Combined space and water heating systems, referred to herein as *combis*, use a single heating device to provide domestic hot water (DHW) and space heating (SH) for a building. The combination of an air handling unit (AHU) and tankless water heater in pre-engineered or engineered applications can enhance the energy efficiency of meeting these heating needs in residential applications.

Although residential combi systems have been applied in buildings for two decades or more; their market share barely exceeds 2%. However, new housing construction practices and modern retrofit measures are leading to more thermally efficient building envelopes and the decline of average home SH loads, making combi systems more applicable. Moreover, manufacturers are beginning to market systems that can better meet these loads.

The U.S. Department of Energy’s Partnership for Advanced Residential Retrofit (PARR) Building America team put commercialized combi units into the field through local contractors who were trained by manufacturers and PARR staff under the auspices of utility-implemented emerging technology programs. With support from PARR, the New York State Energy Research and Development Authority and other partners, the project documented system performance and installations in Illinois and New York.

**Lessons Learned**

- Combis sold as integrated water heater and AHU packages for this evaluation were not designed to maximize temperature drops across the hydronic coils while maintaining sufficient supply air flows and temperatures. Therefore, water temperatures returning from the AHUs to the water heaters were not low enough to induce condensing water heater operation and resulted in annual efficiencies in the eighties (80%).
Some AHU manufacturers have focused on combi system performance. Their AHUs are designed with water-to-air heat exchangers that more effectively transfer heat from the hot water to the room air, thereby maximizing coil-temperature drops while maintaining comfortable supply air. Resulting efficiencies from those systems were in the low nineties (90%).

To satisfy market demand for unlimited DHW, contractors may choose the highest capacity tankless water heater available. However, despite manufacturer-claimed turndowns of up to 10:1 (in terms of burner capacity), results from this evaluation indicate compromised performance when SH loads were low.

There are often strong correlations between reduced AHU return water and increased efficiencies. More research is needed to better understand factors that affect condensing operation, such as heat exchanger and combustion design and control strategies.

Field tests for these evaluations exposed installation deficiencies that were caused by contractor unfamiliarity with the products and the complexity of field engineering and system tweaking to achieve high efficiencies. Widespread contractor education must be a key component to market expansion of combi systems.

Installed costs for combis need to decrease by about 15%–25% to make the utility total resource cost of combis marginally acceptable. Utilities use this methodology to weigh the benefits of an energy efficiency measure against the total cost to implement it.

Utilities are looking for ways to improve the benefits of high-efficiency standalone water heating measures in their energy efficiency programs. Raising water heating and SH efficiencies with one energy efficiency measure could increase the benefits enough to outweigh the cost to implement a combi system measure.

Looking Ahead

Demonstration and pilot data are extremely valuable for providing as-installed performance data, user satisfaction, and installing-contractor behavior. However, the many host-site variables make direct system comparisons difficult. More research is needed to determine how well heating systems such as traditional furnace/water heater, combis, and heat pumps compare in similar as-installed scenarios under controlled conditions.