

Integration of hydrogen and ammonia energy into combined cycles: the FLEXnCONFU project

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Aim and approach used

Within the strategies to achieve the European Union's carbon neutrality target by 2050, replacing fossil fuels with alternative sources such as renewables or secondary raw materials represents a prominent action line. The EU is currently dependent on natural gas (NG) to facilitate such transition, for its lower carbon footprint and greater grid stabilization capacity. However, combined cycle (CC) plants and likewise any system employing gas turbines (GTs), could potentially benefit from the integration of alternative energy sources to meet the grid's requirements at peak demand times, thus curtailing their carbon footprint significantly. Ammonia and hydrogen convey two promising energy vectors that if successfully deployed may considerably aid in the large-scale energy switch and help reduce CC plants' reliance on fossil fuels. The FLEXnCONFU project [1] plans to demonstrate the feasibility of integrating Power-to-X (P2X) solutions in CC plants at TRL 6 and 7, realizing their full potential to diversify the supply network, making it more flexible to accommodate a carbon neutral economy.

Scientific innovation and relevance

The main goal of the FLEXnCONFU project is to prove the viability of integrating ammonia and hydrogen energy in gas turbine systems, adapting existing equipment to various fuel mixes to maximize autonomy when covering production energy needs at peak demand times. Proper grid-oriented control strategies that enhance the flexibility of the Power-to-X solutions will be developed, aiming to match ammonia and hydrogen production with periods of low power demand. The technological developments resulting from this project together with the integration strategies presented, may be replicated elsewhere as they are versatile enough to be applicable to any GT system. To expedite integration of the new technologies, plant and equipment models will be carefully calibrated and validated, to determine optimal operation schemes and assist plant managers and operators with successful implementation. Advanced monitoring and control tools will be deployed for predicting and securing optimal performance.

Expected impacts are fully realizable since the EU reached an "all-time high" of 89.5% NG dependency in 2019 [2]. Incorporating P2X solutions in GT systems, will facilitate the grid/system coupling, i.e., integration of the gas and electricity grids, necessary to diversify the supply network and prevent customary operational problems associated to fluctuating demands.

Preliminary results and conclusions

The FLEXnCONFU project intends to demonstrate the profitability and technical feasibility of integrating alternative energy sources in the production loop of CC plants, through modifying the gas turbines to inject different blends of fuels. A reactor for ammonia synthesis will be designed together with the selection of the most adequate catalyst to carry out the reaction; experiments will be performed at pilot level to realize the system's capabilities and optimize functioning. Novel NOx mitigation technologies will also be explored during the experimentation phase. EDP's power plant in Ribatejo, Portugal, will serve as the demonstrator for hydrogen integration, aiming to reach up to 30% H₂ concentration, decreasing the plant's greenhouse gas (GHG) emissions. The development of dynamic models predictive of plant operation, reflecting the electrical grid load fluctuations, will attempt to increase the annual CC plant efficiency through facilitating smart scheduling.

Overall, the FLEXnCONFU project will involve concerting efforts from multiple stakeholders concerning innovation in process technology and simulation, control and automation, and GHG abatement. It is expected that outputs from this venture can leverage CC plants potential to facilitate the transition towards a carbon neutral Europe by 2050.

References

[1] "Home," FLEXnCONFU. <https://flexnconfu.eu/>.

[2] "Natural gas supply statistics - Statistics Explained." https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Natural_gas_supply_statistics&oldid=500422

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