Hydrogen Enabling Renewables Working Group

Update for the HTAC

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Members

- Peter Bond (Brookhaven National Laboratory)
- Charles Freese (General Motors)
- Rob Friedland (Outside Member - Proton Energy Systems)
- Maurice Kaya (Energy and Management Consultant)
- Harol Koyama (IdaTech)
- Frank Novachek (Xcel Energy)
- Robert Shaw (Aretê Corporation)
- George Sverdrup (Outside Member – National Renewable Energy Laboratory)
- Sandy Thomas (Outside Member – Independent Consultant)
- Levi Thompson (University of Michigan)

Purpose

Examine the various ways in which hydrogen might serve as an enabler for high penetrations *(>50% nationally, on an energy basis)* of variable renewable energy in the United States.

Summarize the opportunities and challenges of using hydrogen as an enabler for renewables in a white paper for DOE executive management.

Potential Applications

- Energy storage
- Energy transmission & distribution
- Improved renewable resource utilization via vehicle fuel production
- Supplement to Natural Gas System

Initial Focus Area

- Grid energy storage
  - Integration of variable renewable resources (ramp rate controls, time shifting from off-peak to on-peak, reserve margins, etc.)
  - Reduction of variable renewable energy curtailments due to baseload bottoming and/or transmission and distribution system constraints
- Basis
  - Analysis of this application can be leveraged in the analysis of other applications
  - DOE interest in energy storage for integrating renewables

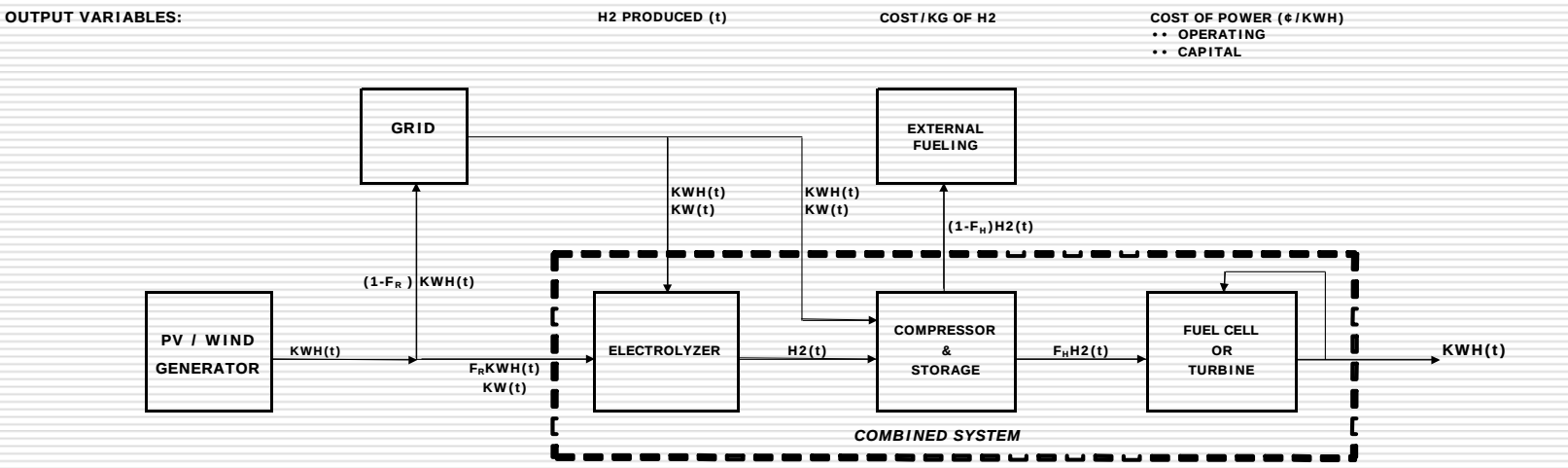
Plan for Evaluating Energy Storage Application

- Identify and assimilate information needed to evaluate the viability of hydrogen energy storage to:
  - Mitigate the variability of renewable energy
  - To be competitive with other energy storage technologies, including:
    - associated infrastructure requirements and
    - the relative probability of a solution being commercially available in the next 10 years
- Develop simple model for examining the basic economics
- Apply model to hydrogen and other competing energy storage systems
- Compare results
- Identify key issues for hydrogen system competitiveness

Identified Information Needs

- Scale of energy storage required to enable 50% penetration of renewables on an energy basis
- Levelized cost per kWh of energy (total life-cycle normalized) from hydrogen storage systems vs. alternative storage technologies that are commercial or projected to be in a comparable time frame,
  - At various scales
  - At various hours of storage
- Infrastructure required (and costs) for hydrogen energy storage systems that is not required for alternative energy storage systems, and visa-versa, at various geographic scales (national, regional, local, distribution feeder levels)
  - Different configurations (i.e., energy transmitted by pipe or wire?)
  - Scale of systems (i.e., number of nodes)
  - Cost of operating and maintaining each infrastructure
- Dynamic response capabilities from hydrogen and other energy storage systems
- Energy storage applications that may be unique to hydrogen systems that can deliver additional value as perceived by customers
- Performance & economics data from existing renewables integration projects world-wide

Simple Energy Storage Model Concept (DRAFT)



Assume the *Combined System* runs 24/7 with input either from the Renewable Generator or the Grid.

Note: Model could be run in hourly segments or integrated over a day, week, month, or year.

Questions for HTAC

- Does the HTAC/DOE agree with the Working Group's decision to initially focus on grid energy storage?
- Are there other applications that the Working Group should be considering?