U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

LWR Integrated Energy Systems Interface Technology Development & Demonstration

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Pathway: Advanced Reactor Development Projects

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Abstract

The principle objective is to carry out planning, design, installation, testing, demonstration, and evaluation of non-electric, hybrid energy technologies connected to a light-water reactor (LWR) power plant. The expected result of this project is to have both a fully-functional hydrogen plant capable of operating as a hybrid system to test diverse electrolysis technologies coupled with a LWR and the design development for a hybrid reversible system. Both of the project deliverables are to be integrated into the normal operating routine of a nuclear power plant. In addition, a detailed report will be developed at the conclusion of the project that will highlight the technical feasibility and economic viability of implementation of these non-electric hybrid energy technologies. This report will ultimately be used by other utilities that operate nuclear power facilities for large-scale commercialization (i.e. hundreds of Megawatts.)

This project is a continuation of a previously funded proposal to have Idaho National Laboratory (INL) perform Technical Economic Assessments (TEAs) of hydrogen production using nuclear energy in the Minnesota and Arizona regions (Track I) and to perform a Low Temperature Electrolysis (LTE) hydrogen production demonstration at the Davis-Besse Nuclear Plant (Track II) operated by FirstEnergy Solutions, Inc. Track III of the proposed project will install a high temperature hydrogen generation pilot plant capable of producing approximately 4 kg of hydrogen per hour or greater. This hydrogen generation plant will first be commissioned and operated at INL. It will then be commissioned and operated at a nuclear plant to collect data, monitor performance of high temperature steam electrolysis (HTSE), interactions with the nuclear power plant / electricity distribution systems, as well as to understand its operation in different seasonal climate conditions. The product hydrogen will be used for on-site purposes and the remainder can be introduced into the local hydrogen market to support development. Major interfaces required for LWR hybrid operations (e.g. connections for steam and electrical power output between the electrical grid and electrolysis unit) are to be developed, tested, and refined in this project. This project will also include the development of a methodology of

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managing hybrid operations in a state regulated cost recovery environment to demonstrate overall positive impact to the customers.

Track IV of the proposed project will similarly develop the initial design and feasibility assessment for plant modifications to integrate a reversible hydrogen electrolysis system with the plant secondary system and for hydrogen storage infrastructure at the Palo Verde Nuclear Generating Station. Based on these evaluations and the modifications at First Energy Solutions and Xcel Energy plants, Track IV will subsequently develop the engineering design package to install and demonstrate the technical-economic feasibility of a fully integrated reversible electrolysis unit for hydrogen production and responsive power generation. The demonstration design is expected to incorporate storage to accommodate the daily hydrogen production for this reversible system.

This project will plan, develop, and test potential technological solutions to improve the long-term economic value of nuclear plants in regions challenged by low priced natural gas and renewable electric generation. The use of hybrid systems can preserve the benefits of nuclear plants, including grid stability and carbon-free energy while creating a market-based solution in response to increasing low-cost power as well as variable renewable energy supplies. This aligns with the purpose of Title VIII of the Energy Policy Act of 2005 and will help to ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions.

The objectives of the project will include:

(1) Demonstration of safe nuclear plant thermal energy extraction for non-electric / hybrid energy application
(2) Demonstration of carbon-free hydrogen production by nuclear energy and HTSE
(3) Verification of reference U.S.-based HTSE system design for nuclear power plants
(4) Enable supply chain of U.S.-based manufacturing and technology for non-electric applications
(5) Simulations of HTSE system performance at large scale (e.g. 200 MWe)
(6) Design preparation to support future demonstration of reversible HTSE to produce, store and then use stored hydrogen to produce additional electricity during times of high electric grid demand.