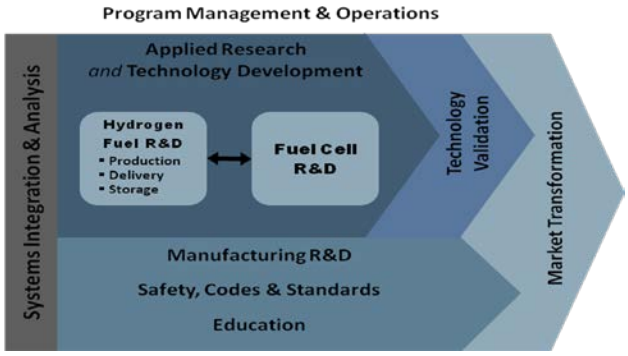
6.0 Program Management and Operations



The U.S. Department of Energy's (DOE's) Hydrogen and Fuel Cells Program (the Program) is composed of activities within the Offices of Energy Efficiency and Renewable Energy (EERE); Fossil Energy (FE); Nuclear Energy (NE); and Science (SC). EERE's Fuel Cell Technologies Program (FCT Program) represents the major component of this effort. The FCT Program Manager manages the Program to maintain a cohesive overall program and to be consistent with the National Academies recommendations. This structure allows for clear lines of communication and integrates the many participating offices, agencies, laboratories, and contractors.

The Program includes research, development, and demonstration (RD&D), systems analysis, systems integration, safety, codes and standards, and education activities, requiring the integrated efforts of federal offices, field offices, national laboratories, academic institutions, and numerous contractors spread across the country. Many individuals and organizations participate through partnerships with automotive and power equipment manufacturers, energy and chemical companies, electric and natural gas utilities, building designers, diverse component suppliers, other federal agencies, state government agencies, universities, national laboratories, and other stakeholder organizations. The diversity and size of the Program require a Program Management and Operations approach based on a uniform set of requirements, assumptions, expectations, and procedures.

6.1 Program Organization

The Program's organizational structure is shown in Figure 6.1.1. Program management takes place at DOE Headquarters in Washington, D.C. Project management is conducted in the field office locations in Golden, CO; Morgantown, WV (National Energy Technology Laboratory); Idaho Falls, ID; and Chicago, IL. Project implementation is carried out at the national laboratories, industry and universities, and through coalitions with state and local government agencies.

The management approach is grounded in the following results-oriented management principles:

- A vertical organization with clear lines of responsibility and authority
- Top-down (to project) program planning from conception to technology validation, and time-phased technical, cost and schedule baselines
- Centralization of key functions to ensure effective integration of the Program's projects
- Independent Program control systems ensuring maximum visibility/transparency.

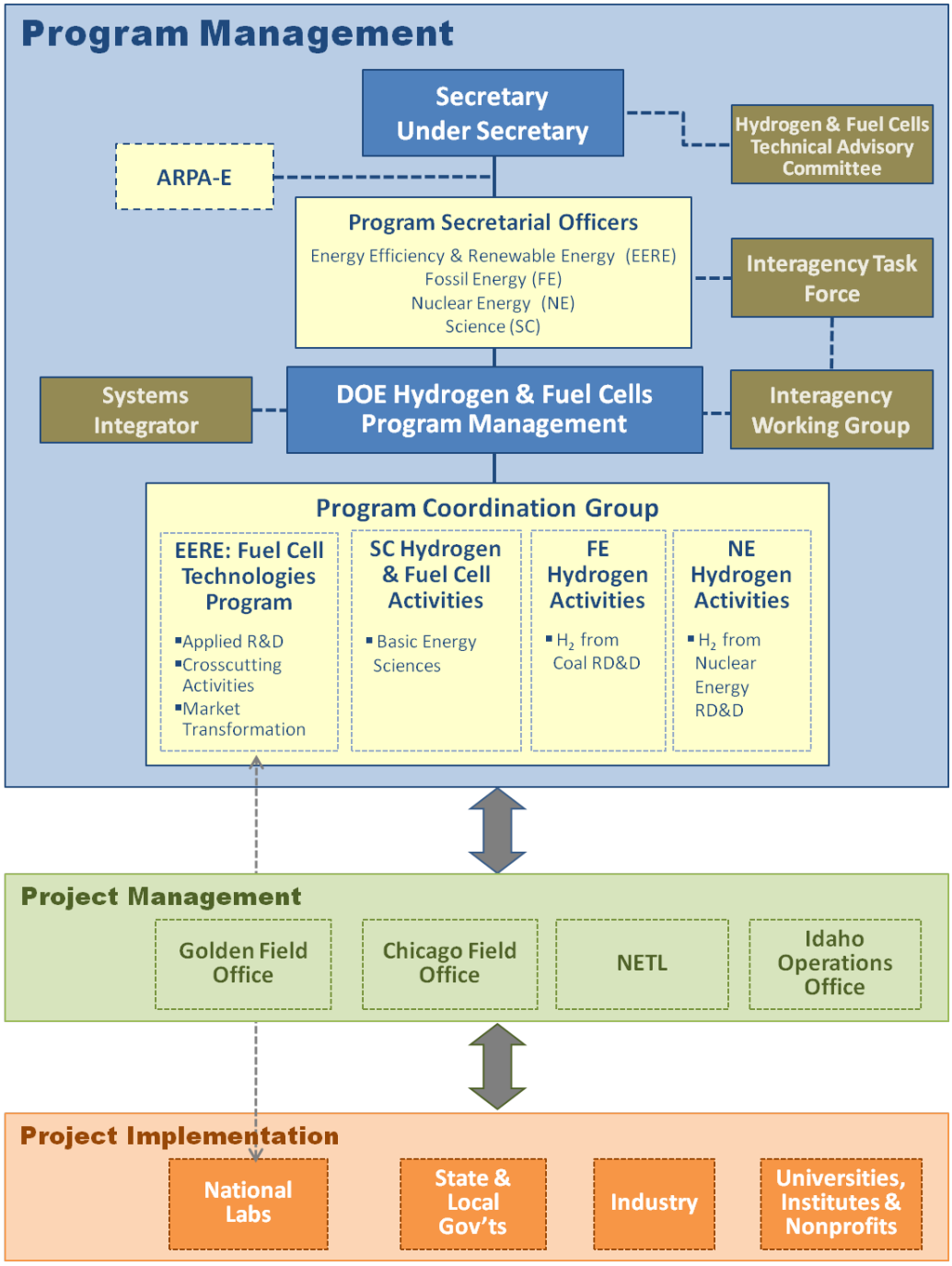


Figure 6.1.1 DOE Hydrogen and Fuel Cells Program Organization Chart.

Advisory Groups

The Program seeks the best available information from experts in a variety of fields, such as chemistry, chemical engineering, materials science, environmental sciences, biology, physics, mechanical engineering, and systems engineering. Since the creation of the Program, a variety of groups have been identified or created to oversee, review, or advise Program activities. Two examples of advisory groups include the following:

National Academies

At DOE's request, the executive arm of the National Academy of Engineering appointed a committee in September 2002 to conduct a study of Alternatives and Strategies for Future Hydrogen Production and Use. The study evaluated the status and cost of technologies for production, delivery, storage, and end-use of hydrogen, as well as reviewed DOE's hydrogen research, development, and demonstration strategy. The final report is available at http://books.nap.edu/books/0309091632/html/index.html. The initial evaluation was followed up with a second analysis in 2004 to evaluate technology costs and barriers and research and development (R&D) needs in the Program. The final report for this evaluation is available at http://books.nap.edu/catalog/10922.html. The Energy Policy Act of 2005 (EPACT) requests that the National Academy of Sciences (NAS) conduct a review of the Program every fourth year from the date of enactment. The NAS also conducts biennial reviews of DOE's RD&D progress under the U.S. DRIVE partnership (U.S. DRIVE). U.S. DRIVE includes the DOE; the United States Council for Automotive Research LLC (USCAR – the collaborative research company representing Chrysler Group LLC, Ford Motor Company, and General Motors); Tesla Motors; five energy companies – BP America, Chevron Corporation, ExxonMobil Corporation, Phillips 66 Company, and Shell Oil Products U.S.; two utilities – Southern California Edison and Michigan-based DTE Energy; and the Electric Power Research Institute (EPRI). The most recent reviews were published in August 2005, available at http://www.nap.edu/openbook.php?isbn=0309097304, March 2008, available at http://www.nap.edu/catalog.php?record_id=12113, and November 2010, available at http://www.nap.edu/catalog.php?record_id=12939.

Hydrogen and Fuel Cell Technical Advisory Committee (HTAC)

HTAC was established under Section 807 of EPACT to provide technical and programmatic advice to the Energy Secretary on hydrogen research, development, and demonstration efforts. Announced in June 2006, HTAC is composed of up to 25 members representing domestic industry, academia, professional societies, government agencies, financial organizations, and environmental groups, as well as experts in the area of hydrogen safety. HTAC is tasked with reviewing and making recommendations to the Secretary in an annual report on:

- The implementation of programs and activities under Title VIII of EPACT;
- The safety, economic, environmental, and other consequences of technologies for the production, distribution, delivery, storage, and use of hydrogen energy and fuel cells;
- The plan under section 804 of EPACT (i.e., Hydrogen and Fuel Cells Program Plan http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/program_plan2011.pdf.

The Secretary will consider, but is not required to adopt, HTAC recommendations and will either describe the implementation of each recommendation or provide an explanation to Congress for the reasons that a recommendation will not be implemented. The Secretary also provides the resources necessary for HTAC to carry out its responsibilities.

Partnerships

Through cooperative partnerships, the Program leverages the capabilities and experience of stakeholders in industry, state and local governments, and international organizations. The roles of these groups vary, as does the nature of their collaboration with DOE. In broad terms, the roles that these stakeholder groups play are as follows:

- **Industry**. Partnerships in developing, validating, and demonstrating advanced fuel cell and hydrogen energy technologies.
- **State and Local Governments**. Partnerships in codes and standards, field validation, and education.
- **International**. Partnerships in R&D, validation, codes and standards, and safety.

Industry

U.S. DRIVE facilitates frequent and detailed precompetitive technical information exchange on a broad portfolio of technologies, including hydrogen and fuel cells. By providing a framework for discussing R&D needs, developing technology roadmaps, and evaluating R&D progress, U.S. DRIVE helps to accelerate R&D progress, to avoid duplication of efforts, and to ensure that industry commercialization needs inform DOE R&D targets. The Partnership's Executive Steering Group (ESG) oversees U.S. DRIVE, with responsibility for high level technical and management priorities (see Figure 6.1.2). The ESG includes the DOE Assistant Secretary for Energy Efficiency and Renewable Energy and Vice President-level executives from each of the U.S. DRIVE member companies.

U.S. DRIVE's operations groups support the ESG, manage U.S. DRIVE activities, and enable regular and strong coordination across U.S. DRIVE. Operations group members include the DOE Program Managers for the FCT Program and the Vehicle Technologies Program, as well as DOE's U.S. DRIVE Director. The Vehicles Operations Group includes the senior technical managers from the automotive companies, the Fuel Operations Group includes senior level technical directors from energy companies, and the Electric Utility Operations Group includes senior level technical managers from the utilities and EPRI.

Organization

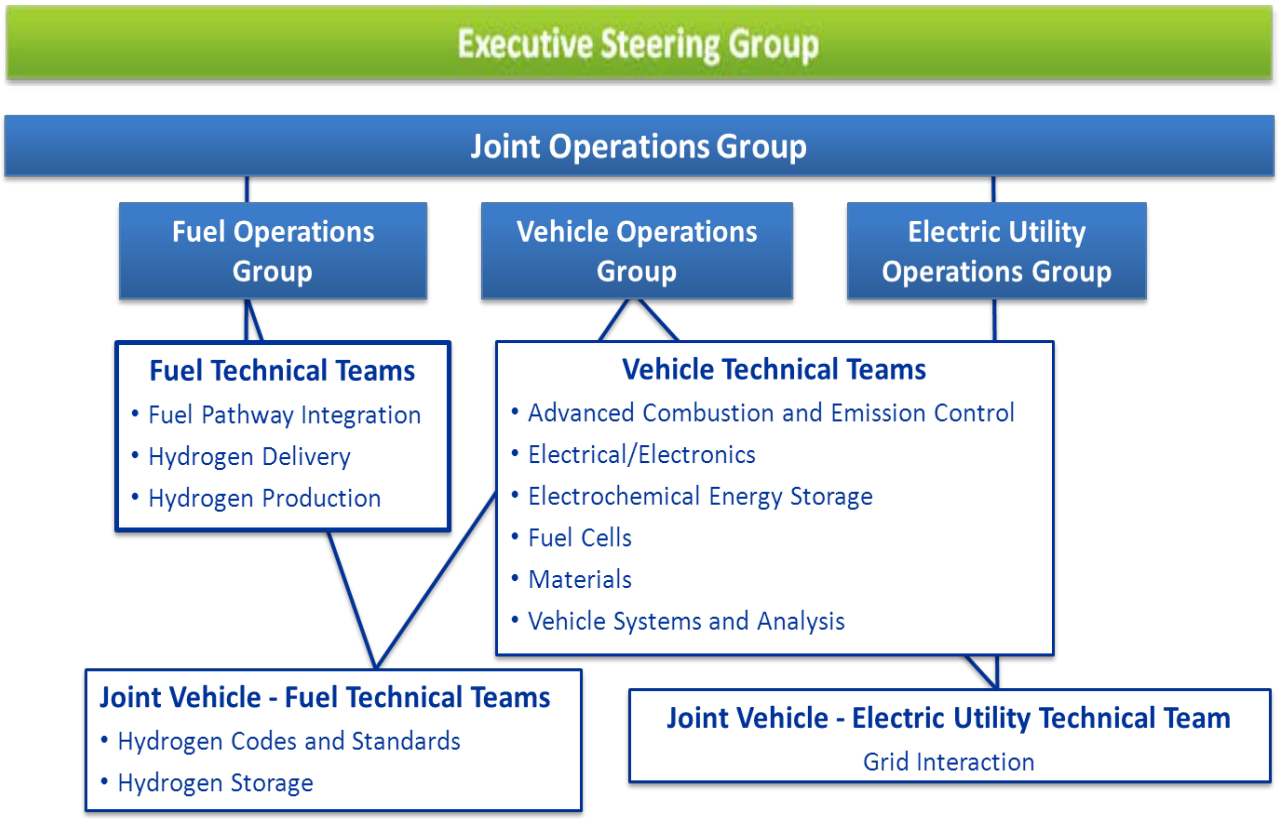


Figure 6.1.2 U.S. DRIVE Organization Chart

The Partnership's technical teams consist of scientists and engineers with technology-specific expertise from DOE, national laboratories, and the automotive, energy, and electric utility partner companies. Teams meet monthly to discuss R&D challenges, develop/update technology roadmaps, and evaluate R&D progress toward goals and technical targets.

State, Local, and Regional Entities

The FCT Program collaborates with state and local government organizations and various regional entities to promote development and demonstration of hydrogen technologies. For example, the California Fuel Cell Partnership is a unique collaboration of auto manufacturers, energy companies, fuel cell technology companies and government agencies that is placing fuel cell vehicles on the roads in California. This partnership is showcasing new vehicle technology that could move the world toward more practical and affordable environmental solutions. In addition to DOE, the other government partners include the California Air Resources Board, the California Energy Commission, the South Coast Air Quality Management District, the Upper Midwest Hydrogen Initiative, the U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA).

A comprehensive database has been developed that catalogues initiatives, policies and partnerships involving stationary fuel cell installations, hydrogen fueling stations and vehicle demonstrations in the United State. Details may be found at www.fuelcells.org/info/charts/h2fuelingstations-US.pdf and www.fuelcells.org/info/statedatabase.html.

State and local partnerships are the primary vehicle through which DOE meets the needs of individual citizens, cities, counties and states across the nation. The FCT Program does the following:

- Works with states and communities to promote the Program
- Identifies and engages community and state partners
- Coordinates with public and private sector activities.

International

On April 23, 2003, DOE called for an international partnership to accelerate progress in hydrogen and fuel cell technologies. As a result of the Secretary's vision, efforts were initiated with 16 countries and the European Commission in the areas of codes and standards, fuel cells, hydrogen production, hydrogen storage, economic modeling, and education. These efforts led to formation of the International Partnership for Hydrogen and Fuel Cells in the Economy (www.iphe.net).

The Department's call for the international partnership built on the efforts of the previous several years, during which DOE coordinated international activities to advance hydrogen and fuel cell technologies. DOE continues to take a leadership role in the International Energy Agency Hydrogen Implementing Agreement (www.iea.org) and Advanced Fuel Cell Implementing Agreement (see Table 6.1).

In addition, the FCT Program is working with international groups, such as the International Organization of Standards, to develop a comprehensive set of codes and standards, which will facilitate the global demonstration and commercialization of hydrogen and fuel cell technologies.

Table 6.1 International Energy Agency Hydrogen and Advanced Fuel Cells Implementing Agreements Tasks	
Hydrogen	**Fuel Cells**
Hydrogen From Renewables: Biohydrogen Advanced Materials for Waterphotolysis Near-term Market Routes to Hydrogen by Co-utilization of biomass as a renewable energy source with fossil fuels High Temperature Production of Hydrogen **Fundamental and Applied Hydrogen Storage Materials Development** **Hydrogen Systems** Small-scale Hydrogen Reformers for On-site Hydrogen Supply Wind Energy and Hydrogen Integration Distributed and Community Hydrogen Systems **Hydrogen Safety** **Analysis** Global Hydrogen Systems Analysis Large Scale Hydrogen Delivery Infrastructure	Polymer Electrolyte Fuel Cells Molten Carbonate Fuel Cells Solid Oxide Fuel Cells Fuel Cells for Stationary Applications Fuel Cell Systems for Transportation Fuel Cells for Portable Applications

Coordination

Interagency Task Force and Interagency Working Group

The Hydrogen and Fuel Cell Interagency Working Group, which has been meeting regularly since early 2003, provides a key mechanism for collaboration among federal agencies involved in hydrogen and fuel cell RD&D. Co-Chaired by DOE and the White House Office of Science and Technology Policy (OSTP), the working group has now focused its activities more specifically on fulfilling the responsibilities assigned to it in EPACT (Section 806). Principal activities involve education and information-sharing across federal agencies to promote the development of safe, economical, and environmentally friendly hydrogen energy systems. The working group is also responsible for assisting DOE with decisions related to federal agency procurements of fuel cells and hydrogen energy systems and with support for the development of hydrogen and fuel cell safety codes and standards. The working group web site, www.hydrogen.gov, provides additional

information and a portal to details about federal activities to advance the development of hydrogen and fuel cell technologies.

In August 2007, a high level Interagency Task Force was established to assist DOE with decisions related to improving efficiency in the federal government by promoting federal agency deployment of fuel cells and hydrogen energy systems.

6.2 Program Management Approach

The overall management of the Program consists of a performance-based planning, budgeting, analysis, and evaluation system:

Program Planning

The Energy Policy Act provides the foundation for the Program. The Program integrates the hydrogen planning in EERE, SC, FE, and NE, which is reflected in the Program Plan. Each office has its own research plan, which supports the Program Plan and provides more technical detail. These plans are coordinated to ensure consistency throughout DOE and to avoid duplicative research efforts.

Program Budgeting

The budget for the Program falls under the jurisdiction the Energy and Water subcommittees. The key activities by DOE office are shown in Table 6.2.

Table 6.2 DOE Hydrogen and Fuel Cells Program Key Activities

EERE

- Hydrogen Fuel R&D
  - Hydrogen Storage
  - Hydrogen Production and Delivery
- Fuel Cell Systems R&D
- Technology Validation
- Safety, Codes and Standards
- Systems Analysis
- Education
- Manufacturing R&D
- Market Transformation

Office of Fossil Energy

- Fuels, Hydrogen from Coal
- Carbon Sequestration [a]
- Pipeline Infrastructure [a]

Office of Nuclear Energy

- Generation IV Nuclear Systems Initiative [a]

Office of Science

- Chemical Science, Geoscience, and Energy Science
- Materials Science and Engineering

[a] These appropriations support the DOE Hydrogen and Fuel Cells Program, but are not directly a part of it, and would be funded even without it.

Analysis and Evaluation

Program budget performance is regularly evaluated by the Office of Management and Budget (OMB), in consultation with the OSTP. Each year, each Office reports its current status against pre-established Program goals. In addition, projects are evaluated through both the Program's Annual Merit Review and Peer Evaluation and also U.S. DRIVE technical team review.

6.3 FCT Sub-Programs

Using hydrogen as an energy carrier will require successfully addressing RD&D challenges including lowering the cost of hydrogen production, delivery, storage, and fuel cells; establishing effective codes and standards to address safety issues; and education to raise awareness, accelerate technology transfer, and increase public understanding of hydrogen energy systems. To ensure the success of the hydrogen infrastructure, the Program established sub-programs that are shown in Figure 6.3.1.

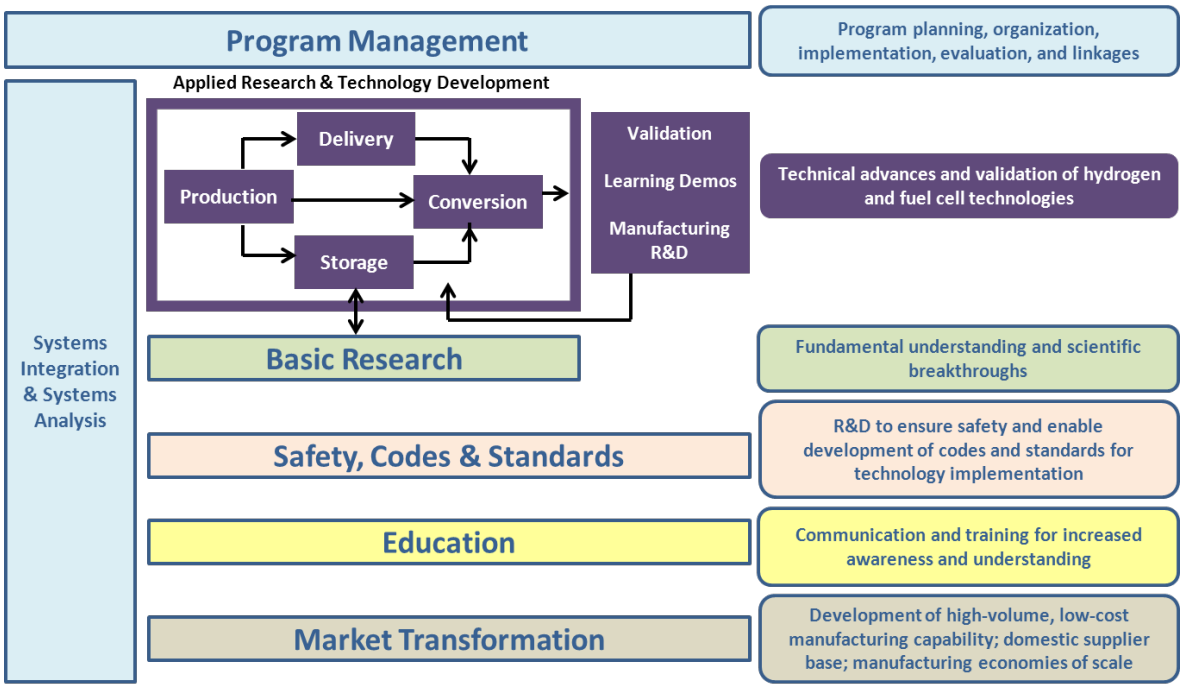


Figure 6.3.1 Sub-programs of DOE's Fuel Cell Technologies Program

6.4 Program Implementation

The implementation strategy is based on three guiding principles:

Linking the RD&D and Education Efforts to Policies, Requirements, and the Process for Selecting Options

The Program's mission is to research, develop, and validate technologies for producing, storing, delivering and using hydrogen in an efficient, clean, safe, reliable, and affordable manner. [1] An implementation strategy has been developed to ensure that all Program activities and procedures are consistent with the overall mission and the requirements contained in the Hydrogen Program Plan.

Organizing the Work

To ensure an appropriate master schedule and defensible budget request for the FCT Program through 2020, a detailed Work Breakdown Structure (WBS) was developed. The WBS serves two main purposes: (1) to ensure that the right work is being done and (2) to ensure that the right work is done correctly. Program goals were imposed "top-down," consistent with the policies and requirements contained in the Program's Plan, whereas detailed tasks, schedules, and budgets were established "bottoms-up." The WBS divides the Program into manageable segments of work to facilitate program management, cost estimating and budgeting, schedule management, cost and schedule control, and reporting of cost and schedule performance. It ensures all required work is incorporated in the Program and that no unnecessary work is included.

Managing and Monitoring the Program

The Program is managed in accordance with its approved integrated baseline: the technical baseline (i.e., a compilation of the Program's technical requirements) and the programmatic baseline (i.e., the work scope, schedule, and cost deemed necessary to satisfy the technical requirements). The programmatic portion of the integrated baseline ensures that the amount of work to be accomplished, the time allotted to accomplish the Program activities, and the resources required to complete the work scope are evenly balanced.

Program Control

To ensure that the Program remains on schedule and within cost, a Program control system has been instituted with the following objectives:

- Provide assurance that all work has been planned and considered in developing the cost and schedule baselines
- Identify the necessary procedures and organizational measures required for effective and timely management of the effort

[1] The Department of Energy Hydrogen Program Plan: An Integrated Strategic Plan for the Research, Development, and Demonstration of Hydrogen and Fuel Cell Technologies, September 2011, available at http://www.hydrogen.energy.gov/pdfs/program_plan2011.pdf

- Ensure that these measures are implemented and that the resulting information accurately reflects the status of the Program
- Establish a review and decision-making process that addresses Program dynamics.

Under the Program control system, integrated cost, schedule, and technology baselines are developed. The performance of the Program offices and supporting organizations in completing tasks is measured against these baselines and reported back to their organizations, to track program performance and take corrective actions, if necessary. The Program uses a change control process, a procedure by which changes to an accepted work product are carefully proposed, assessed, conditionally accepted, and applied. The change control process provides a measure of stability to the Program and ensures consistency across sub-programs.

Responsibilities for Program Control

The Chief Engineer is responsible for the Program's integrated baseline oversight. The Systems Integrator – in support of the Chief Engineer – gathers, integrates, and analyzes information on the scope, schedule, and budget of the sub-programs. The sub-program plans and schedules are integrated into a Program plan, work breakdown structure, and master schedule. Together these plans comprise the programmatic baseline that is associated with a specific version of the technical baseline. The Systems Integrator analyzes this information to ensure that all technical requirements are addressed and are consistent, and to identify critical paths, milestones, and decision points. The Systems Integrator provides tools and information to support DOE in monitoring performance against schedule and budget and in identifying risk.

Implementation of Program Control

Figure 6.4.1 provides an overview of the Program's control process. The primary inputs to Program control include the integrated baseline (refer to the Systems Integration section of the Multi-Year Research, Development and Demonstration Plan), budget guidance, and results of prior Program reviews.

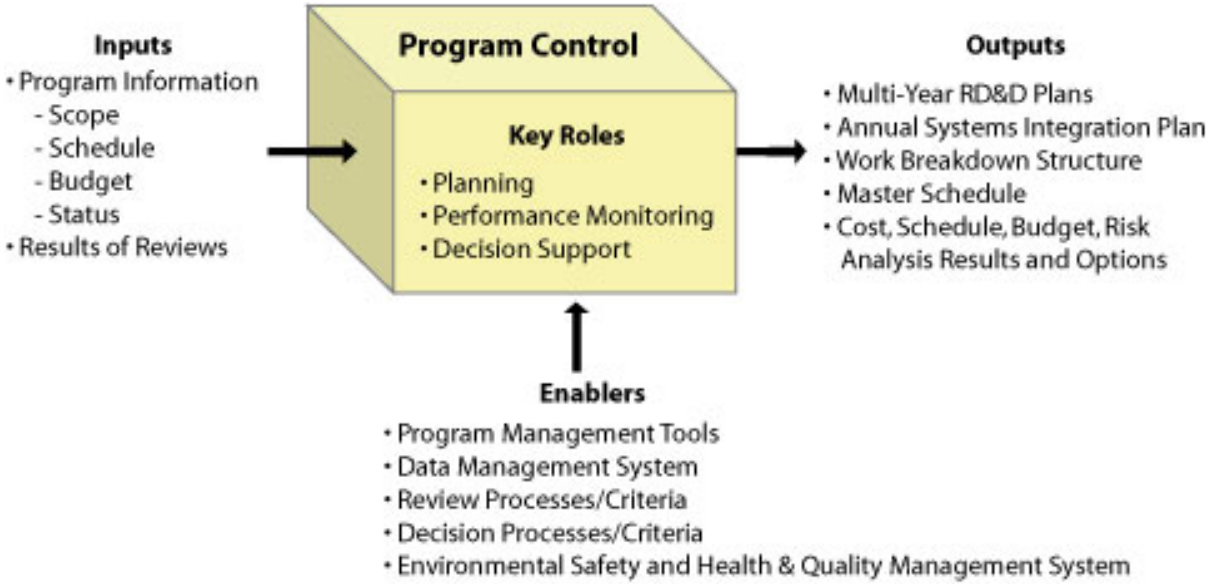


Figure 6.4.1 Program-Control Process

Decision-Making Process

A stage-gate type process is being used to manage R&D investments. The stage-gate process is a disciplined approach for evaluating projects at key points. The stage-gate process being used includes go/no-go decisions and down-select points that must be passed before work on the next stage can begin. Reviews held at these key stages ensure that a project has met its milestones and satisfies the criteria for proceeding to the next stage of the program. Reviewers may include individuals from government agencies, national laboratories, and the private sector.

Technical criteria are used at each stage and decisions are made to either:

- Advance the project to the next stage
- Continue the current effort because not all goals have been met
- Place the project on hold because the need appears to have gone away, but could re-emerge
- Conclude the project because it is unlikely to meet its goals or there is no longer a need for the effort.

Each of the gate reviews considers the impact on the direction of the overall Program of both new knowledge and insights that have been gained during the progression of the Program.