Commercialization and Deployment at NREL

Advancing Renewable Energy and Energy Efficiency at Speed and Scale

Prepared for the
State Energy Advisory Board

NOTICE

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy
and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information

P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/help/ordermethods.aspx

Cover Photos: (left to right) PIX 16416, PIX 17423, PIX 16560, PIX 17613, PIX 17436, PIX 17721

Printed on paper containing at least 50% wastepaper, including 10% post consumer waste.

CONTENTS

LIST OF ACRONYMS

AFDC – Alternative Fuels Data Center

AOP – Annual Operating Plan

ARRA – The American Recovery and Reinvestment Act

CCIA – Colorado Cleantech Industry Association

CEPA – Clean Energy Policy Analyses

C&TT – Commercialization and Technology Transfer (NREL)

CRADA – Cooperative Research and Development Agreement

CREED – Center for Renewable Energy Economic Development

CY – Calendar Year

DOE – U.S. Department of Energy

EPAct – Energy Policy Act

EECBG – Energy Efficiency and Conservation Block Grants

EERE – Office of Energy Efficiency and Renewable Energy (DOE)

FEMP – Federal Energy Management Program

GEO – Governor's Energy Office

GFTT– Government Funded Technology Transfer

IAC– Integrated Applications Center (NREL)

IEC– Innovation and Entrepreneurship Center (NREL)

IP – Intellectual Property

M&O – Manager and Operator

MTC– Market Transformation Center (NREL)

NASA – National Aeronautics and Space Administration

NCAP – NREL Commercialization Assistance Program

NREL – National Renewable Energy Laboratory

OEDIT – Colorado Office of Economic Development and International Trade

PEMP – Performance Evaluation Management Plan

PFTT– Privately Funded Technology Transfer

R&D – Research and Development

SAC– Solar America Cities

SEE Action – State Energy Efficiency Action Network

TAP – Technical Advisory Program

TCDF – Technology Commercialization and Deployment Fund

USDA – U.S. Department of Agriculture

USDA 9003 – Biorefinery Assistance Program

USDA 9004 – Repowering Assistance Program

USDA 9007 – Rural Energy for America Program

WAP – Weatherization Assistance Program

WFO – Work for Others

WIP – Weatherization and Intergovernmental Program

WPA – Wind Powering America

INTRODUCTION

In 2007, the U.S. Department of Energy issued this challenge: expand the laboratory's role as a leader in clean energy technology development to also be a catalyst in the transition from early adoption of new technologies to broad market acceptance of widely available energy efficiency and renewable energy solutions. The Alliance for Sustainable Energy, manager and operator (M&O) of NREL, vigorously responded to the challenge in philosophy and in practice.

At NREL, we have a unique, mission-driven approach to complete the cycle which begins with R&D and is not complete until new technologies are introduced into the marketplace, and proven technologies are adopted broadly.

> **NREL's Mission Statement**
>
> NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals.

Commercialization and deployment at NREL focus on "speed and scale." We move technologies to the marketplace quickly (speed), and we work on removing market barriers in order to enable widespread market adoption (scale) of proven technologies.

COMMERCIALIZATION AND TECHNOLOGY TRANSFER AT NREL

Technology commercialization at NREL moves renewable energy and energy efficiency innovations created at NREL and elsewhere deliberately and rapidly to the market. This critical part of NREL's mission is executed through a cutting-edge Commercialization and Technology Transfer (C&TT) organization. Through both adoption and innovation of best-in-class commercialization and technology transfer practices, C&TT executes a "speed of business" work ethic in all transactions, leading to increased laboratory productivity, partner satisfaction, and repeat business.

NREL's C&TT organization has combined and integrated traditional functions in a centralized Commercialization and Technology Transfer organization and staff. We adopt best practices from other organizations, and we pioneer new programs in our effort to move NREL technologies from the laboratory to the market with all deliberate speed.

In recent years we have embarked upon an effort to increase the effectiveness of all of our technology transfer efforts, taking traditional technology transfer to new levels of efficiency and effectiveness and establishing our own cutting-edge programs. As a result, patenting, licensing, and royalty income have all increased, while cycle times for partnership agreements have decreased significantly.

Our goal – one executed with passion, innovation, and creativity – is to ensure that NREL technologies (and those of our research and industry partners) help transform our nation's energy future.

"Traditional" Technology Transfer

NREL conducts the following traditional technology transfer activities:

- Establishes and nurtures technology-rich relationships with private industry and other government entities towards the creation of Cooperative Research and Development Agreements (CRADAs) and other technology partnering agreements
- Works closely with technical staff to ensure that their innovations are reviewed and, if applicable, patented in a timely manner
- Creates impactful licensing agreements with outside entities that positively drive the commercialization of NREL technologies, and maintains previously executed licenses to ensure licensee compliance with contractual and fiscal obligations
- Enhances external relationships with the investor and entrepreneurial communities by organizing and hosting the Industry Growth Forum, the premier venture capital event for early stage companies developing renewable energy and energy efficiency products.

In recent years, NREL has made significant process improvements in preparing and executing technology partnership agreements (TPAs), reviewing and patenting inventions, and licensing NREL technologies. Our continuous improvement efforts have enhanced innovation output, and

the laboratory's transactions processes are cited by industry as reasons to partner with NREL. Through these efforts, we have reduced process times for CRADAs by 50%, from 118.5 days to 83 days, and process times for Work for Others (WFO) agreements have been reduced by 37%, from 124.5 days to 83 days.

Other best practices efforts include the following:

- Enhanced intellectual property information system to support technology partnership agreements, innovation management, and licensing workflows
- Facilitated contract negotiation using advanced collaboration tools
- Continued improvements to model agreements to make them more user friendly
- Reduced transaction times for each phase of agreements processing (TPA and licensing agreements) and documented progress using tracking metrics.

Cutting-edge Technology Transfer

NREL also executes cutting-edge programs such as the EERE Energy Innovation Portal, the Innovation & Entrepreneurship Center (IEC), Privately Funded Technology Transfer (PFTT) and the EERE Technology Commercialization and Deployment Fund (TCDF). Additionally, NREL partners with the state of Colorado and other renewable energy and energy efficiency stakeholders in the Colorado Center for Renewable Energy Economic Development (CREED). These five initiatives strengthen NREL's ability to more rapidly transfer technology, grow NREL's business activities, and support innovative start-up companies.

EERE Energy Innovation Portal

A significant challenge facing technology seekers is the ability to locate technologies that can underpin new companies or build out a product line for existing companies. Because each of the seventeen DOE national laboratories operate quite independently and therefore each maintains an independent listing of technologies available for licensing, it has not previously been possible for a technology seeker to browse all DOE technologies in one location. The Energy Innovation Portal was envisioned as a single source for national laboratories and other stakeholders (such as university partners) to advertise their available technologies, as well as a "one-stop shopping" destination for those seeking to license technologies from the DOE to enhance their business competitiveness. The Portal was also envisioned to enable the national laboratories to build a community around their common interests and join forces in licensing "bundled" intellectual property (IP).

The Portal currently showcases more than 400 marketing summaries with business-focused introductions to technologies, including potential application, advantages over existing solutions, and contact information. Additionally, the Portal facilitates access to more than 15,000 U.S. patents and patent applications that resulted from DOE funding.

The Portal is supported by, and contains technology marketing summaries from many national laboratories, including, but not limited to, Argonne National Laboratory, Brookhaven National Laboratory, Idaho National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, National Renewable Energy Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory and Sandia National Laboratories. The Portal's research partners extend beyond the national laboratories as well and include NASA, the University of Colorado, Colorado State University, and the Colorado School of Mines. A full list of research partners is available on the Portal at http://www.techportal.eere.energy.gov.

The Portal enables NREL to track the contacts each lab receives through the Portal regarding any given technology available for license. NREL actively markets the Portal through news releases, conference exhibits, and word-of-mouth. Portal visibility in FY11 has increased dramatically.

*"By connecting American entrepreneurs with cutting-edge, ready-to-commercialize technologies from the National Labs, the **DOE Innovation Portal** is helping to grow our economy and create the next generation of American jobs"*

-Dr. Steven Chu
U.S. Secretary of Energy
PIX 16286

Innovation and Entrepreneurship Center

NREL has committed to aid in the development of clean energy companies in Colorado and throughout the nation, both in service of our renewable energy mission and to contribute to economic development. To rise to this challenge, NREL has developed a comprehensive program that utilizes NREL's programmatic strengths and existing partnerships with regional and national economic development leaders. The mission of NREL's Innovation and Entrepreneurship Center is to develop and deliver programs and services designed to bring innovation and entrepreneurship to the interface of NREL and its external partners.

The Center is focused on:

- Creating an *Innovative and Entrepreneurial Environment* that is a seamless part of the fabric of NREL
- Promoting NREL as a key catalyst for economic development by accelerating and improving the yield of regional clean energy innovations
- Facilitating robust access to capital and other resources for clean energy entrepreneurs
- Enhancing NREL's small business contracting efforts and Mentor-Protégé program.

External offerings from the IEC include the nationally-recognized NREL Industry Growth Forum, the NREL Commercialization Assistance Program (NCAP), the NREL Venture Capital Advisory Board, and leadership in CREED.

Industry Growth Forum: Historically, new clean energy companies had difficulty finding investors and investors often were unaware of emerging companies. In the early 1990's, as a service to the entire clean energy industry, NREL pioneered an assembly of companies and investors—the first of its kind in the clean energy space. NREL's Industry Growth Forum is now the nation's premier event for emerging clean energy and energy efficiency technology startups to gain exposure to and feedback from venture capitalists, corporate investors, government agencies, and strategic partners. The Forum features presentations from more than 30 emerging clean energy companies which have competed for the chance to present, provocative panels led by thought leaders, facilitated one-on-one meetings, and technology accelerator workshops. It is the perfect venue for growing companies to prepare, refine, and present their business to a wide range of stakeholders and potential investors. Collectively, companies who have presented at the Forum since 2003 have raised more than $3.4 billion in growth financing.

NREL Commercialization Assistance Program: Small technology-based companies can benefit from NREL expertise, capabilities, and equipment, but many of these small companies are not aware of the resources available at NREL, nor the process for accessing these resources. NCAP was created to help emerging companies overcome technical barriers to commercializing clean energy technology by enabling easy access to NREL. The program specifically helps renewable energy and energy efficiency companies by providing up to forty hours of technical assistance or information to help small businesses with particular technology problems or needs. Examples of assistance include short-term access to technical expertise and facilities such as testing and measurement of systems or components, analytical testing of materials, insights on existing or emerging technologies, assistance in addressing technological performance, market analysis, or addressing general technology problems. NCAP is funded from NREL licensing proceeds and is therefore free of charge to small businesses.

Venture Capital Advisory Board: National laboratory engagement with the venture capital community has met with mixed results, since the needs of the venture capital community and the operating conditions at the laboratories were sometimes incompatible. In its desire to greatly increase its communication and interaction with the large network of venture capital firms which invest in cleantech, NREL formed the VC Advisory Board. This Board is an interface group to the larger network and is a cornerstone in our efforts to promote the growth of the clean-tech industry sector. The funds represented on the Board have more than $4 billion under management. The Board advises NREL and our collaborators on our strategic plans and resultant programs in the clean energy sector, including topics such as:

- Development of clean energy start-ups and how they can successfully raise financing
- Commercialization of mission relevant technologies

- Speed to market for new technologies
- Identification and fostering of technologies that can serve an unmet market
- Identification and analysis of market trends
- Assessment and commentary on the technology pipeline.

Technology Commercialization and Deployment Fund Program

Finding new ways to leverage private sector investment is a core element in NREL's strategy for accelerating the commercialization of new technologies, and having access to risk capital to entice private sector investment is central to NREL's strategy. NREL provides access to capital from a variety of sources, and leads venture community activities that make investment capital more readily accessible to clean energy companies who need it. The sources include leveraging DOE programs such as the Technology Commercialization and Deployment Fund (TCDF).

The purpose of the TCDF program, launched by EERE in 2007, is to provide funding for technology maturation to bridge the "valley of death" that many promising nascent technologies face when research funding ends, but the technology requires further development before a commercial partner will invest. Under the TCDF program, commercial partners cost-share project development costs, which typically range from $150,000 to $1 million. Projects were submitted by researchers and commercial partners, and were selected based on their fit with the program, the value of NREL's IP position, and the potential for near-term commercial impacts.

NREL's TCDF portfolio includes projects in the following technology areas:

- Solar (eight companies: four thin film, two concentrating solar thermal, one concentrating photovoltaic, and one manufacturing equipment)
- Buildings/energy efficiency (two companies)
- Hydrogen (one company)
- Biomass (one company).

Privately Funded Technology Transfer Program

The Alliance for Sustainable Energy, as the operator of NREL, sought to aggressively pursue a technology transfer agenda that would leverage private sector funding, from Alliance and other non-government sources. Privately Funded Technology Transfer (PFTT) is a way to enable private investment in what was previously a solely government-funded activity. Government Funded Technology Transfer (GFTT) refers to the government-funded process of electing title (under the Bayh-Dole Act) to inventions resulting from federal government funding, patenting those inventions, and marketing/licensing them to the private sector for use in new products or processes and in providing maturation funding to advance new inventions. Privately Funded Technology Transfer refers to the same chain of events, with one important difference: private (non-federal) funding is used for all costs related to an invention once it is elected. In this way, private dollars are used to leverage the federal investment in research and development to bring cutting-edge technologies to the marketplace.

In FY10, NREL launched a robust and "best practice" PFTT program. NREL elected a first set of technologies into the PFTT program, and maturation projects for these technologies are in various states of completion.   Seven projects were completed, and an additional three projects were terminated prior to completion. Six additional projects will be completed during FY11.

The Colorado Center for Renewable Energy Economic Development
In order to maximize the local economic impact of NREL's rich history and reputation in renewable energy and energy efficiency research, development, demonstration, and deployment, NREL is seeking to use its "convening power" to help harmonize economic development activities in Colorado, in partnership with the State. The Colorado Center for Renewable Energy Economic Development (CREED) is dedicated to the growth of the clean energy economy; the Center's programs will be a driving force to catalyze Colorado as the "Silicon Valley" of renewable energy.

CREED, which opened its doors in March 2011, acts as a convener and coordinator among Colorado clean energy organizations. The CREED facility provides space for Colorado clean energy organizations, regional incubators, and the small and growing clean energy companies they support. Each resident organization has its own charter, but all benefit from the synergy of co-location and access to the programs provided by CREED.

The Innovation and Entrepreneurship Center leads NREL's participation in CREED. Together with our partners, we work to deliver best-in-class programs that meet the needs of small and growing companies in the renewable energy space. These programs include both technical and business education, and training content, as well as providing opportunities for organizations, entrepreneurs, and investors to network.

Organizations participating in CREED include the:

- Governor's Energy Office (GEO) (satellite office)
- Colorado Renewable Energy Collaboratory (The Collaboratory)
- Colorado Office of Economic Development and International Trade (OEDIT) (satellite office)
- Colorado Cleantech Industry Association (CCIA)
- CleanLaunch Incubator
- NREL's entire Commercialization and Technology Transfer organization.

NREL provides an array of programs and services through CREED:

- Mentoring, education, business management, interaction with NREL staff, and networking opportunities to support the development and growth of clean energy companies
- Hoteling and meeting space for visiting professionals

- Event space for activities such as the CREED ACCEL series (a "pitch practice" workshop held monthly) and the CREED Entrepreneur Series (classes, workshops, and facilitated meetings with investors)
- A focal point to better leverage NREL expertise and facilities.

CREED is a centralized, coordinated, resource-rich environment in which the burgeoning Colorado cleantech industry can continue to grow and thrive.

DEPLOYMENT AND MARKET TRANSFORMATION

Over the past few years, NREL has adapted its strategy and approach to emphasize and build critical mass in analysis, outreach, tool development, and approaches to effectively disseminate decision-grade information to federal, state, and local government entities, as well as industry stakeholders. Defining and understanding attributes of a sustainable future energy system is helping us to accelerate large-scale adoption of proven technologies to meet national energy goals. NREL's Deployment and Market Transformation directorate is a centralized organization that works across the entire spectrum of energy efficiency and renewable energy technologies. This centralized approach leverages resources across NREL to create synergy and best practices across technical programs. Deployment and Market Transformation is structured around the two broad categories of clients served by NREL:

> **Two Elements of NREL's Deployment and Market Transformation Organization**
>
> *The Integrated Applications Center (IAC)* serves clients who have not yet determined a renewable energy technology approach or solution. These clients seek "technology neutral" guidance and may require an entire suite of decision support tools and processes to help them select technology solutions among options. This suite encompasses assessment, analysis, and project development support, including financing approaches. Typically clients of the IAC include communities, facility managers, and government agencies or personnel. The Technology Assistance Program and FEMP are examples of programs supported by IAC.
>
> *The Market Transformation Center (MTC)* serves clients who are already focused on specific renewable energy technologies. These clients require a different suite of tools and processes to help them accelerate the deployment of a family of technologies. Typically, MTC clients include companies in the technology supply chain and communities that have already decided on a given technology. Programs supported by MTC focus on removing barriers to implementation or adoption of a technology. Examples include Wind Powering America and Solar America Cities.

technology specific and technology neutral (see sidebar). NREL's entire deployment organization promotes efficiency and renewable energy solutions, regardless of where the solutions originated.

NREL continues to evolve its deployment and market transformation processes and approaches for partnering with governments and industry as we work to maximize our impact on the speed and scale of market penetration of energy efficiency and renewable energy.

Increasingly, NREL's deployment activities require NREL staff to branch out from the traditional lab environment to provide comprehensive implementation expertise, sustained "on-the-ground" technical assistance, and to facilitate networks in places where putting energy innovation into action is a top priority. NREL's goal is to have national impact through a deployment strategy of engagement and partnership with market stakeholders at a local level.

Non-Technical Barriers to the Adoption of Renewable Energy and Energy Efficiency

Numerous technical barriers to energy efficiency and renewable energy technologies exist in the market (cost, permitting, grid interconnection, etc.); these are well documented by DOE and NREL and are not summarized here. Instead, this paper focuses on non-technical barriers that NREL has determined to be the most significant impediments to achieving large-scale adoption of proven and cost-effective solutions. In this section, we have summarized the barriers that represent opportunities where partnerships between state and local agencies and DOE laboratories could have a significant impact on the implementation of energy efficiency and renewable energy projects.

Insufficient Capacity at the State and Local Level

In many situations, insufficient capacity creates several related and significant barriers to deployment of energy efficiency and renewable energy at the state and local level, where resources for energy issues compete with other public interests, such as economic, health, and safety needs. Many state and local energy offices are short-staffed and struggle to keep ahead of clean energy opportunities. Another hurdle is in developing the depth and breadth of skills or knowledge sufficient to bring about a systemic transformation, unless they engage outside support and expertise. Because of resource limitations, energy offices may lack the project management capacity to address or coordinate complex clean energy programs and initiatives across state-wide departments.

Effective programs at the state level also require energy champions who are empowered to make decisions and drive implementation of technologies at scale. The cyclical nature of state and local government systems can mean high turnover of staff and political appointees, which can hinder a sustained effort of deployment-related technical assistance and outreach activities.

In addition, the pace of change occurring in energy efficiency and renewable energy technologies, financing options, codes, standards, and regulations make it unrealistic for state and local agencies to stay abreast of all the current options available to them. "Information overload" hinders progress when too many resources lead to confusion about which sources are most applicable for state and local agencies, or whether the sources are credible and unbiased.

Inadequate Means to Access Expertise, Tools, and Know-How

Another ongoing challenge for state and local entities is the level of access and inadequate options for accessing the federal resources and experts available at, for example, a national laboratory. Complex policies and funding mechanisms both on the federal and the state and local sides present hurdles. Technical assistance programs provide a mechanism to access short-term assistance, but historically, the issue has been establishing agreements to facilitate long-term market transformation and deployment opportunities. National laboratories cannot adequately address the needs at the state and local level because of insufficient resource allocation. Overcoming this barrier requires a transition from a project-by-project approach to a more

efficiently delivered systems approach. Without a comprehensive and integrated agreement mechanism or strategy, capacity needed to meet the full spectrum of state and local needs remains limited and inadequate to fully support large-scale deployment.

Marketplace Status Quo

Setting the conditions for transformation of our energy systems involves fully engaging the marketplace, however, as in any situation of transformational change, overcoming the "status quo" can sometimes prove to be the greatest challenge of all. In the case of our energy system, the significant amount of investment required for a new infrastructure is difficult to mobilize in the face of great uncertainty. The financial and regulatory sectors understand the existing system and require technical and market expertise in advanced energy topics to effectively integrate renewable energy and energy efficiency into the existing energy system.

The town of Greensburg, KS is an example of what can be accomplished in the absence of the typical status quo barrier to replacing expensive infrastructure. When the infrastructure was literally destroyed by forces of nature, Greensburg started over, from the ground up, completely transforming its infrastructure in both energy efficiency and renewable energy, demonstrating effective partnering between the public and private sectors at a variety of levels.

Lack of a Framework about Roles, Metrics, and Goals for DOE Labs in Deployment

Traditionally, the primary measures of success for national laboratories have been tied almost exclusively to the quality of their scientific R&D accomplishments. Today, DOE labs must not only produce world-class scientific advances, but also must aid deployment and market adoption of proven, cost-effective technologies to help meet national goals.

To reflect its commitment to deployment, NREL has taken the initiative to introduce new metrics and goals into its performance plan. These new metrics and goals are described in the section called "Best Practices."

Human Factors and Limited Awareness of Energy Issues by the General Public

Human and social factors impede adoption, implementation, and acceptance of renewable energy and energy efficiency technology projects. Often, perceived advantages and disadvantages determine community support or opposition to development of both utility-scale and small-scale projects. Many organizations and individuals require economic incentives to take on these types of projects.

The generally low level of energy awareness is a related barrier to adoption. Many inaccurate, biased, or incomplete sources of information about energy and energy systems persist. This means the average layperson, or even a trained technologist, must distinguish facts from myths. The media can sometimes add credibility to an otherwise unreliable or biased source of information, but in an attempt to represent all views, may inadvertently contribute to inaccurate information.

Many important issues need to be clearly and accurately communicated to address human factors, increase public awareness, and create a motivation to change the way we produce and use energy. These issues are illustrated by questions such as:

- Where does energy come from and how is it made?
- What are the pathways for making electricity and fuels?
- What is a life-cycle assessment and why is it important?
- What are the true costs of various forms of energy?
- How sustainable are the various energy sources?
- What are the direct and indirect implications of using a given source of electricity or fuel?

Best Practices of Technology Deployment

NREL leads or plays a key role in more than a dozen federal programs and initiatives to accelerate deployment and market transformation. To support these federal programs, NREL staff members make extensive use of webinars, podcasts, video conferencing, and local stakeholder meetings and workshops. NREL maintains and makes available a large suite of information sources, websites, downloadable reports, and software tools to support state and local policy and decision making in government and industry. These online or mobile resources provide on-the-ground partners and NREL staff with the data and calculations that support deployment efforts anytime and anywhere.

A list of the most frequently accessed resources such as webinars, podcasts, workshops, web resources, and mobile applications are included in Appendix A.

Deployment Programs and Initiatives Supported by NREL

- ARRA – EECBG
- ARRA – Section 1603 (U.S. Treasury)
- Better Buildings Initiative
- Clean Cities
- EPAct and regulated fleet programs
- FEMP, including Federal Fleets
- Integrated Deployment
- Solar Market Transformation
- Recovery Thru Retrofit
- SEE Action
- USDA 9003, 9004, and 9007
- Wind Powering America
- Weatherization and Intergovernmental Programs, including TAP, WAP, and Workforce Guidelines

The following section describes NREL's best practices that support federal deployment programs and initiatives listed in the sidebar above. Similarly to the "Barriers" section, we focus here on the best practices that illustrate opportunities where partnerships between state and local agencies and DOE laboratories are having a significant impact on the implementation of energy efficiency and renewable energy projects.

Focusing on Stakeholders

NREL's deployment programs focus on identifying, understanding and meeting stakeholders' needs specific to their location. With the goal of identifying the right regional solutions for stakeholders, we access the depth and breadth of the lab's world-class technical expertise. Combining this expertise with a comprehensive understanding of regulatory, political, social, economic, and market issues, our teams identify the key local barriers and help stakeholders to overcome them. NREL identifies, helps to create, supports, and facilitates networks of champions in all sectors. The Clean Cities program exemplifies this approach (see side bar). This foundational focus on local communities and same methodology are evident in other programs such as Wind Powering America (WPA), Solar America Cities (SAC), and Integrated Deployment.

> **Clean Cities**
>
> An initiative of VTP, Clean Cities is a public/private partnership that provides regional coalitions, technical data, web tools, resources, implementation support, and coordinated strategies for voluntary, community centered programs to achieve maximum petroleum reduction. Clean Cities contributes to the energy, environmental, and economic security of the United States by supporting local decisions to reduce dependence on imported petroleum, and to identify mutual interests, meet objectives, develop regional economic opportunities, and improve air quality. The Clean Cities partnership consists of nearly 100 coalitions working with 8,400 local stakeholders and continues to grow in both size and success.

A driving principle of this approach is NREL's historical knowledge that enables our teams to anticipate needs and potential barriers based on past experience in the full spectrum of deployment programs. A process of continuous analysis, and sharing best practices and lessons learned guides future solutions and provides an ever evolving set of offerings, such as training, outreach strategies, decision-support tools, and replicable models for transformation at the local level.

Community Energy Tools Initiative

Community energy and sustainability planners have expressed a need for a comprehensive resource to aid in their energy planning process and energy transformation efforts. With the understanding of the challenges state and local entities face in accessing a national lab such as NREL, we are developing an online resource to assist communities to plan, develop, and implement sustainability projects, known as the "Community Toolkit."
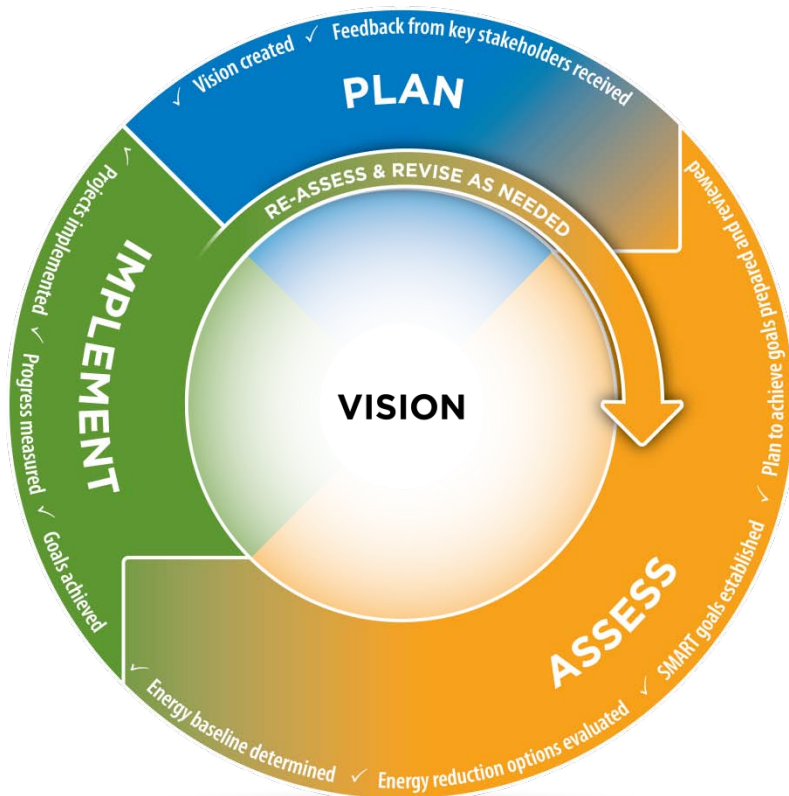
NREL'S PROCESS FOR ENERGY TRANSFORMATION

Figure 1: The underlying NREL process for supporting transforming energy systems as depicted here is the basis for our Community Toolkit.

This toolkit includes a searchable database of tools, case studies, and other technical resources intended to facilitate all aspects of these projects. The toolkit will also allow the user community to comment on the usefulness of the tool and contribute additional resources, fostering feedback and peer-to-peer exchanges. With continuous feedback from the users, the tools and other resources in the toolkit will be updated appropriately to effectively meet user needs.

NREL Forum and Dialogue

For the first time in 2010, NREL convened a Clean Power Futures Forum. Key decision-makers and stakeholder representatives gathered to discuss the issues, challenges, and opportunities the electricity sector faces in the 21st Century related to achieving high penetration of renewable energy and energy efficiency in the power sector as well as fuel and transportation issues. Participants remarked on the breadth of stakeholder perspectives, depth of sophistication and knowledge, and high energy level around the table. Given NREL's core mission, a key objective of the forum is to identify challenges and opportunities. Based on the positive response, NREL plans to make this an annual forum to help continuously refine and deepen our understanding of the challenges and opportunities associated with transformation the U.S. energy and fuel systems. The 2011forum will focus on the fuels and transportation sector.

Partnering with Governments

NREL recognizes that strong and productive partnerships with state, local, and federal agencies are essential to strategic deployment, innovation, and collaboration. Through combined efforts, NREL and its partners lead by example to implement, evaluate, and document projects, and thereby accelerate deployment through sharing of best practices. NREL employs a range of customized technical assistance mechanisms based on community and local market needs. When

a state or local community's need is highly technical and requires in-depth expertise, NREL delivers on-the-ground assistance and engages face-to-face with stakeholders. The need could be related to disaster response, as in Greensburg, KS, New Orleans, LA, or Haiti. Assistance often involves providing fundamental or in-depth technical knowledge, such as performing on-site assessments to determine best technology selection, design, and application or implementation of cost-effective and high performance projects.

NREL also provides technology-specific project financing and development webinars to reach out to large federal, state, and local audiences. These are accomplished through the Federal Energy Management Program (FEMP), Weatherization and Intergovernmental Program (WIP), Wind Powering America (WPA), Solar America Cities (SAC), and other DOE programs. NREL supports the U.S. Department of Agriculture (USDA) rural development deployment programs. We leveraged knowledge and experience from the lab's work with USDA to the development and support of the U.S Department of Treasury's ARRA Section 1603 Program that enables commercial entities to receive grants in lieu of tax credits for renewable technology projects. To date, the 1603 Program has issued $7.1 billion in grants and supported more than 10.5 GW of installed renewable electricity capacity.

NREL has also established outreach programs that bring key decision-makers and market influencers to the laboratory to help them better understand energy efficiency and renewable energy. An example is NREL's Executive Energy Leadership Program that provides an opportunity for non-technical decision-makers throughout the community to learn about technologies, analytical tools, and financing to help guide their energy related decisions and planning. NREL has received and is responding to requests to make this program available to other communities across the country.
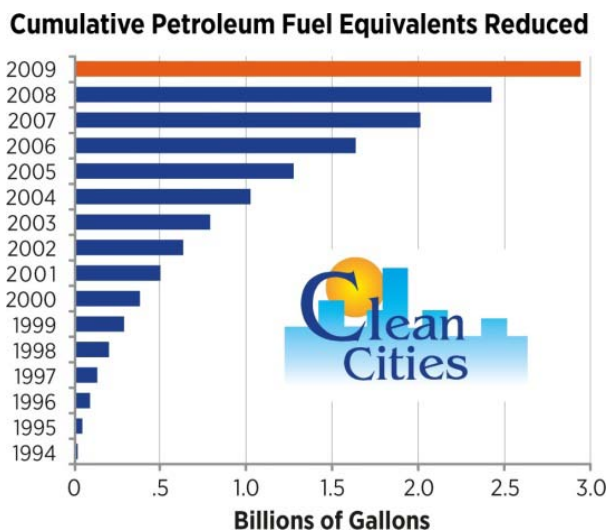

Figure 2. NREL metrics demonstrate that Clean Cities has saved nearly 3 billion gallons of petroleum from 1993 to 2009.

Measuring our Impact on Deployment: Metrics and Goals

NREL supports most if not all of EERE's deployment initiatives, and in many instances NREL has helped DOE create, design, and implement those initiatives, including Clean Cities, Wind Powering America, the Technical Assistance Program, Integrated Deployment, Solar Decathlon, and Solar America Cities.

NREL works closely with DOE to establish and then work toward aggressive market adoption targets agreed upon by DOE and NREL, and typically vetted with other stakeholders. These metrics and goals are then incorporated into the Annual Operating Plan (AOP) for that

deployment or market transformation program. For example, in Clean Cities, we have a CY2011 target to displace 611 million gallons of petroleum-based gasoline in our transportation sector. In Wind, we have an agreed-upon goal to help increase the number of states with a minimum of 100 MW of installed wind capacity, and to implement the Wind for Schools program in 11 states to support the training of university students.

The Alliance for Sustainable Energy works with DOE to measure the overall performance of the management and operations of NREL each fiscal year. Progress towards deployment objectives are tracked in specific areas including how NREL leverages the federal investment in deployment funding; customer satisfaction with deployment-related products, services, and assistance; and the laboratory's impact on accelerating market transformation.

Creating an Integrated Deployment Model

In 2007, DOE requested NREL to help New Orleans rebuild with more efficient building technology after Hurricane Katrina. That project led to several, even more comprehensive energy deployment projects, which has resulted in DOE and NREL developing an energy deployment approach that addresses the entire energy system for any given location. The model, called Integrated Deployment, has been developed and used at several locations, including cities, states, federal agencies, and island nations. To date, the model has been successful at any level and size as long as the major decision-makers and political leaders are committed to the effort. A common Integrated Deployment framework has evolved that enables a holistic approach and results in transformation of the location's energy system and energy usage.

Integrated Deployment accelerates market adoption of energy efficiency and alternative energy solutions to power homes, businesses, and vehicles through a comprehensive and aggressive approach. To address the complex challenges of the multi-technology and multi-stakeholder problem, NREL created a process that not only supports deployment of each technology area, but also looks at the integration of all the various technologies.

Hawaii Clean Energy Initiative: An Integrated Deployment Example

Goal: Achieve 70% Clean Energy by 2030 in Hawaii's homes, businesses, and vehicles through energy efficiency and renewable energy.

Results Since Initiated in 2008:
- 40% RPS and 30% EEPS by 2030 (passed in 2009)
- 400 MW of wind through undersea cables under development
- Electric-vehicle-ready grant and rebate program established
- Residential and commercial building energy codes brought up to date
- Net zero energy community built at affordable living prices.

CONCLUSION

NREL, as a national resource, has the expertise to influence and help transform the clean energy economy. NREL is working to speed the commercialization of new clean energy technologies to the marketplace and expand the scale at which proven clean energy solutions are used. NREL's commercialization and deployment activities employ an integrated approach to identify effective pathways to market and remove the barriers that impede successful adoption. We engage in a wide range of activities which are focused on to addressing existing barriers to technology transfer and market transformation. Our efforts support government at all levels, industry, small businesses, entrepreneurs, and renewable energy markets, among our many stakeholders.

To learn more about these activities and programs visit:

- NREL Applying Technologies web site: www.nrel.gov/applying_technologies/
- NREL Commercialization and Technology Transfer web site: http://www.nrel.gov/technologytransfer/
- EERE Deployment web site: www.eere.energy.gov/deployment/index.html
- EERE Energy Innovation Portal web site: http://techportal.eere.energy.gov/

APPENDIX A: SELECTED DOE AND NREL RESOURCES

The following provides a listing of resources developed by DOE and NREL that are frequently accessed to support deployment of energy efficiency and renewable energy efforts at the state and local level.

Analytic Tool and Resources

Software

BeOpt
The BeOpt tool is designed to identify the most cost-effective combinations of efficiency strategies for whole-house energy savings.
www1.eere.energy.gov/buildings/building_america/building_energy_optimization.html

HOMER
HOMER helps users design and analyze hybrid power systems, which contain a mix of conventional generators, cogeneration, wind turbines, solar photovoltaics, hydropower, batteries, fuel cells, hydropower, biomass and other inputs. This tool analyzes the variability of resources such as wind and solar and how they can be optimally integrated into hybrid systems.
www.homerenergy.com/

In My Backyard (IMBY)
This tool estimates the electricity that can produced with a solar photovoltaic (PV) array or wind turbine installed in a home or business. Homeowners, businesses, and researchers use IMBY to develop quick estimates of renewable energy production at locations throughout the continental United States, Hawaii, and northern Mexico.
www.nrel.gov/eis/imby/

Jobs and Economic Development Impact (JEDI) models
The Jobs and Economic Development Impact (JEDI) models help to estimate the economic impacts of constructing and operating power generation and biofuel plants at the local and state levels. JEDI analyzes concentrating solar power, photovoltaics, biofuels, coal and natural gas power plants.
www.nrel.gov/analysis/jedi/

PVWatts
NREL's PVWatts^{TM} calculator determines the energy production and cost savings of grid-connected photovoltaic (PV) energy systems throughout the world. It allows homeowners, installers, manufacturers, and researchers to easily develop estimates of the performance of hypothetical PV installations.
www.nrel.gov/rredc/pvwatts/

System Advisor Model (SAM)
A performance and economic model designed to make performance predictions for grid-connected solar, small wind, and geothermal power systems and economic estimates for distributed energy and central generation projects.

Maps and Atlases

NREL maps and atlases provide valuable insights into local conditions, including available resources and infrastructure, as well as potential demand.
http://www.nrel.gov/applying_technologies/maps_atlases.html

Find these resources on the NREL maps website:

BioFuels Atlas
An interactive map for comparing biomass feedstocks and biofuels by location.
http://maps.nrel.gov/biomass

Fleet Atlas
An interactive map used by federal fleets to find alternative fuel stations near their fleet vehicle locations.
http://maps.nrel.gov/fleetatlas

The Solar Power Prospector
 A mapping tool developed for the Solar Power industry. This tool helps developers site large-scale solar plants by providing easy access to solar resource datasets and other data relevant to utility-scale solar power projects.
http://maps.nrel.gov/prospector

Trans Atlas
Displays an interactive map of alternative fuel and vehicle data.
http://maps.nrel.gov/transatlas

Community and State Resources

Community Energy Strategic Planning Academy
Assistance for selected cities and counties to develop individualized, robust Community Energy Strategic Plans with concrete energy goals tailored for each community.
http://www.nrel.gov/applying_technologies/state_local_activities/cesp_academy.html

Community Greening: How to Develop a Strategic Energy Plan
(DOE/GO-102010-2826) February 2010. This is a step-by-step guide for city leaders who want to develop a strategic electricity plan using policies that encourage energy efficiency and use of renewable energy in their community.
www.nrel.gov/applying_technologies/pdfs/community_greening.pdf

Community Renewable Energy Development
This website provides case studies on five communities selected by DOE for renewable energy deployment projects in 2009. NREL provides the technical assistance to these communities to overcome a wide range of barriers to clean energy development.
www.eere.energy.gov/commercialization/communityre/index.html

Database of State Incentives for Renewables and Efficiency (DSIRE)
This comprehensive source offers information on state, local, utility and federal incentives and policies that promote renewable energy and energy efficiency.
www.dsireusa.org

EERE State Activities and Partnerships
This website provides links to state energy statistics, state energy publications and websites, and state resource maps.
http://apps1.eere.energy.gov/states/information_resources.cfm

Effective Community-Wide Policy Technical Assistance: The DOE/NREL Approach
Doris, Elizabeth (NREL/BR-6A42-48689) November 2010. Provides lessons learned and provides a step-by-step process for implementing effective policy assistance.
www.nrel.gov/applying_technologies/state_local_activities/pdfs/48689.pdf

Integrated Deployment Model: A Comprehensive Approach to Transforming the Energy Economy
Mary Werner (NREL/TP-7A20-49230). November 2010. This paper describes development of a comprehensive energy deployment approach that addresses the entire energy system for any given location. The Integrated Deployment model has been developed and used at several locations, including cities, states, federal agencies, and island nations.
www.eere.energy.gov/deployment/pdfs/49230.pdf.

Solar America Communities
Provides resources to help state and local entities integrate solar technologies into their communities.
www.solaramericacommunities.energy.gov/

State and Local Clean Energy Policy Analyses
This website provides resources that analyze the effectiveness of state energy policies, and evaluate the role of policy in clean energy development.
www.nrel.gov/CEPA

Tribal Energy Program
This Web site provides information about Native American renewable energy and energy efficiency projects that have been funded by DOE. It includes case studies, information on business opportunities and project financing, and other resources to help tribes with their energy projects.
http://apps1.eere.energy.gov/tribalenergy/

Technical Assistance Program Blog
This blog is a platform where the audience can learn from technical and programmatic experts and share best practices about their renewable energy and energy efficiency programs.
www.eereblogs.energy.gov/tap/

Technical Assistance Program Webinars
This site provides presentations on state and local clean energy policy analyses, project financing mechanisms, and applying renewable energy and energy efficiency technologies to drive market

growth.
www.nrel.gov/applying_technologies/state_local_activities/webinars.html

Technical Assistance Solution Center Services
This is a portal through which SEP and EECBG recipients can access a network of experts for assistance with their renewable energy and energy efficiency policies and programs.
www1.eere.energy.gov/wip/solutioncenter/technical_assistance.html

Federal Assessment Tools and Training

The Federal Energy Management Program (FEMP) provides several resources for federal agencies that also have applicability for state and local agencies. Visit www.eere.energy.gov/femp/index.html.

Software
The Building Life-Cycle Cost (BLCC)
This program analyzes capital investments in buildings.
www.eere.energy.gov/femp/information/download_blcc.html

EnergyPlus
This simulation program helps building designers and owners save money, reduce energy and improve indoor air quality.
www.eere.energy.gov/femp/information/download_energyplus.html

FEDS 6.0
The Facility Energy Decision System provides a comprehensive integrated resource planning approach to selecting technologies with a minimum life-cycle cost.
http://www1.eere.energy.gov/femp/information/download_feds.html

WATERGY 3.0
A spreadsheet model that uses water/energy relationship assumptions to analyze the potential of water savings and associated energy savings.
www.eere.energy.gov/femp/information/download_watergy.html

Training
FEMP offers extensive selection of online training and topical webinars to help energy managers increase this knowledge and expertise on the latest energy requirements, best practices, and technologies.
http://apps1.eere.energy.gov/femp/training/

Technology Resources

Buildings

Building America

This program provides guidance for reducing energy use in existing and new homes, including the DOE Building America Guides that show how to achieve 40% energy savings in various climates. www1.eere.energy.gov/buildings/building_america/

Fuels and Transportation

Alternative Fuels and Advanced Vehicle Data Center

The Alternative Fuels and Advanced Vehicles Data Center (AFDC) provides a wide range of information and resources to enable the use of alternative fuels, in addition to other petroleum reduction options such as advanced vehicles, fuel blends, idle reduction, and fuel economy. Visit: www.afdc.energy.gov.

Find these resources on the AFDC:

Data Downloads

Allows users to download raw data from the database.
www.afdc.energy.gov/afdc/data_download/

Diesel Exhaust Fluid Locator

Allows users to search for diesel exhaust fluid distributors using Google maps.
www.afdc.energy.gov/afdc/locator/def/

Fleet Experiences Search

Pulls fleet experience stories for display by category, fuel/technology type, and application.
www.afdc.energy.gov/afdc/fleets/fleet_experiences.html

Fuel Properties Search

Allows user to create a custom chart of fuel properties by selecting from a list of fuels and properties.
www.afdc.energy.gov/afdc/fuels/properties.html

Heavy-Duty Vehicle Search

Find and compare heavy-duty alternative fuel vehicles, engines, or hybrid propulsion systems and generate printable reports.
www.afdc.energy.gov/afdc/vehicles/search/heavy/

Incentives and Laws Search

Allows users to browse and search the database of federal and state laws and incentives.
www.afdc.energy.gov/afdc/laws/

Light-Duty Vehicle Search

Find and compare light-duty alternative fuel vehicles and generate printable reports.
www.afdc.energy.gov/afdc/vehicles/search/light/

Petroleum Reduction Planning Tool
Allows fleets, consumers, and business owners to create a strategy to reduce fuel use. Users can login as a guest without a password or register to create and save their scenarios.
www.afdc.energy.gov/afdc/prep/index.php

Related Links Search
Returns a list of related links stored in the database by category.
www.afdc.energy.gov/afdc/related_links.html

Publications Search
Allows users to search the citations database of thousands of documents.
www.afdc.energy.gov/afdc/progs/pubs.php

State Information Search
Allows users to select a state from the map to display state-specific information about that state.
www.afdc.energy.gov/afdc/states/

Station Locator
Allows users to search for alternative fuel stations using Google maps.
www.afdc.energy.gov/afdc/locator/stations/

Stations Custom Query
Allows users to create a custom query to search for alternative fuel stations.
www.afdc.energy.gov/afdc/fuels/stations_query.html

Station Counts
Creates a listing of alternative fuel station counts by state and fuel type.
www.afdc.energy.gov/afdc/fuels/stations_counts.html

Truck Stop Electrification Site Locator
Allows users to search for truck stop electrification locations using Google maps.
www.afdc.energy.gov/afdc/locator/tse/

Videos
Displays a list of videos by category or allows the user to use a search feature to find a specific video.
www.afdc.energy.gov/afdc/videos/

Clean Cities

Clean Cities advances the nation's economic, environmental, and energy security by supporting local actions to reduce petroleum consumption in transportation. A national network of nearly 100 Clean Cities coalitions brings together stakeholders in the public and private sectors to deploy alternative and renewable fuels, idle-reduction measures, fuel economy improvements, and emerging transportation technologies. Visit cleancities.energy.gov.

Find these resources on the Clean Cities website:

Clean Cities Coalition Locations
Displays a map of Clean Cities coalition locations with a listing of coalitions below the map generated from the coalitions database table.
www.afdc.energy.gov/cleancities/coalitions/coalition_locations.php

Clean Cities Coordinators
Displays a listing of Clean Cities coordinators and their contact information from the database.
www.afdc.energy.gov/cleancities/coalitions/coalition_contacts.php

Clean Cities Solicitations
Pulls the Clean Cities solicitations list for display on the web page.
www.afdc.energy.gov/cleancities/current_opportunities.php

Wind

Wind Powering America
Wind Powering America is a nationwide initiative designed to increase the use of wind energy across the United States by working with regional stakeholders. State-by-state breakdowns of wind resource potential, success stories, installed wind capacity, news, events, and other resources are updated regularly. Visit www.windpoweringamerica.gov/.

Find these resources on the Wind Powering America website:

Agricultural Sector, Native Americans, Schools, Economic Development and Policy Resource and Tools
These pages list resources and tools for specific wind development sectors. As an example:
www.windpoweringamerica.gov/agricultural/tools.asp

News and RSS Feeds
Provides access to Wind Powering America electronic newsletter subscription and RSS feeds.
www.windpoweringamerica.gov/news/

Resources and Tools
Provides links to wind maps, wind energy videos, podcasts, publications, news, wind-related events, and past events with which Wind Powering America was involved.
www.windpoweringamerica.gov/tools.asp

State Wind Activities
Provides a clickable map of state level Wind Powering America activities.
www.windpoweringamerica.gov/state_activities.asp

Success Stories
A listing of Wind Powering America success stories
www.windpoweringamerica.gov/success_stories.asp

Wind Working Groups
A clickable map provides contact information about states that have wind working groups.
www.windpoweringamerica.gov/wind_working_groups.asp

Wind Resources
Provides high-resolution wind maps and estimates of the wind resource potential that would be possible from development of the available windy land areas after excluding areas unlikely to be developed.
www.windpoweringamerica.gov/wind_maps.asp

Wind for Schools
This goal of this project is to install small wind turbines at rural elementary and secondary schools (hosts) while developing Wind Application Centers at higher education institutions.
www.windpoweringamerica.gov/schools_wfs_project.asp