ENERGY STAR® Residential Water Heaters: Second Draft Criteria Analysis and Proposal

Water heating represents between thirteen and seventeen percent of national residential energy consumption, making it the third largest energy end use in homes, behind heating and cooling and kitchen appliances. As homes become more energy efficient, the percentage of energy used for water heating steadily increases. Water heating is the only major residential energy end use that ENERGY STAR does not address.

Developing ENERGY STAR criteria is essential to expand the value of the ENERGY STAR brand and its continued relevance in the marketplace. ENERGY STAR is a critical driver of technology in the market. When developing ENERGY STAR criteria, the Department of Energy (DOE) considers and balances a varied set of objectives, ensuring that the established criteria:

- Provide meaningful differentiation between ENERGY STAR qualified products and those that just meet the Federal standard.
- Will result in significant energy savings, both for consumers and the nation as a whole.
- Are cost-effective for consumers as well as manufacturers.
- Provide consumer choice, both in terms of number of models and a wide range of manufacturers.
- Do not compromise functionality or performance of the qualified product.
- Do not rely on proprietary technologies.

Almost all water heaters sold in the U.S. are traditional storage units with nearly an even split between gas and electric. Of the 9.8 million water heater shipments in the U.S. in 2006, 4.8 million were conventional electric-resistance and 4.7 million were conventional gas storage. Gas tankless water heaters accounted for 254,600 shipments, representing 2.6% of the market. Currently, small manufacturers with limited production capacity are the predominant producers of solar and heat pump water heaters. Solar water heater shipments amount to an estimated 2,430 units per year, while heat pump water heater shipments amount to less than an estimated 2,000 units per year. Currently, residential gas-condensing water heaters are not in the market.

ENERGY STAR can assist in the deployment of advanced water heating technologies to the residential market. High first cost, poor product performance, limited availability and the lack of consumer interest have been attributed, in part, to a lack of production and promotion from major manufacturers. Major manufacturers have claimed there is not enough consumer demand to warrant producing these products. ENERGY STAR can serve as an end goal for industry and a catalyst for consumer demand. Consumers recognize the ENERGY STAR label as delivering the same or better performance as conventional products while using less energy and thus saving money. The label carries legitimacy and a sense of reassurance for consumers. ENERGY STAR can collaborate with its partners to develop consumer demand, contractor expertise, consumer education, and encourage product availability.

Water Heater Technologies

Electric, gas and solar water heaters are each categorically unique in relation to the efficiency they can achieve heating water. Since each technology is inherently different than another, each technology will have its criteria based on its own merits. Certain technologies will have criteria that are exclusive. DOE is intent on establishing a program that does not favor one energy source over another.

The energy consumption and savings calculations are based on the DOE test procedure,[1] which accounts for standby energy as well as energy consumed from additional sources. All figures for the technology profiles are in Tables 1 and 2 on pages nine and ten. For reference, the DOE residential product classes are included on page twelve.

Electric-Resistance Storage Water Heaters

Conventional electric-resistance water heaters have a glass-lined steel tank and foam insulation along with two electric heating elements located near the base and top of the tank. Cold water enters the base of the tank where it is heated by the lower electric heating element. The hot water rises to the top of the tank where it is drawn for consumption. When hot water consumption is high, the upper heating element is turned on to provide additional heat to the water before it exits the water heater.

Improving energy efficiency of electric resistance water heaters in the residential market is limited. Typical fifty-gallon electric resistance water heaters have Energy Factors that range from 0.904 to 0.95. Using the DOE test procedure for calculations, a fifty-gallon electric resistance water heater with an Energy Factor of 0.95 would consume 4,622 kilowatt-hours per year (see Table 1 on page ten for figures). This is a savings of 4.8% in comparison to the typical fifty-gallon electric resistance water heater with an Energy Factor of 0.904 at the Federal standard. A savings of 4.8% is not significant and does not offer meaningful differentiation in accordance with the ENERGY STAR guiding principles. Given current and potential energy savings, electric resistance water heating technology is nearly maximized and not under consideration for ENERGY STAR.

DOE has taken into account stakeholder feedback and comments supporting the exclusion of electric resistance water heaters in the program. Stakeholders have indicated the savings are too insignificant as the primary reason for exclusion. In addition, stakeholders have suggested that electric resistance technology is highly inefficient over the full fuel cycle and it potentially increases total energy consumption and emissions. Given stakeholder input, electric resistance water heaters are not appropriate for inclusion in ENERGY STAR.

High-Performance Gas Storage Water Heaters

Conventional gas storage water heaters have a center-flue design, a glass-lined steel tank and foam insulation along with an atmospheric burner at the base of the tank. Cold water enters the bottom of the insulated tank in close proximity to the gas burner. Gas is combusted in the burner and the combustion products ascend through a flue in the center of the tank. Heat from the burner and the combustion products are passed onto the flue and base plate, where it transfers to the water in the tank. The water is heated and rises to the top of the tank where it is drawn for consumption. High-performance gas storage water heaters tend to use a power vent to assist the venting of combustion gases in order to achieve a greater Energy Factor.

[1] Title 10, Code of Federal Regulations, Chapter 11, Part 430, Subpart B, Appendix E

DOE has taken into account stakeholder feedback and comments supporting the inclusion of high-performance gas storage water heaters in ENERGY STAR under a limited three-year timeframe. Stakeholders have indicated the limited three-year timeframe maintains industry incentive to develop gas condensing and advanced non-condensing or near-condensing technology. It can also introduce ENERGY STAR into the market more effectively by allowing distributors and plumbers to become familiar with the program.

Stakeholders have indicated the establishment of a lower minimum Energy Factor of 0.62 is arguing for relaxed criteria based on present practice and not on energy savings or technological capability. In addition, stakeholders have stated that a minimum Energy Factor of 0.65 is a level that can offer significant enough savings to warrant inclusion in ENERGY STAR. DOE holds the disposition that ENERGY STAR should act as a driver of the market and is in agreement with these stakeholder perspectives.

ENERGY STAR will include high-performance gas storage water heaters at the onset of the program for a limited timeframe of three years. By establishing ambitious, but attainable criteria for gas storage water heaters, manufacturers and water heating initiatives can come closer to bridging the technological gap between gas storage and advanced non-condensing or near-condensing water heaters. At the conclusion of the three-year period, ENERGY STAR will no longer qualify high-performance gas storage water heaters. At this time, ENERGY STAR will target advanced non-condensing or near-condensing gas water heaters for inclusion in the program.

Draft Criteria
ENERGY STAR is considering high-performance gas (natural gas and propane) storage water heaters for inclusion in the program. The proposed criteria are:

- A minimum Energy Factor of 0.65.
- A minimum First-Hour Rating requirement of 67 gallons-per-hour. This is to ensure models earning the label provide sufficient hot water delivery.
- A minimum six-year warranty. This is to ensure models earning the label are reliable and perform properly.

Savings and Payback
Using the DOE test procedure for calculations, a fifty-gallon gas storage water heater with a 0.65 Energy Factor would consume an estimated 230 therms per year. This is a savings of 12%, or 31 therms, in comparison to the typical conventional gas water heater. The annual energy savings equal $43 using the national average gas rate. The monetary savings will pay for the price premium in eight years, given the current price premium in the market. However, manufacturers have indicated they will redesign high-performance gas storage water heaters to decrease first cost since an ENERGY STAR label would open these models to a wider consumer segment. Currently, high-performance water heaters are considered the luxury category of the water heater market; they are manufactured with additional features and marketed to the high-income market segment. Given product redesign and increased demand, manufacturers envision a price premium decreasing considerably.

Market Share
High-performance gas storage water heaters account for an estimated 100,000 residential sales per year.[2] The number of high-performance gas storage water heaters available on the market is significantly lower in comparison to the rest of the conventional gas water heater market. However,

[2] Based on conversations with manufacturers.

manufacturer feedback indicates the most significant barrier is market pull, which ENERGY STAR can augment. If just 10% of the nation's 4.7 million gas water heater shipments were high-performance gas storage water heaters with an Energy Factor of 0.65 instead of conventional models with an Energy Factor at the federal standard, the aggregate energy savings would amount to nearly 14.6 million therms per year.

Whole-Home Tankless Water Heaters

Gas tankless water heater technology uses a similar concept as conventional water heater technology to heat water, but without a storage tank. Cold water enters the base of the heater where a flow sensor is triggered when the unit's minimum water draw is met, activating the gas burner. The burner immediately fires and begins to heat a heat exchanger. The cold water encircles the heat exchanger and then exits the unit. Once the heat exchanger becomes hot, the water reaches its set point temperature.

DOE has taken into account stakeholder feedback and comments recommending an increase in minimum Energy Factor and a decrease in minimum gallons-per-minute (gpm) for whole-home tankless water heaters. Stakeholders advised increasing the minimum Energy Factor level due to the discrepancy between the results of the test procedure and the performance in the field. In addition, stakeholders indicated that a tankless water heater with a 3.5 gpm at a 77°F rise is overkill for the largest market segment of tankless water heaters. This market segment is primarily one-bathroom and/or two-person households, empty nesters that do not require the type of delivery intended for larger households. Lower occupancy households, such as apartments or condominiums, are pressured towards wasting energy by burning more BTUs than necessary if they are inclined to choose an ENERGY STAR qualified model with a minimum 3.5 gpm at a 77°F rise.

After reviewing stakeholder feedback and analyzing the water heater market ENERGY STAR will increase the minimum Energy Factor to 0.82 and decrease the minimum gallons-per-minute (gpm) to 3.0 at a 77°F rise. An Energy Factor of 0.82 will improve market differentiation for gas tankless water heaters eligible to earn the label. A gpm of 3.0 accounts for apartment and condominium households who would like to purchase an ENERGY STAR qualified tankless water heater that is not oversized for their purposes. Apartment and condominium households favor tankless water heaters due to the reduced space requirements they present.

Draft Criteria
ENERGY STAR is considering whole-home gas tankless water heaters for inclusion in the program. The proposed criteria are:

- A minimum Energy Factor of 0.82.
- A minimum gallons-per-minute (gpm) requirement of 3.0 gpm at a 77°F rise. This is to ensure models earning the label provide sufficient hot water delivery.
- A minimum ten-year warranty.

Savings and Payback
Using the DOE test procedure for calculations, a whole-home gas tankless water heater with a 0.82 Energy Factor would consume 183 therms per year. This is a savings of 30%, or 78 therms, in comparison to the typical gas storage water heater. The annual energy savings equal $108 using the national average gas rate. The monetary savings will pay for the price premium in 5.5-15 years, depending on installed cost. Installing whole-home gas tankless water heaters in new construction is the more cost effective option. Gas tankless water heaters require larger gas lines to achieve delivery

for whole-home performance. Replacing gas lines is generally expensive. A Federal tax credit is currently available that can offset 10% of the installed cost of a tankless water heater with an Energy Factor of 0.80 or greater. When taking the tax credit into account, the monetary savings will pay for the price premium in 4-13 years.

Market Share
Gas tankless water heaters currently account for 254,600 sales per year. Manufacturers can produce models that meet or exceed a 0.82 Energy Factor with a 3.0-gpm flow at a 77°F rise. If 10% of the nation's 4.7 million gas water heater shipments were whole-home gas tankless water heaters with a 0.82 Energy Factor instead of conventional models with an Energy Factor at the Federal standard, the aggregate energy savings would amount to nearly 36.7 million therms per year.

Electric Tankless
Electric tankless water heaters viable for whole-home water heating delivery require electric service over 100 amps. A significant number of homes only have 100 amps of service available, making electric tankless water heater applications inappropriate. Upgrading from 100 amps service to 200 amps can cost thousands of dollars.[3] A Federal tax credit is not available to offset some of this cost. In addition, the best electric tankless water heaters can only achieve a 0.99 Energy Factor, which is just 9.5% more efficient than the Federal standard and without room for improvement. Electric tankless water heaters are impractical for most homes given the substantial retrofit costs for whole-home service in relation to the energy savings potential.

Often, a single transformer serves multiple households. When a collection of homes in a neighborhood uses electric tankless water heaters, the rated overload capacity of the transformer would be exceeded during times of peak demand.[4] Load control of electric tankless water heaters would be very difficult. Large-scale use may necessitate the passing of demand charges onto households since the cost for supplying short duration peak loads would be expensive. Electric tankless water heaters would create complications once the market is transformed.

Heat Pump Water Heaters

Heat pump water heater technology uses a vapor compression refrigeration system to transfer heat from the surrounding air to water stored in a tank. A low-pressure liquid refrigerant is vaporized in the heat pump's evaporator and then is passed onto the compressor. The compressor increases the pressure of the refrigerant, increasing the refrigerant's temperature. Then, the heated refrigerant runs through the condenser coil encircled within the storage tank. The heat is transferred from the refrigerant through the coil to the potable water. Once the refrigerant delivers its heat to the water, it has cooled and condensed, and then passes through an expansion valve where the pressure is reduced and the cycle starts over.

Draft Criteria
ENERGY STAR is considering drop-in or integrated heat pump water heaters for inclusion in the program. The proposed criteria are:
- A minimum Energy Factor of 2.0.
- A minimum First-Hour Rating requirement of 50 gallons-per-hour.
- A minimum six-year warranty.

[3] Global Energy Partners, LLC "Electric Tankless Water Heating: Competitive Assessment" March 2005
[4] Ibid.

Savings and Payback
Using the DOE test procedure for calculations, a fifty-gallon heat pump water heater with a 2.0 Energy Factor would consume an estimated 2,195 kilowatt-hours per year. This is a savings of nearly 55%, or 2,662 kilowatt-hours, in comparison to the typical electric resistance water heater. The annual energy savings equal $277 using the national average electric rate. The monetary savings will pay for the price premium in three years, which is just over third of the ten-year life of a heat pump water heater. A federal tax credit is currently available that can offset 10% of the installed cost of a heat pump water heater with an Energy Factor of 2.0 or greater. When taking the tax credit into account, the monetary savings will pay for the price premium in 2.5 years.

Market Share
Heat pump water heaters account for less than 2,000 residential sales per year. Only small manufacturers with limited capacity are currently producing heat pump water heaters. Major manufacturers have indicated they are interested in developing this product if a market can emerge and compete. ENERGY STAR can assist in the development of this market with the collaboration of its partners. If just 10% of the nation's 4.8 million electric water heater shipments were heat pump water heaters with an Energy Factor of 2.0 instead of conventional models with an Energy Factor at the federal standard, the aggregate energy savings would amount to nearly 1.3 billion kilowatt-hours per year.

Solar Water Heaters

Solar water heater technology uses the sun's thermal energy to heat water. Solar water heaters typically are designed to serve as preheaters for conventional storage or tankless water heaters. The sun's rays strike a solar collector, which absorbs the thermal energy and transfers this heat to water in a storage tank or water entering a tankless water heater. Solar water heaters come in a wide variety of designs. The Solar Rating and Certification Corporation (SRCC) applies objective measures to certify solar water heaters.

DOE has taken into account stakeholder feedback and comments recommending a decrease in the warranty level due to industry practice and current market. Stakeholders have indicated the standard warranty in the solar industry is five years for the solar system and up to ten years for the solar collector(s). After reviewing stakeholder feedback and analyzing the water heater market ENERGY STAR will adjust the minimum warranty to ten years for solar water heaters to account for industry practice.

Draft Criteria
ENERGY STAR is considering solar water heaters for inclusion in the program. The proposed criteria are:
- A minimum Solar Fraction of 0.50.
- OG-300 certification from the SRCC.
- A minimum ten-year warranty.

Savings and Payback
An OG-300 certified solar water heater with a 0.50 Solar Fraction and a fifty-gallon electric storage back-up water heater (with an Energy Factor at the Federal standard) would achieve a Solar Energy Factor of 1.8.[5] Using the DOE test procedure for calculations, the energy consumption for such a solar

[5] Natural Resources Defense Council "Solar Water Heater Fact Sheet" October 2004.

water heater system, with a 1.8 Solar Energy Factor, would correspond to an estimated 2,439 kilowatt-hours per year. This is a savings of 50%, or 2,418 kilowatt-hours, in comparison to the typical electric resistance water heater. The annual energy savings equal $251 using the national average electric rate. The monetary savings will pay for the price premium in ten years, based on the average installed cost. A federal tax credit is currently available that can offset 30% of the installed cost of a solar water heater with a Solar Fraction of 0.50 or greater. When taking the tax credit into account, the monetary savings will pay for the price premium in six years.

An OG-300 certified solar water heater with a 0.50 Solar Fraction and a fifty-gallon gas storage back-up water heater (with an Energy Factor at the Federal standard) would achieve a Solar Energy Factor of 1.2. Using the DOE test procedure for calculations, the energy consumption for such a solar water heater system, with a 1.2 Solar Energy Factor, would correspond to an estimated 125 therms per year. This is a savings of 52%, or 136 therms, in comparison to the typical gas storage water heater. The annual energy savings equal $188 using the national average gas rate. The monetary savings will pay for the price premium in 12.5 years, based on the average installed cost. The tax credit can offset 30% of the installed cost of a solar water heater with a Solar Fraction of 0.50 or greater. When taking the tax credit into account, the monetary savings will pay for the price premium in 7.5 years.

Market Share
Solar water heaters account for an estimated 2,430 residential sales per year, with electric storage back-up having more prevalence in the market than gas storage back-up. A number of manufacturers can produce OG-300 rated solar water heaters with a Solar Fraction of 0.50 or greater. If just 2% of the nation's 4.8 million electric water heater shipments were OG-300 rated solar water heaters with a 0.50 Solar Fraction instead of conventional models with an Energy Factor at the Federal standard, the aggregate energy savings would amount to more than 232 million kilowatt-hours per year. If just 1% of the nation's 4.7 million gas water heater shipments were OG-300 rated solar water heaters with a 0.50 Solar Fraction, the aggregate energy savings would amount to nearly than 6.4 million therms per year.

Gas Condensing Water Heaters

Gas-condensing water heater technology is similar to conventional gas storage water heater technology with some exceptions. The gas burner is typically encased in the vertical flue towards the middle or top of the water heater tank. Incoming induced air mixes with natural gas for burner combustion. The resulting hot gases travel through a helical heat exchanger coil, where heat is transferred from the gases to the water in the tank. The gases condense as they reach the end of the coil and are drained as slightly acidic water. The ability to capture the heat of condensation of the combustion gases is the major enhancement with gas condensing water heaters. The burner heats the water like typical gas storage models, but the combustion gases are vented through coils to supply additional heat to the water that conventional models do not provide.

ENERGY STAR will increase the minimum First-Hour Rating to 67 gallons-per-hour for gas condensing water heaters. This aligns with the National Plumbing Code's suggested First-Hour Rating for gas storage water heaters intended for whole-home purposes.

Draft Criteria
ENERGY STAR is considering residential gas condensing water heaters for inclusion in the program. The proposed criteria are:

- A minimum Energy Factor of 0.80.
- A minimum First-Hour Rating of 67 gallons-per-hour.
- A minimum eight-year warranty.

Savings and Payback
Using the DOE test procedure for calculations, a fifty-gallon gas condensing water heater with an Energy Factor of 0.80 would consume 187 therms per year. This is a savings of nearly 30%, or 74 therms, in comparison to the conventional typical gas storage water heater. The annual energy savings equal $102 using the national average gas. The monetary savings will pay for the price premium in 4-9 years,[6] depending on installed cost. A federal tax credit is currently available that can offset 10% of the installed cost of a gas-condensing water heater with an Energy Factor of 0.80 or greater. When taking the tax credit into account, the monetary savings will pay for the price premium in 3-7.5 years.

Market Share
Currently, residential gas-condensing water heaters are not available on the market. However, manufacturers have indicated they are interested in developing this product if a market can emerge and compete. ENERGY STAR can assist in the development of this market with the collaboration of its partners. If just 5% of the nation's 4.7 million gas water heater shipments were gas-condensing models with a 0.80 Energy Factor instead of conventional models with an Energy Factor at the Federal standard, the aggregate savings would amount to 17.4 million therms per year.

Summary

ENERGY STAR is proposing draft criteria for residential high-performance gas storage, gas condensing, gas tankless, heat pump and solar water heaters for whole home applications. A moderate displacement of conventional water heaters at the Federal Standard with ENERGY STAR qualified models would achieve cumulative energy savings of more than 1.5 billion kilowatt-hours and 75 million therms per year. These energy savings would equal more than $260 million in monetary savings using the national average electric and gas rates. By establishing ENERGY STAR water heater criteria, DOE envisions ENERGY STAR qualified water heating technologies progressing in the market and gaining a nominal market share within five years.

DOE is requesting interested stakeholders to provide comments on the proposed criteria. Please submit comments to both Richard Karney (richard.karney@ee.doe.gov) and Josh Butzbaugh (jbutzbaugh@drintl.com) by November 26, 2007. Comments will be posted as they are received on the Water Heater Criteria Development page (http://www.energystar.gov/waterheaters).

[6] $1,300-$1,800 projected installed cost. Super Efficient Water Heating Appliance Initiative, PIER Draft Final Project Report, March 2007, California Energy Commission (CEC-500-05-010). American Council for an Energy Efficient Economy "Emerging Technology and Practices" 2004

Table 1: Energy and Cost Comparison: Electric Water Heating – 50-gallon capacity

Electric Water Heater	Standard	High-Performing	HPWH	Solar
Energy Factor	0.904	0.95	2.0	1.8[7]
Annual Consumption (kWh/yr)[8]	4,857	4,622	2,195	2,439
Annual Savings (kWh/yr)	None	257	2,662	2,418
Annual Cost of Operation ($/yr)	$505	$481	$228	$254[9]
Annual Savings ($/yr)	None	$27	$277	$251
Life Expectancy	13 years[10]	13 years	10 years[11]	20 years
Lifetime Savings (kWh)	None	3,084	26,620	48,360
Lifetime Savings ($)	None	$321	$2,768	$5,029
Installed Cost	~$650	~$700	~$1,500[12]	~$3,200[13]
Price Premium	NA	~$50	~$850	~$2,550
Payback on Price Premium	NA	~2 years	~3 years	~10 years
Tax Credit (See p. 11)	None	None	$150	$960
Payback w/ Tax Credit	NA	NA	~2.5 years	~6 years
Residential Annual Sales	~4.8 million[14]		<2,000[15]	2,430[16]

[7] Natural Resources Defense Council "Solar Water Heater Fact Sheet" October 2004. Typical Solar Energy Factor for an electric solar water heater with a 0.5 solar fraction.
[8] Energy consumption estimated using the DOE test procedure. Based on the following formula: (12.03/EF) x 365
[9] SWH annual costs do not include maintenance expenses, which are estimated as $150-$200 every 3-5 years according to discussions at the Water Heater Technologies Meeting (3/22/06)
[10] Federal Energy Management Program "How to Buy an Energy Efficient Electric Water Heater" September 2004
[11] Oak Ridge National Laboratory "Durability Testing of a Drop-In Heat Pump Water Heater" April 2004
[12] Vermont Energy Investment Corporation "Residential Heat Pump Water Heaters: Energy Efficiency Potential and Industry Status" November 2005
[13] Energy Information Administration "The National Energy Modeling System: An Overview 2003" April 2003. Average cost for a solar water heater. Since most installations are customized, cost is widely variable.
[14] Gas Appliance Manufacturers Association 2006 Shipments
[15] Oak Ridge National Lab (ORNL) "The Drop-In Residential Heat Pump Water Heater"
[16] Energy Information Administration, 2004 Renewable Energy Annual, Tables 38 and 39

Table 2: Energy and Cost Comparison: Gas Water Heating – 50-gallon capacity

Gas Water Heater	Standard	High-Performing	Tankless	Gas-Condensing	Solar
Energy Factor	0.575	0.65	0.82	0.8	1.2[17]
Annual Consumption (therm/yr)[18]	261	230	183	187	125
Annual Savings (therm/yr)	None	31	78	74	136
Annual Cost of Operation ($/yr)	$360	$317	$253	$258	$173
Annual Savings ($/yr)	None	$43	$108	$102	$188
Life Expectancy	13 years[19]	13 years	20 years[20]	15 years	20 years
Lifetime Savings (therms)	None	279	1,560	1,110	2,720
Lifetime Savings ($)	None	$385	$2,153	$1,532	$3,754
Installed Cost	~$865[21]	~$1,215	~$1,470-$2,500[22]	~$1,300-$1,800[23]	~$3,200
Price Premium	None	~$350	~$605-$1,635	~$435-$935	~$2,335
Payback on Price Premium	None	~8 years	~5.5-15 years	~4-9 years	~12.5 years
Tax Credit (See p. 11)	None	None	$150-$250	$130-$180	$960
Payback w/ Tax Credit	NA	NA	~4-13 years	~3-7.5 years	~7.5 years
Residential Annual Sales	~4.7 million[24]		~254,600[25]	NA	2,430

[17] Natural Resources Defense Council "Solar Water Heater Fact Sheet" October 2004. SEF refers to Solar Energy Factor.
[18] Energy consumption estimated using the DOE test procedure. Based on the following formula: (41,045 BTU/EF x 365)/100,000
[19] Federal Energy Management Program "How to Buy an Energy Efficient Gas Water Heater" September 2004
[20] Energy Trust of Oregon "Tankless Gas Water Heaters: Oregon Market Status" December 2005
[21] Based on survey data collected for the Super Efficient Water Heating Appliance Initiative "PIER Draft Final Project Report" March 2007, California Energy Commission (CEC-500-05-010)
[22] Based on information in Energy Trust of Oregon "Tankless Gas Water Heaters: Oregon Market Status" December 2005 and survey data collected for the Super Efficient Water Heating Appliance Initiative "PIER Draft Final Project Report" March 2007, California Energy Commission (CEC-500-05-010)
[23] Based on information in Super Efficient Water Heating Appliance Initiative "PIER Draft Final Project Report" March 2007, California Energy Commission (CEC-500-05-010) and American Council for an Energy Efficient Economy "Emerging Technology and Practices" 2004
[24] Gas Appliance Manufacturers Association 2006 Shipments
[25] Ibid.

Assumptions

Annual energy use is based on the DOE test procedure and calculated assuming an inlet water temperature of 58ºF, a set point of 135ºF, daily hot water demand of 64.3 gallons, and 365 days per year of use. The energy rates are $1.38 per therm for gas and $0.104 per kilowatt-hour for electric, the average 2006 residential rates in the U.S.[26]

Available Tax Credits

Energy Policy Act of 2005; Section 1335, Tax credit amounting to 30% of purchase of qualified solar water heaters.

- Maximum credit of $2,000 per tax year; unused credit may be carried over.
- Must be certified by Solar Rating and Certification Corporation or comparable entity endorsed by the government of the State.
- At least half of energy by must be derived from the sun.
- Credit applies to property installed in primary residence of U.S. and covers both equipment and labor costs associated with installation, piping and wiring.

Energy Policy Act of 2005; Section 1333, Homeowner Tax Credit

- 10% of the amount a taxpayer pays for installation including labor and property (materials/equipment) to make qualified energy efficiency improvements during a taxable year.
- Qualified energy efficient property includes:
    - Electric heat pump water heater (EF $\geq$ 2.0)
    - Natural gas, propane, or oil water heater which has an Energy Factor of at least 0.80
    - The credit cannot exceed $500 in aggregate over the life of the program.

[26] Energy Information Administration (DOE) data; average rates from January 2006 through December 2006

Residential Water Heater Product Classes[27]		
Storage	**Gas-fired**	A nominal input of 75,000 Btu/hour or less and a rated storage volume from 20 to 100 gallons
	Oil-fired	A nominal input of 105,000 Btu/hour or less and a rated storage volume of 50 gallons or less
	Electric	A nominal input of 40,956 Btu/hour or less and a rated storage volume from 20 to 120 gallons
	Heat Pump	A maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature to a higher temperature level for the purpose of heating water
	Tabletop	A box enclosure designed to slide into a kitchen countertop space and dimensions of 36 inches high, 25 inches deep and 24 inches wide
Tankless	**Gas-fired**	A nominal input of over 50,000 Btu/hour up to 200,000 Btu/hour and a rated storage volume of 2 gallons or less
	Electric	An input of 12 kilowatts or less

[27] Title 10, Code of Federal Regulations, Chapter 11, Part 430, Subpart B, Appendix E.