

State Technologies Advancement Collaborative (STAC)

Summary of Development and Market Adoption Benefits From STAC Research Projects

Introduction

The National Association of State Energy Officials (NASEO), Association of State Energy Research and Technology Transfer Institutions (ASERTTI), and U.S. Department of Energy (DOE) signed an intergovernmental agreement on November 14, 2002, that allows states and territories and the Federal Government to better collaborate on energy research, development, demonstration and deployment (RDD&D) projects. The agreement established the State Technologies Advancement Collaborative (STAC) which allows the states and DOE to move RDD&D forward using an innovative competitive project selection and funding process. A cooperative agreement between DOE and NASEO serves as the contracting instrument for this innovative federal-state partnership obligating funds from DOE's Office of Energy Efficiency and Renewable Energy and Office of Fossil Energy to plan, fund, and implement RDD&D projects that are consistent with the common priorities of the states and DOE. DOE's Golden Field Office provides Federal oversight and guidance for the STAC cooperative agreement.

Through STAC, an innovative funding process was established to solicit, select, and help fund innovative energy research projects in energy efficiency, fossil energy, and renewable energy as a means of accelerating the development and market adoption of clean, sustainable and efficient energy technologies.

These projects included research, development, demonstration, and deployment (RDD&D) efforts, were multi-state in nature, and supported technologies where common Federal and State priorities in energy efficiency, fossil energy, and renewable energy existed. Further, these projects were chosen because the States or industry had identified specific assistance that was needed to help a specific product or service advance through a particular stage of technology innovation. Because the STAC projects worked on technologies in various stages of commercial acceptance, this summary describes benefits that resulted from the STAC RDD&D projects in terms of how the technology advanced through the innovation process.

Background

Industry, states, regulatory agencies, and non-profit organizations were concerned that the enormous potential to deploy energy efficiency and renewable energy products and services was being limited by factors related to uncertainties in the process by which innovative products and services are adopted. DOE, in collaboration with its stakeholder community, concluded that there was such a breadth of energy efficiency and renewable energy products and services available for adoption by potential users and the maturities of these products and services were at such different levels of development that a comprehensive, state-Federal partnership effort for RDD&D was needed.

Given this market pull factor, the STAC effort was developed to provide DOE the means to encourage states, industry, universities, and non-profit organizations to collaborate on projects that would:

1. reduce technical or product performance uncertainty,
2. remove technical or regulatory barriers, or

3. provide educational or technical information needed to move energy efficiency, fossil energy, and renewable energy products and services through the technology adoption process.

STAC, using NASEO as its operating agent, issued three annual competitive solicitations (2003-2005) requesting proposals that spanned not only innovative product development, demonstration, and deployment efforts but, much needed, targeted research that supported these projects. Solicitations covered a range of technologies and programs including buildings, industrial, transportation, distributed energy resources, hydrogen learning centers, and fossil energy. DOE provided a total of \$19.1 million in funding for the three solicitations, while state and industry partners were required to provide between 20 – 55% (non-federal sources) in cash and/or in-kind cost share.

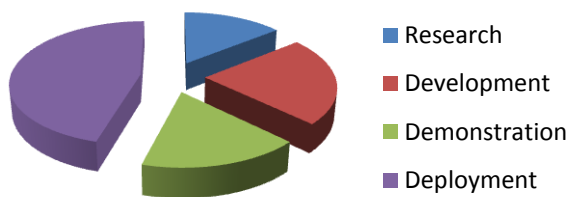
Approach to Assessing STAC Benefits

Specific criteria, such as cost share, geographic diversity, make-up of proposing team, and balance of RDD&D projects funded were developed and applied in each of the three solicitations.

STAC selected projects met, and in many cases, exceeded these first stage requirements. DOE invested \$19.1 million in STAC projects between 2003 and 2005 while leveraging an additional \$13.2 million (average cost share per project of 40%) in required state and private industry cost-share funds. While \$13.2 was the overall committed cost share, many project participants provided larger cost share amounts to the individual projects. The actual total cost share amount provided shows a higher leveraging amount of \$18.2 million, thus making a significant statement about the importance states and private industry placed on these projects.

Twenty-two states were awarded at least one prime contract, and organizations in all 50 states were involved as subcontractors in at least one STAC project. Project teams included the full spectrum of organizations including: state energy organizations, universities, small business, national laboratories, private industry, Native American organizations, and venture capital groups.

Portfolio of Projects



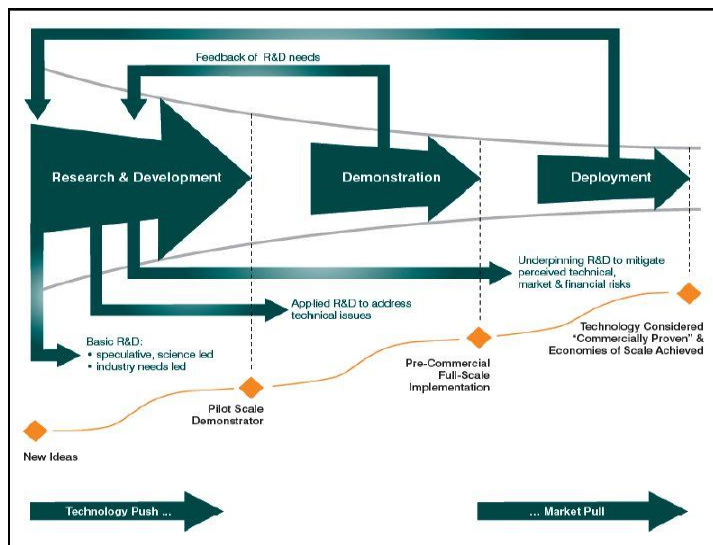
Total STAC projects awarded through the three solicitations showed a balanced portfolio of RDD&D selections.

DOE wanted to utilize the STAC approach to provide support not only to different industries and end users, but also to support adoption of different energy efficiency and renewable products and services at different stages of developmental maturity. For example,

- commercial building architects and engineers designing new structures were in the early adopter stage of using building performance models to predict and manage energy use and needed actual deployment quality data to help understand how to profitably exploit these models;

- the mature food processing industry was losing sales abroad but analyses had shown that U.S. processors could recapture market share by reducing energy costs; and
- the emerging fuel cell and hydrogen fuel industries needed to create interest in these opportunities through education by disseminating the latest technical information and helping decision-makers fully understand the potential of these applications.

Innovation covers the full research, development, demonstration and deployment process. It is rarely a linear process and almost always has important interaction among different actors – government, academia, businesses, financiers – and involves feedback loops across stages as shown in the classic Innovation Funnel concept.



Products and services developed in the R&D stage do not automatically (or successfully) move through the various stages and transform into a technology that is ready for commercial deployment. Companies with technologies at the demonstration stage may identify problems and need to revisit earlier stages or industries may need assistance at the deployment stage from regulators.

STAC funded projects across the full gamut of the RDD&D process. Most of the STAC projects produced benefits that were only able to be described in

qualitative terms because of their location in one of the early stages of these four innovation categories. Some of the more mature product or service projects did produce quantifiable results in terms of energy saved or measurable environmental improvements. Benefits from all these projects are described in the final reports on the STAC website at www.stacenergy.org.

To illustrate how diverse but important the STAC project benefits were, the following examples describe specific individual project benefits with respect to the innovation category of the project.

STAC Research Projects – (needed to address specific product or service problems):

1. Iron-Based Mixed Metal Carbide Fischer-Tropsch Catalysts

Prime Contractor – Clemson University

Partners - Louisiana State University, Research Triangle Institute, Süd-Chemie Inc.,
 Rentech, Energy Technology Partners LLC, the South Carolina State Energy
 Office, and the Louisiana State Energy Office

DOE-STAC Funding = \$875,499

Team Cost Share Committed = \$459,095

Actual Cost Share Provided = \$459,095

The U.S. has large domestic coal reserves and using the Fischer-Tropsch (FTS) process is of great interest for upgrading low-value coal and biomass to high-value liquid fuels and

chemicals especially if biofuels are the feedstock since there would essentially be no net CO₂ emissions. The total biomass produced each year as waste material from agriculture and forest operations could be converted into roughly 40 billion gal/yr of liquid fuel, roughly 25% of the current US gasoline usage.

The project team achieved a significant success by demonstrating two catalysts that are equal to or better than other potential commercial Fe-based catalysts for the Fischer-Tropsch synthesis. Each of the two catalysts has the potential for exploitation in a slurry phase design which is the preferred configuration for a FTS reactor. Even though this project has now reached its completion date, Clemson University has continued in 2010 to move the work forward by collaborating with Energy Technology Partners LLC and Clemson's cost-share partner, Rentech, to carry out additional long term (500-3000 h) slurry phase runs with at least the FeMnK catalyst.

2. Motor Control and Power Conversion Technologies Using FLEXMOD

Prime Contractor – Advanced Energy

Partners - Raser Technologies, Inc., Washington State University Energy Program

DOE-STAC Funding = \$389,184

Team Cost Share Committed = \$97,300

Actual Cost Share Provided = \$343,454

DOE estimates that improved system controls including variable speed drives for pump, fan, and compressed air systems alone could save nearly 15,000 gigawatt-hours and potentially \$900 million in annual energy savings. These estimates are based on the fact that many of the more than 13 million electric motors used in industrial applications are operating inefficiently due to changing loads or less than optimum control schemes.

This project team developed a more efficient, modular, motor controller capable of operating with a range of motor sizes and types. The controller has a substantial market penetration potential benefit because it can be manufactured at reasonable cost and tests show its use can result in substantial energy savings in industrial and residential applications. The project had a further substantial innovation benefit because the motor controller has significant potential for development and then deployment in the emerging hybrid vehicle market.

STAC Development Projects (support for a specific commercial application):

1. Building Commissioning – Innovation to Practice

Prime Contractors – California Energy Commission (CEC), New York State Energy Research & Development Authority, Texas Engineering Experiment Station, Oregon Department of Energy, University of Nebraska

Partners - Iowa Energy Center, Northwest Energy Efficiency Alliance

DOE-STAC Funding = \$999,229

Team Cost Share Committed = \$1,225,017

Actual Cost Share Provided = \$1,228,075

Since 1998, when the DOE's National Strategy for Building Commissioning determined that deployment of building commissioning tools in commercial buildings would reduce energy annual consumption and save owners literally millions in operating costs, two significant barriers have prevented widespread adoption of such tools:

- the need for proven tools and technologies that standardize and simplify commissioning approaches and reduce implementation costs; and
- concern about the uncertainty of cost savings and other benefits.

The project team developed and tested an Automated Building Commissioning Analysis Tool (ABCAT) in multiple buildings of various size, climate zones, space utilization, and HVAC system types. The testing determined that ABCAT is affordable and reduces loads in commercial buildings by identifying significant energy consumption changes that go undetected by building energy management personnel. ABCAT has the potential of decreasing energy consumption levels by 15-30%. Although similar attempts have been made in fault detection and diagnostic (FDD) tools at the whole building level, ABCAT is simpler and more flexible to use – traits that are desired by industry professionals.

2. Development, Implementation and Deployment of Auto Fault Detection & Diagnostics for Vapor Compression Equipment

Prime Contractor – Purdue University

Partners - Ben Franklin Technology Partners, Field Diagnostic Services, Inc., Honeywell Corporation

DOE-STAC Funding = \$426,249

Team Cost Share Committed = \$721,600

Actual Cost Share Provided: \$890,000

Automated fault detection and diagnostics (FDD) systems for HVAC applications have the potential to significantly improve energy efficiency and comfort and reduce operating and service costs in both residential and small commercial buildings. These cost reductions are possible because approximately 60% of the installed cooling within the U.S. is associated with packaged air conditioners having relatively small individual cooling capacities, and these systems require regular, scheduled maintenance. This project involved the development of new FDD algorithms for both a portable tool device and an embedded (during manufacturing) diagnostic system.

The technology developed by the project team clearly showed it was of use as a commercial product and is already being marketed as a field retrofit to existing packaged air conditioning equipment. Honeywell expanded a four branch RCI (rooftop unit retrocommissioning initiative) pilot service program in 2006 to a full North American deployment in 2007. HVAC tune-up utility programs throughout the U.S. have adopted the generalized service assistant platform including PG&E, NYSERDA, SMUD, and AVISTA. The project also leveraged other industry products and capital formation related to the wireless technology evolution by incorporating diagnostic algorithms into a personal data assistant (PDA) linked to the portable tool device.

STAC Demonstration Projects (pre-commercial demonstration of technologies at scale to give a stronger indication of production and operating costs and the opportunities for cost reduction)

1. Western Food Process Efficiency Initiative

Prime Contractor – Oregon Department of Energy

Partners - WA State University Energy Program, ID Department of Water Resources, Energy Division, California Energy Commission, Lawrence Berkeley National Laboratory, Del Monte Foods, Northwest Food Processors Association, Northwest Energy Efficiency Alliance

DOE-STAC Funding = \$730,652

Team Cost Share Committed = \$897,125

Actual Cost Share Provided: \$1,032,957

This project was a collaboration among four Western states where food processing is one of the largest energy using industries in these states. The project was important to this regional industry by helping it increase market share and compete internationally and domestically through energy cost reduction and increasing efficiency, productivity, and product quality distinction.

From a relatively small investment of funds, this STAC project was very productive – it created a portfolio of regional energy management and system optimization best practice resource tools from fourteen case study reports that implemented energy cost saving demonstration projects. The estimated annual energy savings from just these demonstration projects was 3,175,627 kWh (2,281 Metric Tons CO₂) and 39,955 net natural gas therms (200 Metric Tons CO₂). The project team was also able to create an emerging technologies resource base for the food processing industry and disseminate the information across the region through an Energy Web portal (the only such U.S. site for the food processing industry) designed and created during the project and maintained by two food processing associations that collaborated in the project.

2. Full-Scale Trial of High Capacity Gas-Fired Paper Dryer

Prime Contractor – Minnesota Department of Commerce, State Energy Office
Partners - West Michigan University, Gas Technology Institute

DOE-STAC Funding= \$608,284

Team Cost Share Committed = \$728,573

Actual Cost Share Provided: \$728,573

Dryer capacity is usually the limiting production factor at papermaking plants, and the drying process consumes nearly two-thirds of the total energy in papermaking. This project demonstrated a full-scale unit designed for significantly higher drying drum surface temperatures that increased drying speed and energy efficiency.

The paper industry has expressed strong interest in the project results because, for those facilities which can adopt the process changes, the payback period for the modifications is estimated to be less than one year. It is likely the higher capacity gas-fired paper dryer concept has significant market penetration potential because it can increase production of dryer-limited paper machines by 10-20% and result in substantial capital savings for both retrofits and new capacity.

3. Multi-fleet Demonstration of Hydraulic Regenerative Braking Technology in Refuse Truck Applications

Prime Contractor – NYSERDA

Partners – Maryland Energy Administration, Maryland Department of the Environment, New Jersey Board of Public Utilities, Shorepower Technologies, LLC, New West Technologies, LLC, Bosch Rexroth Corp., City of New York Department of Sanitation, City of Baltimore, Bureau of Solid Waste

DOE-STAC Funding= \$493,711

Team Cost Share Committed = \$941,915

Actual Cost Share Provided = \$4,142,179

Hydraulic Regenerative Braking (HRB) technology has proven to be effective in urban stop and go applications of heavy-duty vehicles because it significantly reduces fuel consumption, emissions, and brake maintenance while at the same time improving vehicle performance.

During braking, HRB technology recovers a vehicle's kinetic energy that is otherwise lost as heat generated by friction brakes.

This project involved a long-term field demonstration of HRB technology which collected data on operational performance, efficiency, emissions, maintenance and cost using standardized testing procedures on two refuse truck fleets in New York City and Baltimore. This project has the potential for major market penetration by providing large cities with final design specifications developed for HRB systems based on realistic route and vehicle data that included extensive debugging of HRB systems using advanced data acquisition instrumentation of baseline and HRB equipped vehicles.

4. Hybrid Electric School Buses: The Road to Reduced Fuel Consumption, Healthier Children and Cleaner Air

Prime Contractor – Advanced Energy (AE)

Partners - New York State Energy Research & Development Authority, NC Department of Public Instruction, FL Department of Education, Durham School Services, Little Rock School District, Sigourney/Keokuk Community School District, Keota Community Schools, Nevada Community Schools

DOE-STAC Funding = \$840,000

Team Cost Share Committed = \$1,050,191

Actual Cost Share Provided = \$1,448,973

Almost all school buses sold in the U.S. are traditional, fossil fuel designs. Manufacturers have resisted adopting new, significantly more efficient, less-polluting hybrid technologies because of the economic investment needed to move from initial technology development to successful market deployment.

This project team included partners from a number of states to form a buyer's consortium that assisted AE in developing detailed specifications used to issue an RFP to several bus manufacturers. The environmental and economic benefits from this project are expected to be far-reaching because of the broad geographic participation and industry participation. Fifteen hybrid demonstration efforts were begun in 2007, and the monitoring and data collection and analysis has already provided significant information on how route selection for buses is critical to performance; how driving style affects hybrid fuel economy even in buses; why proper training of maintenance personnel is essential for deployment of hybrid school buses; and that multiple charging locations help improve fuel savings. This project resulted in the development and sale of the first commercially available plug-in hybrid vehicle in the US. Additionally, the project increased the acceptance and dissemination of advanced transportation technologies that use less fuel, save money, and are gentler on the environment.

STAC Deployment Projects (integration of products and services into existing markets by providing needed information, reducing barriers or creating subsidies to ensure fair, competitive markets):

1. National Database of Energy Efficiency Policies and Incentives

Prime Contractor – North Carolina State University – NC Solar Center

Partners - WA State University, Texas State Energy Office, PA Department of Environmental Protection, North American Insulation Manufacturers Association

DOE-STAC Funding = \$430,000

Team Cost Share Committed = \$108,500

Actual Cost Share Provided = \$113,985

Prior to this project, the Database for Renewable Energy Incentives (DSIRE) was a modest database designed to share information about renewable energy incentives, only providing information on incentives for business, government, industry, and the public on all state policies specific to renewable energy. It had quietly built up a nationwide following as the best source for helping policy-makers and the public keep up with renewable energy incentive programs across the U.S. states and territories.

The project goal was to significantly enhance and expand the effectiveness of DSIRE to include building energy efficiency (EE) financial incentives and regulatory policies from state, local, Federal, and utility sources. Its benefits have been broad and far-reaching. The addition of energy efficiency and regulatory policy information organized by state and territory has led to over a ten-fold increase in traffic on the DSIRE+EE site, and now average monthly visits to the site are in excess of 250,000. The enhanced database has proven to be a critical resource for a wide audience from consumers and businesses who need timely information on incentives in order to make purchasing decisions to government officials who have approval or influence over the creation of incentives and regulations.

2. Creating and Demonstrating Incentives for Electricity Providers to Integrate Distributed Energy Resources

Prime Contractor – Massachusetts Division of Energy Resources

Partners - Massachusetts Technology Collaborative, California Energy Commission, Electric Power Research Institute, San Diego Gas & Electric Company, Southern California Edison, National Grid, RealEnergy, New Jersey Board of Public Utilities, Solar Turbines

DOE-STAC Funding = \$349,666

Team Cost Share Committed = \$1,482,000

Actual Cost Share Provided = \$1,482,000

Distributed Energy Resources (DER) technologies and programs have been shown to have demonstrable benefits by states that have used regulatory strategies to help electricity providers integrate these systems into utility-specific businesses through creation of new business models.

This project has the benefit of broad geographic impact because two large states, one eastern and one western, demonstrated the most promising DER approaches through actual pilot projects. Results from the pilots were used to identify and address key state-specific business and regulatory barriers to DER. These results are a significant benefit to states and electricity providers because they provide a tested comprehensive set of business models and regulatory templates for integrating DER solutions into existing systems.