Energy Trust of Oregon's Refrigeration Operator Coaching: Harvesting Energy Savings from Peer-based Learning and Technical Support

JP Batmale, Energy Trust of Oregon
Brian Crumrine and Kyle Huth, Cascade Energy Inc.

ABSTRACT

Energy efficiency training has been a key strategy for companies looking to reduce their energy consumption and drive savings. Energy efficiency trainings often focus on market transformation and do not include rigorous savings analysis. Training sessions are typically brief—half-day or day-long events—with minimal follow-up. Content retention is low—in some cases, less than 10% (Wickes, Sickert & Dias 2007).

However, converting training into a resource acquisition offering with measurable savings is possible through an innovative approach that recognizes the importance of:

- Taking a hands-on approach to training that occurs on the facility floor, with a combination of peer-to-peer interactions and strategic one-on-one coaching
- Learning experiences that build participants' confidence and ability to apply new knowledge to complex issues
- Engaging an organization at all levels, so that participants have support from upper management
- Assessing energy savings facility-wide through top-down regression models, rather than assessing savings on individual improvements

In 2011, Cascade Energy, Inc. was selected by Energy Trust of Oregon to implement a peer-based, training offering called Refrigeration Operator Coaching (ROC). ROC takes learning to the facility floor where practical skills are implemented with technical guidance, giving operators the ability to identify and act on energy saving opportunities.

In 2011 and 2012 ROC participants averaged 6.7% energy savings, with some facilities achieving greater than 15%.

This paper discusses the benefits of peer-supported operator coaching based on the ROC methodology; outlines the ROC offering and demonstrates how training focused on retro-commissioning and behavioral opportunities can be linked to clear and measurable cost and energy savings.

Introduction to ROC

Industrial refrigeration systems, due to their size and complexity, offer excellent potential for large, verifiable energy savings through training in low- and no-cost operations and maintenance (O&M) improvements. ROC is an Energy Trust industrial energy efficiency offering that builds on these advantages.

t. ROC's energy efficiency training for large, industrial refrigeration systems combines workshops involving a cohort of peers, with on-site technical support and coaching so clients can

implement system retro-commissioning, strategic energy management inspired reporting, policies, and procedures improvements to create accountability and foster communication, and web-based energy management software energy information system (EIS) to track energy performance.

Since 2011, Cascade Energy and Energy Trust of Oregon have implemented ROC at nine industrial facilities in Oregon. ROC achieved verifiable energy savings by integrating "top-down" regression analysis of energy consumption into the offering. Energy Trust has been able to claim savings for most participants with verifiable, and in most cases, significant energy savings.

The methodology used in ROC can be applied to other energy intensive industrial systems. Refrigeration facilities are ideal candidates for an energy efficiency offering such as ROC, which focuses on training and coaching to achieve lasting energy savings, because the savings can be so demonstrably large. For Energy Trust, the regional concentration of large food processing and cold storage facilities with refrigeration systems that dominate their facility's load use profile made offering operator coaching for refrigeration systems especially attractive. Recent success in using top-down regression analysis to measure energy savings across an entire facility also encouraged Energy Trust to consider an operator coaching offering (Crossman, Hamilton & Lehoux, 2011). Lastly, the culture in Northwest supports offerings like ROC. Utility funded efficiency trainings are common in this region (NEEA, 2013), and there are active chapters of the Refrigerating Technicians and Engineers Association (RETA) that encourage training and collaboration within the industrial refrigeration community. All these factors contribute to the success of the ROC training offering.

System Size and Complexity Lead to Energy Efficiency Potential

Northwest Oregon has a substantial number of food processing and cold storage facilities. Many operate industrial refrigeration systems that consume a large amount of electricity. Industrial refrigeration systems often consume between 40% to 80+% of total energy utilized at cold storage and food processing facilities.

While running refrigeration systems efficiently is important, operators are not always clear how to do so without impacting production or safety. This is due to several factors. First, industrial refrigeration systems are made up of multiple customized components with numerous parameters and system set points. The operation of one system component often influences the energy efficiency of another. Second, the amount of energy consumed in a refrigeration system is highly influenced by changing weather conditions. Third, industrial refrigeration systems' cooling and freezing loads can vary from day to day and product to product. In combination, these factors add up to a complex and dynamic environment that is challenging to manage. However, the complexity of refrigeration systems also means that there are many opportunities to gain energy efficiency, particularly from low- and no-cost operations and maintenance (O&M) actions. This is especially true as refrigeration operators make daily decisions and take actions that impact, not only how well a system cools or freezes a product, but also how much energy the system requires to complete the job. Given the magnitude of energy that refrigeration systems consume, operators have a tremendous influence over them on any given day.

Background

Energy Trust of Oregon is an independent nonprofit organization, overseen by the Oregon Public Utility Commission (OPUC). Energy Trust provides solutions and cash incentives that help customers save energy, use renewable energy, and lower costs in homes and businesses. Energy Trust serves the customers of Portland General Electric, Pacific Power, NW Natural and Cascade Natural Gas. Since 2002, Energy Trust programs have directly saved customers over $1 billion on their energy bills. Annually, Energy Trust consistently meets or beats savings and renewable generation targets set by the OPUC. The cumulative impact of Energy Trust's work has been to help keep energy costs as low as possible for their customers and the Northwest region.

Cascade Energy provides industrial energy efficiency expertise to utilities around North America. Cascade Energy implements Refrigeration Operator Coaching as a contractor to Energy Trust.

Strategic Energy Management Offerings

Energy Trust's industrial and agricultural customers are served by the Production Efficiency (PE) Program. This program includes a mix of service and incentive offerings that range from prescriptive lighting to custom capital studies and incentives. In 2012 the PE Program helped industrial and agriculture customers save over 127 million kWh and 879,000 therms.

Beginning in 2008 the PE Program began acquiring energy efficiency resources from Strategic Energy Management (SEM) offerings. Energy Trust was influenced to adopt SEM offerings by the success of the Northwest Energy Efficiency Alliance's Continuous Energy Improvement efforts. SEM offerings have played a pivotal role in Energy Trust's diversification strategy to engage more customers and acquire more savings per customer.

Since 2008 Energy Trust's SEM offerings have served over 70 customers and collectively saved over 93 million kWh. These savings are independent of capital investments, custom or prescriptive, that may occur during the SEM engagement. Energy Trust's successful experience with several SEM offerings made them receptive to Cascade's proposal to launch ROC in 2011. This was partly due to the fact that ROC claimed energy savings based on many of the same principles and concepts found in other SEM offerings.

Participant Selection Factors for ROC

Based on two years of experience running this program offering, ideal candidates for ROC exhibit the following qualities:

1. **Adequate Baseline Refrigeration Energy Use**: The amount of energy consumed by a refrigeration system is a strong indicator of potential energy and cost savings. Energy savings tend to be anywhere from 4% to 15% or more of baseline refrigeration energy consumption. That means the baseline quantity of consumption can yield an estimate of savings. Given the average implementation cost of ROC, Energy Trust seeks sites that

consume at least 3.5 million kWh/yr. of refrigeration-based energy. Refrigeration energy consumption makes up a large percentage (often greater than 50%) of total facility energy use at qualifying sites. This is an important factor when modeling energy use from a facility-wide perspective. Acquiring energy efficiency resources from a ROC offering requires that energy savings be visible for modeling purposes at the utility meter level. If a refrigeration system is too small, it may be difficult to identify energy savings from refrigeration O&M improvements. For smaller systems, utilizing "top down" energy modeling may not be possible.

2. **Willingness of Refrigeration Operators to Take on Energy Efficiency Projects**: ROC requires that operators invest their time and be willing to participate. Because ROC is extremely hands-on it is described as a "project," and not a traditional training. Operators must embrace the project-aspect of ROC (including homework) along with working side-by-side with ROC engineers and technicians to achieve success. A deep level of refrigeration expertise is not required. Operators gain a significant amount of knowledge and experience through workshop discussions and interactions with their peers and coaches.

3. **Support from Executives and Management:** Based on lessons learned from previous SEM engagements, formal support from management is essential. ROC participation takes time. To be successful participants need the support of management. Conversely, this support also holds operators accountable to perform well and ultimately to use the knowledge gained to drive energy efficiency at their facility.

4. **Consent to Sharing Data with Energy Trust:** The use of top-down energy modeling and an EIS requires that a site be willing to share production data with Energy Trust. Participating sites must be willing to coordinate with their utility to install hardware on the meter that enables near real-time transmission of energy data to the EIS.

ROC Offering Design

Strategy and Methodology

The following three strategies form the basis for Refrigeration Operator Coaching:

Knowledge is best acquired in a peer-group environment. ROC operates on the premise that the most valuable learning experience happens when participants gather together to share ideas, discuss problems, and devise practical solutions to complex problems. ROC delivers multiple training workshops to a consistent group of industrial refrigeration operators. This approach is proven to be more effective than traditional trainings where a skilled trainer or technical consultant teaches to a group on a one- or two-day basis. "Cohort-based" strategic energy management offerings have a history of success in the Pacific NW (Crossman, Hamilton & Lehoux, 2011).

Learning translates to effective action aided by regular technical support. ROC is successful when operators take action and make changes at their facilities, and when those actions result in quantifiable energy savings. When the learning process is supported by regular, on-site technical support, operators feel more confident in taking corrective action.

Results are revealed through tools that monitor energy performance. Similar to SEM offerings, ROC provides tools for effective performance tracking of energy intensity. The ROC strategy also provides web-based tools to monitor real-time progress and provide immediate feedback. The offering helps companies build on these tools to drive continuous and cost-effective savings as they connect people to energy information, actions to results, and projects to measurable returns.

With these strategies in mind, ROC methodology is based on the following five key components:

1. Identifying participant roles: executive, sponsor, and refrigeration champion
2. Offering six workshops involving a peer cohort of refrigeration operators
3. Providing monthly on-site engineer and technician support
4. Conducting facility-wide energy modeling
5. Administering energy performance tracking

Participant Roles

Success in ROC hinges on steady participant involvement leading to specific actions. Every participating site identifies two key roles, the executive sponsor and the energy champion, to help drive success.

Executive Sponsor

Participation requires an investment of time and effort, and the operators involved must have the management support needed to succeed. Each participating site designates an executive sponsor—someone in a supervisory role, such as a plant manager, facilities director, maintenance manager, etc. This individual possesses the willingness and ability to provide the management support needed for operators to be successful. Specifically the executive sponsor:

- Provides management level support
- Works with the refrigeration energy champion to develop realistic goals and timelines, based on an energy management plan that's aligned with the strategy and vision of the organization
- Allocates sufficient budget to support ROC efforts and success
- Allows ROC participants and other staff to invest the time required for action item implementation and reporting
- Reviews facility energy performance with the ROC team on a regular basis

Refrigeration Energy Champion

Each facility identifies one person to be in charge of translating workshop concepts and lessons into completed energy-saving actions. At a minimum, the refrigeration energy champion is responsible for:

- Implementing, managing, and tracking ROC action items. This includes securing regular and on-going participation of all members of the ROC team (internal and external).
- Preparing for and participating in all the training sessions
- Using tools and software to track and respond to energy performance data on a regular basis

Participating sites are encouraged to send multiple operators to each workshop, along with the refrigeration energy champion, and to involve those operators in actions taken at their site.

Participant Workshops

The mingling of multiple companies into a single ROC cohort is a key component of the offering. The cohort meets for six, half-day workshops covering topics critical to refrigeration efficiency, with homework in between and regular presentations from the participants. Over an eight-month period, cohort members forge strong relationships as they share implementation lessons learned at their own facility. Sessions are hosted in a rotating fashion at participating sites, allowing group members to broaden their perspectives on systems and system efficiency.

Instruction and coaching is delivered by the same team of refrigeration experts who provide technical support.

Workshops consist of topical lectures, progress reports from participants, and facility-based activities that expand on the topic of the day. The sessions are highly focused on identifying and understanding low- and no-cost O&M opportunities for saving energy, and include elements of persistence and performance tracking. Each workshop tackles the energy efficiency of a specific aspect of an industrial refrigeration system, as well as focusing on how the different systems interact and impact one another. ROC includes the following six workshops, which are focused on the main components of a refrigeration system, as well as on tracking performance and recognizing results:

1. Introduction/Compressor Optimization
2. Condenser Optimization
3. Evaporator Optimization
4. Defrost Optimization
5. Energy Performance Tracking and Controls
6. Persistence and Celebration of Results
7.

Each workshop places strong emphasis on active participation, and avoids the traditional “one-way” presenter-to-student lecture format.

During the course of each workshop a list of specific action items, or tasks, leading to energy savings, is presented and discussed in the group. Each participant is expected to return to their facility and implement the action items. The refrigeration energy champions from each facility provide informal progress reports during every workshop. These discussions allow participants to share successes and/or barriers they've encountered. This peer-to-peer interaction is invaluable in helping all participants increase their understanding and collectively devise practical approaches for completing ROC action items. While the topical lectures provide ideas and concepts, the participant discussions are often where energy-saving ideas become practical solutions.

At each workshop, the group tours the host facility and pays specific attention to the system or area relevant to the day's topic. These activities are meant to apply classroom learning to the application of energy efficiency concepts in a real-world setting. The group participates in a structured activity where they observe and measure refrigeration system operation.

On-site Technical Support

Refrigeration operators leave each workshop armed with new knowledge and peer perspectives, as well as a list of action items to implement at their facility. Because each individual site has unique requirements and constraints, and each refrigeration system has its own "personality," an experienced refrigeration technician makes monthly visits, to help bridge the transition from workshop to on-site implementation. These technical support visits offer many opportunities to discuss how action items apply to a specific facility. They help identify practical ways to overcome barriers and are invaluable in changing perceptions of risk. Regular visits from the technician also help establish a rhythm of activity and accomplishment–however small–over the eight- to nine-months that sites work on their action items. This is especially important as many action items, such as suction and discharge pressure adjustments, encourage incremental improvements.

Many facilities are reliant on a contracted refrigeration vendor to operate and maintain their systems. On occasion, these vendors have been involved in ROC technical support visits and are able to provide a critical perspective when implementing energy saving action items.

Facility-Wide Energy Modeling

The energy savings achieved from ROC are the result of many small actions that can add up to significant results over time. Due to the nature of the savings and the desire to instill the habit of regularly "checking" for progress, energy savings is measured through a process of "top down" regression modeling. Using a baseline regression model forms the foundation for participants to account for overall, facility-wide energy intensity. This model then allows participants to compare actual energy consumption with predicted energy consumption, based on independent variables, significant and particular to that site. To ensure validity, regression model criteria utilize Bonneville Power Administration's MT&R Reference Guide Rev3.1 (ESI 2012) and best-practices Energy Trust has developed over many SEM engagements.

The resulting energy model–encompassing both the baseline and treatment period–is used as a basis to calculate energy savings at the end of the ROC engagement. The final energy model

can then be used on an ongoing basis to provide regular energy performance tracking at participating sites during and after ROC, as described in the next section.

Energy Performance Tracking

As part of ROC, Energy Trust provides two years of web-based energy information system (EIS) support. This service combines the installation of hardware and web-enabled software. The EIS is designed to offer real-time energy performance tracking by monitoring hardware that is installed to automatically provide energy data in close to real-time. The EIS software can automatically track and store, not only electricity data, but also appropriate weather and production data, if supplied by the site. The EIS integrates the baseline energy model and provides regular feedback on changes in energy performance in a dynamic production environment. It also provides quick and easy visualization of trends in energy performance, determining the net energy impact of completed action items or to identifying and responding to degradation in energy performance (often referred to as *backsliding*).

A fundamental reason for utilizing an EIS in ROC is to help participants connect the actions they take with changes in energy performance. To facilitate this connection, the EIS annotates actions on energy performance charts and allows them to be shared within an organization. This provides an interactive, collaborative way to share, communicate, and understand changes in facility energy performance.

Results and Analysis

Results from ROC 2011 and 2012

Energy Trust has completed two Refrigeration Operator Coaching offerings. In the first year, from spring to fall 2011, the cohort included five sites. The second year, from spring to fall 2012, involved four sites. In both years, participants included cold storage and food processing facilities.

Initial energy savings results for the first two ROC cohorts were better than expected. Energy savings were quantified using the baseline regression energy models in comparison to actual energy use. Facility-wide energy savings are at 6.7% across all nine sites that completed ROC. This equates to 12.6% when considering energy savings as a percent of refrigeration subsystem energy use. Some participants saved as much as 20% of their refrigeration system energy use, and one even saved 30%. Figure 1, below, illustrates the energy savings at all nine sites.

Figure 1. Energy Savings Summary, ROC 2011 and 2012

Participant	***Refrigeration System Savings***	***Facility-Wide Savings***
Cold Storage	**18.7%**	**8.9%**
Cold Storage	**1.5%**	**1.1%**
Dairy	**30.3%**	**11.1%**
Dairy	**19.2%**	**10.3%**
Food Processor	**12.1%**	**6.6%**
Food Processor	**9.1%**	**5.9%**
Food Processor	**1.8%**	**1.5%**
Food Processor	**11.4%**	**4.9%**
Food Processor	**7.8%**	**4.3%**
Average Savings	**12.6%**	**6.7%**

Results Analysis

The first two cohorts that participated in Refrigeration Operator Coaching were very successful. As described above, energy savings outcomes have been consistent and significant. Following is a discussion of some of the key factors that contributed to ROC's success.

Energy savings result from actions in two basic O&M categories. Energy savings achieved from Refrigeration Operator Coaching can be grouped into the following two categories of low- and no-cost actions:

1. **Set point adjustments and equipment staging**–Examples include decreasing discharge pressure, increasing suction pressure; defrost timing and compressor and condenser sequencing.
2. **Ongoing maintenance opportunities**–Examples include condenser cleaning, evaporator cleaning, sensor calibration, and evaporator valve group commissioning.

Like any O&M measure or SEM engagement, persistence of energy savings depends on the level of adoption and integration of ROC materials by facility personnel. ROC was designed to impact, not only the knowledge base, but also facility culture so that issues related to limited personnel or tight maintenance budgets do not necessarily supersede the tremendous impact these seemingly minor adjustments can have on energy efficiency.

Control set points run a refrigeration system and play an important role in energy efficiency. ROC participants have found that modest changes in set points result in dramatic reductions in energy use while maintaining the same, or better, production rate and quality.

Ongoing maintenance efforts, including sensor calibration, heat transfer surface cleaning, and removal of contaminants, are critical to long-term performance. ROC participants identified areas where maintenance had been postponed due to competing priorities. The ROC workshops helped them understand the energy penalty associated with deferred maintenance. As a result, many sites rearranged priorities to ensure that maintenance took place. For example, evaporator coil cleaning is not an easy task to complete, especially if evaporators are near the ceiling in a

busy cold storage room. Dirty coils lead to poor heat transfer, which forces the refrigeration system to work harder. When ROC participants understood the impact delayed coil maintenance had on a facility's energy bill, they made evaporator coil cleaning a regular maintenance item.

The cohort approach increases opportunities to save energy. ROC participants often expressed reluctance to trying a new approach where there was a perceived risk to other priorities, like production. In a high pressure production environment where even an hour of downtime results in substantial loses, participants tend to be risk averse. At ROC workshops, however, participants hear about energy-savings actions their peers have implemented with success. This provides a level of confidence and encourages creative problem-solving. For example:

- An operator shared his efforts to lower the minimum discharge pressure, a key system set point that impacts energy use. Participants suggested ideas about the cause of the problem, such as poor defrost capability. A discussion took place resulting in several potential solutions to resolve the problem.
- A cold storage facility engineer shared his efforts to optimize the defrost strategy using a centralized control system. One of his peers, running the same control system, questioned the strategy. Upon further discussion, it became clear that the engineer's system needed a modest upgrade. Once complete, the system ran a far more efficient defrost strategy.

Concern about collaborating with competitors in a ROC cohort is minimal. In the two years that ROC has been implemented in Energy Trust territory, not one site has refused to participate based on concerns about working alongside an industry competitor. Similar to what Energy Trust learned via its related SEM offerings, is that the opposite has been true. Typically, participants are happy to host workshops and allow their peers to tour the facility and perform activities on refrigeration system components. In only one case a participant refused to host a workshop due to the presence of a competitor. In that situation, the competitor did not reciprocate the sentiment and was unconcerned about hosting a workshop that included a walk-through of the engine room.

The collaborative atmosphere between participants may be due to the fact that industrial refrigeration systems are not closely tied to a company's intellectual property or specialized methods of processing or storing food. As a result, participants tend to be very forthcoming with details about how their refrigeration system operates. They realize that by being open their peers will do the same which, in the end, benefits everyone.

Facilities with O&M energy efficiency experience still benefit from ROC. Two ROC participants had already implemented efficiency projects related to their refrigeration systems. One facility had a tune-up five years prior to participating in ROC. Another facility was part of an Energy Trust "Kaizen Blitz" project (an intensive effort to implement low- and no-cost energy actions) four years before ROC. Both projects were very successful, with energy savings greater than 10% of total facility energy usage. At the end of their participation in ROC, both sites again realized substantial energy savings. The energy saved was not due to recovery from backsliding in operational set points or maintenance practices. Although some backsliding did occur in both cases, it was insubstantial. Instead, the energy savings resulted from new opportunities. The

lesson learned is that it is possible to achieve additional energy savings through O&M actions at facilities with a history of pursuing energy efficiency.

Participant Perspectives

Operators at participating facilities have consistently given ROC high marks. When asked to rate their overall experience, Uli Schildt, Energy Engineer at Darigold, had this to say about participating in ROC:

"In my opinion this is one of the best, perhaps the best, energy efficiency programs I've seen. I think that because of the eight month duration it helps facilities to not lose focus. Some other programs that last only a few days don't achieve nearly the same results."

Participants reported that the focus and education provided by ROC helps operators take the next step in identifying and implementing energy savings opportunities. Randy Edmiston, a Sysco maintenance and refrigeration manager located in Portland, Oregon, described his experience this way, "As a busy maintenance manager it is all too easy walk right by a piece of equipment that is working. However, is that piece of equipment working efficiently? ROC helped focus us on this question, and, despite years of doing energy efficiency projects, we still found opportunities to save."

It is clear that participants value the peer-group approach. Keith Beckman with BrucePac, a food processing plant, described the benefits of the peer-group approach this way: "It was ideal to have the trainer, technicians and other operators in the room together. We were able to pose questions and have everyone weigh in with practical solutions based on similar experiences at other facilities."

On-site technical support was appreciated by participants because it helped smooth the transition from the workshop to actual implementation. "We often were able to begin a discussion around a specific problem during a workshop, and then finalize a practical solution during site visits by Cascade Energy's refrigeration technician," Keith Beckman said.

The Future of ROC

With two years completed and significant energy savings to show for it, Energy Trust and Cascade are interested in improving and expanding the operator coaching offering. A range of improvements is being considered including:

Changing the Facility-size Requirement

The current level of effort required to implement ROC necessitates participation by facilities with large industrial refrigeration systems that consume greater than 3.5 million kWh/yr. of energy. This excludes many small- to medium-sized food processors and cold storage facilities in Energy Trust territory that do not meet this threshold. Cascade and Energy Trust are exploring whether or not it is possible to deliver ROC cost-effectively to smaller facilities.

Resolving Questions about Re-enrolling Previous SEM Participants

A past participant in an Energy Trust SEM offering (e.g. Kaizen Blitz) participated in ROC with great success. Regression modeling revealed that no backsliding occurred and claimed energy savings were in addition to those achieved during the previous SEM participation (i.e. energy savings were not double counted). In addition, several past SEM participants are currently enrolled in ROC 2013. It appears that successive SEM offerings can be complementary when managed properly. Given a three-year measure life on all SEM engagements (including ROC), the questions remain: When is it appropriate to re-enroll a site into another SEM offering? Should Energy Trust wait longer than the three-year measure life before re-enrollment?

Applying the Concept of Operator Coaching as an Offering to Other Sub-systems

Industrial refrigeration is a prime candidate for operator coaching due to high energy consumption, potential for energy savings, and operator impact on energy use. Other sub-systems maybe also be good candidates for operator coaching such as compressed air, pumping, dust collection and HVAC systems. Certain market segments may, also, lend themselves to a multi-sub-system operator coaching offering. For example, food processing facilities all operate compressed air, pumping, and lighting systems. A cohort-based operator coaching offering might pull a group of facilities together to focus on low- and no-cost energy savings opportunities in these common sub-systems.

Conclusion

The first two years of Refrigeration Operator Coaching have been successful, both from a participant perspective, as well as from an energy savings perspective. Participating operators have been very engaged in the process, and taken full advantage of the cohort environment. They've successfully implemented low- and no-cost improvements to their refrigeration systems and verified their facilities' increased energy efficiency. They acquired new skills in tracking energy performance and tying specific actions to energy and cost savings.

The success in 2011 and 2012 has led Energy Trust to support another cohort for ROC in 2013. The concept of operator coaching is proving to be a successful resources acquisition approach for Energy Trust. Cascade and Energy Trust will continues to work together to expand and refine this offering for future implementation.

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