ENERGY STAR Water Heaters Product Specification Framework May 2011

Questions for Discussion

1. Do consumers set out to buy water heaters specifically with a tank, or are they indifferent?

Most (80+%) water heater purchases are replacements, and for ease and speed of replacement, there is a bias toward replacing with a similar type of heater to what was previously installed. A small percentage of buyers will specifically look for a certain type of heater (tankless, heat pump, solar, condensing gas, etc.), but the majority are like-for-like replacements, with very limited fuel-switching occurring.

2. Is it appropriate to assess tankless and storage technologies based on one EF level?

ABSOLUTELY NOT! The current NAECA test method over-rates tankless heaters, so using one EF level as the criterion would unfairly bias toward tankless heaters.

3. How might we compare system sizes between tank and tankless units?

This compares gas storage to gas tankless only. For Tankless, we assumed 70F temperature rise and standard flow rate/fixtures (i.e., no body spray systems, garden tubs). This implies 50F incoming water temp. The Tankless side should be adjusted up or down for colder or warmer incoming water temperature respectively.

Tankless	Storage/Tank
380k Btu	100-gallon
240k Btu	75-gallon
199k Btu	65-gallon
199k Btu	50-gallon
180/190k Btu	40-gallon
140k Btu	30-gallon

Due to the many variables that affect sizing of heaters (especially tankless heaters), – incoming water temperature being one of the more important - a better suggestion might be to put a sizing calculator on the ENERGY STAR website. Most manufacturers, both tank and tankless, have such tools on their respective websites.

4. Should hybrid systems (more than 1 gal storage per 4,000 Btu/hr input, but less than 20 gallons total) be considered? Is there a test method for these products?

Yes, hybrid systems should be considered. However, several pieces of relevant information should be pointed out:

- Most whole-home hybrid systems will have inputs above 75,000 Btuh in order to provide a useful amount of continuous hot water (one of the primary value propositions for not only hybrid heaters, but tankless heaters and many advanced tank-type heaters as well). This again shows the blurring of the line between NAECA “residential” heaters and EPACT “commercial” heaters.
- A hybrid with an input of 199,999 Btuh can have 49.9 gallons of storage and still fall below the 1 gallon per 4k Btuh limit. It could therefore be considered a tankless (instantaneous) heater, per the definition of instantaneous water heater in 10 CFR Part 430 § 430.2, and since it falls below 200k Btuh, should be eligible to be tested as a tankless unit and be rated with an EF.
- However, since the method of test for Instantaneous Water Heaters given in 10 CFR Part 430 Appendix E § 1.7.2 defines a gas instantaneous water heater as having “… an input greater than 50,000 Btu/hr but less than 200,000 Btu/hr, and has a manufacturer’s specified storage capacity of less than 2 gallons.”, while a 49 gallon, 200k Btuh hybrid appears to fall within NAECA, it would not have a method of test applicable to it, as it does not fit the definition for the method of test. **THIS IS VERY CONFUSING!**
- 20 gallons of storage is an arbitrary limitation on capacity – as shown in the preceding comment, a tankless unit can, by definition, have up to a 49+ gallon capacity and still meet the definition of tankless. Plus, there are hybrids on the market with greater than 20 gallon capacity.

- Is, for example, a 25 gallon, 100k Btuh hybrid a tankless heater (under NAECA definition), therefore eligible to rated in EF but without a test method, or is it an EPACT-covered storage heater eligible to be rated with thermal efficiency?
- (All of the above bullets merely serve to reinforce the need for a resolution to the confusion caused by having two very different energy descriptors required for differing sizes of the same technology of water heaters.)

We continue to believe that a more straightforward solution to the "what criterion can we use to include all kinds/sizes of water heaters?" question is to stop trying to force everything into a single criterion, and allow multiple criteria (like both EF and Thermal Efficiency) for ENERGY STAR eligibility. While (currently) a manufacturer cannot make a representation of what EF equals what TE, perhaps EPA would be permitted under the law to provide a general cross-reference so that a consumer can compare EF to TE? (For example, 0.77 EF = 90% TE - ??)

5. What is the potential for gas condensing storage products to be developed at or below 75,000 Btu/hr input rating?

Technologically feasible, but as pointed out above, continuous hot water has become a desired attribute of advanced water heaters (tank, tankless, or hybrid). The energy input needed to accomplish providing useful volumes of continuous hot water puts tank-type heaters out of NAECA and into EPACT coverage, so they are rated in thermal efficiency instead of energy factor. This is all the more reason to expand ENERGY STAR to include EPACT-covered residential water heaters.

6. What is the range of projected installed costs for gas condensing storage units? What are the associated maintenance costs over a product's lifetime?

These are our "educated guess" estimates of a national average <u>for installation costs only</u>. Actual costs will vary widely depending on a number of variables.

- Standard storage gas and electric like-for-like retrofit = $500.00 (for reference)
- Retrofit condensing storage for atmospheric = $600.00
- Retrofit condensing storage for non-condensing power-vent = $550.00

Also, for reference:

- Retrofit non-condensing tankless for storage atmospheric = $2000.00 (assumes standard horizontal venting with on-wall vent termination & gas line upsize)
- Retrofit condensing tankless for storage atmospheric = $1800.00
- Retrofit condensing tankless for standard tankless = $700.00

We don't believe there are any significant incremental maintenance costs for a gas condensing storage heater relative to other storage heaters.

7. Do gas condensing storage water heaters reliably draw enough energy out of flue gas to condense, or is there an issue with partial load that affects efficiency under field load conditions?

Yes, they do draw enough energy out of flue gas to condense, and part-load (field-load) conditions do not significantly impact this. In order to condense at any load condition, at least the last portion of the heat exchanger (before the flue gas exits the heater) must be exposed to "cold" water that is below about 125 F. The design of all known condensing storage water heaters are designed to have the last portion of the heat exchanger in the bottom of the tank, where the coldest water will be, due to stratification. During any draw, heavy or light, the cold water comes into the bottom of the tank (either via a side inlet, or via a dip tube), and if the bottom "slice" of cold water is deep enough to trigger the tank thermostat to ignite the combustion system, there is enough of a cold water slice to make sure that the heater condenses.

8. How do consumers make a decision to purchase a solar water heater? What do they compare it to for cost and operational savings?

We believe there are two main motivators…the initial is the consumer's desire to be "green" and the second is the ROI (return on investment). The desire to be "green" will, at times, trump the lack of an acceptable ROI (ROI varies market by market). In a very few markets the ROI may drive the decision to purchase.

The ROI decision is initially made by comparing the SEF of the solar system to the EF of a gas or

electric solution. In many cases a solar site analysis is to be conducted (mandated), which will resolve some of the issues discussed below regarding the latitude, but it is hard to verify. The regional correction factor could be implemented without the need for a site-by-site analysis.

9. How does the SEF metric compare to EF metric? Could they be considered equivalent compared? Does the SRCC calculate a First Hour Rating parameter that could be compared to that from the DOE test?

With one very significant caveat, SEF and EF are reasonably comparable metrics. For calculating annual cost of operation, for example, both SEF and EF can be substituted for each other in the cost equation to come up with an annual dollar figure (whereas solar fraction, or SF, is not as readily "substitute-able" for EF). The major caveat is regional variation due to ambient conditions, and that both EF and SEF are based on national average conditions. The "regional" variation in EF is primarily due to ground-water temperature, which can vary even in the same geographic area (municipal water supply versus an individually owned deep well, for example), so use of an average condition is reasonable, out of necessity. The regional variation in SEF is due to solar incidence, and is overwhelmingly depended on latitude. (True, orientation of the collectors of an individual solar system is important – i.e., South-facing, flat roof, or shaded – but latitude is the major overriding factor that affects performance.) The impact on EF of regional variation in supply water temperature is not as significant of an impact as regional solar incidence is on SEF, though, and if SEF is used as the metric/criteria for ENERGY STAR eligibility, we strongly recommend that regional "correction factors" be developed and used in conjunction with the SEF. As an illustration of the need, today's ENERGY STAR criterion of SF>= 0.5, with an electric back-up heater, results in an SEF of 1.8 (at the national rating conditions). Setting an equivalent SEF criterion of 1.8 SEF for eligibility would rule out many, many high-performing systems in much of the country. Specifically, there are systems rated at 1.5-1.6 SEF that will perform at 90% SF in Arizona – much higher than today's threshold criterion of 0.5 SF, but less than the "national equivalent" of 1.8 SEF. However, with an appropriate set of regional correction factors, SEF would be a very good metric for solar hot water systems that would be comparable to EF for conventional water heaters.

We are not aware of a comparable SRCC metric for first hour rating. Storage capacity is typically sized for daily demand….first hour rating is not reported

10. What are the sales channels for solar water heaters?

There are three primary sales channels: through solar distributors, solar dealers/distributors, and the conventional plumbing wholesaler/contractor channel. Solar water heaters are not yet much of a presence in retail outlets.

11. Are there any alternatives to the OG-100 test and/or OG-300 rating method?

Yes. From the ENERGY STAR web page on Federal Tax Credits:

"At least half of the energy generated by the "qualifying property" must come from the sun. The system must be certified by the Solar Rating and Certification Corporation (SRCC) ***or a comparable entity endorsed by the government of the state in which the property is installed.*** " (emphasis mine)

http://www.energystar.gov/index.cfm?c=tax_credits.tx_index

Each entity may have its own method. Wisconsin, for example, has their own computer program into which the panel performance characteristics and the physical parameters of the remainder of the system components are entered, and a resulting pass/fail metric is determined.

12. In what situations are add-on heat pump water heaters actually used? Are there situations in which they compete directly with new units, particularly new integrated heat pump units?

To the degree that we understand this market segment, typical installations are efficiency upgrades to existing electric water heaters when reduced operating costs are desired. They are sometimes installed on newly purchased electric heaters, which should be considered as competing with new integrated heat pump heaters.

13. What are the distribution channels for add-on electric heat pumps?

Two, of which we are aware: plumbing wholesaler/contractor channel, and direct internet sales.

14. Is COP the most appropriate metric for assessing the efficiency of Add-On Heat Pump water heaters? How could COP be used in conjunction with the EF of the tank to determine total system efficiency?

NO! The most appropriate metric is one that allows the consumer to evaluate add-on HP's against alternate technologies, whatever they may be, so the add-on metric must be EF, or something directly comparable (like regionally-corrected SEF, for solar water heating systems would be). Introducing another yet another metric, like COP, into the comparison would only create more confusion for a consumer. We do not have sufficient experience with add-on HP's to address how COP and tank EF could be combined for a system EF.

15. At what performance level would a COP requirement be set so as to assure the consumer of significant energy savings? What are the costs associated with this?

We do not agree with using COP as a measure of performance for three reasons: it will vary with environmental parameters, a good testing protocol has not been adequately defined, and actual performance is very dependent on the size of the tank onto which the add-on HP is installed. However, if COP were to be used to rate such units, we recommend that a minimum of 3.2 COP should be used (since that closely correlates to an EF of 2.0). This will result in performance levels that are similar to the products that are in the markets today, so the equipment and installation cost can be based on current heaters.

16. What additional performance requirements should be considered for the add-on heat pump category? How could those requirements be verified?

In order to evaluate an add-on heat pump correctly, the unit onto which it will be added will have to be well defined. This is necessary to insure that is no gain or loss in performance due to differences in the type of unit onto which it is added. If this is not done, then the ability to compare one unit to another will be severely impaired. Requiring minimum tank capacity for the "host" heater, with the consumer submitting a model and serial number of the heater for verification that the add-on was installed on the appropriate size tank could be a possible means of verification.

17. What are the appropriate warranty requirements to assure consumers a reliable product?

Equivalent to the requirements for an integrated heat pump water heater. **NOTE:** A.O. Smith voids the warranty on our water heater (all of our brands) if an AirTap add-on heat pump water heater module is installed on our heater. The substantial amount of copper heat exchanger introduced into the tank puts a drastically increased load on our anode, causing premature consumption of the anode, and likely early failure of the tank (water leak) because of reduced corrosion protection. Installation of other brands of add-on modules that use external heat exchangers do not void our tank warranty.

18. How would models appropriate for POU be distinguished from whole home models? Maximum input power? Storage capacity as well or instead? Should there be a limit on physical dimensions?

The criteria should be different for tankless and storage. For tankless, maximum power input should suffice. For storage, power input will be (much) less, and water capacity becomes more of a controlling factor. A limit on physical dimensions is perhaps feasible, but great care would have to be taken to choose a valid size envelope without being arbitrarily restrictive.

19. How can the efficiency of POU systems be characterized? Are the current test procedure and existing metrics sufficient?

System efficiency is a new concept in the existing requirements for water heaters (and most everything else). !0 CFR Part 430 (or 431) coverage is for *products*, not systems, and the methods of test are all tailored to evaluate product performance (and hold the product manufacturer accountable for meeting product performance claims based on those test methods). A *system*, particularly a water heater point-of-use system, has many additional components in addition to just the water heater, not to mention the huge influence of basic system design/layout and installation workmanship. It is unreasonable to expect the manufacturer of only one of the components of that system (the water heater) to be accountable for the efficiency of an entire system over which he has no control.

The current test procedure for tank-type water heaters is problematic for small-volume POU storage heaters, as it would be impossible to get a 10+ gallon draw from a 2 – 6 gallon heater.

20. How would water savings be measured for point-of-use products? How can in-field energy savings best be quantified? Would the savings be compared to other point of use products?

Since water savings in a POU system depends almost entirely on the water distribution piping that feeds the POU water heater(s), we do not see a way to quantify water savings except by before-and-after measurements on a case-by-case basis. Similar to the discussion in the answer to question 19, it

is unreasonable to hold a water heater manufacturer accountable for such a nebulous metric.

21. Can the efficiency of whole home and POU systems be compared? If so, how?

Same “system” answers as above. The only way we know is before-and-after measurement on a case-by-case basis.

22. What additional performance requirements should be considered for the point-of-use category? How should those factors be verified?

As discussed above, we don’t believe that a water heater manufacturer can be held accountable for system performance, efficiency, or water savings, so we recommend that POU heaters (both tank and tankless) be rated like whole-home heaters – by efficiency and water-delivery capabilities. Since the existing methods of test (including first hour rating) aren’t applicable to POU heaters, specific tests would need to be developed. Perhaps a POU version of first hour delivery could be developed to determine the volume of useful temperature hot water that the heater could deliver in one draw.

23. In what situations are POU water heaters actually used? Are there situations in which they compete directly with whole home units?

Today, their residential applications are mostly for remote bathrooms that are well away from the bulk of the hot water usage points in the rest of the house. Installation of a POU heater resolves the problem of waiting an extremely long period of time for hot water to arrive at the fixture(s) in that remote bathroom. We are not aware of significant use in lieu of whole home units today, but if a new house’s water distribution system was designed with POU heaters specifically in mind, several of them throughout a house could be used instead of a single whole home heater. This would entail adoption of “non-traditional” piping systems, at least by today’s practice.

24. Are there any differences in the distribution channels of point of use units vs. whole home?

Both are in the wholesaler/plumbing contractor and retail channels, but tankless POU water heaters are believed to have a meaningful direct internet sales channel, whereas storage POU and whole home heaters do not.