Newsletter

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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 Global encourages and facilitates information exchange and cooperation to accelerate research, development, demonstration, and deployment of safe, secure and affordable carbon-neutral energy solutions.

IN THIS ISSUE

Christer Björkqvist
Managing Director,
ETN Global

Shifting priorities in policy and practice: exploring realistic pathways to decarbonisation

With the first quarter of 2025 behind us, I am proud to reflect on the momentum we have built together across ETN Global. Our recent Annual General Meeting & Workshop in Bergen marked a strong start to the year, with inspiring discussions, cross-sector collaboration, and a clear signal from our user community: the transition to a secure, flexible, and carbon-neutral energy system cannot wait.

A strong sign of this urgency came shortly after our AGM and site visit to the Northern Lights project, with the announcement of a final investment decision (FID) for Phase 2 of the joint CCS venture by Equinor, TotalEnergies, and Shell. This confirms their long-term commitment and will expand transport and storage capacity from 1.5 to over 5 million tonnes of CO_2 annually by 2028. A significant and encouraging step for large-scale decarbonisation.

Equally important is the recognition that no single solution will deliver the energy transition. Our user community continues to stress the need for a portfolio of complementary solutions. This aligns with ETN Global's own decarbonisation pathway approach, which supports the advancement of low carbon solutions (CCUS and low carbon/carbon-neutral fuels), energy efficiency, operational optimisation, integrated energy systems, and product sustainability (lifetime extension, repairability and reduced environmental impact).

Hydrogen readiness was another key topic of discussion at our workshop and will be further addressed through an ETN Global Taskforce, which is adopting a pragmatic approach to developing a common process for the industry.

At the policy level, we see both opportunity and uncertainty. Recent political signals suggest a growing awareness of the limitations of some emerging technologies and a shift toward a more pragmatic, balanced approach to decarbonisation. This may open the door to greater recognition of proven, reliable solutions, such as gas turbines operating on low carbon or carbon free fuels, CCUS, and hybrid systems, as key enablers of climate targets. As the energy trilemma continues to shape the policy agenda, the value of mature technologies that can deliver sustainability, security of supply, and cost-effectiveness in parallel is becoming increasingly clear.

In this context, ETN Global continues to advocate for technology-inclusive policy frameworks, at both European and international levels, that acknowledge the critical role of dispatchability and energy security. A stable regulatory environment and clear investment signals are essential to support the infrastructure and technology deployment needed to close the anticipated capacity gap.

In this issue, you will find updates from across our network - from the launch of a dedicated CCUS Working Group to new and ongoing collaboration on ammonia and hydrogen combustion, policy developments in Europe and beyond, and the continued growth of our membership. These achievements reflect both the strength of our community and the urgency of our shared mission.

As always, I encourage you to stay engaged, share your ideas, and take part in shaping the future of sustainable energy solutions. Your contributions are what make ETN Global such a uniquely impactful platform. The more we collaborate, the more we achieve!

ETN Global's 21st Annual General Meeting & Workshop highlights

ETN Global's Annual General Meeting (AGM) and Workshop took place on 25-27 March 2025 in the city of Bergen, Norway. We were generously co-hosted by our member Equinor.

Event at a glance

ETN Global's Annual General Meeting (AGM) & Workshop gathered 140 participants - a fantastic turnout that reflects the strength and growing reach of our network.

Over three energising days, attendees engaged in a packed programme of keynote speeches, training sessions, panel discussions, and exclusive site visits to two world-leading CCS initiatives:

- the Northern Lights and
- the Technology Centre Mongstad (TCM).

Launch of CCUS Working Group

Prior to the site visits, ETN Global held a high-level strategic meeting with industry leaders to discuss accelerating the deployment of carbon capture, utilisation, and storage (CCUS) and hydrogen technologies. The discussions emphasised the importance of cross-industry collaboration in overcoming technical, regulatory, and economic challenges. The meeting provided the ideal setting for the official launch of ETN Global's CCUS Working Group (WG), which will support ongoing efforts to advance carbon capture deployment through cross-sector collaboration. The WG is now up running and ETN Global Members are welcome to nominate representatives.

The full press release can be found here.

ETN Global's achievements over the last 12 months

Our AGM & Workshop provided not only an opportunity to reflect on a year of collective progress, but also to look ahead and set the priorities for 2025. Since our AGM in 2024, we welcomed 17 new members, expanding our network to 144 organisations. ETN Global now brings together members from across the globe, with the strongest representation in Europe and a growing presence in North America. Our top 10 countries by membership are: the UK, Germany, the Netherlands, Italy, the US, Norway, Belgium, Sweden, Canada, and France, reflecting a dynamic and engaged international community.

Over the past 12 months we have made strong progress across our activities:

- Published five major technical reports;
- Actively participated in eight projects;
- Advocated for the recognition of dispatchable, carbon-neutral energy technologies as well as the importance of system integration and flexibility in future energy systems.

Our Working Groups delivered over 20 collaborative initiatives, while ETN Global events and webinars continued to serve as valuable platforms for knowledge exchange, innovation and dissemination.

These accomplishments reflect ETN Global's commitment to supporting the development and deployment of innovative, flexible, carbon-neutral energy solutions that align with the needs of the turbomachinery user communities.

A detailed overview of ETN Global's achievements presented during the event and summarising activities since 2024 AGM - Activity Update 2024-2025 - along with the Working Groups' objectives for 2025-2026 and all the presentations, are now available for download on the event webpage (login required). ■

ETN Global publishes Laser Powder Bed Fusion Machine Evaluation Initiative report

In January 2025 ETN Global has released a report on its "Laser Powder Bed Fusion (LPBF) Machine Evaluation Initiative", an industry-funded project, conducted by a consortium of selected members from our Additive Manufacturing Working Group. The study analysed the capabilities of LPBF machines from multiple Original Equipment Manufacturers (OEMs), focusing on manufacturing components using Alloy 718, a material critical for gas turbine applications.

The initiative tested the machines' ability to produce consistent, high-quality parts using identical powder feedstock and heat treatment processes.

Key findings include:

- Consistency in material properties: All tested machines produced parts with consistent tensile strength, hardness, and overall material properties when using the same powder feedstock and heat treatment process.
- Variability in productivity: Productivity and ease of use varied due to differences in machine-specific support systems, design layouts, and integration processes.
- High quality across systems: Despite logistical challenges and complex part designs, consistent quality was maintained across all evaluated machines.

To download the report, please visit the following page on our website. ■

New members

Since our last quarterly newsletter, the following new members have joined ETN Global, and we wish them a warm welcome:

SINTEF Energy Research is an applied research institute specialising in cutting-edge, research-based knowledge and infrastructure both in Norway and internationally. In relation to turbomachinery, SINTEF performs fundamental research with advanced experimental and numerical tools as well as developing burners that meet stringent emission limits in various applications, including combustion processes adapted to carbon capture and storage.

EnergyLink International is a leading supplier of specialised and balanced solutions for air and noise emissions control, acoustic consulting, mitigation, and gas turbine auxiliary systems. The company provides full-service engineering, procurement, manufacturing management, and construction. Supported by an expansive network of qualified, low-cost country fabricators, enabling the delivery of quality global fabrication for the clients.

GE Aerospace is an OEM of aeroderivative gas turbines offered through GE Vernova and Baker Hughes. GE Aerospace aeroderivative gas turbines support industrial, Oil & Gas, and Power applications.

University of Roma Tor Vergata – Department of Industrial Engineering has its activities divided into the fields of fluid dynamics, machines, materials technology, physics, technical physics and power electronics. The Department coordinates the three-year and specialised degrees in Mechanical and Energy Engineering, the three-year degree in Engineering Sciences as well as offers PhD courses and master's degree courses.

Golar LNG has a proud history of innovation, having been a pioneer in both the Floating Storage and Regasification Unit and Floating Liquefied Natural Gas segments (FLNG). The company advocates for LNG as a key transition fuel, positioning it as a complement to renewables and a practical solution for immediate emissions reductions by supporting the shift away from oil and coal.

Marvel Tech is an enterprise operating in zero-carbon power generation; currently developing a hydrogen-ammonia gas turbine. Since 2015 the company has successfully developed the world's first tri-fuel combustor, which can burn hydrogen, ammonia, or natural gas on a single combustor without changing the hardware. The combustor has received official certification from SGS.

Pembina Pipeline is a dynamic energy transportation and midstream provider that has been serving customers for 70 years. The company owns pipelines that transport hydrocarbon liquids and natural gas products produced primarily in Western Canada. In addition, Pembina operates gas gathering and processing facilities, as well as an oil and natural gas liquids infrastructure and logistics business.

Mechademy delivers prescriptive analytics for rotating equipment in the oil and gas industry. Its flagship product, Turbomechanica®, combines physics-based models with machine learning to detect issues early, maximising uptime and asset life. Backed by global turbomachinery and AI experts, Mechademy advances reliability through cutting-edge diagnostics, teamwork, and knowledge sharing. ■

Advancing ammonia-fuelled turbines: A joint initiative by PSM/ Thomassen (PSM) – a Hanwha company, and Baker Hughes – an interview with the representatives

Figure 1:
Valentina Civelli,
Hydrogen Market Development and Technical Solutions Leader, Climate Technology Solutions, Baker Hughes

Figure 2:
Jeffrey Benoit,
Vice President, Clean Energy Solutions, PSM - a Hanwha company

The recent announcement of a collaboration between Hanwha and Baker Hughes to develop small-size ammonia-fuelled turbines is a notable step forward in bringing clean fuel solutions to hard-to-abate sectors and transportation. What inspired this collaboration and what are the implications?

Jeffrey: Hanwha is very focused on developing a comprehensive portfolio of clean energy solutions for their customers and is one of the reasons they acquired PSM in 2021. At PSM, we have spent decades developing innovative technologies to enhance the performance and reliability of existing gas turbines used in power generation today, with a strong focus on fuel flexibility. That experience gave Hanwha the internal capability to develop a carbon-neutral NH_3 combustor solution for gas turbines, which is a promising option for maritime propulsion applications. That was one part of the exciting puzzle, but of course, Hanwha also needed to find the right gas turbine OEM partner.

Valentina: Decarbonising hard-to-abate industries and transportation is one of the most pressing but high-potential opportunities of our time. The decarbonisation challenge is far too complex to be solved with one single technology, which is why we need a diversified approach tailored to industry and geography specific dynamics. Recognising this, at Baker Hughes we have built a diversified portfolio of technology solutions that can meet the needs of today and tomorrow's energy ecosystem, from high efficiency gas turbines to pipeline integrity, plant upgrades, modular and integrated CCUS, emissions abatement, clean power, hydrogen, and digital solutions. We are excited to collaborate with Hanwha in this remarkable collaboration, to further expand clean fuels combustion capabilities, positioning gas turbines as key contributors to decarbonising marine propulsion and other sectors.

Could you elaborate on the fuel-flexible combustion system and its capabilities?

Jeffrey: The multi-can design itself is a dry, diffusion flame combustion system uniquely designed to meet the International Maritime Organization's (IMO) rigorous Tier III NOx emissions without Selective Catalytic Reduction (SCR) exhaust treatment, negligible nitrous oxide (N_2O) emissions, and very limited ammonia slip. To ensure operational flexibility, it can operate from 100% natural gas to 100% NH_3 and any variable blend of natural gas and NH_3 on a continuous basis, depending on the fuel availability. Initially, the combustor will be ignited via natural gas, with continued development to allow start up on 100% NH_3 for net zero carbon emission compliance.

The announcement highlights ammonia's role in decarbonising hard-to-abate sectors. How do you see this technology complementing other low-carbon solutions in the maritime industry? And how could it be used in other markets, beyond maritime industry?

Jeffrey: First, we see NH_3 is an excellent energy carrier and fuel option to eventually replace fossil diesel fuel in high value maritime applications, especially where carbon tariffs are to be implemented, such as the EU's Carbon Border Adjustment Mechanism (CBAM). Second, the on-board NH_3 can be cracked into H_2, allowing the use of fuel cells coupled with battery systems to generate electricity for the ship's hotel load. Additionally, Hanwha Engine, integrated into Hanwha last year, is developing low speed eco-friendly low carbon emission ammonia propulsion engines, giving operators options across various ship classes and applications.

Valentina: Ammonia can be liquefied at mild temperature or pressure conditions, enabling for cost effective storage and transportation. For this reason, NH_3 is an excellent energy carrier for land-based application and many countries are considering it as a replacement for natural gas in their decarbonisation plans. Several NH_3 import terminal projects are underway in northern Europe and Asia, where the NH_3 will be then converted into H_2 to decarbonise hard to abate sectors. The capability to directly burn NH_3 in gas turbines, without the additional efforts for conversion process, greatly enhances the financial viability of clean power generation. The new direct ammonia combustion system has several advantages over existing solutions developed for piston engines. In fact, it has very low ammonia slip (less than 10ppm) without the need for a continuous exhaust scrub system and, as importantly, doesn't require cofiring with fuel oil when burning pure ammonia, leading to complete decarbonisation.

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Hanwha has already conducted a successful proof-of-concept test for the ammonia combustor. What were the key takeaways from that test, and how does it inform the next development phases?

Jeffrey: PSM conducts all its high-pressure combustion system development testing at DLR, the German Aerospace Center, in Cologne, Germany, and has since 2003. DLR's state of the art data acquisition and fuel delivery systems allow our combustor design to be run at and beyond full engine conditions.

Continuous product development test campaigns at DLR have resulted in PSM's latest multi-OEM FlameSheet™ combustion platform, now installed and/or operating on almost three dozen gas turbines worldwide. Most critically, the FlameSheet™ combustor can operate on up to 100% hydrogen in a dry lean premix mode of operation, with single digit NOx emissions. Many of the learnings from our FlameSheet™ combustor development efforts and technology developments have been leveraged for this NH_3 combustor platform.

Key takeaways to date included operational characteristics of different fuel injection and mixing schemes, transfers between NH_3 and natural gas fuel, measurements and attenuation methods of combustion acoustic dynamics, mechanical design integrity and exhaust emissions levels.

Results from this test campaign have already been fed into the next phase of development planned for this year, supported by the recently signed Joint Development Collaboration Agreement (JDCA), allowing further cooperation on the integrated design and operational conditions.

Baker Hughes recently completed a feasibility study on the turbine. What were the most significant challenges identified, and how are they being addressed in the next development phase?

Valentina: the development of an ammonia turbine requires a holistic approach. From basic architecture design to thermodynamic optimisation, from materials assessment to performance estimate, the turbine engine integrated with the ammonia combustor is fully verified and optimised to take advantage of the new fuel. Therefore, more than a single most significant topic, the biggest challenge is to harmonise and tune everything with the aim to provide a proven and reliable turbine.

How does this technology address NOx emissions, particularly with ammonia as a fuel source?

Valentina: For NOx emissions specifically, the Baker Hughes small-size turbine engine hosts a combustor with high-residence time and axial zoning. The turbine has variable geometry nozzles and thus adds the flexibility of adapting its regulation to optimal emissions reduction.

Jeffrey: It is true the inherent nitrogen content of NH_3 can lead to the formation of NOx, certainly above the levels from dry lean premix combustion of natural gas or hydrogen. To address this reality, PSM has developed a dual-stage combustor in which a rich NH_3 combustion region is created to minimize the formation of N_2O followed by a lean fuel combustion stage to minimise the formation of NOx. This design approach is well suited to the attributes and unique properties of NH_3 as a fuel and enables compliance with the stringent IMO Tier III NOx emission standard without the need for an SCR system (Selective Catalytic Reduction exhaust after-treatment).

With a target commercialisation date of 2028, what are the next key milestones in the development timeline?

Valentina: Baker Hughes turbine development plan is built in three phases: conceptual design, detailed design and manufacturing and testing. We target to complete the full engine test with ammonia by the end of 2027, after which the turbine (~16MW power range) will be commercially available for orders.

Jeffrey: Beyond this year's continued development testing at DLR, the next key milestones are a full combustion system ready for a sector rig test in 2026, followed by full engine testing in 2027.

Any final thoughts for industry stakeholders watching this development?

Valentina: small-size gas turbines can accelerate shipping decarbonisation, transitioning from diesel motors to turbines powered by ammonia and hydrogen. In naval propulsion applications such turbines can be installed in combined cycle, achieving comparable efficiency with reciprocating engines; differently from the latter, they can work with 100% clean fuels, without the need for any oil as co-firing fuel and with negligible fuel slip (less than 10 ppm). This will be an extraordinary transition to witness and participate in. For on-shore power-gen and mechanical drive applications, a gas turbine capable of burning 100% ammonia will resolve current issues and inefficiency linked to ammonia cracking and will enable end users to burn ammonia directly.

Jeffrey: The use of ammonia as a fuel source for producing next zero carbon power continues to affirm the design and application versatility of the gas turbine in the clean energy transition. This represents a viable demand use case for at-scale ammonia production using hydrogen from reformed or pyrolytic fossil natural gas with CCS and/or renewable hydrogen from electrolysers.

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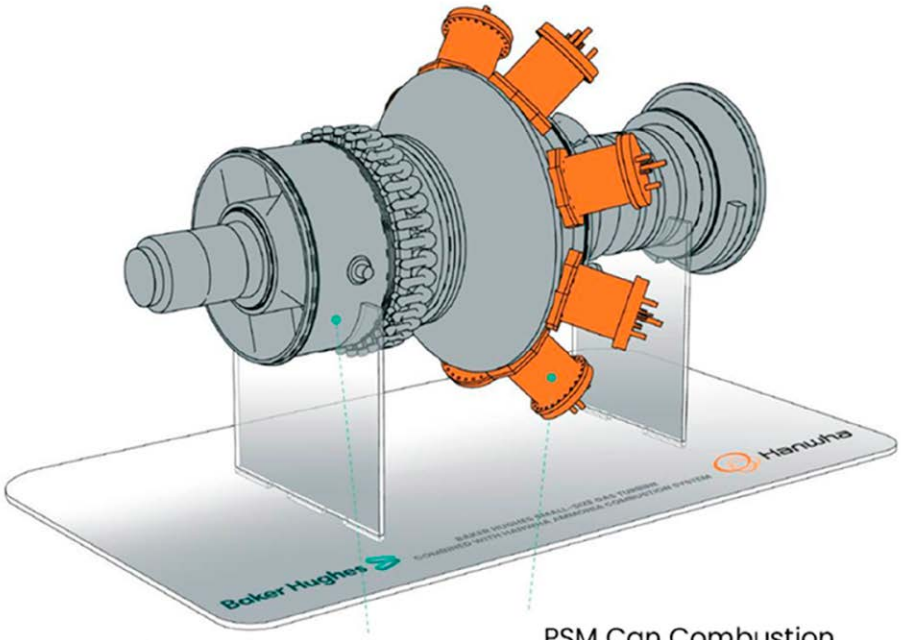

Phase 1: Ignition via Natural gas

Phase 2: Start up w/ 100% ammonia for Net-Zero compliance

Power: ~16 MW

Fuel: 100% Ammonia ←→ 100% Natural Gas

Successfully Tested proof-of-concept w/ 100% Ammonia as fuel. Final Engine Test w/ Ammonia by end of 2027

Emissions: TIER III IMO w/out SCR, for Ammonia & Natural Gas

Negligible Ammonia slip, N_2O <5ppm.

Target Efficiency: >46% in Combined Cycle

Applications: Naval Propulsion System; On-Shore Power Generation & Mechanical Drive

To read the Press Release from Baker Hughes on this collaboration, visit this page. To read an article written by Hanwha Power Systems - visit this page. ■

2025 Brian Pitt Excellence Awards (BPEA)

In January 2025 ETN Global's Young Engineers Committee launched the 2nd edition of the Brian Pitt Excellence Awards (BPEA) – Master Thesis competition, building on the success of the inaugural edition in 2024.

Figure 3: Brian Pitt

About Brian Pitt Excellence Award

The award is named in honour of Brian Pitt, a former Rolls-Royce employee long-standing supporter of research collaboration in the gas turbine field.

The award recognises master's degree students who embody Pitt's dedication to excellence and innovation in the fields of energy and turbomachinery.

2025 competition and prizes

2025 BPEA competition is organised in three stages:

- Stage I: Initial abstract submission: deadline 4 April 2025
- Stage II: Summarised thesis submission: deadline 16 May 2025
- Stage III: Online competition event: 2 July 2025

The competition has now entered Stage II, with abstracts submitted and reviewed, and participants currently preparing to submit their summarised master theses

The winner will receive:

- A fully funded invitation to attend the ETN Global's 12th International Gas Turbine Conference (IGTC) on 14-15 October 2025 in Brussels (Belgium). The invitation covers round-trip travel expenses, accommodation and registration fees.
- An opportunity to submit an invited paper and present their research to the Energy & Turbomachinery community (subject to approval by the IGTC Conference Advisory Board).

The other four finalists will receive:

- A discounted fee to attend ETN Global's 12th International Gas Turbine Conference (IGTC) equivalent to that offered to ETN Global YEC Members).

To learn more about 2025 Brian Pitt Excellence Awards (BPEA) – Master Thesis competition, please visit the competition's webpage. ■

ETN Global's LM2500 User Group meeting

ETN Global's LM2500 User Group meeting will be held on 03-05 June 2025 in Aberdeen, Scotland. Representatives of LM2500 user companies are invited to register to attend here. Registrations will close on 27 May at 12 pm (CEST).

The three-day event will include the following agenda:

- User sessions: discussions among users on top-priority topics
- Technical sessions with selected service providers & suppliers
- GE aviation sessions: special session on latest developments & upgrades and technical discussions on high-priority topics
- Networking opportunities during breaks and at dinner
- Exhibition opportunities

Independent vendors and/or service providers may attend by invitation from the user group's Steering Committee.

To register and learn more about the event, visit the event webpage. ■

ASME Turbo Expo 2025

ASME Turbo Expo (Turbomachinery Technical Conference & Exposition) 2025 will be held on 16-20 June 2025 at Renasant Convention Center in Memphis, Tennessee, USA. It is a 5-day technical conference alongside a 3-day exhibition.

ETN Global will be well represented and is also supporting the event as a media partner. Our Managing Director Christer Björkqvist will organise and moderate two panel sessions:

- *"Voice of the Customers: Decarbonisation Pathways and International Cooperation"*
- *"Pathways Forward: Advancing Gas Turbine Technology with OEM Innovation"*

He will also participate as a panellist in the panel session *"Measuring and Communicating Gas Turbine Research Impacts"*.

In addition, our colleagues Giuseppe Tilocca and Antonio Escamilla will co-chair:

- *"Turbomachinery Solutions for Decentralised Energy: A Pathway to Resilient and Competitive Power and Heat Supply"*

They will also deliver a training on micro-gas turbines as part of the Tutorial of basics programme.

To register and learn more about ASME Turbo Expo 2025, visit the event website. ■

International Gas Turbine Conference 2025

ETN Global's 12th IGTC "Advancing turbomachinery innovations and strategies for net-zero pathways" will take place at the Tangla Hotel on 14-15 October 2025 in Brussels, Belgium. We invite all interested parties to save the date and arrange travels.

About the IGTC

The IGTC, is ETN Global's well-established and renowned biennial event, dedicated to showcase technical advancements in gas turbine technology and exploring the critical role of turbomachinery in the energy transition and a net-zero society.

The conference features the latest technical developments along identified net-zero pathways, serving as a crucial information platform for the turbomachinery community. It also offers valuable opportunities for the Research & Development (R&D) community to engage with users, suppliers, service providers, and policymakers. Additionally, the event provides insights into the European and global energy markets, while sharing updates on current R&D activities and recent achievements in flexible, efficient, reliable, and sustainable energy solutions.

Attendees

The turbomachinery and energy community: utilities, industrial operators, energy companies (including oil & gas, pipeline operators and LNG companies), gas turbine manufacturers, suppliers and service providers, consultancies, research centres, universities, international analysis & forecasting organisations and policymakers.

Proceedings of the previous 11th edition of IGTC available

Please note that proceeding of the 11th International Gas Turbine Conference titled "Dispatchable technology and innovations for a carbon-neutral society" are available here.

Figure 4: Attendees of ETN Global's 11th International Gas Turbine Conference, titled "Dispatchable technology & innovations for a carbon-neutral society". The prestigious event gathered 160 participants, featured 18 keynote speakers and 20 technical presentations, and was supported by 9 sponsors and 6 media partners.

For more information about the 12th IGTC, please visit the event webpage.
Information on all previous conferences is available here. ■

Advancing hydrogen combustion for turbomachinery: Peter Griebel from German Aerospace Centre (DLR) discusses the recent high-pressure burner test and key findings from the FLEX4H$_2$ project

Figure 5:
Peter Griebel,
DLR

DLR recently finished the high-pressure scaled burner test campaign. What is the role of DLR in the FLEX4H$_2$ project and what exactly was investigated in your test bench?

DLR has a long tradition in the development of hydrogen combustion. Due to the participation in EU-funded projects like ENCAP and H_2-IGCC, we were able to build a strong expertise in investigating hydrogen combustion phenomena at gas turbine (GT) relevant operating conditions with sophisticated laser diagnostics. In addition, DLR has been working closely with Ansaldo Energia, previously ALSTOM Power, since 2007 to support the development of sequential combustion technology (e.g. FUEL FLEX, H_2-SEV projects).

In FLEX4H$_2$, DLR is performing high-pressure tests of a simplified sequential combustor geometry at GT relevant operating conditions in an optically accessible rig, providing experimental data for both numerical modelling validation and the optimisation of the engine operation concept.

In the recently finished measurement campaign, spontaneous ignition and flashback behaviour have been studied at a wide range of sequential combustor operating conditions in our test bench HBK-S.

What is so unique about the test bench HBK-S?

Thanks to the excellent optical access, the combustion phenomena can be analysed in great detail not only with conventional measurement methods, but also with non-intrusive sophisticated optical and laser diagnostics.

The research platform with its very well-known boundary conditions is therefore often used to investigate scaled or single burners to gain detailed insight into combustion processes and to generate valuable data sets for the validation of numerical models. The extensive infrastructure, with a wide range of different gaseous and liquid fuels available, also allows complex testing with hydrogen mixtures as well as pure hydrogen under relevant engine conditions. The test rig is therefore particularly valuable for optimising gas turbine combustors for future use of hydrogen.

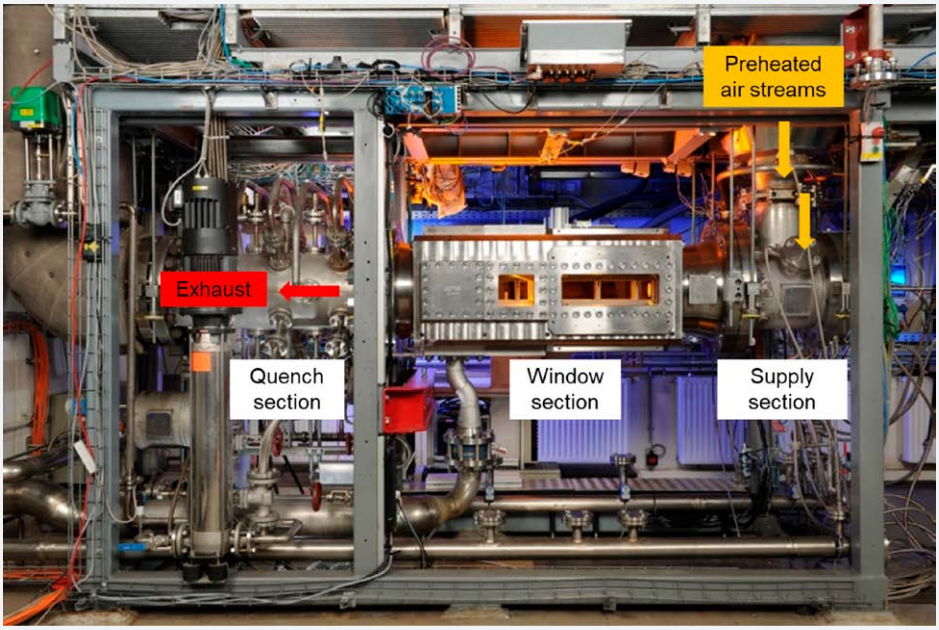

Figure 6: Optically accessible high-pressure combustor rig (HBK-S) at the DLR institute of Combustion Technology.

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What are the key findings of the performed test?

In the FLEX4H$_2$ measurement campaign, an extensive variation of the key sequential combustor operating parameters such as inlet temperature, pressure, velocity, and equivalence ratio were performed, focusing on the characterisation of auto-ignition stabilised flames. The position and the shape of the heat release zone (flame zone) were measured with OH*-Chemiluminescence (CL). In order to investigate extremely fast phenomena like spontaneous ignition and flashback, OH*-CL high-speed imaging with a recording rate of 5000 Hz (5000 images per second) was applied.

The key findings are the following:

- A stable flame was achieved for a wide range of sequential combustor operating conditions.
- At very high inlet temperatures, flashback and flame stabilisation at the fuel injector have been observed.
- Significant input was provided to help the definition of the engine operating concept.
- The generated results will serve as an excellent data basis for the validation of the models used in the numerical simulations within the project. ■

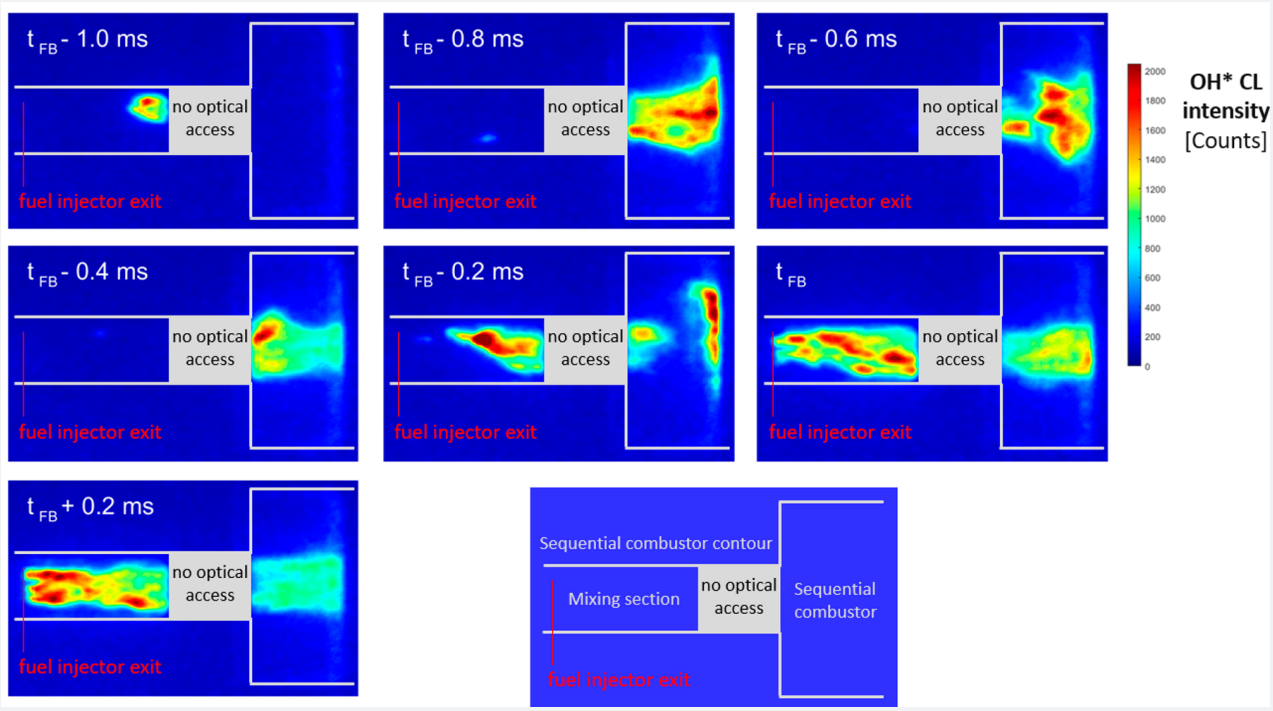

Figure 7: A sequence of OH*-CL images extracted from the high-speed video illustrating the extremely fast nature of spontaneous ignition (t= tFB-1 ms) and flashback. At t= tFB the fame stabilises at the fuel injector exit due to a flashback (FB) event.

Clean Hydrogen Partnership

Co-funded by the European Union

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

The FLEX4H$_2$ project is supported by the Clean Hydrogen Partnership and its members Hydrogen Europe and Hydrogen Europe Research (GA 101101427), and the Swiss Federal Department of Economic Affairs, Education and Research, State Secretariat for Education, Research and Innovation (SERI)

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Shifting climate and energy policies: global and European implications

Recent political developments on both sides of the Atlantic signal a decisive shift in climate and energy policy, carrying significant consequences for international sustainability efforts and industries such as energy and turbomachinery.

On 5 March 2025, TIME published an article titled *"Here Are All of Trump's Major Moves to Dismantle Climate Action"*, highlighting President Donald Trump's extensive rollback of environmental regulations. In total, 125 environmental rules and policies were dismantled, notably including the United States' withdrawal from the Paris Agreement. His administration expanded oil and gas production despite record-high outputs under the previous government and imposed substantial staff cuts at the Environmental Protection Agency (EPA), reducing its regulatory capacity. Additionally, $3 billion earmarked for electric vehicle (EV) infrastructure was frozen, delaying progress towards sustainable transport.

The implications of these moves extend beyond US borders. The withdrawal from the Paris Agreement weakens international climate negotiations, while stalled EV infrastructure investment slowes global momentum for greener transport solutions. Diminished EPA oversight also risks lowering international environmental standards, presenting new challenges for organisations dedicated to sustainability, energy transition, and emissions reduction.

Meanwhile, in Europe, policy dynamics are undergoing their own transformation. On 17 February 2025, *POLITICO* reported on President Ursula von der Leyen's surprise deregulation initiative in an article titled *"How von der Leyen Blindsided Brussels with Her Deregulation Drive"*. Introduced in November, the fast-tracked agenda centres on "omnibus" bills designed to simplify EU rules and reduce bureaucratic hurdles, aiming to boost industrial competitiveness.

While welcomed by several business groups and member states, critics expressed concerns over reduced transparency and potentially weakened environmental protections. Many policymakers were caught off guard by the initiative's pace and centralised management, which marked a noticeable pivot in EU priorities — from a firm focus on environmental sustainability to a more growth-driven economic strategy.

This deregulation drive, much like the policy shifts in the US, presents both opportunities and risks for the energy and turbomachinery sectors. On one hand, accelerated permitting processes and streamlined regulations could facilitate industrial projects and lower operational costs. On the other, there's a tangible risk that long-term environmental targets, clean energy initiatives, and regulatory stability could be compromised if economic growth consistently takes precedence over sustainability.

Both the US and EU developments underline the increasingly complex intersection between climate policy, industrial strategy, and energy security. For organisations committed to sustainable energy solutions, such as ETN Global, these shifts reinforce the importance of strategic adaptation, resilience, and international collaboration. Despite policy uncertainties, the commitment to advancing clean, efficient turbomachinery and energy systems remains vital - not only for industry competitiveness but for the long-term environmental and economic stability of global markets. ■

ETN Global advocating for a secure, flexible and decarbonised energy system

In January 2025 ETN Global published a white paper *"The Critical role of dispatchable power generation for a sustainable and secure energy transition"*. This document outlines four key challenges related to security of supply facing Europe's energy system, as it transitions towards carbon-neutral future, shifting from one dominated by fossil-fuels towards one based primarily on variable renewable energy sources. It proposes actionable solutions and calls for immediate action from the European policy makers, and industry leaders to address these:

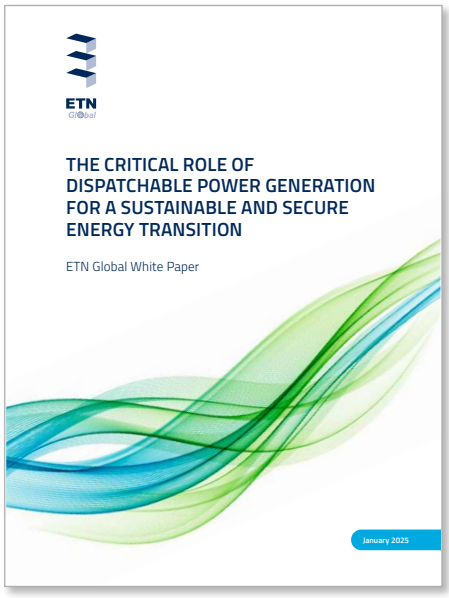
1. Flexibility challenge:
   - The issue: As Variable Renewable Energy (VRE) sources like wind and solar grow, Europe's grid must meet increasing flexibility demands to avoid instability and blackouts. By 2050, flexibility needs are projected to grow fivefold.
   - The solution: Double the availability of dispatchable energy resources by 2030 and quintuple them by 2050, including energy storage systems, smart grids, and dispatchable generation technologies.
2. Grid stability challenge:
   - The issue: Balancing demand and supply amid rising VRE integration requires reliable dispatchable solutions for long-duration storage and peaking capacity.
   - The solution: Incentivise dispatchable thermal turbines fuelled by hydrogen or carbon-neutral fuels, integrate ultra-fast-response solutions, and create robust regulatory frameworks to ensure grid stability.
3. Carbon-neutral fuel challenge:
   - The issue: Limited availability, high costs, and insufficient infrastructure hinder the adoption of hydrogen and other carbon-neutral fuels.
   - The solution: Accelerate investments in hydrogen production, infrastructure development, and large-scale testing of hydrogen-fuelled turbines to reduce costs and build market confidence.
4. Aging fleet challenge:
   - The issue: Europe faces a net decline in flexible generation capacity due to the decommissioning of a number of dispatchable power plants, risking energy adequacy.
   - The solution: Provide financial incentives and regulatory support to extend the operational lifespan of existing fleets and encourage modernisation efforts.

ETN Global's proposed solutions and calls to action aligned with the European Commission's political guidelines and strategic objectives, including the Clean Industrial Deal. To incentivise investments that can ensure a secure, sustainable and competitive energy future, there is a urgent need for a stable regulatory framework and supportive policies.

Since its publication, the White Paper has been shared with EU policymakers and the media, and ETN Global has engaged in a series of constructive meetings to discuss our calls for action with:

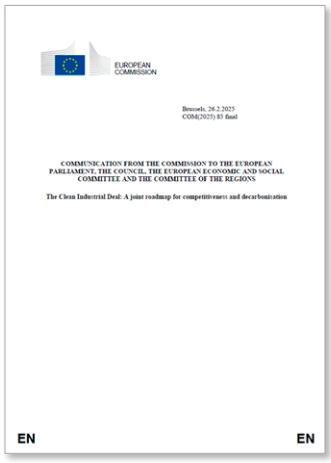
- **European Commission**: Representatives from DG ENER, including senior advisers and team leaders working on energy security, electricity markets, and policy development.
- **IEA**: Experts from various divisions, including power sector, renewable energy, energy modelling, and secure electricity integration.

These calls have initiated an ongoing dialogue and have been highly appreciated. ETN Global Secretariat remains committed to a close collaboration with policymakers and the International Energy Agency.



To download the White Paper "The Critical role of dispatchable power generation for a sustainable and secure energy transition", please visit the following page on our website. ■

EC releases Clean Industrial Deal document


EUROPEAN COMMISSION

Brussels, 26.2.2025
COM(2025) 85 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

The Clean Industrial Deal: A joint roadmap for competitiveness and decarbonisation

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On 26 February 2025 European Commission presented two documents: Clean Industrial Deal and Affordable Energy Action Plan. The Clean Industrial Deal is the EU's roadmap for competitiveness and decarbonisation, aiming to support energy-intensive industries and clean-tech sectors while ensuring Europe remains a global industrial leader.

Key components of the Deal, which are of interest to our energy & turbomachinery community are:

- Increase access to affordable energy – largely based on the Affordable Energy Action Plan:
  - Support for energy-intensive industries to transition to clean energy.
  - Power Purchase Agreements (PPAs) and financial guarantees to lower costs.
  - Investments in smart grids, interconnections, and energy storage.
- Boost clean product supply and demand:
  - Priority sectors: hydrogen, carbon capture, and electrified industrial processes.
  - Public procurement and private incentives for low-carbon products.
  - Expansion of the Hydrogen Bank and support for industrial carbon management.
- Finance clean transition – through Clean Industrial Deal State Aid Framework, Innovation Fund, Industrial Decarbonisation Bank & InvestEU regulation:
  - Creation of an Industrial Decarbonisation Bank (€100 billion) to fund clean industrial projects.
  - Expanded Innovation Fund for decarbonisation technologies.
  - EIB-backed programs for clean tech and manufacturing scale-up.
- Empower circularity – implementing Critical Raw Materials Act and Circular Economy Act:
  - Target to increase circular material use from 11.8% to 24% by 2030.
  - New EU-wide Circular Economy Act to enhance secondary material use.
  - Support for remanufacturing and recycling, reducing raw material dependency.
- Strengthen EU competitiveness:
  - Measures to counter unfair global competition (Carbon Border Adjustment Mechanism, trade defence tools).
  - Strategic procurement of critical raw materials within the EU.
  - Focus on clean energy trade agreements and supply chain diversification.

The Clean Industrial Deal presents opportunities to access funding, lower energy costs, and improve sustainability while strengthening their competitive edge in the clean energy transition.

To learn more about the two documents from the European Commission visit the following links: Clean Industrial Deal and Affordable Energy Action Plan. ■

Upcoming meetings and events

Preliminary list of meetings/events*	Date	Location
ETN Global LM-2500 UGM	3-5 June 2025	Aberdeen, Scotland, UK
ETN Global HLUM (invitation only)	13 October 2025	Brussels, Belgium
ETN Global 12th IGTC	14-15 October 2025	Brussels, Belgium
ETN Global US HLUM (invitation only)	18 November 2025	Houston, USA
ETN Global SGT-A35 UGM	4-6 November 2025	Pau, France
ETN Global Frame 5, 6B, 7E & 9E UGM	November 2025	TBC

* *For the full list of ETN Global-led & other international 2025 meetings & events, visit our event page on the website.*

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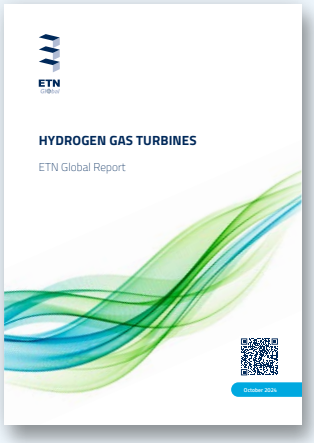
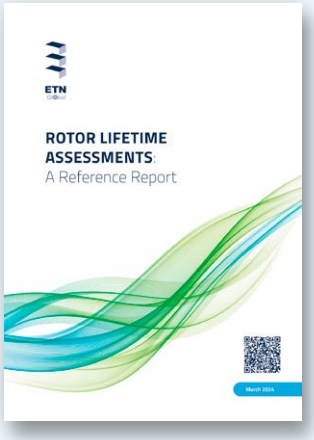
ETN Global at a glance

Download our latest publications:

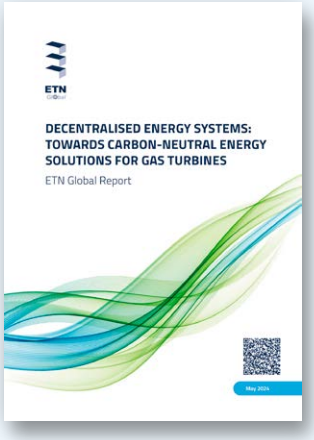
Hydrogen Gas Turbines 2024 edition report



Rotor lifetime assessment: a reference report



Decentralised energy systems: Towards carbon-neutral energy solutions for gas turbines



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