Energy Trust of Oregon Path to Net Zero Pilot: Pushing the Limits in the Oregon New Construction Market

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ABSTRACT

Reducing human-induced global warming is critical to maintaining ecological stability. Directives to achieve a standard of net-zero energy use for new building construction projects have necessarily emerged, although a set of guiding design strategies to achieve this goal is still a thing of the future. In order to discover what these design strategies are, we need to try innovative new approaches now even with the risk of initial failure.

To stimulate this innovation, Energy Trust of Oregon New Buildings is motivating the Oregon design community through a unique program offering. The Path to Net Zero pilot supports a select group of pilot projects to implement high-performance design in pursuit of significant progress toward net-zero annual energy use. Pilot projects that are able to achieve 60% less energy consumption than Oregon code, through a combination of at least 50% energy efficiency beyond code requirements and on-site renewable energy generation, are eligible to receive enhanced incentives for design charrettes, technical building design, equipment installation, and monitoring and reporting. Energy Trust will exercise some flexibility in applying cost-effectiveness protocols in an effort to encourage aggressive and inventive energy-efficiency strategies that may hold future promise for widespread, economical use.

This paper will: 1) Predominantly describe the implementation structure of the pilot and 2) Briefly discuss early process findings and outline design strategies and measures that are being considered by pilot projects as they pursue high-performance design and net-zero energy.

Introduction

Finding the means to decrease emissions from buildings is a critical piece of the greenhouse gas reduction puzzle. Each new building project is essentially a clean slate, and therefore a logical testing ground for innovative building design techniques that minimize greenhouse gas emissions, with the end-goal being buildings that operate on a net-zero or even net-generational basis. Recognition of the potential impact of new buildings has resulted in initiatives such as Cascadia Green Building Council's *Living Building Challenge*, the *Architecture 2030 Challenge*, the U.S. Department of Energy's *Commercial Building Initiative*, and California's *Long Term Energy Efficiency Strategic Plan*. However, the comprehensive integration of energy-efficient designs and technologies with renewable energy technologies to achieve net-zero energy buildings has been only sporadically tested at best.

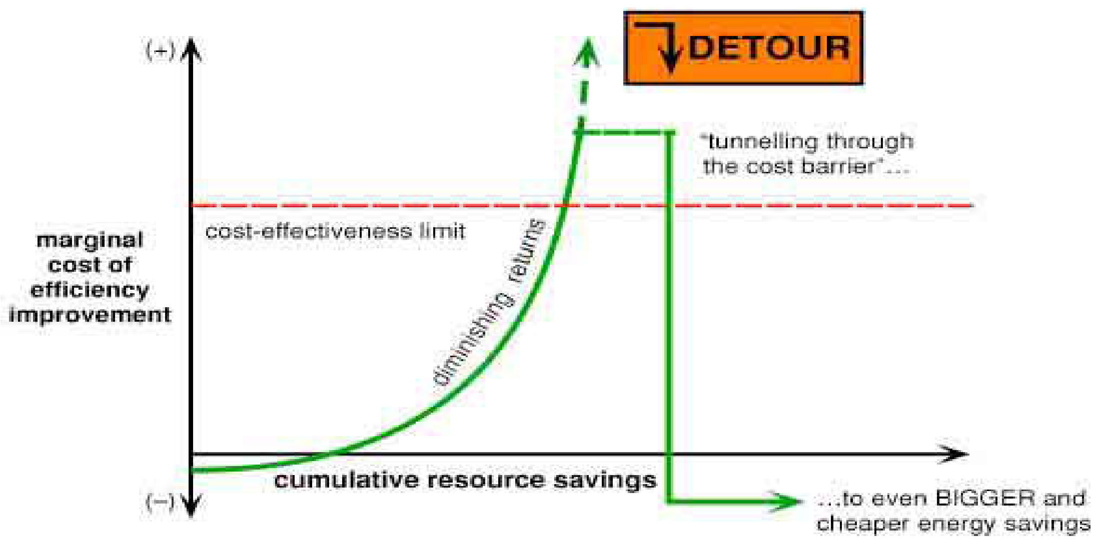
Challenges for Net-Zero Building Design

A number of challenges face the building design and construction industry in trying to attain the goal of net-zero energy buildings. In order to design low energy and net-zero energy buildings, it is essential for the entire design team, owner, operator, and tenants to be involved from an early stage in an integrated design process; however, fully integrated design is not the norm for development at this time, particularly for small buildings. Accurate and iterative energy analysis during the design process is a key to maximizing the efficiency of buildings. Unfortunately, much of the design community lacks the depth and breadth of knowledge necessary to model innovative building designs that integrate a number of complex energy-efficient technologies and strategies. In making a building increasingly efficient, designers typically focus on reducing heating, cooling, mechanical, and lighting loads. As these are reduced, plug loads become an increasing percentage of the building's energy use that must be addressed possibly through new control strategies or by attempting to alter occupant behavior.

Design teams also face a challenge in attempting to design on-site renewable resources that can meet the building's load. Solar photovoltaic (PV) systems are a universal solution to offset some or all of the load; however, a larger building, especially one with multiple stories, will have a larger load that will require more solar access to offset. Typical PV must compete for roof space with skylights, HVAC and communications equipment.

Innovative designs and technologies that lack field testing present a perceived risk to a project owner, who ultimately wants a building that is not just efficient but also easy to operate, inexpensive to maintain, and comfortable for the occupants. Designs that approach net-zero must overcome the law of diminishing returns in order to be cost-effective. In *Natural Capitalism*, Paul Hawken and his co-authors present the concept of "tunneling through the cost barrier" (Hawken et al. 1999, 114).

Figure 1. Tunneling Through the Cost Barrier



Source: Hawken et al. 1999

Most of the measures that are typically addressed in a resource acquisition model are represented on the curve of diminishing returns. High-performance buildings need to effectively tunnel through the cost barrier by reducing or eliminating building systems which have a high capital cost and long-term energy use costs. To reach that point, project teams strive to adopt passive design principles that include shell features, orientation, shape, and building operating systems. To eliminate energy-consuming systems, both owners and designers must overcome the perceived risk associated with new and less common design strategies and technologies.

The design community has a lot of challenges to overcome in order to build to a net-zero standard. In fact, as of May 2010 date there are only eight buildings registered in the US DOE Zero Energy Buildings Database and all of the buildings that have been logged are smaller than 15,000 sq. ft. (United States Department of Energy 2010).

In an effort to encourage Oregon's design and construction community to build innovative projects in pursuit of a net-zero standard, Energy Trust of Oregon developed and launched a Path to Net Zero pilot in 2009 through its Business Energy Solutions: New Buildings program. The pilot was developed with significant input from a variety of stakeholders, including local developers, architects, engineering firms, and energy analysts; regional energy and building experts; utility representatives in Oregon and California; and federal and state efficiency program managers.

Energy Trust's Goals for the Pilot

Energy Trust of Oregon is an Oregon non-profit that administers energy-efficiency and renewable energy incentive programs to Oregon's electric and gas customers of Pacific Power, Portland General Electric, Northwest Natural Gas, and Cascade Natural Gas. Energy Trust New Buildings provides incentives and technical support to new buildings, major renovations, and tenant improvement projects. Energy Trust New Buildings seeks to promote energy efficiency to the builders and developers of new buildings by providing financial incentives and technical support to achieve efficiency above the energy requirements of the Oregon Structural Specialty Code, Chapter 13 (code), which is approximately 5% more stringent than ASHRAE 90.1 2004 (Oregon Department of Energy).

The New Buildings program has provided incentives and assistance to projects since 2003. The program currently provides incentives through several paths, including the Standard Track (prescriptive savings and incentives), the Custom track (modeled or calculated savings and incentives), and the LEED® Track (savings and incentives based on LEED certification documentation).

The Path to Net Zero pilot seeks to move construction projects to achieve aggressive energy efficiency targets To do this, the pilot offers financial incentives and technical support. In developing and launching the Path to Net Zero pilot, Energy Trust defined the following goals: 1) push the envelope on design principles and techniques to evolve the knowledge of Energy Trust and the market; 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 and work with owners to adjust operations to meet design goals; 4) identify what works and incorporate these principles into the steady-state program offering and; 5) identify where returns on efficiency diminish to the point that it becomes more cost-effective to install PV than to attempt to find more opportunities for efficiency.

Pilot Program Offerings

Eligibility

Paul Torcellini and his co-authors define net-zero goals in four different 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 has chosen to pursue 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.

To be eligible for the Path to Net Zero pilot, projects must focus foremost on energy efficiency. The project owner must be committed to designing and constructing a building with site energy usage that is at least 50% better than code through energy efficient design and energy conservation measures, and at least 60% better than code through any combination of energy efficiency and on-site renewable energy generation, primarily photovoltaic systems. Percent savings beyond code must be calculated in kBtu to capture both electric and gas energy savings. Projects enrolling in the Path to Net Zero pilot must be in the schematic design stage or earlier, though exceptions have been made for projects already in contact with the program. Budget for the pilot is limited to test the approach before launching a larger-scale effort. The pilot was launched in May 2009 and quickly filled with 15 interested projects, ten of which have goals to pursue a net-zero standard, the rest of which are striving to meet the minimum requirements.

Energy Trust phased the release of the four stages of the pilot throughout 2009. Each stage encompasses program services and an incentive offering. The stages are: 1) early design assistance 2) technical assistance 3) installation and commissioning, and 4) monitoring and reporting. Pilot projects are meant to participate in all four stages of the pilot. Pilot offerings parallel regular program offerings but the technical assistance and financial resources available are much more extensive. If project teams are unable to meet the energy savings goals required for pilot participation, they are able to revert to the regular program offerings.

Early Design Assistance

Early design assistance is intended to help offset the cost of an integrated design charrette. By consulting with stakeholders during the pilot design, Energy Trust concluded that it is critical to bring together the building's team members early to establish a working paradigm of the buildings energy goals. Having everyone at the table early in the process helps the team realize a shared vision and allows them to identify overlapping or conflicting design strategies or criteria. By coming to agreement early on, the team is able to move from conceptual design to a working building that realizes the goals of the whole team.

Early design assistance is offered for any project in schematic design or earlier that is committed to the energy savings goals required for participation in the pilot. Projects receive a $10,000 incentive, compared to the regular $2,500, for early design assistance regardless of project size. Energy Trust requires that the following team members participate in the design charrette: project owner, architect, engineer, energy analyst, general contractor (if known), Energy Trust program representative, charrette facilitator, commissioning agent, and building operator. If anyone is unavailable, the project owner is required to describe how the missing perspective will be represented.

Energy Trust requires the project team to submit a charrette report addressing energy-related topics, including results of bioclimatic studies, preliminary energy end-use breakdown, energy efficiency and renewable energy measures (with an emphasis on PV), preliminary energy savings estimates by measure or design feature, and commissioning, operation, and monitoring strategies.

Technical Assistance for Energy Studies and Modeling

Based on feedback from stakeholders provided during the design of the technical assistance offering for the pilot, Energy Trust realized that the standard $25,000 incentive cap would not be sufficient for net-zero project teams. The energy modeling process is more resource-intensive for project teams attempting to push the envelope with highly efficient building designs and cutting-edge technologies. In these projects, the energy model is used as a critical tool to guide design decisions, comparing system types, and influencing equipment selection.

Stakeholders also recommended that Energy Trust broaden the scope of studies eligible to receive technical assistance funding. While Custom Track projects may only receive funding for energy modeling or energy savings calculations, in the pilot this list was expanded to include all design analyses that influence the design of the building and have an impact on energy use, such as daylighting analysis and computational fluid dynamics modeling.

For Custom Track projects Energy Trust requires that energy savings are evaluated against a baseline of code. The program considered an alternative approach for the pilot that would set a baseline based on typical building energy usage derived from utility and national energy utilization index (EUI) data. Based on a typical EUI, the program could set a target EUI for projects, with a net-zero target being an EUI of 0; however, this approach was not pursued as the program would not be able to verify that energy savings were calculated and claimed relative to the code baseline. Ultimately, the program decided to use the established method for estimating and claiming savings: a project runs a baseline code model and a proposed model; savings are calculated as the difference between the two models. Measures are evaluated for cost-effectiveness individually, accounting for interactions.

Energy Trust offers twice the Custom Track technical assistance incentives for this pilot. Projects can receive up to $0.10/kWh and $0.80/therm based on the energy savings calculated in the energy studies, up to a cap of $50,000. A minimum incentive was established at $10,000 to assist small projects with engineering costs that would otherwise be prohibitive. In no case does Energy Trust pay more than the full cost of the energy study.

The program engineering staff is heavily engaged in the pilot projects and meets with the project team early in the process to scope the technical analysis. At these scoping meetings, the program engineer and project team discuss the energy efficiency measures being considered for the project, strategies for evaluating the cost effectiveness of measures, and any potential review concerns, such as appropriate baseline inputs. Engineering staff are available throughout the life-cycle of the projects to confer with design teams on applicable design analysis techniques and performance actualization strategies.

Installation and Commissioning

Early in the pilot design process, Energy Trust recognized that enhanced installation incentives would be a powerful tool for projects that construct buildings modeled and designed to meet the required energy savings goals. The program considered offering tiered and stepped incentives based on estimated savings, so that projects with higher savings beyond code could receive incentives at a higher rate. In the end, the program decided to implement a flat incentive per unit of energy because of concerns about the accuracy of the energy models and incentive gaming. Based on discussions with stakeholders the program determined that the combination of an enhanced design and technical assistance incentive and a flat installation incentive that is double the Custom Track offering is sufficient motivation to move projects toward net-zero onsite energy use and will help provide some of the resources needed to get there.

The installation incentives for the pilot are set at twice the per unit savings for the Custom Track $0.20/kWh and $1.60/therm for energy savings achieved beyond the code baseline, as estimated in the approved energy model. Installation incentives are capped at $500,000. For purposes of calculating the project's achievement of the 60% energy savings goal, savings beyond code are calculated on a kBtu basis, to include both electric and natural gas.

Unlike the regular program offering, commissioning is required for pilot projects because the program has invested more resources in these projects and anticipates the projects to be more complicated than typical buildings. Projects must commission the building utilizing a qualified Commissioning Authority (CxA) who has experience with the commissioning protocol and associated deliverables outlined in *ASHRAE Guideline 0: Commissioning Process*. The CxA is responsible for creating a commissioning plan, reviewing construction documents at 50% and 90%, reviewing all change orders that occur during the project, conducting commissioning and equipment testing, and creating a Commissioning Report. At minimum, projects must commission any variable performance measures for which they request incentives. The program conducts a site visit to verify that all specified measures are installed and functional.

Monitoring and Reporting

The green building and energy efficiency communities acknowledge that "high-performance" and green buildings often do not perform as expected. In a study of 121 LEED-certified buildings, New Buildings Institute found that over half had measured EUIs that deviated from the design projected EUIs by 25% or more (Turner et al. 2008). More importantly, many high-performance buildings and their design teams do not have the monitoring capability to observe how the building is performing compared to the design model. Similarly, Energy Trust has historically claimed savings and paid incentives based on modeled savings.

The monitoring and reporting (M&R) offering for Path to Net Zero pilot projects is unique to the pilot and it is designed to help owners and operators achieve the targeted energy savings by gaining actionable information about their buildings' performance to diagnose operational issues and adjust operations. Secondary goals of the offering include: reporting performance data back to design teams to inform future project designs, identifying the cost and cost effectiveness of reporting M&R, and understanding the validity of whole building energy models for predicting energy use and building performance. "Reporting" was purposefully chosen instead of "Verification" to alleviate market fear of retribution for lagging performance.

Because the pilot incorporates a wide variety of project sizes and building types, the program designed an incentive offering that sets a minimum requirement, while still encouraging teams to strive for more in-depth monitoring and reporting capabilities. At a minimum, participants are required to establish whole-building 15-minute interval data for electric consumption or one-hour interval data for natural gas consumption, as well as on-site renewable energy production. Participants must be able to report this data electronically to the program for 18 months following occupancy. Additional incentives are provided for subsystem monitoring.

Conversations with stakeholders during the pilot development made it clear that automated performance tracking systems would be the best way to retrieve and understand monitored data. These tools vary greatly in complexity and features and can take the form of energy information systems, building automation systems, and fault detection and diagnostic tools. The program also discovered through the development process that staying engaged with projects during the 18-month period following occupancy will be crucial to ensuring that monitoring systems are working as intended and the data reported is being used to appropriately assess performance and diagnose operational issues.

The program created an *M&R Plan Template* for participants who meet a perceived gap. This template provides 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. The program is also creating an *M&R Applications Guide* to teach participants basic monitoring and reporting concepts, describe energy performance tracking tools and common features, and provide references to additional monitoring resources.

The M&R offering for Path to Net Zero projects incorporates three stages of M&R activities: planning (during the design and construction documents phases), setting up the systems (during construction), and ongoing reporting (for 18 months from occupancy). The Program has developed requirements and offers assistance in each of these three stages.

Planning for monitoring and reporting. During design and construction documentation, participants must submit an M&R plan to the program. They are strongly encouraged to use the *M&R Plan Template*, though any participant that creates a LEED M&V Plan to achieve LEED Energy and Atmosphere Credit 5 can submit that plan instead. Program engineers are available to provide assistance and advice to participants during the development of this plan. The plan must show how the participant will meet the minimum requirement of whole-building 15-minute interval metering for electric, one-hour interval metering of gas, and one-hour interval metering of on-site renewable energy used in the building. Participants must be able to report interval data electronically to the program on a monthly basis. The plan should also outline what reports and analyses the owner/operator will create and utilize as a result of the monitoring. Draft and final plans are reviewed and approved by program engineers and critical performance metrics are identified with the project's specific needs in mind.

In addition, participants are strongly encouraged to set up the electrical system and panels so that the building can be monitored at the subsystem level. In the event that whole-building monitoring demonstrates that the building is not operating as expected, the ability to monitor sub-systems will greatly assist owners in identifying problem systems. If applicable, panels should be designed to allow for monitoring of HVAC equipment, lighting systems, plug loads, and process loads, such as data servers or foodservice equipment.

Whole-building monitoring will likely require data coordination with the projects' local utilities. Project participants are encouraged to communicate with their utilities early in the design phase to ensure that the correct meter is ordered and installed and to explore data collection and reporting resources that may be available through the utility.

Setting up building monitoring and reporting systems. During construction, participants must install monitoring equipment and reporting systems as described in the approved M&R plan. Equipment installation will be verified at the post-installation site visit, and system reporting and uploading of data should be verified by the commissioning agent

For all projects, the program will pay up to $5,000 to help participants meet the whole-building monitoring requirements. Eligible costs include equipment and labor costs to upgrade to interval meters and the installation costs and monthly subscription fees for up to 18 months of an energy performance tracking system. Participants must outline the tracking system's reporting capabilities in the M&R plan and these capabilities must be approved by the program for the system to be considered an eligible cost.

For projects that set up interval subsystem monitoring of at least one system, the program will offer an additional incentive of $0.20/sq. ft. Projects can pursue both the whole-building and sub-metering incentives, up to a combined maximum of $30,000. Additional eligible costs for subsystem monitoring include labor and equipment costs for temporary data logging to investigate building performance during the 18-month M&R period and costs for recalibrating the building energy model based on monitored data.

Ongoing reporting. Building owners must report data and any reports generated to the program electronically on a monthly basis for the first 18 months of operation. Projects are encouraged to provide web-based data access to the program to facilitate information sharing. Building owners must also schedule and attend quarterly check-ins with the program. These check-ins may be conducted in-person or through a conference call, and should be attended by the building's facility manager, building operator, and owner. Key members of the design team are also invited and encouraged to attend. The goals of these meetings are to identify building operational issues and outline strategies to address these issues to help the building realize its energy performance potential. M&R is not intended to address indoor air quality as specified by ASHRAE 62.1.

The program will review the data and reports quarterly and provide the owner/operator with suggestions for data collection, reporting procedures, and technical and operational improvements to optimize building performance. In a final hand-off meeting, the program will provide additional training as needed to help the owner/operator continue with actionable monitoring and reporting for the building. If the building is not performing as expected, the program may recommend temporary monitoring, occupant surveys, or other auditing and analysis measures to help the owner diagnose the problems.

Preliminary Findings

Process Lessons

The pilot was quickly filled and there is a waiting list. Enrolled projects range in size from 1,500 to 500,000 square feet. Building types include retail, event space, office, multifamily, and government facilities. Perhaps not surprisingly, most projects enrolled in the pilot are being developed by the owner/occupier of the building. This allows the owner to recover the costs of high-efficiency design over a longer time period. Interestingly, this may also allow the owner to explore design solutions that will take dedicated behavioral adjustments like adapting to a wider range of temperatures and controlling plug loads.

Most of the enrolled projects have completed their design charrettes. Charrette feedback has been positive and the charrettes have served the intended purpose: to help shape design paradigms for the participating projects, including setting expectations about project economics. Charrettes have also helped to establish how site considerations like building orientation and wind shear affect performance. High-performance design strategies and technologies have been discussed extensively in the charrettes, which helps the project teams prepare for the research, analysis, and risk assessments necessary to implement the design.

Maintaining close contact with pilot participants will be important to the success of the pilot. To address this, the program has established multiple touch points with the participating teams, including attending design charrettes, leading technical scoping meetings, advising on and reviewing M&R plans, conducting quarterly check-ins during the M&R period, and reviewing technical models, energy studies, commissioning reports, and monitored data.

Design Strategies and Measures

Though most of the pilot projects are still in the early stages of design, the program has already noticed common themes among the design approaches and technologies being explored. The program is tracking these design strategies in an effort to identify key approaches that are worth consideration in the design of a net-zero energy building. At pilot conclusion, analysis of the data collected during the M&R phase will inform the program on what strategies are most effective and can be duplicated through future program offerings.

The building envelope is an obvious first point of focus. It is clear from the early design strategies that pilot participants consider a high-performance building envelope and a reduction in fenestration area to be key strategies for reaching the energy goals. The code standard for insulation is high enough in Oregon that a marginal increase in insulation beyond code is often not cost-effective; however, many projects are tunneling through the cost barrier by downsizing HVAC systems or, in some cases, even removing HVAC systems altogether through a better envelope coupled with appropriate fenestration in order to reduce heat loss and heat gain without eliminating the opportunity to day-light spaces.

During the design charrette, projects define the typical energy use for the proposed building in an effort to gain a clear understanding of which building systems and equipment have the largest impact on energy consumption. As expected, HVAC is one of the bigger energy loads and it receives a lot of attention from the design teams. Small buildings tend to be heating-dominated and large buildings tend to be cooling-dominated. Fortunately, Oregon's climate allows the majority of the cooling load to be met with functional economizers that provide cool outside air. HVAC design strategies and technologies being considered include:

- Natural ventilation utilizes cross ventilation and/or stack effect. Projects are exploring both pure natural ventilation systems, which rely solely on natural air movement to meet cooling and ventilation loads, and hybrid systems, which provide natural cooling and ventilation with a mechanical system back-up used only during peak cooling conditions.
- Displacement ventilation that makes use of convective currents and natural buoyancy forces to move air at very low velocities across the space—These systems typically provide elevated supply air temperature (cooled to 60-65˚F instead of 55˚F) low to the ground with a low air pressure delivery system, thus reducing fan power, lowering cooling load, and expanding the range of economizer (free-cooling) operation.
- Geothermal heat pumps are being considered for some of the projects, but the associated costs are too high for most projects. That said, some projects have found that the installation costs have been decreasing as commercial installations of the technology become more prevalent in the region and contractors become more familiar with installation techniques.
- Heat exchangers are being used to recover heat from exhaust air in order to preheat incoming ventilation air. Conventional heat recovery ventilators (HRVs) are being used, which transfer heat to incoming ventilation air from the return air that would otherwise be exhausted out of the building. A couple of exploratory methods of heat recovery are also being used in smaller pilot projects, including:

- Solar Wall - preheating of air using a south facing building wall and metal capture cavity that is warmed by solar radiation.
- Solar PV Panel Heat - Capturing the hot air that builds up behind solar PV panels, and using this heat source to preheat ventilation air. This approach not only preheats outdoor air, it also increases the efficiency (electrical output) of the solar panels.

- Zonal heating and cooling systems help to minimize simultaneous heating and cooling. This strategy can eliminate a central HVAC system and moves from an air-based system with high fan horsepower requirements to a hybrid hydronic/air system with small zonal fans or an all hydronic system. Zonal heating and cooling methods being considered are:
    - Radiant floors, panels, and beams that condition each zone individually using chilled or hot water. Each zone/room has its own thermostat and controls, and each zone/room is intended to be in either heating or cooling mode at a given time. When possible these systems are being coupled with natural or displacement ventilation.
    - Variable refrigerant volume (VRV) heat pump systems have the ability to transfer excess heat from one space to another. These systems typically consist of an outdoor heat pump unit serving multiple zones within the building. Compared to standard heat pump systems, these units are able to vary compressor loads and refrigerant flow and transfer heat between spaces when there is a diversity of zones needing cooling and heating. . The success of these systems is dependent on the building internal zone and perimeter zone thermal load characteristics and proper refrigeration circuiting between these zones.

Domestic hot water (DHW) heating equipment efficiency is also a focus for pilot projects. The technologies being considered are all fairly well established in the market: using solar hot water pre-heat systems, heat pump water heaters, high-efficiency condensing boilers or on-demand water heating technologies, and low-flow fixtures. Additionally, one project is considering limiting hot water to kitchens and showers and providing only warm water to restrooms .

Many projects are considering daylighting to offset energy use in electric lighting systems. One project has undertaken an extensive daylighting analysis to further inform the lighting design. At the very least, all projects are attempting to minimize electric lighting. Overall lighting power densities should be significantly lower than the levels outlined in code.

Plug loads present one of the largest challenges for all buildings participating in this pilot. Design teams typically don’t consider addressing plug loads and these loads are considered unregulated. As much as 20-25% of a code building’s energy is used by plug loads. Aggressively reducing regulated (non-plug) building loads as required by this pilot can result in plug loads that represent 50-60% of a building’s energy unless plug loads are strategically addressed Plug load decisions are usually left in the owner or occupant’s court, and the selection of plug load equipment or control strategies is often running in parallel with the design and construction process, with little or minimal interaction between the two. Pilot projects are considering innovative ways to control plug loads including:

- Reducing the number of copy centers by having more centralized and sometimes shared copy centers

- Purchasing the most efficient office equipment and appliances available
- Implementing energy savings features on equipment
- Incorporating a color-coded plug system in which one plug color indicates a circuit controlled by an occupancy sensor or timeclock and another indicates a circuit that is permanently on.

Cost-Effectiveness Screening for Measures

Energy Trust exercises cost-effectiveness criteria to determine whether a measure is a good investment for rate payers and society. Once measures pass these cost-effectiveness tests Energy Trust does not dictate which measures projects install. Projects enrolled in the pilot have encountered challenges in meeting Energy Trust's cost-effectiveness criteria. Three major issues have been identified in relation to Energy Trust's cost-effectiveness screening requirements: 1) the high incremental cost accompanying emerging energy efficiency technologies may overpower energy benefits; 2) due to the 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) for designs that remove major building systems (e.g. passive cooling strategies), a negative incremental cost may result in a simple payback much less than one year or even negative.

Energy Trust understands these challenges and has therefore adopted a more liberal framework to evaluate which measures are eligible for incentives in the pilot. Energy Trust always allows projects to incorporate non-energy benefits into the cost-benefit calculations and this pilot is no exception. In addition, for pilot projects the program considers measures on the margin of cost-effectiveness under the following circumstances: (1) there are significant and well-defined, but difficult-to-quantify non-energy benefits and the incremental measure cost is only marginally greater than the value of the savings(2) the measure leverages other cost-effective actions, which in combination are cost-effective, or (3) the measure is part of an Energy Trust-approved market transformation effort that forecasts decreases in cost that justify early expenditures (e.g. some LEDs).

In recognition of the highly interrelated nature of high-performance and net-zero buildings, Energy Trust allows project teams to bundle some measures for cost-effectiveness screening provided they are closely related by design, cost and energy savings. Energy Trust also provides incentives for measures or measure bundles that have none or negative incremental costs but often have very real technical and emotional barriers. Examples of measures that are considered for bundling include:

- Architectural features and window glazing selections that facilitate daylighting control strategies and enhanced lighting design.
- Improvements to the building envelope that reduce heating and cooling loads and thereby impact HVAC equipment selection and/or equipment sizing.
- A cooling system designed to provide ventilation and cooling through a combination of natural ventilation and supplemental mechanical cooling. The supplemental mechanical cooling system sizing and operation is highly dependent on the natural ventilation design, and would be difficult to assess independently.

Typically Energy Trust only provides incentives for measures with a simple payback of one year or more. To address potentially low or negative simple paybacks for particular measures in the pilot, Energy Trust allows simple paybacks of less than one year because pilot measures may require significant design-related costs and risks that are not captured in typical equipment and construction costs.

PV systems are not required to meet efficiency cost-effectiveness criteria to earn Energy Trust incentives. Such incentives are prescriptive on a dollar-per-watt basis and are calculated to cover the incremental “above-market” cost to generate a kWh with PV. The integration of solar PV systems into the building that provide additional benefits (shading, heating, daylighting glazing, water heating, etc) will be evaluated and encouraged to maximize energy production and energy savings, thus enhancing the overall cost-effectiveness of the PV system.

Additional Implementation Challenges

Several projects are considering incorporating a commercial kitchen. Commercial kitchens are not governed by code and therefore require special consideration by the program and a unique modeling approach. Projects with commercial kitchens will have two options for modeling the kitchen: 1) They 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 will need to work closely with the program to establish appropriate assumptions for kitchen equipment loads in the baseline energy model.

Implementation of an adequate controls system is going to be critical to keep the building systems operating according to design intent. Constant building monitoring in relation to control schemes programming will be necessary to make sure that the controls are working properly. Ironically, energy monitoring equipment itself often uses energy, so project teams must consider the building monitoring system as an overall piece of the energy pie. Design teams must also balance the need to incorporate enough controls to operate the building efficiency, while not creating a control scheme that is so complex it is unmanageable by the building operator.

Conclusion

Energy Trust’s Path to Net Zero pilot has been well received in the Oregon market with a whole range of building sizes and types filling the pilot to capacity. The four stages of the pilot: 1) early design assistance 2) technical assistance 3) installation and commissioning, and 4) monitoring and reporting thus far seem to provide good program touch points for assisting a project through its life cycle. Most projects participating in the pilot will be owner-occupied. Common themes emerging in pilot projects include an emphasis on enhanced envelope, methods to dramatically reduce or eliminate HVAC, innovative approaches to DHW, daylighting and the battle to control plug loads. Energy Trust has employed more liberal cost-effectiveness criteria and even these are a proving to be a hurdle for enrolled projects. Moreover, some end-uses are not designated by code and the program has had to adapt to address these. Finally, the paradox of using energy to monitor energy performance presents an interesting challenge. Energy Trust and the market remain optimistic that viable, high-performance buildings will result from the pilot and Energy Trust expects that lessons from the pilot will inform future program design.

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