American Council for an Energy-Efficient Economy
WASHINGTON, DC

May 15, 2003

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 comment on the April 4, 2003 document, *Energy Star® Labeling Potential for Water Heaters.* This letter comprises the response of the American Council for an Energy-Efficient Economy (ACEEE).

*Background***.**

The American Council for an Energy-Efficient Economy 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.

DOE's Analysis is Reasonable

In general, the analysis presented is credible and adequate for designing a voluntary program. However, across the board, ACEEE believes that the prices used are somewhat higher than would be found in the market once Energy Star is fully established, and that energy costs during the lifetime of any Energy Star product are likely to be higher that the values used. The paper generally presents issues clearly, with some exceptions. For example, we are not yet convinced that treating solar systems as adjuncts to electric water heaters is better than treating solar collectors and their auxiliaries as systems.

ACEEE Comments on Program Goals

The closing paragraph of the *Executive Summary* states: *"ENERGY STAR promotes efficient technologies, but also seeks technologies that are reliable, available and economically feasible for the average consumer."* We would add a bit to this set of objectives, and suggest that a program should also:

- Deliver significant amounts of energy savings, and thus, pollution prevention.
- Protect and enhance the hard-earned value and integrity of the Energy Star brand for Market Transformation.
- Validate and encourage early adopters and market leaders.

Our comments are framed carefully, because water heating is very important. Across the nation, it is the second largest site energy use in houses. Year round, more visitors to the ACEEE web site are seeking information on efficient water heaters[1] than any other buildings topic. ACEEE joins the Department in concluding that many consumers want reliable information on the best available water heaters.

Summary of Recommendations

From our review of the April 4 *Energy Star Labeling Potential* study, we make the following recommendations, which are elaborated in the text that follows:

1. The savings from new residential water heating technologies at low market penetration rates dwarf those from modest improvements to existing storage technologies. Therefore, the focus of an Energy Star program should be transforming the market toward these new technologies.
2. Energy Star labels should embody sufficient performance improvement to make a difference to the consumer individually and the environment as a collective good. Empirically, we know of no Energy Star programs for which qualifying products save less than about 10% relative to baseline units. Therefore, we recommend that Energy Star water heaters should aim to improve performance by about 10% as a minimum.
3. Because the performance differences among resistive water heaters after the implementation of the 2004 NAECA standards is so small (5%), ACEEE strongly recommends *against* any Energy Star program for these units themselves. Such a program would save very little energy, and undermine the value of the Energy Star brand.
4. For combustion-type water heaters, ACEEE recommends a program built around a 0.65 EF for storage water heaters, and 82% recovery efficiency for instantaneous units.
5. To accommodate the shifts in water heater technology and markets that could flow from a good Energy Star program, ACEEE recommends early publication of specifications for a January 1, 2005 or January 1, 2006 program launch.
6. In the time before launch, DOE should continue and expand a variety of approaches to promote deployment of advanced technologies.

ACEEE Supports Energy Star for Heat Pump Water Heaters (HPWHs)

ACEEE strongly recommends launching a program for heat pump water heaters (HPWHs). 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 analysis for the Department suggests great (perhaps excessive) concern about reliability of new technologies, but HPWH have been on the market for at least two decades and are ready for market transformation now. Still, to allay the concerns that the Department and others may feel, Energy Star should consider warranty requirements for the tank that are comparable to those of high quality resistive water heaters, and heat pump warranty requirements equivalent to those for premium grade

[1] http://aceee.org/consumerguide/topwater.htm.

central air conditioners. Because the current market is small, the Department may wish to consider announcing a program now to begin in January 2005 or January 2006. This 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.

ACEEE Opposes Energy Star for Resistive Water Heaters

Thorne and Egan (2002)[2] studied customer perceptions of the 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 (HPWH). For present purposes, the most important finding is that the consumers readily 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).

If consumers "see" both kinds of electric water heaters as a single class of service-providing equipment, it seems 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.

	Tariff, $/kWh					
EF	$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/kWh[3]. Across the entire range of 50 gallon resistive water heaters 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

[2] 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.

[3] 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

less than the range in most other Energy Star programs. In comparison, the consumer would save $172/yr (62%) by using a good HPWH (EF=2.5) relative to the *best* resistive water heater.

In addition, it would be very difficult to set an appropriate performance level for an Energy Star resistive water heater program. There are extremely small numbers of models available at EF=0.95, but about 40% of all models that will meet the 2004 minimum criterion have EF of 0.93 or better. This is too large for an Energy Star program designed to spotlight exemplary equipment. Furthermore, during the DOE water heater standards rulemaking, it became apparent that the EF of many high-efficiency resistance water heaters was exaggerated. DOE and the manufacturers have taken steps to address this problem, but DOE would need to verify that this problem is fully solved before considering these units for an Energy Star label.

ACEEE finds no compelling arguments in favor of an Energy Star program for instantaneous resistive water heaters, either. Their water heating capacity is too low for whole-house application in conventional houses. Their power requirements are extremely high, and use among houses within a subdivision is likely to show relatively low diversity, so the utility load factor would be troubling.

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 threatens to erode the brand equity built up by Energy Star.

Energy Star for Fossil-fuel Storage Water Heaters

ACEEE recommends setting an Energy Star performance level of EF=0.65 for 40 gallon gas-fired storage water heaters, with the EF requirement declining modestly with increasing tank size. 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). This is a 9% EF difference, about the same as the minimum savings for an Energy Star refrigerator. Thus, such a program would roughly conform to the minimum efficiency range we suggest. Second, EF=0.65 is also the level in a pending Senate proposal for tax credits for efficient water heaters. This amendment was developed with support from AGA and ACEEE, and is likely to introduced on the Senate floor in June. Third, the best available gas water heater is a condensing unit with theoretical EF less than 1.0, in contrast with the situation for electric water heating, where a 2.6 EF heat pump water heater is listed today.

To illustrate the basis for this position, the best available gas water heater is a condensing unit with theoretical EF <1, in contrast with the situation for electric water heating, where a 2.6 EF heat pump water heater is listed. As noted above, a consumer would save $172/yr (62%) by using a very good HPWH (EF=2.5) relative to the *best* resistive water heater. In contrast, assume that a consumer could buy a near-ideal combustion unit (almost zero standby losses, etc.) with EF=0.95. Using the GAMA directory formula, at $1/therm this unit would save less than $55/yr relative to our EF=0.65 recommendation for Energy Star – less than 1/3 of the savings of a heat pump water heater already on the market.

An EF target of 0.65 thus represents a reasonable "stretch" between the NAECA minimum standard and the best available technology. While condensing fossil-fired water heaters are technically feasible, they are unlikely to be cost-effective for the foreseeable future, except when installed as part of a combination space heating/water heating system.

An EF=0.65 or greater can be achieved with several different technical approaches, including condensing water heaters marketed today (primarily as combination hot water and space heating sources). Another approach that we believe has significant potential is an advanced power-vented water heater. From an efficiency perspective, the principal advantage of such a unit is that it minimizes off-cycle losses by heat transfer from the heat exchanger to the vent. It also eliminates the draft hood, eliminating off-cycle losses of heated house air. It opens a path for heat exchanges with greater pressure drops that are more effective but would not work with gravity venting. From a market perspective, power vent units are being adopted for new construction. Combined with condensing furnaces, power vent water heaters allow eliminating the chimney, so the economics are quite attractive. They are also attractive for retrofits where the alternative is lining the chimney, since power vent units can use sidewall venting with plastic pipe.[4] Table 2 summarizes ACEEE's rough estimates of the economics of such units, which seem acceptable for an Energy Star program.

Table 2. Estimated costs of advanced power vent water heaters.

Estimated costs of high efficiency power vent water heaters.			
Cost Element	Cost	Units	Source
Baseline 2003 unit, 40 gal, EF=0.59			
Purchase, Option 3 (0.59 EF)	$265.13		TSD, Table 8.4.25
Installation, Option 3 (0.59 EF)	$164		TSD, Table 8.4.25
Total installed price	$429.57		
Option 6 + Power Vent, EF=0.65			
Purchase, Option 6	$280.67		TSD, Table 8.4.25
Power vent assy. + controls	$100.00		ACEEE estimate
CPVC direct vent, per code	$68.26		calculated as <2x cost of electric outlet, etc
Electric outlet near WH, etc.	$ 34.13		TSD, 8-57
2003 baseline installation cost	$164		TSD, p. 8.53
Total installed price	**$647.50**		
Incremental Cost, purchase and installation	**$217.93**		
% increased price	51%		
Energy Use			
2004 unit @ EF=0.59 (Option 3)	26.75	MMBtu/yr	TSD, Table 8.4.26
2004 baseline unit	0.59	EF	
Estimated gas consumption, Option 6 + PV	23.82	MMBtu/yr	
Option 6 + PV	0.65	EF	
Savings	2.94	MMBtu/yr	
Savings	29.35	therm/yr	
Gas tariff	$ 1.00	$/therm	ACEEE estimate based on current prices
Annual savings	$ 29.35		
Simple Payback	**7.4**	**Yr**	

In addition to this approach, there are other technology options that could potentially qualify. As noted above, the most obvious is the condensing water heater, which is available today. While

[4] ACEEE believes that these units also can be used with existing chimneys, provided that the water heater controls the vent fan in a way that prevents long-duration wetting of the chimney.

stand-alone condensing water heaters may not be cost-effective, combination space-heating and water heating devices could qualify and be cost-effective.

An argument against a program for combustion water heaters is the relatively small range of efficiencies, as measured by EF. For 40 gallon units, the 2004 minimum standard is 0.59, and the maximum available now is 0.65,[5] an EF range of 9%. The level of 0.63 EF recommended in the Department's analysis already includes 27% of available models that meet the 2004 standard, and this fraction would undoubtedly increase if 0.63 becomes the Energy Star threshold. Instead, setting an Energy Star minimum of at least 0.65 will promote a more selective group of products while stimulating innovation such as high efficiency power vent units. We thus recommend .65 EF as a minimum performance criterion for flame-type units.

We also recommend a minimum 0.65 EF for Energy Star labels for free-standing oil-fired storage water heaters. At present, 2 of 13 models in the GAMA directory, both from the same manufacturer, meet this performance level, but the time between program announcement and implementation should allow entry by other firms.

Further, ACEEE recommends that all fossil-fueled "combo" units (ones that combine functions of a boiler and a storage water heater) with a C_{EF} at 0.65 or higher be eligible for Energy Star certification, provided their C_{AFUE} meets of exceeds the AFUE set by NAECA for furnaces and boilers. Specifically, a high C_{EF} is not sufficient for those products with a low AFUE.

For all of these reasons and the relatively large savings that could be achieved by a program for storage type fossil fuel water heaters, ACEEE supports an Energy Star program with appropriately stringent specifications for these classes.

ACEEE Supports Energy Star for Instantaneous Combustion Water Heaters

Based on the Department's analysis, ACEEE supports a program for these units. It should include a minimum RE of 82%. The technologies are mature; it is time to give the marketing support to manufacturers and vendors. This 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.

ACEEE Supports Energy Star for Solar Water Heater Systems

In one important sense, ACEEE diverges from the perspective of the research paper. The paper prepared for DOE proposes that solar systems be considered a subset of electric resistance systems. ACEEE believes that this sends a message that electric resistive systems can be very efficient. We strongly prefer to treat solar water heating as its own class, rated and qualified on the basis of performance of the solar collector and the rest of the system, as discussed below.

Thus, ACEEE supports an Energy Star program for solar water heating *systems*. It can build on the Solar Rating and Certification Council (SRCC) standard for solar water heaters, *OG-300, Certification of Solar Water Heating Systems.*[6] However, the performance of solar systems depends strongly on local climate, and on the "balance of system" (parasitic loads and energy for

[5] 1 of 785 models in the October, 2002 GAMA directory
[6] http://www.solar-rating.org/standards/ogdocuments/OG300SEP02.pdf. Checked May, 2003

back-up when solar heating is inadequate). It is not easy to deal with all of these factors, but inadequate attention to details will lead both to "gaming" and to large numbers of dissatisfied consumers – with concomitant damage to the Energy Star brand. Thus, ACEEE proposes that Energy Star be awarded for 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.
- Designates (using a standard system to be defined) the climate zones for which the system meets Energy Star performance criteria. The performance level to be required for the Energy Star program needs some additional study.

Together, these requirements may assure that the models designated as Energy Star-compliant will deliver performance in the field that warrants the appellation. Although the requirement of climate zone-specific rating introduces some complexity, the path for this has been blazed by the Energy Star windows program, with similar rationale: performance depends strongly on climate for both product classes.

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).

Discussion

ACEEE appreciates the thoughtful effort of the Department towards an Energy Star water heating standard; it will stimulate progress and much thoughtful discussion. We have concluded that:

- There should be no program for technologies where the range of available efficiency ratings is less than about 10%. The small potential savings for consumers from products in such categories threaten the Energy Star program's brand equity as a symbol of products that provide significant energy savings.
- For this reason, ACEEE opposes an Energy Star program for resistance water heaters. An even more compelling argument is that empirical study has shown that consumers see resistive and heat pump water heaters as equivalent water heating methods.
- A program for heat pump water heaters should be encouraged.
- An Energy Star program for fossil fuel storage water heaters can be justified if the performance level chosen is sufficiently rigorous to bring attainable levels of improved product to the market.
- An Energy Star program for instantaneous combustion water heaters, at an appropriately stringent level, is worthwhile.
- Solar water heating *systems* deserve their own category. It should rate *systems,* not collectors, and be open to a variety of supplemental technologies.
- A uniform start date, either January 1, 2005 or January 1, 2006, would balance the need for early availability of product for consumers (the specification should be issued much earlier) with time for manufacturers to adjust production schedules and make other market arrangements, develop promotional materials, etc.

Technically, this set of recommendations is reasonably robust. There may be divergent views of our assessment of resistive and flame-type storage water heaters. ACEEE believes that the distinctions we draw are justified on two grounds: on the resistive side, the range of performance variation is too small to support a differentiating program, and the cost-effective potential of HPWHs is so great that resistance units cannot be described as offering Energy Star performance levels. Conversely, on the fossil fuel side, the upside potential is limited to condensing units that have EF less than 1.0, much less than the potential of HPWH on the electric side. Thus, there is less "head room" for improvement. At the same time, there is a greater range of performance variation among products on the market, so the Energy Star designation can be justified based on energy savings.

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 bottom 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.

Again, perhaps the greatest danger is setting too low a threshold for inclusion in the Energy Star program, as by including resistive water heaters. The minimal savings attained and the large foregone savings would combine to seriously debase the value of the Energy Star brand.

Sincerely,

Harvey M. Sachs