DOE Hydrogen Program

Distributed ENERGY SYSTEMS

Extending today's resources... creating tomorrow's choices

Hydrogen Generation from Electrolysis

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Distributed Energy Systems

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PDP13

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Original Start March 2004
- Current Scope
  - May 2007 to Dec 2007

Budget

- Total Project Funding $2.2M
  - 50% Cost Share
- $0K DOE Funding for FY06
- $760K DOE Funding for FY07

Barriers

- G. Capital Cost
- H. System Efficiency
- J. Renewable Electricity Generation Integration

Objectives

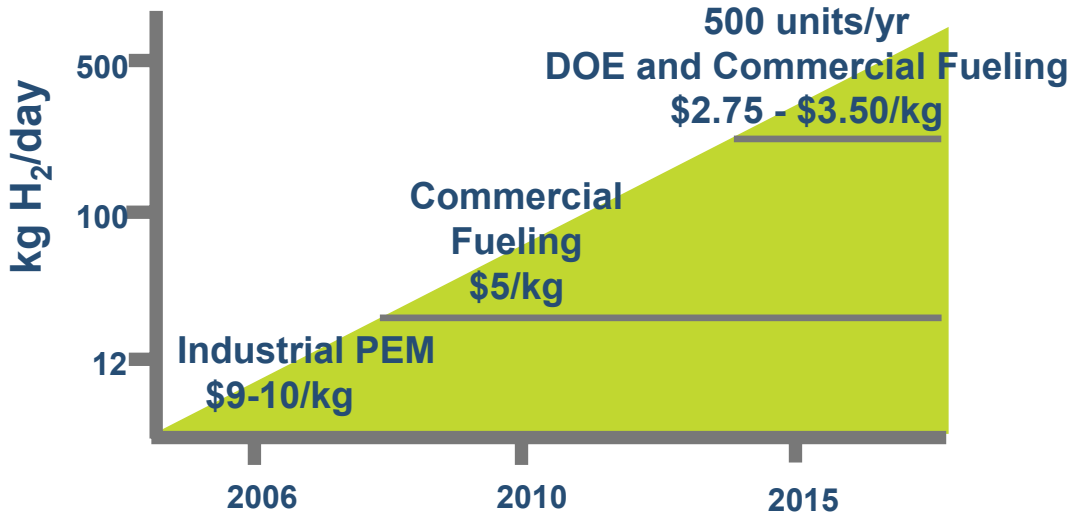
- Establish Pathway to Larger PEM Systems
- 100 kg/day with Growth to 500 kg/day
- Emphasis on Capital Cost and Energy Efficiency

Table 3.1.4 Technical Targets: Distributed Electrolysis Hydrogen Production[a,b,c]

Characteristics	Units	2003 Status	2006[c] Status	2012 Target	2017 Target
Hydrogen Cost	$/gge	5.15	4.80	3.70	<3.00
Electrolyzer Capital Cost[d]	$/gge $/kW	N/A N/A	1.20 665	0.70 400	0.30 125
Electrolyzer Energy Efficiency[f]	% (LHV)	N/A	62	69	74

Approach

- **System Design and Analysis**
  - Design Trade Studies
  - Conceptual Design



$/kg H_2 Fuel Cost is Derived from H2A Model

Approach

- **Design Trade Studies**
  - Build on Previous Modeling Work
  - Identify the Best Candidate Solutions, Taking Into Account Interactions Among Subsystems
  - Trade Criteria Driven by DOE Technical Targets
  - Focus Areas
    - Cell Stack Size, Configuration, Number
    - Cell Stack Power Supply Topology
    - Drying Efficiency
    - Water Management
    - Thermal Management

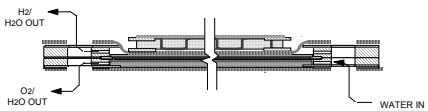
Approach

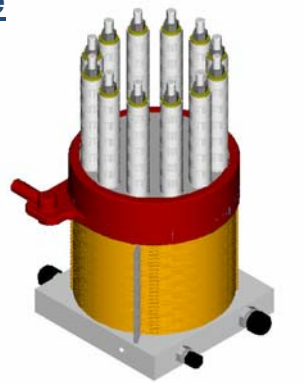
- **Cell Stack Trade Study**
  - Baseline vs. Bipolar Plate Design
  - Size vs. Number

Commercial Baseline

Parts Count: 29 per cell

Unit Cell

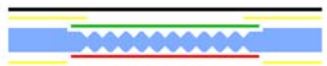


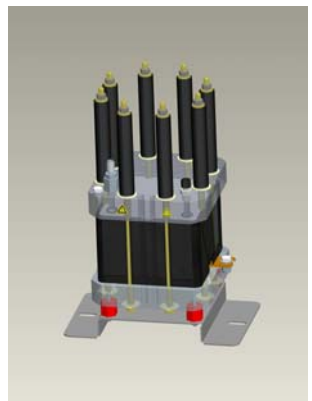


Next Generation

Parts Count: 9 per cell

Unit Cell

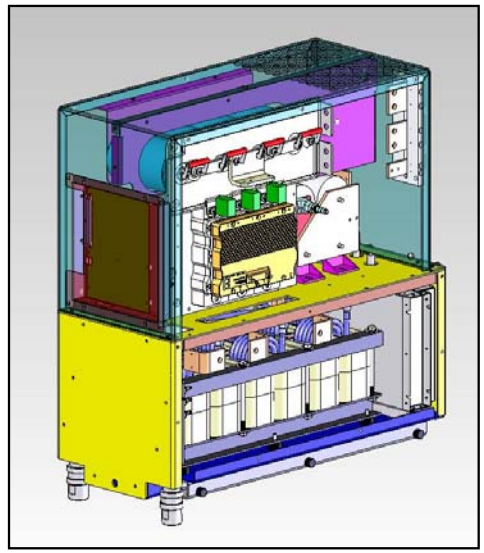




Approach

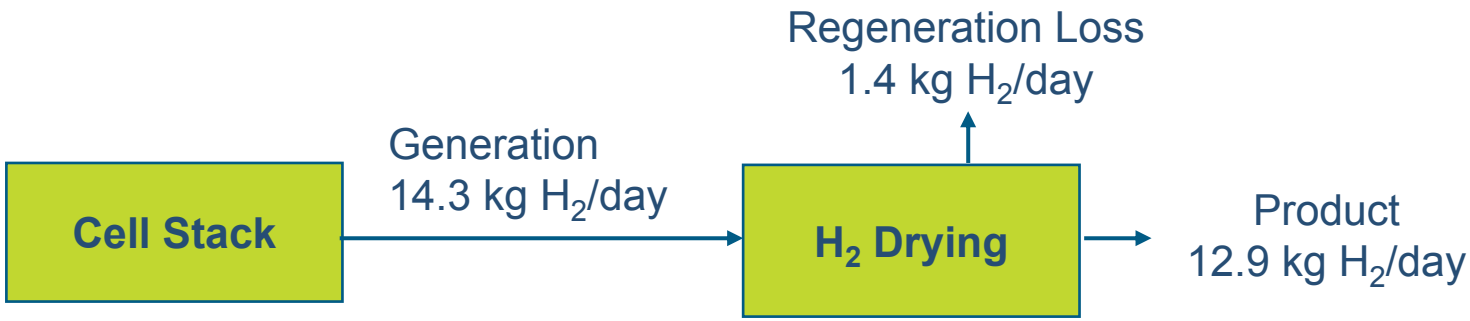
- **Power Supply Trade Studies**
  - Optimize Voltage and Current
    - Efficiency
    - Cost
  - Current and Upcoming Topologies
    - Cross Platform Power Supply
    - Flex Phase
  - Interface with Renewable Sources

Flex-Phase™ module



Approach

- **Drying Efficiency Trade Study**
  - Current Loss up to 10% H2 Gas During Regeneration Cycle
  - Target 3% or Less Regeneration Loss
  - Examine New Techniques at Larger System Size

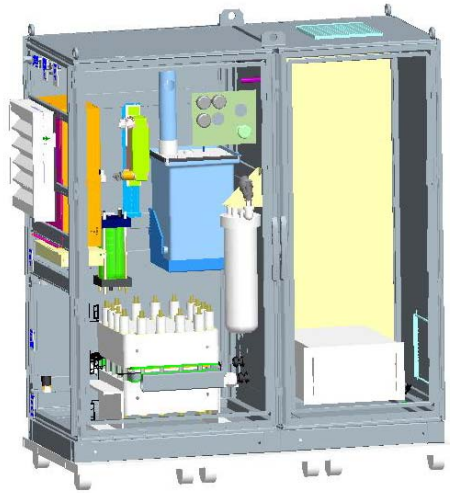


Approach

- **Water Management Trade Study**
  - Discrete Systems for Each Cell Stack vs. Combined Systems
    - Larger Quantity of Two Phase Flow
    - Larger Pressure Vessels
    - Cost
    - Code Requirements
- **Thermal Management Trade Studies**
  - Ventilation vs. EX Components
  - Heating and Cooling Requirements

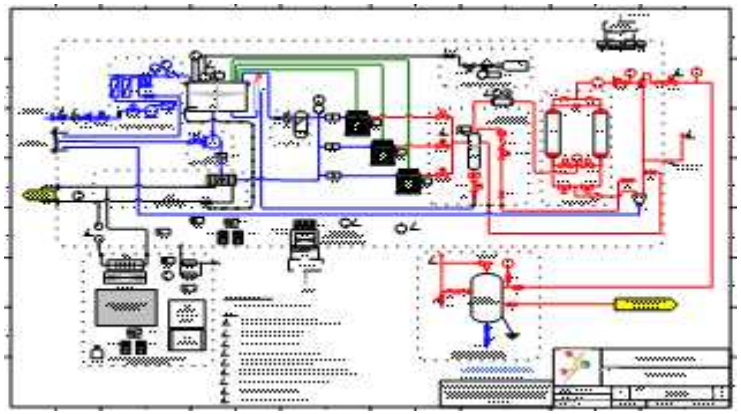
Approach

- **Conceptual Design**
  - Enable Cost and Efficiency Improvement Estimates, Compared to Current Values
  - Starting Point for Cost-reduction Discussions with Suppliers
  - Basis for Future Detailed Design
  - Functional Architecture
  - Physical Architecture



Approach

- **Functional Architecture**
  - P&ID
  - Top Level Electrical
  - Preliminary Hazard Analysis
  - Sub-system Design Intent
  - Sub-system Interconnection
- **Physical Architecture**
  - CAD Model – Layout and Mounting
  - Component Size and Weight
  - Mass Flow Analysis



Summary

- **100 kg/day - Pathway to Larger PEM Systems**
  - Higher Efficiency
  - Lower $/gge, $/kW
- **Design Trade Studies to Identify Best Options**
- **Conceptual Design**
  - Provide More Accurate Cost Reduction Estimates
  - Basis for Future Detailed Design