Dow Chemical
partnered with
Idaho National Laboratory

NE-23-29899, Assessment of Small Modular Reactors

YEAR AWARDED: 2023

TOTAL PROJECT VALUE: $625,000 ($500,000 DOE, $125,000 Dow)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Daniel Mikkelson (INL), Scott Bury (Dow), Michael Curtis (Dow)

DESCRIPTION: Headquartered in Midland, Michigan, Dow Chemical Co. is the largest chemical and materials manufacturer in the United States and one of the largest in the world. The company seeks to help create a sustainable future for the world through materials science expertise and collaboration with widely diverse partners. The focus of this project was to examine the possible use of small modular reactors (SMRs) for producing electricity and process heat in its industrial operations. Determining what integration equipment will be needed to meet redundancy targets and how the systems will be controlled is critical to moving forward. Dow collaborated with researchers in Idaho National Laboratory's Integrated Energy Systems (IES) group to review processes and technologies, examine engineering process design for thermal integration of nuclear and chemical plants, and provide preliminary evaluation of control methods. Dow provided two sites: its St. Charles Operations (SCO) facility in Louisiana, adjacent to the Mississippi River, and its Carrollton facility in Kentucky, next to the Ohio River.

BENEFIT: Nuclear technology developers can use this analysis to demonstrate to potential industrial energy clients how they might be able to meet their heat and electricity demands. The IES analysis leverages the Framework for Optimization of Resources and Economics (FORCE), specifically the Holistic Energy Resource Optimization Network (HERON), for thermodynamic analysis of advanced reactor technologies.

IMPACT: Four or five SMRs at St. Charles should enable around a 30% reduction in site emissions relative to the 2021 values. And introducing around 167.3 MWth of microreactor capacity at Carrollton should allow for near-complete emissions elimination. Given the current deployment timelines for advanced reactor systems, these solutions likely will not be deployable until the mid-2030s at the earliest — not necessarily an immediate solution, but still available to be included as part of Dow's 2050 decarbonization goals.

SIGNIFICANT CONCLUSIONS: At the SCO site, it was determined that sets of only HTGRs, 800 MWth, or only LWRs, 1250 MWth, were statistically indistinguishable from an economic standpoint using current literature cost estimates. The solution indicates that, per the current cost projections for advanced reactors sized appropriately for integration with the SCO facility, no technology has proven to be clearly economically superior at this point. Colocation at that facility or siting a new location even closer to the Dow facility, should be possible to provide CHP.

At the Carrollton site, the thermal and electrical demands were deemed too small to be efficiently met by SMRs, due to reliability considerations (as maintenance, unplanned, or refueling outages would effectively shut down the entire plant). Due to the nature of currently proposed microreactor designs, the high economic uncertainty between designs, and the thermal conditions required at the Carrollton facility, different microreactor designs were considered to be relatively interchangeable.

NEXT STEPS: These solutions require deployment of nuclear technology beyond the current licensed electricity generation configurations. Engaging with licensing entities is key, and showing how large, combined heat and power (CHP) applications can be implemented without altering nuclear-sensitive design points may be valuable.