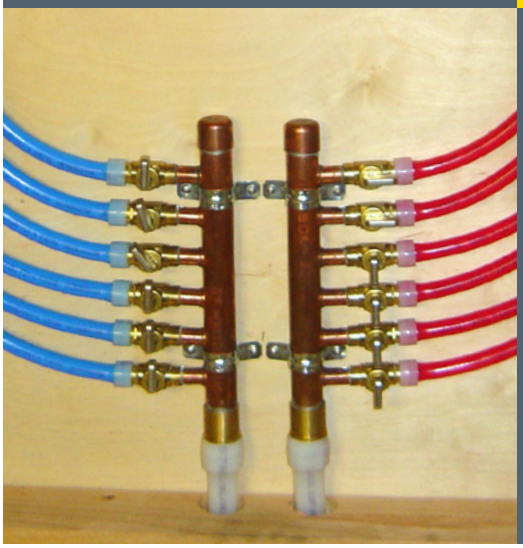

BUILDING AMERICA TOP INNOVATIONS HALL OF FAME PROFILE

INNOVATIONS CATEGORY:

3. Effective Guidance and Tools Solutions
3.3 Research Tools

Model Simulating Real Domestic Hot Water Use

NREL and the Davis Energy Group used the Domestic Hot Water Event Schedule Generator to accurately quantify effects of low and high water usage on distribution system measures such as pipe insulation, home run plumbing, and demand-controlled recirculation loops.

Historically, domestic hot water has been estimated to account for approximately 15% of residential energy use. In high-performance homes, it is projected to grow to 20% of energy use. Thus, Building America research is improving domestic hot water modeling capabilities to more effectively address one of the largest energy uses in residential buildings.

BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

As progress continues with high-R, tightly sealed thermal enclosures, domestic hot water becomes an increasingly important energy use in high-performance homes. Building America research has improved our ability to model hot water use so new hot water technologies can be more accurately assessed and more readily integrated into high-performance homes.

Energy savings for certain residential building technologies depend greatly on occupant behavior. Domestic hot water use is a good example. Simulating realistic occupant behavior is a major challenge because of wide variations in household usage of hot water. Even an individual household has highly variable behavior from day to day, introducing a random component to the problem. However, an accurate simulation of occupant hot water use patterns is important for understanding energy usage in high-performance homes where advanced water heating technologies are often installed. In high-efficiency homes, water heaters have a greater impact on the utility bills than in standard construction because thermal enclosure improvements reduce the share of household energy usage for heating and cooling.

The installed energy savings for advanced residential hot water systems can depend greatly on occupant use patterns. Quantifying these patterns is essential for analyzing measures such as tankless water heaters, solar hot water systems with demand-side heat exchangers, distribution system improvements, and recirculation loops. To help Building America more accurately reflect water usage, the National Renewable Energy Laboratory (NREL) developed the Domestic Hot Water Event Schedule Generator.

This advanced spreadsheet tool can generate a series of year-long hot water event schedules consistent with realistic probability distributions of start time, duration and flow rate variability, clustering, fixture assignment, vacation periods, and seasonality. For example, gas tankless water heaters do not fire at low flow rates (usually less than 0.5 gpm), and when used with solar preheat, may not fire even at higher flow rates when the entering water is above 80°–90°F (Hendron et al. 2010). Tankless water heater efficiency is also influenced by thermal mass effects in the burner, which in turn are strongly affected by the time between hot water events.

Building America found solar hot water system performance, like other systems, is heavily influenced by hot water use patterns.

Hot water distribution system measures such as pipe insulation, home run plumbing, and demand-controlled recirculation loops are affected by the time between draws and which fixtures produce the draw for each event. High- and low-use households can have very different energy savings potentials. These effects were quantified in a study by NREL and Davis Energy Group (Hendron et al. 2010).

Advanced water heating technologies like solar thermal systems are also heavily influenced by hot water use patterns. The energy saved by a solar hot water system with a demand-side heat exchanger is affected by the flow rate in the heat exchanger and the overall volume of hot water use (Davidson et al. 2002). Wastewater heat recovery depends on the flow rate and duration of each event. Hot water tank and solar integrated collector storage (ICS) sizing considerations may include an analysis of the realistic peak hourly demand for hot water that randomly occurs over a year because of event clustering. The cost effectiveness of an ICS system is also strongly affected if a household uses a high or low volume of hot water each day.

REFERENCES

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