NUCLEAR ENERGY RESEARCH INITIATIVE

Centralized Hydrogen Production from Nuclear Power: Infrastructure Analysis and Test-Case Design Study

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Collaborators: General Atomics; University of South Carolina; Entergy Nuclear, Inc.

The National Energy Plan proposed by President Bush foresees that energy from hydrogen will have an increasing role in the national economy, and that a large-scale, hydrogen-based, energy economy will augment the current fossil fuel energy economy, reducing the nation's dependence on imported petroleum.

Achieving the vision of a hydrogen-based economy requires safe, cost-effective methods of producing and distributing hydrogen in the quantities needed to support a major part of the Nation's energy and transportation needs. Also required is a strategy for making the transition to such an economy, especially because the infrastructure needs for centralized hydrogen production are considerably more complex than those for the alternative method of distributed hydrogen production using electrolysis.

The objective of this research is to identify, characterize, and evaluate the critical technical and economic issues associated with a new and innovative approach to centralized hydrogen production-thermochemical decomposition of water using heat from a nuclear reactor. These issues include hydrogen production, storage, distribution, and end-user integration.

Outcomes of this research will include the information needed to evaluate the technical feasibility and economic attractiveness of nuclear reactor-produced hydrogen, as well as the detailed characteristics for a commercial prototype system and an analysis of the economics of building such a system. The resulting methodology will help in developing the actual production facilities and related infrastructure. Technology gaps identified in this study will be the basis for future research projects designed to overcome barriers to implementation.

This research will define the process and infrastructure needed for nuclear hydrogen production to become a reality. In the process, the project will take advantage of many past and current studies of either production or infrastructure issues. However, although hydrogen infrastructure studies have been performed, no comprehensive analysis exists of an integrated nuclear reactor-thermochemical production system and the required supporting infrastructure. Therefore, this study will be unique in examining the integration of nuclear and thermochemical processes with infrastructure, and will define the engineering and economic factors needed to deliver nuclear-produced hydrogen to end users.
This study will build on existing design studies being supported by the Department of Energy through the Nuclear Energy Research Initiative, and will have two phases:

- Phase A, Infrastructure Analysis-conduct a comprehensive examination of nuclear hydrogen production methods and related hydrogen infrastructure systems. From this phase will come the detailed information needed to evaluate the technical feasibility and economic attractiveness of nuclear-thermochemical hydrogen production and to build a prototype commercial system.
- Phase B, Test Case Preconceptual Design-develop more specific, detailed results by conducting a test-case design study and economic analysis that hypothesizes thermochemical hydrogen production at a specific site and with a specific end-user. The Department of Energy's Savannah River Site and an existing local chemical plant will be the basis for this study. This phase is particularly applicable to determining the feasibility of using nuclear reactor-produced hydrogen for industrial applications such as oil refineries and chemical plants during transition to a large-scale, hydrogen-based energy economy.

The proposed project is led by the Westinghouse Savannah River Company (WSRC) through its applied research and development laboratory, Savannah River Technology Center (SRTC). Supporting SRTC will be a highly qualified team of two major industrial partners, General Atomics (GA) and Entergy Nuclear, Inc.; a leading university partner, the University of South Carolina (USC); and two experienced hydrogen consultants, Mr. Robert B. Moore, (retired, Air Products and Chemicals), and Dr. Joan Ogden, Princeton University. The team members will contribute extensive expertise and experience in every discipline required to make this project a success.

WSRC, with over 50 years of nuclear and hydrogen expertise as well as extensive research and development (R&D), production, and project experience, will take the lead in defining the hydrogen storage, transmission, and delivery systems, and will provide overall project management. GA brings a wealth of experience in nuclear reactor design and the thermochemical process, and will lead the process definition in these two areas. Entergy Nuclear, the nation's second largest nuclear power plant operator, will validate the preliminary design and cost information and provide an overall utility-company perspective on the project. USC has considerable expertise in hydrogen and fuel cell technology, and will lead the effort to develop an economic model to evaluate the various hydrogen infrastructure scenarios. USC will be supported in their tasks by the two key consultants, Robert Moore and Dr. Joan Ogden, both of whom have extensive backgrounds in hydrogen infrastructure studies and planning.

Hydrogen produced from nuclear power not only has many attractive environmental advantages, including the reduced emissions of nitrous oxides, sulfur, and global warming gases. It also has the potential to impact the Nation's energy security by reducing a dependence on imported oil. However, uncertainty about the supply system and the price of end-use hydrogen precludes an accurate assessment of hydrogen's potential future contribution to the national energy supply. This unique, comprehensive study will help define that future by providing valuable information for assessing the merits of nuclear hydrogen production, both for near-term hydrogen supply for chemical plants and for longer-term hydrogen supply for the hydrogen economy.