The future of Energy Star and other voluntary energy efficiency programs

Alan Meier
International Energy Agency
9, rue de la Fédération
Paris, France
alan.meier@iea.org

Keywords

Energy Star, voluntary energy efficiency programmes, standards, labels

Abstract

ENERGY STAR© is the largest, most successful, voluntary energy efficiency programme in the world. In order to remain effective, it must address both technical and administrative problems. Technical problems include reconciling programmes dealing with components and whole buildings; dealing with cross-fuel performance; and definitions and energy test procedures for new, complex products. Administrative problems include: deciding if Energy Star is a truly international programme and developing satisfactory exit strategies for programmes whose incremental savings no longer justify the investment of staff and resources.

Why Discuss the Future of Energy Star?

Countries around the world have established or adopted voluntary energy efficiency programmes. (International Energy Agency, 2000). The largest programme, and one of the oldest, is ENERGY STAR© (Energy Star, 2003). It was established in 1992. The success of Energy Star is generally recognised but there has been little public discussion regarding its long-term role in U.S. energy and climate policies. This paper describes some of the technical and administrative issues that Energy Star must confront if it is to remain an effective policy tool to save energy and minimise environmental pollution. The discussion focuses on Energy Star but other voluntary energy efficiency programmes, from the European Group of Energy Efficient Appliances (GEEA, 2003) to the Korean "Energy Boy" endorsement scheme (KEMCO, 2003), face similar questions. Indeed, most eco-labelling and certification programmes, such as the Blue Angel Program (Der Blauer Engel, 2003), also must evolve in order to stay relevant and challenging. The purpose of this paper is not to make recommendations but to list some of policy decisions that will be required in the next decade.

Original Goals of Energy Star

Energy Star was established in 1992 by the U.S. Environmental Protection Agency (EPA). It is now operated jointly with the U.S. Department of Energy (DOE). Energy Star first targeted computers and other office equipment. Energy Star was to a great extent responsible for establishing the energy-saving "sleep mode" in that equipment. The programme quickly expanded to cover heating equipment and consumer electronics. It now covers over thirty different kinds of products, ranging from consumer electronics to commercial buildings.The impact of Energy Star programmes has been reviewed by Brown et al. (2002).

The procedure to create a programme is the same for nearly every product. First, Energy Star staff identify products whose energy savings potential is large. Second, staff establish a minimum efficiency specification, and then certify all products that meet the specification (Sanchez et al., 2000). Energy Star aims to establish performance specifications that allow the top 25% to qualify for certification. The entire process is undertaken with frequent discussions and negotiations with the concerned industries. Manufacturers like the programme because the Energy Star symbol gives

Table 1. Major product areas covered by Energy Star in the United States and elsewhere.

United States	Canada and Mexico	Australia and New Zealand	Europe, Japan, Taiwan
Office equipment (personal computers, displays, copiers, etc.)	X	X	X
Consumer electronics (televisions, video cassette players, digital disk players, etc.)	X	X	
White goods (refrigerators, dishwashers, clothes washers, etc.)	X		
Heating and cooling equipment (air conditioners, furnaces, heat pumps, fans, etc.)	X		
Building materials (insulation, high albedo roofs, etc.)			
Homes			
Commercial Buildings			

their products *cachet* and offers another means of distinguishing their products from those of their competitors.

From the beginning, Energy Star was conceived as an environmental programme because its home was inside the U.S. Environmental Protection Agency. The logic was that saving energy reduced greenhouse gas emissions. (This justification arose partly because the Department of Energy insisted that all *energy* conservation programmes—both mandatory and voluntary—were its responsibility.) Thus, from the beginning, the official goal of Energy Star (to improve the environment by reducing emissions) was overshadowed by the operational goal of saving energy. This awkward situation initially created friction between the two agencies. It had been exacerbated by the fact that industry appreciated Energy Star and disliked the mandatory efficiency programmes administered by the DOE.[1] At least 80% of the Energy Star budget goes to EPA and its contractors, the remainder going to DOE and its contractors. The infighting between the agencies has largely dissipated, thanks to clear delineation of responsibility and essentially independent operation.

Energy Star now covers over thirty types of product. The major product areas are listed in Table 1. At least seven other countries have joined Energy Star and adopted parts of the programme. Table 1 also lists the partner countries and the product areas that they have adopted.

The Balancing Act

Energy Star staff work closely with industry when establishing a performance specification for a new product, or revising a specification for an existing product. Staff must balance several factors when setting a specification (Sanchez et al., 2000). The specification must be stringent enough so that only a fraction – ideally 25% – complies. In addition, staff need to demonstrate that the specification saves meaningful amounts of energy and is cost-effective (Meisegeier & Chinery, 2000). Industry typically argues for a weaker specification but Energy Star staff may have further outside information showing that product efficiency is improving in any event, so the specification should be set in anticipation of future, more efficient equipment soon appearing in the marketplace.

The staff must also take care to avoid setting a specification (and launching a new programme) when only a few products qualify (Werling et al., 2000). Thus, Energy Star staff must carefully balance these forces when launching a new product and the cut-off point may not necessarily fall at the 25% level. One strategy has been to announce two phases of specifications at the same time. The first phase (or "tier") is lenient and allows a large fraction of the products to meet the specification. A second phase, with a date of initiation a few years later, is very strict, possibly with no complying products currently in the market. This strategy solves some of the problems described above by initially engaging the manufacturers but then requiring them to make major efficiency improvements to continue participation.

The almost ad hoc procedures adopted by Energy Star would appear to contrast sharply with those used by the Blue Angel eco-label, where the procedure is carefully circumscribed, with several formal meetings, a "jury" and milestones along the way to finally selecting a product and specifications (Müller, 2002). Nevertheless, the concept of "balance" also enters the decision at many points

Is Energy Star's Goal to Save Carbon or Increase Efficiency?

Energy Star's stated mission is to reduce greenhouse gases, yet all of its performance specifications are expressed in terms of energy. This creates at least two inconsistencies in its programmes. One arises where both electric and gas versions of a product exist, as for furnaces, boilers, and water heaters. The second concerns the way in which performance specifications are designed.

On the first, Energy Star has always established separate performance specifications for electric and gas products. Electrically-heated homes have different specifications

1. The turf battles between the EPA and the DOE are not unique to the United States; indeed, similar situations arose in Japan, Germany and France.

from gas-heated homes. This makes sense from an economic perspective because electric heat is more expensive than gas heat in most regions. But the specifications also lead to Energy Star electrically-heated homes that have higher greenhouse gas emissions than for comparable gas-heated homes (with the present mix of power generation sources). Furthermore it is often cheaper to build a house meeting the electric-heating criteria for Energy Star than for the gas-heating criteria. Energy Star has traditionally shied away from any programme that might encourage fuel-switching because this would antagonise some of its partners (notably electric utilities). The Energy Star programme for water heating was delayed in part because of difficulty in overcoming the fuel choice problem between electric and gas-fired water heaters.

Some Energy Star performance specifications are absolute values, regardless of the product's size or features. For example, the maximum standby power levels on audio equipment are a flat 2 watts. But most of the Energy Star performance specifications are expressed in terms of an efficiency, that is, a unit of service per unit of energy expended. For example, the specification for air conditioners is expressed as a unit of cooling power per unit of electrical power (COP). Refrigerator efficiency is expressed in terms of kWh per unit of refrigerator volume. Many other product specifications are defined in this way, including those for homes, furnaces, and personal computers[2]. The same efficiency level applies to a wide range of sizes. The constant-efficiency approach is biased towards larger products. It is typically easier to meet the efficiency criteria with a larger product than a small product because there are various economies of scale. The impact of this bias is most evident for energy targets for new homes. It is relatively cheaper to build a very large Energy Star home than a small one, even though the greenhouse gas emissions from the larger home will be greater than those from a small, inefficient house.

Energy Star could make the efficiency criteria progressively stricter with increases in size. This is a variable-efficiency strategy (Meier, 2000). Figure 1 shows how a progressively stricter energy efficiency requirement compares to the present, fixed-efficiency, situation. There are both physical and economic reasons to support progressively stricter levels. Heat loss typically scales with the surface area of a house, not the floor area. However, the ratio of surface area to floor area generally declines with increasing floor area, so larger homes need less insulation to meet the same efficiency budget. It is also reasonable to assume that higher efficiency levels are economically possible with larger products because more alternatives become possible. Larger Energy Star homes would continue to generate more emissions than smaller Energy Star homes, but they would generate less than a simple, linear extrapolation based on floor area would suggest. Such a policy might also encourage greater reliance on solar and other renewable sources.

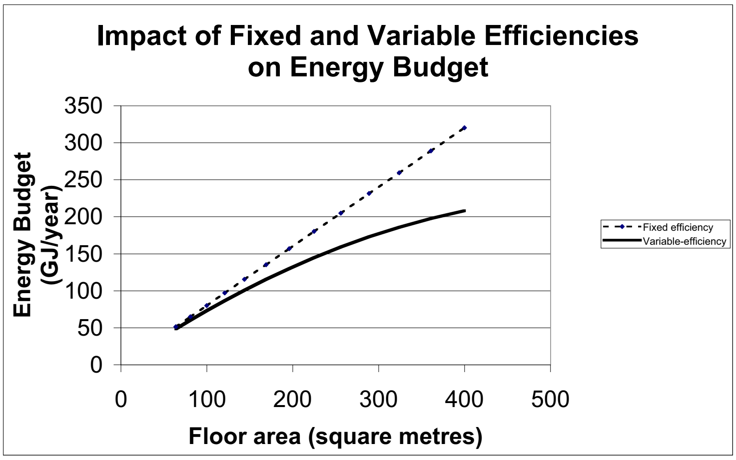

Figure 1. *Impact of fixed and variable efficiency limits on the energy budget for a house. (Values are shown for qualitative purposes only).*

Reconciling Energy Star Programmes for Components and Whole Buildings

Energy Star administers programmes for whole buildings (residential and commercial) and a host of products that operate inside those buildings. To a great extent these programmes operate independently and are not linked (Brown et al., 2002). The existing commercial buildings programme determines eligibility for Energy Star by comparing billed energy use to a large database of energy use statistics for other, similar, buildings. This creates some unusual situations where a building largely equipped with Energy Star products (transformers, office equipment, exit lights, etc.) does not automatically qualify as an Energy Star building. Similarly, a commercial building winning Energy Star accreditation need not have any efficient equipment inside it. In principle, however, an efficient building should include a significant proportion of efficient equipment – HVAC, windows, lighting, etc. – inside it.

New residential buildings qualify by exceeding a certain score in the Home Energy Rating System (HERS). The HERS scoring system covers mostly structural criteria (thickness of insulation, window efficiency, air-tightness, etc.) but also includes the heating and cooling system and domestic water heating.The criteria for an Energy Star home cover less than half of the home's total energy use, with the remainder caused by appliances. The focus on the built-in aspects makes sense because the contractor negotiates for the Energy Star accreditation and cannot be held responsible for the appliances brought in by the occupants. However, the builder often has discretion regarding the number of appliances installed and many important, energy-consuming products reside in the grey area where either contractor or buyer will be responsible. In both cases, an Energy Star house could be easily outfitted with average-efficiency appliances, resulting in a high overall energy use.

The disconnection between Energy Star programmes for individual components and for whole buildings is likely to

2. The sleep mode level is determined by the maximum power rating of the PC's power supply.

grow because new building components continue to be added to the Energy Star portfolio. Recently, for example, rooftop air conditioning units were added to the list of products for commercial buildings and ceiling fans were added for homes.

There is no obviously technical approach to fully reconcile the whole-building and products-based Energy Star programmes but some partial solutions may exist. Prescriptive checklists could be used. A commercial building qualifying for Energy Star on the basis of utility bills might also be required to contain a certain number of Energy Star products from a checklist. Alternatively, a building may qualify as Energy Star if it contains more than a certain number of Energy Star products and a whole-building consumption less than a specified value.

Requiring Products to Meet Several Performance Criteria

It is becoming increasingly difficult to characterise the product's energy performance by testing a single feature. Traditionally, the approach has been to test efficiency while the product is performing the primary service (that is, cooling, dishwashing, washing clothes, etc.). These measurements have become misleading because new products typically have several operating modes. The non-primary modes can be responsible for a large fraction of a product's annual energy use. Extreme cases are video cassette recorders and set-top boxes, where about 75% of annual energy use occurs while the products are in idle or "off" modes (Rosen & Meier, 2000). The standby mode is the most common mode not captured in the performance specification. Energy consumed during standby is usually small—less than 50 kWh/year—but can sometimes account for over half of a product's total energy use. Many—but not all—heat pumps have crankcase heaters (to keep the oil and refrigerant separated). These heaters draw about 50 W (corresponding to 450 kWh/year) but their use is not included in the Energy Star performance specification. Sometimes the tests fail to measure all the energy inputs. This is the case for fuel-fired furnaces, where the efficiency tests measure combustion efficiency but ignore the electricity consumed by fans and controls.

Future Energy Star specifications for products will need to include several criteria if they are to adequately reflect annual energy usage. This multi-criteria approach has already begun with dishwashers (where standby power use was added to the Energy Star performance requirements) and is under consideration for computer displays, CPUs, and other office equipment. Most of these products already have at least three operating modes (standby, sleep and active), all of which are responsible for a significant amount of electricity consumption.

Other kinds of criteria could be added to address the energy and environmental impacts of a product. The efficiency of an air conditioner at peak demand does not directly determine the unit's energy consumption, but it will impact the overall demand for electricity and the type of generating unit used to meet that demand. Thus, the Energy Star specification might include two criteria: overall efficiency during a regular operating cycle and efficiency at peak demand. But other kinds of specifications are possible, such as maximum noise level or resistance to momentary power interruptions. These kinds of specifications also contribute to the idea that an Energy Star product is of higher quality than products lacking the Energy Star label. It is not clear how industry would react to a major broadening of the criteria.

Increasing Difficulty of Defining Products

Most Energy Star programmes are directed towards specific products, that is, refrigerators, televisions, PCs, and roofing materials. This approach has been successful so far but is likely to become more difficult in the future for two reasons. First, product definitions are becoming less distinct. A recent example of this problem is the convergence of televisions and computer displays. Originally televisions were treated as consumer electronics and computer displays as office equipment, resulting in different specifications (standby versus sleep modes). Now the same device can function as either a display or a television, but how should Energy Star treat it? The consumer electronics and office-equipment industries—where products are evolving particularly rapidly—have the most products that are converging, splitting and re-combining, but the trend is observed with more traditional equipment, too.[3] This problem is actually more serious for mandatory efficiency standards because they must address 100% of the product whereas voluntary programmes can exclude "exotic" devices representing small fractions of the sales.

Even after a product has been successfully defined, all parties must agree on an energy test procedure. Establishing internationally recognised test protocols typically requires several years. The task has become more complicated because the products have several operating modes (rather than simply "on" and "off"), each of which needs to be measured separately.

Is Energy Star an International Programme?

Energy Star is a voluntary programme created and run by the United States. The EPA owns the copyright for the Energy Star logo; it develops (with DOE) the technical specifications and runs the web site. Over time, however, the programme has developed international aspects, especially with respect to office equipment. Manufacturers of office equipment typically design their products to meet all international standards (to facilitate international trade), so the Energy Star symbol has gained global recognition and the technical specifications for office equipment have gradually become *de facto* international standards.

Energy Star has established partnerships with several countries (see Table 1), including limited joint control of the office equipment programme with the European Union (Joint Research Center, 2003). At least five countries have established their own Energy Star web sites. See, for exam-

3. Refrigerators/computers, washing machine/dryers, water heaters/de-humidifiers.

ple, the sites for Japan (Energy Conservation Center of Japan, 2003) and Australia (Australian Greenhouse Office, 2003). The partnerships were originally established because the partner countries saw a simple way to create voluntary programmes rapidly by piggybacking. Energy Star has also reached agreements with partner countries as a service to manufacturers. The Energy Star certification would help the manufacturers distinguish themselves while lowering the cost of conducting international business.

Energy Star can function internationally when the same product is sold everywhere and the test procedure is the same. This is the situation for most consumer electronics and office equipment, partly because Energy Star helped develop the test procedures. All the partner countries have adopted the specifications for office equipment and many have adopted the specifications for consumer electronics. However, this approach succeeds only where countries rely on the same energy test procedures. Only Canada and Mexico have adopted Energy Star for white goods (because they use similar test procedures). On the other hand, Australia is not permitted to use the Energy Star logo to promote efficient refrigerators, clothes washers, or air conditioners because these products' energy efficiencies are measured differently in Australia. Australia and other countries may therefore be forced to operate two labelling programmes, which both confuses consumers and raises the administrative costs.

Japan faces a unique problem. Its TopRunner mandatory efficiency programme covers several of the same office products and consumer electronics as Energy Star. (Japan is the only country with efficiency regulations for office equipment and consumer electronics). Today's Energy Star specifications are slightly stricter than the mandatory TopRunner levels, but proposed TopRunner minimum efficiencies may soon become stricter than Energy Star specifications. A voluntary programme makes no sense if its criteria are weaker than the levels required by local regulations. Unless Energy Star can be adjusted to remain significantly more efficient than the minimum levels allowed by the TopRunner regulations, Energy Star will become irrelevant for those affected Japanese products.

At present, Energy Star sees little benefit of expanding its international activities beyond office equipment and consumer electronics, although some products may have sufficient international trade to justify it (notably refrigerators, washing machines, windows, high-albedo building materials, etc.). To do so might require acceptance of new test procedures and new specifications that would probably be unique for each country. How could Energy Star maintain quality control over the logo and the criteria? On the other hand, participating countries might be able to benefit greatly from increased consumer recognition, greater market leverage, and reduced administrative costs.

Internationalisation of Energy Star also poses internal problems. First, Energy Star would need to share control of the programme with other countries. Sharing that control would lead to less flexibility, slower decision-making and decisions that might not benefit U.S. consumers and manufacturers. Energy Star has already sampled those delays working with the European Union on the revisions to specifications for office equipment.

In the future, Energy Star will need to confront the problem of terminating (or greatly revising) product specifications, possibly in tandem with the creation of mandatory efficiency programmes. This kind of action will be much more difficult to co-ordinate if Energy Star is controlled by an international group.

An Exit Strategy

Incremental savings from new specifications for some mature products have stopped increasing and may even be declining in the consumer electronics office equipment segments. At the same time, technical innovations have opened product areas, creating large savings potentials. Energy Star lacks a clear procedure to "declare victory" with respect to a product and to move staff on to other, more fruitful, areas. An Energy Star programme for electric water heaters, for example, probably deserves a much larger investment of staff than cordless telephones because the energy savings potential is so much larger.

There are at least three possible exit strategies. "Total victory" occurs when the market is completely transformed, that is, there exists no significant range in efficiencies, and further efficiency improvements are not cost-effective. In this case, Energy Star could simply close down the programme [4]. Alternatively, Energy Star may discover that further savings are possible by re-orienting the specification to capture additional energy use (and, presumably, savings). Energy Star has adopted this approach for office equipment and consumer electronics by expanding the scope of the specification to include other operating modes.

The third exit strategy is to convert the voluntary programme into a mandatory minimum efficiency regulation. This raises a larger issue of the role of voluntary programmes in energy policy. Is it simply the first step towards regulation or is it a separate tool in the policymaker's toolbox? In many cases, the voluntary programme appears to address energy or environmental problems that cannot be easily solved with a regulation (Müller, 2002; Menanteau, 2003). The conversion of voluntary programmes to mandatory standards could also undermine other Energy Star programmes. Manufacturers may refuse to participate in new Energy Star programmes because they view them as the first step in a sequence of actions eventually leading to a mandatory standards programme.

Nevertheless, there may still be situations where the best strategy is conversion to a regulation. If the Energy Star specification in those cases becomes the minimum efficiency level, manufacturers of Energy Star products should not object because their units already comply. In practice, however, most manufacturers offer products with a range of efficiencies, so some of their products will comply and others will not. There will probably be little support for this strat-

4. This already happened unintentionally when the mandatory efficiency regulations for refrigerators were upgraded. Only a few units were significantly more efficient than the minimum standard, so an Energy Star specification made no sense.

egy. It is also unclear how countries without the mandatory programmes would react to the termination of the voluntary programme.

Conclusions

Energy Star is arguably the most successful voluntary energy efficiency progravmme in the world. The challenge is to sustain the energy savings as the market is gradually transformed by raising specifications in existing programmes and expanding to new products to capture new energy savings potentials. The technical challenges include defining sets of new products, creating test procedures, and selecting the appropriate Energy Star product specifications.

These programmes must also be created, packaged, and marketed in ways that make them attractive to manufacturers, who want the programmes to be simple, with specifications that are easy to meet. Manufacturers will be less eager to participate as the programme requirements become technically more complex and demanding. The extent to which they will participate will depend on the *cachet* of the Energy Star label, that is, the extent to which consumers believe that the recommendation denotes additional value, features, or quality. To remain successful, Energy Star must remain credible to both consumers and manufacturers. This will be difficult to sustain.

These new goals must be attained in spite of limited staff and budget. For this reason, the value of each programme must remain high. This means that programmes with small incremental savings need to be phased out in favour of programmes yielding greater savings per unit of investment. Energy Star needs a procedure to "declare victory" with respect to a product and move on to tackling new challenges. One important aspect of any programme termination will be the uncertain relationship between Energy Star programmes and mandatory efficiency standards.

It is easy to dwell on the present and future uncertainties regarding Energy Star programme. These should not mask the fact that it remains a vibrant programme, still willing to try new ideas and approaches towards voluntary efficiency programmes. It is certainly capable of addressing the challenges described here and help manufacturers and consumers alike to save energy into the foreseeable future.

References

Australian Greenhouse Office. (2003). Energy Star Web Site. Retrieved 19 January 2003 from www.energystar.gov.au/

Brown, R., Webber, C., Koomey, J. (2002). Status and Future Directions of the Energy Star Program. Proc. of 2000 Summer Study on Energy Efficiency in Buildings. Pacific Grove, California. American Council for an Energy Efficient Economy.

Der Blauer Engel. (2003). Der Blauer Engel. Retrieved 17 March 2003 from www.blauer-engel.de/

Energy Conservation Center of Japan. (2003) International Energy Star Program. Retrieved 19 January 2003 from www.eccj.or.jp/ene-star/index_esu.html

Energy Star (United States). (2003) Energy Star Home Page. Retrieved 19 January 2003 from www.energystar.gov

Group for Energy Efficient Appliances. (2003). GEEA Home Page. Retrieved 17 March 2003 from www.efficient-appliances.org/

International Energy Agency (2000). Energy Labels & Standards. International Energy Agency. Paris.

Joint Research Center of the European Commission. (2003) EU Energy Star Programme. Retrieved 19 January 2003 from http://energyefficiency.jrc.cec.eu.int/energystar/

KEMCO. (2003). Home Page of the Korea Energy Management Corporation. Retrieved 19 March 2003 from www.kemco.or.kr.

Meier, A. (2000). "Living in a Carbon-Constrained World". Home Energy Magazine. March/April: page 2.

Meisegeier, D., & Chinery, G. (2000). Best Practice Upgrades for Energy Efficient New Homes. Proc. of 2000 Summer Study on Energy Efficiency in Buildings. Pacific Grove, California. American Council for an Energy Efficient Economy.

Menanteau, P. (2003). "Can negotiated agreements replace energy efficiency standards as an instrument for transforming the electrical appliance market?" Energy Policy 31 (9), pp. 827-835.

Müller, Edda. "Environmental Labelling, Innovation and Environmental Policy Lessons Learned from the German Blue Angel Program". Federation of German Consumer Organisations. August 2002. Berlin.

Rosen, K. & Meier, A. (2000). Energy Use of U.S. Consumer Electronics at the End of the 20th Century. Berkeley, California: Lawrence Berkeley National Laboratory Report No. 46212.

Sanchez, M., Clark, R., Fanara, A., Hershberg, C., Schmeltz, R. (2000). New Product Development: The Pipeline for Future Energy Star Growth. Proc. of 2000 Summer Study on Energy Efficiency in Buildings. Pacific Grove, California. American Council for an Energy Efficient Economy.

Werling, E., Collison, B., Hall, J. (2000). *More Lessons Learned in the Energy Star Homes Program*. Proc. of 2000 Summer Study on Energy Efficiency in Buildings. Pacific Grove, California. American Council for an Energy Efficient Economy.

Acknowledgements

This paper was written after valuable discussions and comments from Richard Brown, Chris Calwell, Andrew Fanara, Craig Hershberg, Richard Karney, Mithra Moezzi, Bruce Nordman, Rachel Schmeltz and Carrie Webber.