Microtherm, Inc.

Comments on Draft Criteria for Energy Star Residential Water Heaters

Prepared by David E. Seitz, President.

General

Support establishment of Energy Star program for residential water heaters.

First principle of Energy Star is to identify the most efficient products on the market, traditionally considered the upper 25%.

Residential Water Heater criteria should include both the top performing of conventional models and advanced technologies.

Delete all warranty criteria, not specified for Energy Star Furnaces and Boilers

For storage water heaters, criteria should be volume dependent. It is a simple as providing a table of EF per standard volume size.

Specific Criteria:

A. CONVENTIONAL TECHNOLOGIES.

1. Electric Storage Water Heaters

We disagree with proposal for no criteria. Should specify criteria at top of range of current EFs.

Represents 5% energy savings; actual annual energy services may be as much as the benefit of efficient motor on a gas or oil furnace.

2. Gas Storage Water Heaters

Disagree with proposal. Should specify criteria at top of range of current EFs.
Can be combined with "Advanced Non-Condensing Gas" criteria.
One approach would be Tier I/Tier II criteria.

B. ADVANCED TECHNOLOGIES

The "Analysis" states:

"Advanced Technologies

Advanced water heating technologies vary in the technological characteristics they employ to heat water. Electric, gas and solar water heaters are each categorically unique in relation to the efficiency they can achieve heating water. Since each advanced 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."

3. Gas fired tankless water heaters.

We disagree that gas fired tankless water heaters should be considered at this time under the Energy Star program. The DOE has been aware of the concern regarding the suitability of the test protocol from which the Energy Factors for gas tankless have been derived since 1998.

a. ***The Federal Register*** 5/11/1998 pg. 25999

"EPRI commented that for large, whole house, fossil fueled instantaneous water heaters, the losses due to warm up and cool down after each water draw become significant because of the thermal mass of the water and the heater exchanger---."

DOE: "Additionally the DOE needs data to substantiate any change to the number of draws during the 24 hour simulated use test for tankless water heaters because changing the number of draws is likely to reduce the energy factor for existing units thereby requiring a modification to the energy conservation standard for those products."

and

b. DOE RULEMAKING FRAMEWORK 9/2006

"6. ENERGY USE"

"The purpose of the energy use analysis is to assess the energy-savings potential of different product efficiencies. The energy use analysis may require certain engineering assumptions regarding product application, including how the product is operated and under what conditions."

"For residential instantaneous water heaters, direct heating equipment, and pool heaters, DOE plans to rely on the assumptions in the test procedure to establish the typical annual energy consumption of the product. For residential instantaneous water heaters, DOE will also consider any other available energy use calculation methodologies that better reflect the energy use under actual field operation conditions".

In addition to the assumptions in the test procedure, DOE **also needs test data to establish the annual energy use of direct heating equipment, pool heaters, and instantaneous water heaters at each efficiency level.** "

c. The NAHB Research Center provided a study to the NREL in 2003 ***"PERFORMANCE COMPARISON REPORT FOR RESIDENTIAL WATER HEATING TECHNOLOGIES"***

Actual use patterns monitored in this study demonstrated a very high percentage of hot water is used in very short, low flow draws

This report is based on a full years monitoring of 2 homes in Ohio, referred to as a High Use and a Low Use Home (referring to volume of hot water used). (**See Exh. 1**)

For the High Use home there were approximately 46,585 minutes of hot water use of which only 585 minutes of use (**1.3%**) were at flow rates above 3 gpm. In contrast over 38,000 minutes of use **(82%)** were at 1 gpm or less**.**

Then as to the issues related to purported energy savings of the gas tankless.

d. Energy savings. The "Analysis" suggests that a gas tankless provides a 30% savings.

We disagree and do not believe it is 30% more efficient the DOE standard for gas storage tank heaters.

Based on the aforementioned NAHB data it is fairly obvious that 6 draws at 3 gpm do not represent the typical flow or duration of hot water use in residential applications and thus the energy factors derived from new test protocol the DOE suggests, would in all likelihood be substantially lower.

In addition it has been demonstrated in studies performed by others including the California Energy Commission that when low flow rates and short draws are utilized as are shown to constitute the majority of hot water usage, the efficiency and thus energy factor for gas tankless water heaters is significantly reduced.

Furthermore this statement of 30% increase in efficiency fails to consider the electric consumption used by the gas tankless for power vent, cooling of the heat exchanger and standby power for the electronics which is most likely to be greater than that of the combined conventional gas storage tank and gas condensing water heaters estimated 150 kWh per year. (See footnotes 18, 19 in Table 2 of Analysis)

Therefore, if the gas tankless actually has an energy factor verified by newer and more appropriate testing of say .70, the difference would then be 20% and the savings only 47 therms per year for a total savings of $60. Since the current

effective E.F. is already lower than represented because of the failure to consider other energy costs, that's a $60 savings less at least $15 per year for electric or then an assumed savings of $45 per year.

If, as according the "analysis" a 9.5% gain in efficiency over the DOE standard for electric tankless does not justify the electric tankless retrofit (less expensive than gas), then a $45 annual savings would certainly not justify the higher $2,500 cost of the gas tankless installation.

Finally if these assumptions are verified through a newer and more appropriate test methodolgy, then either the energy factor standards for gas tankless must be lowered or the tax rebates of up to $60 million dollars annually ($300 X 254,000) for the gas tankless, currently given for products requiring energy factors of .80, must be stopped.

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e. Environmental issues to be considered related to the use of gas tankless water heaters in residential applications.

As the fuel to air ratio changes with lower flow rates there is the probability that there will be less efficient combustion of fuel resulting in higher incomplete combustion potentially making some of the gas tankless virtual smog machines.

DOE RULEMAKING FRAMEWORK 9/2006:

DETERMINATION OF EMMISSIONS RESIDENTIAL GAS APPLIANCES.

'While NEMS-BT contains provisions for estimating emissions of NO_x and SO_2 from power generation, it does not estimate household emissions from gas appliances. Therefore, DOE plans to conduct an analysis that includes separate estimates of the effect of energy conservation standards on household NO_x and SO_2 emissions based on simple emissions factors derived from the literature. DOE will report household SO_2 emissions savings, although they are small, because the SO_2 emissions caps do not apply to the residential sector."

f. Maintenance, service life other issues and concerns:

Each of these concerns, including the waste of water, voided warranty when failure occurs as a result of hard water, uniquely resulting from the use of gas tankless are covered well on page 4 of the "Analysis" and we agree with the comments.

3. Whole-Home Electric Tankless Water Heaters.

The First principle of Energy Star is to identify the most efficient products on the market, traditionally considered the upper 25%.

Electric whole house tankless water heaters used in residential use particularly those recognized by the DOE (**Exh. 2**) as being used, but considered as commercial because they exceed the 12kW limitation, provided in an arbitrary definition for residential electric tankless, certainly fall into the top 25% of advanced technologies for residential water heating.

"The Department is intent on establishing a fuel neutral program that does not favor one energy source over another."

We, therefore, disagree with proposed exclusion of electric tankless water heaters from the Energy Star rating and further disagree with the characterization that there isn't enough savings over the DOE standard electric storage tank water heaters.

a. Energy Savings

We understood the comments of the DOE contained in the January 2007 Rulemaking Framework for proposing to exclude electric tankless from the classes covered by energy standard requirement was that the DOE believes correctly that the electric tankless at 99% efficiency is already as efficient as it can get and that there would not be sufficient energy savings gained through improved efficiency to justify being part of the RULEMAKING program. (**See Exh. 2**).

Surely the DOE does not consider energy savings from any advanced water heating technology of 9% plus over any other high efficiency electric water heaters to be insignificant.

Furthermore the very same NAHB Report to the NREL found the electric tankless to provide significantly higher energy savings over the DOE standard electric water heater than that represented in the "Analysis" (See Exh. 3)

b. Benefits Unique to Electric Tankless Water Heaters

There are many significant factors that are not only **unique to electric tankless** but support the inclusion of the proven better electric tankless technology including but not limited to the following:

i. The water and energy savings potential that can be obtained by locating these **small** whole house units closer to the major points of hot water use. The use of the electric tankless make such installation location much easier than one can normally do with storage tanks or gas tankless. (See Exh. 3)

ii. The electric tankless is uniquely better suited for use with pre-heated water

and has, in applications by PATH evaluations as well as DOE sponsored "Zero Energy Homes" demonstrated significant contribution to improving the efficiency of solar thermal systems. The same will be true for geo-thermal, and any other water that is pre-heated by renewable sources.

iii Electric tankless technologies do not waste water having to reheat the heat exchanger prior to delivery. In fact the storage of approximately 1 gallon of warm to hot water in self insulating engineering plastic heat exchanger provides a perfect source of initial hot water during peak hot water use draw periods.

iv. Electric tankless are considerably easier to maintain than gas tankless water heaters and the better technology uses standard readily available heating elements.

v. Electric tankless can be used with well insulated tanks in electric load shifting programs to generate stored hot water at night and, because the better technologies contain programmable micro-computers, programmed to add heat during the day at low peak use periods defined by the individual utility.

vi. Electric tankless are considered safer for residential use and have not been the subject of Consumer Product Safety Commission recall as have gas tankless versions.

vii.. Renewable and sustainable energy: How can one say that this country must move towards these energy sources and exclude any advanced, extremely, high efficient electric water heating technology. Temperature based controlled versions (no flow switch) of this technology are uniquely suited and are particularly significant with respect to their performance in applications as back up and boosters to applications utilizing pre-heated water including solar, geothermal and even heat pump water heating technologies. The great majority of gas water heaters are not suitable for these applications.

viii. The use of special versions of wall hung tankless water heaters not only provide the domestic hot water but the same unit utilizing priority control technology provide off peak space heating in radiant floor heating applications allowing the electric utilities in the mid west to generate revenue at "off peak periods" which heat collected at night reduces the day time load. The consumer wins too with significantly reduced energy costs even lower than gas. (Wright Hennepin Electric Coop-Minnesota)

c. Issues and Concerns

i. Electric Service Requirements.

Analysis: “Electric tankless water heaters are impractical for most homes given the immense electrical requirements and retrofit costs for whole home service.”

These comments in the “Analysis” indicating the electric tankless won’t work in normal residential applications because of the electrical requirements is not only NOT accurate. but ignores the corresponding cost for the requirement of additional gas service and very stringent venting requirements for gas tankless.

The standard for electric residential service has for many years ranged from 150 to 200 amps.

The electric whole house water heater is and has been evaluated each year since 2000 in many normal homes under the PATH and “Zero Energy Home” programs. Homes with these nominal 150-200 amp services can without retrofit accommodate a whole house electric tankless water heater. Furthermore upgrading the electric service in a home adds value to the home. Adding dedicated gas service and special venting to accommodate a single large gas tankless does not. See the following quote.

“The temperature based control models as utilized by the SEISCO can be used to boost the utility of a very efficient tank heater, almost double the efficiency of a solar water and improve significantly the efficiency of heat pump and geothermal water heaters installed in a home with as little as 100 amp service.” (Thomas Harman, Ph.D., Chair for Computer Engineering at University of Houston, Clear Lake Campus (Johnson Space Center) who serves on Panel 2 of the NEC and author of 10 editions to the “Guide to the National Electric Code”)

ii. Additional issues identified in other studies:

Recently EPRI conducted power quality testing on electric tankless water heaters for the Southern Company and identified certain products that utilize older technology which create significant power quality issues related to light flicker. These technologies should not be considered for and can easily be identified through the inclusion of test protocol similar to that used by EPRI.

iii. Ability To Meet Current test requirement

The definition of electric tankless has for many years been limited to an electric tankless version having an input maximum of 12kW. We agree that a 12kW electric tankless cannot meet the test requirements and in fact is not a whole house alternative for a storage tank water heater. At the same time we reject the allowance of a gas tankless rated at 199,000 btu to be considered as residential while not providing the very same consideration to the larger and suitable electric tankless, the DOE is aware are being used very successfully in residential applications, at the equivalent imput of 47 kW.

The load requirements in most homes to accommodate the 47kW in accordance with the NEC load calculations is typically 300 amp service. This size electric service is more common than the very large gas service that is required for the large gas tankless.

The fact that the two types of advanced technologies are not being treated with the same considerations represents a basic failure to meet the DOE objectives for establishing "---a fuel neutral program that does not favor one energy source over another."

4. Market Share:

It is not a correct statement to characterize the sales of electric tankless to be small in number. The volumes of the electric whole house water heaters are estimated at over 30,000 units a year and growing rapidly. Typically the split in market share has been practically even between gas and electric storage tanks. The difference in the current levels of achieved market share are more the result of the introduction of gas tankless by foreign manufactures (Japan) who do not have suitable whole house electric tankless. This was followed by one U.S. water heater manufacturer whose parent company is a Japan corporation which manufacturers gas tankless water heaters.

Electric whole house tankless water heaters are manufactured in many power ranges. Typically a range from18kW to 36kW providing selections of the most suitable product for the area and size of home. The electric models can easily provide such a range of product since all that is typically required is a change in the wattage of the heating elements while the rest of the structure remains the same.

It is not as cost effective to manufacture and market gas tankless in such ranges of models as it takes a great deal more than just changing heating elements to be provide this same range of gas products.

The DOE tests have typically used 57F as the inlet water temperature. We believe that the minimum flow rate for the testing should be based on 2.5 gpm at a 63 degree rise A temperature rise requirement which will achieve more than 120F is meaningless in a tankless water, which unlike the storage tank is capable of producing the 120F hot water endlessly within the limits of its input design.

We also believe that requiring higher than required minimum flow rates reflects competitive efforts to exclude a range of whole house electric tankless water heaters that meet the consumers requirements. Furthermore this practice perpetuates the current inequity of non-comparable products. (12kW limitation for electric but 199,000 btu for gas)

5. The Test Procedures for all tankless water heaters need to be changed.

i. The testing should be inclusive and not exclusive. Minimum flow rates for testing should be adjusted to meet the reasonable minimal requirements for residential applications. The NAHB study and actual experience clearly demonstrates that a large share of the residential market in warmer markets can be adequately accommodated with heaters having an input of 18kW or the gas equivalent, assuming .80 EF, of 77,000 btu. This is based on an assumption of 70F inlet water raised to 120F. The maximum flow rate would be approximately 2.5gpm. Over half the population which are 50 or over are generally empty nesters. Those living in the Sun Belt are generally more than adequately accommodated with this level of hot water performance.

   One of the unique benefits of the use of tankless is the wide range of design options that should be utilized. Continuing the past inequities that exist and eliminating these options is not in the best interest of any energy conservation program.

ii Testing must be based on actual use patterns to obtain meaningful energy ratings. There is no reason to wait, the NAHB study certainly provides good baselines that may be further improved upon by additional studies.

iii. Definitions, particularly for advanced technologies, must be conforming with respect to fuel sources.

Heat Pump Water Heaters

Lower the minimum Energy Factor to a value that indicates the model operates as a heat pump; something on the order of 1.2. Any heat pump water should qualify.

Solar Water Heater

Any solar water heater should qualify. Lower the minimum solar fraction criteria.

Gas Condensing Water Heaters

This criteria should be expanded to include small commercial condensing gas water heaters (i.e. input ≤ 130,000 Btu/h) that cannot be rated for EF but which are sometimes used in residential applications. This criteria would be a minimum thermal efficiency of 85%.

The minimum first hour rating is unnecessary.

Advanced Non Condensing Gas Storage

Agree with this as a Tier II criteria.
Should be a table of EF per volume size for sizes, (30, 40, 50, 60/65, 75).

EXHIBIT 1

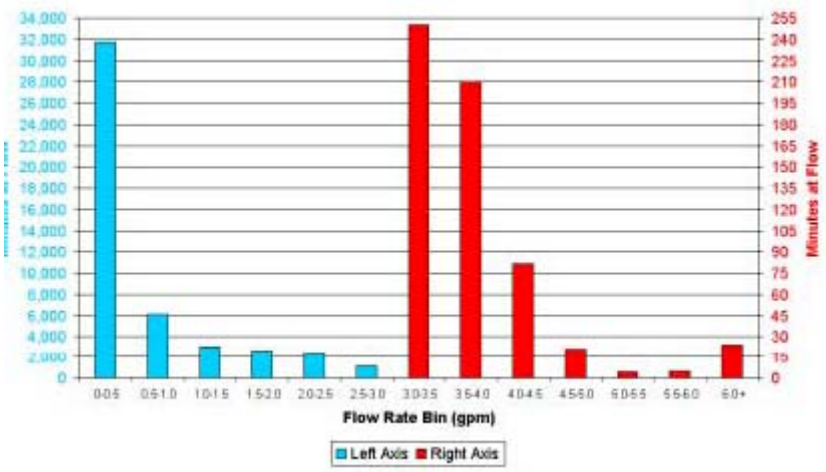

Figure 33. Frequency of flow rates in high-use home

EXHIBIT 2

JANUARY 2007 RULEMAKING FRAMEWORK RESIDENTIAL WATER HEATERS (EXCLUSION OF ELECTRIC TANKLESS)

"DOE recognizes that electric, instantaneous water heaters with an input of less than 12 kilowatts are subject to the energy conservation standards in section 430.32(d) of 10 CFR Part 430. However, DOE is proposing to exclude electric instantaneous water heaters from consideration in this rulemaking because there is no significant energy savings potential from these products.[9] The energy efficiency metric for water heaters is a combination of standby losses and recovery efficiency. All electric water heaters, including instantaneous water heaters, have minor losses in recovery efficiency, and electric instantaneous water heaters have negligible standby losses due to their small storage size. <u>In addition, many of the electric instantaneous water heaters currently on the market are well above the existing minimum energy conservation standard and utilize the available technologies to reduce the standby losses of the product. "</u>

[9] DOE does not intend to propose a separate definition for "electric instantaneous water heaters" for incorporation into Appendix E in Subpart B of 10 CFR Part 430. DOE believes that manufacturers do not need such a definition to determine whether their products are covered by the statute, nor to test their products using the test procedure set forth in that subpart.

Table 1. Product Classes for Residential Water Heaters*

Residential Water Heater Class	Characteristics
Gas-fired Storage-Type	Nominal input of 75,000 Btu/hour or less; rated-storage-volume from 20 to 100 gallons
Oil-fired Storage-Type	Nominal input of 105,000 Btu/hour or less; rated-storage-volume of 50 gallons or less
Electric Storage-Type	Nominal input of 40,956 Btu/hour or less; rated-storage-volume from 20 to 120 gallons
Gas-fired Instantaneous	Nominal input of over 50,000 Btu/hour up to 200,000 Btu/hour; rated-storage-volume of 2 gallons or less

* Only the product classes covered by this rulemaking are shown. The table does not include tabletop and instantaneous electric water heaters.

EXHIBIT 3

Executive Summary

This report by the NAHB Research Center is a continuation of past Renewables and Energy Efficiency Program (REEP) technical efforts sponsored by the National Renewable Energy Laboratory (NREL) through 1999 and 2000. This work was undertaken to verify the estimated energy savings for hot water systems. The test results presented here support water heating energy savings reported in 2001.

Results of weekly performance testing and annual simulations of electric water-heating systems are presented. A laboratory test experiment was conducted to measure the energy performance of two different types of water heaters. electric storage tank and demand (tankless).in two types of plumbing distribution systems, copper piping in a tree configuration and cross-linked polyethylene (PEX) piping in a parallel configuration. Two water-usage patterns were used in the week-long experiments and in the annual simulations: one representing a high-usage home and the other representing a low-usage home.

Using the Transient Energy System Simulation Tool, TRNSYS[1], a simulation model was developed to estimate energy consumption for each hot water system and to further simulate other system design options. The simulation model was calibrated with heat-transfer coefficients determined by experimental results. Annual simulations showed an increase in overall system efficiency of 12% for the demand water heater with a parallel piping distribution system over the storage tank water heater with copper piping for the high-use home and an increased efficiency of 26% for the low-use home. When normalizing the total output energy for each system, the electrical energy savings of the demand water heaters with a parallel piping system over the standard tank with a tree-piping system (tank/tree system) was 34% for the low-use home and 14% for the high-use home.

In addition, the energy analysis indicates that a parallel piping system combined with either a tank or demand heater results in energy savings of 6% for the high-use home and 13% for the low-use home. Furthermore, an economic analysis shows a positive annual cash flow for the parallel piping system, when considering the mortgage payment and electricity costs, over a standard tree plumbing system, regardless of the heater type. These results are consistent for both the high- and low-use homes.

A point-of-use model was subsequently developed to simulate a hot water system having multiple demand heaters distributed at the outlets and served by a tree-type supply piping (cold only). Because the heaters are located at the outlets, lower delivery temperatures are required. Using the point-of-use model, simulations show that the system efficiencies are nearly 100% and annual energy consumption can be reduced by almost 50% for the low-use home and

28% for the high-use home over a storage-tank water heater with a tree-type distribution system.

When improving the energy efficiency of the overall water-heating system, especially in the reduction of piping losses, the environmental benefits extend beyond those of reducing use of electricity or other fuels. Reductions in water use, often significant, may be obtained if the period of time to wait for hot water to arrive at the outlet is reduced as with the parallel piping system or even eliminated as with the distributed-heater system. Other energy benefits occur when low, but frequent, unintentional uses of hot water, such as a single-handle kitchen faucet set near the cold-water position, are eliminated with demand heaters that do not activate at low flow rates.

[1] University of Wisconsin-Madison, Solar Energy Lab, http://sel.me.wisc.edu/TRNSYS/Default.htm.