



July 13, 2007

Mr. Richard H. Karney, P.E.,
Manager, ENERGY STAR Program
U. S. Department of Energy
1000 Independence Avenue SW
Washington DC 20585

Dear Richard:

Thank you for the opportunity to provide additional comments on the May 2, 2007 document, *ENERGY STAR® Residential Water Heaters: Draft Criteria Analysis*, and the June 5 workshop. This letter comprises the response of the American Council for an Energy-Efficient Economy (ACEEE).

Background.

ACEEE is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. ACEEE fulfills its mission by conducting in-depth technical and policy assessments; advising policymakers and program managers; working collaboratively with businesses, public interest groups, and other organizations; publishing books, conference proceedings, and reports; organizing conferences and workshops; and educating consumers and businesses.

ACEEE was involved in the NAECA and EPAct legislation establishing federal efficiency standards, and has been active in all rulemakings since then. We have also been very active in the ENERGY STAR program, both in the technical aspects of setting performance criteria and in the field support of ENERGY STAR program implementation. In these processes we have developed a strong sense of the technical, economic, market, and institutional issues involved in the ENERGY STAR arena. We bring that broad experience to these comments.

ACEEE staff serve on ASHRAE T.C. 6.6 (water heating), have carried out market evaluations for commercial heat pump water heaters, and for other emerging technologies (including solar-assisted water heating, in our Emerging Technologies series). ACEEE also served on the SEGWHAI team, both as staff and as a member of the Advisory Committee, so we have some current knowledge of the industry and its challenges.

The Big Issues

1. The ENERGY STAR program was designed to recognize better products where a range of efficiencies is available in the market, and where the better products (roughly the top quarter of the models available) offered significant, cost-effective, savings to the consumer. It has been a dichotomous program (“go/no go”) rather than one with efficiency tiers, such as good-better-best.
2. The US Water Heater market is dominated by storage electric and atmospheric storage gas water heaters.¹ Products in both product classes show tightly clustered efficiency

¹ Whole-house tankless gas water heaters may have a 1% market share now..

- levels, with a total efficiency range among models with reasonable market share limited to about 5% (between legal minimum and most efficient with reasonable model choice). This is substantially below the efficiency spread for other appliances. The small savings potential means that an ENERGY STAR program that recognizes differences among these conventional models offers little savings and little value to consumers.
3. Conversely, the advanced technologies with much higher efficiency (heat pump water heaters, condensing gas storage water heaters solar, etc) have very low annual sales. They are emerging technologies, for which consumers have difficulty finding qualified installers and responsive sources. Such products have not been traditionally considered for ENERGY STAR programs.
 4. As noted by J. Lutz, LBNL, the underlying DOE rating method for water heaters (EF), is known to be poorly adapted for comparing performance of different technologies. Annual energy consumption estimated using EF is very likely to give results that differ systematically from field performance. Thus, it is not a firm basis for an ENERGY STAR program or incentive programs that are tied to ENERGY STAR performance criteria. On the other hand, this problem is not unique. For example, the ENERGY STAR central air conditioner program has been forced to adopt a second performance metric, EER, to offer a useful program for its partners.²

To date, these issues have stalled efforts to develop an ENERGY STAR program for residential water heating systems. We commend all involved for attempting to break out of this stalemate by dividing water heaters into separate categories, such as “near-condensing,” “condensing,” and “tankless.” This is a one way to encourage innovation.

ACEEE Recommendations

Develop a new ENERGY STAR approach for emerging technologies

Many of the technologies being considered for the ENERGY STAR water heating program are emerging, at least in the US. As noted above, they don’t fit comfortably into the usual ENERGY STAR criteria. We understand that EPA and DOE are considering an “top tier” program within the ENERGY STAR brand family for emerging technology products with low market share but very high potential to save large amounts of energy. ACEEE would strongly support such a program as a very promising way forward for some water heating (and other) product categories.

To accommodate the shifts in water heater technology and markets that could flow from a good ENERGY STAR program, ACEEE strongly encourages publication as soon as possible of specifications (e.g, EF levels) for advanced products such as condensing water heaters, heat pump water heaters, and solar water heating systems. In this way, manufacturers can bring qualifying products to market quickly, confident that they would earn the ENERGY STAR designation when they are available to the public.

Recommendations for conventional gas and electric storage water heaters

1. In general, ACEEE does not support ENERGY STAR recognition of conventional gas or electric resistance storage water heaters. The savings potential (as estimated by differences in EF) for the best widely-available conventional water heaters are very low (~5%), and compare poorly with other ENERGY STAR product classes (~10–15%).

² http://energystar.gov/index.cfm?c=airsrc_heat.pr_crit_as_heat_pumps

ACEEE believes that ENERGY STAR recognition of such small savings threatens to debase the brand's value.

2. There is one exception: ACEEE would support a time-limited (< 3 yr) program for the best current products (0.65 EF), if it would effectively introduce the value of ENERGY STAR to water heating market channels, particularly plumbers and distributors. At the end of that interval, the label would be withdrawn for these products. Such a program must be time-limited from the outset, or it will strongly discourage introduction of more advanced products, particularly advanced gas units at near-condensing (0.7) and condensing (0.80) levels.
3. ACEEE strongly opposes setting the ENERGY STAR level *below* 0.65 EF for gas storage water heaters, for several reasons:
 - a. Each of the three dominant manufacturers (A.O. Smith, Bradford-White, and Rheem) stated at the June 5 meeting that they could work with 0.65 EF, implying that they did not see good reasons for a lower level.
 - b. For a 40 gallon (typical) gas storage water heater, the nominal savings for 0.65 are 9.4%, which is in the vicinity of other ENERGY STAR products. In contrast, a 0.62 EF would yield only 4.3%.
 - c. As noted by one manufacturer, the rationale for such a program is that the aggregate savings potential is large even though individual savings are small, because products such as 0.65 gas w.h. and 0.95 electric w.h. could see rapid market share increases.

We recognize that there are relatively few products today at 0.65, but we take the manufacturers' workshop comments as indicating that there are few barriers except market pull, which would be provided by ENERGY STAR. We also recognize that today's products at 0.65 are predominantly power-vented, but this does not seem to be required for that performance level.³ In general, this means that incremental costs of ENERGY STAR water heaters at 0.65 are highly speculative. Thus, we feel that even well-intended objections to 0.65 based on present incremental costs can lead to erroneous conclusions.

ACEEE expects that some stakeholders will favor a low ENERGY STAR criterion of 0.62, and some utilities offer rebates at this level today. From our experience working with utility program planners and others, we believe that arguing for a relaxed criterion based simply on present practice, and not on technology and energy savings, is very weak.

In the absence of ENERGY STAR, utilities that have wanted to offer rebates have had few choices. Before the 2004 standards took effect, there was headroom for cost-effective rebate programs. A few utilities have continued these incentive programs, at the

³ Power venting requires access to 120v electricity. However, it also should eliminate off-cycle entrainment and loss of conditioned or semi-conditioned air from the vicinity of the (inside) water heater. Off-cycle conditions are expected roughly 22 hr/day, and these induced air losses are not accounted for in the EF method. Power venting is also an enabling technology, in that it allows abandoning the chimney when a condensing furnace is installed.

0.62 levels, but their value seems to be very limited on the basis of savings (roughly \$10/yr at \$0.08/kWh). We think it is relevant that CEE has not organized a market transformation program at 0.62 (or alternative level). Given that the products available at this level are just minor variants on mature technologies and promise only modest savings (<5%), ACEEE finds that 0.62 is inappropriate for ENERGY STAR and unlikely to induce significant market change.

Furthermore, since publication of the Department's 2003 *Labeling Potential...* study, new technology paths for storage water heaters have emerged, both as concepts developed by the SEGWHAI team, and as products introduced into the market. This indicates that there is likely a much greater opportunity for ENERGY STAR to become involved at what is now the leading edge of water heating technologies.

4. Bullet 3 notwithstanding, ACEEE is concerned about an ENERGY STAR program for electric resistive water heaters at EF 0.95. Although this approaches the highest level feasible, the savings are small (~5%). As important, ACEEE has found that consumers view resistance and heat pump water heaters as a single class of electric water heaters (Attachment 1). Setting a 0.95 EF level for resistive water heaters may signal that this is "good enough," and slow efforts to increase the market share of newer heat pump water heaters. We recognize that there may be pressures to offer programs for electric products as quickly as for gas products, but have concluded that the technical potential of water heaters using the two energy sources differs enough that this pressure should be resisted. We make additional comments on "fuel switching" below.

Recommendations for advanced gas-fired storage water heaters.

ACEEE recommends setting a separate ENERGY STAR performance level at about 0.70 for near-condensing storage gas water heaters, and at about EF=0.80 for gas-fired condensing storage water heaters. This balances several factors. First, the 2004 minimum standard for (40 gallon) storage-type gas water heaters is 0.59, and the best available is 0.65 (with the exception of some combination space heating units around 0.86). Approaches to these performance levels have been outlined by SEGWHAI (www.segwhai.org). All of these approaches have the shared value of eliminating off-cycle induced draft, which prevents the entrainment of conditioned house air. This seems to be an important, but poorly understood, parameter, since it is not included in the EF test.

For all of these reasons and the relatively large savings that could be achieved by a program for advanced storage gas water heaters, ACEEE supports an ENERGY STAR program with appropriately stringent specifications for these classes. The specifications and eligibility requirements should be published as soon as possible, and the label should be available when qualifying products reach the market.

Recommendations for tankless gas water heaters

Based on the Department's analysis, ACEEE supports a program for tankless gas water heaters. The technologies are mature. We recommend EF=0.82. An ENERGY STAR program at this level would give current manufacturers confidence that the market would be carried to larger sales levels by the ENERGY STAR endorsement, justifying investments in better products and greater manufacturing capability. It might also encourage market entry by other firms. In this, we note that the current EF rating method gives results for instantaneous water heaters that are anomalously high relative to expected field performance.

Several reservations have been expressed about including tankless gas water heaters in the ENERGY STAR program now. These cluster around issues such as these:

1. Installation costs are extremely high for converting from storage gas (or electric) in existing houses. Thus, the economics are extremely poor. Existing houses are about 80% of the water heater market.
2. In general, tankless water heaters require annual maintenance, which may be costly and is not expected of alternative technologies.
3. Is scaling a problem in hard water areas?
4. A major focus of tankless water heater marketing is “endless hot water.” Will this encourage increased consumption of natural gas, even if done more efficiently?

Greater field experience, including before-and-after studies in planning by CEE, may resolve many of these questions. Situations like these are characteristic of emerging technologies (our “Big Issue” #3). ACEEE recognizes the strong record of tankless technologies in other countries, and the potential of the technology to improve efficiency (when combined with rational water distribution, etc). As a result, we’re neutral about early inclusion in an ENERGY STAR program, but would strongly support publishing specifications now for a program to be launched when certain conditions are met. We would also support including them in any kind of “top tier,” emerging technologies program within ENERGY STAR..

Recommendations for Heat Pump Water Heaters (HPWHs)

ACEEE strongly recommends launching a program for heat pump water heaters (HPWHs), by publishing performance and other specifications now. Alternatively, as for tankless water heaters, this could be done through a “top tier,” emerging technologies program within ENERGY STAR.

We recommend EF=2.0 for the initial ENERGY STAR specification. Technically, higher levels (e.g. 2.5) seem to be readily achievable in theory and in the lab, but we fear that the effort to get the highest feasible efficiency is premature until the technology has a better track record. However, given that residential HPWH with CO₂ cycles and high COPs are available in other countries, and that many other approaches are potentially viable, we recommend that the Department remind all parties that ENERGY STAR criteria are subject to regular revision.

As shown by the Department’s own analysis, the potential savings, even at modest market penetration rates, dwarf those of other technologies. DOE has invested large sums in research and development funds to support market deployment of reliable units. Utilities and others have carried out noteworthy programs, and vendors are supporting their products. The program should be designed to give manufacturers confidence that the market would be carried to larger sales levels by the ENERGY STAR endorsement, justifying investments in better products and greater manufacturing capability. It might also encourage market entry by other firms.

Recommendations for Solar Water Heater Systems

We agree with the Program Manager that a program can be built on the Solar Rating and Certification Council (SRCC) standard for solar water heaters, *OG-300, Certification of Solar Water Heating Systems*.⁴ ACEEE suggests that ENERGY STAR designation be awarded for

⁴ <http://www.solar-rating.org/standards/ogdocuments/OG300SEP02.pdf>. Checked May, 2003

systems in which the manufacturer provides the solar collector, controls, pump(s), as *per* OG-300. This must include specifying the storage (capacity and EF) and back-up systems required to meet ENERGY STAR levels. These requirements may assure that the models designated as ENERGY STAR-compliant will deliver performance in the field that warrants the appellation. As for other emerging technologies, ENERGY STAR may want to consider developing a "top tier" brand extension for these water heater types as well.

Because the cost of installing solar water heating is much lower at time of construction than as a retrofit to existing houses, we strongly recommend that the ENERGY STAR new homes program examine whether it gives as much credit as feasible for solar installations, and even for making houses "solar ready" with rough-in piping for solar water heaters (and rough-in wiring for photovoltaics).

Fuel Switching.

We have heard concern that the presence of an electric resistance option could lead to consumer fuel switching based on first cost. There are many reasons to oppose reliance on resistive heating, but we find that fuel-switching is rather unlikely and predict that it would be very uncommon (Attachment 2).

Assuring reliability of ENERGY STAR water heating systems

Some stakeholders suggest that emerging technologies should be required to carry inclusive warranties for extended periods (approaching the expected life time of the appliance). Manufacturers have noted that this would add a large "actuarial" price premium for the covered products, perhaps \$150/unit. The goal of the long warranty requests is to protect consumers and incentive program sponsors (such as utilities). ACEEE believes that this goal can be met through a variety of alternative qualification criteria, criteria that recognize the substantial investment in brand equity by manufacturers who carry most of the market risk. As one example of alternatives to extended warranties, the original "Super Efficient Refrigerator Program" required responders to its RFP to show rather high minimum US sales, or to show a distribution and repair infrastructure appropriate for the anticipated number of SERP products.⁵ With such an approach, a new entrant to the US market could offer extended warranties, choose to partner with a current large-scale manufacturer (who might sell products under its own brand name(s)). We believe that multiple approaches can serve the needs and expectations of consumers and program sponsors.

Conclusions

Water heating is often the second largest energy use in the house. Under the right circumstances, an ENERGY STAR program for water heaters could help raise efficiency, reduce homeowner bills, and prevent pollution. Such an approach would have to emphasize the higher efficiency technologies (solar, heat pump water heaters) while recognizing current market limitations. The low market share of emerging technologies with enormous potential may require evolution of the ENERGY STAR platform. ACEEE would strongly support the adoption of a "top tier" brand extension under ENERGY STAR, as one way to raise visibility of "discontinuous" emerging technologies, because they have such huge energy-saving potential.

It is also important to publish specifications for eligibility for these emerging technology products as soon as possible, so manufacturers have specific goals for marketable products. The bottom

⁵ This issue has was also addressed by SEGWHAI.

line is that the savings associated with these technologies, even at low levels of market penetration, are much greater than the best that can be hoped for by pushing conventional technologies as far as possible.

Sincerely,

Harvey M. Sachs
Director, Buildings Program

Attachment 1.

Thorne and Egan (2002)⁶ studied customer perceptions of the FTC EnergyGuide label, in a study designed to propose improvements to the label design that would facilitate consumer understanding. As one part of the study, they carried out a “simulated shopping experience” involving over two hundred “customers.” These customers, who did not know the goal of the experiment, “shopped” for electric water heaters. Samples with realistic prices, feature lists, and different versions of the EnergyGuide label were displayed, and the consumers ranked their choices. The panel included one heat pump water heater. For present purposes, the most important finding is that the consumers accepted the HPWH as just another form of water heater. Of the five models presented, it was rated second most likely to be bought (participants reported that price was a major barrier, but they understood its very attractive life cycle economics). Since consumers “see” both kinds of electric water heaters as a single class of service-providing equipment, it is irrational to erect a separate class for resistive water heaters. This is particularly true since the best (50 gallon) resistance storage water heater on the market today has an EF of 0.95, and the 2004 minimum specification is 0.90. Consider the data of Table 1

Table 1. Estimated Annual Operating Costs of Electric Water Heaters with varying EF and electricity rates. Based on equation of p. 154 of GAMA Directory.

EF	Tariff, \$/kWh					
	\$0.06	\$0.08	\$0.10	\$0.12	\$0.14	\$0.16
2.5	\$105	\$141	\$176	\$211	\$246	\$281
0.95	\$277	\$370	\$462	\$555	\$647	\$740
0.94	\$280	\$374	\$467	\$561	\$654	\$747
0.93	\$283	\$378	\$472	\$567	\$661	\$755
0.92	\$286	\$382	\$477	\$573	\$668	\$764
0.91	\$290	\$386	\$483	\$579	\$676	\$772
0.9	\$293	\$390	\$488	\$585	\$683	\$781

For the average customer, a difference of 0.01 in EF corresponds to a saving of \$3/yr at \$0.08/kWh⁷. Across the entire range of 50 gallon resistive water heaters that were expected to be available in 2004, from EF 0.90 to 0.95, the energy cost difference is \$20/yr. The 5% difference between least efficient complying model (0.90) and best available resistive water heater (0.95) is much less than the range in most other ENERGY STAR programs. In comparison, the consumer would save \$140/yr by using a good HPWH (EF=2.0) relative to the *best* resistive water heater.

Thus, the small savings potential within the resistive class and the tiny savings relative to the savings from a technology that consumers see as equivalent (HPWH) show why an ENERGY STAR program for resistive water heaters could erode ENERGY STAR’S brand equity.

⁶ Thorne, J. and C. Egan, 2002. *An Evaluation of the Federal Trade Commission's EnergyGuide Appliance Label: Final Report and Recommendations*. Report A021, American Council for an Energy-Efficient Economy, Washington, DC.

⁷ Using the formula from Gas Appliance Manufacturers Association [GAMA] APRIL 2003 Consumers Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, p. 154. Arlington, VA. Available at <http://www.gamanet.org/consumer/certification/RWHApr03.pdf>

Attachment 2: Why Fuel Switching is unlikely to be a problem

In discussions, some have suggested that including 0.95 resistive storage water heaters in a program for “conventional” storage water heaters could encourage fuel switching, from gas to electricity. ACEEE believes that this is extremely unlikely to become an issue, because the costs of converting are so much higher than the difference in equipment prices.

SEGWHAI research and industry sources strongly suggest that only 20% of the water heating market is for new construction (including extensive remodeling?). For this 20%, the contractor of spec-built and tract developments will choose either gas or electricity, and install either a 220v. line OR a gas line (typically ½”). Particularly in the non-custom markets, it would seem unlikely that the builder would run both the gas line and 220v electricity to the WH, stove, and dryer.

Thus, the remaining 80% of sales are to replacement markets that are essentially locked in to the existing energy source. The ability to switch fuels is limited by the high incremental cost of providing the other energy source (and, in the case of gas water heaters, the appropriate vent). Even for the “DIY” (do-it-yourself) homeowners who purchase and install replacement water heaters, there is a formidable difference between virtual “plug-and-play” replacement with the same energy source, vs. changing from electricity to gas, or vice-versa. In addition, a high fraction of replacements are failure-driven, with speed and cost the major drivers. It seems unrealistic to think that many of these customers are interested in a change that will add hundreds of dollars of first cost and a fair amount of extra time.

Even though electric water heaters cost ~\$50-\$100 less than gas water heaters, we have never heard assertions that many replacement customers are tempted to spend much more money to change the energy source. The exception may be tankless gas water heaters, whose very high incremental installed costs is perceived to be offset by other benefits (endless hot water).