Contribution ID: **277** Type: **Oral**

Small Modular Reactors and cogeneration: impact of steam extraction on power conversion performance

The evolving energy landscape requires a shift in the operational paradigm of nuclear power plants, traditionally employed as electric power generators, to meet the increasing need for grid flexibility and leverage dispatchable and low-carbon thermal power to decarbonise hard-to-abate processes.

These requirements can be met by extracting steam from the power conversion cycle to drive non-electric applications, such as high-temperature steam electrolysis for hydrogen production, which is the reference end-use considered in this study. In this work, the impact of different steam extraction and return points in terms of pressure, temperature, and mass flow rate on the performance of the balance of plant of a light-water cooled Small Modular Reactor (SMR) is investigated. The power conversion system of the SMR has been modelled and optimised, aiming to maximise cycle efficiency in response to different cogeneration requirements (up to 36 MWth), using the EBSILON Professional tool.

The results show that the steam reinjection points downstream of the heat delivery to the end-user have the largest impact on the overall cycle performance. Such analysis offers a general overview of nuclear cogeneration opportunities, providing a quantitative evaluation of the impact of converting an SMR's balance of plant to drive non-electric applications.

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Track Classification: Topical Group A: SMR Design, Technology and Fuel Cycle: Track 5: Non-Electric Applications for SMR