NEUP Nuclear Energy University Program
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Integrated Marine Platform for Hydrogen and Ammonia Production

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Program: Nuclear Energy Enabling Technologies Crosscutting Technologies

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ABSTRACT:

The objective of this project is to investigate the economic and environmental value of alternative configurations of a floating integrated GW-scale green hydrogen/ammonia production facility powered by an advanced nuclear reactor. The process steps include desalination, electrolysis to produce hydrogen, nitrogen capture from the air, synthesis of ammonia, and compression of the ammonia for storage. The production of green ammonia is one near-term option for decarbonization of the shipping industry.

Deploying a reactor on a floating platform offers several advantages, most importantly in the utilization of shipyard fabrication to reduce costs. Production of green hydrogen and green ammonia could be tightly integrated with a nuclear power plant on a floating platform production since there are no external feedstocks required besides the electricity and seawater. Floating Production Storage and Offloading units (FPSOs) have become an established part of the upstream oil and gas industry. About 270 FPSOs are currently deployed worldwide, built to an increasingly modularized format.

This research investigates the economic and environmental benefits of alternative configurations of the integrated floating platform concept. It also investigates how such a platform can best be integrated with onshore assets, including port facilities and components of a regional hydrogen cluster, as well as the regional electric grid. A main focus is on how different configurations enable flexible operations which can increase the value of the platform.

Task 1 analyzes how siting options and environmental, safety and security considerations shape the available set of configurations. It details the feasibility of storage options for component processes, including thermal storage for the reactor and the integrated system's operational flexibility. Finally, it estimates the cost of alternative configurations. The main output of this task will be a narrowed set of possible configurations with specifications for storage and operational flexibility, and costs, which will be documented in publications.

Task 2 analyzes the optimization of the platform as an integrated energy system, including links to the local regional economy, whether with the electrical grid or with local industrial assets making up a hydrogen cluster. Using INL's stochastic framework RAVEN and its dispatch plugin HERON, we evaluate the value of flexibly switching between production of hydrogen/ammonia and dispatching electricity to the grid. We improve HERON's ability to represent the electricity price volatility features evolving from a shift to low-carbon generation technologies. Finally, we consider specific siting options and address the integration of the platform into the economic structure of a port. This task will produce three publications, one valuing the flexibility of alternative configurations, one documenting the price volatility model, and one presenting the comprehensive assessment of a chosen platform and siting option.