ETN European Turbine Network

## ETN - EUROPEAN TURBINE NETWORK

Join us in a powerful European network promoting environmentally sound gas turbine technology with reliable and low cost operation

## A STRONG PARTNERSHIP ACROSS EUROPE BRINGING THE WHOLE VALUE CHAIN TOGETHER

ETN represents gas turbine technology for power generation, mechanical drive and marine applications. Collaboration across the whole value chain creates a powerful network with the ability to achieve tangible advances in gas turbine technology.

A common strategy and research effort between all the stakeholders, along with a supportive European Union policy, will enable the expansion and increased competitiveness of the gas turbine sector in Europe.

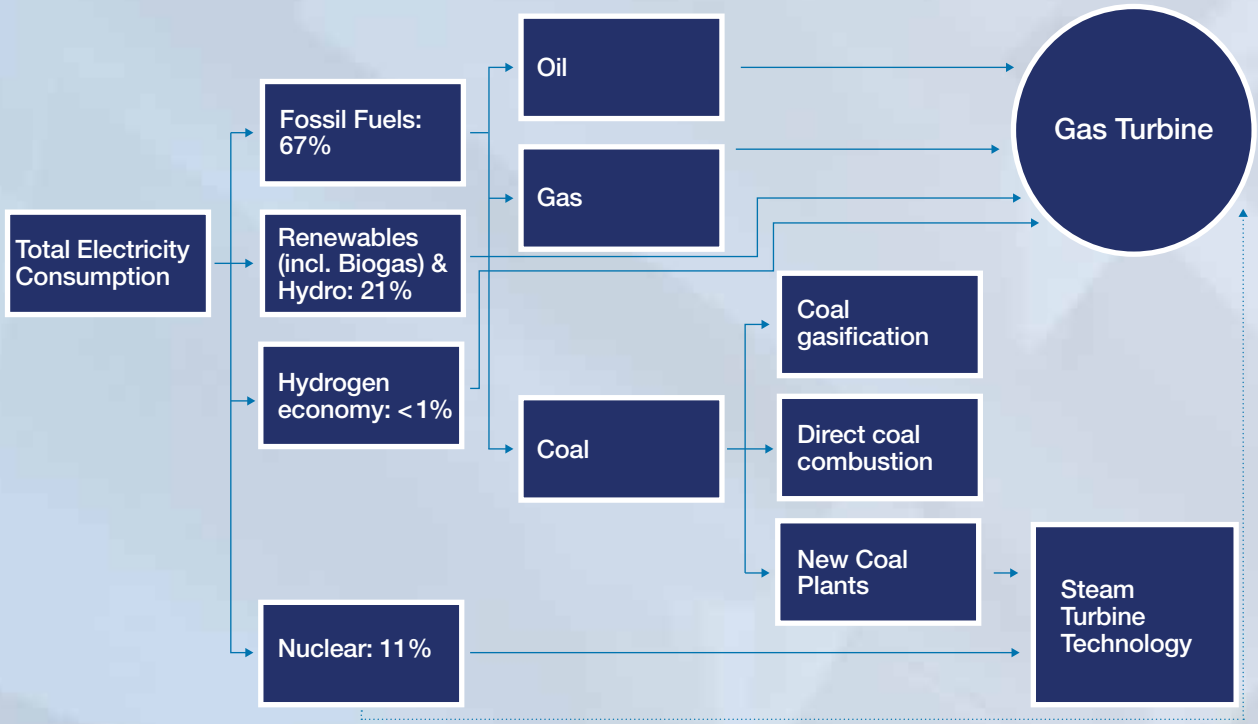
## A EUROPEAN ASSOCIATION OPEN TO ALL GAS TURBINE STAKEHOLDERS AND OFFERING:

| | | | |
|---|---|---|---|
| A common strategy for research & development | Technical Committees and Working groups in priority research areas | Projects, studies and databases | A forum for the exchange of views and experience |
| Extensive networking opportunities | Information on EU research policy and funding opportunities | Visibility among stakeholder groups and in the political arena | Opportunities to influence EU legislation and research policies |

## FUTURE ENERGY POLICIES NEED GAS TURBINE TECHNOLOGY

Forecasts of world power demand predict a substantial increase over the next 25 years. It is also widely accepted that fossil fuels will still be the dominant fuel for power generation in 2030, both in Europe and throughout the rest of the world. Hence to convert fossil fuels to power, gas turbines are and will remain a key technology.




Projected power generation in 2030 by fuel type (International Energy Agency, 2009)

## GAS TURBINES - THE MOST IMPORTANT CONVERSION TECHNOLOGY FOR THE FUTURE

| | | |
|---|---|---|
| High conversion efficiency – up to 90 % in cogeneration cycles | Extensive fuel flexibility | Significant potential for reduction of harmful emissions and cost of power |
| Essential for future clean coal cycles | Key role in the $CO_2$ Capture and Storage process | Important component in environmentally friendly hybrid systems |

## TECHNOLOGICAL ADVANCES LEADING TOWARDS ZERO EMISSIONS

Major improvements and innovative breakthroughs in gas turbine technology will lead the way towards zero emission power generation. Similar potential is also seen in the application of gas turbine power for mechanical drive in the production and delivery of fossil fuels.

However, major research investments will be required for the development of new advanced gas turbine technologies with superior emission and efficiency performance, thus fulfilling the EU objectives for $CO_2$ reduction, security of supply and energy conservation.

# European Turbine Network

ETN is a European non-profit making association with representation from the complete value chain of gas turbine technology. ETN started its activities in January 2005 and currently has 75 members as of May 2010.

| | | |
|---|---|---|
| Power generation and oil & gas operators | OEMs | Research and educational establishments |
| Supplier and service providers | Technology consultancies | Associations |

## MEMBERS

**Board Members**

- **Bernard Quoix,** Total - **ETN President**
- **Catherine Goy,** E.ON UK - **ETN Vice President**
- **Herwart Hoenen,** RWTH Aachen University - **ETN Treasurer**
- **Roald Skorping,** Statoil
- **Jacques Maunand,** EDF
- **Giovanni Cerri,** University Roma TRE
- **Pericles Pilidis,** Cranfield University
- **Uwe Kaltwasser,** MTU Maintenance
- **Andy Williams,** Wood Group
- **Gary Lock,** Frazer Nash

## MEMBERSHIP

Membership is open to all companies and organisations based in the European Economic Area or in Switzerland that are actively engaged in the investment and deployment of technologies related to gas turbines and that fully support the objectives of ETN.

**Membership fee**
For profit making organisations: 5.250 Euro/year
For non-profit organisations: 800 Euro/year

For further details about ETN and membership, please contact:
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# MEMBERS FROM 16 EUROPEAN COUNTRIES

| ORGANISATION | COUNTRY | TYPE OF ORGANISATION |
|---|---|---|
| AAF Power & Industry | United Kingdom | Supplier/Service Provider |
| ALSTOM | Switzerland | OEM |
| Ansaldo Energia | Italy | OEM |
| Ansaldo Thomassen | The Netherlands | Supplier/Service Provider |
| Camfil Farr | Sweden | Supplier/Service Provider |
| Cardiff School of Engineering | United Kingdom | University |
| Cenaero | Belgium | Research Institute |
| Chalmers University of Technology | Sweden | University |
| Challoch Energy | Belgium | Consultancy |
| Chromalloy | The Netherlands | Supplier/Service Provider |
| COGEN Europe | Belgium | European Association |
| Cogsys Manchester | United Kingdom | Consultancy/Service Provider |
| Cranfield University | United Kingdom | University |
| Delft University of Technology | The Netherlands | University |
| Dimset-University of Genova | Italy | University |
| DLR | Germany | Research Institute |
| Donaldson Europe | Belgium | Supplier/Service Provider |
| Dong Energy | Denmark | User – Electricity Producer |
| Dresser-Rand | Norway | OEM |
| EDF | France | User – Electricity Producer |
| Eindhoven University of Technology | The Netherlands | University |
| Electrabel / Laborelec | Belgium | User – Electricity Producer |
| Endesa Generacion | Spain | User – Electricity Producer |
| ENEA | Italy | Research Institute |
| ENEL | Italy | User – Electricity Producer |
| E.ON UK | United Kingdom | User – Electricity Producer |
| ERA Technology | United Kingdom | Consultancy |
| ERSE | Italy | Research Institute |
| Euroturbine | The Netherlands | Supplier/Service Provider |
| Flame Spray | Hungary | Supplier/Service Provider |
| Frazer Nash | United Kingdom | Consultancy |
| Gas Turbine Efficiency Sweden AB | Sweden | Supplier/Service Provider |
| Hykeham Consultancy | United Kingdom | Consultancy |
| Iberdrola | Spain | User – Electricity Producer |
| Imperial College London | United Kingdom | University |
| International Power | United Kingdom | User - Electricity Producer |
| Jülich Research Centre | Germany | Research Institute |
| KEMA | The Netherlands | Consultancy |
| KTH | Sweden | University |
| Lund University | Sweden | University |
| MTU Maintenance | Germany | Supplier/Service Provider |
| National Grid | United Kingdom | User - Electricity Producer |
| National Technical University of Athens | Greece | University |
| Neste Oil | Finland | User – Oil & Gas Operator |
| Paul Scherrer Institute | Switzerland | Research Institute |
| Poznan University of Technology | Poland | University |
| Rolls-Royce | United Kingdom | OEM |
| RWTH Aachen University | Germany | University |
| Score Group | United Kingdom | Supplier/Service Provider |
| Shell Global Solutions | The Netherlands | User - Oil & Gas Company |
| Siemens Industrial Turbomachinery | Sweden/UK | OEM |
| Statoil | Norway | User - Oil & Gas Company |
| Stork Thermeq | The Netherlands | Supplier/Service Provider |
| Sulzer Elbar | The Netherlands | Supplier/Service Provider |
| Technical University of Munich | Germany | University |
| Total | France | User - Oil & Gas Company |
| Turbocare | The Netherlands | Supplier/Service Provider |
| ULB – Free University of Brussels | Belgium | University |
| University of Bergamo | Italy | University |
| University of Bologna | Italy | University |
| University of Leeds | United Kingdom | University |
| University of Ljubljana | Slovenia | University |
| University of Padova | Italy | University |
| University of Perugia | Italy | University |
| University of Roma TRE | Italy | University |
| University of Sheffield | United Kingdom | University |
| University of Stavanger | Norway | University |
| University of Sussex | United Kingdom | University |
| UTC of Rolls-Royce Fuel Cell Systems | Italy | University |
| Vattenfall | Denmark | User - Electricity Producer |
| Vattenfall Benelux (Nuon) | The Netherlands | User – Electricity Producer |
| VBR Turbine Partners | The Netherlands | Supplier/Service Provider |
| VGT - Dutch Gas Turbine Association | The Netherlands | Association |
| Vibro-Meter | Switzerland | Supplier/Service Provider |
| Wood Group | United Kingdom | Supplier/Service Provider |

# Technical Committee
## CYCLE EFFICIENCY

**Chairman**
Abdulnaser Sayma
University of Sussex, UK

**Vision**
Improved performance of gas turbine components and intelligent system integration will enhance fuel efficiency and environmental performance of future power generation units.

**Background**
In all future power generation scenarios, gas turbines will utilise carbon based fuels such as natural gas, oil, coal and biomass. In addition, there is an urgent need to reduce $CO_2$ emissions in the future. This target has to be reached in two different ways. In the short to medium term, significantly higher cycle efficiencies are a measure to decrease the $CO_2$ emissions of gas turbine-fired power plants. This will include the efficiency improvement of conventional gas turbine cycles, but also the implementation of new advanced processes. For the longer term, the zero $CO_2$ emission power plants will be the appropriate target. Therefore, in the future, considerable efforts have to be directed to the development and improvement of $CO_2$ capture and storage technologies.

**Research Areas**
The following priority research areas have been identified:

- Upgrading and retrofitting of existing units (e.g. fogging & adsorption chiller)
- Efficiency improvement of the gas turbine related to increased peak efficiency for base load engines
- Optimisation of the gas turbine efficiency over a wide operating range
- Cycle optimisation, including the possibility of $CO_2$ capture, for:
  - Gasification systems for coal and, to a minor extent, biomass, expected to mainly concentrate on combined cycles
  - Combination of a combined cycle and biomass fuelled system for improved $CO_2$ capture and storage
  - Wet turbine cycles
- Turbomachines for $CO_2$ free processes such as fuel cell / GT hybrid cycles
- Hydrogen fuelled gas turbines

# Technical Committee
## FUEL FLEXIBILITY AND EMISSIONS

**Chairman**
Rob Bastiaans,
Eindhoven University
of Technology, NL

**Vision**
To have gas turbines capable of operating in an efficient, safe and reliable manner utilising a wide range of fuels whilst minimising polluting emissions such as NOx and aiming at zero $CO_2$ emissions.

**Background**
Gas turbines form a significant proportion of global power generation. All aspects of gas turbine technologies are being progressed in order to improve their performance. Fuel flexibility is one such aspect; widespread gas pipeline interconnectivity and LNG imports are leading to varying gas quality, and alternative fuels usage (for example biofuel and syngas) is becoming a commercial necessity. Gas turbine equipment will be required to operate in this new environment with minimal hardware or controls changes required to accommodate the foreseen range of fuels. Their operation will need to have ever improved life, reliability and availability in order to remain competitive with other power generation technologies. Additionally, the push towards lower carbon emissions whilst maintaining, and lowering further, other pollutant emissions (NOx, SOx, smoke, PAH etc) requires the development of novel fuel usage technologies for these gas turbines.

**Research Areas**
The following priority research areas have been identified:

- Development of gas quality detection and automatic combustion system adjustments to enable continuous, low emissions, high efficiency power generation
- CFD modelling of combustion systems to provide understanding of acoustic vibration modes etc.
- Detailed combustion process research (flame propagation etc)
- New combustion concept development, incl. catalytic combustion, flameless oxidation, indirect firing
- Combustion system development to utilise broader Wobbe Index range fuels, incl. any LNG fuel implications
- Increased operational range below current emissions levels
- Use of biomass derived fuels (liquid and gas) and coal derived syngas, as these will be more commonplace and available on reasonably large scales - especially in non EU areas
- Move towards all combustion processes to be in 'zero ($CO_2$) emissions' environment, i.e. carbon capture and storage technologies to be implemented
- Diluted $H_2$ fuels usage, with technologies leading to 100% $H_2$ combustion (in association with carbon capture and storage)

# Technical Committee
## MATERIALS DEGRADATION AND REPAIR TECHNOLOGIES

**Chairman**
Ron van Gestel,
Chromalloy, NL

**Vision**
To extend the ultimate life and repair interval for key hot section components by 30%.

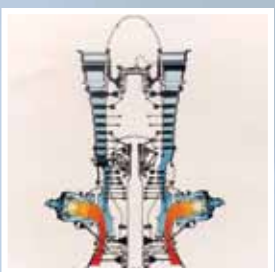
**Background**
A major point of concern for most gas turbine users is the availability and reliability of their engines. Among other causes, such as controls, these issues depend strongly on the operation induced degradation of the key hot section components. These components include the turbine blades and vanes, together with the combustors. The target of the technical committee is to provide the industry with useful tool(s) to allow one to assess and predict the rate of degradation of these key components. This will be based upon quantitative measurements (including in-situ). Based upon this, guidelines will be provided for the specific engine/components. During this exercise, particular attention will be paid to the maintenance costs. The effects of repairs, any repair induced degradation as well as an extension of limits of repairability will also be addressed.

**Research Areas**
The main phases of a project will be:

- Identification of the engine availability and the reliability determining components
- Identification of the life limiting degradation models of the key gas turbine engine components
  - > Development of measurement techniques to determine key parameters
  - > Consequences of interaction of multiple degradation mechanisms on the life of a component
- Extension of the predictability of the key degradation mechanisms
  - > Development of analytical tool(s)
- Consequences of repair processes on predictability
- Extension of the limits of repairability

# Technical Committee
## CONDITION MONITORING, INSTRUMENTATION AND CONTROL

**Chairman**
Chris Dagnall,
Cogsys, UK



**Vision**
25,000 hours of gas turbine operation without intervention

**Background**
There are many different types of condition monitoring techniques and systems which can be applied to monitor a gas turbine. There are also many different ways to design and implement a control system. These condition monitoring systems and control architectures are designed with certain objectives and goals, including machine protection and safety, and support of condition and periodic maintenance strategies.

The instrumentation and control systems need to be more reliable so that single point instrument problems do not cause a machine trip. Control system architecture needs to be restructured and developed to provide robust, reliable and safe operation of a gas turbine when instrumentation or control system faults occur. The technical committee will investigate the possibility to deploy condition monitoring technologies from other industries to replace intrusive inspections which would require the machine to be shutdown. Finally, one important task is the development of reliable decision support software to allow machine degradation to be reliably predicted and monitored.

**Research Areas**
The main target is the development of new technology to allow the running periods of machine components to be extended to meet the technical committee objective. Following priority research areas have been identified:

- Replacement of boroscope inspection (such as pyrometer)
- Avoid offline water wash
- Control and measurement of emissions
- Damage detection and monitoring of components
- Management of hot gas path components
- Fault tolerant control

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