Hawaii Hydrogen Power Park

2003 Hydrogen & Fuel Cells Merit Review Meeting

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Objectives

- Demonstrate an integrated Hydrogen Power Park comprised of the following:
  - Electrolyzer powered by a renewable energy source. (Barrier V-Renewable Integration)
  - Hydrogen storage & distribution system. (Barrier V-Renewable Integration)
  - PEM fuel cell connected to grid & building. (Barrier V-Renewable Integration)
  - Optional hydrogen fueled vehicle hydrogen dispensing system.
- Demonstrate hydrogen as an energy carrier.
- Investigate interface issues with grid and buildings. (Barrier S–Siting)
- ID codes & standards required to site a Power Park. (Barrier S–Siting)
- ID barriers to a hydrogen infrastructure.
- Educate local authorities on hydrogen technologies. (Barrier S–Siting)
- Economic analysis of hydrogen infrastructure using actual data. (Barrier R – Cost)
- Generate public interest & support. (Barrier S–Siting)

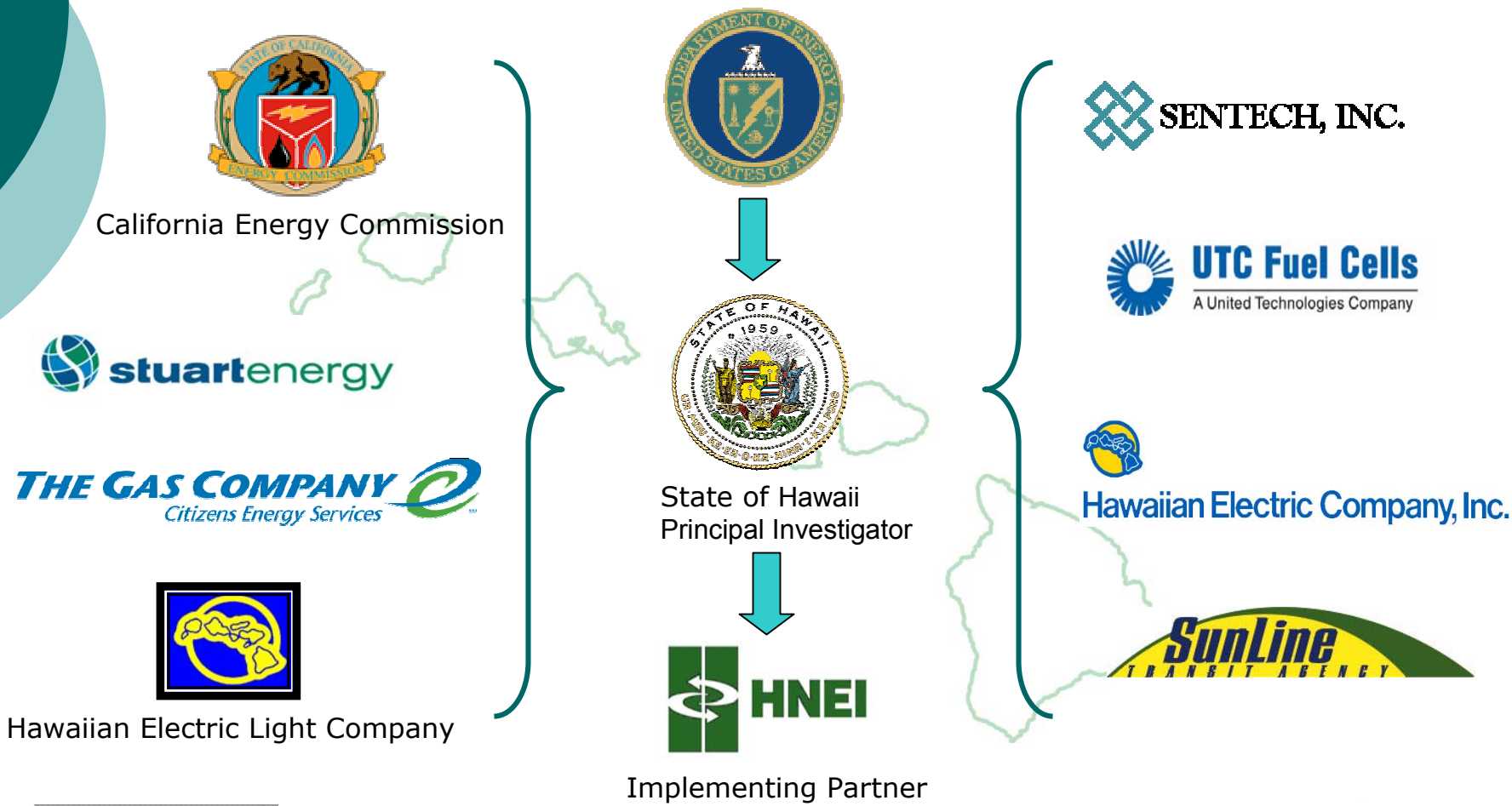
Benefits to Hawaii

- Supports the “Hawaii Hydrogen Mission” plan.
- First step in building a Hawaii hydrogen infrastructure.
- Leverages other Hawaii-based (DoD) hydrogen programs.
- Stimulate creation of a hydrogen high tech industry in Hawaii.
- Help make Hawaii “hydrogen friendly” - Identify & overcome institutional barriers.
- Inform State policy & decision makers.
- Create environment to mitigate financial risk for investors.
- Attract private sector strategic partners for Asia Pacific markets.
- Instill a “sense of wonder” in our students.

Approach

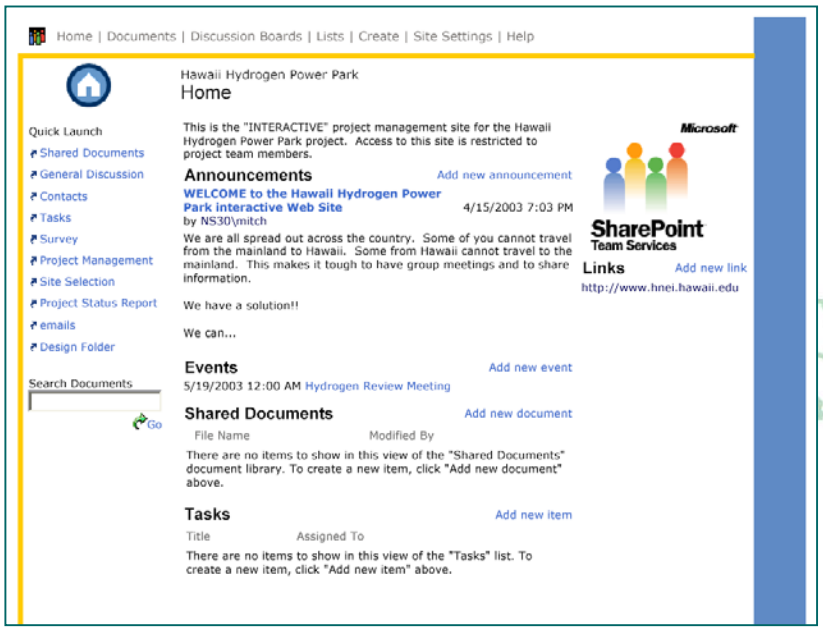
- Leverage Hawaii Fuel Cell Test Facility (HFCTF):
  - Mitigate technical, schedule and financial risk.
  - Accelerate implementation.
- Work with industry technology leaders such as UTC Fuel Cells, Stuart Energy Systems and SunLine to transfer technology & “lessons learned”.
- Multi-phase project development to limit technical & project risk:
  - Provide off-ramps.
  - Program flexibility.
- Integrate a modular Hydrogen Power Park system that can be easily transported & demonstrated inter-island:
  - Promote Pacific Rim market opportunities.
- Utilize commercial off-the-shelf components whenever possible to mitigate risk.
- Develop & implement innovative public outreach program:
  - Utilize web & learning channel cable TV.

Technology Transfer/Collaborations



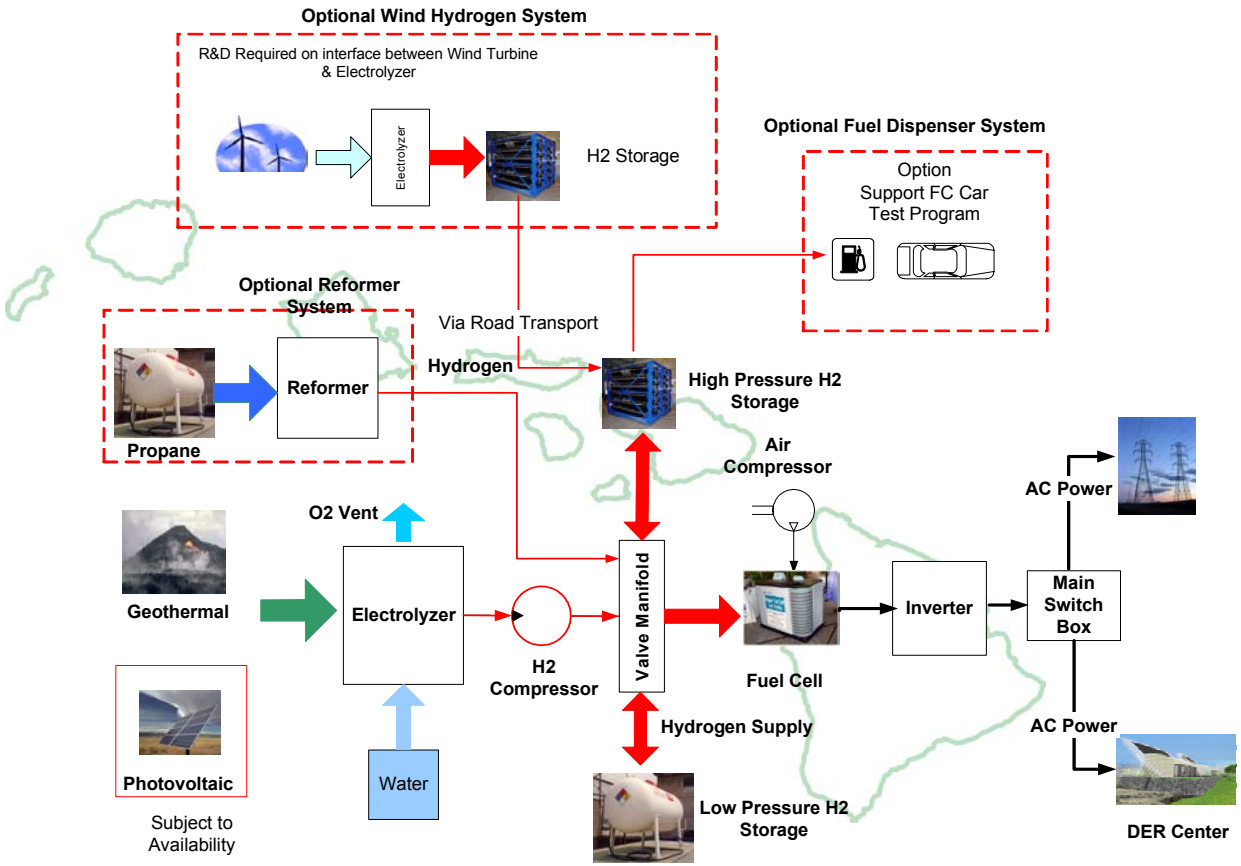
Collaboration & Coordination

Management Website Initiated – www.H2PP.com



- Interactive project management web site promotes close coordination with our partners.
- Automated notice of new information sent to partners.
- Rapid exchange of information & technical specifications.

Power Park Conceptual Design



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Hawaii hydrogen power park

HNEI
Hawai'i Natural Energy Institute
University of Hawai'i at Mānoa

Conceptual Design Features

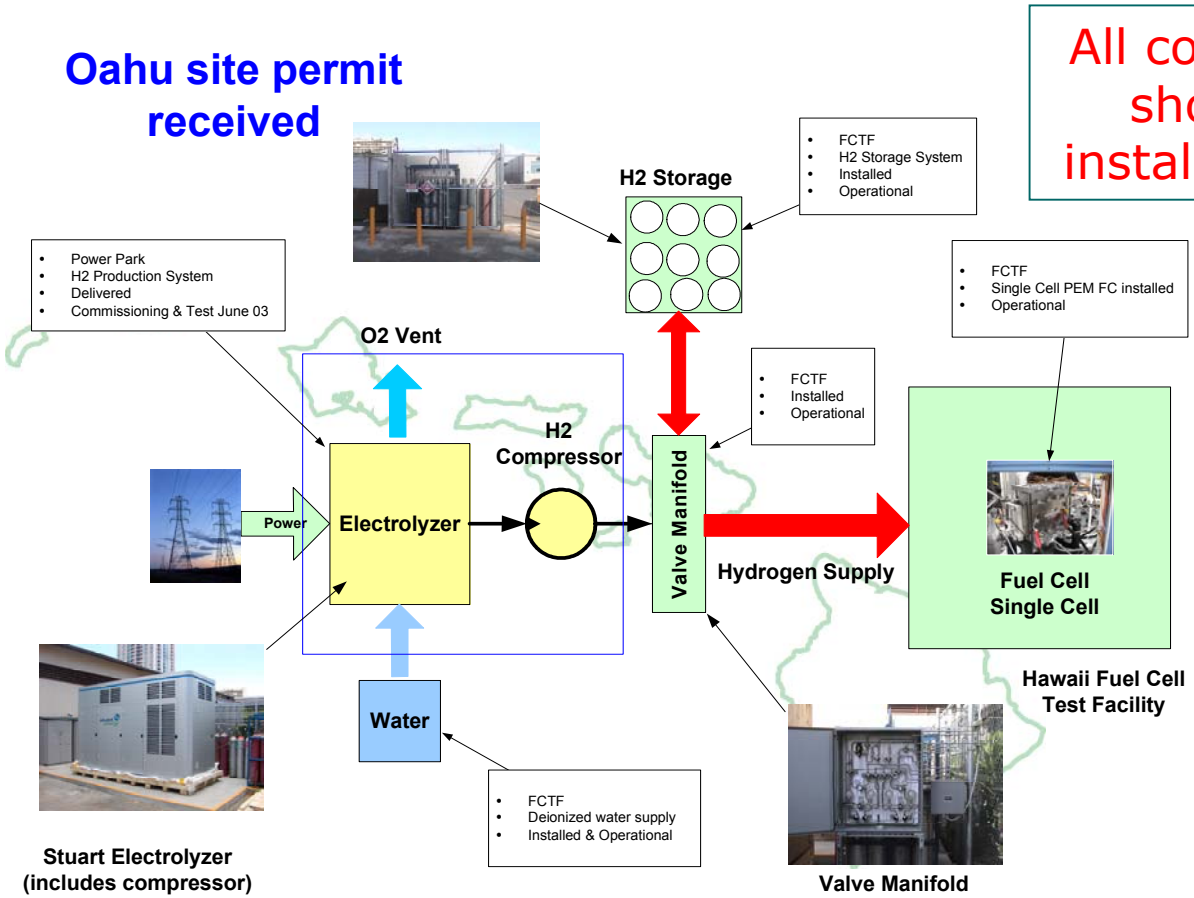
- Modular design provides for flexibility in siting, matching components & addition of optional subsystems.
- Low pressure hydrogen storage utilizing propane tanks.
- High pressure storage using lightweight, modular composite tanks.
- Modular fuel cell power system based on UTFC 5kW units.
- Geothermal energy delivered by HELCO grid.
- Desired options:
  - Wind-hydrogen production system to demonstrate renewable energy derived hydrogen.
  - Propane reformer.
  - Hydrogen vehicle gas dispenser system to support transportation demonstration projects.

Technical Accomplishments

Oahu 1 status as of 01 May 03

Oahu site permit received

All components shown are installed on site



FCTF leveraged assets

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Progress Summary

- Overall project approximately 3 months ahead of schedule.
- Site Selected – NELHA Gateway DER Center.

- Permits for Oahu system development site issued.

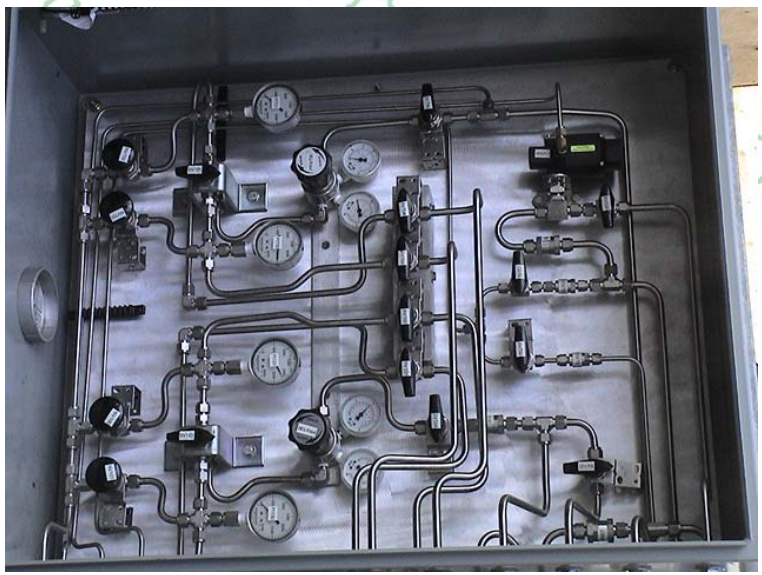
Leverages Hawaii Fuel Cell Test Facility to accelerate program.

Progress Summary

- Stuart Electrolyzer Delivered.
  - Installation & commissioning underway.
  - Projected to be fully operational mid June 03.

Progress Summary

- Prototype gas distribution panels installed & operated.
  - To be tested with electrolyzer.
  - To be modified as required for Power Park.



Leverages Hawaii Fuel Cell Test Facility to accelerate program.

Progress Summary

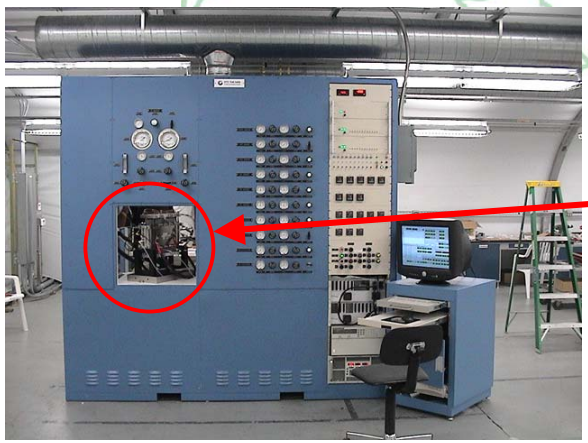
- Hawaii Fuel Cell Test Facility High Pressure Hydrogen Storage System installed and operated.
- Utilized to test Electrolyzer.

Leverages Hawaii Fuel Cell Test Facility to accelerate program.

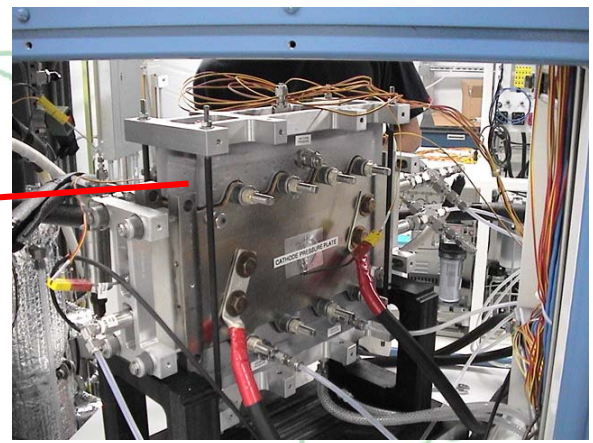
Progress Summary

- UTC Fuel Cell (UTCFC) single-cell PEM fuel cell available for initial testing of electrolyzer output utilizing Hawaii FCTF capabilities.

Leverages Hawaii Fuel Cell Test Facility to accelerate program



UTFC PEM fuel cell test stand



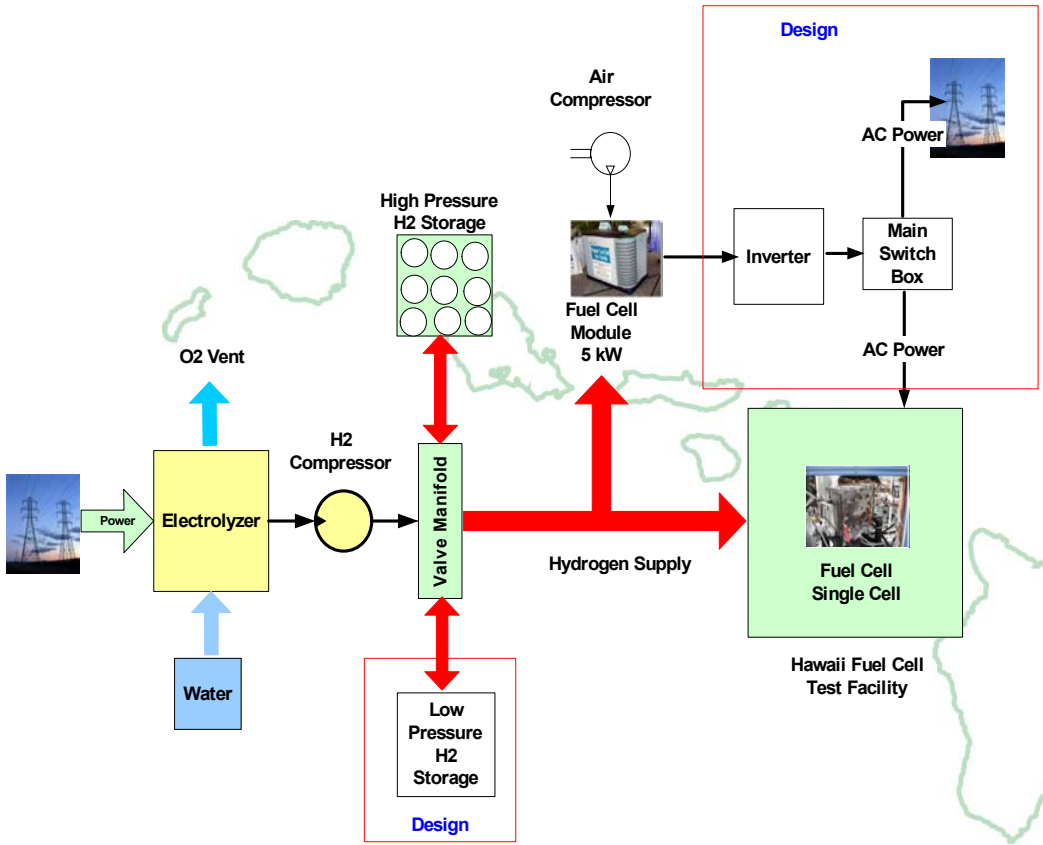
UTFC single-cell PEM fuel cell

Project Progress – Bottom Line

- System integration significantly accelerated by leveraging DoD-funded Hawaii FCTF.
- 3 months ahead of schedule.
- Key hardware on site.
- Site selected.
- Oahu permit issued.

Future Work Plans

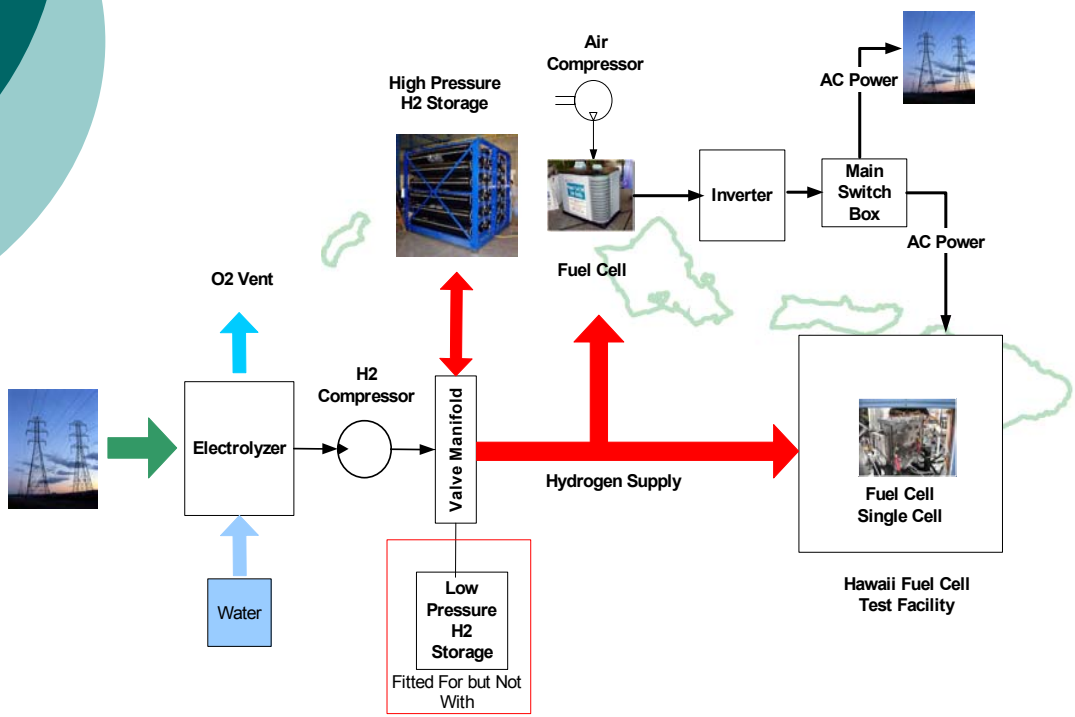
Oahu 2: Projected status as of 31 Dec 03



- Integrate 5kW fuel cell module.
- Design FC utility & building interfaces.
- Design Low Pressure Hydrogen Storage System.
- Design Data Acquisition System.
- Design Remote Control System.

Future Work Plans

Oahu 3: Projected status as of 31 March 04
Test full system before shipping to NELHA



- Fully test system prior to shipping to NELHA test site.
- Integrate FC utility & building interfaces.
- Integrate NELHA High Pressure H2 Storage System.
- Integrate Low Pressure Hydrogen Storage System less storage tank.
- Integrate Data Acquisition System.
- Integrate Remote Control System.

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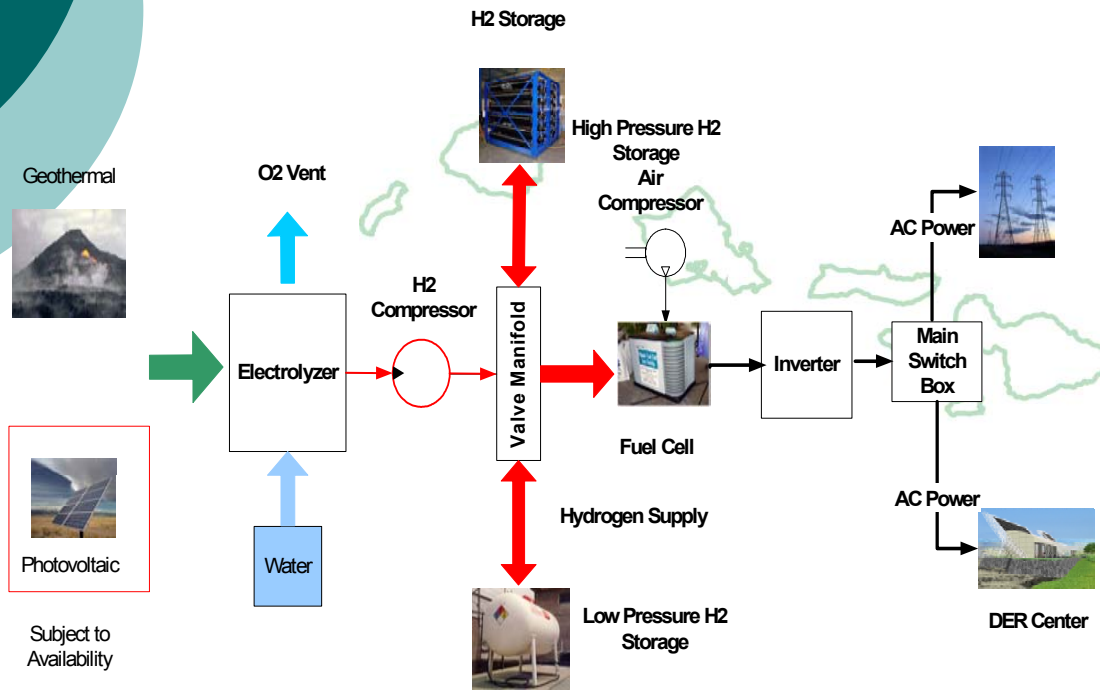
Future Work Plans

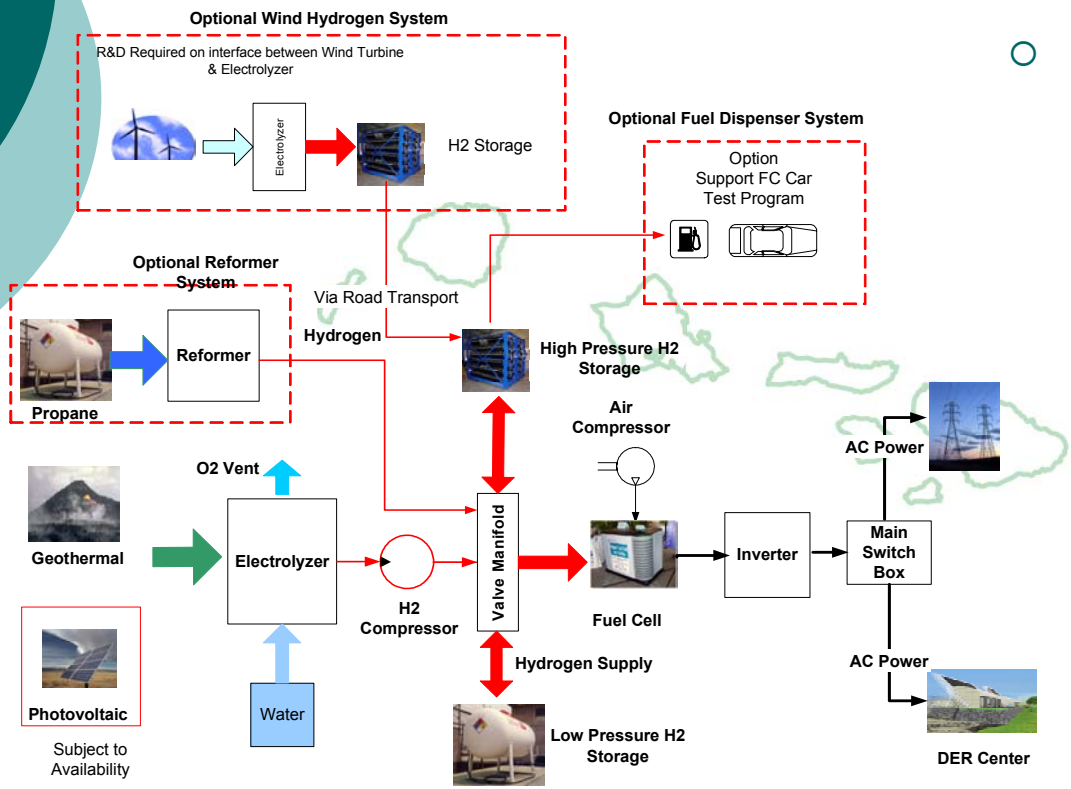
NELHA 1: Projected status as of 30 June 04
Ship & install system at NELHA



- Obtain Hawaii County permits.
- Complete NELHA site preparation.
- Deliver & install system.
- Install Low Pressure H2 Storage System.
- Install Remote Data Acquisition & Control systems.
- Train local system operators.
- Commence experiments.
- Collect data.
- Analyze & report results.
- Conduct public outreach activities.

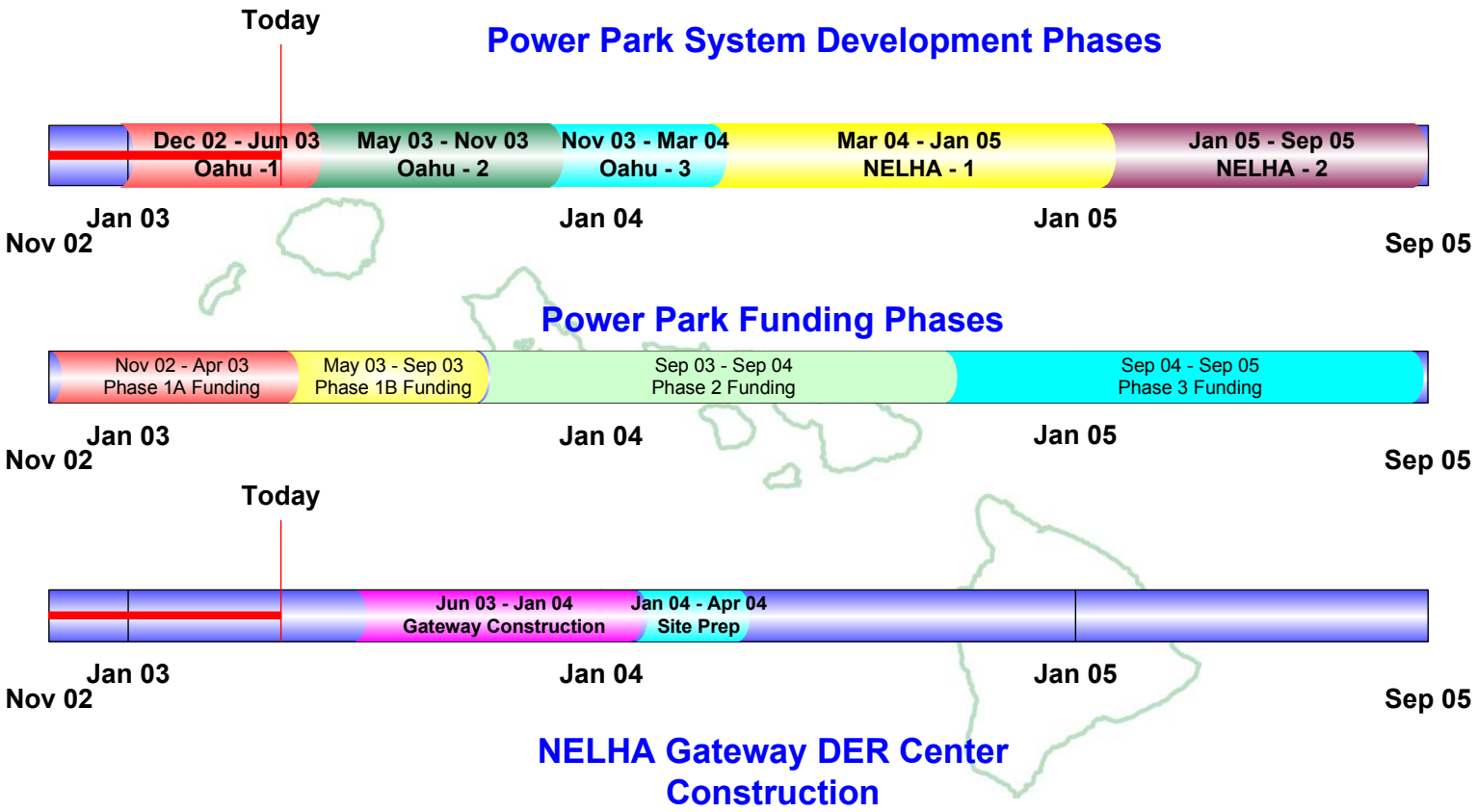
Future Work Plans

NELHA 2: Projected status as of 31 Dec 04
Ongoing testing & evaluation at NELHA



- Desired Options
  - Install Wind Hydrogen Production System to support President's Hydrogen Fuel Initiative.
  - Transport H2 to NELHA.
  - Install H2 Dispensing System to support Freedom Car Program.

Timelines


Today
Power Park System Development Phases
Dec 02 - Jun 03
Oahu -1
May 03 - Nov 03
Oahu - 2
Nov 03 - Mar 04
Oahu - 3
Mar 04 - Jan 05
NELHA - 1
Jan 05 - Sep 05
NELHA - 2
Nov 02
Jan 03
Jan 04
Jan 05
Sep 05
Power Park Funding Phases
Nov 02 - Apr 03
Phase 1A Funding
May 03 - Sep 03
Phase 1B Funding
Sep 03 - Sep 04
Phase 2 Funding
Sep 04 - Sep 05
Phase 3 Funding
Nov 02
Jan 03
Jan 04
Jan 05
Sep 05
Today
Jun 03 - Jan 04
Gateway Construction
Jan 04 - Apr 04
Site Prep
Nov 02
Jan 03
Jan 04
Jan 05
Sep 05
NELHA Gateway DER Center
Construction