Building America Case Study

Technology Solutions for New and Existing Homes

Retrofit Integrated Space and Water Heating: Field Assessment

Minneapolis, Minnesota

PROJECT INFORMATION

Project Name: Retrofit Integrated Space and Water Heating: Field Assessment

Location: Minneapolis, MN

Partners:

Center for Energy and Environment, *www.mncee.org/*

Sustainable Resources Center, *www.src-mn.org/*

University of Minnesota, *www.bbe.umn.edu/index.htm*

NorthernSTAR Building America Partnership

Building Component: HVAC

Application: Retrofit; single family

Year Tested: 2012

Climate Zone(s): All zones (research done in Zone 6)

PERFORMANCE DATA

Cost of energy efficiency measure (including labor): Full: $8,000, incremental: $3,900 (compared to 80% annual fuel utilization efficiency [AFUE], 60% EF)

Projected energy savings: About 20% space heating and water heating savings

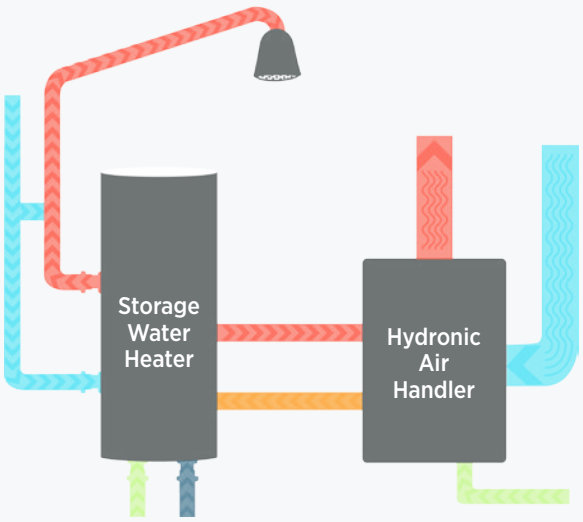
Projected energy cost savings: $150/yr

Building America SM U.S. Department of Energy

Better insulation and tighter envelopes are reducing space heating loads for new and existing homes. As a result, decreased space heating loads make it possible for both space and domestic water heating loads to be provided with a single heating plant, thus saving significant amounts of energy. These systems are called combination (combi) systems and were the focus of a study conducted by the U.S. Department of Energy team, NorthernSTAR Building America Partnership.

Combi systems can directly replace the existing forced air furnace and water heater, and consist of a high efficiency water heater or boiler and an optimized hydronic air handler. The air handlers are designed with large heat transfer coils to achieve highly efficient space heating. In addition to saving energy, these systems virtually eliminate natural draft appliance spillage issues through the use of a powered or direct combustion vent.

Combined Water and Space Heater
Using storage water heater



Installation diagram for a storage tank-based combi system. This system uses an open loop for space heating, which requires that air handler is rated for potable water and that water is circulated through the air handler at least once a day to prevent stagnation.

Description

For existing systems in the basement of a single-family home, space heat was provided by a forced-air natural gas furnace with an AFUE rating of 78%. Water heating was provided by a natural draft natural gas water heater with an EF rating of 59%.

This photo shows a combi system replacement using a condensing storage water heater and a hydronic air handler. At this home, this system saved more than 20% on space and water heating natural gas usage.

For more information, see the Building America report, Retrofitting Combined Space and Water Heating Systems: Laboratory Tests, at buildingamerica.gov

Image credit: All images were created by the NorthernSTAR team.

In this project, the NorthernSTAR team monitored 20 homes to characterize how combi systems performed compared to existing systems. At each of the homes, the team installed a detailed monitoring system that collected data on energy use, household load, and system efficiency. After a full year of monitoring, the team found that the combi systems saved 19% of natural gas usage for space and water heating and showed an annual average combined efficiency of 87%. This analysis indicated that these high efficiency combi systems were typically operating in the condensing mode and providing acceptable, and in some cases, improved occupant comfort.

The combi systems were shown to have the same gas consumption as separate high efficiency natural gas furnaces and water heaters, at lower first costs. However, combi systems are tricky to install and many installers are unfamiliar with them. This makes it difficult for combi systems to economically compete with a common installation of a condensing furnace and power vent (energy factor [EF]=60) water heater. Increased market share and installer experience may result in lower first costs for combi systems, allowing them to be competitive with this market.

Lessons Learned

- The water temperature returning to the heating plant must be minimized to achieve condensation. Water temperature of 105°F or lower was targeted to ensure high performance.
- Custom design, equipment pairing, and optimization were required to balance high performance with occupant comfort at each site.
- Installation and optimization guidelines were developed that ensured an average natural gas savings of 19% for space and water heating.
- In addition to energy savings, these systems improved the combustion safety of homes and, in some cases, the flexible capacity of the combi system improved sizing and led to a more comfortable conditioned space for occupants.
- Separate condensing space and water heating equipment can be installed to reach comparable energy performance and combustion safety as combi systems, but separate systems are more expensive.

Looking Ahead

Future work will build on the results from this research and show that combi systems utilizing condensing water heaters and boilers can provide both space and water heating with efficiencies of 90%. However, combi systems are still relatively new to the market and often require on-site engineering and design. Therefore, future research will focus on system control options to reduce on-site design and engineering, improve system efficiency, and increase system capacity.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

For more information, visit:
www.buildingamerica.gov

The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

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