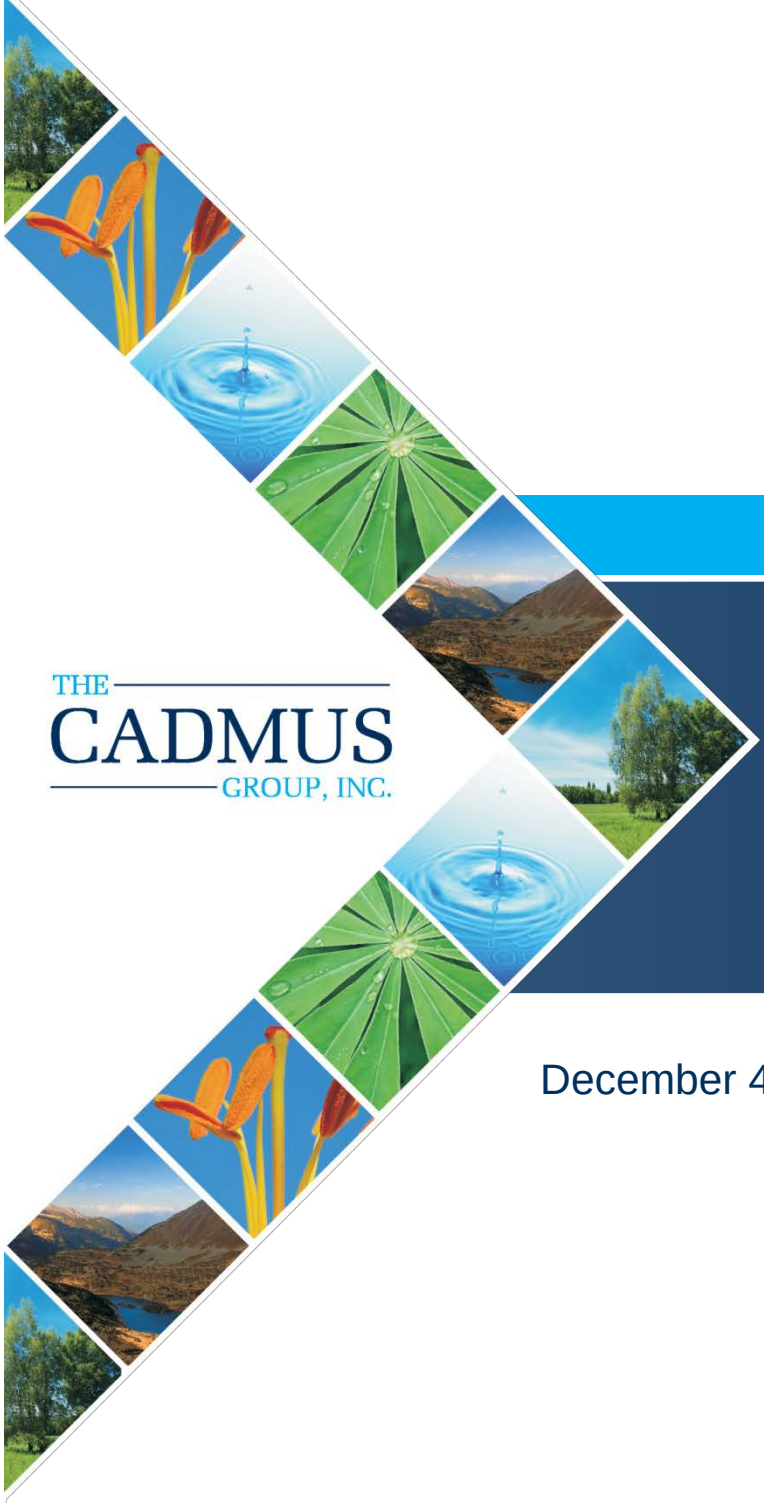

THE CADMUS GROUP, INC.

Evaluation of the Path to Net Zero Pilot Program

December 4, 2012

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EXECUTIVE SUMMARY

This report describes what has been learned from assessing Energy Trust of Oregon's Path to Net Zero Pilot (PTNZ) program. PTNZ was launched in May 2009 and provides increased support and incentives to new non-residential building projects intending to achieve exceptional energy performance. Four phases of support are provided: Early Design Assistance; Technical Assistance; Installation and Commissioning; and Monitoring and Reporting. PTNZ intends to gather data to better:

- Understand the opportunities, motivations, and barriers for net zero buildings
- Describe the design decisions, equipment, and strategies making these buildings possible
- Inform the design of new commercial building energy efficiency programs
- Encourage the development of net zero buildings

The evaluation team has worked with PTNZ sponsors and implementers over the course three years to track the program's progress and lessons learned. For this report, the evaluation team conducted interviews with ETO staff and implementers, reviewed technical documents, and completed in-depth interviews with 26 participants representing 13 projects, 12 which are still in the pilot and 1 which has dropped out. The 12 active projects in PTNZ included:

- Six projects that have completed construction,
- Three projects that are in design development,
- Three projects that are stalled.[1]

Program Experience, Benefits and Value

I thought ETO didn't just provide a lot of words – they provided actions – the right program and scope that pushed us to get to a building that would be beneficial to owners, tenants, operators – shooting for the moon and landing in the stars. – Building Owner speaking about why he participated in PTNZ

Overall, praise for PTNZ is robust. Satisfaction across all steps of the pilot received high ratings, with some steps being somewhat better received than others. Participants reported the highest satisfaction with the Early Design Assistance phase (i.e., the design charrette process) that focused their attention on energy efficiency and energy reduction targets. Program implementers agreed that setting targets, and finding out if they met them, helped nudge participants through the program.

Most participants said the Early Design and Technical Assistance incentives were essential for their participation and cited the financial incentive package as a particularly valuable aspect of PTNZ. In addition, they paid high compliments to pilot staff and to the program's level of technical feedback.

[1] Some projects withdrew from the pilot after being interviewed, and some projects that are stalled in the schematic design phase were not contacted for an interview. Thus, the number of projects still in the program is 12 while the number of projects the evaluation team conducted interviews for is 13.

Overall, participants reported that the program could improve on its communication surrounding documentation and reporting requirements. Project teams tended to experience the most confusion or challenges in meeting the Technical Assistance and Monitoring and Reporting requirements.

It is clear that participating in PTNZ, a long-term and complex commitment, has yielded tremendous value for most participants. While many were already committed to a high performance building, they reported that the program helped them see it through. Most participants reported that they would not have been able to build the same building without PTNZ. They cited these primary benefits for participating: financial support to pursue additional modeling or studies, enhanced education, and increase PR and credibility.

Key Conclusions and Recommendations

Across all projects, key conclusions and recommendations include:

1. **Conclusion: The energy target is an important attraction for participation and motivates participants to meet program requirements**.

   Recommendation: Ensure that energy targets are a key feature and attraction for the program. Given the change in the energy code, reconsider what the targets should be and how they should be distributed between efficiency and renewables.

2. **Conclusion: Early design and technical assistance are critical program elements for success in a high-performance building program like PTNZ because setting direction at the outset is easier, cheaper, and much more likely than changing direction later.**

   Recommendation: Provide significant incentives for early design assistance and technical assistance to ensure the program has the opportunity to influence and assist in optimizing the building design.

3. **Challenges exist in meeting program requirements for individual measure cost-effectiveness, especially for pilots where cost-effectiveness parameters may not be known.**

   Recommendation: Consider removing the program cost effectiveness requirements, in order to let the owner decide what is cost-effective. Analysis can be simplified by considering the whole package of measures rather than conducting a measure-by-measure analysis. Consider basing incentives on energy savings performance, and providing incentives in a way that helps building owners afford the package of measures to meet their energy goal.

4. **Conclusion: Monitoring and reporting in PTNZ holds value for the broader high-performance building market, including building operators, but the requirements can be challenging for participants**.

MEMO

Date: February 21, 2013
To: Board of Directors
From: Philipp Degens, Evaluation Manager
Jessica Rose, New Buildings Program Manager
Subject: Staff Response to the Path to Net Zero Process Evaluation

The Path to Net Zero pilot evaluation revealed that projects can achieve aggressive energy efficiency goals by utilizing currently available construction methods and technology, and that the process for achieving these goals can be supported through the delivery method used in this pilot. Evaluators' methodology was to track progress as it occurs by staging interviews at key points. This worked well to provide staff valuable information early and was a good fit due to the project timeframes, in-depth nature of projects and capturing feedback from project teams to support program design. New Buildings is engaging innovators and early adopters in the market and pushing for significant energy savings using strategies that were found to be successful in the evaluation of the pilot.

The evaluation report indicates that very early engagement with the project team and the building owner to set an energy goal was a highly successful strategy. Staff found this drove decision-making further down the line and the achievement of net zero goals. This strategy also supported subsequent decisions on equipment selection and supported overall retention of energy efficient features. Program outreach staff were available to help project teams identify energy-saving strategies early in the construction development cycle, when the opportunity cost of including these strategies is at its lowest, then leveraged early design assistance, technical analysis and equipment incentives. Linking higher incentives with higher goals worked to encourage technical deep-dives needed to pencil out the savings and cost-effectiveness. Working jointly with the owner and the project team early to set energy goals is a critical step to get buildings on the path to net zero.

Applying individual measure cost effectiveness testing is a challenge for buildings striving to meet a whole building energy reduction goal when the emphasis is total energy usage reduction, though there are benefits to both approaches and exceptions to this measure level requirement. Individual measure cost-effectiveness analysis may also be useful for project teams as they work to meet energy savings goals within a given budget. Energy Trust is required to apply cost-effectiveness tests at the measure level, and may allow bundled measures that are interactive or interdependent and may allow measures that are cost-effective to be bundled with an enhancement (i.e., improved envelope performance that reduce mechanical equipment costs because of reduced load). These exceptions are applied to projects and outlined in New Buildings Technical Guidelines to support project teams.

Buildings designed to meet high energy savings goals may rely on measures that require occupant and building operator buy-in, such as reducing plug loads or relying on control systems that may be overridden. While occupant behavior is important to meeting overall energy goals, it is difficult to claim savings from measures that are solely behavior-based due to persistence

issues. The program anticipated that monitoring and reporting would be a difficult part of the pilot and developed the *Monitoring and Reporting (M&R) Applications Guide* (with a section on designing for meterability) as a tool to aid project teams. With this tool, project teams can begin thinking about the requirements early in the project, including how to design electrical systems to accommodate metering equipment. Due to the increasing availability of metering devices and data display systems, benefits and costs must be weighed carefully, with selection based on building type and complexity as well as anticipated use of the data. The challenge with the requirement was in deciding what to monitor and how to display the information and determining what equipment would meet those needs. Program staff revised the guide are looking to streamline implementation by incorporating M&R into the commissioning process, also helping to ensure the monitoring system is functioning properly and facility personnel are trained in using the system.

Evaluators finally concluded that “both financial and non-financial motivations are strong influences on owners wanting to build net zero buildings” and recommended modifying the way incentives are structured to support the diversity of potential net zero projects, aligning support with needed skills and resources. This is the concept behind the broad array of incentives offered in the regular program and the Small Commercial Efficiency Pilot. This combined with New Buildings increased emphasis on the early design stages of a project aligns the program by design to fit the needs of individual project teams and move them along the pathway. This will build on our strategy to take a market position as an education and resource provider, expanding the focus on market transformation and inspire many teams to build the path to net zero.

Recommendation: Consider refining the M&R requirement to establish M&R goals at the beginning of a project during the building design process. PTNZ can also help reduce confusion by specifying certain monitoring systems and reporting processes that will meet the requirement, as well as incorporating further prescriptive guidelines such as minimum data requirements. Other options such as incorporating M&R into the commissioning process, which often can extend beyond initial building occupancy, or having a post-occupancy evaluation process, may be appropriate to consider under the context of monitoring and reporting. Finally, to the extent possible, PTNZ implementers should tak4 over primary responsibility for filling out any forms and paperwork.

5. **Conclusion: Occupant and building operating behavior are likely to be a more important part of building performance in high performance buildings than in other buildings**.

   Recommendation: Although more research is needed to establish this conclusion, consider including making attention occupant and building operator behavior as an explicit part of any future program. Some energy saving credit should be given to occupant behavior measures, but implementation requirements need to be tied to this credit. These requirements could include occupant training, greater involvement of operations and maintenance staff during design, and feedback to occupants on building performance. Particular emphasis might be placed on managing "plug loads" which are a growing percentage of building load and are heavily influenced by occupant behavior.

6. **Conclusion: Smaller buildings can result in program administration challenges.**

   Recommendation: Consider options for simplifying the requirements for small buildings by offering more streamlined processes and prescriptive packages and guidelines.

7. **Conclusion: Both financial and non-financial motivations are strong influences on owners wanting to build net zero buildings.**

   Recommendation: Consider structuring incentives to continue pushing owners and design teams to enhance the design and provide a safety-net for those who are already motivated to be highly efficient, but don't have all the needed skills or money to do so.

1. INTRODUCTION

The Path to Net Zero (PTNZ) pilot program at Energy Trust of Oregon (ETO) is an innovative effort that provides increased design, technical assistance, construction, and measurement and reporting incentives to new non-residential or mixed use building projects which intend to achieve exceptional energy performance. The buildings in this pilot program combine energy efficiency and renewable energy sources with the goal of achieving substantially reduced or net zero on-site energy use.[2]

PTNZ responds to the challenges of designing and constructing high energy performance buildings. While interest in net zero energy buildings continues to grow, the design and construction techniques needed to achieve net zero buildings are not widespread. For instance, these buildings require an integrated design process where the owner, design teams and other stakeholders evolve and agree on crucial aspects of the approach, and where expert energy modeling can show how efficiency can be maximized. Integrated design, however, is hardly the norm for most new commercial buildings and especially not smaller ones.

Challenges also exist in how to get highly efficient buildings financed and marketed, since they may be perceived as more expensive and risky to operate. In addition, the popularity of more stringent approaches already in the northwest market, such as meeting the wider sustainability requirements LEED certification, both aids and complicates the progress to net zero buildings. PTNZ, which focuses just on energy performance, will help map and test building designs and technologies to determine which methods can meet significant energy performance increases and still create marketable buildings.

This final report on PTNZ builds on a November, 2010 memo by the evaluation team. The overall purpose of this report is to provide ETO and program implementation decision-makers and staff with insights about the factors affecting the design, construction, and operation of net zero buildings and to inform the design of future high performance building programs.

Goals

ETO staff and pilot program implementers identified the following goals for the pilot:

- To understand the opportunities and barriers for net zero buildings and how to encourage greater market adoption
- To better understand the design decisions, equipment, and strategies that make net zero buildings possible
- To inform the design of future new commercial building energy efficiency programs and incentives that support and encourage the development of net zero buildings
- To encourage the development of net zero buildings

[2] In this memo, we will use the term net zero buildings to refer to all high performance buildings that meet the requirements of PTNZ.

The evaluation statement of work identifies these indicators will be used to gauge PTNZ's success:

- 10 projects enroll and complete the pilot, including a variety of sizes and building types.
- Communication between the project team and the program influences project design
- At the end of the pilot, program experience has produced increased understanding about:
  - The costs and savings of particular approaches
  - The cost-effectiveness of net zero buildings and cost trade-offs among approaches
  - PTNZ challenges for different building types, sizes, usage, and climate zones

Tasks and Methods

The evaluation team has worked with PTNZ sponsors and implementers over the course of three years to track the program's progress toward meeting its goals and to capture lessons learned. Most data are qualitative. The key tasks and methods used for this evaluation are the following:

- **Interviews with program sponsors and implementers.** The evaluation team conducted interviews with ETO and PECI program staff members twice during the PTNZ progress. The focus of these interviews was to gather feedback, insights, and lessons learned about PTNZ.

- **Interviews with owners and design teams for each participating project.** The evaluation team conducted at least two interviews with at least one owner and design team representative for all viable projects. For this report, the total number of respondents is 26. Due to their involvement with the pilot and the stages for each project, not all respondents answered all questions.

  These interviews asked participants to reflect upon the phases of the pilot that they completed, their satisfaction with its elements, and recommendations for improvement. It also initiated a conversation about the energy efficiency measured installed in the building and associated trade-offs and challenges, motivations to participating in the pilot, market barriers and opportunities, and lessons learned. Please see Appendix B for the participant interview guide.

- **Review of program background and supporting documents.** The evaluation team reviewed and analyzed relevant summary reports, Energy Analysis Reports (EARs), and Monitoring and Reporting (M&R) plans for appropriateness and reasonableness. The results of this review are provided in Section 4 of this report.

2. PROGRAM HISTORY AND DESCRIPTION

Energy Trust of Oregon launched PTNZ May 1, 2009 as part of Energy Trust's Business Energy Solutions New Buildings program. Portland Energy Conservation Inc. (PECI), in collaboration with ETO and many other stakeholders, designed the pilot and is responsible for implementing it. PTNZ offers enhanced incentives for owners who enter the program during the conceptual or schematic design stages of their projects and who wish to construct buildings with energy performance that achieves:

- At least 50% energy savings beyond Oregon code[3] through energy efficiency alone or
- At least 60% energy savings beyond Oregon code through energy efficiency and renewable energy

Program Stages

To some degree, PTNZ parallels the custom track of ETO's New Buildings program; however, both PTNZ's requirements and its incentives are significantly higher.[4] In addition, PTNZ services and incentives include early design assistance and measurement and verification elements that do not currently exist in the ETO new commercial buildings program. Finally, PTNZ also offers greater flexibility in how technical assistance incentives are used. The program has four stages of participation and corresponding types of technical support (e.g., meeting program reporting requirements) and/or incentive payments, as described below:

1. **Early Design Assistance (EDA)**: Technical support up to $10,000 is available to offset the cost of an integrated design charrette which gathers together key program actors at the start of the design process to discuss design opportunities and major design decisions. PTNZ requires that all the key perspectives be represented at the charrette and that the project team submit a report that describes all energy-related topics such as preliminary energy savings estimates for measures and design strategies and use of renewable.
2. **Technical Assistance (TA)**: Technical support up to $50,000 is available for energy studies and building simulation modeling. Both the depth and scope of analysis are increased for these projects compared to typical custom path projects, since modeling is used as an essential for making design decisions. Engineering staff from the program meet with project team at an early scoping meeting to explore and define the types of technical analyses that will be done; these engineers are available to consult with the project team throughout the PTNZ process. The modeling can include any type of

[3] PTNZ savings goals are based upon the Oregon code in place at the time of program launch; a new energy code has recently been adopted which is more stringent.

[4] If projects are not able to achieve the savings goals specified for PTNZ, they can revert to and take advantage of the regular program offerings. Incentives available can be double the amount or more compared to the New Buildings program.

analysis that sheds light on design choices and their impact on energy use, include things such as daylighting analysis and fluid dynamics modeling.

3. **Installation and Commissioning (I&C):** Technical support up to $500,000 is available to install high efficiency measures and strategies as developed in the TA stage of the program. Commissioning is a required component for every project, no matter the size, to help ensure these more complex buildings return the extra investment that is being made in them.
4. **Monitoring and Reporting (M&R)**: Technical support and up to for $5,000 is available for whole building monitoring and reporting. Additional incentives are available for subsystem monitoring. The maximum overall incentive cannot exceed $30,000. This step supports better understanding of actual building performance so that building owners and operators can diagnose and adjust the building so that it meets energy savings goals. M&R activities also can be used to provide feedback to design teams that will inform future projects, investigating how well whole building modeling predicts energy use and savings, and tracking the costs of M&R efforts.

   M&R activities include developing an M&R Plan, setting up systems during construction to enable monitoring and reporting, and providing electronic reports on building performance each month for the first 18 months of operation. PTNZ also requires owners to attend quarterly check-ins to discuss and troubleshoot any operational problems that interfere with the building's energy performance.

Current Project Status

After the launch of PTNZ, 15 projects quickly enrolled. Three projects dropped out and were replaced. Since then, three more projects withdrew from the pilot due to budget constraints, leaving 12 projects enrolled at various stages. At the time of writing this report:

- Six projects have completed construction,
- Three projects are in design development,
- Three projects are stalled.

The projects that are currently enrolled show that PTNZ buildings vary greatly. These buildings range in size from 1,500 to over 500,000 square feet and include offices, educational facilities, meeting spaces, and mixed use buildings. While most of the buildings are publicly owned and will be owner-occupied, there are also some exceptions to that pattern. Of the six buildings that have completed construction and are undergoing monitoring and reporting, four are educational facilities or classrooms, one is a mixed-use development consisting of multifamily housing and retail, and one is a community center. Table 1summarizes the current status of each project, their size, type, and projected energy savings.

Figure 1. PTNZ Project Status and Information

Project	Design Development	Under Construction	Completed Construction	Size (sf)	Estimated Savings (kWh)	Building Type
Chemeketa	■	■	■	65,000	322,524	Higher Education
DaVinci	■	■	■	1,500	6,578	Education K-12
Hood River	■	■	■	5,600	41,571	Education K-12
June Key Delta	■	■	■	2,700	25,547	Community Center
PCC Newberg	■	■	■	12,000	120,087	Higher Education
Siteworks EcoFlats	■	■	■	16,927	29,405	Mixed Use: Residential & Retail
Edith Green	■	■		510,658	2,761,963	Office
Blanchet House	■			28,000	56,130	Residential: Dormitory
XVI Vernon	■			58,496	295,844	Mixed Use: Residential & Retail
OSC	*Project stalled due to funding*			*220,000*	*3,325,911*	*Office & Retail*
Independence Station	*Project stalled due to funding*			*58,424*	*562,555*	*Mixed Use: Residential & Retail*
Greenville	*Project stalled due to siting*			*80,000*	*1,201,028*	*Grocery*

3. PTNZ PARTICIPATION: LESSONS FROM THE FIELD

To gather insight at the project level, the Cadmus team conducted in-depth interviews with at least two participants from 13 projects; 12 of these projects either completed or are still in the pilot while 1 project has since withdrawn from the pilot. Findings presented in the first interim report were largely based on participant feedback through the early design assistance phase. This report supplements our initial report by providing feedback from participants as they progressed through subsequent phases of the program. Table 2 summarizes the program participant interviews and which stages have been covered during our interviews with them. This section, where noted, also includes insights from interviews with PECI and ETO Energy Trust program staff.

Table 2. Stages Covered By PTNZ Participant Interviews

Project	Early Design Assistance	Technical Assistance	Energy Saving Measures	M&R Plan	M&R Equipment Installation	Commis-sioning	Reporting Period
Blanchet House	■	■	■				
Chemeketa	■	■	■	■	■	■	■
DaVinci*							
Hood River	■	■	■	■	■	■	■
June Key Delta	■	■	■	■		■	
PCC Newberg	■	■	■	■	■	■	
Siteworks EcoFlats	■	■	■	■	■	■	■
XVI Vernon	■	■	■				
Edith Green**	■						
OSC**	■						
Madras City Hall***	■						
Blue Lake Park***	■						
Heron Lakes Clubhouse***	■						

Notes:
*The DaVinci high performing classroom was grandfathered into PTNZ during construction, so feedback on the delivery of the pilot is limited.
**As of May 2012 the Edith Green GSA building and Oregon Sustainability Center were still in design development and therefore evaluators have only completed a first-round interview for these projects.
***Madras City Hall, Blue Lake Park, and Heron Lakes Clubhouse participants withdrew from the pilot program.

Understanding of PTNZ Goals

All participants were asked to articulate their understanding of PTNZ goals; some were quite passionate and eloquent, reflecting their longstanding belief in greener, high efficiency buildings. By and large, the majority of responses captured Energy Trust's goal to incent high performance buildings through covering the incremental costs of sophisticated design measures. A nearly equal number of responses discussed the goal to push the envelope in high performance building

design and drive innovation toward net zero buildings, including through "unconventional" approaches.

Other responses touched on the many benefits of the program – including raising public awareness, enhancing education in the design and construction sectors, benefiting communities, demonstrating that path-to-net zero practices are feasible today, and identifying obstacles in order to implement solutions down the road. In addition, many responses alluded to the role of PTNZ as a market catalyst, driving change:

[PTNZ is] pushing owner, developers and architects. . .to get everyone to focus on energy issues and how to get to net zero, instead of focusing on LEED. . .providing that gap in funding. . .[to take] it to the next level."

"Changing the framework of developers, rehabs, all the way down to how that affects the consumer in their home-- changing their perceptions and giving them tools to save energy – it has a huge educational component."

Motivations

For almost all of the projects, we found that the decision to participate in the pilot or at least to pursue a high efficiency, net zero building was driven by the owner. In some cases, the design team or an Energy Trust representative may have alerted the building owner about the pilot, but commitment or drive was attributed to the owner. This finding has implications for the target audience of high-performance building programs at Energy Trust, as well as representing an important aspect of "market readiness" for the concept of net zero building practices.

When asked what motivated them to develop a net zero building, the clear majority of respondents were highly motivated to contribute to sustainability through high performance buildings. As one owner put it: "[I wanted to] build an energy efficient building. [ETO had the] right program and scope that pushed us to get to a building that would be beneficial to owners, tenants, operators – shooting for the moon and landing in the stars."

When asked why they participated in PTNZ, however, most respondents (20 out of 23) said it was the financial incentives that helped them make the decision or "pushed them over the edge." Two respondents emphasized the financial and business aspects of participating in the program as follows:

We were almost there. . .we could plug the extra incentives into our pro forma . . .to make it feasible. . .the challenge is. . .to show them financially how we would still get the right return.

You know, cash incentives are huge. Tax credits and all this other kind of stuff that you go through with other programs such as LEED or federal programs or state programs don't exist to the bank. Cash incentives are real to the banks, and to the lenders, and everyone else who is involved. So that's a BIG factor to really help us afford the equipment and show it in the business plan.

Other reasons for pursuing a high-efficiency building or participating in PTNZ included the following:

- To test what is possible, demonstrate new technology, to play around
- To teach building occupants about efficiency and to promote efficiency more generally to those who use the buildings
- To respond to a nudge or encouragement from the design team
- To achieve operating cost savings
- To be a showcase and to be a leader
- To be part of something with a clear path and defined goals for "being green."

Concerns

When asked about any concerned they had about participating in PTNZ, the majority of respondents said they did not have any concerns and that they did not encounter any barriers. Respondents reported having a lot of faith in their owners, their design teams, and PTNZ staff.

Still, some did express concerns about the feasibility of meeting the higher energy savings requirements through the design process, and how they would cover the extra up-front costs if the targets were not achieved. Others were concerned that participating in the pilot would increase the overall cost of the building and undermine cost-effectiveness. A few mentioned the extra time it took to coordinate and shepherd the project through the program, and, in one case, a respondent talked about the challenge of making sure the right contract language was in place to obligate federal funds.

Program Experience

Our in-depth interviews asked participants a series of questions about the various components of each program step. Satisfaction with their experience was rated on a scale of 0-10, where 0 meant extremely dissatisfied and 10 meant extremely satisfied.

The next section of this report provides feedback based on questions that asked participants about overall experience overall experience with PTNZ – levels of satisfaction at each stage, what is working well, and what could be improved. After we report on respondents' overall views, we provide a more detailed exploration about participants' experience in each program stage. It is important to note that the number of respondents is notably smaller for the later program stages – commissioning and M&R – resulting in the analyses being more qualitative

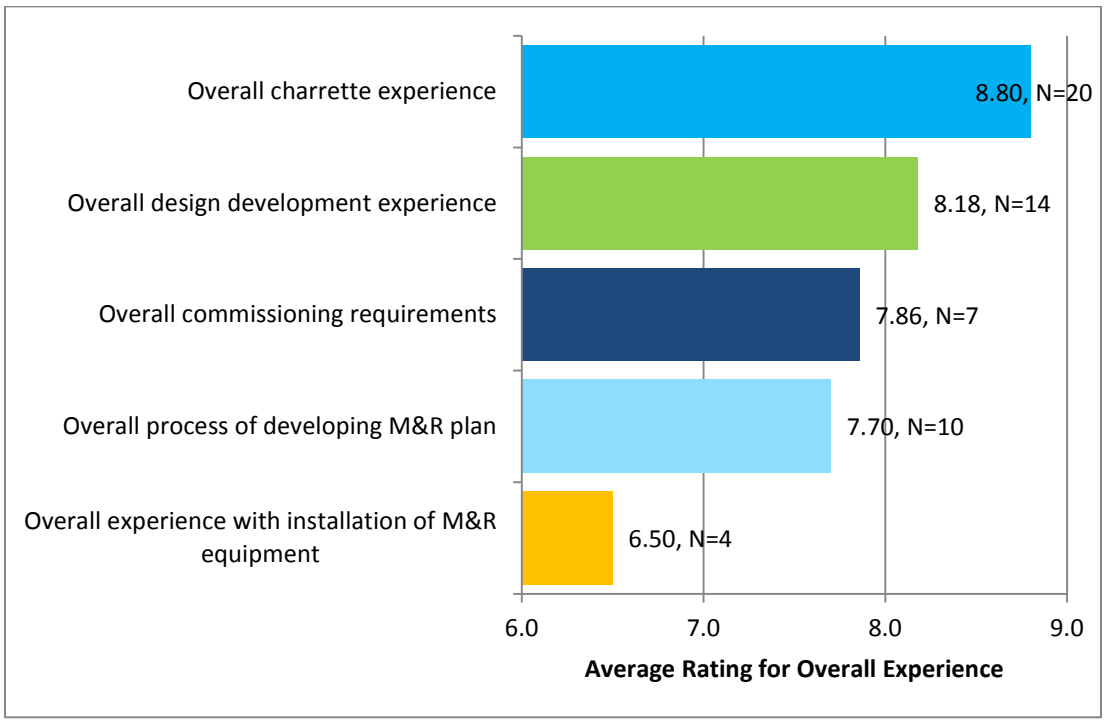
Overall Program Experience

SATISFACTION

Since the large majority of respondent satisfaction ratings were positive and in a narrow range between 5 and 10 on a 0 to 10 point scale, we present average satisfaction ratings throughout this section. However, we also discuss any outlier low ratings.

As shown in Figure 1, average satisfaction across all program steps ranged between "6.5" and "8.8."[5] Satisfaction ratings were highest for the charrette experience (8.8) and stair-step down to the lowest average rating for the installing M&R equipment (6.50, n = 4). These findings suggest the first stages of the process bring respondents a flush of discovery and excitement while the later phases introduce more down-to-earth requirements, analysis, and paperwork that may be more difficult to meet. Still, given the complexity and length and obligations of participating in PTNZ, these ratings are quite positive.

Fig. 1 Average Satisfaction across Program Steps[6]



PROGRAM ASPECTS THAT WORKED WELL

When the evaluation team asked participants to think about the program as a whole and all of the different services that they received, the most common response was that the financial incentives that ETO provided during the pilot worked very well for the projects. Some participants mentioned specific incentives such as those for solar PV, the early design assistance, or for energy modeling. One design team member responded, *"The funding [is what worked well]. That's the piece that gave us the opportunity to do the technical piece. Without that, I don't think a lot of owners would do this."*

[5] Due to the relatively small and changing number of respondents, particularly in the later stages of the program, challenges exist with reporting aggregate metrics. Thus, these ratings should be viewed as relative guideposts only. For all data presented in this section, no tests were conducted for significance.

[6] Source: Questions 13.a, 19.a, 31.a, 36.a, 38.a

Two other common responses were that the people in the program were great to work with, and that the technical assistance and feedback worked well for the projects. Here is what some team members said about working with program staff:

"One is just the people and their attitudes and values. They want to be helpful. They understand when issues occur and their impact. They work with you to find solutions. The program flexibility and people have been wonderful."

"Everyone has been awesome to work with. We've gotten incredible suggestions. The engineers and everyone have been great. The people are super in the program, and they really get it."

PROGRAM ASPECTS THAT NEED IMPROVEMENT

The evaluation team also asked participants the flip side of the coin – which areas of the pilot program need improvement? The most common answer that participants reported was that the PTNZ pilot could improve the clarity of its communications. This feedback generally referred to process and protocol, documentation, incentive structure, or requirements. One design team member suggested,

"Make things a little simpler or clearer. I did not feel we had a handle on the process going along…I did not feel I had a grasp globally on the incentives and how they worked, and what forms needed to be put together. It would have been helpful to the owner and design team to have that laid out beforehand, [so we had] a good understanding of incentives available and what needed to be done to meet those."

Two people suggested that the program should reconsider its baseline approach and consider switching to EUI, with one design team member saying: *"There are a lot of issues with the baseline. Because if you change building profile (more skin load), it can change the baseline. The metrics are kind of off. In our case we got a better performing building, but the metric was worse. If the goal is saving energy, maybe the metric is wrong. Maybe have something based more on EUI rather than percentage savings. If two buildings meet code and one has 10% lower EUI, it should get credit for that."*

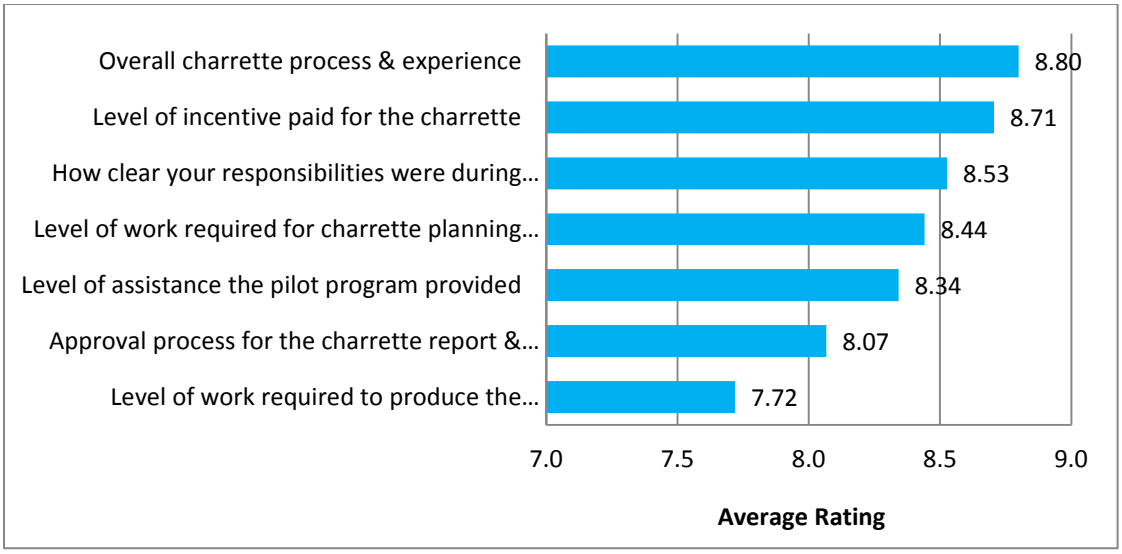
Two owners had comments about incentives or program emphasis; one recommended that the Energy Trust begin providing an incentive for publically displaying energy use. Another said: *"The big one is that I think it should be more focused on the early stages of the project. Where the document you produce feeds the design, rather reports on the design development. Especially given the goals of the program, that would be more useful. The difficulty is justifying the incentive. . . The more that this program can be structured to be an early-phase program, the more useful it is going to be. Maybe it becomes a tiered program or something."*

Early Design Assistance

SATISFACTION

Representatives from 10 projects (up to 20 respondents for each question) provided feedback on the Early Design Assistance portion of PTNZ; this phase of PTNZ focuses on the delivery of a design charrette and the resulting report documenting the charrette process. Figure 2 summarizes respondents' satisfaction with seven aspects of this phase.

Figure 2. Average Satisfaction with Early Design Assistance on a Scale of 0-10[7]



Almost all participants rated the various elements of their journey through the PTNZ's Early Design Assistance phase quite highly; most ratings were between 7 and 10 for most elements. Some were incredibly enthusiastic, saying they could not be where they are now without the charrette. In a few cases, ratings were lower (but not below 6) for the amount of effort required to conduct the charrette, to produce the report, and to get approval of the report. However, one designer gave even less favorable ratings (in the 3-4 range) for the amount of work required to produce the charrette report and for the approval process. This person thought the charrette reporting requirements were too detailed and the approval process was "kind of a black box." Program staff also wondered if the charrette report requirements might be lessened. A few participants indicated the pilot incentive only covered a portion of the charrette cost.

Positive feedback and high satisfaction were reported both by participants who had limited experience with design charrettes as well as seasoned design professionals:

"I thought it was great. I haven't done a lot of charrettes, but this was fun. This was good. We had a good group there… and had some fun with it. When we completed the charrette I think everyone was satisfied with where we were headed."- Owner

"This was most intense charrette I have ever been in. It was cutting edge and kind of out there. Out-of- the-box and really brainstorming… It was a really good charrette. Tons of people participated." – Design team member

MOST IMPORTANT OUTCOMES

When asked the most important outcomes of the design charrette, the top three responses across all projects were:

1. Identifying the energy saving strategies and influencing energy goals

[7] Source: Questions 13a.-13.g

2. Hearing different perspectives from building users and experts, and bringing all stakeholders to the table
3. Aligning goals

Other valuable outcomes or aspects of the charrette that participants noted included the importance of thinking outside of the box, fostering relationships, affirming the owner's commitment to pursue ambitious energy goals, and having it documented in a report.

"The charrette process is excellent in that you are able to get people in the room with different experiences to share ideas and create the best possible outcome. Once we started discussing ideas we were able to resolve issues and it made us develop things further. It was critical. At that point, I thought I knew everything I wanted to do, they thought they knew everything they wanted to do, and we were able to resolve what we were really going to actually do, which is better for everybody."- Owner

Additionally, program staff at both PECI and Energy Trust reported that the early design assistance seemed to be one of the most critical parts of the pilot, in that it enabled and encouraged the project team to coalesce around a goal. Program staff underscored the particular importance of commitment and goal alignment in the early design stages of a high-performing, path to net zero building, as compared to a more conventional path.

IMPROVEMENTS

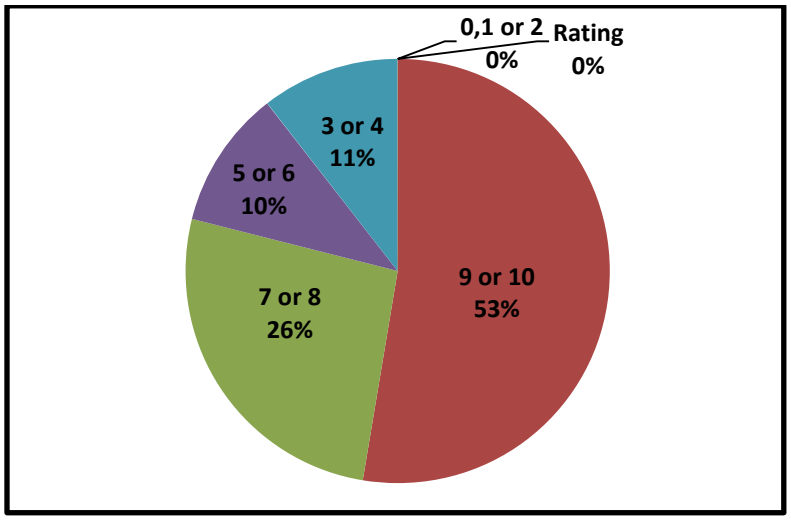
When asked, the majority of participants had no suggestions for improving this stage of the pilot. A few suggested changes, however. One person suggested the number of mandatory attendees be reduced since this affects the cost and the ability to schedule the charrette. Another person noted potential public awareness opportunities, and suggested consideration of how to use the charrette as an education tool. Two people thought it could be interesting to do a follow-up charrette of sorts, because they thought it was such a valuable experience to get everyone in one room. One design team member speculated about how it could work to integrate the schematic design better with the design development:

"The charrette was great. It could work well to transition into the energy modeling and not have it be a separate process for the next phase –from SD (schematic design) to DD (design development) – there are some duplications in that process…That would allow us to start rejecting things that don't make sense during the SD, to have something real thing to look at… The modeling should be expanded to take you to the finish of SD – [to see] where to layer in things."

NECESSITY OF FINANCIAL INCENTIVE

When rating the incentive on a scale from 0-10 where 0 is not at all necessary and 10 is extremely necessary, 79% of the respondents rated the incentive for the charrette as a 7, 8, 9, or 10. Out of 18 people who provided further reasoning for their ratings, we found that the majority (eight) reported that the charrette simply would not have happened without the incentive. The remaining 10 responses were split evenly between those who ventured that the charrette would have happened anyway, and those that said it is likely that the project would have held one, but it would have been much different and probably smaller.

Figure 3. Necessity of incentive for the design charrette on a Scale of 0-10, N=19[8]



SETTING AN ENERGY SAVINGS TARGET

Program staff reported that setting an energy savings goal was a critical component of the path to net zero. The program requirement of achieving at least 50% energy savings beyond Oregon code through energy efficiency alone or at least 60% energy savings beyond Oregon code through energy efficiency and renewable energy was a big part of driving the design process.

When we asked participants what the factors were in deciding on a final energy savings target, they reaffirmed the importance of the program goal. The most common response was that what drove their target was the program requirement of 50% or 60% savings. The second most common responses we heard was either that the project "wanted to get to net zero," that budget restrictions impacted the target, or that the physical characteristics of the building impacted their target (i.e., having enough roofspace for solar PV). Additionally, three respondents mentioned their goal to achieve LEED Platinum.

Technical Assistance

SATISFACTION

Representatives from seven projects provided feedback on the Technical Assistance portion of pilot, which included producing an energy analysis report (EAR) for the building, undertaking modeling and studies, and receiving technical assistance and feedback from PECI during the process. Some projects conducted a scoping meeting to discuss the energy analysis approach, but others did not. Figure 4. summarizes respondents' satisfaction with nine aspects of the design development stage.

Overall, participants continued to report high satisfaction with the Technical Assistance, but feedback reflected that there were more challenges in this step than during the Early Design

[8] Source: Question 17

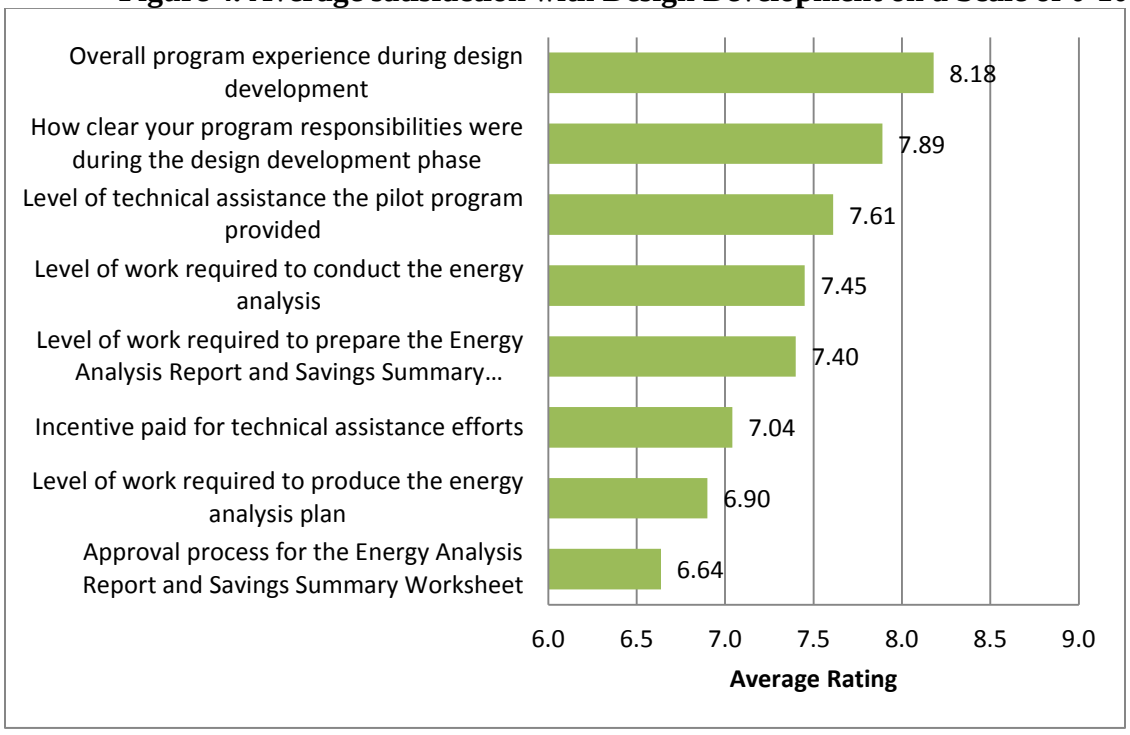
Assistance and the charrette. Average ratings remained positive (between 6 and 9), but most aspects of the Technical Assistance received at least one rating under 5. The top three challenges reported by participants were:

1. There was confusion about some part of the process, including paperwork or approval
2. The incentives did not cover the costs of the design development
3. There were program staff changes that in some cases caused confusion or slowed the process down, but participants were largely understanding about this challenge.

One owner, who rated his satisfaction as a "five," commented, "*My engineer told me they put more effort into the modeling than the incentive covered. Fortunately they were willing to do that. As far as the worksheet I was satisfied with it. There was a fair amount of back and forth. It took a while to get straightened. But in general it was a good process.*"

One design team member rated the overall TA as a "10," but then later offered the following feedback: "*Technical assistance was great. There were some things that were a little challenging but it was because we were trying to do something right, you know? There was more work involved than I thought. The level of work required to fill out the savings worksheet – I would rate more like a 5 or 4. It was hard to understand how to fill it out. It was complicated.*"

Figure 4. Average satisfaction with Design Development on a Scale of 0-10[9]



MOST IMPORTANT OUTCOMES

When asked what the most important aspects of this stage were, the most common response by far was that the technical assistance helped the project narrow in on the measures that would get

[9] Source: Questions 19.a-19.i

them the necessary energy savings. Another common response was that the TA gave project teams a better understanding of the cost-effectiveness of the measures; allowing them to make more informed decisions and refine the design when appropriate. Overall, respondents seemed to emphasize that the Technical Assistance and feedback from program staff allowed them to improve the design. On the program side, the review of the modeling has been helpful for staff in applying lessons learned to other programs and offerings.

CHALLENGES

According to program staff at PECI, finalizing the energy modeling was one of the most difficult areas for participants to get through. In particular, staff identified two separate, but related, obstacles: 1) the cost-effectiveness requirement for individual measures, and 2) measuring energy savings on an individual basis when designing a very integrated building. As one program staff person put it,

"In energy modeling, the Energy Trust cost-effectiveness requirement was a hurdle for all the projects. It becomes this exercise of, "we've done the modeling for the building, but now can we bundle measures together, because they're not cost-effective on their own, but maybe they're interrelated, or can share costs?" We were looking for these ways to make it pan out to meet the Energy Trust requirements. This is really hard to do for a building that is very integrated. It's hard to piece out the radiant floor savings from the boiler savings, from the heat recovery measure savings. They are so intertwined… it is still a very grey area on every project."

IMPROVEMENTS

When asked what would improve this stage of the pilot, four participants suggested improving communication – i.e. providing more clarity about the requirements, streamlining paperwork, or being clearer about the approval process. Another four participants suggested that ETO consider ways to improve the modeling approach and in some cases the incentive structure. These comments included:

- Consider using other common modeling protocols. The Energy Trust baseline is different than what is used for LEED, some project engineers struggled with modeling for Energy Trust and LEED. Some consulting firms already have a system in place to do both, but it is extra work and therefore extra time billed to the client. (2 comments to this point).

- Work on a way to get or designate measurable savings from human behavior. Consider ways to provide incentives for behaviors that support the net energy design. (1 comment)

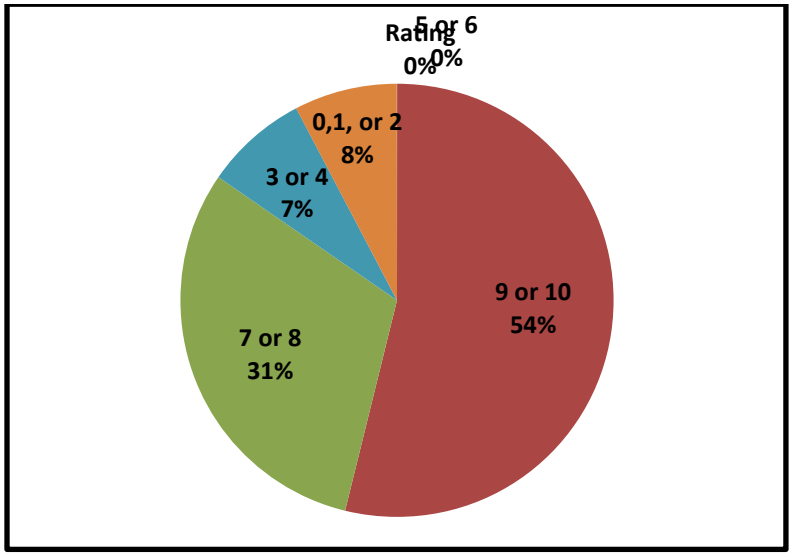
- Improve the incentive structure to reflect the ambition of projects that are really striving for net zero; increase the incentives, even if that means on taking less projects. (1 comment).

NECESSITY OF FINANCIAL INCENTIVE

As was reported for the charrette, the majority of participants viewed the Technical Assistance incentive as very necessary. When rating the incentive on a scale from 0-10 where 0 is not at all necessary and 10 is extremely necessary, 85% of respondents rated the TA incentive as a 7, 8, 9, or 10. In this case, only two respondents commented that they would have likely done the

modeling anyway, while eight people told us that they would not have been able to do the modeling or additional studies without the incentive, or, that their modeling would have been much more limited.

Figure 5. Necessity of incentive for the technical assistance on a Scale of 0-10, N=13[10]



Installation and Commissioning

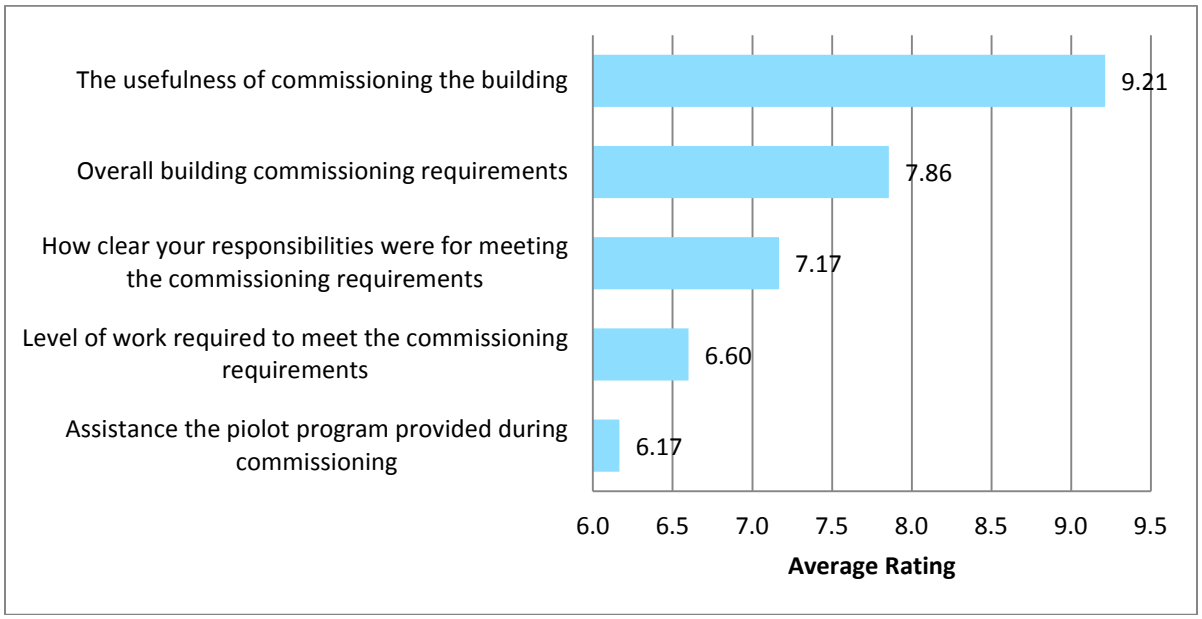
SATISFACTION

Representatives from just four projects provided feedback on the Installation and Commissioning portion of PTNZ. This step required that buildings undergo commissioning. Projects were required to submit a report, conduct an on-site inspection, and solve any issues that the commissioning may have uncovered in order to meet energy performance expectations. Release of funding for the installation of the measures was tied to this stage, (although this requirement was revised as noted below). Some projects are still undergoing commissioning, which restricted their ability to provide feedback on those components. One project team did not recall their experiences with this stage. Regarding satisfaction of the approval process for the energy efficiency incentives and the level of the incentives, two teams rated them between 7 and 10. Regarding satisfaction of preparing and submitting the completion form, the commissioning report, and the invoices, two teams rated these between 6 and 9. They rated their satisfaction with the site visit between 8 and 10.

Figure 6. summarizes respondents' satisfaction with the commissioning requirement in general (Feedback is from four projects).

[10] Question 24

Figure 6. Average satisfaction with Commissioning on a Scale of 0-10[11]



PARTICIPANT COMMENTS

Feedback was generally positive but in some cases comments reflected confusion about the program steps and requirements, or frustration about how long commissioning took. We found that program staff has a strong understanding of the challenges that participants have reported.

One of the major complications was tying the measure installation incentives with the commissioning report requirement, because in some cases it is necessary to commission the building for 6 months to a year after completion and occupancy. In this situation, program staff were able to respond quickly when they discovered this problem. Now, the program has unbundled the funding for installation from the commissioning report. In addition to that improvement, PECI staff reported that another challenge that surfaced was that the costs of commissioning depend on the size and scale of the building, so it does not make sense to have one, uniform incentive for all projects. We discuss the next steps for this further in the Conclusions section of this paper.

Another comment from a design team member on the commissioning step was, *"I wish that there had been more incentive for commissioning requirements. I wish the objective had been to cover the commissioning completely, that would have made things a lot easier, and we would have gotten better service from the commissioning agent. Regarding the clarity of requirements, we had to go back and forth quite a bit. Once I understood I was able to manage that process a lot better."*

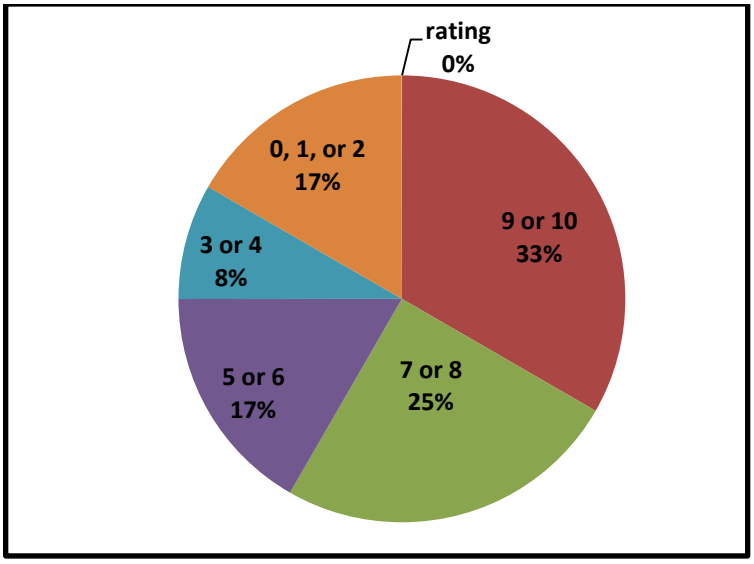
[11] Questions 38.a-38.d

NECESSITY OF INCENTIVE

In this case, we asked participants how important the program's incentives were **in deciding which energy conservation measures to install**. Because program participants had this information ahead of time, we asked this question of all the projects that went through the Technical Assistance stage. When rating the incentive on a scale from 0-10 where 0 is not at all important and 10 is extremely important, 58% of the respondents rated the incentive as a 7, 8, 9, or 10. Although this question is aimed to gage influence and not necessity, it is still notably lower than what participants reported for the Early Design Assistance and Technical Assistance.

When asked why they gave the rating, the most common response was that the incentives influenced the decision, but were not the deciding factor (6 responses). The second most-common response was that the energy savings was a bigger factor in determining which measure to install than the incentive was (3 responses). The least common answer was that the incentives directly impacted which measures to install (2 responses).

Fig. 7. Importance of incentives in deciding on energy efficiency measures on a Scale of 0-10, N=12[12]



Monitoring and Reporting

SATISFACTION

Representatives from five projects provided feedback on developing the monitoring and reporting (M&R) plan, four projects provided feedback on installing the M&R equipment, and three projects were able to provide feedback on submitting the data and meeting quarterly. Like the commissioning requirement, projects stressed the value of monitoring and reporting, but comments reflected confusion and challenges in many cases. Again, we found that in this area there is high alignment between the obstacles that participants are reporting and program staff understanding of the complications with this aspect of the pilot.

[12] Source: Question 29

Figures 8 and 9 show average satisfaction ratings with developing the M&R Plan and with the installation of the equipment. Regarding the post-occupancy data reporting and quarterly meetings, satisfaction ratings were between 6 and 10.

Fig 8. Average satisfaction with the Monitoring and Reporting Plan on a Scale of 0-10[13]

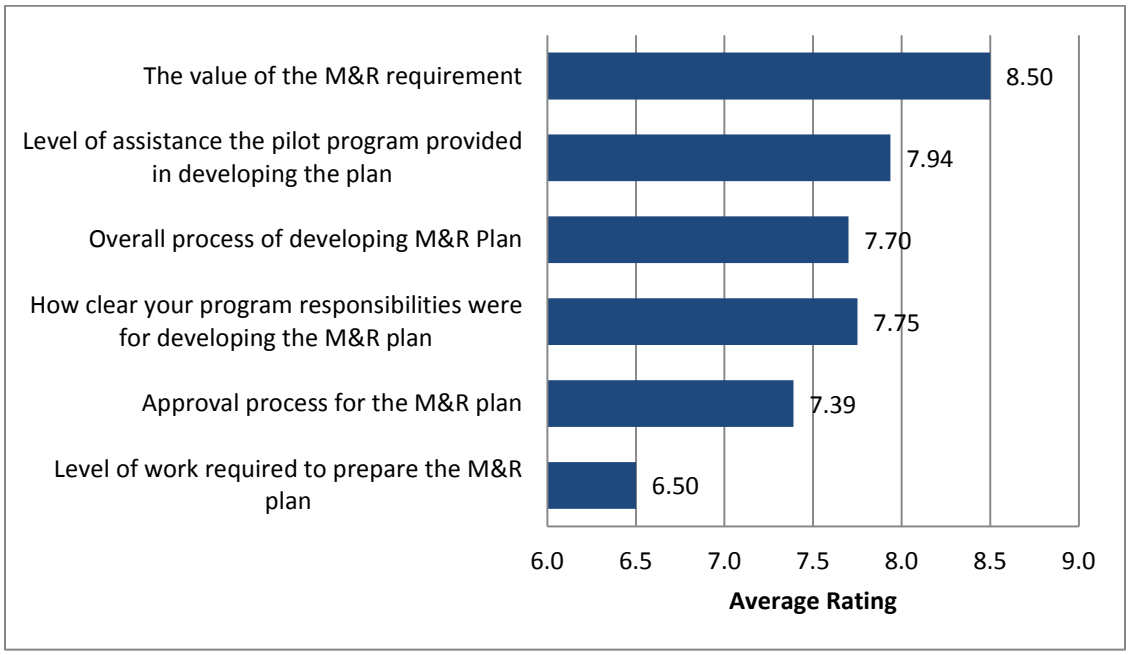
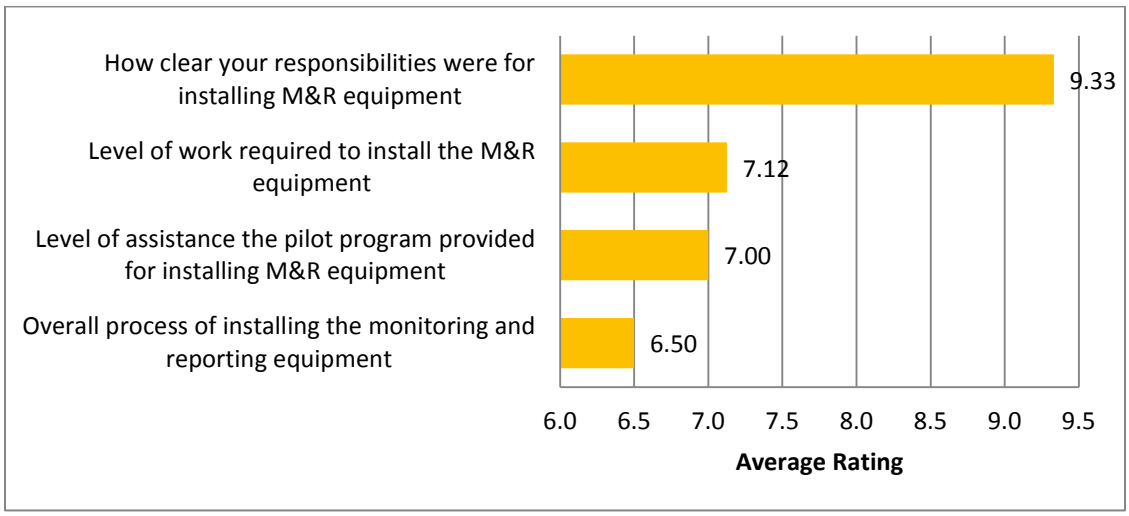


Fig 9. Average satisfaction with the Monitoring and Reporting Equipment Installation on a Scale of 0-10[14]



[13] Source: Questions 31.a-31.f

[14] Source: Questions 36.a-36.d

PARTICIPANT COMMENTS

Reported obstacles with the monitoring and reporting aspect of the pilot seemed to stem from a combination of factors, including:

- The inherent challenges with monitoring a high efficiency, solar-powered, multi-system building,
- PTNZ pilot program requirements and assistance, or
- Technology being relatively new to the market or untested.

Specifically, 3 out of 5 projects that have submitted an M&R Plan reported confusion about requirements or suggested that the program could be clearer. Three out of the four projects that have installed the M&R equipment reported challenges with installation, complained about the length of time it took, or discussed the complexity of integrating data. Some illustrative feedback on the development of the M&R plan and the complexity of installation include the following comments:

"When you're dealing with any program for the first time, it always seems to take a while. It was another entity and protocol to deal with. You got your LEED, you got your net zero, you got your state energy check plan, so lots of reports. If we had to do it again it would probably be smoother."- Feedback on developing the M&R plan from one design-team member

"Certainly things could have come up earlier in the process when everyone was agreeing, certainly some of the added information that was required of us should have been known." – Feedback on developing the M&R plan from an owner

"We almost did not pay attention to PTNZ requirements for monitoring and reporting. That seemed to be the lowest level. We were interested in building operations, and wanted to make the data available to people walking through building and make more sophisticated data available to student and design professionals. We had issues because we needed to bring in the data from three sources: solar PV, EMS [energy management system], and submetering equipment for natural gas and electric use, which had its own software. To integrate that data and get it on display, we are a getting solar subcontractor to give us a proposal to provide an integrated program with an option with a display unit. It has taken months." – Feedback on M&R equipment installation from an owner.

Again, program staff are well aware of the challenges with this step in the program and are actively thinking about possibilities for improvements. In our recommendations section, we discuss this further. PECI staff shared some further insights on where they see challenges occurring. Their comments centered on the following three main hurdles:

- Even though monitoring and reporting is required, installing the systems "feels like an afterthought." During construction, teams are focused on the building and making sure the measures are installed correctly. The result is that it has taken a long time for projects to get the systems in place and up and running. *"We had hoped it would have been more integrated into the construction of the building, but it didn't really turn out the way we had hoped."*

- It is hard for program staff to assist projects, because there is a lot of flexibility in the M&R requirement. The decision about which system to install and how to approach M&R is largely left up to the owner, which causes some confusion. *"They are looking to us to tell them. We were thinking that the system needs to meet their needs, but people really aren't thinking about what data is useful. They aren't thinking about that yet."*

- There is a disconnect between what the M&R plan says and what actually gets installed or implemented. *"We required them to do a plan before we paid the installation incentive, but it was just a plan…Things change since the plan, there's always something missing or unavailable…"*

Some projects went beyond the minimum requirement to install monitoring equipment. These projects sought to leverage the monitoring and reporting technology to impact human behavior through real-time, public display of energy consumption. By incorporating a public interaction component into the M&R, each project has faced additional challenges but both remain committed to their belief that improved knowledge about energy will translate to tangible economic and environmental benefits. One project hopes to inspire competition among tenants and directly impact their energy consumption and lower the owner's utility bills. One school plans to use the monitor as a teaching tool for students and faculty.

Common Energy Savings Measures

Energy saving strategies varied from project to project. Table 3 lists the common features and strategies based upon an analysis by program staff.

Table 3 Common Energy-Efficient Features[15]

Design Strategies or Technologies	Number of Projects	Design Strategies or Technologies	Number of Pilot Projects
Increased insulation, high performance glazing, other envelope improvements	8	Plug Loads	3
*Heat Recovery	6	Geothermal	2
Daylighting	6	LED Lighting	2
Efficient Hot Water Heaters	6	Monitoring Display	2
Solar PV	5	Solar Water Heating	2
Low Flow Fixtures	5	Variable Refrigerant Flow	1
Hydronic Heating and/or Cooling	4	Displacement Ventilation	1
Passive Cooling	4	Transpired Solar Collectors	1
Natural Ventilation	4	Irrigation Water Heat Exchanger	1
Demand Controlled Ventilation	3		

[15] "Notes from the Trail: Checking in on the Path to Net Zero," Submitted for the 2012 ACEEE Summer Study, by Becky Walker, Erin Rowe, Sarah Fujita, and Jessica Rose

When asked to discuss the individual energy saving measures, the strategies seemed to separate into three groups:

1. Strategies they normally would do[16];
2. Strategies that are higher performance versions of what they would normally do; and
3. Strategies that go beyond what they normally do.

Participants told us it is the integration of these strategies that is important in achieving a net zero building. As we reviewed the individual strategies they were using, some respondents emphasized that the strategies need to be considered as a package. They are dependent on each other, therefore it does not make sense to report them separately.

> *"You cannot make a building efficient when you break out the individual pieces because it is more about the synergies of how they tie together. Breaking out in separate pieces does a disservice of meeting the end point. Without one the others do not work as well. It is irrelevant to break out. All things are important."*

This has implications for how measures/strategies are considered by the pilot. Traditional new construction programs provide incentives by measure and there are requirements that must be met by each measure. The pilot is being more liberal about measure requirements and the bundling of measures, yet as we have heard from program staff, the cost-effectiveness requirement may still require fine-tuning in order to be most effective at spurring high-performance, integrated building design.

Trade-Offs and Risk

For those few projects 'grandfathered' in, participants identified cost trade-offs as a key influence on which strategies to employ in their buildings. They said they put in the best systems they could afford and that budget constraints sometimes caused them to select a system with lower performance than they wanted. Another trade-off that was mentioned was the competition between strategies for roof space. Daylighting (skylights), ventilation jacks (natural ventilation), and PV systems all require roof area. In cases where a PV system is planned to offset a large portion of the site energy use, there may not be enough roof area to accommodate the needed PV capacity. The trade-off between thermal mass and acoustics and daylighting and exterior envelope performance also came up for a few of the projects.

These few participants said the use of passive systems to meet their energy goals posed some of the primary risks they faced. A passive cooling system does not have a mechanical cooling unit that can be turned on when it gets really hot outside. In some cases, conventional norms of comfort will not be met, requiring that enhanced education for building users will often be necessary as compared to a conventional building. This presents risks as stated by a project owner:

We have to keep faculty happy. Will we have buy-in? Will people back away from that decision if we get complaints? How do we educate people to use that facility? How do we handle rooms that are really hot? Those are certainly questions.

[16] Note, however, that 'normal' for the PTNZ participants may be advanced for other owners and design teams.

These initial findings suggest that the pilot helps participants address trade-offs and reduce the risk associated with unfamiliar design strategies. The modeling and analysis that is being supported by technical assistance is providing information for better design decisions that improve confidence in how the building will perform.

Measures Not Installed

In addition to asking participants about their final decisions on energy conservation measures, the evaluation team also explored which measures didn't make the cut, and why.

Projects reported a wide variety of energy efficiency or broader sustainability strategies that were considered but then decided against. Interestingly, the reasons for not installing a measure were split between the measure not being cost-effective and other reasons. In cases where another reason was reported, some measures were eliminated based on their energy performance. Most of the time they were eliminated because of practicality, roof space competition, need for additional permits, or trade-offs with occupant comfort. For example, one project team wanted to explore a wind turbine, but was concerned with obtaining the necessary land-use permits. Another project wanted to implement an electric vehicle car-sharing program, but determined that the charging time for the vehicle would not be practical when considering the high demand for the car.

Ground source heat pumps were the most commonly considered, yet decided against, measure. This was almost always due to the cost of drilling. Other common measures that participants reported exploring but deciding not to use were rainwater capture and water treatment/stormwater mitigation techniques.

Measures that were considered but not installed:[17]

- Solar Hot Water
- Rainwater capture
- Ground source heat pump/geothermal
- Water treatment
- Green roof
- Wind turbine
- On demand water heater
- Passive strategies
- Economizer
- Heating strategy
- Solar charger for EV
- Envelope measures

[17] Source: Question 27

4. REVIEW OF ENERGY ANALYSIS REPORTS AND M&R PLANS

Each PTNZ project must submit an Energy Analysis Report (EAR) and a Monitoring and Reporting (M&R) Plan to the Program for review and approval. PECI, as the pilot implementer, is collecting cost and energy performance information from the EARs and from monitoring and reporting as data becomes available. The evaluation team reviewed and documented these activities, focusing on the following projects that are completed, mostly completed, or through the energy analysis phase:

- Hood River Middle School Science/Music Building
- Siteworks EcoFlats
- Chemeketa Community College Health Sciences Complex
- June Key Delta House Community Center
- Portland Community College – Newberg
- Blanchet House of Hospitality
- Hugh Development LLC – XVI Vernon

This section summarizes the results of this work.

Steps in the PTNZ Reporting and Review Process

It is helpful to understand where the activities considered in this section fit into the overall PTNZ reporting and review process. Program staff interact with members of the project design team (and their analyst) throughout this process as the design team submits documents and the Program reviews and approves them. This process ensures that program requirements are being met and that analysis results are reasonable.

Each project goes through the following steps, but the sequence of the steps can vary and there are steps that can be skipped (as noted).[18]

1. Design Charrette conducted, meeting minutes submitted to the program for review and approval. Early Design assistance incentive is paid upon approval.
2. Analyst submits energy analysis plan (referred to as PEAP, SOW or EM). This is a one-page memo that outlines the project, planned efficiency measures, modeling approach, and cost.
3. Scoping meeting is held to iron out any issues (this does not always occur).
4. Energy analysis plan is reviewed by the Program, analyst provides feedback/responses in review memo, and plan is approved.
5. Analyst submits EAR with documentation. This includes plans, drawings, cut sheets, controls sequences, incremental cost documentation, energy model files, other calculations, and related analyses.

[18] Information provided by PECI

6. EAR is reviewed by the Program (2 reviewers). Typical checks include:
    a. Reasonableness of baseline and proposed energy consumption and savings
    b. Modeling inputs, outputs and drawings to ensure that measures are modeled per the design
    c. Validity of baseline model (e.g. are baseline model assumptions reasonable, and align with industry standards)
    d. Validity of modeling technique or assumptions used for proposed measures
    e. Evaluation of costs and cost-effectiveness of each measure
7. Review comments are returned to analyst. Analyst responds back to program in review memo, and provides any updated documentation, reports or energy models. Reviews typically require 2-3 iterations before approval.
8. Commissioning plan is reviewed and approved. Site verification checklist is created highlighting items to be documented (measures and what to look for) during a site visit.
9. Modeling incentive is paid and installation incentive is reserved
10. M&R plan is submitted. This can happen earlier during the energy analysis steps above. Plan is reviewed with some comments back and forth between the analysts and documented in the review memo. Once requirements are met it is approved by the Program
11. Building is built; commissioning report is completed and submitted to the Program (the commissioning report may be submitted later if the commissioning process continues during initial occupancy).
12. Commissioning report is reviewed/approved (this may occur later), site visit is completed, and installation incentive is paid out (this step was revised so the installation incentive could be paid in cases where commissioning continued after initial occupancy).
13. Once M&R equipment is installed / complete, an M&R site visit is completed to verify installation of meters and functionality of data collection or energy dashboard system. M&R incentive is paid out.
14. Energy consumption data is provided to the program for 18 months, and quarterly meetings are established between the program, owner and design team members to discuss building performance.

This section of the evaluation report focuses on steps 6, 7, 10, and 14.

EAR Review

The evaluation team considered seven EARs that were completed and went through the Program review process. The Program has a report template that all of the projects either used directly or conformed to. Overall, the review process appeared effective.

All but two of the EARs that we reviewed were robust analyses with sufficient detail and appropriate scope for the facilities being analyzed.

Two of the reports were very cursory and lacked enough detail to adequately review. In these cases, the information about the building and the measures being analyzed was insufficient and unclear. It appeared the analysts for these two projects were not familiar with preparing an EAR or were unable to devote the attention to doing the work well. This was confirmed in conversations with program staff. In contrast, the successful EARs were completed by analysts that had prior experience meeting the requirements of the ETO New Construction Program. These analysts have developed methods and templates of their own to efficiently complete these reports.

Additionally, effective communication was critical for a successful modeling process. PTNZ structured the process so communication began early with the design charrette, the energy analysis plan, and the scoping meeting. For projects that experienced challenges with their EARs, this communication did not go as well or was not as integrated into the design process – resulting in the program requirements being viewed more as a follow-up step.

Common EAR Challenges

Program staff creates a review memo for each EAR that documents the results of their review. The issues that came up most frequently in the review for the successful EARs were:

- Questions and clarifications about energy model/analysis assumptions or approaches: this might include how a measure was being modeled, assumptions about numerical inputs, or the baseline being used
- Cost-effectiveness and bundling of measures: this might include questions about incremental costs, properly determining cost-effectiveness, measures that were not cost-effective, and what measures could be "bundled" for the cost-effectiveness calculation

In general, the comments did not have significant impacts on revising the models for the five successful EARs, but they did impact how measures were considered and how cost-effectiveness was calculated.

The other two projects did not have final review memos because the energy analysis was completed by program staff in order to meet the requirements of the pilot. Staff determined that this was the most efficient way to address the concerns that came up in their review and still keep the projects in the PTNZ pilot.

In some cases, the issues that came up for these PTNZ projects were not unique. It is common for any project undergoing EAR review in the Energy Trust NewBuildings Program to have issues with submittals (something is often missing), model assumptions, the baseline, incremental cost, and measure cost-effectiveness. However, some of these issues are more significant for a PTNZ project. Namely,

- Model assumptions carry more weight when modeling measures that are not common or that are not included in the standard options in the model
- The baseline can be more difficult to determine because it may not be the case of simply putting in a more efficient system, but aspects of the building may be completely re-configured

- Incremental costs can be difficult to determine in an integrated design when one efficiency feature influences other features in the building.
- Measure cost-effectiveness becomes more of an issue in a high-performance building because measures that are less cost-effective (higher costs and lower savings) have to be considered in order to meet ambitious performance targets. So measures that do not meet the program's cost effectiveness test and thus do not qualify for incentives still need to be considered. However, these are the measures a building owner might most need an incentive for. The question then is whether these less cost-effective measures can be bundled with related measures that are more cost-effective. In general, PTNZ projects design teams tend to look at measures as a whole and are resistant to the program requirement to consider measures individually.

M&R Plan Review

The evaluation team reviewed three M&R plans that had been developed by the projects and reviewed by program staff. Overall, the concept of creating M&R plans and collecting monitoring data is a new component for Energy Trust New Building paths; and an area where program staff have limited experience. Although there have been challenges with this phase of the pilot program, PTNZ experiences with M&R have the potential to add significant value for future program offerings.

Plan Effectiveness

Projects used a template for their M&R plans that was provided by the program. In reviewing the three completed plans, the evaluation team came across two main challenges that impact the effectiveness of the plans:

- Difficulty in understanding the goals of the monitoring, and how the goals would be achieved. (i.e., projects did not usually specify what they were hoping to find out).

- Difficulty in assessing the appropriateness of the monitoring plan and system. The intent in some cases seemed to be satisfying the Program requirements, although this does not suggest the projects did not want to do monitoring. One project was also doing monitoring to meet LEED requirements (and there may be others) and our interviews suggest that others were interested in understanding how their buildings were performing.

Review Process

The M&R review process focused on whether the plans met Program requirements. As might be expected, the M&R plan review comments focused on clarifications and requested more information about what was needed and what was going to be done. Looking at the plans and review comments, one gets the sense that they started a conversation between program staff and the project team, in which next steps were then decided on.

The M&R plan process added value by helping the project teams think about what they wanted to monitor and how it might help them operate their buildings better. Program staff recognize they need to make improvements to this process by learning from this experience. Some of their suggestions are included in our recommendations section, which we explore later on this report.

Cost and Energy Savings Data

A desired outcome of the pilot program is to obtain estimates of the energy savings and costs associated with the varying technologies and design approaches used in the pilot projects. The Program is collecting the following cost and savings information:

- Incremental cost, energy savings, and cost effectiveness information for every energy efficiency measure or measure bundle from each EAR
- Energy use data. For most projects this consists of whole building electricity use and PV production data at 15 minute intervals and natural gas use data at one hour intervals. It also may include sub-meter data for some building systems or some parts of a building that are of particular interest.

The measure cost data has not been pulled into a database or analyzed as a whole. Program staff have used the data for radiant floor systems to help them to promote this system in their current offerings. They do plan to use the data they have collected. This data can be used for comparison with future new construction projects to help gage what costs are reasonable. One challenge in analyzing this data that merits consideration is differences in incremental cost calculations across projects.

So far, the program has started collected energy use data from five completed projects. Two challenges they have experienced is getting the data from the projects in a consistent and timely fashion and differences in the formats for how they get the data. Thus, each project has been a custom project from a monitoring standpoint. As a result, they have not been able to efficiently collect this data and get it in a standard format for analysis.

The process has gone the smoothest with projects where the design team is still engaged and interested in the building performance and the owner is also interested and using the data. This is somewhat unusual. Traditionally, the design team moves on to the next project and the owner does not have the time or motivation to track energy use - making it less likely someone will take the responsibility to ensure that monitoring is happening.

The program has been weather-normalizing the actual measured data and comparing it to the modeled consumption by plotting the actual and predicted monthly energy use. They have been using the data to determine if a project is meeting its net zero energy or other energy use goals. They have also been using the data to look at scheduling and operational issues and in a few cases have been able to identify problems that have been corrected to improve building performance. For example, in one case they noticed a spike in heat pump use during colder months and were able to correct a problem in the control sequence.

Only one project has provided a full year of data and it is close to meeting its net zero goals. Another building seems to be falling a little short of its net zero goal because the production of

the PV system was over-predicted, but it is near net zero.[19] Data collection is in its early stages for other projects that have been completed and are occupied.

[19] In this case, "net zero goal" refers to the projects own goals to meet operate the building with net zero energy, not the program's goal of 50% or 60% above code.

5. BARRIERS AND SOLUTIONS TO PURSUING NET ZERO BUILDINGS

When we asked participants their thoughts about what might be discouraging about pursuing a high-efficiency or net zero building and what were some ways to address these obstacles, we received a wide array of suggestions. The obstacles that participants reported generally fell into one of five categories, with real or perceived costs being the most commonly reported barrier:

1. Increased costs – real or perceived
2. Reluctance to try new design techniques, systems, or technologies
3. Perception of risk among developers that the public is not receptive
4. Skepticism about reaching lofty goals or that "Net zero" can really be done
5. Lake of available data in the marketplace to justify risks

When answering the question about next steps to overcome these barriers, respondents often gave multiple suggestions that spanned from solutions at the project level, to the direction that the market needs to go in order to enable net zero buildings, to specific program suggestions for the Energy Trust. These solutions, as reported by participants, are captured in Figure 9 and align with associated barriers.

Figure. 9. Barriers and Solutions Matrix

Barrier	Solution										
	Project-level Solutions		Market Solutions				Suggestions for ETO				
	Design and modeling incentives	Technical Assistance	Enhanced education and public awareness	Real estate market valuation of EE	Improved market for high-efficiency buildings to drive costs down	Shift toward performance-based approaches with M&R	Encourage ambition while emphasizing feasibility	Advertise pilot program experiences & make owners available	Use "Menu Approach" like ETO Small Commercial program	Play bigger role in state/local policy to advocate for gov't fiscal incentives	Leverage LEED; the owners want it, the public recognizes it
1. Increased costs - Real or Perceived	■		■	■	■			■		■	
2. Reluctance to try new design techniques; systems; or technologies	■	■	■		■	■	■	■	■		
3. Perception of risk among developers that public is not receptive			■	■				■			■
4. Skepticism about reaching lofty goals/"Net zero" goal	■	■	■				■	■	■		
5. Lack of available data in marketplace to justify risk	■				■	■		■			

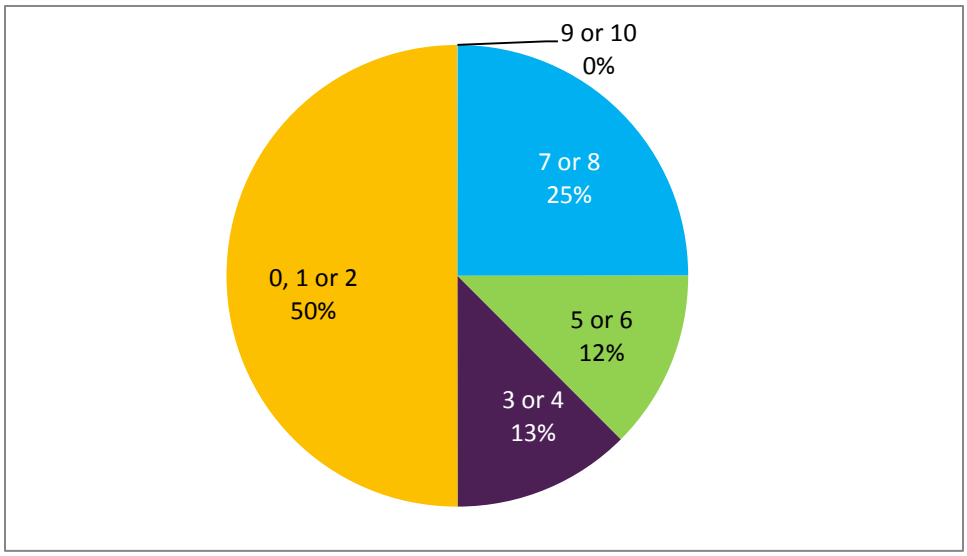
6. INFLUENCE AND VALUE

It's clear that the PTNZ pilot had tremendous value for the majority of participants and significantly influence building design of the projects through the early design and technical assistance that the pilot provides. Questions about the pilot's influence were often difficult for participants to answer. Similar to how participants reported their motivations for becoming involved in the program, most said they began with an underlying commitment to pursuing a net-zero building. But they gave PTNZ most of the credit for helping them see it through.

The majority of respondents said that without the influence of the pilot program, they would have had an efficient building of some kind, but the program made it higher performing. A few said they would not have done the building at all or that they might have gotten there without the assistance of the pilot. Some said that without the pilot, the building would have cost more, or it would have been much more difficult to complete.

When asked to rate the likelihood of building the same building, in the same timeframe, without the help of the pilot program, 63% of respondents rated the likelihood a "4" or below (very unlikely). No respondents rated the likelihood as a "9" or "10."

Figure. 10. Likelihood of Building the Same Building without PTNZ Pilot Program on Scale of 0-10, N=8[20]



Not surprisingly, participants receiving special waivers to join the pilot after they had already been through schematic design had already made decisions about efficiency strategies and many had done design charrettes on their own. These respondents tended to say the pilot had limited influence on their basic choices. However, they did note the pilot was important for improving

[20] Source: Question 54

the quality of their designs. For example, the technical assistance modeling allowed the design of some strategies (like natural ventilation) to be improved.

We were going to do most of this anyway. It put us over the top. More than being able to do the strategies, it made the strategies more successful. . . .If these buildings are successful it will lead to more people constructing them in this manner. . . . I think that is more where the value lies rather than we were able to do something we were not going to do.

Most of the participants in the earlier stages said that they thought the pilot helped solidify their goals and their commitment to meeting them as well as providing data that backed up the energy savings claimed in the building design. Several cited how important it was to have the charrette report. In addition, preliminary data suggest that the program's influence on the actual choices was greater, pushing them to be leaders, to commit the whole team to same goals and ideas, and to see where they could, for instance "push the acceptable range for comfort."

Think it definitely influenced energy goals – to have ETO there, M&E there. . .to have the client 100% on board; educational opportunity for everyone. . .so much buzz in the room and the brains are cranking.

When asked about the primary benefits of participating in the program, the top three things that respondents mentioned were:

1. The incentives to cover the enhanced modeling and the CFD
2. Improved education
3. The PR benefits or credibility of having been a part of the program.

Other things that participants mentioned were the overall improved performance of the building and the reduced overall costs of the project. Here is what one owner said about the value of the Technical Assistance incentive:

"One of best aspects was extra money for enhanced modeling. That modeling reduced ventilators we were going to put on building from something like 300 to 75. Huge financial impact in terms of savings and available roof real estate. That money for enhanced modeling was worth its weight in gold. It allowed us to be much more sophisticated about the daylighting and ventilation in particular."

And what one design team member reported:

"There's probably only a handful of engineering firms that have the experience. My biggest benefit is becoming familiar with net zero and being able to converse with clients on this, and being able to talk intelligently about this."

7. LESSONS LEARNED FROM THE PATH TO NET ZERO

From the participant interviews, program staff interviews, and review of technical documents, the evaluation team compiled the following conclusions and lessons that can be applied to future New Building program offerings at ETO. Each one is discussed in more detail below.

1. The energy target is an important motivator and attraction for participation.
2. Early design assistance and technical assistance are critical program elements for success in a high-performance building or PTNZ program.
3. Challenges exist in meeting program requirements for individual measure cost-effectiveness.
4. Monitoring and Reporting in PTNZ holds value for the broader high-performance building market.
5. Occupant and operator behavior is likely to be a more important part of building performance in high performance buildings.
6. Smaller buildings can result in program administration challenges.
7. Both financial and non-financial motivations are strong influences on owners wanting to build net zero buildings.

Key Conclusions and Recommendations

1. **The energy target is an important attraction for participation and motivates participants to meet program requirements**.

   Having a defined energy savings goal at the start of the project is critical for encouraging people to consider options to reach the goal, as well as discouraging them from eliminating features during design and construction that are needed to meet the goal. The concept of being "net zero" is a further motivation for some owners, as this communicates ambition and being on cutting edge. The credibility and support of ETO to meet the goal helps to mitigate the perceived risk for participating.

   Recommendation: Ensure that energy targets are a key feature and attraction for the program. Given the change in the energy code, reconsider what the targets should be and how they should be distributed between efficiency and renewables.

2. **Early design assistance and technical assistance are critical program elements for success in a high-performance building or PTNZ program because setting direction at the outset is easier, cheaper, and much more likely than changing direction later.**

Participants rated both the early design assistance and the technical assistance components of the program highly, and appreciated the flexibility that was available for additional modeling and analysis. The Technical Assistance helped projects to meet the energy goal and to identify the package of measures and to optimize the building design to meet the goal. This assistance makes the program more attractive to design teams, who are often the ones to recommend the program to owners, and mitigates the risk to owners.

Feedback from participants suggest that incentives for early design assistance and technical assistance may carry more weight than incentives for energy efficiency strategies. When rating the importance of the incentive in deciding which energy efficiency measures to install, only 58% of the respondents rated the incentive as a 7, 8, 9, or 10. In comparison, 79% of the respondents rated the necessity of the early design assistance incentive and 85% rated the necessity of the technical assistance as a 7, 8, 9, or 10.

Recommendation: Provide significant incentives for early design assistance and technical assistance to ensure the program has the opportunity to influence and assist in optimizing the building design.

3. **Challenges exist in meeting program requirements for individual measure cost-effectiveness, especially for pilots where cost-effectiveness parameters may not be known**.

When designing a high-performing building, participants used a whole building, integrated design approach. Measure incentives are valuable, but seemed to be less important than design assistance in influencing the choices owners made, particularly when individual measure cost-effectiveness is required to be calculated. While the program provided some flexibility to this point, there were challenges around determining which measures could be bundled together. This seemed to create extra work both on the part of analysts and program reviewers in many cases with little added value. "Cost-effectiveness" as defined by the program may not be an appropriate way to determine which measures should be installed.

Recommendation: Consider removing the program cost effectiveness requirements, in order to let the owner decide what is cost-effective. Analysis can be simplified by considering the whole package of measures rather than conducting a measure by measure analysis. Consider basing incentives on energy savings performance, and providing incentives in a way that helps building owners afford the package of measures to meet their energy goal.

4. **Monitoring and Reporting in PTNZ holds value for the broader high-performance building market, including building operators, but the requirements can be challenging for participants.**

Monitoring and reporting is an integral component of the path to net zero, but was also the area where the learning curve was steepest in the pilot. Participants and program staff

indicated that there was confusion and lack of clarity on what monitoring and reporting involved even though they both see the inherent value of monitoring and reporting the building, and the essential role it plays in solving building operation problems.

Participants also indicate a real commitment to ensuring the energy goal is being met. Thus, the lessons learned about the best ways to monitor high-performance buildings are key for future programs, and for transitioning toward performance-based design and construction approaches. In particular, the monitoring of data becomes more critical if the program were to pay incentives for kWh savings or for actual energy performance.

Recommendation: Consider refining the M&R requirement to establish M&R goals at the beginning of a project during the building design process. The program can also help reduce confusion by specifying certain monitoring systems and reporting processes that will meet the requirement, as well as incorporating further prescriptive guidelines such as minimum data requirements. To the extent possible, PTNZ implementers should take over primary responsibility for filling out any forms and paperwork.

Other options such as incorporating M&R into the commissioning process, which often can extend beyond initial building occupancy, or having a post-occupancy evaluation process, may be appropriate to consider under the context of monitoring and reporting.

5. **Occupant and building operating behavior are likely to be a more important part of building performance in high performance buildings than in other buildings**.

Because energy use is lower in these buildings, the actions of occupants have a much greater influence on energy use. Participating projects were using "behavior measures" to help meet their energy goals. While not assigning energy savings to these measures, the PTNZ pilot was receptive to these efforts and considered these behavior measures when allowing a few projects to stay in the pilot even though they fell a little short of the energy performance targets. However, there is acknowledgement that more consideration needs to be given to how to incorporate occupant behavior into the program.

Recommendation: Although further research is needed on this issue, consider including occupant behavior as an explicit part of any future program. Some energy saving credit should be given to occupant behavior measures, but implementation requirements need to be tied to this credit. These requirements could include occupant training and feedback to occupants on building performance. Particular emphasis might be placed on "plug loads" which are a growing percentage of building load and are heavily influenced by occupant behavior.

6. **Smaller buildings can result in program administration challenges.**

Small buildings accounted for a significant portion of the PTNZ participants. These building still require all the analysis and review effort of a larger building, but the amount of energy savings is smaller. These smaller buildings can require more effort on the part of Program technical assistance and review staff because the project teams are smaller, have

fewer resources, and may have less experience participating in new construction programs.

Recommendation: Consider options for simplifying the requirements for small buildings by offering more streamlined processes and prescriptive packages and guidelines.

7. **Both financial and non-financial motivations are strong influences on owners wanting to build net zero buildings.**

   Incentives and operating cost savings were reasons to participate, but they competed with other strong motivations for initial interest in pursuing a net zero building. The majority of owners participating in the program had a desire to reduce their environmental impact, to be responsible, and to be leaders in their communities. For this reason, PTNZ may do a better job of improving building design than in changing design choices.

   Recommendation: Consider structuring incentives to continue pushing owners and design teams to enhance the design and provide a safety-net for those who are already motivated to be highly efficient, but don't have all the needed skills or money to do so.