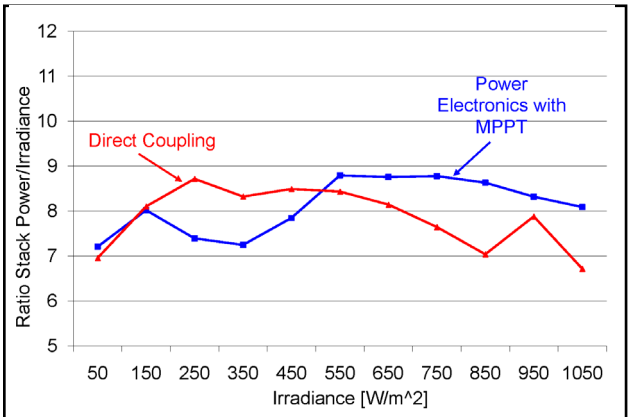
NREL Improves System Efficiency and Increases Energy Transfer with Wind2H2 Project, Enabling Reduced Cost Electrolysis Production

Project: The Wind-to-Hydrogen (Wind2H2) Project integrates wind turbines and photovoltaic (PV) arrays with electrolyzer stacks to split water into hydrogen and oxygen with renewably generated electricity. NREL seeks to improve hydrogen production from renewable sources efficiently and cost-competitively.

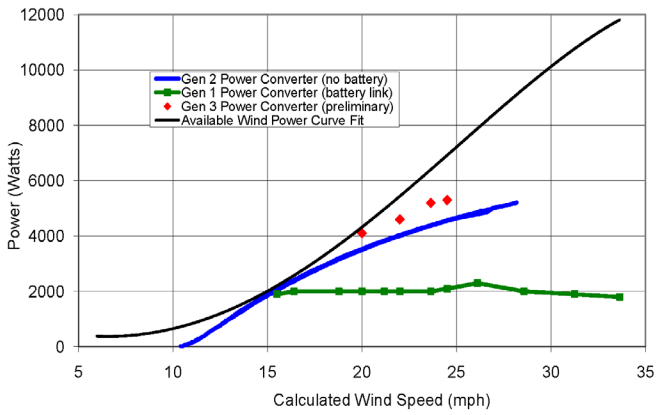
Team: Wind2H2 Project at the National Wind Technology Center (NWTC) in partnership with Xcel Energy.

Accomplishment: NREL has improved energy transfer within the system, which will help increase the efficiency of producing hydrogen through electrolysis while reducing costs (first reported in July 2009).

In an effort to improve energy transfer within wind turbine-based renewable energy systems, NREL has designed and continues to test improved AC-DC power electronics systems between a variable-speed 10-kW wind turbine and polymer electrolyzer membrane (PEM) electrolyzer stack. The test results (below) showed continued improvement from the Gen 1 to some preliminary data (♦) of the Gen 3 design using improved control algorithms.



Comparison of experimental data between direct-coupling and MPPT power converter approaches.



Energy transfer improvements from the 10-kW wind turbine tested by NREL. The graph shows successive improvement, including the latest preliminary third generation improvement in the green shaded area.

Increased Energy Transfer: NREL continues to improve energy transfer from a 10-kW solar PV array, comparing directly coupling the PV array to the electrolyzer stack with a connection through a maximum power point tracking (MPPT) power electronics package designed at NREL.

The experimental testing (above) revealed that direct coupling outperformed power electronics when solar irradiance levels are below 500 W/m^2 while the MPPT power converter delivered more energy to the stacks between 500 and 1,100 W/m^2. These findings have operational implications where a direct coupling approach would be utilized in the morning, evening, and on cloudy days, then switched to a power converter when irradiances exceed 500 W/m^2.

Reduced Cost: Based on these investigations, NREL engineers estimated that optimizing power electronics in large-scale wind-based renewable electrolysis systems could reduce the cost of wind-to-hydrogen production by 7%, from $6.25/kg to $5.83/kg. System level integration of renewable energy sources and electrolyzer stacks can improve energy transfer within the system, increasing system efficiency and lowering overall cost of production.

Applicable DOE Technical Target: Reduce the cost of central production of hydrogen from wind-based water electrolysis to $3.10/kg by 2012 and reduce the cost to less than $2.00/kg by 2017.

Significance of Accomplishment: NREL's analysis, based on the Wind2H2 experimental results, showed a potential 7% cost reduction per kilogram of hydrogen based on capital cost improvement by eliminating the inverter from the wind turbine and the AC-DC power electronics in the electrolyzer and replacing both with a DC-DC converter between a wind turbine and electrolyzer stack.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.
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