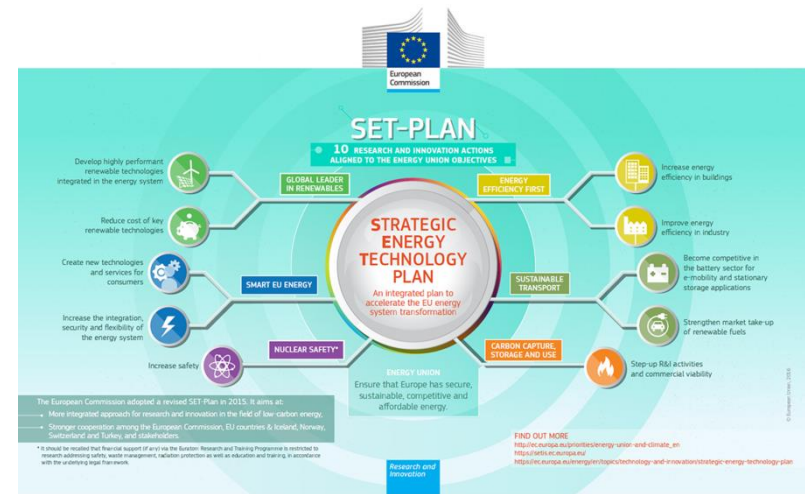
**Vision:** An Energy Union that can ensure secure, affordable and climate-friendly energy

## 5 dimensions

- Energy security
- Energy efficiency
- Energy market
- Climate action: decarbonising economy
- Research, innovation and competitiveness



## Strategic Energy Technology Plan SET-Plan





# Clean Energy for All Europeans

Package – Adapted in Dec 2018

## New Energy Legislative 2030 Framework for Climate and Energy





# **“A Clean Planet for all”**

## **European Commission’s Proposal released, November 2018**

### **EC’s strategic long-term vision for a prosperous, modern, competitive and climate neutral economy by 2050 released.**

The roadmap to a climate neutral economy incl. 7 strategic areas:

1. energy efficiency;
2. deployment of renewables and electrification;
3. clean, safe and connected mobility;
4. competitive industry and circular economy;
5. infrastructure and interconnections;
6. bio-economy and natural carbon sinks;
7. carbon capture and storage to address remaining emissions

2019

- **Review process by EP and Council started**

2020

- **Final version expected in early 2020**



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# European Parliament's Response

to the EC's 1st draft: long-term net-zero strategy  
February 2019



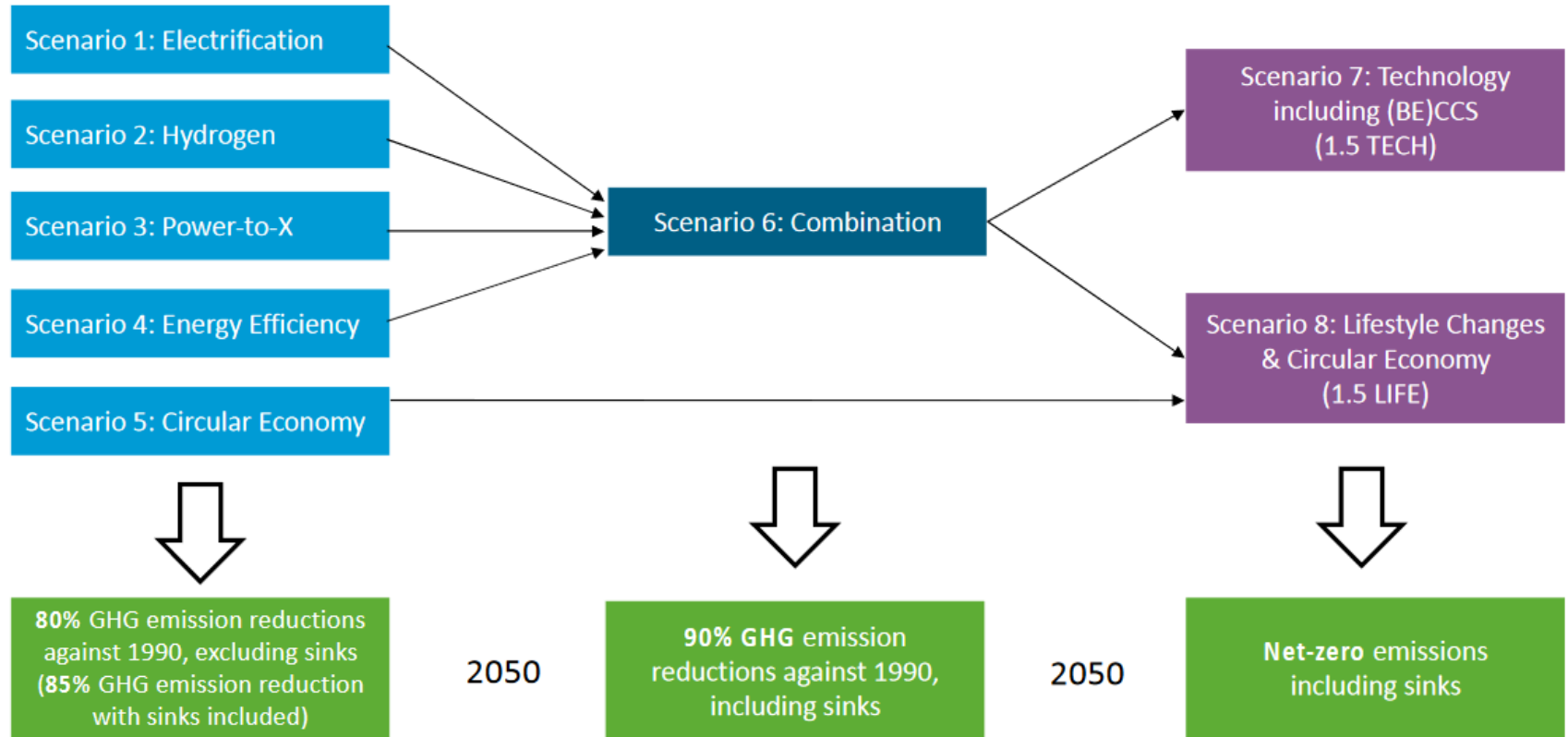
EP supports only 2 out of the 8 EC scenarios

These scenarios require more ambitious targets to reach net-zero greenhouse gas (GHG) emissions by 2050 in a cost-efficient way:

- **2030 emission reduction targets to 55%** (compared to 1990 levels)
- **Allocate at least 35% of the budget on research (Horizon Europe) to support climate objectives**

# EC net-zero strategy proposal

## Long-term strategy



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

# **Natural gas expected to increase by 20% by 2030 and LNG export to double by 2040**

**Climate change and local air pollution concerns  
result in an accelerated switch from coal to gas-  
fired power**

***Natural Gas predicted, by DNV GL, to become the  
world's largest primary energy source by 2025***




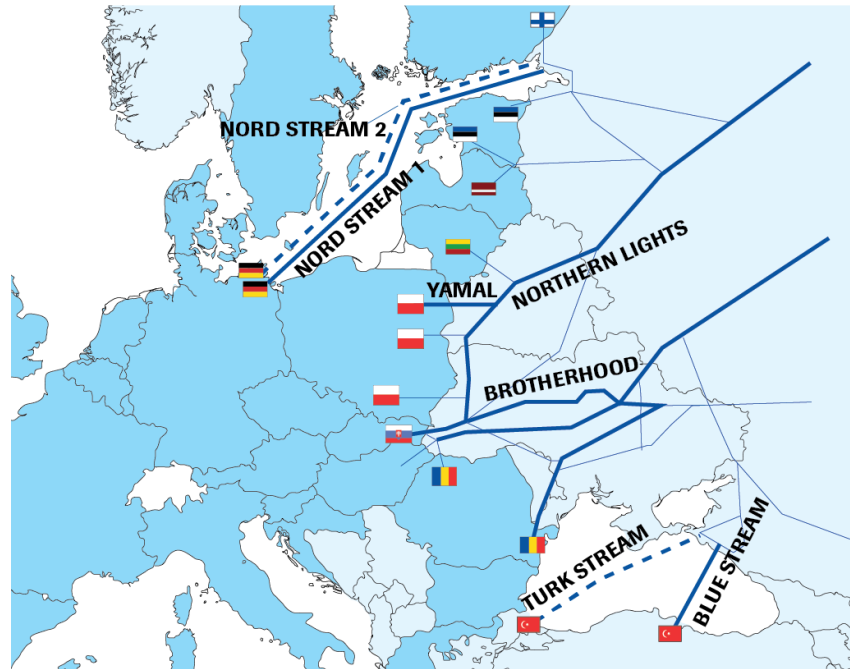


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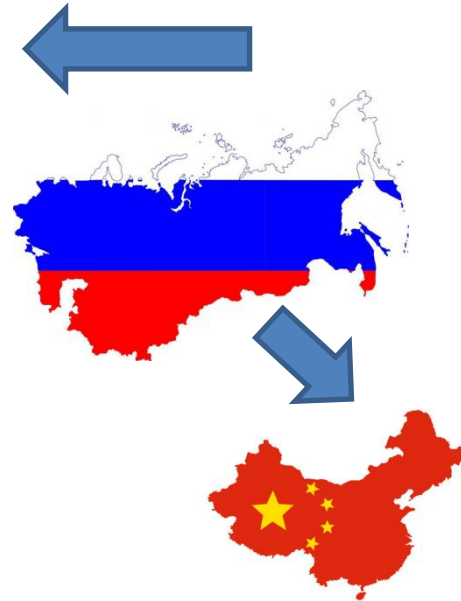
# Geopolitical positioning for export of natural gas



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



**201 bcm**  
in 2018



## Big investments!





# ETN Meetings since April 2018



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# Meetings 2018-2019

## since the AGM 2018



- ❖ Engine-specific User Groups meetings: SGT-A35, LM2500
- ❖ European Commission - US DOE meeting: 8 October 2018
- ❖ High Level User meeting: 9 October 2018, Brussels
- ❖ IGTC-2018 - The Future of Gas Turbines: 10-11 October
- ❖ Board Meetings: 18-19 July, 12-13 Dec 2018, 27 March 2019
- ❖ Project Board meeting: 17-18 Jul, 11-12 Dec 2018, 27 March 2019
- ❖ Working Group meetings: Additive Manufacturing, Air Filtration, MGT, Bearing project
- ❖ External Cooperation Conferences: Nexturbine, China; ASME IGTI, US; GPEX, Barcelona; ME Rotating Equipment Conference, Dubai; GTEN, Canada



# ASME 2018 TURBO EXPO

Turbomachinery Technical Conference & Exposition  
Presented by the ASME International Gas Turbine Institute

CONFERENCE  
June 11 – 15

EXHIBITION  
June 12 – 14

Norges Varemesse  
Lillestrøm, Norway

## ETN Co-Chairing of the EPC User Panel Session



## ETN Stand in the Expo





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# Engine-specific User Groups



Sitges (Barcelona) Spain,  
26-27 April 2018



Berlin, Germany,  
20-21 June 2018



## Process

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

## Content

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

# High Level User Meetings

9 October, Brussels

**Yearly strategic meeting 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
- ❖ 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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# The Future of Gas Turbine Technology

## 9<sup>th</sup> International Gas Turbine Conference

10-11 October 2018

Le Plaza Hotel in Brussels, Belgium



**5 keynote sessions**

**9 technical sessions: 30 technical papers**

**150 attendees**

# Working Groups, Projects and other activities since March 2018



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# 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:

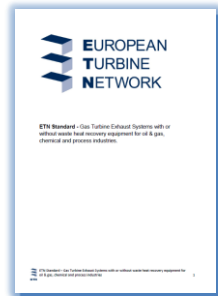
Create an ISO standard on exhaust system designs for gas turbines

ETN liaison member of ISO/TC192

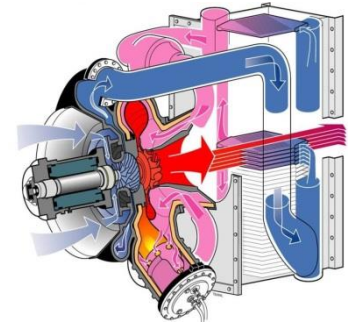
- ❖ ETN WHRES standard submitted to ISO/TC192 in February 2016

### 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.



# Micro Gas Turbine Working Group



## Objectives

- ❖ **Explore markets opportunities and solutions;**
- ❖ **Implement cooperation projects** in order to reduce cost and increase the Technology Readiness Level (TRL) of individual components and systems;
- ❖ Set-up conferences and workshops to **facilitate cooperation** in both horizontal and vertical projects;
- ❖ **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.

## Activities

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





# 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



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# Ammonia Interest Group

Ammonia and Hydrogen combustion  
Two separate R&D topics under one new WG

Objective: To extend the fuel Spectrum to carbon-free fuels



**Surf the Hydrogen wave!**

## Hydrogen WG

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# Hydrogen Working Group

Explore, enable and optimise 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





# 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 lead 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



# 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!

# Dissemination Projects

# The OMSOP Project

## Optimised Micro Turbine Solar Power

Completed in Autumn 2017



Demonstration of concentrated solar power technology using a parabolic dish system powering a micro-gas turbine

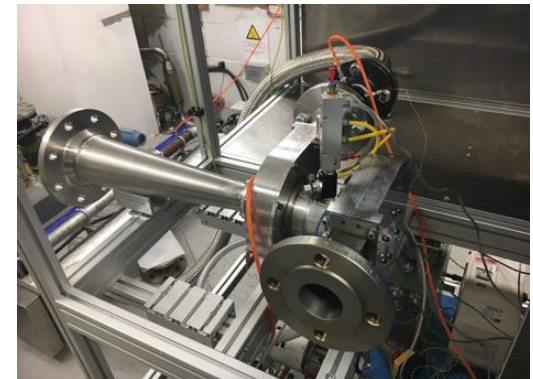
**Dissemination**  
September 2018

Chinese delegation visit

Visit to City University,  
London; KTH, Stockholm  
and Enea, Rome



Demo facilities at ENEA's  
facilities in Rome Italy





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Dissemination  
projects

# Bio-HyPP

## Biogas-fired Combined Hybrid Heat & Power Plant

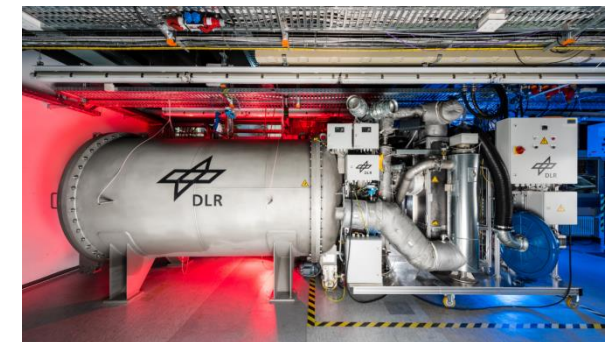
Development of a **full-scale technology demonstrator** (TRL 4) of a **hybrid power plant** (SOFC and MGT) using **biogas** as fuel (2015-2019)

- Objectives:

Electric power	30 kW	Electric efficiency	> 60%
Total efficiency	> 90%	Operational range	25-100%
Emissions (NO <sub>x</sub> /CO)	<10/20ppm	CH <sub>4</sub> content	40-100%
Power to heat ratio	> 2	Primary energy savings	> 50%



MGT hybrid test rig



SOFC hybrid test rig

### Stakeholders' meeting and onsite visit – 08 May 2019

The Bio-HyPP consortium is inviting stakeholders for a full day session to discuss about project activities and results, and to exchange insights and perspectives about the technology and related market potential.





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Dissemination  
projects

# PUMP-HEAT



## Objective

Demonstration of an innovative concept based on the coupling of a fast-cycling highly efficient heat pump (HP) with Combined Cycles.

The integrated system features thermal storage and advanced control concept for smart scheduling.

[www.pumpheat.eu](http://www.pumpheat.eu)



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# NEXTOWER

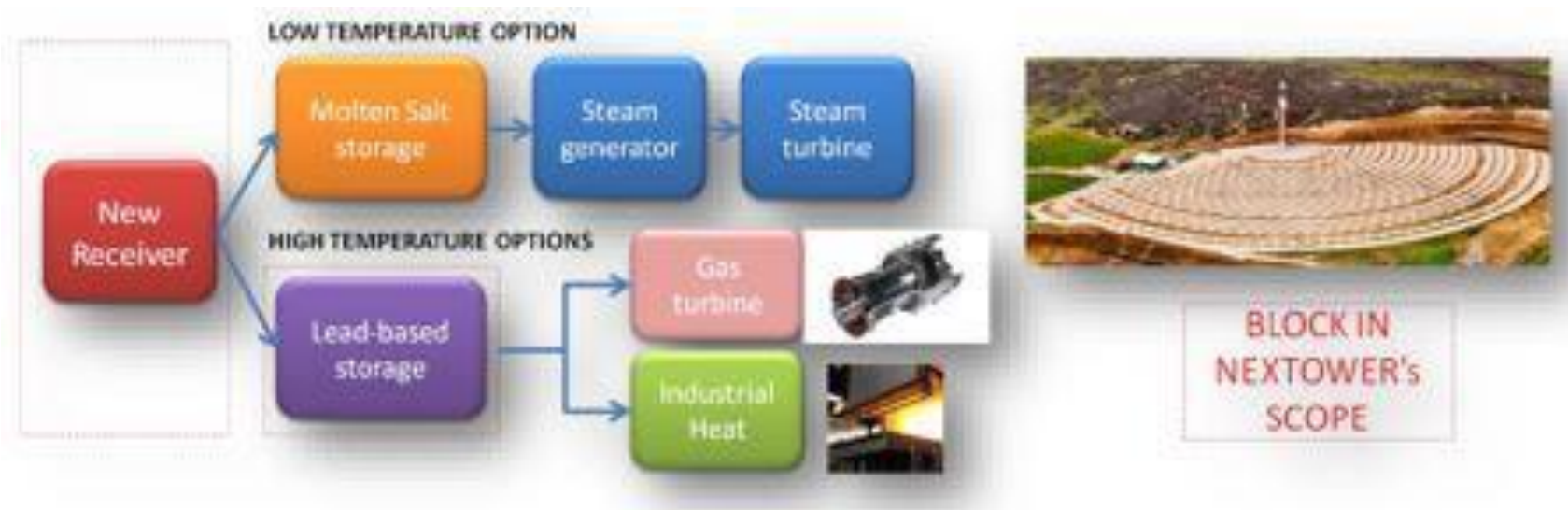


Dissemination  
projects



## Objective

Demonstration of high-performance durable materials for the next generation of concentrated solar power (CSP) air-based tower systems, making them commercially competitive in the energy market beyond 2020.



<http://www.h2020-nextower.eu>

# Activities to pave the way for R&D funding

# 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



# Exploring cooperation opportunities between EC and US DOE

**Meeting between high level EC and US DOE representatives**

8 October 2018

**Objective:** to explore cooperation opportunities on RD&I activities in common areas of interest building on the already successful cooperation between UK and US DOE







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# Oil and Gas Climate Initiative



OIL AND GAS CLIMATE INITIATIVE

**Delivering solutions for a sustainable low-emissions future**

**Objective:** reduce the greenhouse gas emissions

- Energy efficiency waste heat recovery
- Low carbon technology solutions
- CCUS CO<sub>2</sub> recycle

**March 2019:** ETN meeting with Dr. Ganesh Kailasam, Technology Director OGCI Climate Investments LLP

**Objective:** to present ETN, our R&D report and explore cooperation opportunities

**Outcome:** Willing to listen and review any development ideas/projects



**ExxonMobil**



أرامكو السعودية  
saudi aramco



# EUTurbines

## Power the EU campaign

*Driving the transition to renewable-gas power generation*

In January 2019, EUTurbines launched their ongoing campaign with a joint OEM statement that:

- ❖ All new gas turbines would be able to handle a 20% share of hydrogen by 2020 and a 100% share by 2030
- ❖ Retrofit solutions would be provided and OEM fuel specifications would be reviewed

<https://powertheeu.eu/>



# Publications



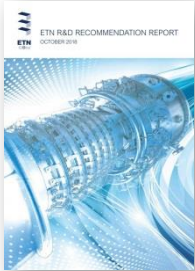
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# Publications and databases

## **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 gas turbines.

# Collaborating Conferences



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# Collaborating Conferences (1)

**NexTurbine** the 8<sup>th</sup> Annual Summit,  
29-31 May 2019, Wuxi, China



ASME Turbo Expo,  
17-21 June 2019, Phoenix, US



International Gas Turbine Congress  
NOVEMBER 17-22, 2019, TOKYO, JAPAN



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# Collaborating Conferences (2)



Middle East Rotating Machinery  
Technology & Innovation Conference,  
8-10 Oct 2019, Dubai, UAE



European Utility Week and PowerGen Europe, 12-14 November  
2019, Paris, France

Future Energy Asia  
Feb 2020, Bangkok





# Communication



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# Communication

## New [www.etn.global](http://www.etn.global) website

- ❖ Main communications platform and database for member information
- ❖ New features: new navigation, mobile friendly design, event registration, online platform for users and new sections such as educational courses

## Social media

- ❖ ETN accounts on Twitter ([@etngasturbine](https://twitter.com/etngasturbine)) and LinkedIn ([ETN – European Turbine Network](https://www.linkedin.com/company/ETN-Europe))

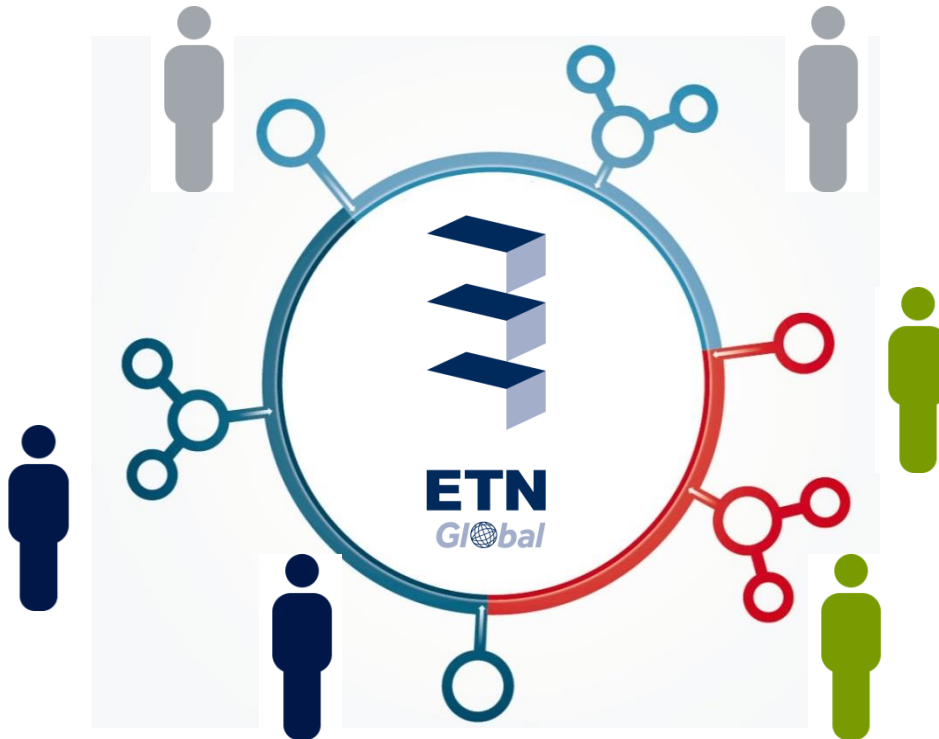
## ETN publications

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



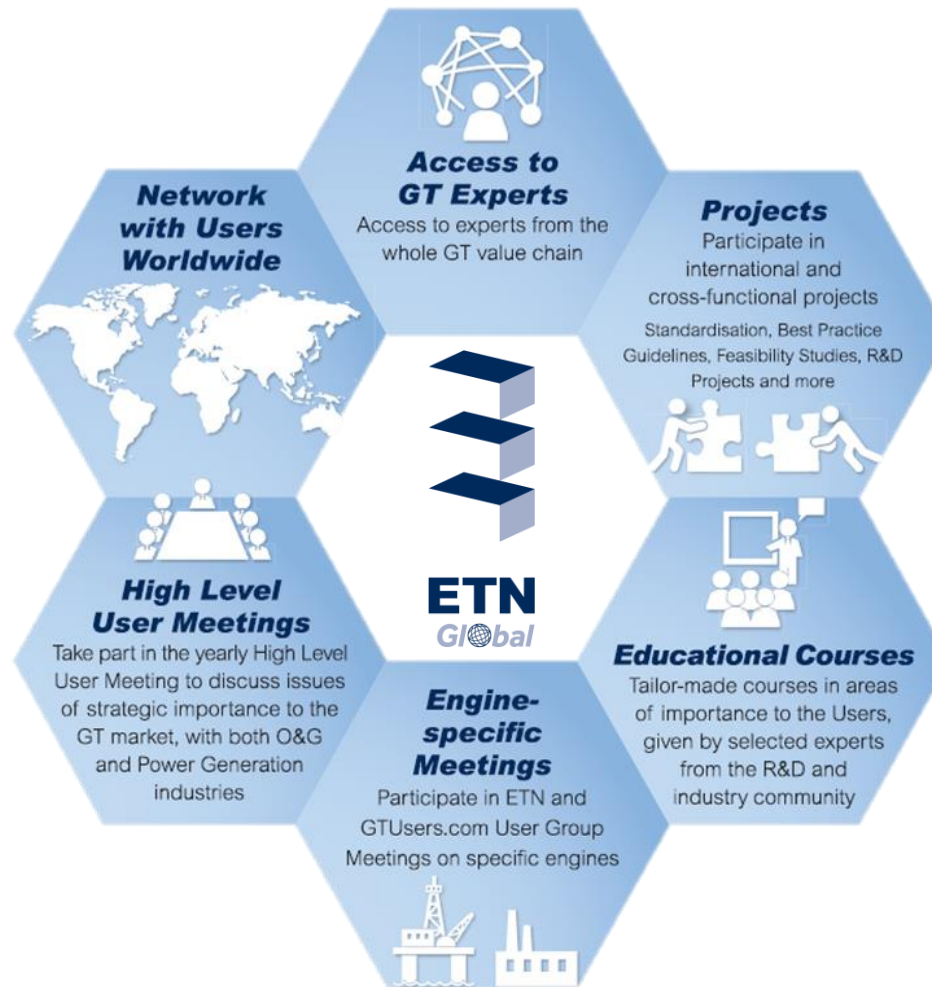
# Education/Training Platform

Involvement of the ETN community



**ETN is collecting  
Turbomachinery related  
educational courses  
from Members**

**Please send us relevant  
courses with a short  
description and link to be  
displayed on our website**



# Questions?

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