DOE Hydrogen Program

Development and Demonstration of a New-generation High Efficiency 2-5 kW Stationary PEM Fuel Cell System

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Project FCP34

Overview

- Timeline
  - Start June 2007
  - Finish June 2010
  - 1% complete
- Budget
  - $4.4 million project
    - 50% DOE cost share
  - Projected funding for FY07 $270K
- DOE Technical Plan Barriers
  - Durability
  - Cost
  - Performance
  - System Thermal and Water Management

- DOE Technical Plan Objectives

	Project Target	DOE 2011 Target
Electrical Efficiency	40%	40%
Durability (Hours)	40,000	40,000
Capital Cost ($/kW)*	400	750

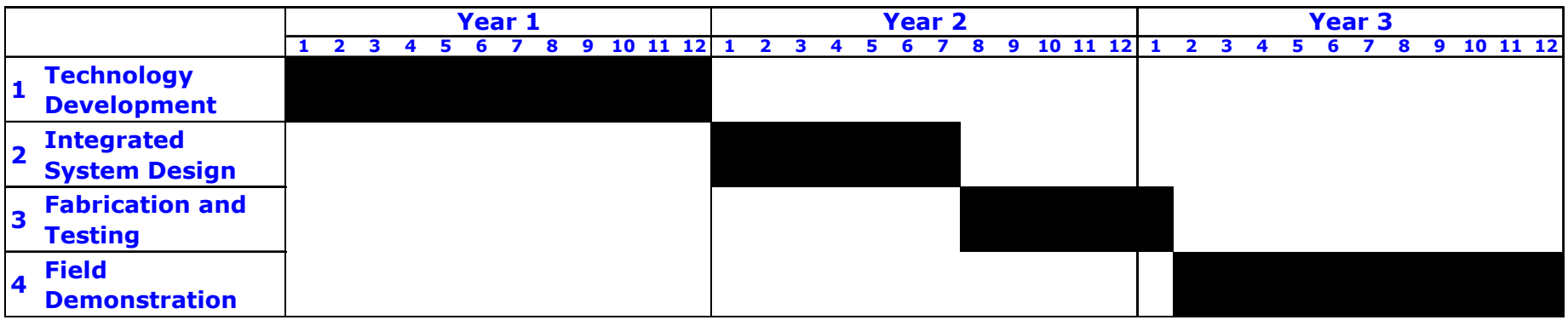
- Partners
  - Intelligent Energy sister companies
    - Loughborough UK – PEM fuel cells
    - Albuquerque US – membrane reformers
  - CSU Pomona – materials

*Capital cost target assuming high volume production

Objectives

Overall: Develop and demonstrate a PEM fuel cell based 2-5 kW_e combined heat and power (CHP) system that can meet DOE cost and performance targets

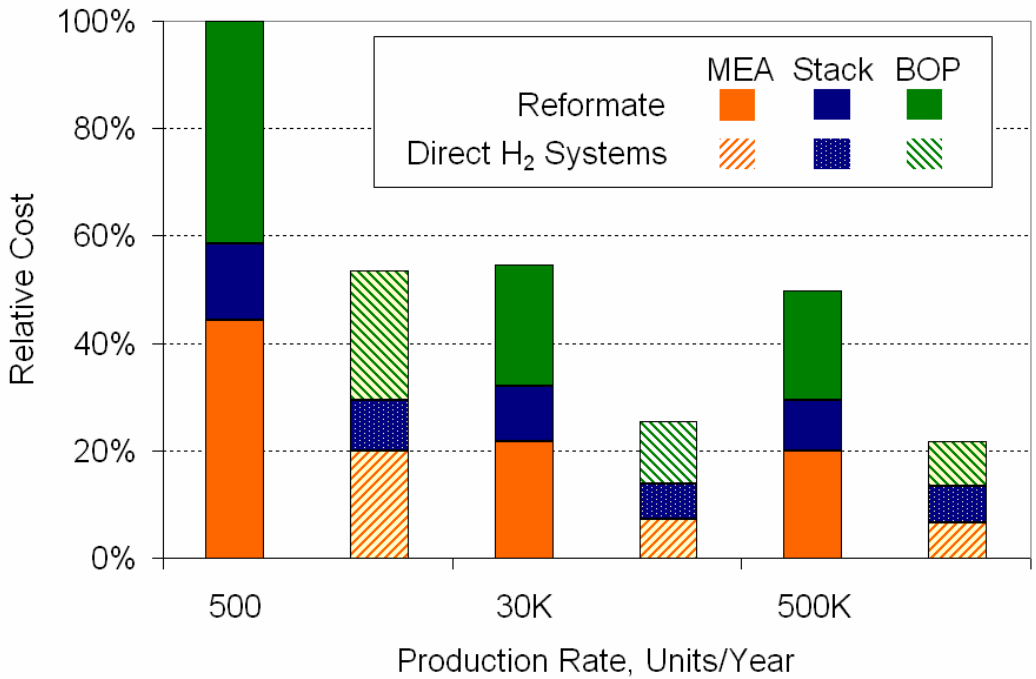
- Task 1: Subsystem technology development
  - Fuel processor development – IE U.S.
  - Fuel cell development – IE U.K.
- Tasks 2 & 3: System design, fabrication and testing
- Task 4: Field demonstration



Approach

Open Architecture - High purity hydrogen interface between fuel cell, fuel processor

- Advantages
  - Improved fuel cell performance
  - Increased fuel cell lifetime
  - Lower fuel cell cost
  - Smaller reformer
  - High fuel utilization
  - Simplified integration
  - Independent operation of fuel cell, fuel processor

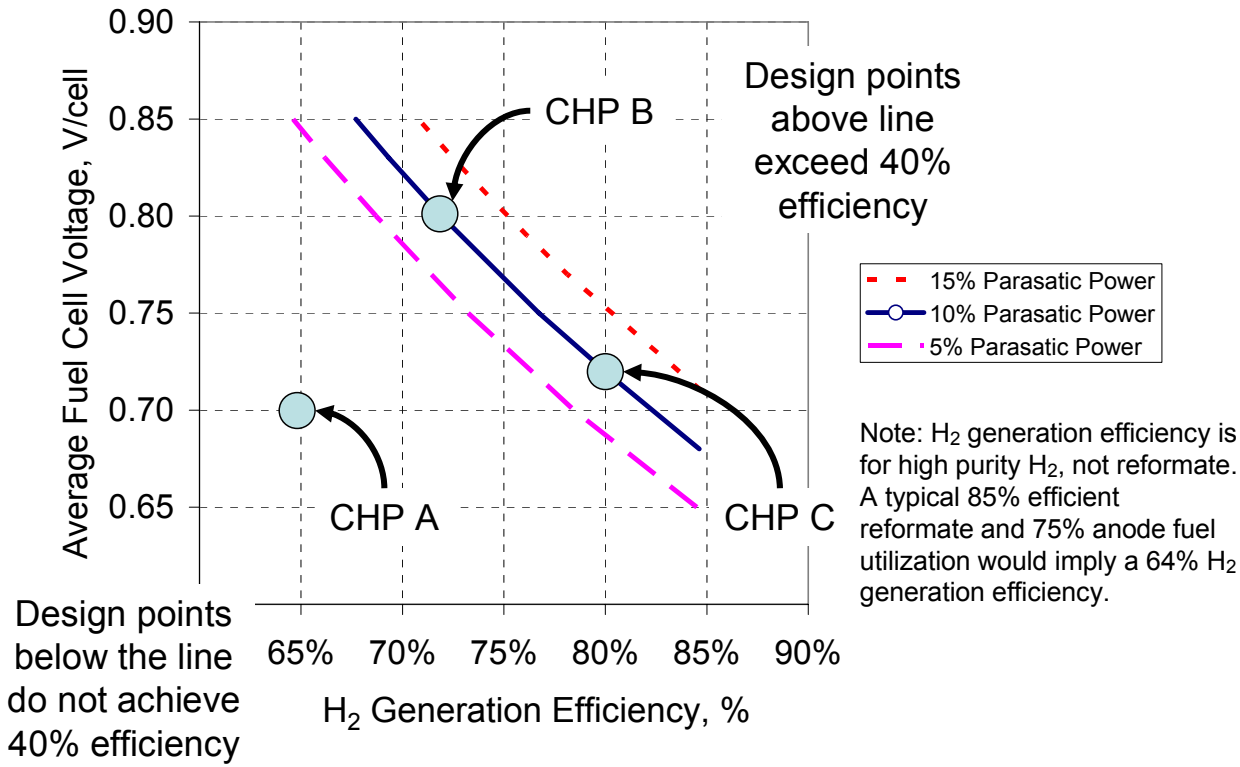


Reference: James, B.D., et al. Directed Technologies, 2003 Hydrogen and Fuel Cell Annual Merit Review Meeting, May 2003

Approach

Approaches to reaching efficiency target

- Increase cell voltages
- Increase hydrogen generation thermal efficiency
- Decrease parasitic loads



Approach

Approach to fuel cell stack & system performance improvements

- Improved flow-field design
- Fluid flow modelling
- Advanced MEA design
- Diffuser optimised for water management
- Advanced bipolar plate materials
- Reduced air pressure requirements
- Pressed plate architecture to address cost
- Optimized air delivery design
- Optimized power management design & configuration

Approach

Approach to hydrogen generation efficiency improvements

- Two platforms in parallel development
  - MesoFuel advanced membrane reactor
    - Increase reactor pressure
    - Thermal integration improvements
  - Hestia with rapid cycle PSA
    - With 100mV fuel cell voltage improvement, efficiency target can be reached with optimization of current Hestia design
    - With 20mV fuel cell voltage improvement, efficiency target can be reached with integration of CO_2 absorption (AER) into Hestia process

Approach

Field Demo Sites

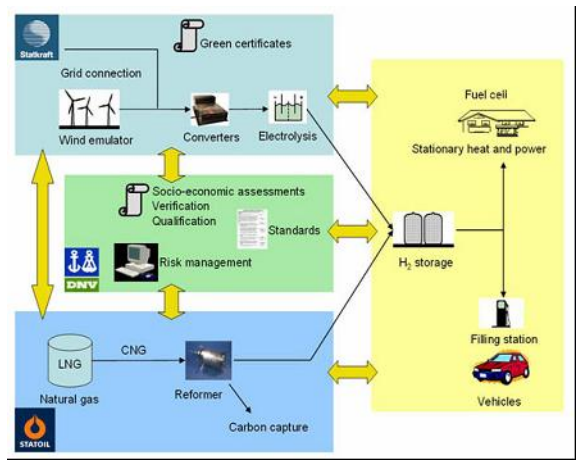
- United Kingdom

  West Beacon Farm (Loughborough)

- Sweden
  E-On Gas (Malmo)

- Norway

  HYTREC Center (Trondheim)



Technical Accomplishments

Reformer

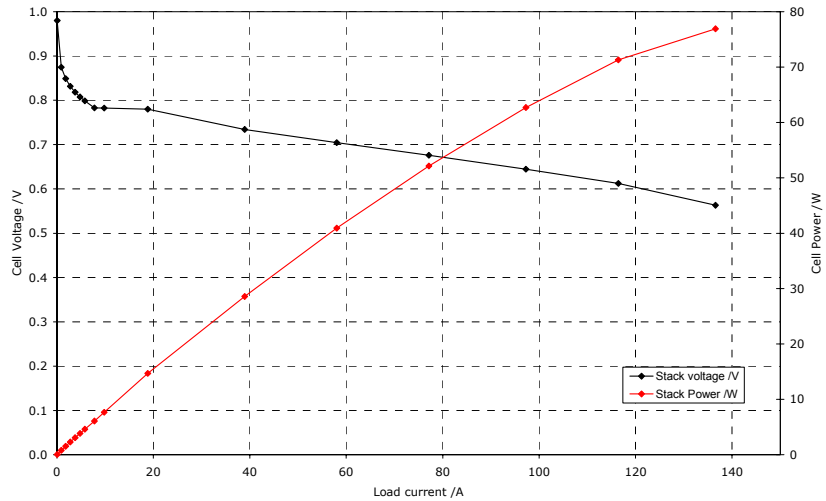
- Fabricated two reactor prototypes of two different designs
- Assembled and commissioned additional test station

Reactor 2 in test station 2

Reactor 1 in test station 1

Fuel cell

- Characterization of increased porosity diffusion media now underway
- Designed matrix of flow field variants
- Assembled and commissioned dedicated test station



Future Work

FY07

- Reformer
  - Initiate materials development for absorption enhanced reformer design
  - Initiate modeling of absorption enhanced reformer design
  - Initiate testing of reactor prototypes and obtain baseline data for most current SMR design
  - Initiate development of high pressure membrane reactor
- Fuel cell
  - Design, prototyping and performance testing of advanced cell materials
  - Initiate fluid flow modeling
  - Initiate fuel cell system design

FY08

- Validate performance of novel subsystem designs
  - Absorption enhanced reformer
  - High pressure membrane reactor
  - High efficiency fuel cell stack
- End of Year 1: Validations are first major milestone
- Initiate Task 2: System Design, Fabrication and Testing

Summary

- Program objective is to develop and demonstrate a PEM fuel cell based 2-5 kW_e combined heat and power (CHP) system that can meet DOE cost and performance targets
- Approach is to optimize fuel reformer, PEM fuel cell subsystems by providing pure hydrogen interface between the two
- The program has just begun, yet significant progress has been made
- First major milestone in FY08: Validation of high efficiency reformer, fuel cell stack designs