

The Hawaii Fuel Cell Test Facility (HFCTF) and Fuel Cell Testing Activities

Hawaii Natural Energy Institute
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa



Hawaii Natural Energy Institute
www.hnei.hawaii.edu

Introduction to the Hawaii Natural Energy Institute (HNEI)



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Hawaii Natural Energy Institute

- Established by the Hawaii Legislature in 1974 to assist the state in developing Hawaii's renewable energy resources
- Operating as a research unit in the University of Hawaii's School of Ocean and Earth Science and Technology (SOEST)
- Staff includes permanent faculty, scientific staff, post-doctoral fellows, graduate students, and administrative support
- Research programs include hydrogen and fuel cells, sea-bed methane hydrates, high value products from biomass, photovoltaics, and biotechnology
- Other activities include the development and management of public/private partnerships to deploy and demonstrate fuel cell and renewable energy technologies, with emphasis on energy policy issues and public outreach



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- 1986 – DOE funded Hydrogen from Renewable Resources Program initiated at HNEI
- 1996 – HNEI named U.S. DOE Center of Excellence for Hydrogen Research and Education
- 2000 – H₂ Feasibility Study under HI House-Senate Resolution
- 2001 – HI Act 283: Funding for development of H₂ partnerships
- 2001 – Hawaii Energy & Environmental Technologies (HEET) Initiative
- 2002 – Hydrogen Power Park – DOE-funded public/private partnership to develop hydrogen infrastructure in a real-world setting
- 2003 – Hawaii Fuel Cell Test Facility opened
- 2004 – Photovoltaic Energy Park – ONR funded 200 kW grid connected PV array with follow-on hydrogen activities
- 2004 – Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems
- 2006 – Hawaii Distributed Energy Resources Technologies for Energy Security



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(HFCTF)

- State-of-the-art fuel cell test facility
- Automated fuel cell testing (24/7)
- Eight test stands
 - (capabilities ranging from small single cell to full-size short stack)
- Testing procedures and equipment calibration based upon ISO 17025
- Wide range of diagnostic and analytical tools
- On-site high purity H₂ generation (Proton Energy)
- On-site air compressor with PSA purification
- Off-site MEA Fabrication and Cell Assembly Laboratory



Test Stand Capabilities at HFCTF



Full Size Test Stands



HiL & Single Cell Test Stand

3 full-size test stands

- UTC, 50 – 600 cm², 1000 A, 2 kW
- Small and full size single cells
- Short stacks

1 Hardware-in-Loop test stand

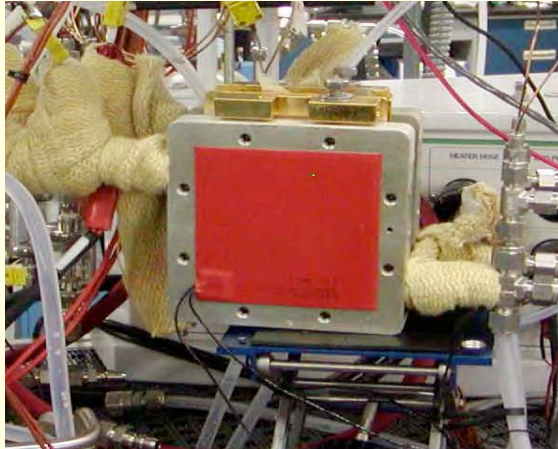
- HNEI design
 - Single cell operation: 200 cm², 200 A, 200 W
 - Stack operation: 100 cm², 150 A, 10-100 V, 5 kW
- Controller response time < 100 ms
- Dynamic testing on single cells and stacks
- HiL real time simulation of fuel cell applications (FCEV, UUV, UAV, CHP)
- System component evaluation
- potential for rapid prototyping

4 single-cell test stands

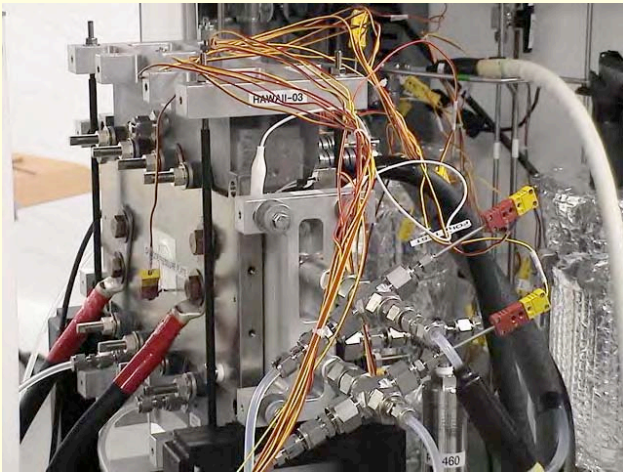
- 2 Green Light, up to 100 cm², 150 A, 800 W
- 2 FC Technologies, up to 50 cm², 120 A, 600 W
- On-line high resolution GC gas analysis (down to < ppm levels)
- Carefully chosen control strategies allow stable operation over hundreds of hours



Performance, Durability, Component Evaluation



50 cm² Cell Test Assembly



600 cm² Cell Test Assembly



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Performance

- Polarization experiments
- Overpotential determination
- Constant current/voltage/power experiments
- Temperature cycling
- Drive cycle testing (transient testing)

Durability

- Start-stop
- Effect of fuel contaminants
- Effect of air contaminants
- Thermal and water management

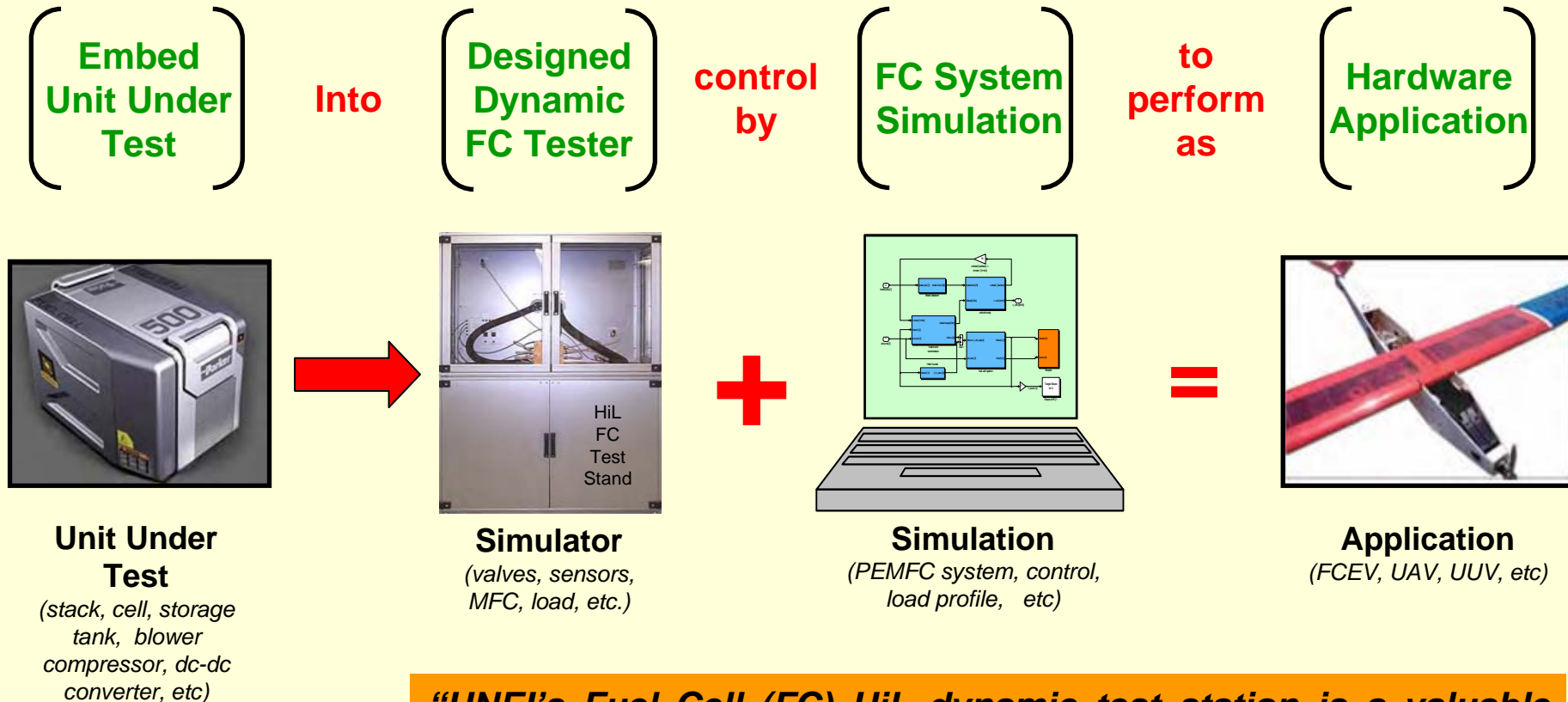
Component and fuel evaluation

- MEA characterization
- Testing of alternative fuels – various reformat formulation
- Evaluation of storage technologies

In-situ & Ex-situ Diagnostics

- H₂-crossover
- Cyclic Voltammetry
- AC Impedance Spectroscopy and HFR
- Gas analysis at inlets & outlets of anode & cathode
- Segmented Cell
- Dynamic HiL testing
- SEM, TEM, XRD, EDS, XRF, Effluent Water Fluoride Analysis

PEMFC HiL DYNAMIC TESTING CONCEPT



“HNEI’s Fuel Cell (FC) HiL dynamic test station is a valuable diagnostic tool for testing PEM fuel cells or stack under conditions relevant to a particular dynamic application. ”



HiL Diagnostics for PEMFC Stacks

HiL testing offers specific diagnostics for:

- **Anode Supply Chain**
- **Cathode Supply Chain**
- **Stack Cooling & Exhaust**
- **Stack & Simulated System**

