Designing a Pilot Program to Encourage Net-Zero Energy Commercial Buildings

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ABSTRACT

Energy Trust of Oregon's Path to Net Zero pilot supports owners and builders of commercial new construction and major renovation projects who are constructing buildings of exceptional energy performance and pursuing a net-zero energy building standard. The program was launched in May 2009. Through this pilot, Energy Trust offers incentives and technical support for early design, design, installation, commissioning and post-occupancy monitoring and reporting. By implementing the pilot, Energy Trust seeks to understand the design process needed for net-zero energy building, the design features and technologies that can be used to achieve significant energy savings, the incremental costs of constructing highly efficient buildings and the tools and resources needed to inform and motivate owners and designers.

Energy Trust recognizes the growing momentum towards net-zero energy buildings and, with its program management contractor PECI, has crafted an incentive offering specifically catered to these highly unique projects. In order to determine the amount and type of additional support needed for net-zero projects, Energy Trust and PECI consulted with specialists in the building development, design and construction industry, as well as program implementers and building science experts. Through these conversations, program staff identified key barriers to net-zero energy building and challenges for program design and implementation. Program staff utilized the lessons learned through research and interviews to develop the Path to Net Zero pilot, which is among the first programs in the nation to provide comprehensive incentive offerings and program support for projects pursuing a net-zero energy building standard.

Background

Conceptualizing a Net Zero Pilot

Energy Trust of Oregon is a non-profit that administers energy-efficiency and renewable energy incentive programs to electric and gas customers of Pacific Power, Portland General Electric, Northwest Natural Gas, and Cascade Natural Gas. Energy Trust’s new commercial construction program, the New Buildings program, provides incentives and technical support to new buildings, major renovations and tenant improvement projects. Since 2003, the New Buildings program has offered a range of financial incentives and technical support to various project types, from simple buildings with prescriptive measures, to complex buildings using whole-building energy modeling, to buildings that are LEED®-certified or earn the U.S. Environmental Protection Agency (EPA) ENERGY STAR®.

The program aims to help project owners achieve energy efficiency beyond the requirements of the Oregon energy code. In January 2009, Oregon Senate Bill 79 directed the Building Codes Division to institute a 15 to 25 percent increase in the energy-efficiency requirements for nonresidential buildings, as compared with 2007 requirements, by 2012. The Building Codes Division responded to this directive with the 2010 Oregon Energy Efficiency Specialty Code, which strives to reduce energy use by 15 percent, thus making the Oregon energy code one of the most stringent in the nation. In order to help Oregon's design and development community meet and exceed these requirements in the coming years, Energy Trust seeks to encourage increasingly innovative building design strategies and technologies.

Nationwide, the goal of reducing energy use in buildings in pursuit of net-zero has become an aspiration for initiatives such as the Architecture 2030 Challenge, Cascadia Region Green Building Council's Living Building Challenge, the U.S. Department of Energy's Commercial Building Initiative, and California's Long Term Energy Efficiency Strategic Plan. Though few net-zero commercial buildings have been successfully built to this point, these challenges have inspired select developers, nonprofit organizations, schools, and governments to pursue construction of net-zero buildings in Oregon.

Energy Trust wants to support these ground-breaking projects with incentive offerings and assistance that can help them meet the unique challenges they face. In developing the Path to Net Zero pilot, Energy Trust defined the following goals: 1) encourage building designers to gain experience with innovative design principles and techniques; 2) provide incentives for cost-effective efficiency technologies and operations strategies that can be used to aggressively reduce energy consumption in a variety of buildings; 3) monitor performance to measure success and inform building operations; and 4) identify challenges and solutions and incorporate these findings into the steady-state program offerings.

Identifying a Pilot Development Process

In January 2009, the New Buildings program team, including staff members from Energy Trust, PECI, and SERA Architects, began developing the pilot by identifying four areas for program involvement. These areas of interest became the four pilot offerings: early design, technical analysis, installation of efficient measures, and post-occupancy monitoring. Because a number of net-zero and high-efficiency projects in Energy Trust's territory were eager to take part in the new pilot, Energy Trust decided to rollout the program in four stages corresponding to the four offerings throughout 2009, beginning in May. This provided a dual-benefit to participants and the program: participants were able to enroll earlier and take advantage of early design assistance, and the program was able to spend more time developing and fine-tuning the offerings while gaining experience working with real projects.

To support the development of each pilot offering, the program team identified stakeholders in the design and construction community who could provide insight into the barriers facing net-zero building projects and suggest ways Energy Trust could provide assistance and support. These stakeholders included architects, engineers, developers, energy analysts, building science specialists, green building consultants and implementers of other energy efficiency programs. With the help of these stakeholders, the pilot development team identified major barriers to constructing a net-zero energy building and identified support solutions for program intervention.

Barriers and Solutions for Achieving Net Zero

A net-zero building must use no more energy than it produces throughout the year on average[1]. Any energy load in the building must be offset with onsite renewable energy generation. Because onsite

[1] The National Renewable Energy Laboratory defines net-zero goals in four ways: net-zero site energy, net-zero source energy, net-zero energy costs, and net-zero energy emissions (Torcellini et al. 2006). For the purposes of the pilot, Energy Trust encourages net-zero site energy buildings, defined as buildings that generate all of the energy that they consume on site on an annual basis. This definition was chosen because it is most similar to how Energy Trust presently tracks resource acquisition goals and is relatively easy to monitor.

generation, usually solar photovoltaics, is typically expensive and space-constrained, the team must reduce the energy use of the building as much as possible while still maintaining the function of the building. For many buildings, this requires energy-use reductions of 50 to 80 percent below common practice. Seeking deep energy savings on that scale requires innovative designs to reduce loads, as well as intelligent use of technology to meet the occupants' needs with minimal energy input. Project teams are challenged by a number of barriers along the road to net zero. These barriers and Energy Trust's offerings for Path to Net Zero pilot projects are described below. See Table 1 for an overview of Energy Trust's incentives and assistance for pilot projects compared to regular Custom Track program offerings.

Table 1: Energy Trust Program Offerings Comparison

Design Phase	Path to Net Zero Offerings	Regular Program Offerings
Early Design	$10,000 for integrated design charrette	$2,500 for project team meeting with less-extensive topic and attendance requirements
Design	$0.10/kWh and $0.80/therm, up to $50,000; scoping meeting assistance prior to modeling; availability of funding for additional energy-related studies	$0.05/kWh and $0.40/therm, up to $25,000
Construction	$0.20/kWh and $1.60/therm, up to $500,000; commissioning required	$0.10/kWh and $0.80/therm, up to $500,000; additional commissioning incentives available
Post-Occupancy	$5,000 for whole-building monitoring and additional $0.20/sq. ft. for subsystem monitoring, up to $30,000	$1,000 - $3,000 for earning the EPA ENERGY STAR®

Process Barriers

In a conventional design process, the owner defines the building's use and spaces for the architect, who then designs the structure with a focus on meeting the owner's use requirements. The architect then hands the project to the engineer who considers the building's location, orientation, and use in determining the energy load and designs building systems to meet that load. The contractor then proceeds to construct the building, often making equipment choice trade-offs to cut costs for the owner. When construction is complete, the building is occupied and operated by a set of people who have rarely been involved in the design and construction process. This practice segregates the disciplines and defines a narrow scope of influence for each of the participants.

Stakeholders consulted during the development of the Path to Net Zero pilot agreed that using an integrated design process was important for high-efficiency design and critical when designing a net-zero building. The entire design must be influenced by the owner, architect, engineer, occupants, building operator, contractor, energy analyst and commissioning agent. Each of these people plays a critical role in the development and use of the building, so each must understand and be committed to the energy goals for the building and each must contribute their expertise throughout the design process. In integrated design, the building is seen as an interrelated system where choices in one area can strongly influence the performance of another. For example, in selecting the site, orientation and space layout of the building, engineers can advise on the climatic conditions and their impact on heating and cooling loads for various parts of the building. The lighting designer, architect, engineer, solar installer and general contractor can work together to optimize roof space between daylighting, mechanical equipment and solar panels. Understanding how the building's systems and design features interrelate is critical to achieving significant energy-use reductions.

The cost of an integrated design charrette depends on the people involved, the preparatory work done for the charrette, and the time spent at the charrette and during follow-up. Stakeholders indicated that a good charrette with numerous team members attending could cost $10,000 per day or more, and some charrettes last for several days. Pre-charrette studies, such as a bioclimatic analysis of the site or box modeling, can add great value to the charrette but cost thousands of dollars. Because integrated design requires additional time from the design team, there is often a tension between the owner's desire to keep a project moving forward quickly and their commitment to following an integrated process and involving multiple parties for each decision. As the pressure to speed up development increases, the time cost of integrated design becomes more expensive to the owner.

To encourage and support an integrated design process, Energy Trust and PECI created an incentive of $10,000 for project teams to hold an energy-focused integrated design charrette. For the owner to receive the funding, the charrette must be attended by a wide range of participants and must cover substantial energy topics, including climate conditions, typical energy end-uses for the building type, energy efficiency strategies, on-site renewable energy options, and operation and maintenance considerations. During the pilot development, stakeholders acknowledged that some of the desired participants may not be identified or available for the charrette but that it is still valuable to have someone representing that point of view. The program allows this type of substitute representation for the pilot projects receiving charrette funding. For example, a building operator for a similar building type could attend and provide input at the charrette if the actual building operator had not yet been identified.

Design Approach Barriers

Another barrier to creating a net-zero energy building is the relative inexperience of design team members with net-zero design techniques. Few design professionals have hands-on experience with the innovative building design strategies that are needed. Strategies such as passive ventilation, night flush, advanced daylighting, heat exchange and thermal massing are complex to design and the outcome is difficult to predict. Whole building energy modeling is often undertaken after the project is well beyond the design process. If the model shows that the project is not reaching the energy use goal needed to be net zero, it can be difficult and expensive, if not impossible, to adjust design elements at that late stage in the process.

Stakeholders in the pilot development recommended that when designing a highly efficient building, the energy model must be used as a design tool. One developer mentioned that modeling a building for aggressive efficiency strategies requires hundreds of runs and parameter inputs and that the modeler needs to be available for calculations even before building the model. Stakeholders also identified the value of other simulation modeling and technical studies that are not typically undertaken for a conventional project. Projects seeking to utilize natural ventilation and thermal massing to minimize or eliminate mechanical ventilation and cooling systems can simulate space conditions using computational fluid dynamics modeling. Daylighting can be maximized using studies that investigate light shelves, skylights, and window placement. By increasing on-the-job experimentation and the number of design iterations, the design team can gain valuable experience with these strategies and can help the owner feel confident that the building will meet the dual goals of occupant comfort and energy efficiency.

To increase opportunities for pilot projects to experiment with strategies and involve energy modelers throughout the design process, the program offers technical assistance support and incentives. The program partners with the Energy Studies in Buildings Laboratory (ESBL) at the University of Oregon to consult with the project teams on advanced design strategies and simulation options. A program engineer conducts a scoping meeting with the project energy analyst to discuss how to best model the baseline and proposed buildings and accurately capture the energy savings from complex strategies and technologies. The program also provides an incentive of up to $0.10 per kWh and $0.80 per therm, up to $50,000, to support whole building energy modeling and any other energy-related studies.

Cost Barriers

Highly efficient building designs that approach net zero must overcome the law of diminishing returns in order to be cost-effective. Many energy measures used to gain efficiencies in buildings become increasingly expensive as the efficiency gains decrease. High-performance buildings can surpass this cost barrier by reducing or eliminating building systems which have a high capital cost and intensive energy use.[2] To do this, project teams strive to adopt passive design principles such as a super-insulated shell, passive ventilation, and thermal massing to maintain comfort with minimal mechanical intervention. These techniques require more expense and iteration during design, but can ultimately save the project money. Anecdotal evidence from one of the architects participating in the pilot indicates that buildings with passive systems can have a similar cost per square foot as other similar-type buildings while saving significant energy. In a study on the cost of buildings modeled to meet the Living Building Challenge, which has net-zero energy use as just one of seven far-reaching goals, the authors found that the cost premium for various building types in Portland ranged from only 4 to 34 percent (Cascadia et al. 2009)[3]. .

While reducing the size of mechanical equipment is beneficial, the greatest gains come from eliminating these systems altogether. However, both owners and designers perceive they are taking a risk in down-sizing or eliminating systems and relying instead on innovative designs and new technologies that many have no experience with. The risk is often greatest for the project owner, who ultimately wants a building that is not just efficient but is ultimately profitable because it is easy to operate, inexpensive to maintain, and comfortable for the occupants.

In order to help owners overcome these cost and risk barriers, the program offers an incentive for the estimated energy savings at a rate that is twice the incentive offered to projects in the general New Buildings program. For project owners who construct the building according to the final energy model, Energy Trust offers $0.20 per kWh and $1.60 per therm, up to $500,000. The program conducts a site visit of all projects to ensure the measures are installed as described in the model.

Barriers to Effective Operations

Optimizing Control Strategies. In order to maximize energy savings to the point of achieving net zero, building designers frequently utilize complex control strategies to ensure no energy-using systems are operating unnecessarily. For example, daylighting controls sense the light level in a space and reduce electrical lighting use or adjust shading devices accordingly. Occupancy controls use sound, heat, or light to determine if a space is unoccupied so that lighting, equipment, electrical sockets, or even heating and cooling systems can be turned down or off. To prevent over-ventilation of spaces with varying occupancy levels, demand control ventilation senses the amount of carbon dioxide in a space and adjusts the ventilation to just meet the need. Many mechanical heating and cooling strategies require controls that sense the temperature outside and inside the building and adjust building operations, such as outside air intake, warm-up operations, and night flush. However, these complex control strategies must be accurately installed to function. Sensors must be properly located and calibrated, and building automation control sequences must

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[2] In Natural Capitalism, Hawken and his co-authors present this concept as “tunneling through the cost barrier” (Hawken et al. 1999).

[3] The authors estimated that a mid-rise office building in Portland could be built to Living Building standards for $263/sq. ft., 24%-29% more expensive than a comparable building, while a university classroom could be built for $337/sq. ft., only 4-9% more expensive than a comparable classroom.

be accurately programmed and tested. Commissioning is an important step to ensure the proper functioning of any building, but it is especially critical in a net-zero building, where every kilowatt-hour conserved is a kilowatt-hour that does not have to be produced onsite.

To help ensure energy efficiency savings are realized, the program requires commissioning for all Path to Net Zero pilot participants. Projects must commission the building utilizing a qualified commissioning authority who has experience with the commissioning protocol and associated deliverables outlined in ASHRAE Guideline 0: Commissioning Process. The commissioning authority is responsible for creating a commissioning plan, reviewing construction documents when they are 50 and 90 percent complete, reviewing all change orders that occur during the project, conducting commissioning and equipment testing, and creating a commissioning report. At minimum, projects must commission all variable performance measures for which they request incentives.

Ongoing Operations. The quest for net zero does not end once a building is built, commissioned and occupied. In order to be net zero, the building must operate efficiently year after year. The green building and energy efficiency communities acknowledge that high-performance and green buildings often do not perform as expected.[4] To maintain efficient operations, the building operators need to be able to monitor the energy use of the building at a level that is understandable and provides enough detail to help diagnose problems. In addition, design teams need feedback from high-performing buildings to be able to compare actual to predicted performance and inform future efficient designs.

However, selecting an appropriate monitoring system can be complex. Project teams must determine the goals of the monitoring: are they monitoring performance for internal goals, operational improvement, educational opportunities, or to achieve a particular certification? They must also consider the level of detail required for the data: time intervals can range from seconds to months, and the data can be collected at the whole-building level, by systems (lighting, HVAC, plug loads), or by subsystems (fans, pumps, etc.). Then the team must seek out various components for the monitoring system: meters and monitoring devices, a data acquisition system to collect the data, a gateway to transmit the data to a central database, and software for analyzing and using the data collected (New Buildings Institute 2009). A dizzying variety of energy information systems tools are available with a wide array of capabilities, from simple displays of usage and energy cost data, to fault detection and diagnostic tools that identify potential issues and suggest causes and remedies. Many project teams have little experience with most of the tools and software available, so selecting a system can be daunting.

The monitoring and reporting assistance for Path to Net Zero pilot projects is designed to help owners and operators achieve the targeted level of energy savings by gaining actionable information about their buildings' performance so they can diagnose operational issues and make adjustments to improve performance. Because the pilot incorporates a wide variety of project sizes and building types, Energy Trust and PECI designed an incentive offering that sets a minimum requirement while still encouraging teams to strive for more in-depth monitoring and reporting capabilities. Projects in the pilot are required to establish at least whole-building 15-minute interval data for electric consumption or one-hour interval data for natural gas consumption, as well as for on-site renewable energy production. By monitoring at these intervals the owner can utilize the data to diagnose scheduling problems and other inefficiencies that wouldn't be apparent through monthly whole-building monitoring alone. Participants must prepare a monitoring and reporting plan during design and construction documents and must be able to report this data electronically to the program for 18 months following occupancy.

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[4] In a study of 121 LEED®-certified buildings, New Buildings Institute found that over half had measured energy usage that deviated from the projected energy usage by 25% or more (Turner et al. 2008).

The program provides a Monitoring and Reporting Applications Guide that helps to inform participants on basic monitoring and reporting concepts, describes energy performance tracking tools and common features, and provides references to additional monitoring resources. The program also provides a Monitoring and Reporting Plan Template that offers a basic outline for a monitoring plan and includes sections on project information, monitoring approach and objectives, corrective action planning, and metering and performance tracking system costs. Conversations with stakeholders during the pilot development made it clear that staying engaged with projects during the 18-month period following occupancy is crucial to ensuring that monitoring systems are working as intended and that the data reported is being used to appropriately assess performance and diagnose operational issues. The program will meet with projects on a quarterly basis for the 18-month period, reviewing data and reports and advising on any operational or monitoring issues that arise. Experience gained from projects at this phase will inform future program offerings as they pertain to monitoring to enhance savings persistence. Currently, non-pilot participants are not required to submit post-occupancy monitoring data to Energy Trust unless they apply for incentives for earning the ENERGY STAR, and then the data is only reviewed for the purposes of approving the incentive payment.

In addition to technical support, the program provides an incentive to help cover the costs of setting up a monitoring system. The program will pay up to $5,000 to help cover equipment and labor costs to upgrade to interval meters and the installation costs and monthly subscription fees for an energy performance tracking system. For projects that set up subsystem monitoring of at least one system, the program provides an additional incentive of $0.20 per square foot, up to a combined maximum of $30,000.

Implementation Challenges

Through the development of the pilot and the first year of implementation, Energy Trust and PECI have identified several implementation challenges that were addressed.

Determining Eligibility Criteria

The program acknowledged from the beginning of the pilot development that the goal of net zero would be difficult to achieve, even for the most experienced and dedicated teams with the simplest building types. Of the net-zero buildings currently operating in the U.S., most are community spaces or classrooms, and most are smaller than 15,000 square feet (United States Department of Energy 2010). Building types with intensive energy uses, such as labs, hospitals and restaurants, have faced difficult hurdles trying to reach net zero. Likewise, buildings over four stories are challenged by having a low roof-to-floor ratio, making it difficult to meet the building's energy loads with on-site solar. Different climates also mean unique challenges for creating highly efficient buildings. Energy Trust wants to promote net-zero for all building types across the state, so the program created eligibility requirements that allow projects to be on the *path* to net zero, rather than requiring participating buildings to achieve net zero.

During pilot development, the program asked stakeholders what threshold could be used to indicate that a building is on the path to net zero. Some stakeholders advocated for setting an energy use target, such as twenty kBtu per square foot; however, this approach presents challenges. The pilot aims to encourage buildings of all types to strive for net zero, but achieving a particular energy use index (EUI) target is more difficult for some building types and easier for others. The program considered setting EUI targets by building type. However, even within a similar building type, energy use can range widely and the issue is compounded for mixed-use buildings. Using existing building data, national data, or available tools like EPA's Target Finder was determined to be insufficient for establishing the baseline of a new building built to Oregon code, which is significantly more stringent than most other states. Using an EUI target that was reduced from a typical code building was also not practical, since much of the equipment in buildings today is not governed by code; one restaurant built to code could use significantly more energy on a square-foot basis than another code restaurant. In order to evaluate energy savings beyond Oregon code, the program needs to establish baseline energy use that is specific to the building being considered.

Energy Trust New Buildings provides incentives for energy savings that exceed Oregon energy code. Projects in the program's custom track create a model of their proposed building and compare it to a model of their building if designed to only meet code requirements. The two models are compared measure by measure to determine energy savings and incentives are awarded accordingly. To demonstrate savings for the pilot program, these models are developed by the project teams. These models are used to determine the improvement over the code building. This method allows the energy achievements to be objectively measured across differences in building type, location, and individual building uses.

During interviews, stakeholders agreed that achieving 40 to 50 percent energy savings beyond the 2007 Oregon energy code was the tipping point where projects would need to consider radical designs[5]. They noted that a project could earn the maximum number of LEED® credits for energy efficiency with 42 percent efficiency beyond an ASHRAE baseline (baseline and number of points varies depending on the version of LEED). Two engineers stated that savings of 50 to 60 percent beyond 2007 Oregon energy code essentially requires unconventional designs such as ground-source heat pumps.

The pilot intends to encourage energy efficiency first, with a secondary focus on renewable energy installations. Therefore, the program created two energy goals in the eligibility requirements: the project owner must be committed to designing and constructing a building with site energy usage that is at least 50 percent better than code through energy efficient design and energy conservation measures, and at least 60 percent better than code through any combination of energy efficiency and on-site renewable energy generation. Percent savings beyond code must be calculated in kBtu to capture both electric and gas energy savings. Before a project can be enrolled, the owner must commit to these energy goals. To ensure projects continue to meet this eligibility requirement, the program assesses the project after each incentive stage. After the early design charrette, the program reviews the charrette report; after the energy analysis is complete, the program reviews the whole-building energy model; after construction, the program verifies the installed measures on site. If a project is falling substantially short of the energy goals at any of these stages, the program can transfer it to one of the regular New Buildings offerings and it is no longer eligible for the enhanced incentives.

In an effort to maximize influence and learning, the program is involved from an early stage. In order to enroll in the pilot, projects must be in the schematic design stage or earlier, though exceptions have been made for projects in contact with the program prior to rollout of the pilot. By engaging projects in early schematic design, the program does risk dedicating time and resources to projects that could be delayed or cancelled. In fact, several potential and enrolled projects are currently on hold while the owner seeks additional funding. However, the program still believes that it is essential to engage design teams during the early incubation period of the project or it is not possible to achieve the goals of the pilot.

Screening for Cost-Effectiveness

Stakeholders consulted during the development of the pilot expressed concerns that net-zero projects will have difficulty meeting Energy Trust's cost-effectiveness criteria. Energy Trust evaluates all measures individually for cost-effectiveness using formulas that take into account the costs and benefits to society and to the utility. Only measures that pass these tests are eligible to receive incentives. Three major issues were identified in relation to Energy Trust's cost-effectiveness screening requirements: 1) the high incremental cost accompanying emerging energy efficiency technologies could overpower energy benefits; 2) due to the

[5] The program compared building energy use to the 2007 Oregon energy code because most of the pilot projects will be permitted under that code.

interactivity of measures in these highly efficient buildings, the energy savings and incremental costs attributable to an individual measure can be difficult to determine; and 3) designs that remove major building systems (e.g. passive cooling strategies), can have a negative incremental cost resulting in a simple payback of less than one year.

To address these challenges, Energy Trust has created a more liberal framework to evaluate which measures are eligible for incentives in the pilot. The program always allows projects to incorporate non-energy benefits into the cost-benefit calculations. In addition, for pilot projects the program considers a measure on the margin of cost-effectiveness if: 1) there are significant and well-defined, although difficult-to-quantify, non-energy benefits, 2) if the measure leverages other cost-effective actions, which in combination are cost-effective, or 3) if the measure is part of an Energy Trust-approved market transformation effort that forecasts decreases in cost that justify early expenditures (e.g. some LED lighting technology).

In recognition of the highly interrelated nature of high-performance and net-zero buildings, the program allows project teams to bundle some measures for cost-effectiveness screening, provided they are interdependent by design, cost and energy savings. Examples of measures that are considered for bundling include: 1) architectural features and window glazing selections that facilitate daylighting control strategies and enhanced lighting design, 2) improvements to the building envelope that reduce heating and cooling loads and thereby impact HVAC equipment selection and/or equipment sizing, and 3) a cooling system designed to provide ventilation and cooling through a combination of natural ventilation and supplemental mechanical cooling. In the last example, the supplemental mechanical cooling system sizing and operation is highly dependent on the natural ventilation design, and is difficult to assess independently.

Typically, Energy Trust only provides incentives for measures with a simple payback of one year or more. For this pilot, the program allows incentives for measures or measure bundles that have zero or negative incremental costs but may have technical and risk barriers, or require significant design-related costs and risks that are not easily quantified. Solar photovoltaic systems are not required to meet cost-effectiveness criteria to earn Energy Trust incentives. Such incentives are prescriptive, offered on a dollar-per-watt basis. The integration of solar photovoltaic systems into the building in ways that provide additional benefits, such as shading, heating, daylighting glazing or water heating, are encouraged to maximize energy production and energy savings, thus enhancing the overall cost-effectiveness of the solar installation.

Paying Incentives for Non-Regulated Loads and Behavioral Measures

To make a building increasingly efficient, designers typically focus on reducing heating, cooling, mechanical, and lighting loads. As these are reduced, process and plug loads become an increasing percentage of the building's energy use and must be addressed. Process loads are often not dictated by code and therefore are challenging for the program and the project team when determining the appropriate baseline. Plug loads, such as the energy use from electronic equipment, appliances, and task lighting, present challenges for project teams estimating and then reducing the energy use as well as for the program valuing those savings appropriately.

Several projects enrolled in the pilot are considering incorporating a commercial kitchen. When determining if a project uses 60 percent less energy than a code building, the project team could theoretically use the same kitchen equipment in both the baseline and proposed models, since commercial kitchen equipment is not governed by Oregon energy code. However, the program wants to encourage energy reductions across all uses of the building, so it created special requirements for commercial kitchens and other process loads. Projects in the pilot have two options for modeling a commercial kitchen: 1) the kitchen may be excluded from the energy model, provided that the project uses efficient equipment specified by the California Food Service Technology Center or incentivized through the New Buildings prescriptive program; or 2) the project may incorporate the commercial kitchen loads into the energy model in order to capture energy savings from innovative design strategies, such as maximizing heat recovery from exhaust heat from vent hoods. In this case the design team must work closely with the program to establish appropriate assumptions for kitchen equipment loads in the baseline energy model.

Plug loads present one of the largest challenges for all buildings participating in this pilot. As much as 20 to 25 percent of a code building's energy is used by plug loads. Aggressively reducing regulated (non-plug) building loads can result in a design where plug loads that represent 50 to 60 percent of the building's energy use. Decisions about plug loads are usually left to the owner or occupant. The selection of plug load equipment or control strategies often happens parallel to the design and construction process, with minimal interaction between the two.

Pilot project owners are working with future occupants and the building design team to come up with innovative ways to control plug loads. Owners of office spaces are considering reducing the number of copy centers by centralizing the printing resources and sometimes sharing them amongst tenants. Most of the project owners in the pilot require that the occupants purchase the most efficient office equipment and appliances available and implement any energy savings features on the equipment. One strategy being used by several of the project teams is to incorporate a color-coded plug system in which one plug color indicates a circuit controlled by an occupancy sensor or time clock, and another indicates a circuit that is permanently on. Other owners want to limit the types of equipment that can be brought into the building, for example by banning space heaters and window air conditioning units. Several projects are hoping that a monitoring system can provide user feedback that will motivate users to conserve energy. This can be further encouraged through the use of contests, peer pressure, and financial incentives from the owner to the occupants.

The program wants to encourage creative efforts to lower plug load energy use, but many of these strategies rely on occupant behavior to realize the energy savings. Energy Trust typically offers incentives only for measures that have measureable, proven, long-lasting energy savings. The program is working individually with projects to identify plug load reduction measures that have quantifiable energy benefits and are likely to persist in real operating conditions. Measures that can meet these qualifications, such as a two-colored wall plug system or equipment purchasing agreements that are written into leases, can be eligible to receive incentives for estimated energy savings. Measures that are hard to quantify or are easily rejected by the building's users may, at the program's discretion, be counted towards the overall energy goals of 60 percent better than code, but will not be eligible to receive incentives. In that case, the project team must work to develop a plan for measuring the success of these measures throughout the 18-month period following occupancy, using sub-system monitoring, occupant surveys, or observed-behavior studies.

Conclusion: Lessons for Net Zero Program Designs

From the development and early implementation of this pilot, several lessons can be drawn for future programs that support the design and construction of net-zero commercial buildings. First, program developers should consult stakeholders in their community prior to determining the program requirements, assistance and incentives. The development of this pilot was greatly influenced by the advice of local experts. Many of the suggestions and warnings they offered have proven to be valuable for implementation.

Next, programs should consider how to stage and release the offerings. This pilot was developed in stages, enrolling projects before the final offerings were determined. This had the advantage of allowing projects to access early design offerings sooner and gave the program team real-world projects to test ideas with. However, nearly all aspects of creating a high-performing building benefit from early consideration, including commissioning and monitoring. By determining all requirements and assistance prior to enrolling projects, a program could more effectively influence participants in all these areas.

Net-zero incentive programs should plan to spend increased program and engineering time supporting the projects. Projects aiming for far-reaching goals and attempting new designs need frequent interaction with the program to make sure they are on the right track. Program engineers supporting the Path to Net Zero pilot attend charrettes, conduct scoping meetings, and iterate with energy analysts through detailed reviews of energy models, measuring cost-effectiveness, and monitoring and reporting plans. Program staff are frequently asked to attend project team meetings and discuss design and measurement and reporting options.

Similarly, programs working with high-performing buildings must be flexible with requirements and timelines, and must listen to project teams to understand their concerns and barriers. Each project team has a unique set of challenges to overcome, from gaining early buy-in and support from the whole team, to engaging funders in the net-zero vision, to addressing tenant needs. By remaining closely engaged with the projects, program staff can anticipate and appropriately handle unique circumstances. Maintaining flexibility for project assistance and incentive timing can present a challenge from a budgeting and forecasting perspective, especially since the projects are likely to have large incentives and savings. Programs can help to mitigate this risk by remaining in close contact with each project team, though setting aside a special pool of funding for net zero initiatives could offer more flexibility for project management.

Programs should consider ways to provide incentives earlier in the design process. Though this puts the program at risk for paying incentives for projects that don't succeed, the early support and commitment is critical for project teams to be successful. Careful vetting of project teams and their commitment to net zero can help to mitigate the risk to the program.

Programs should consider how to provide enhanced support for projects that may not make it all the way to net zero. Many teams may begin with a goal of net zero and find that they cannot achieve it. Though the ultimate goal of the program may be net-zero energy buildings, the lessons learned by not-quite net-zero buildings are equally valuable. Incorporating any project with radical energy savings into the program will help support experimentation and increase the knowledge of design professionals and the experience of developers in the community.

Monitoring of highly efficient buildings is critical to learning from these projects, but simply requiring monitoring may not be enough support for projects. The array of options, expense of systems, and lack of experience of the team and owner make building monitoring a challenge. Financial support and technical assistance are needed to ensure that the monitoring goals of the project and the program are met.

Programs seeking to encourage net-zero buildings should seek out additional tools and resources for the project teams. Where gaps exist, materials should be developed internally or by partnering with other organizations. Project teams appreciate the consultation of experts and are motivated by stories of their experience with other successful projects.

Finally, in order to spur further successes in net-zero building, programs should seek to share data and lessons learned by their project teams. Owners and design teams may be hesitant to share information before the building is successfully operating, but incremental achievements and setbacks are crucial for continuous learning. If programs cannot publicly share information about particular projects, they can utilize program staff as conduits for sharing lessons between projects. Owners should also be encouraged to submit their projects for case studies and databases of high performing buildings. As more project owners seek to achieve net zero and more programs provide enhanced support for their efforts, the sharing of valuable experiences will help accelerate the transition to a future where net-zero building is the norm.

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