Demonstration of Electrolyzer Operation at a Nuclear Plant to Allow for Dynamic Participation in an Organized Electricity Market and In-House Hydrogen Supply

U. Otgonbaatar, S. Szymanski, R. Boardman, M. Ruth, and A. Elgowainy

Exelon, a fortune-100 energy company, is committed to retaining its position as the #1 supplier of carbon-free electricity in the U.S. This will require sustaining Exelon's exemplary nuclear fleet and expanding Exelon's footprint in providing carbon-free sources of energy to U.S. systems. The company can accomplish both goals, with DOE's help, by demonstrating installation and operation of a hydrogen electrolyzer at one of its nuclear plant sites. This project will enable an Exelon nuclear plant to produce and self-supply carbon-free hydrogen, and will initiate simulation and demonstration of dynamic, market-driven operation of a hydrogen electrolyzer in a scalable manner. The project results represent a first step toward regional supply of carbon-free hydrogen, while supporting clean electricity resources on the grid.

Exelon is partnering with Nel Hydrogen and multiple national laboratories to demonstrate an integrated hydrogen production, storage and utilization facility at an Exelon nuclear plant site. Exelon will install a proton exchange membrane (PEM) electrolyzer and an associated hydrogen storage system, supporting infrastructure, and a control system to enable dynamic operation of the electrolyzer. One project goal includes economic supply of carbon-free hydrogen for internal nuclear site use. In addition, Exelon will work with the labs to simulate and demonstrate dynamic control of the electrolyzer, paving the way for participation of hybrid power/hydrogen systems in organized power markets.

This project aims first to demonstrate the economic feasibility of on-site hydrogen generation. For this purpose, Exelon will install a 1MW electrolyzer at an Exelon nuclear plant site. Doing so will require extensive site analysis and preparation, potential regulatory approvals and permits, and successful project management and construction. In addition, Exelon will partner with the national labs to simulate a scaled-up version of the hybrid nuclear plant/electrolyzer system to evaluate the feasibility and economic value of such a system responding to electricity market signals. Dynamic operation of an electrolyzer, allowing a power plant to efficiently respond to market signals in an organized power market, has not yet been demonstrated in the US at a power generation facility. The project participants will also demonstrate remote connection and control of an electrolyzer as a step toward enabling real operation in a dynamic manner.

The project will include tasks that leverage the individual strengths of the partners. These include dedicated engagement from Exelon's nuclear operations and engineering organization to conduct technical and regulatory analyses, and providing engineering and project management expertise to install and operate the electrolyzer at a nuclear plant. The expertise of the national laboratories will be leveraged to demonstrate remote connection and control of the electrolyzer, conduct a simulation of an electrolyzer operating dynamically in response to market signals for the output of the nuclear plant, and a site-specific detailed assessment of economic competitiveness. The electrolyzer will be supplied by Nel Hydrogen, a project partner with a proven track record and a mature technology.

Scaleup of hydrogen production in the U.S. power sector faces regulatory, market, and cost barriers. This project represents a FOAK installation of a dynamically operable hydrogen production facility at a nuclear plant to enable nuclear units to be dispatchable.

The mechanism for hydrogen-based energy storage systems to improve nuclear plant participation in organized power markets is not established, and this project will serve as a first step in demonstrating the feasibility.

The regulatory, economics and commercial lessons learned during the pilot demonstration project will be applicable for a future hub project involving nuclear power produced hydrogen.