LEVERAGING AI FOR ENHANCED EFFICIENCY AND SAFETY IN NUCLEAR PLANTS: FOCUS ON OPERATIONAL PERFORMANCE, FLEXIBILITY, AND DECOMMISSIONING

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The incorporation of Artificial Intelligence (AI) in nuclear power plants represents a transformative opportunity for enhancing operational efficiency and addressing critical challenges in the industry. This paper explores three key areas where AI can significantly impact nuclear plant performance: capacity optimization, flexibility, and decommissioning practices, and presents practical use cases for each.

First, the optimization of capacity through the innovative use of AI is critical in unlocking operational margins on essential parameters. By integrating surrogate models into important systems, such as Instrumentation and Control (I&C) systems, nuclear plants can achieve higher effectiveness and reliability. New approaches have been developed to estimate the departure from nucleate boiling ratio (DNBR) using a neural network model. The test results show that a higher level of accuracy in predicting the DNBR can be achieved with the neural network model for both steady-state and transient operating conditions.

Secondly, the flexibility of nuclear power plants is examined through the lens of the OAPS System, which gives real time recommendations to the operator for power variation. As the energy landscape evolves, there is a growing need for operational flexibility. While increased flexibility can improve grid stability and responsiveness, it often results in reduced production levels, consequently decreasing revenue for operators. Therefore, balancing the need for flexibility with economic viability is a pressing concern for stakeholders. The paper will illustrate how securing and optimizing transient manoeuvres through real-time guidance for operators can facilitate flexible operations and improve profitability.

Lastly, the decommissioning of nuclear facilities poses unique challenges that require technological innovation. Initiatives like the robots AMORAC and VIRERO emphasize the importance of supporting decommissioning activities through AI-based automations that streamline the processes for dismantling nuclear sites and equipment as well as to avoid repetitive painful tasks and radiation exposure for workers.

Based on practical use cases, the paper will hence demonstrate how AI can offer potential for improving operational performance within the nuclear sector.

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