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

Building America Case Study
Efficient Solutions for New and Existing Homes

Assessment of a Hybrid Retrofit Gas Water Heater

PROJECT INFORMATION

Project Name: Hybrid Gas Water Heater

Research Team: Alliance for Residential Building Innovation

Building Component: Water heater

Application: Retrofit; single-family and multifamily

Year Tested: 2013–2014 evaluation

Applicable Climate Zone(s): All

PERFORMANCE DATA

Incremental cost of energy-efficiency measure (including labor): Currently uncertain, but installation costs would be minimal.

Projected energy savings: 4%–17% site energy savings relative to a 0.60 energy factor atmospheric gas storage water heater (savings increase as loads decrease).

Projected energy cost savings: $0–$12/year annual utility cost savings for natural gas, up to $50/year for propane (will vary with utility rates, hot water load, and climate). Incremental 10-year cost savings of approximately $100 are projected; however, many areas with higher than $1/therm natural gas rates (or propane customers at $2–$3/gallon) could expect cost savings to be two to three times higher.

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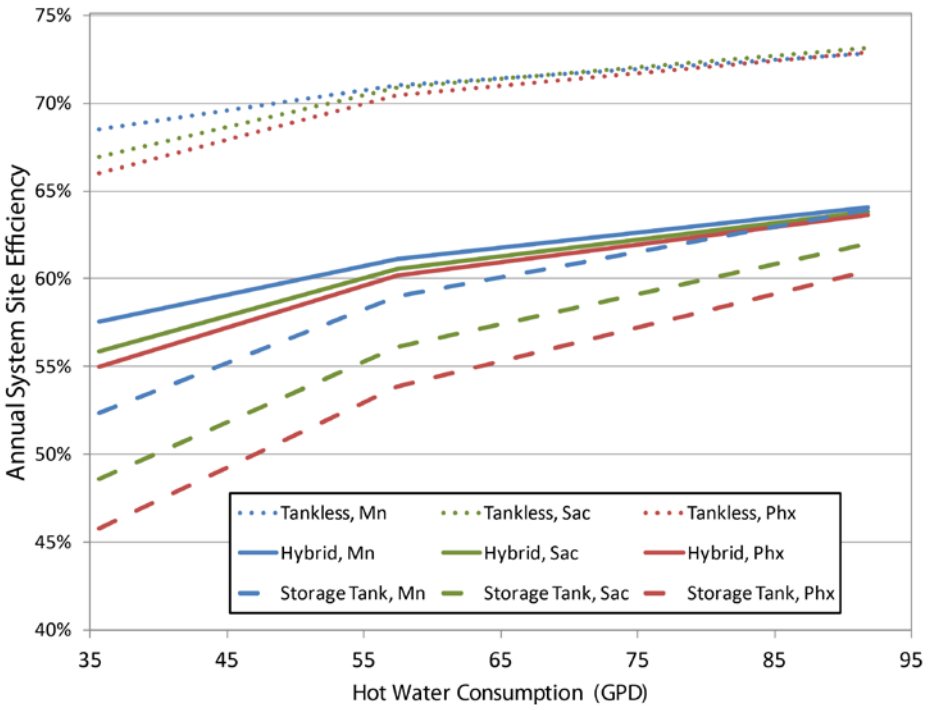
According to 2009 data from the U.S Department of Energy's (DOE's) Energy Information Administration, residential water heaters consumed 1.8 quadrillion Btu annually—less than 18% of the total energy consumed in residential buildings. DOE's Building Technologies Office estimates that the April 2015 adoption of higher minimum residential water heater efficiency standards will save approximately 3.3 quads of energy—equal to approximately $63 billion in energy costs—from 2015–2044. The new standard is also expected to avoid approximately 172.5 million metric tons of carbon dioxide emissions, which is equivalent to the annual greenhouse gas emissions from approximately 33.8 million automobiles.

Efficient gas water-heating options include condensing storage units and tankless units. The market share of tankless units is rising rapidly in new construction; however, tankless retrofits are often hindered by significant costs. These include upsizing gas lines (from the typical ½-in. line that is common to storage water heaters), exchanging the standard Category I/B vent to PVC or stainless vent pipe, and adding electrical service. DOE's 2014 *Research & Development Roadmap for Emerging Water Heating Technologies* identifies the inability to retrofit affordable, efficient water heaters as a key barrier in the marketplace, and it emphasizes that many water heaters are replaced in emergency situations when delays represent a significant inconvenience for the household.

In this project, the DOE Building America Alliance for Residential Building Innovation (ARBI) team completed a modeling evaluation of a hybrid water heater that combines a reduced-capacity tankless unit with a smaller storage tank and is compatible with the commonly available ½-in. gas lines and standard B vents in most homes. This product could meet a significant market need by providing a higher efficiency gas water heater for retrofit applications without incurring significant installation costs.

Results

In this evaluation, the ARBI team used a representative high hot water usage day and modeled a 20-gallon storage tank paired with a 75-kBtu/h tankless water heater (83% combustion efficiency). The team found that this configuration provided adequate hot water delivery characteristics in all climates. This hybrid water heater is projected to improve efficiency by 4.5% annually compared to standard gas storage water heaters in medium- to low-load homes in all climates (see graph to the right). In mild and warm climates, this hybrid water heater better met the hot water demand (>105°F) of high-load homes with little wasted water compared to a standard hot water storage unit. Benefits increase with reduced hot water recovery loads.



Expected annual performance range as a function of load

References

Cole, J. T.; Johnson, T; Glanville, P.; Kalensky, D.; Kosar (Gas Technology Institute). 2010. *Advanced Gas Appliance Development/Final Report.* California Energy Commission, PIER Building End-Use Energy Efficiency Program. CEC-500-2010-034. *http://www.energy.ca.gov/2010publications/CEC-500-2010-034*

Goetzler, W; Guernsey, M: and Droesch, M. 2014. *Research & Development Roadmap for Emerging Water Heating Technologies.* Prepared by Navigant Consulting, Inc. DOE/EE-1136. *https://energy.gov/sites/prod/files/2014/09/f18/WH_Roadmap_Report_Final_2014-09-22.pdf*

For more information, see the Building America report *Assessment of a Hybrid Retrofit Gas Water Heater* at *https://www1.eere.energy.gov/buildings/publications/pdfs/building_america/64550.pdf*.

Image credit: All images were created by the ARBI Team.

Lessons Learned

The performance assessment yielded the following observations:

- The hybrid water heater evaluated in this project is likely best suited for warmer climates and smaller homes in which peak hot water loads would be lower and the impact of reduced standby losses is more significant.
- Water heater performance under low loads is becoming increasingly important as residential hot water loads continue to drop due to lower fixture flow rates, more efficient appliances, energy input from solar or drain reheat systems, and lower loss distribution systems. Reducing water heater storage volume is important to minimizing standby losses and maximizing efficiency in low-load applications.

Looking Ahead

In recent years, the water-heating industry has started to develop a range of new efficient gas and electric product offerings. The greatest market success has been in the area of electric heat pump water heaters. The gas water-heating market is more challenging because gas prices are generally low and efficiency gains relative to standard product offerings are smaller. These factors require lower incremental first costs to deliver cost-effective solutions to the market-place. Utility incentives could play a significant role in developing a viable market for higher performance retrofit gas water heaters.

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