Addressing System Integration Issues Required For The Development Of A Distributed Wind-Hydrogen Energy Systems

Department of Energy Experimental Program to Stimulate Competitive Research
(DOE/EPSCoR) State – DOE National Laboratory Partnership Awards
DOE Grant No. DE-FG02-04ER46115

Dr. Michael Mann (PI), Dr. Hossein Salehfar (Co-PI), Dr. Eduardo Hernandez Pacheco, Kevin Harrison, Christian Biaku, Andrew Peters, Nilesh Dale, Charles Nyberg
University of North Dakota, Grand Forks, ND
mikemann@mail.und.nodak.edu

Wind generated electricity is a variable resource. Hydrogen can be generated as an energy storage media, but is costly. Advancements in power electronics and system integration are needed to make a viable system. Therefore, the long-term goal of the efforts at the University of North Dakota is to merge wind energy, hydrogen production, and fuel cells to bring emission-free and reliable power to commercial viability. The primary goals include 1) expand system models as a tool to investigate integration and control issues, 2) examine long-term effects of wind-electrolysis performance from a systematic perspective, and 3) collaborate with the National Renewable Energy Laboratory (NREL) to design, integrate, and quantify system improvements by implementing a single power electronics package to interface "wild" AC to PEM stack DC requirements.

As a result of meetings with NREL, our partner for the program, we have been focusing our initial modeling work on the development of fuel cell, electrolysis and hydrogen storage modules that can be utilized within the framework of RPM-SIM, the software tool developed by NREL. A PEM fuel cell module has been developed to predict the response of the fuel cell under different operating conditions including operating voltage, membrane temperature, initial hydrogen and oxygen concentrations, and operating pressure. A similar PEM electrolysis module is being finalized. These modules will be incorporated into RPM-SIM to evaluate system integration and control issues for an electric power generation hybrid system.

The research team is establishing experimental facilities to address Goals 2 and 3. This is occurring on several fronts. A Ph.D. student spent 8 months working at NREL's WTC installing and gathering data on their electrolysis system. We have been working with one of the PEM electrolysis manufacturers to obtain a PEM stack that will serve as the heart of our experimental system. The design for the experimental setup allows us to gather fundamental information for the integration of the electrolyzer with a wind generator and optimizing electrolyzer performance. Similar fuel cell facilities are being configured around a 1.2 kW Ballard fuel cell. A 17.5 kW wind turbine has been donated to the School of Engineering and Mines that will be dedicated to this project.

This research facility will initially be utilized to gather fundamental operating and performance data for model verification. Later they will become a part of facilities to test control options that will be developed during the research effort. This poster will present an overview of the project and will include details of the fuel cell and electrolysis models.