Sowing the Seeds of Savings: Lessons from Vermont's Work to Develop and Deploy New Savings Opportunities

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ABSTRACT

The energy efficiency industry needs to invest in emerging opportunities (defined as emerging technologies, emerging services, and new program strategies) in order to attain increasing savings targets in the face of rising baselines. However, efficiency program administrators face several structural barriers to doing so, including requirements that all expenditures are deemed cost-effective and deliver immediate energy savings. Several jurisdictions, including Vermont, Northwest California, New York and others, have established policies and programs to identify, test, and bring to market emerging opportunities, and in doing so have developed new energy-saving measures for their programs and for the industry as a whole.

In this paper, we first make the case for investments in emerging opportunities by describing the changing landscape in which DSM programs operate. Then, we identify the policy underpinnings that have made Vermont's investments possible, and provide recommendations for other jurisdictions on how to establish similar programs. Next, we share case studies from Vermont, focusing on the Efficiency Vermont Applied Research and Development (R&D) Program, a facet of the program portfolio that is unconstrained by cost-effectiveness requirements that is funded at 0.3% of the overall energy efficiency program budget. We describe the outcomes of that program, highlighting how these small investments have generated new savings for customers. Recommendations include the need for policy makers to establish stringent, comprehensive, and binding state energy goals, to set aside funds for emerging opportunities work, and to demand a focus on innovation to solve the biggest challenges facing customers.

The Case for Investing in Emerging Opportunities

Investing in the next generation of energy efficiency technologies, services and strategies (collectively referred to as emerging opportunities in this paper) has never been more important. Rapid increases in federal, state and municipal building energy codes for new commercial and residential construction, as well as mandates for increased levels of energy efficiency in existing buildings are pushing energy efficiency program administrators to identify and develop technology roadmaps for achieving aggressive energy goals. Increases in baselines established by federal appliance and equipment standards and building codes simultaneously provide a cost-effective means to increasing and locking in energy savings nationally, while also imposing a cost-effectiveness hurdle for efficiency program administrators to introduce the necessary, albeit typically higher incremental cost of emerging opportunities for achieving longer term comprehensive energy reductions.

Metrics for evaluating the potential for emerging energy efficiency technologies are no longer limited to simple energy or demand savings, but also in evaluating bi-directional

communications to shift peak loads and act as active energy storage devices to support high penetration renewables. Individual technologies and whole buildings become new opportunities for program administrators to address the forecasted demands on and changing landscape of the utility infrastructure.

Increasing Savings Targets for Programs

Despite rollbacks in Energy Efficiency Resource Standards (EERS) in Indiana and Ohio in 2014, there remain 24 states with electric EERS policies and 15 states with gas EERS standards. Several of these standards require incremental increases in energy efficiency generated over time. For example, Arizona regulations required energy savings of 1.25% of sales in 2011. These will ramp up to 2.5% in the 2016-2020 time period, with a cumulative annual electricity savings target of 22% of retail sales by 2020. Similarly, the Massachusetts Plan for the 2016-2018 energy efficiency programs requires electric savings of 2.93% of retail sales and natural gas savings of 1.24% of retail sales.

Vermont recently released its 2016 Comprehensive Energy Plan, which set state goals to reduce the total energy consumption per capita for buildings, processes and transportation by 15% by 2025 and more than a third by 2050. Additionally, the plan requires renewable energy increases to 25% by 2025 and ultimately 90% by 2050 of total remaining energy used in the state. In order to achieve parallel reductions in greenhouse gases, total energy reductions will be coupled with dramatic shifts away from traditional fossil fuel-based space and water heating and towards new technologies – e.g. heat pumps – and high penetration renewables. These transitions will also require the incorporation of "smart" technologies and the development of low energy load commercial and residential buildings.

Another potential element of increasing savings targets for energy efficiency program administrators is the Environmental Protection Agency's Clean Power Plan (CPP). In February 2016 the Supreme Court placed a stay on implementation of CPP until legal challenges are resolved, creating significant uncertainty about whether the CPP will be implemented. Despite these recent developments, some states including Pennsylvania have pledged to move forward and complete its planning process with the CPP providing a new framework for states to use in considering new or additional investments in energy efficiency. It has spurred a national dialogue on the importance of lowering the carbon intensity of our power sector and on the benefits of energy efficiency and renewable energy investments.

Rising Baselines Increase the Focus on Emerging Opportunities

State and local building energy codes and state and federal appliance and equipment standards lock in technology evolution and energy savings over time. Currently, the U.S. Department of Energy's (DOE's) Appliance and Equipment Standards Program "covers more than 60 products, representing about 90% of home energy use, 60% of commercial building energy use, and 30% of industrial energy use." Since 2013 the DOE has finalized 21 new or higher efficiency standards covering a broad range of applications including heating, cooling, lighting, motors and appliances. Despite achieving reductions of over 70-75% in energy usage of some major household appliances over the last 25 years, the average price of those appliances has decreased and performance and features have increased.

Lighting has been an important component of energy efficiency programs in both the residential and commercial sectors for decades, and thus, warrants special attention in a

discussion of minimum energy performance standards. In 2007, the Energy Independence and Security Act (EISA) established a series of increasing minimum energy performance standards for general service lamps that began to take effect in 2012 and that established a backstop provision for energy efficiency in 2020 of 12-44 lumens per watt, depending on lamp wattage. In February 2016, the US Department of Energy (DOE) released a notice of proposed rulemaking to revisit the 2020 backstop that proposed levels ranging from 6-20 lumens per watt. This is a significant increase in performance compared to the assumed backstop performance standard. While the rulemaking process will take some time to complete, it is clear additional changes in the lighting market and further reductions in lighting energy savings estimates are on the horizon.

In addition to the recent developments in lighting, DOE issued new standards for commercial rooftop air conditioners and heat pumps in December 2015. These standards will result in the largest savings of any single minimum energy performance standard ever developed, and will save $1.7 trillion kWh over 30 years of product sales. These new standards will be phased in starting in 2018 with a 10% efficiency improvement and then culminate with a 25-30% improvement in 2023.

State building codes are also increasing, with significant impacts on energy efficiency programs. Vermont adopted new statewide residential and commercial building energy standards in March 2015 based on the 2015 International Energy Conservation Code (IECC) with state amendments. A more aggressive standard, known as Vermont's "Stretch Code," was also introduced in 2015 for residential buildings for voluntary adoption by municipalities. In addition to requiring significant increases to shell and heating system efficiency of buildings, the Stretch Code also includes test and verification requirements, ENERGY STAR qualified mechanical systems, renewable energy, and electric vehicle charging capabilities.

A Case Study: Vermont's Recipe for Emerging Opportunities

Strong Policy Enables Investments in Emerging Opportunities

Beginning in 2012, as a result of the Vermont Demand Resource Plan Proceedings, a new budget category named "Non-Resource Acquisition" (NRA, which is now called Development and Support Services) was created to advance Efficiency Vermont's and the Public Service Board's (Board) energy efficiency policy objectives. This budget category was intended to fund projects outside of those designed to immediately reduce energy consumption or peak demand. These NRA budget categories include Education & Training, Planning and Reporting, Evaluation, Policy and Public Affairs, Information Technology, Administration, and Applied Research and Development (R&D). The last of these categories is the topic of this paper and consisted of Smart Grid / Advanced Metering Infrastructure and Technology Demonstrations. NRA expenditures, in categories such as R&D, are not expected to directly lead to energy savings that can be claimed immediately, but potentially may be in the future as savings targets increase.

Even before the development of the NRA budget, Efficiency Vermont had historically made modest investments in R&D (for example, testing the eMonitor system for in-home display of energy usage); the objective of this new investment was to enable Efficiency Vermont to remain at the cutting edge of energy efficiency approaches that show potential to generate future energy savings. Beginning in 2012, Applied R&D funding has supported research, development, and demonstration designed to optimize the creation of cost-effective solutions for meeting

Efficiency Vermont's long-term resource acquisition goals. Efficiency Vermont plans these activities to advance the goals of sound product and program design over time, focused on three areas:

1. Field-testing new implementation strategies
2. Technology demonstrations
3. Research on emerging technologies and innovative energy efficiency implementation strategies

R&D activities are crucial to long-term resource acquisition. As the Board noted in Finding 125 of its November 2009 Order in Docket 7466:

> *The non-resource acquisition compensation mechanism provides an appropriate funding vehicle for required EEU long-term planning activities. The non-resource acquisition compensation could be used to support EEU research and analysis of innovative or alternative program designs or models being used in other states or countries. (Fratto pf. at 5 and 8)*

Efficiency Vermont reports on project plans each year as part of its Annual Plan process, sharing incremental results of this research in Quarterly Report narratives and the final results are included in the Annual Report. For those projects that have particularly impressive results or result in completed pilots, white papers are posted to EfficiencyVermont.com. During the inaugural 3-year performance period of 2015-2017, Applied R&D spending totaled approximately $570,000 or 3.3% of the total electric and thermal efficiency budget for Efficiency Vermont. While this is a very small amount compared to the overall Efficiency Vermont program budget (and is dwarfed by R&D budgets of many publically-traded companies and utilities), these funds enable the program to pursue new savings opportunities that it would otherwise be unable to fund, and, as a result, are a critical part of the program portfolio.

Emerging Opportunities Work Occurs within a Larger Context

Sustained development of emerging opportunities requires a strategy for development from ideation to commercialization, as well as a support structure composed of residential and commercial building codes, state and federal appliance and equipment standards, and progressive efficiency programs that allow the flexibility to adopt new technologies and accelerate commercialization.

Efficiency Vermont continues to refine its programmatic approach to develop a comprehensive strategy to achieve Vermont's Comprehensive Energy Plan (CEP) goals for low energy use homes and buildings. In addition to aligning with the broader goals set forth in Vermont's 2016 CEP, Efficiency Vermont has developed longer term, sector-based strategies for the residential, commercial, industrial, agricultural and more recently – transportation sectors. These strategies include maps of how customers can interact with the program over time (see graphic below) and are the basis of forming strategic trade ally partnerships with innovative manufacturers, retailers, distributors, contractors and builders. These trade ally relationships have become critical for piloting new technologies and initiatives and evaluating their performance and effectiveness in Vermont.

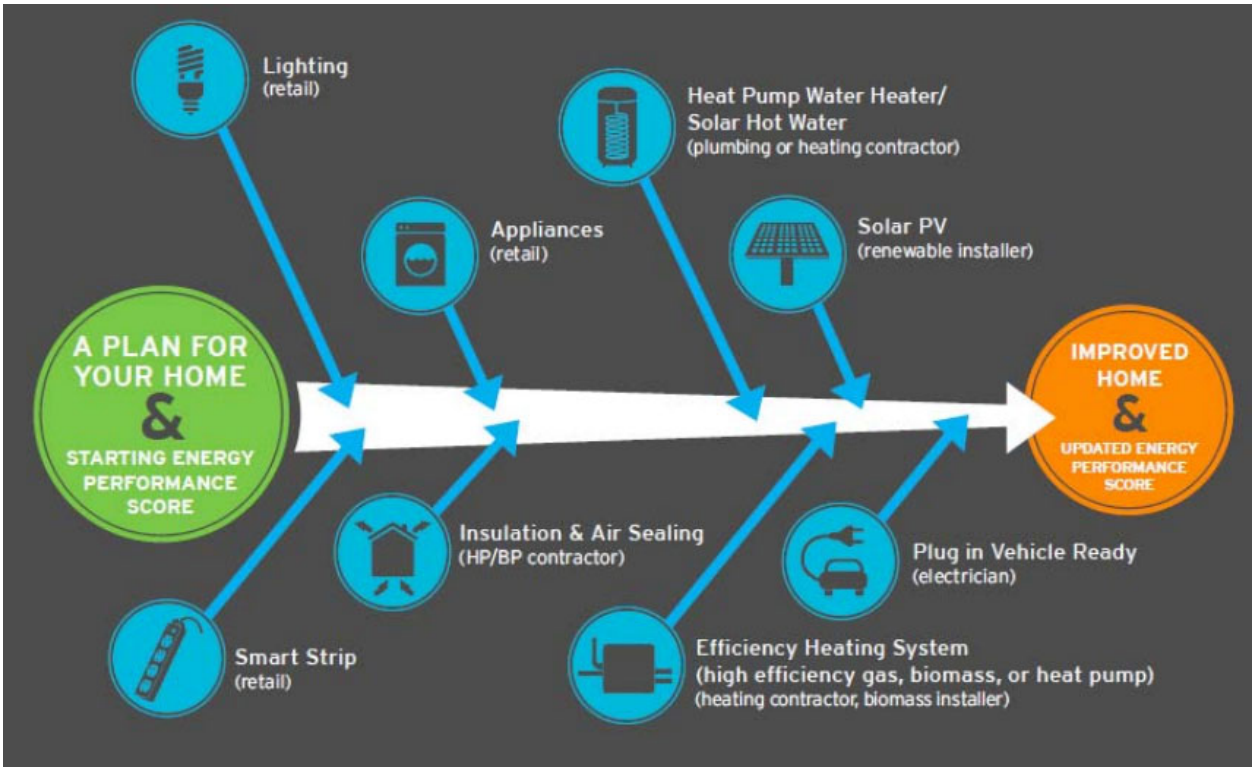

Figure 1. Energy Performance Roadmap for Improved Residential Homes. *Source*: Efficiency Vermont 2015.

In addition to our sector-based planning in concert with the Vermont CEP goals, Efficiency Vermont also acts opportunistically as needs arise; the program's investments in low energy use homes was one borne of necessity. In 2011, flooding from Tropical Storm Irene devastated 15 percent of Vermont's manufactured homes and highlighted the need to find solutions to address both the affordability and resilience against future climatic events. Efficiency Vermont partnered with affordable housing providers and other key stakeholders to design, build, and properly site a new kind of high-performance modular home in the footprint of a manufactured home, known as the Manufactured Home Innovation Project. Built to the highest construction standards, and sited on a foundation, these homes balance higher purchase costs against significantly lower operating and lifetime costs when financed and valued as real property. The presence of a long-term strategic plan for low energy use homes and the availability of Applied R&D funding enabled the program to meet that challenge through a discrete focus on emerging opportunities.

Portfolio Approach to Emerging Opportunities Yields Benefits

In 2015 and 2016, Efficiency Vermont targeted a comprehensive portfolio of 19 Applied R&D projects that spanned all market sectors (residential, commercial, industrial, transportation and agricultural). The individual projects represent a broad range of new technologies, services, and program strategies, provide savings for both electric and thermal end uses, target both existing and new buildings and equipment, and include transportation energy savings opportunities. Examples of specific Applied R&D projects during 2015 and 2016 include:

- Low-E Storm Window Replacement Pilot

- Mapping Total Energy Burden in Vermont Predictive Control Strategies for Building Management Systems
- Low-Cost, Residential-Scale Remote Metering for Solar Water Heating
- Predicting Whole-house Thermal Performance with Smart Thermostats

Using the Manufactured Home Innovation Project as an example, it is clear that our approach of thinking broadly about emerging opportunities is used at the project level as well as the portfolio level. There are several diverse aspects to our work on this project, including establishing a path to net-zero homes, determining how best to incorporate renewables, and broadening strategies to target embodied energy consumption, water consumption, and indoor air quality. These strategies included developing ground-up redesigns of HVAC systems, evaluating and field testing new technologies including cold climate heat pumps and heat pump clothes dryers, and establishing a comprehensive initiative to promote the design, construction, operation, and maintenance of high- performance, low-load residential buildings.

Partnerships with Trade Allies are Essential

In addition to taking a portfolio approach to ensure that all sectors and end uses are covered, we have also been deliberate in building strategic partnerships with key industry stakeholders to support emerging technologies, services, and strategies. This has started with the early stages of research and pilot program design and has extended through full program implementation of energy savings initiatives and public/private partnerships.

An example of the key manufacturer partnerships that Efficiency Vermont developed is with cold climate inverter-driven heat pumps. In 2011, Efficiency Vermont partnered with Mitsubishi and Fujitsu in evaluating cold climate heat pumps within the context of the Manufactured Home Innovation Project. Although inverter-driven heat pumps are almost conventional in 2016, during the original design process in 2010-2011, the technology was still undergoing performance evaluations in cold climates and was not included in Efficiency Vermont's existing HVAC programs. Following the evaluation of heat pumps in the closely monitored high performance home projects, cold climate heat pumps were further evaluated in existing homes as a supplemental heat source through a separate Efficiency Vermont Applied R&D project. The promising results of both evaluations in both new construction and existing homes led Efficiency Vermont to initiate the process for further expansion of the cold climate heat pump technology in residential and commercial programs. Efficiency Vermont worked with product manufacturers closely throughout all phases of the work.

Clear Process for Screening Ensures Best Investments are Made

Efficiency Vermont's New Product Development (NPD) process provides the critical transitional path to take a new technology, service, or strategy from early evaluation and pilots into the broader program portfolio. Efficiency Vermont's Applied R&D program utilizes the idea solicitation and screening portions of the NPD process, but products that go further in NPD endure an additional level of rigor on the market and technology evaluation through research, analysis, program deployment strategies, and early market pilots. As part of the NPD process, staff conduct market analysis including gathering costs and available evaluation data. These inputs are critical to forecasting the program's cost-effectiveness, necessary program investment (both financial and staff time), and corresponding energy and demand savings that the specific

technology, service, or strategy can generate. At this stage in the process, a more in-depth customer mapping exercise is completed to provide a plan to effectively support the market launch. Absent these key planning stages, a new initiative or technology can often be poorly received by program managers and/or the targeted market – resulting in limited program impacts and possible loss of the emerging technology or opportunity into the "chasm" between the early adopters and the mainstream market.

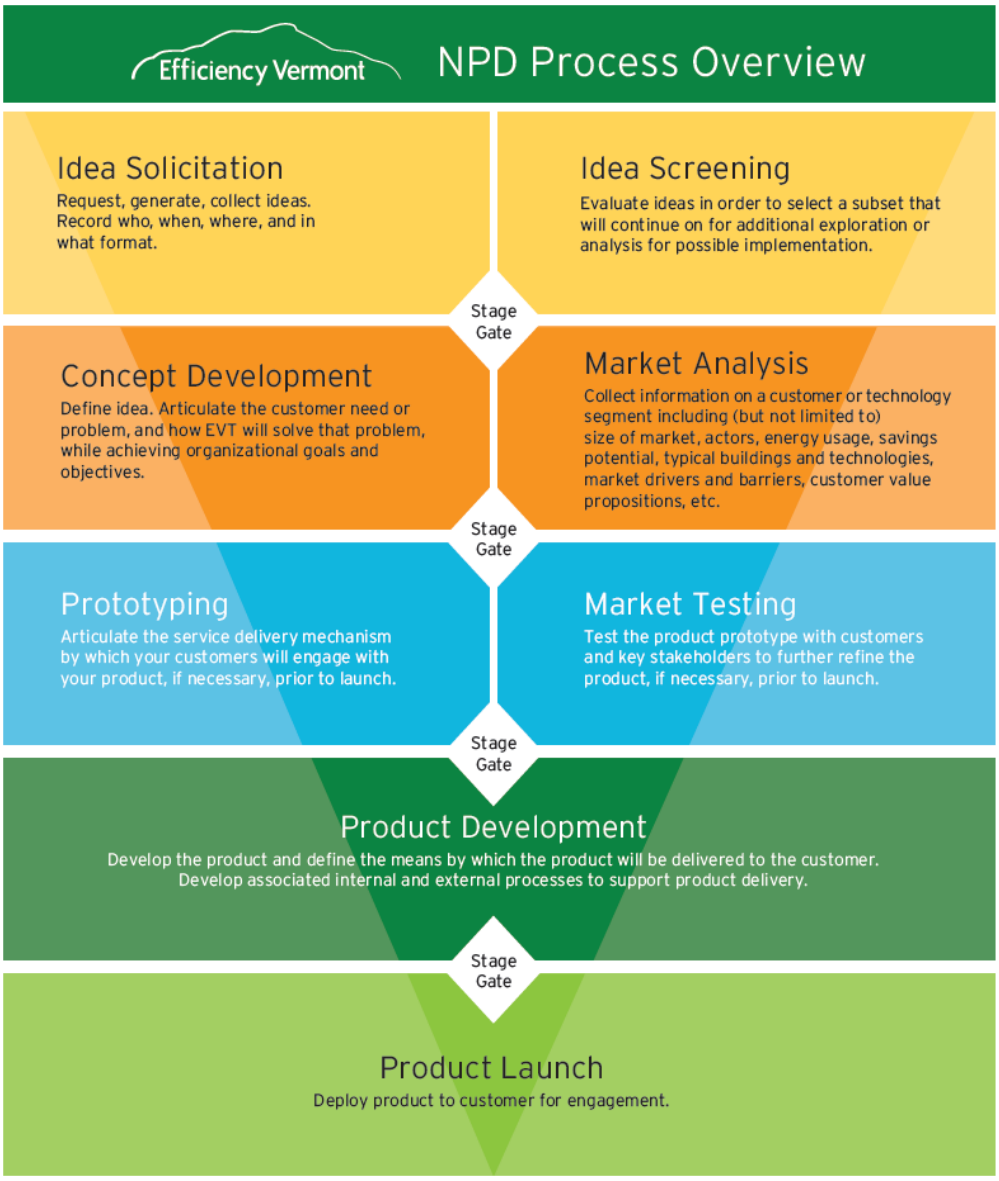

Figure 3. Efficiency Vermont New Product Development Process. *Source*: Efficiency Vermont 2015.

Building a Coalition of Efficiency Programs, Industry and Key Market Actors

Early identification of the key barriers to an emerging technology, service or strategy can provide important insights into the necessary partners for successful market development. In the case of the Manufactured Home Innovation Project, Efficiency Vermont initially partnered with the Vermont Housing & Conservation Board – a quasi-state agency that funds affordable housing and land conservation projects – and the High Meadows Fund – a foundation that "promotes vibrant communities and a healthy natural environment while encouraging long term economic vitality in Vermont." However, this coalition was broadened with the establishment of a working group and project partners that included affordable housing entities, state and private financing organizations, high-performance home builders, the University of Vermont and other key stakeholders. Ultimately Efficiency Vermont pulled together a team with the breadth of knowledge to deal with full range of tasks and issues in front of the pilot program associated with the design (architectural, structural, mechanical, site-work, etc.), permitting and zoning, financing options and appraisals, partner relations, and legal agreements.

Similarly, the partnership with technology manufacturers, efficiency programs and Northeast Energy Efficiency Partnerships (NEEP) has resulted in the development of Cold Climate Air-Source Heat Pump (ccASHP) specification to ensure seasonal high efficiency even at extremely low ambient temperatures experienced in Vermont and other cold climate regions. In addition to collaborating to compile the lab and field evaluations of cold climate heat pumps to inform specification development, NEEP and several northeast utility and statewide efficiency programs coordinate effective program development, market engagement and state policy strategies. One of the key barriers in Vermont to unlocking the broader adoption of heat pumps to offset fossil fuel use for space heating was state legislation restricting Efficiency Vermont to only utilize the limited non-electric funding across its program portfolio. Collaboration between the state legislature, the governor's office, Efficiency Vermont and other energy efficiency advocates resulted in 2014 legislation specifically allowing Efficiency Vermont to utilize electric funding to support the market development of heat pumps in residential and commercial applications.

Efficiency Vermont extended its engagement with other efficiency programs nationally and in Canada in 2016 through its participation in the Consortium for Energy Efficiency's (CEE) new Emerging Technologies Collaborative (ETC). Efficiency Vermont membership in the ETC provides a forum to build a broader coalition of state and utility efficiency programs, networking and opportunity to share early market or technology evaluations and to increase the scale of the market opportunity and engagement with the industry.

Snapshot of Results to Date

In 2016 tangible results of the Applied R&D program pipeline are found in the following developments:

- Creation of a Northeast cold climate specification for ductless heat pumps
- Rapid acceleration of Efficiency Vermont's Upstream HVAC program and partner utility leasing programs of cold climate heat pumps
- The launch of Efficiency Vermont's High-Performance Home Certification program
- Successful public/private partnership with Vermod, a Vermont based manufacturer of super-efficient modular homes

In addition to the successful launch of these initiatives, the Applied R&D program continues to provide other advances in technologies and strategies. Building on the existing relationships developed through prior Applied R&D projects and Efficiency Vermont programs, in 2016 Efficiency Vermont will be evaluating Mitsubishi's new multifunction heat pumps in existing high performance modular homes. The objective of the project is to evaluate whether the multifunction heat pump could serve as a higher efficiency and potentially lower cost solution for a single space and water heating system compared to the separate ductless mini-split and heat pump water heater (HPWH) – while eliminating the HPWH's parasitic load on the conditioned space.

Recommendations for Other Programs

Direct Funding Toward Emerging Technologies, Services, and Strategies

Regulators can and should establish modest funding pools to research emerging opportunities. Often program funding for larger projects may include opportunities for evaluating new technologies or strategies. Additional funding opportunities from foundations, state agencies, foundations and industry partners can supplement smaller direct program investments.

The Department of Energy (DOE) Build Technologies Office (BTO) provides direct research and funding for the early identification, research and deployment of new technologies and strategies offering significant energy savings for commercial and residential buildings. Both the DOE and Environmental Protection Agency ENERGY STAR roadmapping initiatives provide opportunities to identify both areas of focus and opportunities for partnership with industry on new technologies, services and strategies.

Develop a Comprehensive Strategy from Ideation to Commercialization

In addition to Efficiency Vermont, the Bonneville Power Authority, CEE Emerging Technology Collaborative and other emerging technology programs can provide blueprints for developing a comprehensive strategy from ideation to commercialization. Critical initial steps in this process are the original screening, market analysis and rigorous evaluation of early pilot initiatives. Additional steps around market strategy, cost-effectiveness analysis and forecasting adoption rates, program costs and energy savings are important for program development.

Absent having a deliberate path for the development of an emerging opportunity, individual technologies, manufacturers and the broader efficiency industry will not recognize efficiency programs as a true partner for market development.

Build Alliances within the Efficiency Community and Disseminate Results

The early investment in emerging opportunities can provide both an incremental individual benefit to the state or utility territory, but also provide an aggregated benefit to national initiatives to advance markets. Program funding should include time and resources for information dissemination.

Regional and national organizations including the Bonneville Power Administration's Energy Efficiency Emerging Technology (E3T) initiative, the California Emerging Technologies Coordinating Council (ETCC), the Northwest Energy Efficiency Alliance Conduit, the Northeast

Energy Efficiency Partnerships, and the Consortium for Energy Efficiency Emerging Technologies Collaborative support a collaboration among efficiency programs, key industry stakeholders, and government agencies to support long term market development. They serve as valuable forums for sharing results and speeding the adoption of new technologies and program designs across the industry.

Testing new technologies in different climates and markets can provide valuable insights for the development of informed specifications and to improve manufacturers' products. Both the successes and failures of individual efforts – market strategy, building technologies and systems and efficiency services – provide useful insights for efficiency program evolution.

Value Rigorous Evaluation

Regulators can ensure accountability by requiring reporting on what has been achieved with these funds, as well as minimum levels of evaluation for individual projects. Developing a staged approach to project evaluation to allow for both early ideation development and more in-depth market and program development is important. The scale of risk and reward to programs from cost and energy savings typically reflects the scale and depth of evaluation.

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