BPA E3T 2011 Energy Management Technical Advisory Group

Final Report

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WSU Energy Program

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Executive Summary

This report summarizes the 2011 cycle of the Energy Efficiency Emerging Technology (E3T) Program's first Energy Management (EM) Technical Advisory Group (TAG), from its conception in mid-2011 to its final meeting in December 2011.

The E3T program was designed to efficiently evaluate potential new measures that could be deployed in the Pacific Northwest, and is a result of cross-disciplinary collaboration and stakeholder engagement. This streamlined process establishes a system for strategically identifying measures for implementation within BPA's service territory and involves the decision makers from different BPA departments early in the process.

TAGs are a part of the E3T framework, which states a goal "for BPA to engage in an ongoing collaborative effort to 'fill the pipeline' with innovative energy efficiency strategies and technologies that promise significant region-wide energy savings."

This final EM TAG report and appendices include:

- Narrative putting the 2011 EM TAG in context with previous work
- An overview of significant TAG challenges, successes, and operational changes made during this cycle
- Summaries of key stages of the 2011 EM TAG cycle
- Graphics detailing the ranking and scoring results from TAG members' surveys
- TAG recommendations for five technologies selected during the 2011 cycle (Appendix A)
- Rosters of TAG members, partners, and participants attending key meetings (Appendix B)
- Notes on earlier TAG cycles (Appendix C)

The purpose of this report is to provide an overview of events, processes, challenges, and results of the TAG process itself. More detailed documentation of individual technologies and solutions examined during the TAG cycle can be found at E3TNW.org, which serves as the official repository for the information gathered during the E3T process.

Earlier TAG Cycles

This group's work followed three previous E3T TAG cycles, the first focusing on lighting beginning in early 2009, followed by two that focused on heating, ventilation, and air conditioning (HVAC) in 2009 and 2010. During these TAGs, operational details of the E3T TAG process were developed and refined, and recommendations for 13 promising technologies were drafted. Brief summaries of these past TAGs are available in Appendix C. Final reports were completed for each of those TAGs and are available upon request.

2011 Energy Management TAG

Successes, Challenges, and Significant Changes to the TAG Process

The 2011 EM TAG was a success in a number of ways. While it was the third TAG created and the fourth TAG cycle, it was a first TAG to:

- Utilize a new collaborative website developed by E3T staff in spring 2011, E3TConnect.org
- Use smaller working groups to prepare research presentations
- Have a new focus area selected since the inception of the program in 2008
- Have a tiered membership structure and roughly twice as many members as any previous TAG; the initial three groups of members totaled more than 50 individuals, including:
  - **Ranking members**, who are full members who rated and scored the ETs in question;
  - **Corresponding members**, who were invited to events and encouraged to comment both in the meetings and on the ranking survey tool; and
  - **Interested parties**, who were interested in the topic in general but not in a position to serve as TAG members.

Even with the development needed for these, the EM TAG completed the pattern of convening four webinars covering each of the major stages of identifying, ranking, scoring, and confirming recommendations in just over three months, a shorter period than the previous TAG, which was a reconvened HVAC TAG. And the EM TAG produced better research presentations than previous TAGs and well-crafted recommendations.

The range and scope of emerging technologies that potentially could fit into the energy management arena presented significant challenges in developing a definition of the TAG's focus and task. Because the EM TAG's definition continued to be refined as its first meeting convened, it could not be fully utilized as a recruiting tool or to inform TAG members much in advance. However, by the initial meeting, TAG members were given enough information to constrain the selection of potential emerging technologies to align with the desired scope of the TAG as defined by Bonneville Power Administration managers.

Managing the various groups' privileges and access to E3T tools proved challenging enough that ultimately Interested Parties were invited to join an Energy Management group on the program's collaborative website E3TConnect.org, developed to serve as a place for TAG members and others to keep up with numerous areas of interest to professionals working with emerging energy efficiency technologies. All TAG members and staff were invited to join E3TConnect as well, but in addition had access to the website, which serves as the repository for information acquired during the E3T process on the technologies and solutions reviewed.

Despite the need to expand TAG membership to a tiered approach and update research forms, TAG members and staff met these challenges and concluded a new TAG in just over 15 weeks, very close to the time spent on the 2010 HVAC TAG, which had the advantage of being a "reunion" TAG largely composed of TAG members and staff already familiar with the established process.

2011 EM TAG Stages and Meetings

Identification

The purpose of the identification stage is to identify as many potential measures in a given focus area that:

- Are emerging technologies not in common use in the Northwest,
- Can provide quantifiable, reliable electric energy savings in the region, and
- Have the confidence of TAG members or staff to work as intended.

The core product of the information stage is known as "the long list": dozens of items proposed by TAG members and staff for consideration during the TAG cycle. Additionally, basic information in the form of proposer information, cogent titles and brief descriptions for many of these items are added to the E3TNW database by staff, based on information provided by proposers. Largely identical proposals are then consolidated by staff. This basic information, in combination with the discussion during the initial meeting, guides members when rating the items in the ranking stage. This stage also serves to define group identity and cohesion.

TAG members were invited to attend an initial webinar on August 29, 2011 from 9:30 a.m. to 3:30 p.m. Pacific. Rosters of this meeting and others can be found in Appendix B. Following the meeting, a recording of the audio and screen-sharing webinar were posted to the E3TConnect website to enable those who were not able to attend the meeting to review the proceedings and to allow staff and others to refer to specific segments to clarify information destined for the database of emerging technologies at E3TNW.org.

Ranking Survey and Meeting

The main purpose of the ranking stage is for members to rate individual items on the long list of entries brainstormed during the identification stage. The essential product of this stage is a compilation of those ratings, yielding a basic priority ranking of the long list. The initial ranking also provides sufficient focus for further forms-based information gathering on those ETs that ranked near the top.

TAG members were invited on September 9, 2011 to complete a web-based ranking survey including 60 technologies and solutions emanating from the identification meeting. Each technology had a short title and description developed by E3T staff; some also had synopses that included a broader range of initial information. TAG members were asked to rate their support for as many of the ETs listed as they wished on a 0-5 scale:

0 – I do not support this technology
1 – I support this technology with significant reservations
2 – I mildly support this technology
3 – I support this technology
4 – I strongly support this technology
5 – My support for this technology is enthusiastic and unqualified

Unlike the subsequent scoring survey, the ranking scale includes a null value so members can actively indicate no support for a given item, a choice deemed appropriate at this stage but less likely in the scoring stage, when only highly ranked items are considered. General comments were also encouraged. Instructions regarding the ratings included this message:

> *Consider these First Round Emerging Technology Screening Criteria when indicating your preference and the strength of your support:*
>
> 1. ***Emerging*** *– Degree to which this technology is newly developing and currently ready for attention*
> 2. ***Energy Efficiency*** *– Degree to which this technology has potential to provide quantifiable, reliable, and cost effective electric energy savings for end-users in the Northwest region*
> 3. ***Customer Need*** *– Degree to which this technology is a clear and distinct solution to a customer need*
> 4. ***Technically Sound*** *– Degree to which this technology is expected to deliver its intended performance*

During compilation, two proposed ETs were deemed to be so similar as to be duplicative, yielding a final ranked list that included 59 ETs. Ranking results are depicted in Figures 1 and 2, below.

After the ratings of individual respondents were compiled, TAG participants were invited to attend a three-hour ranking review meeting held on October 12, 2011. This meeting provided an opportunity to put the TAG's work in context with subsequent E3T processes and other BPA programs and initiatives.

Jack Callahan provided an overview from the BPA perspective of the basis for evaluating proposed items:

- Is the technology ready and available?
- Are applications well understood?
- Are customers likely to be willing to adopt it?

He pointed out that starting with the TAG's work, important aspects that would be examined include energy savings, monitoring and verification, specifications, and cost effectiveness. These aspects would be developed in more detail for high ranking and scoring ETs. An ET's fit into BPA program structure is also an essential component of the entire E3T process. He summarized the overall E3T process:

- TAG priority list
- TAG recommendations
- Determine next steps
- Implement research plan
- New measure documentation

BPA staff then provided examples of program work in the commercial and industrial sectors. Todd Amundson talked about BPA's Energy Smart Industrial (ESI) Program, including three main components:

- Energy Project Manager (personal and resource limitations)
- Track and Tune (operations and maintenance opportunities in plant and/or subsystem)

- High Performance Energy Management (continuous improvement)

These are all identified in the Sixth Power Plan from the Northwest Power and Conservation Council. Track and Tune takes 9 to 15 months, looking at improvements above baseline. The sustained savings are tracked over 3 to 5 years. High Performance Energy Management involves a year of training for staff at a cohort of individual facilities, including establishing an energy team, developing a baseline and goals, implementing process improvements, and continuous monitoring, again for 3 to 5 years.

Allie Robbins spoke about commercial sector projects, also reflected the Sixth Power Plan goals. Increasing codes and standards diminish program opportunities, so they have explored new ways to find savings. They have three types of projects:

- Deemed Measures: including refrigeration, HVAC, insulation, windows, kitchen, and food service
- Calculated Measures: lighting calculator (which generates the bulk of total savings) and additional refrigeration (Energy Smart Grocery)
- Custom Projects: new construction and other retrofits

She shared BPA ambitions for the current TAG. The hope was for a focus on products and technologies rather than approaches, which overcome current hurdles, including:

- Claiming savings
- Extending measure life beyond one year
- Reducing implementation costs
- Achieving RTF approval

Skip Schick presented on a new initiative focusing on behavior-based energy efficiency (BBEE). BPA issued a funding opportunity announcement for BBEE pilot programs with an application due date of November 7, 2011.

Discussion of the contrast between BBEE and the desires for built-in technologies clarified that, although behavior-based projects are not ruled out of future programs, they require very good base-lining, very good diagnostic and feedback features, and detailed, ongoing tracking systems.

Focusing on the work facing the TAG, Jack Zeiger explored the results of the ranking, focusing on top-ranked ETs and others that were closely related. He explained groupings that functionally characterized individual ETs. Figure 1 codes the top half of the ranked list according to categories. For the rest of the meeting, TAG members and staff looked at whether some of what was conveyed in the presentations from BPA would affect lower-ranking ETs, meriting another look within the EM TAG process. Recurring themes were the importance of good pre- and post-implementation tracking, fitting whatever emerges into the program environment at BPA, and issues of scale.

Mr. Zeiger concluded the meeting by alerting members to expect a scoring survey just before the scoring meeting and cautioning members that presentations at the scoring meeting were intended to inform their responses.

Figure 1. Graphical Representation of Select 2011 EM TAG Ranking Results

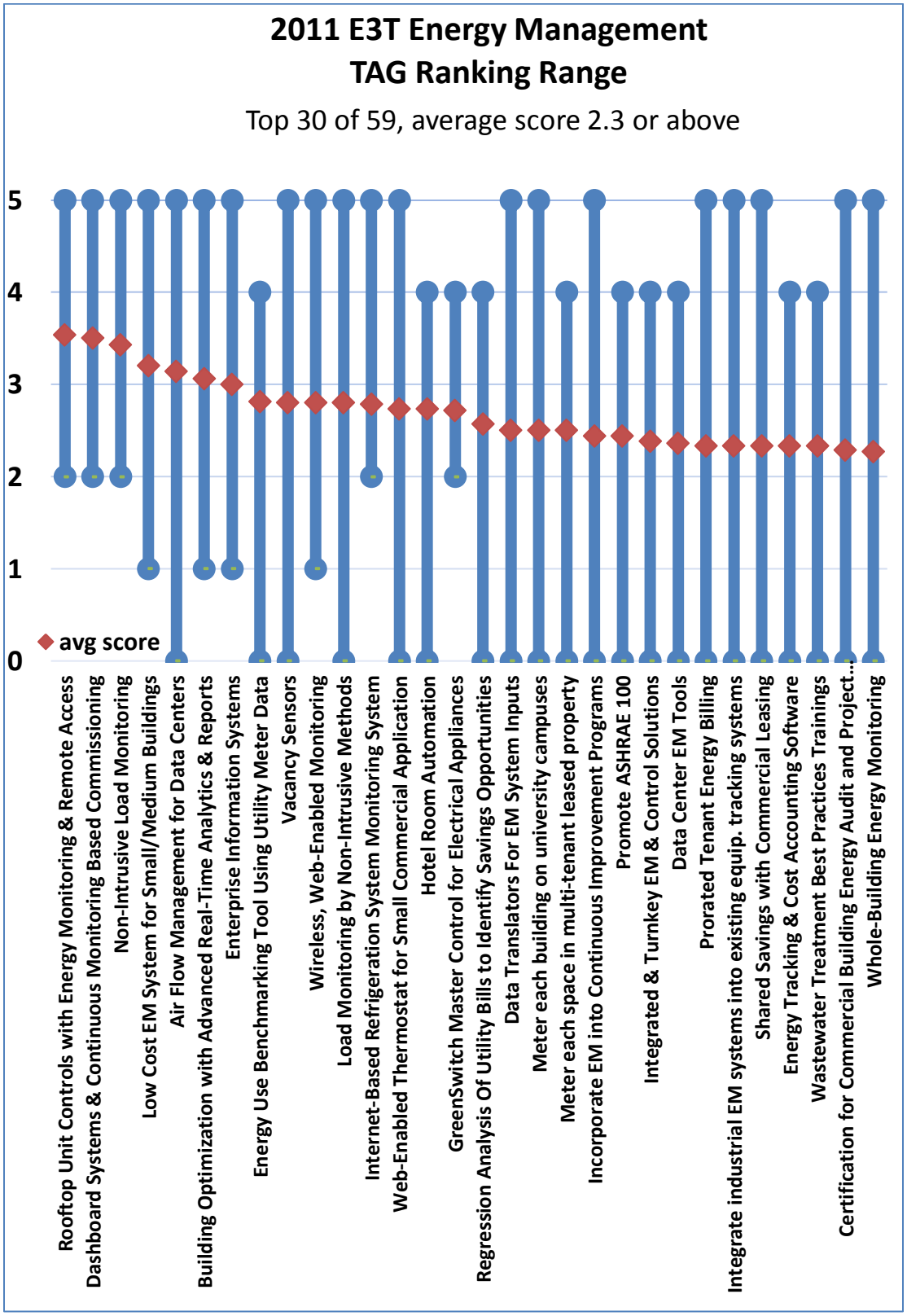


Figure 2. Tabular E3T EM TAG Weighted Ranking Results

Title & E3TNW.org record number	category	hi score	avg score	lo score	# answering	RANK by avg score	# of "5s"	# of "0s"
Rooftop Unit Controls with Energy Monitoring & Remote Access - 338	T	5	3.5	2	15	1	2	0
Dashboard Systems & Continuous Monitoring Based Commissioning - 272	T	5	3.5	2	16	2	1	0
Non-Intrusive Load Monitoring - 358	T	5	3.4	2	14	3	1	0
Low Cost EM System for Small/Medium Buildings - 347	T	5	3.2	1	15	4	3	0
Air Flow Management for Data Centers - 376	T	5	3.1	0	14	5	2	1
Building Optimization with Advanced Real-Time Analytics & Reports - 353	T	5	3.1	1	16	6	2	0
Enterprise Information Systems - 377	T	5	3.0	1	15	7	3	0
Energy Use Benchmarking Tool Using Utility Meter Data - 365	T	4	2.8	0	16	8	0	1
Vacancy Sensors - 349	T	5	2.8	0	15	9	2	2
Wireless, Web-Enabled Monitoring - 355	T	5	2.8	1	15	9	1	0
Load Monitoring by Non-Intrusive Methods - 294	T	5	2.8	0	15	9	2	1
Internet-Based Refrigeration System Monitoring System - 346	T	5	2.8	2	14	12	1	0
Web-Enabled Thermostat for Small Commercial Application - 247	T	5	2.7	0	15	13	1	1
Hotel Room Automation - 97	T	4	2.7	0	15	13	0	1
GreenSwitch Master Control for Electrical Appliances - 336	T	4	2.7	2	14	15	0	0
Regression Analysis Of Utility Bills to Identify Savings Opportunities - 366	MS	4	2.6	0	14	16	0	1
Data Translators For EM System Inputs - 373	T	5	2.5	0	12	17	1	1
Meter each building on university campuses - 330	MS	5	2.5	0	14	17	1	3
Meter each space in multi-tenant leased property - 331	MS	4	2.5	0	16	17	0	2
Incorporate EM into Continuous Improvement Programs - 378	MS	5	2.4	0	16	20	1	3
Promote ASHRAE 100 - 342	POL	4	2.4	0	16	20	0	3
Integrated & Turnkey EM & Control Solutions - 356	T	4	2.4	0	13	22	0	1
Data Center EM Tools - 357	MS	4	2.4	0	14	23	0	1
Prorated Tenant Energy Billing - 368	MS	5	2.3	0	15	24	2	4
Integrate industrial EM systems into existing equip. tracking systems - 371	MS	5	2.3	0	12	24	1	1
Shared Savings with Commercial Leasing - 380	MS	5	2.3	0	12	24	1	3
Energy Tracking & Cost Accounting Software - 345	T	4	2.3	0	15	24	0	3
Wastewater Treatment Best Practices Trainings - 339	TR	4	2.3	0	15	24	0	3
Certification for Commercial Building Energy Audit and Project Manager - 245		5	2.3	0	14	29	1	2
Whole-Building Energy Monitoring - 370		5	2.3	0	15	30	1	2
Advanced Metering - 179		5	2.1	0	14	31	1	2
Increased Use of Key Performance Indicators in HVAC System Optimization - 350		5	2.1	0	15	32	1	1
Home Energy Wireless Controls - 337		5	2.1	0	15	32	1	1
Energy Saving Competitions Among Businesses - 341		5	2.1	0	16	34	1	2
ISO 50,001 - 361		5	2.1	0	13	35	1	1
Wireless Pneumatic Thermostat - 264		4	2.1	0	14	36	0	2
ASD Trainings - 351		5	2.1	0	15	37	1	3
List of Low/No-Cost Measures - 374		4	2.1	0	15	37	0	3
Passive House - 243		4	2.1	0	15	37	0	3
Guidelines for Building EM - 379		4	2.1	0	16	40	0	3
In-Home Energy Use Displays - 362		5	2.0	0	15	41	1	2
Control4 Home Energy Automation and Interface with SmartGrid - 333		5	2.0	0	16	41	1	2
Incentivizing Use of Energy Star's Portfolio Manager - 369		5	1.9	0	15	43	1	4
Logic Flow Diagrams for Sequence of Operations - 375		5	1.9	0	14	44	2	3
Hand-Held Audit Devices - 363		4	1.8	0	13	45	0	4
Continuous EM - 174		5	1.8	0	16	46	1	3
EnergyCAP EM Software - 335		4	1.8	0	13	47	0	3
Educating Installers in New Technologies and Relevant Incentives - 235		4	1.8	0	16	48	0	6
Integration of Technologies - 352		5	1.7	0	15	49	1	5
Zero-Based Benchmarking Tools - 359		5	1.7	0	15	49	1	7
Effective Customer Engagement Programs for Home EM - 295		3	1.7	0	14	51	0	2
National Sharing of Custom Project Lessons Learned - 340		4	1.6	0	16	52	0	4
Creative Financing for Emerging Technology Projects - 334		5	1.6	0	13	53	1	4
Training on Energy Efficient Product Selection - 348		5	1.6	0	15	54	1	5
Increased Feedback From Vendors to Building Managers - 372		5	1.6	0	14	55	1	6
Programs Supporting Energy Savings Indirectly - 364		5	1.5	0	13	56	1	5
Techniques Associated with Technologies for success - 354		4	1.4	0	13	57	0	5
Infrared Drive-by Building Envelope Assessments - 344		4	1.4	0	14	58	0	5
Piggyback on Other Programs for Program Outreach - 343		3	1.3	0	14	59	0	5

Category T = Technology
Category MS = Management Strategy
Category POL = Policy
Category TR = Training

Hi Score = The highest score given by any TAG member, on a 0 to 5 scale
Ave. Score = Total score divided by the number answering
Lo Score = The lowest score given by any TAG member, on a 0 to 5 scale
answering = The number responding to the question

Scoring Meeting

The scoring stage is at the center of the work leading to TAG recommendations. At this point, the focus is limited to a few high-ranking items, allowing in-depth presentations.

Prior to selecting the date of the EM scoring webinar, a determination was made to support presenters by forming working groups focusing on the short list of highly ranked technologies and solutions emerging from the ranking stage. Additional ETs related to those that were highly ranked were grouped with them to aid in preparing for the presentations.

Practice sessions were convened prior to the scoring meeting. The quality of EM TAG presentations was commended by several in attendance, including those who have participated in more than one TAG.

At the scoring webinar, held November 4, 2011, five presentations were made by TAG members, staff, and invited guests.

- Rooftop Unit Controls with Energy Monitoring and Remote Access – presented by Reid Hart of PECI and Peter Criscione from E Source
- Building Energy Performance Analytics Software and Service – presented by Jay Stein of E Source
- Non-Intrusive Load Monitoring – presented by Jennifer Williamson and Dave Kresta
- Low-Cost Energy Management Systems for Small/Medium Buildings – presented by Srivinvas Katipamula of the Pacific Northwest National Laboratory
- Innovative Behavior Change Techniques – presented by Don Rainey of Sain Engineering Associates

Following each presentation, draft recommendations specific to the technology or solution were posited and discussion probing for details of those recommendations ensued. Presentation screen capture and audio is available to TAG members and others on the EM TAG portal at E3TNW.org. There is also space associated with each ET in the database located there to file directly related documents, such as these presentations, as well as supporting studies and other material.

Scoring Survey

TAG members were encouraged to respond to the online survey following the webinar to score the selected technologies presented. The survey was based on the recently modified Measure Benefits TAG Scorecard – the D3 form – which uses a 1 to 5 scale for respondents to rate five separate characteristics of individual emerging technologies. Unlike the original TAG Scorecard, the revised form only asks for input from a user's perspective.

1. Energy Savings
   How significant and reliable are the energy savings per unit?
2. Non-Energy Benefits
   How great are the non-energy advantages for the end user for adopting this technology?
3. Technology Readiness

How ready are the product(s) and providers to scale up for widespread use in the Pacific Northwest?

4. Ease of Adoption
   How easy is it for the end user to change to the proposed technology?

5. Value
   Considering all costs and all benefits, how good of a buy is this technology for the owner?

In addition to their scores, TAG members were encouraged to enter written comments, especially those that could influence recommendations for the particular technology in question.

A separate Energy Efficiency Scorecard – the D4 form filled out by BPA Programs and Planning staff – also asks five questions with a 1 to 5 scale, addressed from the perspective of BPA Energy Efficiency:

1. Energy Savings

   How measurable are the energy savings per unit? Consider BPA/RTF approval.

2. Cost-Effectiveness

   How great do you expect the potential total resource cost (TRC)-effectiveness of this technology to be?

3. Regional Potential

   How likely is this to scale up to significant regional energy savings within five years?

4. Implementation

   How easily can BPA and other stakeholders in the region design and implement a cost-effective delivery program for this technology?

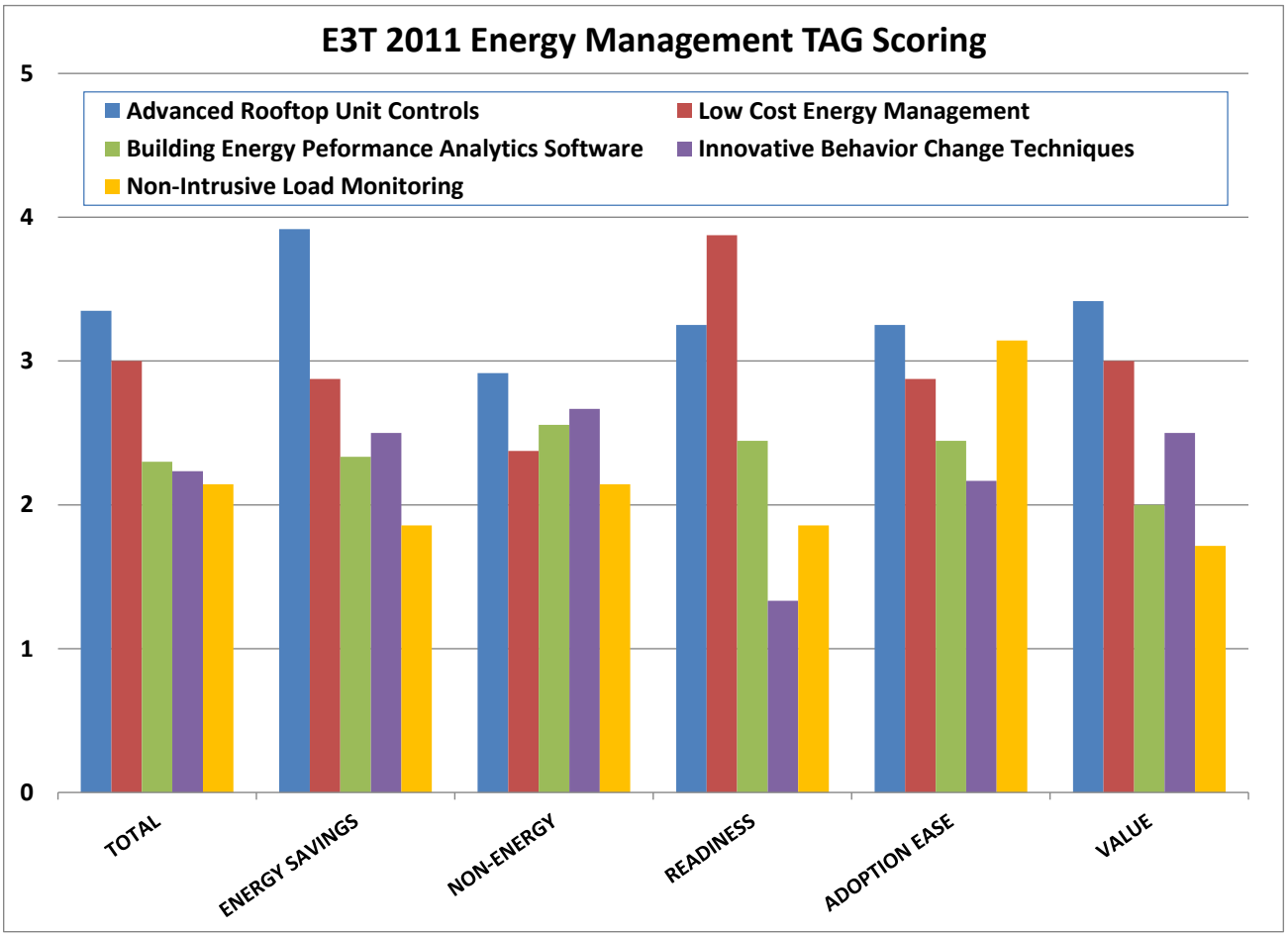
5. Current Opportunity

   To what extent is this a timely opportunity for BPA engagement?

BPA Energy Efficiency staff was invited to complete the latter scorecard and to offer comments on a web-based survey. Respondents completed the TAG scorecard in the week following the scoring meeting. The results of the 2011 E3T EM TAG scoring are graphically depicted in Figure 3. Limited response was registered for BPA scorecards for the top five ETs.

Presentation screen capture and audio is available to TAG members and others on the EM TAG Portal at E3TNW.org. There is also space associated with each ET in the database located there to file directly related documents such as these presentations, supporting studies, and other material.

Figure 3. Graphical Representation of Measure Scoring



Scored technologies are also ranked, both in aggregate and by characteristic. Those ranks are depicted in Figure 4.

Figure 4. Measure Scoring Detail and Ranks

SCORES	Advanced Rooftop Unit Controls	Low-Cost Energy Management	Building Energy Performance Analytics Software	Innovative Behavior Change Techniques	Non-Intrusive Load Monitoring
Total	3.4	3.0	2.3	2.2	2.1
Energy Savings	3.9	2.9	2.3	2.5	1.9
Non-Energy	2.9	2.4	2.6	2.7	2.1
Readiness	3.3	3.9	2.4	1.3	1.9
Adoption Ease	3.3	2.9	2.4	2.2	3.1
Value	3.4	3.0	2.0	2.5	1.7

SCORES	Advanced Rooftop Unit Controls	Low-Cost Energy Management	Building Energy Performance Analytics Software	Innovative Behavior Change Techniques	Non-Intrusive Load Monitoring
Total	1	2	3	4	5
Energy Savings	1	2	4	3	5
Non-Energy	1	4	3	2	5
Readiness	2	1	3	5	4
Adoption Ease	1	3	4	5	2
Value	1	2	4	3	5
Legend	1st place	2nd place	3rd place	other	

Recommendations Confirmation Meeting

Recommendations are the key product of the E3T TAG process. All aspects of the scoring stage — including the presentations, surveys and associated comments, discussions focused on specific technologies and general capabilities and constraints of the program environment, and the forms-based information developed on the short list of technologies — inform the recommendations. A draft of the recommendations based on these inputs was prepared by staff and distributed in advance of a three-hour recommendations confirmation session held on December 6, 2011. EM TAG members were invited to offer written comments in advance and to review and confirm the recommendations during the meeting.

Recommendations meetings are distinct from other sessions in that the focus is on the path forward for the selected items, not on technical performance issues. The recommendations were developed keeping eight questions in mind:

1. **Technology Readiness** – Are products and providers available, reliable, and ready to scale up?
2. **Design & Application** - Are design practices, standards and ratings developed and widely available? Are applications understood and guidelines developed for selection and installation?
3. **Customer Adoption** – Is the customer value identified, communicated, understood, and positive?
4. **Energy Savings** – Are energy savings predictable, consistent, persistent and significant?
5. **Measurement & Verification** – Are the energy savings measurable and are EM&V approaches selected, developed, and available?
6. **Measure Specification** – Are applications, baseline, incremental savings, incremental costs, and measure specification defined and reliable?
7. **Cost Effectiveness** – Is this likely to be a TRC cost-effective conservation resource?
8. **Program Implementation** – Can BPA or its partners implement a cost-effective program to specify and deliver this measure?

Discussion of each of the potential technologies included strong consideration of the capabilities and tools used by staff implementing programs at BPA. In the recommendations phase of the 2011 EM TAG, it was clear that some of the ETs that were considered did not fit the typical model of acquiring efficiency through BPA programs; in these cases, other regional partners were suggested as potential hosts of programs to change behaviors and transform markets.

Recommendations represent the final product of each TAG cycle. Recommendations from the E3T 2011 EM TAG follow in Appendix A.

Appendix A – EM TAG Recommendations

These are recommendations for technologies presented and scored at the scoring session on November 4, 2011, which were confirmed and discussed further during the E3T 2011 EM TAG Recommendations Confirmation call on December 6, 2011.

E3T Energy Management TAG Recommendations

December 2011

These are recommendations for technologies presented and scored at the E3T Energy Management Technical Advisory Group (EM TAG) scoring session on November 4, 2011, which were confirmed and discussed further during the E3T 2011 EM TAG Recommendations Confirmation call on December 6, 2011.

Advanced Rooftop Unit Controls with Remote Access and Energy Monitoring -338	**Overall Score: 3.4**

Description: Controllers to retrofit rooftop units to optimize performance and provide web-based energy monitoring and communications capabilities.

Recommendations:

Research the features of each available model, including checking with other organizations to see what information they have on features, cost, and savings potential for each available controller. Deliver a comprehensive report summarizing secondary research as well as field tests that have been performed, calculation methods, monitoring details, and opportunities for collaboration in field testing. This should include checking with:

- Southern California Edison on the lab testing they are doing on Catalyst and Digi-RTU (Paul Delaney)
- Snohomish County PUD (Alan Budman)
- BC Hydro (Irfan Rehmanji)
- PECI (Reid Hart)
- NBI (Dan Harris)
- Omaha Public Power District (Peter Criscione at E Source)
- TES Engineering (Peter Criscione at E Source)
- RTF RTUG Working Group, working on standard protocol for savings verification for RTU retrofits (Mark Kendall)
- Minnesota Energy Center (Reid Hart at PECI)
- Pacific Northwest National Lab/Catalyst, to be completed by end of January (Srinivas Katipamula)

2. Perform an engineering analysis to determine the climate and applications in which these controllers are most effective, and quantify their relative effectiveness in various conditions. Quantify gas savings separate from electrical savings. Start by:
   - Reviewing PNNL's report that was due 12/31/11, which may satisfy this task.
   - Reviewing the report to BPA by Reid Hart on expected values approach for premium ventilation packages in the Northwest. This report, available on the BPA website, addresses what parameters are most likely to deliver effective savings. Reid Hart developed a site-based calculator, which will be available later.

   - Look at RTU servicing pilots that BPA did in 2009 and 2010 and include useful data on RTU baseline energy use that will be included in the final report due 12/31/11.

3. If needed, based on research about what testing has been done (see #1 above, particularly RTUG and PNNL), establish a field testing protocol to compare products and to determine the accuracy of energy monitoring, and evaluate the performance of the controllers.
4. Consider using engineering calculations to enhance analysis of this technology for addition of specific hardware, such as VSD and integrated economizers. Monitor and evaluate use of this technology to reduce malfunctions and sub-optimal performance.
5. Develop a program specification for utility incentives, preferably one that is performance-based rather than prescriptive or features-based.
6. If needed, based on research about what pilot studies have been performed (see #1 above), design and implement additional pilot studies. Include training for utilities and contractors on reporting for pilot projects.
7. Work on getting this technology provisionally approved by RTF so BPA can initiate a pilot program while continuing to perform field tests to improve the accuracy of results.
8. Provide training to installers and contractors to make sure there is adequate infrastructure to ramp up.

Product Availability:

1. Catalyst
2. Digi-RTU
3. Enerfit
4. Optimum Energy's new (unavailable) controller

Lower Cost Options:

- Innotech
- FDSI – provides links for remote data collection
- Pulse – monitoring system add-ons

Comments:

- PNNL's report, for climate zone for Seattle only and four building types—all under 50,000 sf. Next year they'll expand the parameters to include more indoor temperature settings and VSD compressors.

- Jack Callahan: He expects a wide range of savings, and feels that M&V is pretty costly.

- Irfan Rehmanji: BC Hydro has a pilot at a mall with 26 units, and he agrees with using performance-based spec but also agrees that there is a high degree of variability of savings. Perhaps the spec could use different levels of savings for different building types
- Phoebe Warren: She'd like the specs and application guide to demystify the products where possible.
- Jack Callahan: A product selection and application guide would be nice but not critical; products come and go, so focus on underlying features.
- Jack Callahan: The RTF usually looks for unit energy savings, but the savings for this are too variable. It would probably need to be a standard protocol. Provisional deeming approval would help us get more and better field data.
- Jennifer Williamson: Reid had noted the importance of good installations to get savings.
- Irfan Rehmanji: Each technology involved requires nuances of training; how do we get a handle on that?
- Mark Cherniak: NEEA's work on heat pump trainings might be a good model for this.

E3T Energy Management TAG Recommendations

December 2011

Low-Cost Energy Management and Control System for Small to Medium Commercial Buildings-347	**Overall Score: 3.0**

Description: Affordable and cost-effective energy management controls and monitoring solutions for small- to medium-sized commercial buildings.

Recommendations:

1. Develop a list of requirements for controls systems with reliable control and monitoring capability that are affordable and cost-effective for application in multi-zone small- to medium-sized commercial buildings. If necessary, provide different requirements for different types and sizes of buildings.
2. Perform secondary research to explore previous work in this area. This should include contacting:
    - SMUD; they have done some work in this area.
    - Frank Brown with BPA in Seattle to learn about the Ecofys study of Cypress wireless pneumatic thermostats, bundled with Green Box controller (contact).
3. Identify packaged systems or components that meet the requirements above, including a survey of major controls manufacturers.
4. If we find only components that meet our requirements, develop cost-effective packaged solution(s).
5. To help establish what the target costs of the systems should be, including O&M costs, do a simulation analysis to estimate savings potential for several applications. Include a survey of customer's range of acceptable payback, possibly through ETO's project (Jack Callahan: 2-3 years for most small to medium businesses). Provide target costs for several energy rates.
6. If we do not find any products that meet our requirements, develop a specification and challenge controls manufacturers to meet it as part of a "Controls Challenge."
7. Based on the research above, develop a plan for field testing to determine the performance of the controls and monitoring solutions.
8. If the field tests results indicate cost-effective performance, develop a utility program specification and encourage utilities to provide incentives to building owners who install the packaged solutions.
9. Explore other ways of encouraging building owners to install the systems. For example, provide an energy label that would be recognizable enough in the market to increase rental rates and real estate value.
10. Launch an awareness campaign to educate potential customers, possibly through contractors and service providers, about the benefits of using centralized building controls in the target market.

Product Availability:

The following is a list of manufacturers that may provide relevant products or solutions:

1. Johnson Controls
2. NEST Labs
3. Kite and Lightning

4. Parker
5. Trane
6. E2 America
7. Site Controls (bought out by Siemens, focusing on convenience stores, turnkey solutions)
8. Ecobee Advanced Wireless thermostat, for baseboard heaters
9. WEMS (Wireless Energy Management Systems), from UK, for HVAC/lighting controls, claims to be affordable and non-intrusive (www.wems.co.uk)
10. Honeywell (spider with Tridium interface)?
11. E2 America
12. Site Controls, by Siemens, focusing on convenience stores with turnkey solutions

Comments:

- Should this also include fault diagnosis, or would that add too much cost?
- Dave Bisbee: SMUD has mostly looked at food and liquor stores, not office buildings and larger buildings.
- Nick O'Neil: ETO is working with Kite products, and will have data by first quarter next year.
- Jack Callahan: The measurement protocol would be at a whole building level. This needs to be a whole buildings solution to get enough savings.
- Jack Callahan: An example of a program specification is the EE Grocer program, which has a list of protocols for selling savings to customers and counting savings, and all this is wrapped up in a program specification. This is typically done by a third party, such as PECI did for EE Grocer. Include what needs to be done at each site with pre-defined measures and solutions.
- Irfan Rehmanji: BC Hydro has trouble reaching small/medium-sized business owners directly, so they reach to contractors and service providers that reach out to appropriate owners.

Building Energy Performance Analytics Software and Services -353	Overall Score: 2.4

Description: Software packages and services that analyze energy and performance data for fault diagnostics as well as optimizing system performance in large commercial buildings. Some also establish a baseline and calculate savings based on the baseline.

Recommendations:

1. Perform a literature search to determine what characteristics of the systems are most useful. Include an investigation of commercial programs at Southern California Edison and BC Hydro and look for models establishing standards that could be useful.
2. If the literature search indicates the technology has strong potential for reliable energy savings, perform a survey of facility managers and technicians in buildings where these analytical systems are being used. Find out which systems are working best, determine which features of the analytics systems are most helpful for fault diagnostics and system optimization, and find out how to use them most effectively.
3. Use the results from the survey to design an M&V approach that would estimate the effectiveness of the features with greater accuracy.
4. Design and perform a field test on several buildings to establish savings and cost-effectiveness. Determine if some low-cost systems can provide most of the savings. Might these be more cost-effective solutions than the high-end packages?
5. Develop training programs and an applications guide to help users in the proper selection and effective use of the analytics packages. Develop motivational techniques to encourage effective and persistent use.
6. If the findings from the literature search, survey, and field tests indicate cost-effective energy-saving performance, develop and publish a utility program guide that includes application and design guidelines and incentive criteria.

Comments:

- Jack Callahan: This technology can be challenging to clarify and specify.
- Jay Stein: Lower cost products use only utility data and use algorithms to disaggregate data into end uses. This eliminates the cost and hassle of hooking up all the end use metering. But very little of previous field testing measures the real potential of this technology. BC Hydro's done about as much as anyone, and they're not finding much.
- Jack Callahan: What other utilities are looking at that? Graham Hender is the Continuous Optimization program manager who would know.
- Jay Stein: The most useful tool for BPA would be a matrix showing the features of different products.

E3T Energy Management TAG Recommendations

December 2011

Innovative Behavior Change Techniques-328	**Overall Score: 2.2**

Description: Techniques to educate and motivate the target audience (end users, energy managers, designers, purchasers, and facility managers) to change their behavior and decision-making strategies in order to achieve greater energy savings.

Recommendations:

1. Because of the complexities, ambiguities, and challenges in predicting and measuring savings, this may not fit well into traditional BPA programs. Explore handing this off to NEEA or investigating through other BPA programs.
2. If BPA decides to move forward with this, clarify the components and strategies of an effective behavior-changing initiative. Consider using ideas about successful behavioral change from other disciplines, such as pollution prevention.
3. Investigate programs that have a strong behavior component, including BC Hydro, Conservation Catalysts (Don Rainey's company), the Energy Trust of Oregon (in participation with BPA, using Strategic Energy Management, formally part of Invensis), Honeywell's Behavioral Change program, Puget Sound Energy, Snohomish County PUD, O Power, Energy Savvy, Saine Engineering, and NEEA's hospital program to see what we can learn from them.
4. If the investigation above indicates a strong potential for significant and measurable energy savings, develop a guidebook of effective behavioral change strategies with summaries of case studies.
5. Develop a protocol for measuring the success of the program in order to provide a means for calculating incentives.
    - Clarify the energy savings impacts of behavior changes by defining how to account the impact of variable parameters such as occupancy or tenancy rates, weather, production rates, and other energy efficiency efforts such as capital improvements.
    - Explore the energy accounting software used by resource conservation managers (RCMs) in school districts to see if this could be used to help measure energy savings separate from the impacts of the variables mentioned above.
6. Set up a program of workshops and on-going support to the target audience in achieving effective behavioral changes. Make sure the components of this program are facilitated by people with good technical, communication and motivational skills.

Comments:

- Don Rainey: It may be worth risking $50,000 to potentially launch a program that may save millions of dollars. Focus on RCMs, energy managers, and others responsible for managing high energy use; that should at least pay back the investment. He has formal presentations on this he'd be happy to share. Honeywell's Behavioral Change program has found great benefits but they're not very

forthcoming on the program details. They offer it as an ESCO.

- Don Rainey: Behavioral change has the potential to reduce the total costs of operation beyond energy savings.
- Alan Budman: SnoPUD has a program for schools and one for building re-commissioning that have behavioral components. They have Behavioral Challenge, where customers commit to saving 10% with feedback from SnoPUD
- Irfan Rehmanji: BC Hydro has a work-based conservation program developed with school districts that has now expanded to government facilities. Savings claims are 2-5%. They're trying to get better data to better satisfy program staff. Paul Seo is the Power Smart lead for this.
- Don Rainey: Saine Engineering has collaborative programs for Air Force bases on behavioral change that offer ongoing support, including monthly webinars and face-to-face meetings in addition to regular e-mails.

E3T Energy Management TAG Recommendations

December 2011

Non-Intrusive Load Monitoring -294	**Overall Score: 2.1**

Description: A method of disaggregating facility loads into individual components by non-intrusive methods without the need for submetering.

Recommendations:

1. The TAG determined that this is probably not ready for prime time. Continue to monitor available products and results from other studies of this technology, particularly in the commercial sector, until this technology seems more ready for prime time. In particular, find out what results EPRI and Southern California Edison are getting from their investigations.
2. Create a list of available products, and include each product's capabilities, who is working on them, and results of studies or research.

Comments:

- This may be most useful as a tool for utilities and BPA to reduce costs for large-scale monitoring and to study other energy efficiency measures. This could be useful for research and for behavior change.
- CalSunergy may be willing to do some pilot testing in the NW.
- Jennifer Williamson: Dave Kresta suggested that EPRI is planning research projects, but maybe not in the commercial sector. SCE has a proposal to perform investigations this. NEEA wants to do some lab testing and install some metering in homes next year.
- Jack Callahan: He's interested in this as a cheaper way to do end use monitoring. Mira Vowles is working on a field study with Intel. In addition to these recommendations, which seem appropriate for now, if they find new opportunities to help develop new products, BPA would be very interested in that—for end use load monitoring rather than behavior change.

Appendix B – EM TAG Meeting Rosters

- 2011 E3T EM TAG Ranking Members and Staff
- 2011 E3T EM TAG Corresponding Members
- ID Session Attendance
- Ranking Session Attendance
- Scoring Session Attendance
- Recommendations Session Attendance

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E3T 2011 Energy Management Technical Advisory Group

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Crispin Wong and Jennifer Williamson participated in person.

E3T 2011 Energy Management Technical Advisory Group

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E3T 2011 Energy Management Technical Advisory Group

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E3T 2011 Energy Management Technical Advisory Group

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Appendix C – Earlier E3T TAG Cycles

In 2008, the Bonneville Power Administration (BPA) Energy Efficiency department began a multi-year effort to identify, assess, and develop emerging energy efficiency technologies. The main goal of the Energy Efficiency Emerging Technologies (E3T) program is for BPA to engage in an ongoing collaborative effort to "fill the pipeline" with innovative energy efficiency strategies and technologies that promise significant region-wide energy savings.

A framework was developed for the E3T process in the summer of 2009 as both the 2009 Lighting and HVAC Technical Advisory Groups (TAGs) progressed. The framework has guided past TAGs and informs the path emerging technologies take once TAG recommendations are received by BPA. Three TAGs completed before the launch of the 2011 Energy Management TAG are summarized here.

More information on these TAGs is available in their respective progress and final reports, available upon request. The E3T program maintains a database that serves as the repository of information collected and developed for hundreds of individual technologies and solutions at www.E3TNW.org.

Lighting 2009

In 2009, the E3T program recruited highly qualified, experienced lighting engineers and specialists to serve as volunteers on the first E3T TAG focusing on lighting. The TAG process included a cycle of meetings to identify, rank, score, and develop recommendations for selected energy efficiency technologies. Those basic stages remain the pattern of TAG cycles, although each cycle has introduced significant changes to the timing and duration of meetings and other efforts involved in each stage.

The 2009 Lighting TAG ultimately identified and developed information and recommendations on five technologies:

- Wireless Lighting Controls
- Integrated Classroom Lighting System
- Bi-Level Parking Lighting with Occupancy Sensors
- Bi-Level Stairwell Lighting with Occupancy Sensors
- Bi-Level Office Lighting with Occupancy Sensors

Beyond the technical information garnered from TAG members and staff, perhaps the most important takeaway from the Lighting TAG was an awareness that no matter how promising a technology might appear to a diverse group of experts, TAG results need to align with the capability of plans and programs in existence at BPA to foster their adoption.

A Lighting TAG was planned and readied for launch in the fall of 2010, but was suspended to allow staff to focus on efforts to revisit the E3T framework using input garnered through interviews with key stakeholders. The re-visioning process, as it was known, had significant implications for the TAG process, necessitating a postponement of the second Lighting TAG, now planned for early 2012.

HVAC 2009

Closely following the start of the 2009 Lighting TAG in March 2009, another TAG was convened in May 2009 focusing on heating, ventilation, and air conditioning technologies (HVAC). This first HVAC TAG established a pattern of conducting TAG meetings using screen-sharing webinar software and online survey tools, with no major in-person attendance. However, the actual presence on occasion of TAG members in the Olympia office of the WSU Energy Program was deemed to be very helpful and supportive.

Concluding in February 2010, the 2009 HVAC TAG forwarded recommendations for four technologies:

- Demand Controlled Ventilation for Commercial Kitchens
- Variable Refrigerant Flow Heat Pumps
- Demand Controlled Ventilation
- Indirect-Direct Evaporative Cooling

One key takeaway from the 2009 HVAC TAG was that long intervals between meetings presented challenges to group cohesion. However, the approach taken using online tools and holding online meetings provided the basic platform that TAGs operate on to date, undergirded by the expertise, patience, and professionalism of TAG members.

HVAC 2010

The 2010 cycle of the E3T HVAC TAG was operated in a compressed timeframe, spanning just over three months. The initial identification meeting was convened on June 10, 2010. The 2011 TAG cycle concluded with two recommendations web conferences, the last one held September 16, 2010.

The 2010 HVAC TAG ultimately selected four emerging energy efficiency technologies to advance in the E3T process, proposed steps to identify and assess their potential in BPA's service territory, and laid out strategies for funding and implementing greater adoption of these technologies.

Those four technologies are:

- Variable Capacity Compressors
- Air-Side Economizers for Data Centers
- Web-Based Small Commercial Thermostat
- Advanced Design Rooftop HVAC Unit

Lessons from the 2010 HVAC TAG included the inverse of the 2009 HVAC TAG, especially the compressed timeframe, particularly in the summer, which often ran up against member and staff availability issues. Further, staff realized the importance of enhancing the documentation of technologies beyond the short list of those that emerged from the process with recommendations; the overall process is enhanced if more of the technologies in the E3T database are described and detailed enough to potentially suggest synergies with those going forward in the process.

The successes of the 2010 HVAC TAG included a greater awareness of the level of effort needed at different stages to manage a widespread collaborative effort made up of staff and volunteers who include top professionals in their respective fields. It also showed the value of using online resources that minimized the time commitment and travel expected of TAG members.