

Highlights from the E3T 2014 High Performance Residential Buildings Technical Advisory Group (ResTAG)

Introduction

The E3T High Performance Residential Buildings TAG first convened April 10, 2014 and had a final meeting on June 20, 2014. Between these dates, TAG members identified potential emerging technologies, rated them, and selected five for further research and scoring. Presentations were given on the selected technologies at webinars on May 21 and June 12. The process, participants, documents, and webinars are posted on the E3TNW TAG portal – <http://e3tnw.org/TAGPortal/2014ResidentialBldgTAG.aspx>.

Residential Buildings TAG Focus

The Residential TAG's focus was on emerging technologies for single family, multifamily and manufactured homes. Single family is defined as having no more than four units in a structure, multifamily residential has five or more units in a building up to three stories, and manufactured homes includes factory-built manufactured and modular housing. All residential technologies in the E3T database were considered, with the exception of those already in programs or currently under assessment.

TAG Membership

The 22 members of the TAG included an outstanding collection of senior-level decision makers from top regional and national research organizations working on new and emerging energy efficiency technologies. Participation was voluntary.

Organizations represented by ResTAG members included:

BC Hydro	Nest Labs, Google
CleaResult	NW Energy Works
U.S. Dept of Energy	NY State Energy Research and Development Authority
Ecotope	Pacific Northwest National Laboratory
Energy Trust of Oregon	Passive House Institute
Electric Power Research Institute	Puget Sound Energy
Eugene Water and Energy Board	Seattle City Light
Habitat Design & Consulting,	Snohomish PUD
Lawrence Berkeley National Laboratory	Touchstone Energy
Northwest Energy Efficiency Alliance	

ResTAG Steering Committee

BPA provided a steering committee comprised of two staff members from BPA's E3T team, five staff from BPA's Residential Program Team, and one from PEJD Engineering Services. This steering committee was set up to help guide the TAG process so that end results would advance the plans and needs of BPA Program staff, with the goal of moving some of selected technologies into utility conservation programs. The steering committee reviewed the TAG plan,

the recruiting progress, and provided feedback on the list of technologies to be researched and scored.

TAG Process

ResTAG members brainstormed, discussed, and rated 105 technologies and strategies. The steering committee then selected four technologies from among the 32 highest-rated technologies as well as one strategy – integrated design.

The selected technologies were:

- Ductless heat pump firmware upgrade
- Three function heat pump
- Reducing connected appliance standby loads
- High Efficiency Set Top Boxes
- Passive House (Integrated Design)

The steering committee identified integrated design as a priority prior to the ResTAG ranking process. To provide a framework for the integrated design discussion, the steering committee selected Passive House as a technology to be scored.

ResTAG members were requested to volunteer to make presentations on the five technologies selected. Two developed presentations that weren't exactly on the topic assigned, as described in the E3TNW database. Yet both presentations added real value to the TAG results, and helped to clarify the current status of all the discussed technologies. The presentation on standby loads was a broad survey of the state of standby load reduction and research in the last decade. The original intent was for a focused assessment of the impact of standby due only to an appliance being connected to the Internet for the purposes of data collection, and in particular ones that are not already addressed by ENERGY STAR or federal standards. This discrepancy highlighted the lack of comprehensive research on connected standby.

The presentation on high efficiency set top boxes also broadened out to a discussion of the inherent energy efficiency in various information and entertainment networks, but highlighted the fact that once a consumer had selected a service provider for these networks, there was very little that could be done to reduce the overall energy use of that system for the end user.

During the TAG discussion at the initial meeting, members expressed interest not only in the three-function heat pump, a commercially available product (with limited deployment in the United States), but in another closely related technology, a CO₂ refrigerant heat pump, which is also capable of providing space conditioning as well as water heating (this technology is not currently available in the Northwest, but is the subject of ongoing research sponsored by BPA). As a result of this interest, WSU staff decided to include presentations on both technologies.

Results

Of the five technologies assessed, only one received a high enough score and support within the TAG to be included in recommendations to BPA without reservation; three of the technologies can be recommended with some reservations, and the last is not recommended. The technologies are summarized below, in descending order of overall score (out of 5). The summaries include a highlight of the technology's key features and a summary of ResTAG member comments:

- **Ductless Heat Pump Firmware Upgrade (3.6 score) - Recommended:** As presented to the TAG, research in the energy use of high-performance homes has revealed a flaw in some ductless heat pump systems' control strategy, leading to unnecessary short-cycling at inappropriately high power levels during the shoulder months, resulting in higher-than-needed energy use and potentially reduced compressor life. Discussions with two major manufacturers indicate that this is an addressable issue via firmware upgrade, with a short, in-field service call. Initial data suggest potential annual energy savings of 300-500 kWh per year.

While this technology received high marks in scoring from the TAG, comments in the scoring and discussions during the last TAG meeting indicate some concerns. It is not yet clear if this is an issue confined to low-load, high performance homes or if this firmware upgrade will have significant impact on the 15,000+ ductless heat pumps installed in the Pacific Northwest, or in multifamily applications.

The TAG felt as if additional research was needed to determine savings from this technology for new construction and existing homes before the technology can be adopted by the region. NEEA staff are conducting ongoing research on this technology in high-performance homes.

- **Passive House (3.0 score) – Recommended with reservations:** Passive House is a voluntary residential design and construction standard originating in Europe focused on maximizing performance of a home's thermal envelope in order to reduce the heating or cooling load to less than 4.75 kBtu/ft²-yr in any climate zone.

As noted above, Passive House was selected by the ResTAG steering committee for scoring as a stand-in for integrated design approaches in general. TAG members generally supported the notion of building well beyond code levels, and there was some support for building to Passive House or similar levels as being achievable and more or less affordable, but the majority of comments from the TAG suggested that there is a steep learning curve and cost to the Passive House approach. There was general support from the TAG members at the final meeting for an incremental approach to improve efficiency above current voluntary programs like ENERGY STAR, perhaps involving some sort of rating system, with Passive House at the far end of the spectrum.

Some TAG members expressed concern over ventilation needs for high performance homes such as Passive House, and suggested that additional research was necessary.

- **3-Function Heat Pump (2.9 score) – Recommended with reservations:** A variable speed hydronic heat pump for residential applications. The outdoor heat exchanger is air-to-refrigerant and the indoor heat exchanger is refrigerant-to-water. Output from the indoor heat exchanger is water, cooled or heated by the heat pump, that can be piped to serve a variety of externally connected heat exchange devices (including radiators, integration with an air handler or a radiant floor system) for space heating/cooling and domestic water heating. Incorporation of a desuperheater allows for capturing of waste heat for water heating when the system is in space cooling mode.

As noted above, there were two variations on this technology presented to the TAG, a market-available (but not widely deployed) version, using commonly available refrigerants (R-410a), and a newer technology, using CO₂ as a refrigerant. The CO₂ heat pump is not currently available in the United States, but is undergoing research conducted by WSU and sponsored by BPA.

The TAG comments and discussion indicated that while the commercially available technology promised significant savings, the cost of the technology was prohibitive. These costs may be driven higher by a lack of a trained installer network. TAG comments indicated that the CO₂ heat pump was of great interest to members, and would be a promising technology in the future.

- **Reduce “Smart” Appliance Standby Loads (2.9 score) – Recommended with reservations:**

Though electronic standby loads have been significantly reduced since first identified as an overlooked energy savings opportunity in the late 1990s, the advent of Internet-connected electronic devices has led to an increase in "smart" standby load. Internet-connected devices operate at a higher level 24 hours per day than other electronic devices due to periodic if not continual on-line background communication.

As noted above, the presentation to the TAG was a broad discussion on appliance standby loads, as opposed to the Internet-connected standby specified in the ET. To a large extent, the issue of high energy consumption has been addressed for a significant percentage of appliances (especially high-visibility ones).

However, the extent and significance of connected standby is not known. Most of the studies of appliance standby loads are at least five years old, and predate the deployment of products with this feature. The most recent RBSA study, for example doesn't include these products. More data, either field or laboratory monitoring, is needed to better assess the impact of these products, and what needs to be done to reduce these loads, either through voluntary programs or codes and standards

- **High-efficiency Set-top Boxes (2.7 score) – Not Recommended:** Set-top boxes include cable boxes, satellite receivers, and gaming consoles. Because these devices constantly draw power even during sleep or standby modes, and because of the increasing variety and proliferation of set-top boxes in American homes, it is important to increase the energy efficiency of these units.

The presenter to the TAG indicated that the efficiency of the set top boxes themselves was a relatively minor issue compared to the efficiency of the overall information network used by service providers. Once a consumer signs up for a service (cable, fiber-optic, cell) they have little to no way to impact their energy use over these networks.

At the micro level (set top box equipment), there does not seem to be any role for utilities, other than providing information to consumers which may impact their choices. There may also be a future role for utilities in trying to affect national codes and standards, but the industry has adopted a voluntary standard, which would seem to preempt any government action in the foreseeable future.

On the macro level (service provider networks) there may be opportunities for utility commercial programs to engage with the providers to improve their networks and systems to improve efficiency.

Next Steps

BPA's ResTAG steering committee is convening to discuss the scored technologies, with an eye toward possible future inclusion in programs as a measure. They will themselves be scoring the technologies on E3T's BPA Scorecard, based on a set of criteria intended to help inform the decisions.