BRINGING TOGETHER GAS TURBINE USERS AND THE WIDER TURBOMACHINERY COMMUNITY

ETN GLOBAL – INTERNATIONAL MEMBERSHIP ASSOCIATION

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President's message

Since ETN's establishment in 2005, we have built a powerful network representing the whole value chain of gas turbine technology, addressing operational issues, research & development needs, as well as energy policy and regulation. In 2017, our members decided to take a new step and broaden the scope of the network both geographically and operationally. This essential shift to a system-based approach was needed in order to face the drastic changes in the energy markets and regulation worldwide. With the growing number of global members, we can initiate wider collaborations towards common goals that will benefit the whole turbomachinery community. This will reduce costs and risks but also increases our innovativeness and reduces the time of bringing new developments to the market.

As the President of ETN I have continually promoted an active participation of the users, because it is the operators of gas turbines who bring the technology development requirements and needs to the table. Together with the OEMs, suppliers, service providers, universities, R&D institutes and consultancies, ETN cooperates to reduce cost, optimise operation, accelerate innovation and eliminate barriers to the deployment and growth of new technology solutions.

With the high amount of challenges in today's markets, and an even higher amount of uncertainties in the energy transition to a lower carbon energy mix, we need to take cooperation to a new level to ensure a competitive and innovative turbomachinery community. ETN, as an internationally recognised organisation, bringing together the whole value chain, is the appropriate platform we should use to widen this collaboration.

Based on the unique combination of the wide experience and high expertise among our members, I am confident that we together can reach our ultimate goal, which is to enhance the developments that can deliver flexible, environmentally sound turbomachinery technology with reliable and low cost operation.

I hope you find this brochure informative and that it will encourage you to participate in ETN activities for our journey towards competitive and innovative turbomachinery developments.

Bernard Quoix
ETN President, Total

About ETN

Overview

ETN is a membership association ***bringing together the entire value chain of turbomachinery technology***. Through cooperative efforts and by initiating common activities and projects, ETN addresses the main challenges and concerns of the global gas turbine user community in working groups and projects, composed of experts across the whole value chain.

Vision

Competitive environmentally sound turbomachinery technology with reliable and low cost operation.

Mission

To encourage and facilitate information exchange, research and technology development in areas of importance to the user community.

Objectives

- to support development of cost efficient integrated solutions that will provide significant contributions to the goal of keeping global warming below 1.5°C degrees;
- to strengthen the gas turbine industry and users' market globally;
- to initiate projects and standardisations that can achieve tangible advances and cost reductions in gas turbine technology;
- to provide operational technical input to policy makers in terms of gas turbine environmental compliance, technology watch and R&D needs;
- to act as a platform for exchange of knowledge and experiences;
- to coordinate and highlight research and technology development needs of the user community.

Strategy – Three key pillars

Technical issues and optimised operations

- Risk mitigation and technical solutions to:
  - improve energy efficiency and performance
  - improve operational flexibility
  - improve reliability and availability
  - reduce emissions
- Digitalisation / condition monitoring and life assessment
- Standardisation
- Exchange of best practices

Research and development

- Extended fuel spectrum and flexibility: hydrogen, carbon-neutral and renewable fuels
- Carbon mitigation: CCUS, CSP, advanced cycles
- Power-to-X
- Storage
- Advanced monitoring, component life management
- Digitalisation, additive manufacturing

Market trends, policy & legislation

- Monitoring market trends
- Influencing R&D energy policy
- Monitoring and advising on emission regulation
- Development and contribution to standards

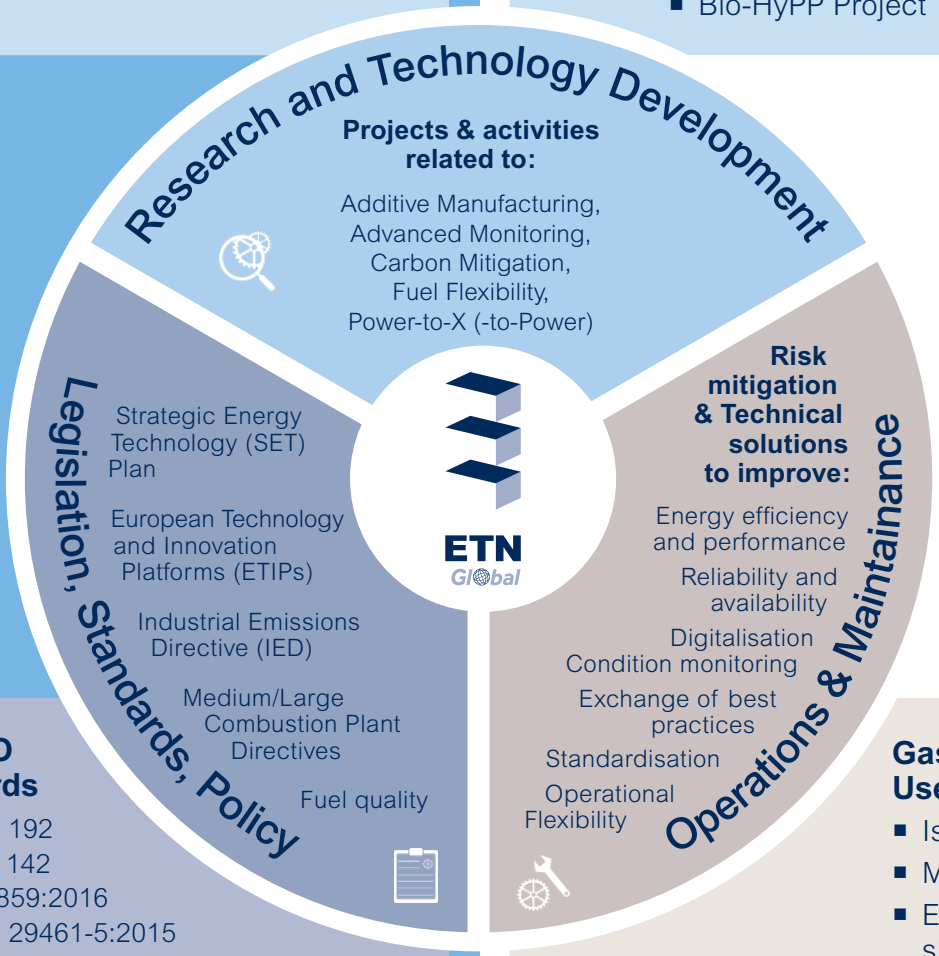
ETN map of activities

ETN publications

- R&D Recommendation Report
- Additive Manufacturing Best Practices booklet
- MGT Technology Summary

Projects and Technical Working Groups

- Hydrogen WG
- Additive Manufacturing WG
- Air Filtration WG
- Exhaust Systems WG
- Micro Gas Turbine WG
- Hot Corrosion WG
- NEXTOWER Project
- PUMP-HEAT Project
- Bio-HyPP Project



ETN/ISO Standards

- ISO/TC 192
- ISO/TC 142
- ISO 19859:2016
- EN ISO 29461-5:2015
- ISO 19372
- Fuel quality and emissions WG

Gas Turbine User Groups

- Issues database
- Meetings
- Experience sharing

Global events & ETN cooperation

ASME Turbo Expo
GTSJ IGTC, Japan
NexTurbine, China
Middle East ROTIC, UAE
ASME IGTI Electric Power Committee
IAGT, Canada
Gastech, Europe
POWERGEN/ European Utility Week

IGTC - The Future of Gas Turbine Technology

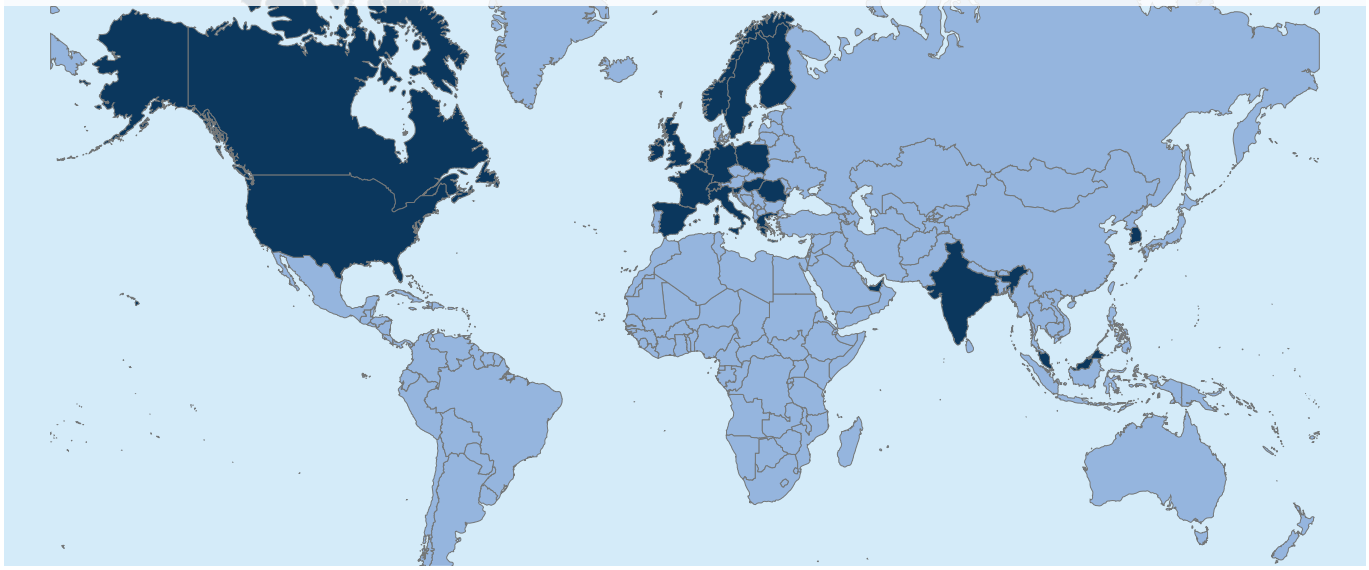
Educational Courses

Members

ETN represents well **over 100 member organisations** active in the whole supply chain of the sector: power generation and oil & gas companies, original equipment manufacturers (OEMs), R&D institutes and universities, suppliers, service providers and technology consultancies.

For the complete list of ETN members, please visit the ETN website: www.etn.global.

A strong partnership bringing together the whole value chain



Organisation Structure

ETN Board

The ETN Board consists of ten elected representatives from five member categories. The Board prepares and **proposes the strategy** of ETN to the General Assembly for final approval. The Board ensures an efficient and sound governance of the association in line with the strategy and goals adopted by the General Assembly.

ETN Project Board

The Project Board provides a **consultative forum and independent support** to new initiatives or issues that are brought to the ETN platform. Its role is to maximise the potential of initiatives and to provide technical and strategic advice as well as support in the project development process.

ETN Technical Committees

The Technical Committees cover the most **crucial areas of future gas turbine technology development**. They serve as forums where the ETN members meet to share experiences and discuss ideas and initiatives, which can later be developed into focused Working Groups and individual projects.

ETN Office

The ETN Office is located in Brussels, Belgium. It acts as a secretariat for the organisation and conducts the running of the association. The role of the ETN Office is to implement the strategy set by the General Assembly, facilitate and coordinate projects and activities of the members, and disseminate the deliverables and results of their initiatives and projects.

ETN R&D Recommendation Report

Every two years, the Project Board publishes ETN's R&D Recommendation Report based on input coming from the entire ETN platform (ETN Board, HL User Committee and Technical Committees). It outlines key research topics of gas turbine development based on the current market outlook and the users' demand.

ETN Office

ETN Board

High Level User Committee

ETN Project Board

Technical Committees

- Low Carbon Gas Turbine Operations
- Operational & Fuel Flexibility
- Materials, Repair & Manufacturing
- Asset Management
- Condition Monitoring & Instrumentation

Working Groups

- Hydrogen Working Group
- Additive Manufacturing Working Group
- Air Filtration Working Group
- Exhaust Systems Working Group
- Micro Gas Turbine Working Group
- Hot Corrosion Working Group

Engine-specific User Groups

- LM2500
- SGT-A35

Working Groups

Hydrogen Working Group

Vision: To enable operation of carbon free fuels in gas turbines.

The aim of the Hydrogen/Ammonia Working Group is to share technical information and address issues related to ammonia and hydrogen combustion in gas turbines. By cooperating on practical combustion issues of hydrogen/ammonia applications, ETN members can develop and implement advanced combustion technologies for gas turbines. This will enable the operation of gas turbines fuelled by hydrogen and/or ammonia used as energy carrier from renewable energy sources.

Additive Manufacturing Working Group

Vision: To enable and optimise the use of additive manufacturing technologies for turbomachinery components.

The objective of ETN's Additive Manufacturing Working Group is to strengthen the cooperation between stakeholders of the turbomachinery value chain on additive manufacturing (AM) topics. Members of the WG benefit from cooperating on AM practices and exchanging knowledge and experiences on the added value that AM could generate, such as short delivery time, efficiency increase by optimised design and delivery of obsolete or "urgent" parts to shorten maintenance outages and overhauls.

Air Filtration Working Group

Vision: To enable 3 years of gas turbine operation without any air filtration issue.

The objective of the Air Filtration Working Group is to allow the users to have a single point of reference for state-of-the-art filtration technology and to address air filtration issues through projects of common interest. ETN represents the WG members in the ISO Technical Committee 142 – "Cleaning equipment for air and other gases", and is actively involved in the drafting of the ISO29461 – "Air intake filter systems for rotary machinery – Test methods". Currently the ETN WG is focused on the harmonisation of different testing procedures for static filter systems in marine and offshore environment.

Exhaust Systems Working Group

Vision: To optimise the design of the Waste Heat Recovery Units and address exhaust system issues.

The goal of the Exhaust Systems Working Group is to address the problems faced by the operators and manufacturers by developing a common standard for the design of gas turbine (GT) exhaust systems. During various meetings it was decided to focus on the creation of the Waste Heat Recovery Unit (WHRU) standard, which has been issued in 2015. In February 2016, the ISO TC 192 – "Gas Turbines" initiated a New Work Item aiming to draft an ISO standard on the WHRU based on the ETN standard. As a liaison member of the ISO TC192, ETN is following the development of the ISO standard.

Micro Gas Turbine Working Group

Vision: To pave the way for the integration of micro gas turbines in the future energy systems.

The goal of the Micro Gas Turbine Working Group is to bring together stakeholders of the whole micro gas turbine (MGT) value chain to initiate a wider collaboration and cost competitive development of the technology in line with the market needs. The objectives of the MGT WG are to: 1) explore market opportunities and solutions; 2) initiate cooperation projects in order to reduce cost and increase the Technology Readiness Level (TRL) of individual components and systems; 3) set up conferences and workshops to facilitate cooperation in both horizontal and vertical projects; 4) pave the way for funding opportunities by highlighting the importance of the MGT technology development, contributing to achieving the 2030 climate and energy targets set by the European Commission.

Hot Corrosion Working Group

Vision: To enable the operation of the gas turbines without any hot corrosion issue.

The goal of the Hot Corrosion Working Group is to understand the likely causes of hot corrosion and address hot corrosion damages on the hot gas path parts of the gas turbine, particularly off-shore or in coastal regions. The involved ETN members share issues and participate in the metallurgical analysis of damage mechanisms. They receive direct feedback from leading technical experts in the R&D and the user community on the most effective mitigation options and potential ways to overcome the problem in the future.

Addressing Users' Issues

High-Level User Meetings

ETN is primarily a user-driven association with a strong user voice within ETN Board. Every year ETN organises a High-Level User Meeting (HLUM) bringing together users from the highest management from both power generation and oil & gas industries to discuss issues of strategic importance to the GT market. The input from the users feeds the strategy that ETN adopts for its activities and projects.

Engine-specific User Groups

The GT user community within ETN decided to implement an aggregated strategy to address gas turbine users' issues and trigger a dedicated response from the OEMs, independent service providers (ISPs) and R&D community. The idea is to set up or support various independent user groups on selected frequently used gas turbine engines within the user community for both power generation and oil & gas sector. The strategy is to have a single and independent voice communicating users' issues and a link to the whole gas turbine value chain which will provide a wide visibility and guidance on exploring and developing solutions.

Objectives of ETN's User Groups:

- To provide a continuous and focused dialog between the user community, OEMs and ISPs to define and develop solutions for prioritised requirements;
- To identify more generic issues that can be brought to the ETN platform to explore potential solutions together with the R&D community;
- To explore opportunities to reduce issues through development of standardisation of GT packages. ETN has already two ongoing Working Groups on Exhaust Systems and Air Filtration.

Educational gas turbine courses

ETN can organise tailor-made courses or workshops globally in areas of importance to the users. These courses would be given by selected experts from the ETN's R&D and industry community.

1	**Collection**	The GT user community reports operational and technical issues as well as future requirements.
2	**Review & Investigation**	Issues are reviewed and short-listed based on frequency and economic impact. Key GT issues are reported to OEMs, ISPs and R&D community.
3	**Solution**	Solutions to the major GT issues and requirements are being explored with the OEMs, ISPs and R&D community.

"In those groups, all parties can share their experience and the whole community can offer their support and knowledge to solve operational problems. There is a tremendous wealth of knowledge in the room and everyone was open in their advice to other members and operators. Fantastic event for all concerned."

Mark George, Sales & Business Development Director, Cullum Detuners Ltd

"I thought the expertise and information sharing was very beneficial to all parties involved, users and suppliers. To learn about the OEM's ongoing commitment to all the design projects and to deliver the expected results in all design areas was also a great takeaway form the meeting. To get a comprehensive update of third-party overhaul suppliers was of great value to me as well."

Hans Weyermann, Engineering Fellow - Rotating Equipment Engineer, ConocoPhillips

Projects

ETN is an association where members can initiate project proposals or participate in projects coordinated by ETN. All initiatives that are brought to the ETN platform are provided with support and guidance by the ETN Project Board.

Examples of project collaboration schemes:

- Exchange of experiences
- Best practice guidelines
- Development of standards
- Feasibility and root cause analysis studies
- Research and development projects
- Education
- Technical position papers

Ongoing EU-funded projects supported by ETN

PUMP-HEAT

Performance Untapped Modulation for Power and Heat via Energy Accumulation Technologies

The PUMP-HEAT project aims to develop and demonstrate the concept of a new advanced energy system, which integrates combined cycle with large size industrial heat pumps and thermal energy storage.

www.pumpheat.eu

NEXTOWER

Advanced materials solutions for next generation high efficiency concentrated solar power tower systems

The goal of the NEXTOWER project is to demonstrate high-performance durable materials for the next generation of concentrated solar power (CSP) air-based tower systems.

www.h2020-nextower.eu

Completed ETN projects

OMSoP

Optimised Microturbine Solar Power System

The overall objective of the OMSoP project was to provide and demonstrate technical solutions for the use of state-of-the-art CSP system coupled to micro gas turbines to produce electricity. The system was designed with a modular approach, capable of producing electricity up to 30kW per unit for domestic and small commercial applications.

www.omsop.eu

H_2-IGCC

Low Emission Gas Turbine Technology for Hydrogen-Rich Syngas

The H_2-IGCC project has advanced the 'technology-readiness' of all aspects when burning hydrogen-rich syngas in gas turbines, including the development of combustion processes, materials, turbomachinery and the optimisation of the whole plant. Several results of the project can also be used for spin-off applications, especially when it comes to the results of the more basic research in combustion, materials, turbomachinery, systems analysis and techno-economical evaluation.

www.h2-igcc.eu

Events and Activities

ETN organises several events each year. These events provide excellent networking opportunities and a chance for members to increase their organisation's visibility within the international turbomachinery community.

The International Gas Turbine Conference: The Future of Gas Turbine Technology

The objective of the biennial International Gas Turbine Conference is to present and discuss future challenges and opportunities for the GT community globally. The conference brings together delegates from the international GT community, including utilities and oil & gas users, OEMs, suppliers and service providers, research institutes and universities as well as policy makers from Europe, Asia, Middle East, North and South America.

Annual General Meeting and Workshop

ETN members meet yearly in March/April to discuss the progress on activities and agree on the future strategy proposed by the ETN Board. Ongoing and new initiatives are also presented to the General Assembly. The meeting provides an opportunity to receive a complete overview of ongoing activities and to influence future initiatives.

Autumn Workshop

The Autumn Workshop, held every second year in October, is organised primarily for the Technical Committees, Working Groups and ongoing projects to progress and/or develop

new initiatives and newly started projects. ETN also invites guest speakers from outside the association to share and discuss future research needs.

Gas turbine courses

ETN organises tailor-made GT courses that fit the needs of member organisations, based on expressed interest. ETN also collects information about the technical gas turbine courses available, given by our members. List of upcoming courses is available on ETN's website.

User Group Meetings

ETN organises both High-Level User Meetings and Engine-Specific User Group Meetings in order to have a single and independent voice communicating users' issues and to link those issues to the whole GT value chain for exploring and developing solutions.

Policy

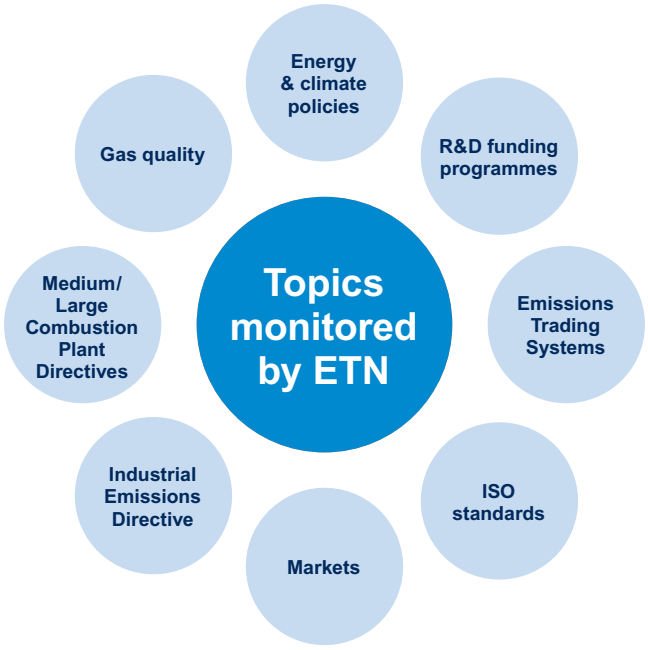
ETN is a proactive association that not only monitors and alerts members on the global policy developments in the energy and research sectors but also provides market and technical input to future energy and research agenda.

ETN advocates the role of gas turbine technology in the energy transition to 2050 and contributes to the design and development of the European Commission's Strategic Energy Technology Plan (SET-Plan). ETN is also actively involved in three European Technology and Innovation Platforms (ETIPs):

- Renewable Heating and Cooling Platform (RHC)
- Smart Networks for Energy Transition (SNET)
- Zero Emission Platform (ZEP)

Fuel quality and emissions Working Group

This Working Group consists of different task forces depending on policy and legislation discussions, such as gas quality and emission compliances.



International cooperation

ETN has developed close cooperation with international organisations and is often invited to chair or speak at various international conferences. ETN members benefit from market information, established contacts as well as reduced participation fees to renowned global conferences.

Established cooperation with:

- GTUsers.com
- The Gas Turbine Society of Japan (GTSJ) – Japan
- The Industrial Application of Gas Turbine (IAGT) – Canada
- ASME IGTI/Electric Power Committee
- POWER-GEN
- International Energy Agency (IEA)
- International energy departments (European Commission, US Department of Energy etc.)
- NexTurbine – China
- Middle East Rotating Machinery Technology & Innovation – United Arab Emirates
- Future Energy Asia – Thailand

Communications

ETN Website: Members Area

ETN members are given access to the Members Area of the ETN website (**www.etn.global**), where they can find databases, studies, research and meeting documents, as well as register for ETN events.

Newsletters

The **Monthly News Summary**, available exclusively to ETN members, summarises the latest developments and happenings within ETN, gives the latest policy news and updates on upcoming meetings and events.

The **Quarterly Newsletter** provides extensive information on ETN's activities and energy policy developments, and is also used as a dissemination tool for ETN and its members' individual developments.

Follow ETN's latest news also on Twitter and LinkedIn

For any submission of project idea or interest in ETN activities, please contact the ETN Office.

ETN Membership Benefits

Access to:

- Technical papers and reports
- ETN/ISO standards
- ETN databases of engine-specific technical issues
- Position papers
- R&D Recommendation Report
- Operational and development needs of the global user community
- OEMs' global gas turbine portfolios
- Policy briefings and market reports
- ETN events and Working Groups
- Reduced conference/expo fees at recognised turbomachinery events

Opportunity to:

- Participate in developing best practice guidelines and international standards
- Propose technical development needs
- Explore ideas and discuss turbomachinery related issues with experts in the field
- Initiate and participate in various international and cross-functional collaboration schemes: studies and R&D projects
- Tailor GT courses for your needs
- Influence energy, research policy and emission legislation
- Disseminate project results, technical research achievements and case studies
- Meet international players & access new markets

Networking

Be Connected

- Extensive networking opportunities with the global gas turbine user community, as well as with the suppliers, service providers and experts in the turbomachinery field.

Policy & Market Information

Be Informed

- Stay tuned on the latest market developments and receive updates on international policies covering the latest legislation related to the GT industry

International visibility

Be visible and heard

- Wide visibility of expertise, products and services from the entire turbomachinery value chain

Project Development & Cooperation

Be Innovative

- Support from the ETN office and Project Board to initiate projects in key areas by providing technical strategic advice and guidance on funding opportunities, as well as project management and coordination support services

Technical Committees

Be Involved

- Benefit from ETN's Technical Committees and Working Groups by exchanging knowledge and developing best practices in priority technical areas

ETN network

The complete list of ETN members is available on our website

ETN a.i.s.b.l.
Chaussée de Charleroi 146-148/20
1060 Brussels, Belgium
Tel: +32 (0)2 646 15 77
info@etn.global
www.etn.global

ETN Global

ETN Membership

How to become a member

You can apply for membership by completing the online form available on the ETN website or by contacting the ETN Office.