# The E3T Framework:
# Fast-Tracking Emerging Technology Development in the Pacific Northwest

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## ABSTRACT

To address the challenges of increasingly ambitious energy savings and climate change mitigation goals, the Bonneville Power Administration (BPA) and partner organizations developed the Energy Efficiency Emerging Technologies (E3T) program, a streamlined approach to identify and assess promising new measures for Pacific Northwest energy efficiency (EE) programs. The E3T program team leads BPA's efforts to qualify new, viable EE technologies for BPA and Regional Technical Forum (RTF) approval and measure deployment. The goal of E3T is to provide a robust pipeline of EE offerings to BPA's customers, creating a substantive contribution toward the region's energy savings targets. This effort, coupled with those of BPA's Technology Innovation Office (TIO), provides emerging technologies and R&D thought leadership to meet near-term and future EE challenges.

The E3T framework consists of five stages with decision points for efficiently moving potential measures from detection to adoption by utility conservation programs. Framework stages include:

- Measure Identification
- Measure Benefits
- Measure Potential
- Action Plan and Assessment
- New Offer

The framework also includes "off-ramps" at each decision point for measures currently lacking key information or attributes for success. Specific next steps are identified for measures that fail at decision points to provide necessary data on the technology, business model, and/or market requirements. The E3T framework builds in part upon best practices from other emerging technologies programs.

This paper and the associated visual presentation illustrate the E3T framework, using examples of technologies in various stages of the E3T process.

## Background

### History

The Bonneville Power Administration (BPA), a federal power marketing agency, provides for about one-third of the electricity needs of BPA's service territory (Washington, Oregon, Idaho, western Montana, and contiguous areas of neighboring states). BPA serves a broad spectrum of customers, including cooperatives, municipalities, public utility districts,

federal agencies, investor-owned utilities, and direct-service industries. Within BPA, the Energy Efficiency department has long played a central role in defining programs and collaborations that enhance their customers' energy savings, as measured in average megawatts (aMW). (One aMW is equal to 8760 MWh, or 8.76 GWh.)

In October 2009, the Northwest Power and Conservation Council (the Council) released its Draft 6th Power Plan for the Northwest, which establishes energy efficiency targets based on the Council's assessment of long-term achievable energy efficiency potential. The 6th Power Plan calls for acquiring 1,200 aMW of efficiency gains over the five-year period from 2010 through 2014. Of that amount, BPA has taken responsibility for achieving the public power share, approximately 42%, or 504 aMW of energy savings.

This amount is double BPA's previous targets and approximately one and one-half times the energy efficiency savings achieved from 2005 through 2009. Additionally, the time period for meeting these increased targets overlaps with a federal phase-out of standard incandescent lamps. This will reduce BPA's ability to count savings from compact fluorescent lamps (CFLs), effectively negating approximately 39% of BPA's savings in the past few years. To achieve these aggressive goals and make up for the loss of CFL savings, BPA has developed a three-pronged strategy to achieve the required efficiency impacts:

1. Expand the market reach and savings of existing opportunities by adding measures, enhancing marketing, increasing and/or optimizing financial reimbursements, streamlining and simplifying programs and program rules and leveraging coordination with regional stakeholders.
2. Introduce new opportunities that target market segments and energy efficiency measures with significant savings opportunities as identified in the 6th Power Plan.
3. Continue to assess the savings and cost effectiveness of new and emerging technologies for their potential to contribute to regional energy efficiency goals.

BPA expects 18% of its savings in the period 2010-2014, approximately 66 aMW (578 GWh), to come from emerging technologies. Much of that will not be available until 2012 or later due to the lead times required to complete technology screening, selection, assessment and Regional Technical Forum[1] (RTF) review.

**Contributing Organizations**

Three closely-coordinated initiatives are supporting BPA's efforts to fill the pipeline with new energy efficient technologies – BPA's Technology Innovation R&D projects, BPA's Emerging Technology program (E3T), and the Regional Technology Advisory Committee (RETAC), a collaboration between BPA and the Northwest Energy Efficiency Alliance (NEEA) to provide regional coordination on emerging technologies and to serve as NEEA's emerging technology advisory committee.

E3T is the product of a year-long collaboration in 2008–2009 between BPA, the Washington State University Extension (WSU) Energy Program, and Livingston Energy Innovations (LEI). BPA provided overall direction and strategic project management, the WSU Energy Program contributed expertise in energy engineering, technology tracking and screening,

[1] The Regional Technical Forum is an advisory and oversight committee for the Northwest Planning and Conservation Council on conservation measure impacts for the Northwest.

tactical project management, advisor recruitment, and database development, and LEI guided development of the E3T scanning, screening, assessment, and program adoption process and authored the E3T User Manual.

**Sources**

BPA staff and collaborators drew upon the best practices of a variety of technology road-mapping and innovation management processes in developing E3T. The BPA Technology Innovation department, which identifies and provides R&D funding to a portfolio of technologies offering the greatest potential value for BPA and retail utilities in the Pacific Northwest, provided strategic context and financial support for E3T's development.

E3T also benefited significantly from strategic and operational advances that the Emerging Technologies Coordinating Council (ETCC) and its member utilities and government partners have developed in California. ETCC's work, particularly the emerging technology approaches developed by California utilities, provided key insights during the development of E3T's conceptual and operational details.

E3T built upon relevant previous work of the WSU Energy Program, which included assessments of new and emerging technologies for the NEEA, and for the Northwest Power and Conservation Council, the identification of emerging technologies poised for adoption in the Northwest over the next 5-20 years. E3T also benefited from a key team member's experience in leading the emerging technologies program for a major California energy utility.

## Concept

To successfully meet the target of achieving 18% of its energy savings goal for 2010-2014 with emerging technologies, BPA reengineered its previous process of introducing new EE technologies through informal demonstration projects. Table 1 on the next page summarizes key E3T program elements and solutions developed to address BPA needs and constraints around new EE technology identification, assessment and documentation.

## Process

The E3T process incorporates an on-line database and a set of data collection forms and protocols. These tools were built to meet the requirements of E3T users, who include BPA Energy Efficiency engineers and consultants on the core E3T team, as well as BPA Energy Efficiency program planners and managers and regional partners involved in helping customer utilities develop new EE measures and programs. By applying these tools, E3T users quickly become aware of what's already known about innovative technologies, including results of previous assessments.

The database, forms and protocols also incorporate business and technical innovations to optimize the speed and cost-effectiveness of new measure development. This enables rapid E3T user decision-making on technologies' readiness for broad market adoption, and on opportunities to build on or partner with the work of others, thus streamlining evaluation of potential new energy efficiency measures for implementation in the Pacific Northwest. The database also provides support for measure review and approval by the Regional Technical Forum, an advisory and oversight committee on conservation measure impacts for the Northwest.

**Table 1. E3T Elements Developed in Response to BPA Needs, Constraints and Issues**

| Need | Constraint / Issue | Solution / Element |
|---|---|---|
| **Promptly address the broad range of EE technologies and end-uses identified in the NPCC's 6th Power Plan.** | Limited staff and budget. | Structured screening process |
| | Limits to in-house expertise and market knowledge. | Technical Advisory Groups |
| | Individual technologies need widely different actions. | Decision Tree |
| | Emerging technology development is often non-linear and discontinuous. | Stage-gate approach |
| **Develop and assess technologies in accordance with BPA Energy Efficiency program needs.** | Failure to deliver desired results if R&D not closely aligned with Energy Efficiency program needs. | Action Plan |
| **Meet specific BPA and RTF requirements for Energy Efficiency measures.** | New Offer Documentation process requires detailed documentation and specific actions at specific times. | Multi-stage structured information collection |

The E3T online database provides a structure of input forms and output lists that permits E3T users to input, aggregate, and evaluate data on emerging technologies. This allows users to concentrate on data collection and structured decision-making, rather than on attempting to evaluate and justify many partly-defined measures on an *ad-hoc* basis.

Thus far, E3T staff have been able to at least briefly characterize key parameters for over 240 emerging energy efficiency technologies using the E3T database and process. For a subset of these, the database includes results of significant secondary research and links to additional product and performance information. During the course of evaluating technologies that are candidates to become new measures, the process guides users to define and conduct a field or lab assessment to obtain missing data. The end goal of the process is to allow the E3T team to efficiently validate the expected energy savings for each item in a portfolio of promising emerging technologies and to provide all information needed to justify a customer incentive structure for implementing the resulting measures.

## Structure

The E3T data collection process applies a stage-gate approach, which divides the process into stages, each having a gate where continuation must be decided. This approach assures cost- and time-effective use of limited E3T resources. The first stage involves collecting readily available data from E3T staff and then applying screening and prioritization gates based on recommendations from Technical Advisory Groups (TAGs). TAGs are comprised of national experts in a technology domain, including professional practitioners and utility staff experts, who assist in the E3T process as volunteers for mutual benefit. The stage-gate approach allows for the winnowing of less promising technologies as early in the process as possible, thereby focusing resources on evaluation of only the most promising technologies.

Following initial evaluations, BPA technical and planning staff, with assistance from market research consultants, conduct additional, more detailed secondary research on candidate technologies. The most promising technologies undergo lab and/or field assessments to validate their performance and identify any potential technical or human-factor challenges as well as non-energy benefits. This and later stages are the most expensive and time-consuming, and are not be pursued unless a given technology has cleared earlier, less resource-intensive stages.

The E3T process consists of five distinct stages, each of which uses one or more forms to guide users through data collection and evaluation for a given energy efficiency technology. Each stage terminates with a scorecard and a yes/no decision gate that determines whether a technology advances to the next stage. Technologies that receive a low score at a decision gate are evaluated using a decision tree approach described later in this paper. The decision tree serves to determine whether the technology merits additional consideration, and what the appropriate next step will be, based on the decision gate and what key data was lacking.

Technologies that have already undergone rigorous validation, or exhibit a high probability of success, are reviewed for their potential to follow a "fast track" proceeding directly to the final stage of the E3T process. The fast track criteria and the final stage of the E3T process, structuring an incentive offer, are described later in this paper.

E3T's five stages, the decision tree, and the fast track option work together to ensure that high-potential technologies receive the most appropriate treatment, such as acquisition of additional supporting data or expediting an incentive offer – as quickly as practical with minimum expenditure of resources.

**Five Stages**

The multi-stage E3T identification and screening process includes:

Stage 1: Measure Identification
Stage 2: Measure Benefits
Stage 3: Measure Potential
Stage 4: Action Plan and Assessment
Stage 5: New Offer

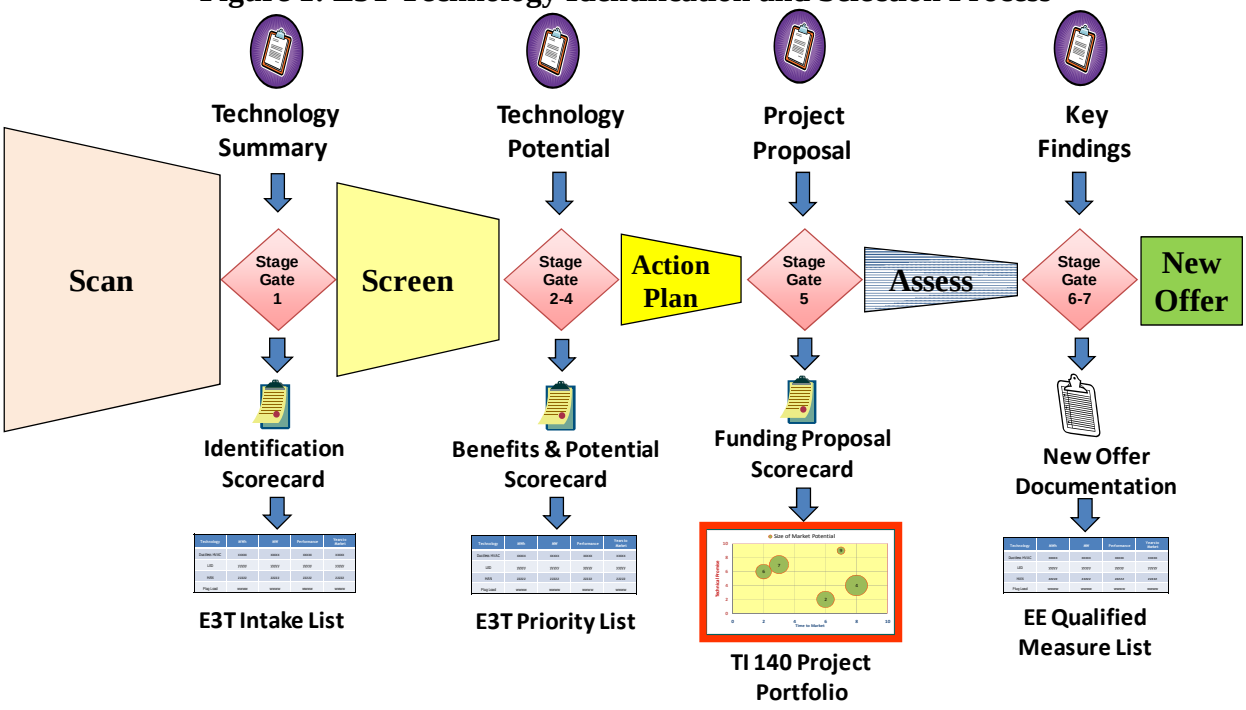
Each stage combines acquisition of key data on the technology and its market readiness with a rating process for screening and prioritizing the technologies that should advance to the next stage. The result of the E3T process is a portfolio of well-documented measures, each supported by a standardized set of supporting data, that are ready to provide significant energy savings and meet the needs of BPA and the retail utilities of the Pacific Northwest.

Figure 1 below provides a graphical representation of the E3T process including decision gates, scorecards and other forms, as well as the "lists" (database screens) that are generated through the process. The following sections provide descriptions of each stage as well as decision tree and fast track elements.

**Stage One: Measure Identification**

The Measure Identification stage focuses on collecting candidate technologies for energy efficiency measures that fit the needs of BPA's client utilities and their customers. First, E3T staff compiles available information about a particular technology and completes the E3T Measure Identification Information form (MII) for inclusion in the E3T database. Input to the MII form can come from a range of sources, including:

**Figure 1: E3T Technology Identification and Selection Process**




Source: Callahan, 2010

- Northwest Power and Conservation Council's 6th Power Plan
- BPA's Energy Efficiency Plan
- E3T Technical Advisory Groups (TAGs)
- Emerging Technology Coordinating Council (ETCC) and its individual members
- Industry publications from sources such as the American Council for an Energy Efficient Economy (ACEEE), E Source, and the Electric Power Research Institute (EPRI)
- Conferences, journals, manufacturer's sales representatives, and other industry sources.
- Literature searches by WSU Energy Program research librarians
- Professional contacts of the E3T staff

This first stage of data collection provides a foundation to clearly define, understand and qualify the technology based on basic attributes including energy savings estimates, cost, effective life, and an energy performance specification.

Using this information, the E3T staff reviews the measures against the following yes/no screening criteria in the Measure Identification Scorecard form (MIS):

- **Emerging technology:** Is this technology new and not yet evaluated for inclusion in BPA programs?
- **Energy efficiency:** Does this technology have the potential to provide quantifiable, reliable, and cost effective electric energy savings for end-use consumers in the Northwest region?
- **Technically sound:** Is this technology technically sound with minimal or no negative impacts expected? Is there reasonable certainty that it will perform as intended?

- **Relevant:** Are performance-related features readily identifiable and related to BPA identified R&D gaps?

The MIS results are aggregated and captured in the E3T database. Technologies that achieve high MIS scores pass through Gate 1 and are displayed in the database Input List, indicating that they qualify for further E3T consideration. Those that do not pass Gate 1 are archived with a note as to why they have been rejected.

**Fast Track**

Measures that have undergone previous rigorous testing or have a high probability of success, as made evident during Measure Identification, can also be "fast tracked." The criteria for fast tracking include:

- **Information availability:** Is there enough information available from assessments performed by other credible entities to skip further screening and assessment?
- **Opportunity availability:** How much benefit is there for immediate action related to some timely opportunity (e.g., a leveraged funding availability, good fit as an add-on to other Energy Efficiency program activities, etc.)?
- **Resources availability:** Are there resources (e.g., BPA staff, budget, etc.) currently available to quickly respond to the opportunity?

Measures that meet the above criteria bypass additional evaluation and proceed immediately to Stage Five: New Offer (or in some cases, proceed to New Offer after limited additional data collection or testing).

**Stage Two: Measure Benefits**

The Measure Benefits stage focuses on bringing deeper subject matter understanding to bear on the relative benefits of the technologies from a technical and consumer perspective and from an energy efficiency program perspective. This portion of the process is performed by E3T's Technical Advisory Groups, which include industry experts, BPA and its customer utilities' staff EE technology experts, plus additional BPA and customer utility staff with expertise in energy efficiency program planning, marketing, and design.

At regular intervals throughout the year, E3T staff convenes a TAG for a particular technology domain or end-use sector ("focus area"). A TAG decision cycle generally consists of four meetings: 1) a Kick-Off (first year) or Annual (subsequent years) Meeting, 2) an Identification Meeting, 3) a Scoring Meeting, and 4) a Confirmation Meeting.

The cycle is designed to first systematically generate a complete list of relevant emerging efficiency technologies, to next progressively narrow down the choices to identify the cream of the crop, to then make recommendations for next steps to assess the technologies, and to ultimately confirm their readiness to become new Energy Efficiency program measures. At each stage, as fewer technologies remain in discussion, the E3T staff and consultants gather more detailed information. The result is a short list of three to six technologies in that focus area that

the experts have determined, through quantitative evaluation backed with TAG professional judgment, are promising enough to justify assessment as a precursor to designating them as new program measures.

**Decision Tree**

The E3T decision tree was developed to formalize the process for redirecting technologies that may not be ready for time- and resource-intensive field assessments. If a technology receives a low score at a decision gate, it is re-evaluated using decision tree criteria to determine whether it merits additional consideration, and what the appropriate next step will be. Based on the specific scoring or data deficiency, the decision tree guides users through a variety of scenarios to identify the type and timing of data collection, research, or testing to best determine a technology's potential for further E3T review and consideration as potential new measures.

For instance, if the technology is determined not to be viable at any gate, it is archived with comments on why it failed to advance, and removed from further E3T consideration. Other alternative steps guided by the decision tree include the following:

- Put the technology on hold for re-examination the following year
- Hand off to one or more regional partners for assessment or implementation
- Perform market research to generate a market assessment report
- Perform a business assessment study to validate the business model viability
- Conduct a field test.

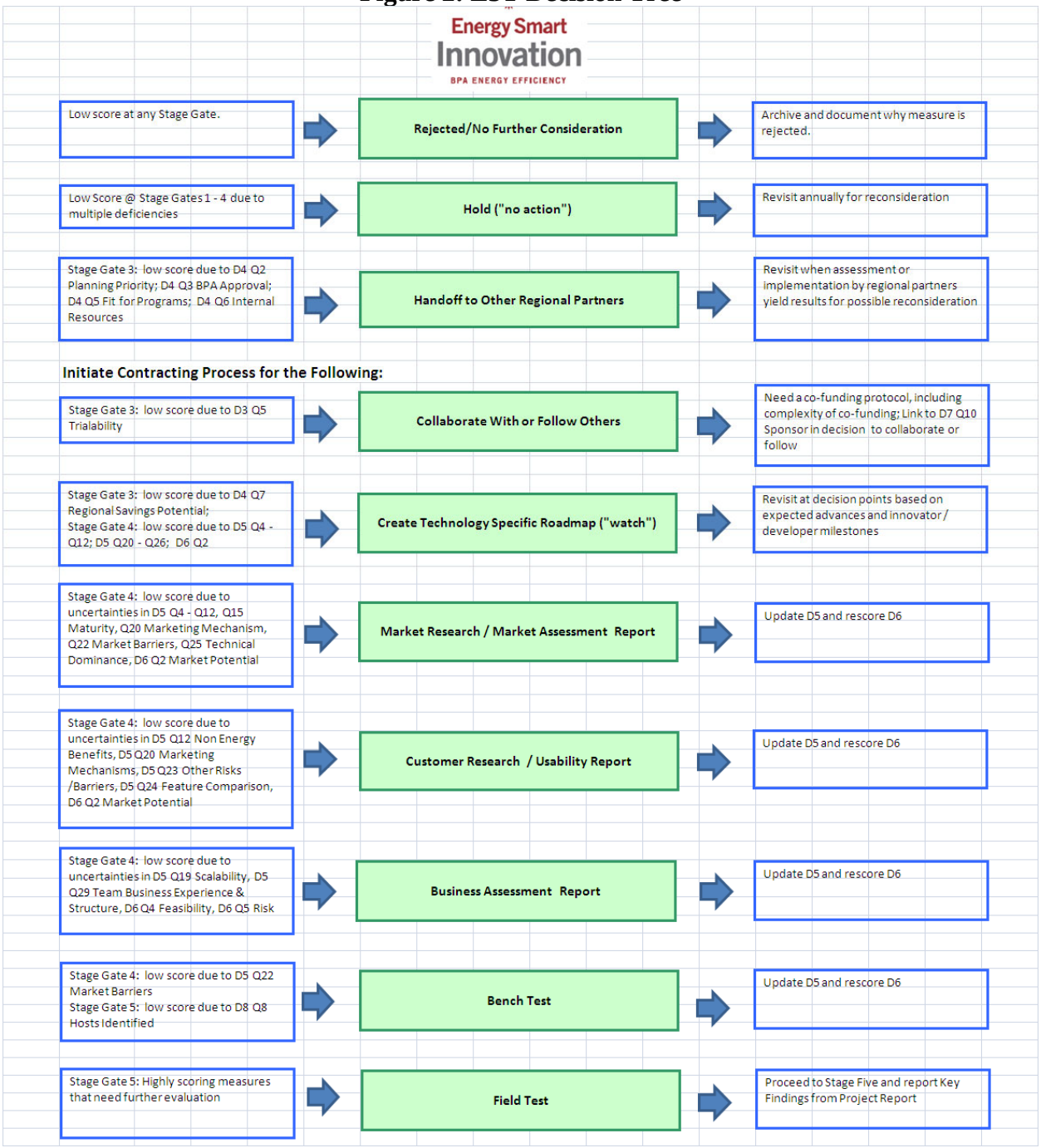
Upon completion of the indicated step, the technology is redirected back to an appropriate point in the E3T process, ensuring that it receives thorough consideration of its merits and potential. See Figure 2 on the next page for further detail on triggering criteria and subsequent actions.

**Stage Three: Measure Potential**

The Measure Potential stage focuses on detailed secondary research on the technology from the BPA Energy Efficiency program perspective. This secondary research is performed by BPA Energy Efficiency staff and consultants, with input from the TAG and the E3T team. Coupled with the results of Measure Benefits, the goal of this stage is to produce a prioritized set of well-documented technologies that have a high potential of being added as official BPA program measures.

At the start of this stage, Energy Efficiency and E3T staff, as well as interested TAG members, conduct additional data collection and secondary research about the measure, using this information to complete the Measure Potential – Information Collection form. These activities both validate the information collected in Measure Identification and provide a more in-depth analysis of the measure's market and energy savings potential.

**Figure 2: E3T Decision Tree**




Source: BPA 2009

Using all of the information collected up to this stage, the E3T leadership team scores the measure's potential on the Measure Potential - Scorecard. If the measure achieves a high score, it passes through Gate 4 and is displayed in the database Priority List, indicating that it is approved for priority consideration, or alternately, that it will be fast tracked. If it does not pass through Gate 4, the measure is screened against decision tree criteria and redirected for further data collection or research.

**Stage Four: Action Plan and Assessment**

This stage focuses on finalizing the decision to conduct a detailed assessment of the technology to fill any information gaps and qualify the technology as a New Offer (a new EE program measure). The assessment project may require market research, customer research, business assessment, or bench or field testing. In this stage, BPA E3T staff perform additional planning, data collection, and scoring steps to evaluate whether, based on all the information obtained so far plus expected results from the proposed assessment, the technology merits the additional investment of time and resources needed to make it ready for program implementation.

First, BPA E3T staff develops an Action Plan laying out the schedule for key project tasks including assessment and New Offer Documentation for implementation and uptake of each fully-documented measure into utility programs.

To conduct an assessment project, a Project Funding Proposal form is prepared. Then, BPA staff evaluates the funding proposal by filling out the Funding Proposal Scorecard. If the project receives a high score, it is approved and funded, and the measure passes through Gate 5. If not, the measure proceeds to the decision tree.

Approved assessment projects are implemented, typically through a contract with a pre-qualified evaluation consultant. At the end of the project, the consultant produces an E3T Project Report.

The most common type of report, a Field Assessment Report, highlights key project findings and focuses on the estimated energy and demand savings that would result from implementation of the measure. It summarizes conclusions of the project and makes recommendations for the future next steps. If the project was a field test and was successful, the measure moves to Approval. Regardless of the type of report, upon its completion the measure moves to the next step defined in E3T process flow chart or the decision tree, as appropriate.

Action Plan and Assessment activities, including the project approval and contracting process, is tracked in the E3T database via the Contract Project Tracking form and displayed in the Project Portfolio, the third level of the E3T database, indicating that it is in the final stages of vetting for consideration as a new Energy Efficiency program measure.

**Stage Five: New Offer**

Once the Project Report is finalized, E3T staff input the key findings to the database via the Key Findings form. EE staff uses this information, along with the data from all other stages, to prepare the New Offer Documentation. This is submitted to BPA Energy Efficiency Planning and Engineering staff to then be presented to the Energy Efficiency leadership team for review and approval, or to the RTF. Once approved, the technology is added to the Qualified Measure List, the fourth level of the E3T database, indicating that it is ready for Energy Efficiency program implementation.

## Examples

The following examples present three energy efficiency emerging technologies that have gone through or are going through E3T evaluation, and the resulting or expected outcomes.

**Mini-Split Heat Pump Assessment and Pilot Project**

Project duration: Oct 2009-Sep 2012

**Technology description**. Mini-split (ductless) heat pumps are an energy efficient alternative to central air conditioning and heating units. Each mini-split heat pump system consists of an outdoor unit and one or more indoor, wall- or ceiling-mounted units, each typically serving a room or zone with climate control needs. Mini-split heat pumps eliminate the need for a ducted climate control system, which leads to significant energy savings since duct losses can reduce HVAC system efficiency by up to 30% (DOE).

**Review process**. BPA conducted a 14-home field assessment in order to validate the energy savings that would result from mini-split heat pump installations, and on the basis of first year results, estimated 4,500 kWh annual savings per unit. This exceeded the RTF savings estimate of 3,500 kWh annual savings per unit.

BPA then decided to proceed with a three-year regional Ductless Heat Pump Pilot, and had installed 3,720 units as of December 2009. BPA will continue to monitor the pilot's results and anticipates significant region-wide adoption. RTF will review second year results, and assuming a consistent outcome from evaluation and analysis of third year data, a New Offer will be formalized as a deemed measure.

**Demand Controlled Ventilation (DCV) Projects**

Project duration: May 2009-Dec 2010

**Technology description**. Demand Controlled Ventilation (DCV) uses a variety of strategies to optimize the control of code-required ventilation levels, while reducing energy usage. DCV strategies include: using carbon-dioxide (CO2), occupancy and other sensors as a proxy for occupancy to modify the damper setting, fan operation and general HVAC unit control. Premium Ventilation builds on the synergies of DCV with a variety of additional benefits: integrated fan cycling, stand-alone direct digital controls, enhanced economizer control, improved damper seals, CO2 sensor self-calibration capability, variable speed drive (VSD), demand-response strategies and ventilation lock-out during warm-up. Incorporating a menu of energy efficiency, demand-response and other strategies into a stand-alone direct digital control offers promise for cost-effective retrofits of small, packaged HVAC units.

**Review process.** Field testing began in spring of 2010 on six small, packaged HVAC units for proof-of-concept, assessment of functionality, verification of whether control algorithms meet ASHRAE Standard 62.1 and ultimately whether Premium Ventilation retrofits are cost-effective for small, packaged HVAC units. A probability-based expected-value savings projection and a parametric simulation model will be used to analyze energy savings for the Pacific Northwest, and help determine whether BPA should seek provisional deemed savings estimates for an incentive offering. In addition, field assessment of 17 theater rooftop units before and after installation of DCV controls is expected to provide additional data for incentives.

**Heat Pump Water Heater (HPWH) Lab Testing Project**

Project duration: Oct 2009-Sep 2011

**Technology description**. Traditional water heaters use fuel combustion or electric resistance to heat water and to maintain the desired hot water supply temperature. In contrast, heat pump water heaters (HPWH) transfer heat from the air to the water in the tank, using the same thermodynamic cycles found in home refrigerators and air conditioners. HPWHs can use less than half as much energy as traditional water heaters to operate (Energy Star).

**Review process.** Recognizing the high potential of HPWHs, BPA is currently conducting lab tests on three new integrated products from major U.S. manufacturers, and has also begun a 2010 – 2011 field test of 40 units in collaboration with the Electric Power Research Institute. BPA is seeking a provisional deemed saving estimate from RTF in 2010, and will employ the E3T process to create a New Offer for HPWHs if field test results support this.

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