

Observatorio
Tecnológico
del **Hidrógeno**

TECHNICAL WORKSHOP

Hydrogen uses for power generation



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CONCLUSIONS

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Key conclusions

- Combined cycle power plants will continue to play **an essential role in ensuring system reliability, flexibility, and security of supply** in an energy system with increasing renewable penetration.
- **The technological transition is already underway**, with manufacturers offering solutions and operational experience that are bringing the industry closer to 100% hydrogen operation.
- **The sector is moving from technological demonstration to the deployment of full-scale projects**, supported by hydrogen-ready solutions and proven operational experience.
- Adapting combined cycle power plants to hydrogen requires a **holistic approach**, incorporating **new design, operational, material, and safety requirements**.
- **The challenge no longer lies solely in the technology itself**, but in **deploying a complete value chain** capable of supplying hydrogen at scale and at competitive costs.

Opening

Combined Cycle Power Plants Are Essential Infrastructure for Power System Security

Renewable hydrogen can enable the evolution of combined cycle power plants toward decarbonized power generation, while also serving as a seasonal energy storage solution and strengthening the resilience of the electricity system.

Renewable generation will continue to increase its share of the energy mix, and **the power system will require solutions capable of ensuring security of supply** during prolonged periods of low renewable generation.

In this context, **renewable hydrogen is emerging as one of the leading alternatives** for providing **long-duration energy storage, enhancing security of supply, and decarbonizing combined cycle power plants.**

“Security of supply, competitiveness, and sustainability must progress hand in hand,” stated Susana de Pablo, General Manager of Engineering, Technology and Digitalization at **Enagás**.

Hydrogen-based power generation does not depend solely on the availability of hydrogen-compatible turbines. It requires a complete value chain, including competitive hydrogen production, storage, transportation, infrastructure, regulation, technical standards, and safe operating conditions.

Furthermore, Susana de Pablo emphasized that **the sector must move from expectations to execution**, prioritizing the demonstration of **hydrogen-ready technologies through real-world projects** and the development of a comprehensive hydrogen value chain.

Panel Discussion

Hydrogen-Fired Combined Cycle Plants: Technological Advances and Ongoing Projects

Miguel Iradiel, Head of Thermal Projects Engineering at EAG (Empresarios Agrupados - GHESA) and moderator of the panel, highlighted that **integrating hydrogen requires addressing the power plant as a whole, incorporating new design, safety, materials, and operational requirements**.

“What level of technological maturity has this solution reached?”

Siemens Energy (María Jazmín Nieto, Gas Turbine Sales Manager, International Projects)

- Hydrogen combustion benefits from **decades of experience** and already has **operational references at very high hydrogen concentrations**, such as the Vesta project (Brazil), developed by Siemens Energy and Braskem, which regularly operates with blends close to 60% hydrogen by volume and has demonstrated operation with up to 88% hydrogen.
- The technical feasibility has been **widely demonstrated**, and the current challenge is to transfer these capabilities from pioneering projects to **competitive and scalable commercial solutions**.

Ansaldo Energía (Miguel Churiaque, Country Manager Spain & Portugal)

- **The compatibility of large-scale gas turbines with hydrogen is already a proven industrial capability.**
- **The operational experience gained and demonstration programs are essential for reducing technological risk.** Ansaldo Energia currently guarantees minimum hydrogen blends of 40% across its portfolio, reaching **up to 70% hydrogen in its most advanced technologies**.
- The main challenge of hydrogen combustion is **controlling flashback without compromising efficiency**. Ansaldo Energia's sequential combustion technology addresses this issue by managing temperature and emissions through two separate combustion chambers.

Panel Discussion

Hydrogen-Fired Combined Cycle Plants: Technological Advances and Ongoing Projects

Miguel Iradiel led the discussion on the conditions required to accelerate the deployment of these projects, addressing issues related to **hydrogen supply, regulation, and market competitiveness**.

“What is needed to drive investment decisions?”

Siemens Energy

- Investment requires the availability of competitively priced hydrogen, a stable regulatory framework, and bankable business models.
- **Efficiency and emissions must remain key priorities. Dry low-emission combustion technologies** make it possible to control NOx emissions without the need for water injection, thereby avoiding additional efficiency losses and increased water consumption.
- **Hydrogen-ready solutions reduce investment risk and facilitate a gradual transition** while maintaining the flexibility and competitiveness of the power system.

Ansaldo Energía

- The market must provide **clear and stable signals** that enable operators to **maintain, modernize, and adapt combined cycle power plants to new operational requirements** that differ significantly from those for which they were originally designed.
- **Hydrogen adaptation must be assessed on a plant-by-plant basis.** While new power plants can be designed from the outset to operate on hydrogen, the conversion of existing facilities will depend on factors such as available space, auxiliary equipment, piping infrastructure, and the new safety requirements.

Hydrogen turbine success stories: operational experience

“True innovation is not measured solely by the percentage of hydrogen achieved, but by the ability to integrate the technology into the power system with guarantees.”

Luis Fernández, Sales Director, New Technologies & Key Accounts at **Mitsubishi Power**, presented the company's main technology validation initiatives aimed at demonstrating **the performance of hydrogen turbines and the entire hydrogen value chain under real operating conditions**. Key highlights included:

- **Validation under real operating conditions is essential** to ensure the reliability, availability, and safety of hydrogen turbines.
- **Takasago Hydrogen Park** enables the **verification of technologies prior to commercialization** and the transfer of operational data to improve turbine designs, **extending validation across the entire hydrogen value chain**. To date, the H-25 turbine has accumulated **thousands of operating hours**, with an output of approximately 40 MW.
- **The technological transition is progressing gradually**, reducing risks along the way. Mitsubishi Power has demonstrated stable operation with **30% hydrogen** in a turbine exceeding **560 MW**, as well as **100% hydrogen operation** in a lower-capacity industrial turbine.
- **Projects such as ACES Delta (Utah)** represent the large-scale implementation of this approach, integrating **220 MW of electrolyser capacity**, hydrogen production of approximately **100 tonnes per day**, storage in salt caverns, and an **840 MW combined cycle power plant** that will progressively transition to operation using pure hydrogen.
- **The transition can be supported by both new power plants and the adaptation of existing assets**. Demonstrations carried out at the **McDonough-Atkinson plant (Georgia, United States)** show that certain combined cycle plants can incorporate increasing percentages of hydrogen, leveraging existing infrastructure while reducing costs and implementation timelines.

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