ETN NEWS

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ETN Global is a non-profit association bringing together the entire value chain of the gas turbine technology community. Through cooperative efforts and by initiating common activities and projects, ETN encourages and facilitates information exchange and cooperation to accelerate research, development, demonstration, and deployment of safe, secure and affordable carbon-neutral energy solutions by 2030.

In this issue

Christer Björkqvist
Managing Director

A lifetime opportunity to accelerate the transition to a sustainable society

The recent natural disasters with the unprecedented flooding in Europe and China as the latest example have reinforced beliefs of the urgency to address climate change. Parallel the pandemic has ripped through countries with the force of a universal tidal wave, leaving behind profound socio-economic destruction. This provides an opportunity for both a sustainable recovery and an acceleration of the energy transition. The European Union is planning to use this occasion and recently announced its largest recovery and stimulus package ever financed in Europe, with a budget of over € 2.0 trillion sealed with sustainable conditions.

From a research and cooperation point of view, the successful developments of vaccines in an unprecedented speed demonstrate what can be achieved when there is a true global emergency, an aligned research community and sufficient resources. There are parallels to be made with our sector and we should be inspired by the power of coordinated global research collaboration. ETN is providing a platform for such a development, and the increased active involvement by our members and commitment to our vision is very encouraging. ETN's ongoing projects and activities show the determination by our members to accelerate the gas turbine transition. Parallel to the FLEXnCONFU and ROBINSON projects, a new CO2OLHEAT project kicked off in June focusing on industrial waste heat valorisation and its conversion into electrical energy via a supercritical CO_2 cycle. With 21 partners from 11 countries, the objective is to develop a cutting-edge supercritical CO_2 technology that will contribute to both energy efficiency targets and GHG emissions reduction. The solution will be demonstrated in a real industrial environment in the EU-first-of-its-kind sCO_2 plant.

Over the last months ETN has also been involved in several webinars where our members have had the opportunity to highlight development needs and cooperation opportunities. This input is transmitted to our Working Groups, in key technology fields, where technology development and cooperation opportunities are constantly explored. These virtual events and activities are crucial, as information exchange, coordination, alignment, and commitment are key in accelerating the transformation of gas turbine technology that will open for continuous dynamic developments and contributions from our sector in the energy transition and beyond.

To be fully successful in our strategy, we also need to demonstrate to policy makers and the society that gas turbine is an enabling technology in the energy mix for a timely achievement of a carbon-neutral society. Being a flexible conversion technology, with low-emission credentials that can be further developed to provide carbon-free energy and heat with seasonal and medium-term storage solutions, gas turbine is a vital element in a successful carbon-neutral energy strategy. These attributes offer important decarbonisation opportunities, as well as a clear path towards a dispatchable zero-carbon technology, suitable for a wide variety of applications. You can read more about this in our newly produced document "Gas turbines: an enabling technology for a carbon-neutral society" and our "Research and Development Recommendation Report".

ETN's new R&D Recommendation Report published

The updated edition of ETN's R&D Recommendation Report was released in July 2021. This must-read publication underlines the necessary R&D efforts for the gas turbine sector in the future.

ETN's vision is to contribute to the development of safe, secure, affordable and dispatchable carbon-neutral energy solutions by 2030, implemented globally by 2050. Therefore, continuous research and innovation efforts in the gas turbine sector are of paramount importance to ensure the key role of turbomachinery technologies in the energy transition era and beyond. This includes the deployment of carbon-neutral energy services and products.

The purpose of ETN's R&D Recommendation Report is to summarise recommendations for R&D topics based on the user community's needs and requirements, as well as energy policy targets. The report is intended to be a living document revised on a biennial basis. In accordance with this, the growing importance of Systems Integration and Energy Storage is now addressed in a dedicated chapter that reviews overall performance improvements that can be obtained by the integration of gas turbine technology in other systems.

The report lists topics in technical areas relevant to gas turbine systems being used in Oil & Gas, Power Generation and Industry; the business segments in which ETN members are active. It considers topics related to the integration of turbomachinery into new energy systems, the development of new system integration solutions, the improvement of the state-of-the-art of component technologies, adaption to future emission regulations and other regulatory frameworks. The topics suggested should trigger respective actions within the ETN community in various forms: R&D projects, feasibility studies, best practice guidelines, development of standards and technical briefing papers.

This publication was drafted by ETN's Project Board, involving experts from the whole value chain: research institutes and universities, OEMs, suppliers, and the user community. We would like to thank the Project Board members for sharing their experience and knowledge while contributing to the various parts of the report.

The full report can be downloaded here. ■

Safe, secure, affordable and dispatchable carbon-neutral energy solutions by 2030, implemented globally by 2050

ETN vision

New members

We are pleased to welcome our new members OPRA Turbines and ADAMS Armaturen.

OPRA Turbines develops, manufactures and services state of-the-art gas turbine systems, and is headquartered in Hengelo, the Netherlands

ADAMS Armaturen develops and supplies industrial valves. Their headquarter and production facility are located in Herne, Germany.

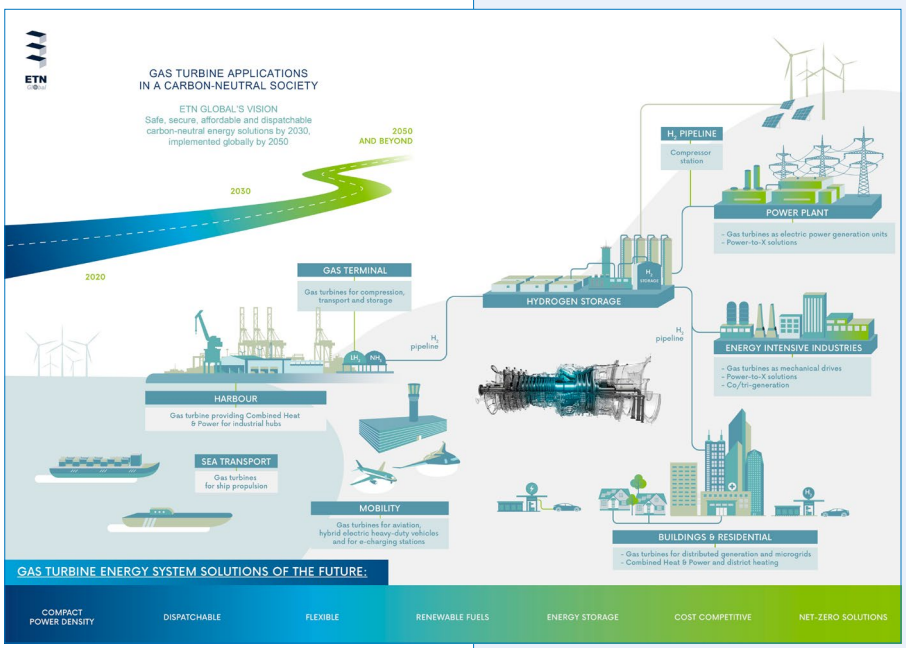
Gas turbines: an enabling technology for a carbon-neutral society – ETN's new publication

Global pledges of carbon-neutrality by mid-century are rapidly changing the energy landscape. There are three core dimensions to consider in preparation of energy strategies: affordability and access; security of energy supply; and environmental sustainability. The World Energy Council defines balancing these aspects as the energy "trilemma". Several factors challenge this balancing act. Firstly, wind and solar, the main contributors to an increasing share of renewables in the energy system are not 'dispatchable', hence unable to provide electricity on demand. Moreover, 70% of today's European energy system relies on non-electric sources; 2050 projections indicate that this share will remain substantial. Even in high electrification rate scenarios, 40-60% of energy consumed will be met with molecule-based fuels.

Solving the energy trilemma requires readily available, efficient and dispatchable technology, providing energy in a secure and sustainable way to back-up electricity from weather-dependent energy sources and heat solutions. Gas turbine technology is unique and versatile, capable of fulfilling all these needs using carbon-free molecule-based fuels such as hydrogen, synthetic methane or other renewable fuels.

With ETN's new publication "*Gas turbines: an enabling technology for a carbon-neutral society*", our objective is to highlight that ETN members are committed to the development of safe, secure, affordable and dispatchable carbon-neutral energy solutions by 2030, to be implemented globally by 2050. Gas turbine dispatchability, decarbonisation options and power density, combined with a wide range of applications across many sectors offer great potential to enable and support the present and future power and heat needs of a carbon-neutral society and beyond. It also demonstrates the need and relevance of continuous support for R&D efforts in the quest for a carbon-neutral society.

Download our new publication here. ■



IGTC
International
Gas Turbine Conference

ETN's IGTC *"Gas turbines in a carbon-neutral society"*

The 10th International Gas Turbine Conference "*Gas turbines in a carbon-neutral society*" will be held virtually on 11-15 October 2021. The International Gas Turbine Conference (IGTC) is a well-established and renowned biennial conference, bringing together the gas turbine user community, manufacturers and suppliers, the research community and policymakers. Our objective is to raise the awareness of how gas turbine technology can contribute and enable the required energy transition, and to highlight from power generation, oil & gas and industrial operators' perspectives the development needs to successfully do so. The conference also provides an opportunity to emphasise and discuss with policymakers the importance of a supportive regulatory framework that will incentivise the required investments.

The IGTC will highlight global opportunities for gas turbine technology in key markets, as well as present, publish and disseminate the latest R&D developments, and address achievements that will help to accelerate the transition to sustainable energy systems by adapting the gas turbine technology to carbon-neutral fuels, hybrid power systems and alternate heat sources.

The conference will include 5 keynote sessions, 9 technical sessions (with 27 technical papers to be presented), a virtual exhibition lounge and innovative networking opportunities. Preliminary programme, more details on registration and information about sponsorship opportunities can be found here. ■

ETN is recruiting

ETN is growing, and we are looking for enthusiastic persons, with a keen interest in gas turbine technology and the energy transition, to join our team.
Read more about these exciting opportunities here. ■

Additive Manufacturing L-PBF Machine Evaluation Initiative

ETN's unique L-PBF Machine Evaluation Initiative was developed among members of ETN's Additive Manufacturing Working Group. The aim of this initiative is to review capabilities of Laser-Powder Bed Fusion (aka L-PBF, Selective Laser Melting) equipment currently available on the market.

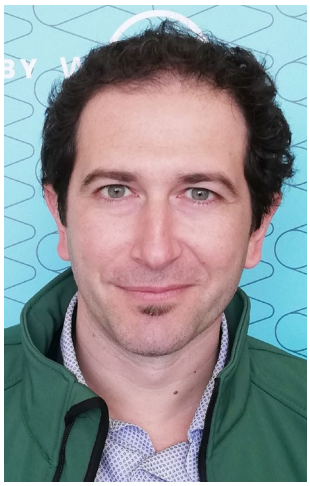
The involved manufacturers will be manufacturing parts with Nickel Alloy 718 powder, according to specifications defined in collaboration with members of the ETN Additive Manufacturing Working Group. The parts to be produced include features of specific interest to the energy sector, such as thin walls and cooling channels. Performance, quality and productivity are key elements that will be evaluated.

The outcome of the project will consist of a detailed report, evaluating and comparing technical and commercial characteristics of selected AM machines available on the market and sample parts they produced. The full report will be available only for the partners. More details are available on our website. If your company would be interested to become a partner, please contact us for more information. ■

CO2OLHEAT

New CO2OLHEAT project launched

ETN's new CO2OLHEAT project *(Supercritical CO_2 power cycles demonstration in Operational environment Locally valorising industrial Waste Heat)* started in June 2021. CO2OLHEAT's main objective is to unlock the potential of unused industrial waste heat and transform it into power. The development of innovative and cutting-edge supercritical CO_2 (sCO_2) technologies will be used to design and demonstrate in a real industrial environment the EU-first-of-its-kind sCO_2 plant. This EU funded project has an overall budget of approximately €18,8 mil. and will run for four years. Download our press release to read more about this project. ■



Interview with Egidio Pucci, Baker Hughes

One of the objectives of the FLEXnCONFU project is to increase gas turbine fuel flexibility through the design and development, as well as test a gas turbine combustion system able to burn hydrogen and/or ammonia. To learn more about the challenges of developing and scaling up gas turbine combustion systems able to burn ammonia, we met with Egidio Pucci, Combustion Technology Leader at Baker Hughes.

Could you tell us more about Baker Hughes' role in the FLEXnCONFU project?

Baker Hughes is participating in the FLEXnCONFU project with its turbomachinery headquarter Nuovo Pignone Tecnologie located in Florence (Italy), to prove the feasibility of green fuels combustion (zero CO_2 emissions) and the performances achievable by gas turbines when burning hydrogen, ammonia, and blends of the two gasses.

The main task of Baker Hughes is to analyse the scale up opportunities for the FLEXnCONFU idea, both at gas turbine level (leveraging numerical analysis) and at system level, to define strategies to burn hydrogen and/or ammonia and reduce carbon footprint of the power plant while limiting the impacts on NO_x emissions.

Baker Hughes with the ENGIE Laborelec partner has already analysed the impact on the thermodynamic performances of a combined cycle power plant changing fuel content percentage of hydrogen and ammonia. Then our team will provide guidance about the hardware and control modifications required for the gas turbines combustion system to accommodate higher fractions of hydrogen, up to the pure hydrogen fuel condition.

Moreover, starting from the concept of the combine cycle plant feed with ammonia, currently in development at lab scale with a micro gas turbine (UNIGE lab), Baker Hughes will lead the solution scale up to a typical 16 MW gas turbine size, providing the technical definition of the combustion system retrofit: such activity will be based on the results of computational analyses, previously verified with the experimental data available from the Cardiff University GTRC single cup tests. Finally, an Environmental Health and Safety (EHS) assessment for the safety of the infrastructure and of the operators will be also performed.

How does the FLEXnCONFU consortium plan to increase power plant flexibility?

EU is strongly pushing on RES (Renewable Energy Sources) and alternative fuels, to increase its fuel independency and to achieve the 2030 goals on CO_2 emissions (55% reduction, measured against 1990 CO_2 emission levels). The Combined Cycle Gas Turbine plants will be, for the next years, one of the best solutions for compensating the intermittency of renewables adopting P2X2P schema (Power-to-X-to-Power). The P2X2P schema is based on the storage of electricity surpluses in a chemical form (like hydrogen and ammonia) to be then conveniently used again as fuel to produce electricity (electrical market arbitrage). The fluctuations in the electrical grid, mainly caused by discontinuities of solar and wind electricity production and/or by end users request variability, can be so levelled with zero CO_2 production.

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Baker Hughes NovaLT16 GT model, object of H_2 and NH_3 combustion development

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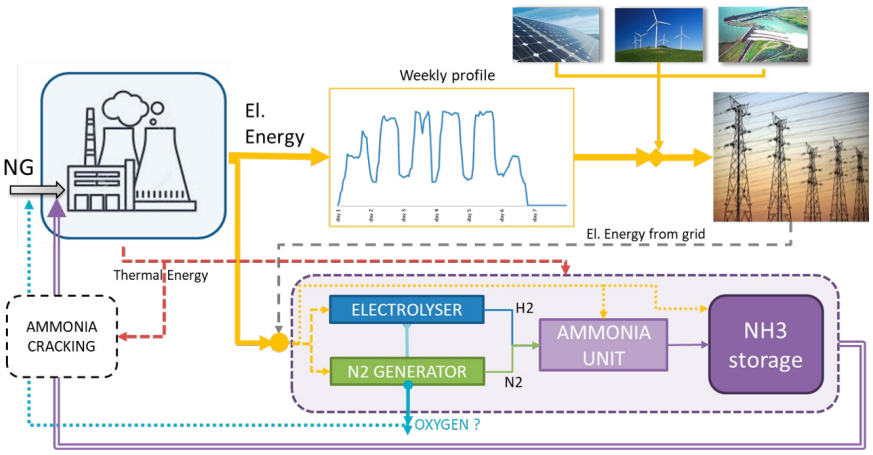

Power to Ammonia solution for Power Plant Flexibilisation

Regarding your tasks to develop the technical definition of a combustion system that allows to burn ammonia, what are the main challenges in developing and scaling up such a system? What are the advantages of deploying a PEM electrolyser?

Combustion of hydrogen, ammonia, and blends of these two gasses, in existing gas turbines leads to an increase of NO_x emissions and, even if NO_x are not greenhouse gases, they have in any case direct and indirect effects on human health. For pure hydrogen combustion, the focus is on solving potential issues as burner flashback/flame holding. Moreover, a combustion system redesign can be developed to achieve lean combustion with a reduced residence time in the high temperature regions, limiting the formation of thermal NO_x. On the other hand, for pure ammonia combustion, the low heating value of ammonia requires to solve potential issues on ignition and flame stability and again on the NO_x formation mechanisms. In this case, the large amount of NO_x generated depends on the nitrogen bounded with the fuel itself, resulting harder to be abated just by performing a burner redesign. So, additional technologies as staged combustion and/or selective catalytic reduction on the exhaust gasses are required. Changing the hydrogen and ammonia percentage content in the fuel blend can help in finding an optimal condition for each of potential combustor architecture. On this matter, a fundamental step to capture the physics behind the NO_x formation mechanisms and flame shape & stability will be the validation of kinetic and CFD models with the combustion tests measurements, currently ongoing in Cardiff GTRC lab.

Regarding the scale up of the combined cycle plant fueled with ammonia, this will be addressed starting from the results that will be collected from the test on a micro GT that will be performed by UNIGE, in its Laboratory located in Savona Italy. The main challenges for these activities are linked to the introduction of a fuel compression phase between ammonia storage and gas turbine injection and the extension of Environment, Health & Safety (EHS) assessment to a real plant environment. Together with the technical definition of the ammonia plant scale up, a techno-economic analysis with the KTH partner will be performed, starting from the one assessed on the micro GT plant at UNIGE lab.

What are the advantages of P2A solution?

Main advantages of the P2A solution are related to achieve both levelling of renewables intermittency and CO_2 emissions abatement, the ammonia being also a carbon free fuel. It could be argued that the loop cycle efficiency can be obtained in a conventional combined cycle plant, due to the number of energy transformation phases, is too low to be an economical viable solution (estimation of about 30% for P2H and 24% for P2A). However, there are different factors can justify the interest in the P2X2P solutions. The simpler one is that in all the scenarios where the electricity surplus is wasted, even if with a low efficiency, an energy saving is in any case achieved. In addition, the energy storage in the chemical form, since is not subjected to a degradation, is an ideal solution from the short term to the seasonal storage. With the growing public demand for climate action, it is reasonable to expect that a P2A solution can benefit of a Levelised Cost of Energy (LCOE) reduction thanks to CO_2 taxation and decrease of the hydrogen and ammonia production costs.

Finally, the sense of urgency to act in the abatement of global CO_2 emissions is also relevant: using existing energy infrastructures indeed is possible to start since today introducing incremental percentages of renewable fuels, leaving freedom to reach further CO_2 emission abatement adopting an incremental steps strategy. ■

www.flexnconfu.eu

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Subscribe to our FLEXnCONFU newsletter **here**

This project has received funds from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 884157.

ROBINSON project & ETN's new Decentralised Energy Systems Working Group

ETN is the coordinator of the EU-funded project ROBINSON *("Smart integration of local energy sources and innovative storage for flexible, secure and cost-efficient energy supply on industrialized islands")*, which started in October 2020. With the goal to help decarbonise industrialised islands, ROBINSON partners aim to support islands through the development of an intelligent, flexible and modular energy management system, better integration of renewable energy sources, biomass and wastewater valorisation, industrial symbiosis, and the optimisation and validation of innovative technologies.

As the project coordinator, ETN wants to highlight the importance of decarbonised energy systems and encourage a wider discussion on future solutions within our network. ROBINSON is closely linked to ETN's new Decentralised Energy Systems Working Group, the project being one of the reasons why we started the new Working Group.

Our Decentralised Energy Systems Working Group will bring together stakeholders of the value chain for decentralised energy solutions involving micro and small gas turbines, with the objective to accelerate the development of cost-efficient integrated secure technology solutions in line with the market needs. The Working Group aims to explore market opportunities and solutions, initiate cooperation projects to reduce cost and increase the technology readiness level of individual components, the gas turbine system and its integration into decentralised and multi-vector sustainable energy systems, as well as its interfaces and interaction with other system components.

The first part of our virtual launch meeting will be organised on 23 September 2021, followed by the second part of the meeting on 28 September. Call invitations will be shared with the ETN members in the next edition of our Monthly News Summary. ■

Interview with Rolf Andre Leidland, ENH

Eigersund Næring og Havn KF (ENH) represents the municipality and the local business of Eigersund, Norway, where the ROBINSON project's demo island Eigerøy is located. With a deep knowledge of the territory, the local and national stakeholders, and the needs of Eigerøy, ENH ensures an alignment between ROBINSON and the island's long-term strategy. To discover more about ENH and the Clean Energy Transition Agenda on Eigerøy, we sat together with Rolf Andre Leidland, Project Manager at ENH.

What is ENH's role in the ROBINSON project?

Eigersund Næring og Havn KF (ENH) is a so-called "kommunalt foretak" – an organisation established and owned by the municipality of Eigersund. It has three main areas of responsibility: Harbour, Industry and Tourism. The goal of the organisation is to ensure that the municipality of Eigersund has a competitive, sustainable and coordinated industrial development, including tourism. In the ROBINSON project, ENH will:

- Provide required information to the definition of the baseline layout, the specifications and the concept final outline to make sure that it fits with the island's future strategies
- Support PRIMA Protein in the preparation of the pilot plant layout and of the layout of the neighbourhood/surrounding, where all existing components are installed
- Perform a social study for social acceptance of the solutions on Eigerøy (including gender) contributing to the social impact management plan prepared by NORCE
- Represent the local business, provide information on tourism and handle the business cases and especially those in connection to the harbour and the electrification of ships
- Be actively involved with the communication & dissemination of results on Eigerøy.

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Why did the island of Eigerøy join ROBINSON?

It is easier to get companies involved in the energy transition while being part of an EU-funded Horizon 2020 project. It proves that green can be positive for both the environment and the economy, giving the industry two good reasons to support the transition. ROBINSON can help industrial companies on Eigerøy to become users of clean, secure and cost-effective energy. Eigerøy, becoming a pilot island on island-decarbonisation-technology, can have a great impact on the interest of and the type of industry coming to the island.

Could you tell us more about Eigerøy's Clean energy Transition Agenda?

The Clean energy Transition Agenda for Eigerøy is accompanying the "Cleaner Harbour" initiative. By using organic waste as biofuel, we also reduce waste to sea. The green shift introduces a new view on what is previously called waste. Waste for one part can be resources for another.

How does ROBINSON leverage the characteristics of the territory?

Eigerøy is a small, but diverse island. The weather varies a lot throughout the year, with wind, rain, sun and snow, and sometimes everything on the same day. There is a variety of different industries, ranging from oil service, offshore industry, entrepreneurs, tech-companies, up to fishing and protein industry. Prima Protein belonging to the latter and also part of the ROBINSON consortium. Farms in different sizes are also a part of the island, and of course the approx. 2500 inhabitants. All this together, in addition to the manageable size, makes Eigerøy a perfect island to set up a small-scale test site, where different technologies can be integrated and play their role in the decarbonisation of Eigerøy. From waste-water valorisation to a renewable fuel based Combined Heat and Power unit and hydrogen energy storage, ROBINSON will leverage the uniqueness of the island offering in return a tailor-made solution that can cover the needs of Eigerøy and support it in the energy transition.

What will be the next steps?

The next step is to get the test-site up and running and prove that it is possible to be clean and green regardless of where you are located.

Any last comments?

Being a part of ROBINSON really makes a difference. It is a real eye opener, showing the wide array of possibilities and alternative solutions to make the transition from fossils to green. ■

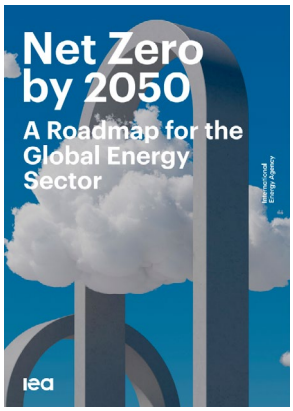
www.robinson-h2020.eu

Follow ROBINSON on &

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 957752.

Eigerøy, Norway © Østebrøts Foto

IEA's roadmap to net zero emissions globally by 2050



The International Energy Agency (IEA) recently released its special report *"Net Zero by 2050: A Roadmap for the Global Energy Sector"*. This roadmap lists the actions needed to achieve the net-zero CO_2 emissions by 2050 and to limit the rise of temperatures to 1.5 °C globally. According to the IEA, this will require a "total transformation of the energy systems that underpin our economies". The report highlights the importance of "rapid deployment of available technologies" and "widespread use of technologies that are not on the market yet." More than 400 sectoral and technology milestones, to transform the global economy, are listed in the report. You can download the full report here. ■

European Clean Hydrogen Alliance

ETN is a member of the European Clean Hydrogen Alliance, which held their third European Hydrogen Forum on 17-18 June 2021. Frans Timmermans, the Executive Vice President of the European Commission, conveyed a very positive message starting his presentation with "hydrogen rocks". With almost 1000 projects in the pipeline, the first milestone of the hydrogen strategy has been fulfilled. The projects of interest to our sector are split between Industry applications (239); Energy sector (191); Building sector (89); and Transport (379). The European Commission will now need to ensure the relevant regulatory framework to support these pilot projects and to incentivise the massive investments that will be required for wide implementation. The maritime sector was used as an example of an area that is quickly taking off, as a network of hydrogen ports is under development where the European Commission sees an important role for green hydrogen and ammonia. Presentations from the European Hydrogen Forum are available here. ■

EU's revised climate legislation

The European Commission presented its new "Fit for 55" package on 14 July 2021. The package consists of inter-connected proposals for EU's climate, energy, land use, transport and taxation policies to reach the objective of reducing net greenhouse gas emissions in the EU countries by at least 55% by 2030, compared to 1990 levels.

The Commission proposes to tighten the EU Emissions Trading System (ETS), which puts a price on carbon, lowering the overall emission cap, increasing the annual rate of reduction, removing free emission allowances for aviation, and extending the ETS to shipping emissions. The EU countries should spend their emissions trading revenues only on climate and energy-related projects.

With the proposed Effort Sharing Regulation, separate emissions reduction targets are assigned to each EU member state. The Regulation on Land Use, Forestry and Agriculture also sets national targets for EU countries. The new Carbon Border Adjustment Mechanism should put a carbon price on imports, in order to avoid "carbon leakage" and pushing emitting production out of Europe.

The Commission brings forward an increased target for the Renewable Energy Directive to produce 40% of all energy from renewable sources by 2030, up from the current 32%. Also the Energy Efficiency Directive and the Energy Taxation Directive will be revised. The proposal of stronger CO_2 emissions standards for cars and vans presents that all new cars registered as of 2035 should be zero-emission, ending the sale of new petrol and diesel cars in the EU.

The proposals will be reviewed and discussed in the upcoming months by the European Parliament and the EU member states, who must agree on all the proposed content before any legislation can enter into force. ■

Upcoming meetings and events

Meeting/Event	Date	Location
SGT-A35 User Group Meeting**	22-24 September 2021	Virtual meeting
Decentralised Energy Systems WG launch meeting**	23 and 28 September 2021	Virtual meeting
High-Level User Meeting**	4 October 2021	Virtual meeting
ETN's 10th International Gas Turbine Conference*	11-15 October 2021	Virtual meeting

** ETN members are entitled to a discounted registration fee | ** Event only for ETN members*

ETN Team

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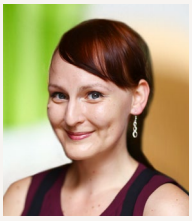

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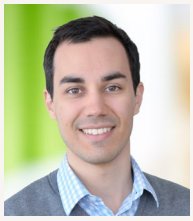

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ETN at a Glance!

Download the ETN Brochure and find out more about our mission & objectives, activities, events and more!

Are you interested to become an ETN member? Download the one-pager showcasing the benefits of being part of ETN's global turbomachinery community.