DOE Hydrogen Program

Pathways to Commercial Success: Technologies and Products Supported by the HFCIT Program

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Project ID: ANP_01_Weakley

Overview

Timeline

- Project start date 8/2007
- Ongoing

Barriers Addressed

- Inconsistent data, assumptions, and guidelines

Budget

- Funding in FY07: $200K
- Funding in FY08: $250K
- Funding in FY09: $100K

(100% DOE funded)

Partners

- Working closely with HFCIT personnel and lab/contractor researchers to identify potential technologies and contacts
- Working closely with various private sector vendors and other technology providers to obtain data on technologies

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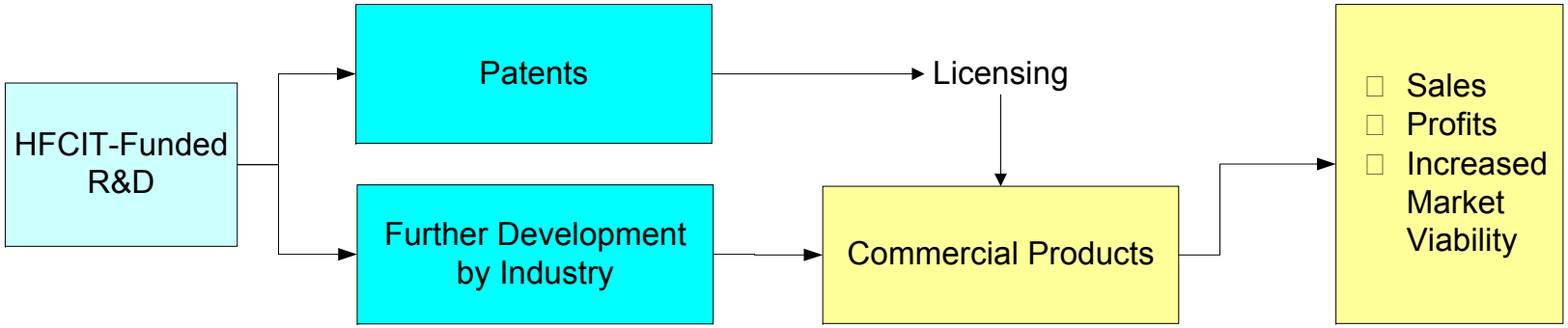
Objective/Relevance

Provide an assessment of retrospective HFCIT program benefits by tracking the commercial success of HFCIT-developed technologies (and technologies developed by HFCIT predecessor programs) and estimating their impacts/benefits



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Milestones and Deliverables

Month/Year	Milestone/Deliverable
September 2008	*Deliverable*: Provide PNNL report detailing the benefits of the commercialized technologies and potential benefits of the emerging technologies contained in the database **(Draft report delivered)**
September 2009	*Deliverable*: Update the HFCIT technology tracking database containing information on commercial and emerging technologies **(On track to complete)**
October 2009	*Deliverable*: Update the HFCIT report on the status of commercialized and emerging technologies **(On track to complete)**

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Approach

- **Task 1: Conduct initial patent search and continue to update it (ongoing)**

  Continue updating the patent list for technologies linked to the HFCIT program efforts

- **Task 2: Develop initial list of potential commercial and emerging technologies and continue to add to the list (ongoing)**

  Conduct interviews with HFCIT staff and patent holders to create the initial list of commercial and emerging technologies. Contact lab/contract researchers to determine current status of technologies from the potential list. Continue interviews each year to add to the list of potential commercial or emerging technologies.

Approach

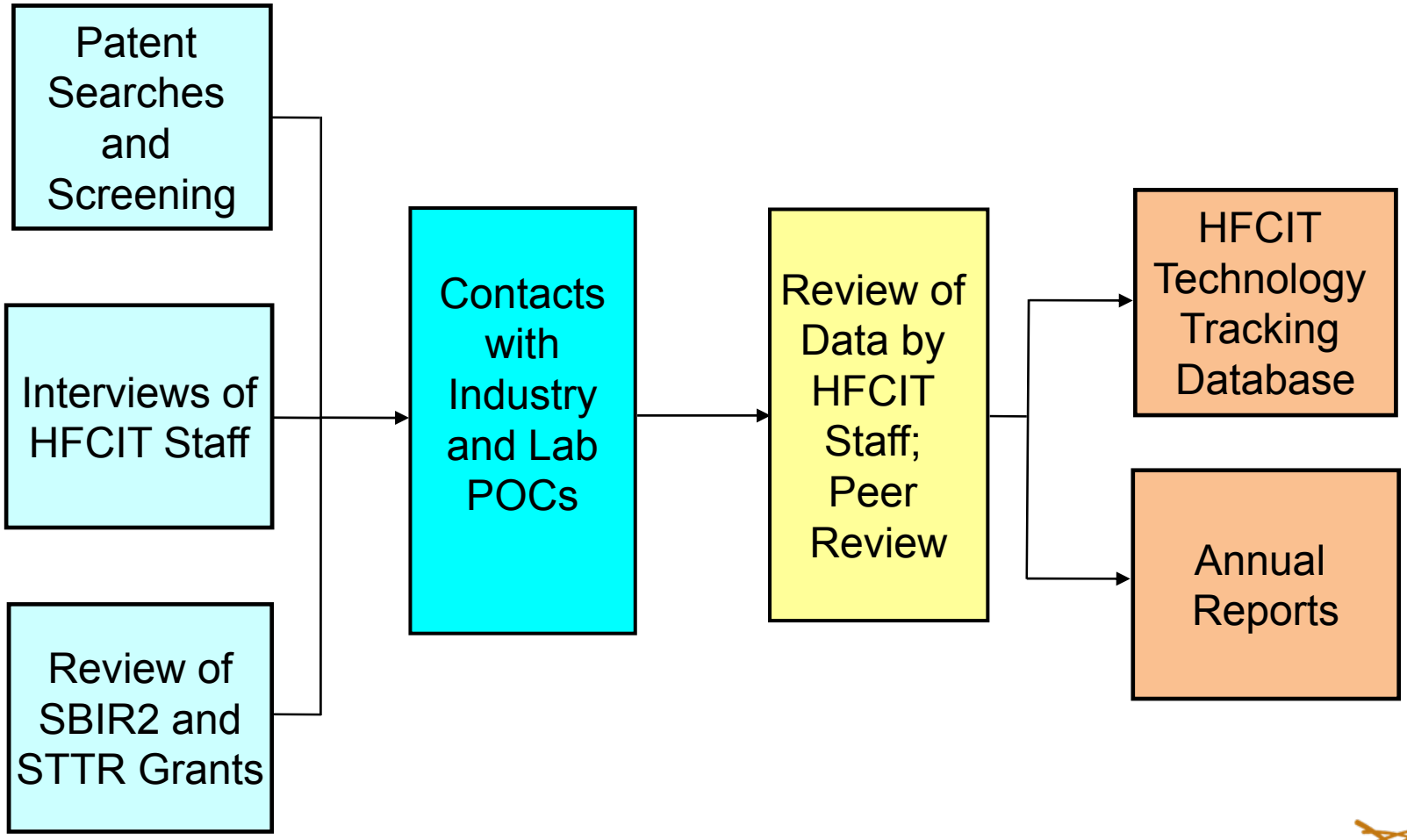
- **Task 3: Create, Populate, and Update HFCIT Technology Tracking Database (ongoing)**

  Gather data on newly-identified commercial and emerging technologies, and update information on previously identified technologies. Enter the information into the HFCIT technology tracking database by category (fuel cell, production/delivery, and storage).

- **Task 4: Produce and Update Technology Descriptions and Annual Report (ongoing)**

  Create technology descriptions for newly-identified commercial and emerging technologies and update descriptions for previously-identified technologies; obtain reviews by researchers/industry contacts. Complete and continue to update annual report that describes the technologies and provides information on impacts/benefits.

Technology Tracking Project: Process



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Accomplishments: Task 1 – Patent Search

- Conducted a fuel cell patent search. Results reviewed by PNNL and HFCIT staff to narrow list down to:
  - 74 fuel cell patents
  - 49 hydrogen production/delivery patents
  - 21 storage patents

- Contacted the patent holders to determine the status of the patents.

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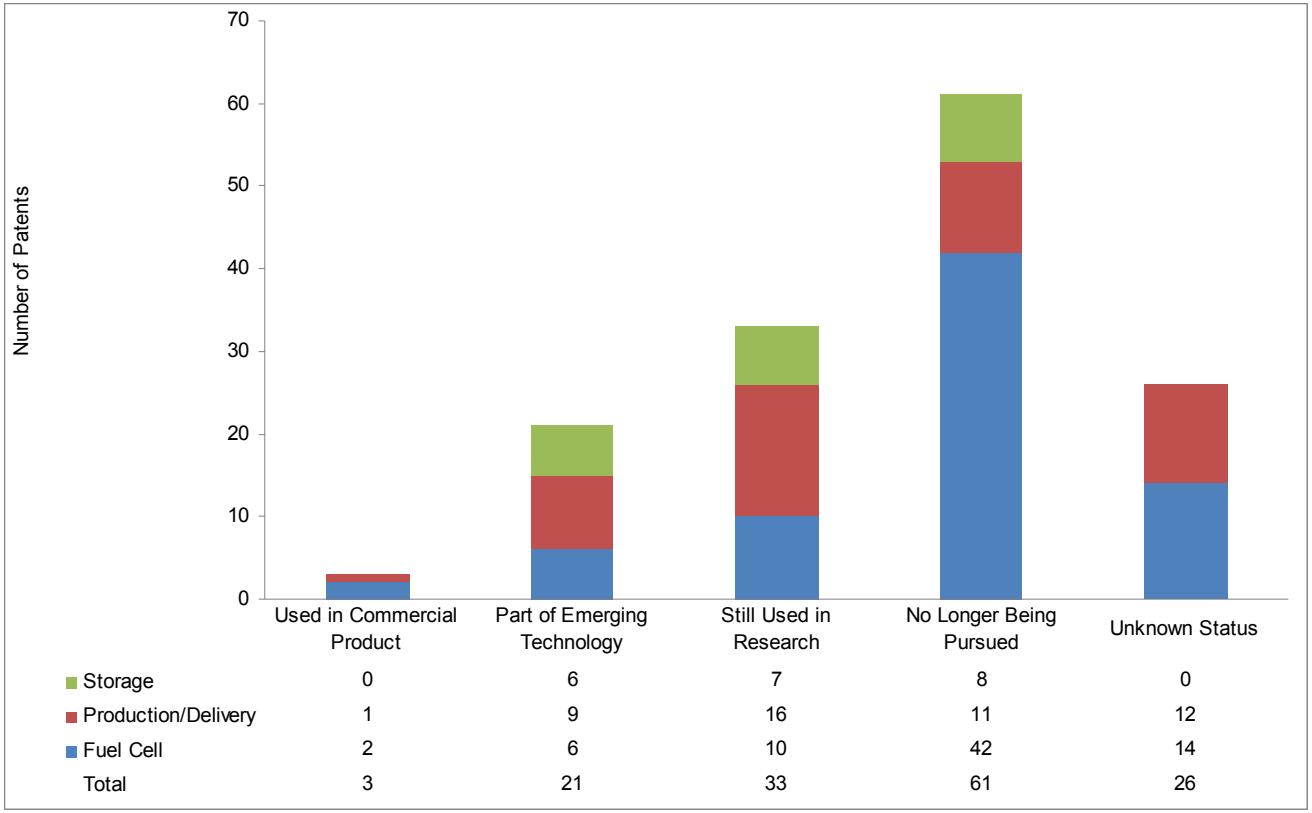
Accomplishments: Task 1 – Patent Search

Of the 118 patents reviewed, 48% are being used in commercial products, are part of emerging technology development, or are still being used in research.



	Used in Commercial Product	Part of Emerging Technology	Still Used in Research	No Longer Being Pursued	Unknown Status
Storage	0	6	7	8	0
Production/Delivery	1	9	16	11	12
Fuel Cell	2	6	10	42	14
Total	3	21	33	61	26

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Accomplishments: Task 2 – List of Commercial and Emerging Technologies

- Conducted one-on-one interviews with HFCIT staff using annual reports from 2002-2007 to create list of potential commercial and emerging technologies
- Contacted patent holders to determine whether any technologies were developed or are being developed based on their patents
- Reviewed SBIR2 and STTR grants from 2002-2007 to identify potential emerging and commercial technologies
- From the list created, contacted private sector vendors and other technology providers to determine the status of each technology (commercial/emerging/still being used in research/no longer being developed)

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Accomplishments: Task 2 – List of Commercial and Emerging Technologies

- As of 12/31/08 the list included
  - Fuel Cells: 13 commercial, 23 emerging, 8 no longer being developed
  - Production/Delivery: 7 commercial, 20 emerging, 8 no longer being developed
  - Storage: 2 commercial, 6 emerging, 2 no longer being developed

- The list is a living document; information is updated continually in the database and reported annually.

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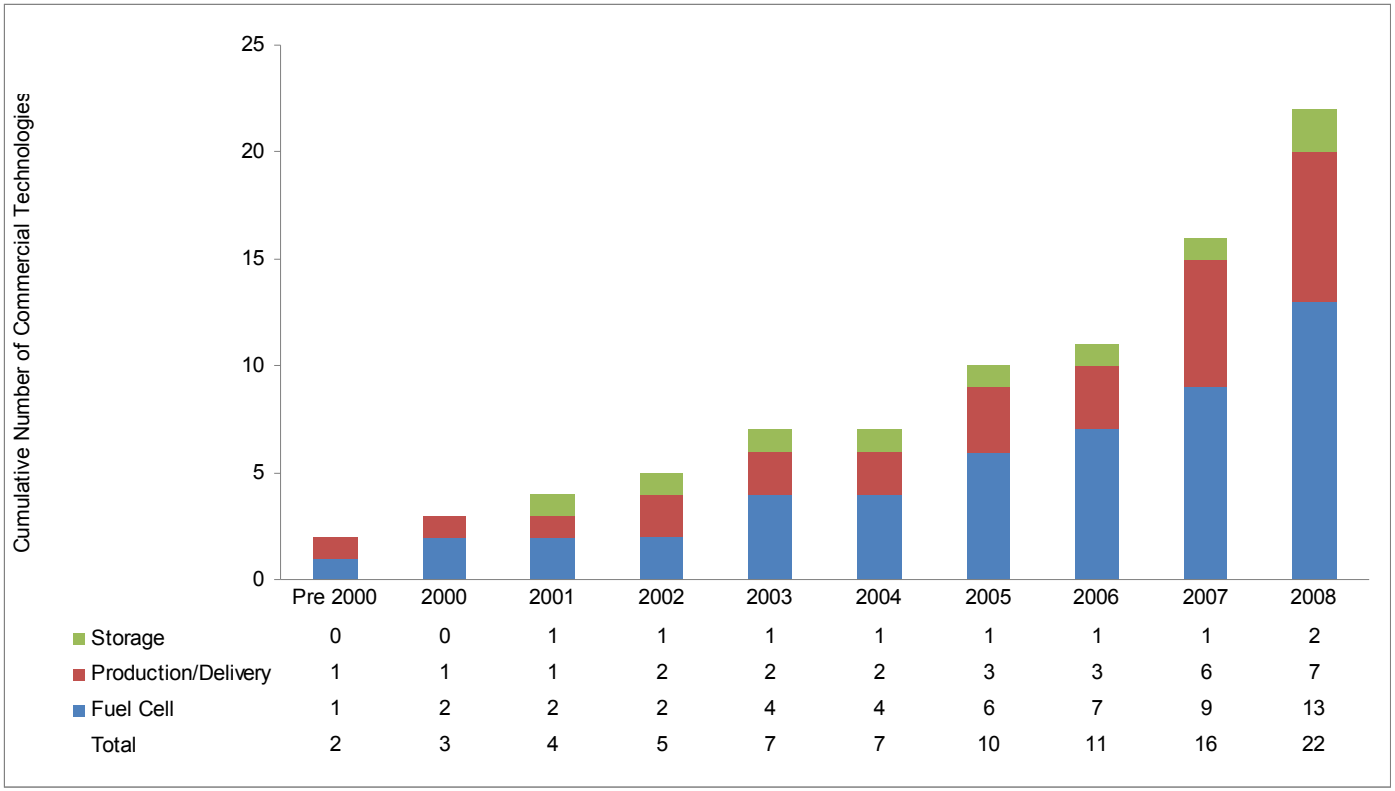
Accomplishments:
Task 2 – List of Commercial Technologies

Since 2006, an increasing number of HFCIT-funded technologies have been entering the market.



	Pre 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008
Storage	0	0	1	1	1	1	1	1	1	2
Production/Delivery	1	1	1	2	2	2	3	3	6	7
Fuel Cell	1	2	2	2	4	4	6	7	9	13
Total	2	3	4	5	7	7	10	11	16	22

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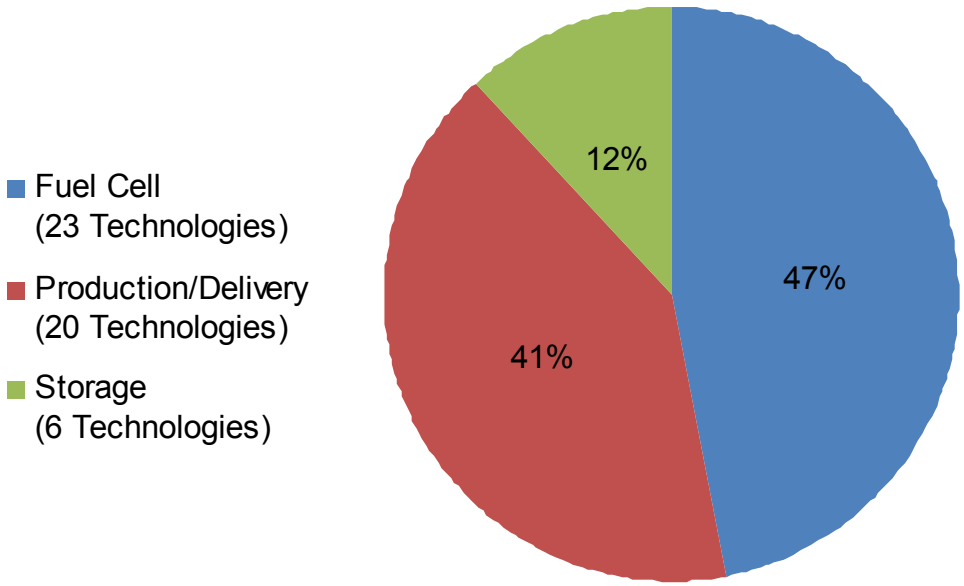
Accomplishments:
Task 2 – List of Emerging Technologies

These 49 emerging technologies form the potential pool from which future technologies could be commercialized.



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Accomplishments: Task 2 – Examples of Commercial Fuel Cell Technologies

XX25™: Portable Reformed Methanol Fuel Cell

- Developed and sold by UltraCell Corporation
- Commercialized in 2007 with **200+ units sold**
- Lightweight, rugged fuel cell unit for mobile power
- Supplies up to 25 watts of continuous power for radios, laptops, etc.

Corrosion Test Cell for PEM Bipolar Plate Materials

- Developed at LANL and licensed to Fuel Cell Technologies, Inc.
- Commercialized in 2008 with **2 units sold**
- Represents conditions in an operating PEM fuel cell
- Allows more efficient and less costly testing of fuel cell materials

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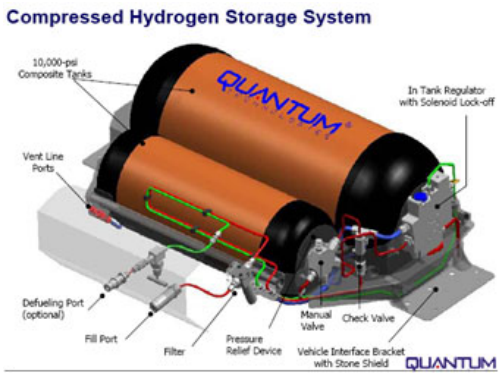
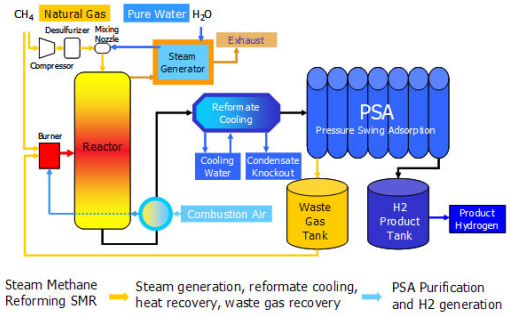
Accomplishments
Task 2 – Examples of Commercial Hydrogen Storage/Production Technologies

Hydrogen Composite Tanks



- Developed and sold by Quantum Fuel System Technologies Worldwide, Inc.
- Commercialized in 2001 with **2000+ tanks sold**
- Lightweight, all-composite tanks for high-pressure storage
- High capacity improves the range of hydrogen-powered fuel cell vehicles

Hydrogen Distributed Production System



- Developed and marketed by H_2Gen Innovations, Inc.
- Became **commercially available** in 2008
- Achieves high fuel efficiency and high purity hydrogen
- Modular design allows reliable refueling stations without large infrastructure

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Accomplishments:
Task 3 – Technology Tracking Database

- Gathered data from private sector vendors and other technology providers and entered the information into the database
- Divided database into commercial and emerging technologies and into fuel cell, production/delivery, and storage
- Maintained database at PNNL and at DOE-HQ on an internal server that is available to HFCIT staff

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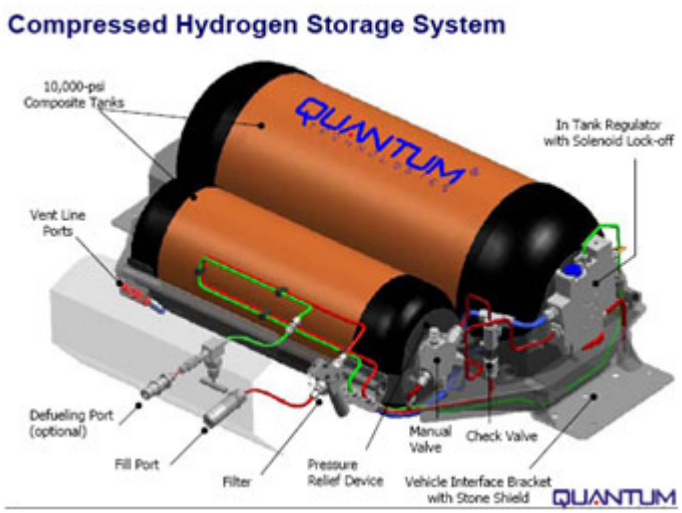
Accomplishments:
Task 3 – Technology Tracking Database

For each technology the following specific types of data are collected from the private sector vendor or other technology provider and reported the information in the database.

Technology Title

- **Overview:**
  Name of industry partner or research organization, year commercialized and number of operating units
- **Applications:**
  Areas where technology can be applied
- **Description:**
  Summary description of the technology, research development activities, and its benefits
- **Benefits:**
  Qualitative description of technology improvements including environmental, quality, productivity, safety, etc.
- **Graphic:**



- **Capabilities:**
  Operational characteristics that display improvement over the baseline technology
- **Contacts:**
  DOE and industry partner name, address, and phone number
- **Status:**
  Annual update on technology activities and commercialization efforts
- **History:**
  Summary of prior year efforts

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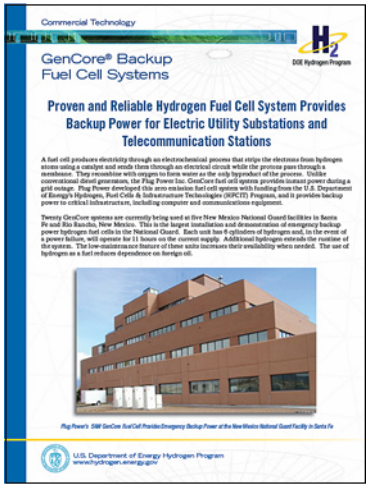
Accomplishments: Task 4 – Technology Descriptions and Annual Report

- Technology descriptions of information in the database include the following:
  - Description (2-3 paragraphs)
  - Graphic/photo
  - Overview (developer/manufacturer and units sold)
  - Applications (uses for the technology)
  - Capabilities (technical information highlighting improvements)
  - Impacts/Benefits (e.g., sales, safety, and environmental benefits)
  - Contact information (company and POC)


Commercial Technology

GenCore® Backup Fuel Cell Systems

DOE Hydrogen Program

Proven and Reliable Hydrogen Fuel Cell System Provides Backup Power for Electric Utility Substations and Telecommunication Stations

A fuel cell produces electricity through an electrochemical process that strips the electrons from hydrogen atoms using a catalyst and sends them through an electrical circuit while the protons pass through a membrane. They recombine with oxygen to form water as the only byproduct of the process. Unlike conventional diesel generators, the Plug Power Inc. GenCore fuel cell system provides instant power during a grid outage. Plug Power developed this zero emission fuel cell system with funding from the U.S. Department of Energy's Hydrogen, Fuel Cells & Infrastructure Technologies (HFCIT) Program, and it provides backup power to critical infrastructure, including computer and communications equipment.

Twenty GenCore systems are currently being used at five New Mexico National Guard facilities in Santa Fe and Rio Rancho, New Mexico. This is the largest installation and demonstration of emergency backup power hydrogen fuel cells in the National Guard. Each unit has 8 cylinders of hydrogen and, in the event of a power failure, will operate for 11 hours on the current supply. Additional hydrogen extends the runtime of the system. The low-maintenance feature of these units increases their availability when needed. The use of hydrogen as a fuel reduces dependence on foreign oil.

Plug Power's 5kW GenCore Fuel Cell Provides Emergency Backup Power at the New Mexico National Guard Facility in Santa Fe

U.S. Department of Energy Hydrogen Program
www.hydrogen.energy.gov

- Review and approval by private sector vendors, other technology providers, and HFCIT staff
- Annual report is being finalized and updated, detailing the impacts/benefits of commercial technologies and the potential impacts/benefits of emerging technologies

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Challenges

- Reluctance by industry to provide information that might help competitors
- Difficulty in documenting contribution of DOE research to commercial products
- Difficulty in getting price data on commercial products because some products are one-of-a-kind
- Difficulty in finding contacts for patents or projects from many years ago
- Loss of data from companies changing ownership or losing key personnel who understand history of DOE involvement

Collaborations

- Contacted private sector vendors and other technology providers to obtain technology data on commercial and emerging technologies:
  - Fuel Cells – 36
  - Production/Delivery – 27
  - Storage – 8
- Worked with HFCIT staff to obtain technology tracking list and contact and background information on research projects from the list
- Worked with HFCIT staff to obtain patent information

Future Work

- Create web pages for technology descriptions
- Finalize the annual report
- Meet with HFCIT staff to review the results of the FY08 effort and to add to the list of technologies for FY09
- Conduct a peer review of PNNL's HFCIT project and annual report
- Update the status of all the technologies by re-contacting each company/organization annually
- Enter information into the database and produce a technology description (for all new technologies)
- Conduct patent citation analysis to better understand knowledge benefits of the HFCIT program

Summary

- Technology tracking provides
  - Effective management of R&D Programs
  - Budget defense
  - Strategic planning
  - Portfolio management
  - Institutional memory
- Report and database will help organizations with HFCIT-sponsored commercial products highlight the impacts and benefits of their products, potentially expanding their markets
- Report and database will help emerging technologies be publicized to interested commercialization partners