Minimizing Investments by Investing in Minimums: Energy Savings Through Appliance Standards

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ABSTRACT

Hundreds of millions of dollars are spent annually across the country on public-purpose energy-efficiency programs. Appliance standards offer two important benefits as an *exit strategy* for these programs: universal and least-cost adoption. The federal appliance standards process addresses only selected product categories and, as a lowest-common-denominator process, often leaves substantial energy savings opportunities on the table from the regional perspective. Unfortunately, federal preemption prevents regional and local attempts to pursue more appropriate or aggressive standards for these covered products. Furthermore, few states besides California have their own appliance standards covering opportunities that are not subject to federal preemption. Yet such state standards offer significant opportunities, especially where supported by interested stakeholders. By providing standards development assistance, stakeholders may support improved appliance standards at both the state and federal levels.

In this paper, we describe both why Pacific Gas and Electric Company (PG&E) elected to provide CASE (Codes & Standards Enhancement) initiative support for the state standards development processes and the general CASE approach in the hopes that these perspectives may be useful to stakeholders interested in developing and or supporting state standards elsewhere. Furthermore, we provide specific CASE examples including Exit Signs, Dry Type Low Voltage Transformers, Commercial Clothes Washers, and others both as examples and as appropriate products for other state proceedings.

Introduction

Hundreds of millions of dollars are spent annually across the country on public-purpose energy-efficiency programs. Informational, educational, and resource acquisition (rebate) programs tend to influence those that are innovators or early adopters, leaving the majority of the market only marginally or not at all affected. Often little consideration is given to how the improvements influenced by these programs will be institutionalized, or how the market will eventually be transformed permanently within reasonable cost constraints. Appliance standards provide a logical *exit strategy* for many of these programs, by advancing these measures into universal practice once they become moderately well accepted.

By setting mandatory minimums, appliance standards equally influence all market segments thereby causing rapid and universal adoption. Establishing permanent appliance standards costs far less; about one-twentieth as much as indefinitely operating voluntary energy-efficiency programs (Stone et al. 2002). Not only do appliance standards generally cost far less to implement than rebate programs from a programmatic perspective, they also drive down the cost of high efficiency products to consumers. As premium energy efficiency features are converted to required minimum features, competition drives them from premium to commodity (lowest) pricing, as demonstrated by the history of refrigerator and central air conditioning efficiency standards (Geller & Goldstein 1998). Through the timely (as soon as practicable) adoption in appliance standards, efficiency benefits established by voluntary programs are locked-in permanently, freeing up the limited public goods program dollars to begin transforming the next set of products that require intervention to improve their efficiency.

Strategic support of appliance standards offers a significant opportunity to accelerate the adoption rate of appliance efficiency features and to leverage expenditures on voluntary energy efficiency programs. Below, we first identify the opportunities that compelled Pacific Gas and Electric Company (PG&E) to invest in appliance standards development. We then describe the approach to supporting the process through Codes and Standards Enhancement (CASE) efforts. Finally, we provide a summary of recent and current PG&E-sponsored CASE initiatives provided in the improvement of California appliance standards. These perspectives and examples are provided in the hopes that they may facilitate the development of state—and also federal—appliance standards initiatives in other regions.

Appliance Standards Support Opportunities

Faced two decades ago with the growing energy-efficiency standards movement in California, Florida, New York and a few other states, national appliance manufacturers opted to support establishment of national standards rather than disparate state standards. This made sense since manufacturers make product for a national market. Uniformity is important in keeping costs of production down. As part of the national appliance standards framework, state and local governments are prevented from establishing local standards that exceed the stringency of federal standards for products covered by the federal process. State and local governments may seek a waiver from this preemption, but this has never been done, is believed to be a long and difficult process, and surely would be resisted by manufacturers.

To date, federal appliance standards have delivered substantial savings estimated to amount to 1.2 quadrillion BTUs saved annually in the year 2000 (ASAP 2000). These savings impacts are impressive and will continue to increase. Unfortunately, bureaucratic and political barriers have delayed individual appliance rules and their subsequent savings by many years. Furthermore, the levels at which these standards have been established and the product categories not covered by these standards leave many untapped opportunities for savings through standards at the state and local levels. In manufacturing products for a national market, regional or local needs may be bypassed. Similarly, federal standards for many products tend to fall short of their optimal economic levels in a given region due to the unique aspects of that region relative to the national average conditions.

For example, peak electric load has been a critical problem in California. Air conditioning equipment could be required to have good full load performance in hot dry climates such as the Central Valley, or high deserts in Southern California. The national appliance standards were developed in response to the national market, however, dictating, for example, that HVAC products are optimized for least-cost and maximum performance in the moderately hot, highly humid climates of the southern and eastern portions of the country. Manufacturers are fundamentally opposed to requiring efficiency improvements that are not national in nature and fully consistent with the presently accepted methods. Thus, federal appliance efficiency standards tend to be absolute minimums. Since they must be cost-effective, they tend to be defined by the economics in regions and market segments least benefited by the proposed standards as evidenced by the recent central air conditioning standard revisions. For climate-sensitive HVAC equipment, there is a strong justification for either regional federal standards or easing the criteria for a waiver from federal preemption so that states could adopt region-specific standards. California with its electricity crisis wanted and needed better air conditioner efficiency standards.

State appliance standards are attractive opportunities for pursuing efficiency savings from products not covered by the federal appliance standards and thus not restricted by federal preemption. State standards are better able to optimize the standards levels to local factors, such as climate and utility rates. There is a synergistic effect between the state and federal standards processes, with each supporting progress in the other arena through precedents and data collection. For example, federal residential clothes washer rules facilitated development of the recent California commercial washer rule. Likewise, local standards activity can drive development of federal standards, as happened in the 1980s with refrigerator standards, and as is happening now with air conditioning efficiency. In California alone, the stakes are high. Stone points out that the impact of the recent Title 20 rulemaking amounts to several thousands of giga-watt hours (Stone et al. 2002).

Both the federal and California appliance standard rulemaking processes are designed around rational and objective technical, cost, and market considerations. Where individual standards are to be developed, significant amounts of data and market research must support proposed standards in order for them to be seriously considered by the rulemaking bodies. Historically, much of the data utilized in the assessment of standards levels has been provided by manufacturer-related stakeholders, who tend to resist new standards individually and through associations. Additional product, economic and market data provided by stakeholders other than manufacturers can improve the quality of the analysis of standards levels and the discussions among stakeholders, as well as help to balance potential biases inherent in manufacturer data and perspectives. This opportunity to improve the standards development process exists at both the federal and state levels, but is especially compelling at the state level where local stakeholders are better positioned to provide locally relevant technical, market, and economic data.

In 1997, PG&E, as part of its portfolio of public interest energy efficiency programs, proposed an Energy Standards program to the California Public Utilities Commission. Prior program efforts had worked to increase the availability of high-efficiency measures in the market, reduce incremental cost, and influence greater utilization of measures, but the process of translating program accomplishments into permanent standards was more reactive than strategic. It seemed that large opportunities were being missed. The Energy Standards program proposed an integrated, focused effort of working with the California Energy Commission (CEC) to prepare the technical arguments for improvements through CASE studies, build support and agreement among key constituencies, and advocate for adoption. PG&E enlisted the support of teams of internal staff and various consultants to research and prepare CASE studies and participate in the CEC public processes. Over the past 5 years, the program has grown to include several dedicated standards projects: appliances, residential buildings, commercial buildings, support for the presently developing outdoor lighting standard, and time dependent valuation (TDV). TDV is an effort to change the economic baseline of the standards from a flat valuation of energy to one that is time and seasonally differentiated in relation to forecast generation, transmission, and distribution costs (Mahone et al. 2002).

Strategic intervention by interested stakeholders, such as PG&E in the standards process, can markedly increase the amount of energy savings acquired through the standards process (Stone et al. 2002). Where assignment of credit for such intervention is important to stakeholders, Stone provides a workable methodology for attributing credit for these enhanced savings impacts. For example, in the recently completed proceeding on California Appliance Standards, Title 20,[1] PG&E proposed, argued for, and succeeded in achieving improvements in air conditioners, water heaters, high efficiency exit signs, incandescent torchiere lamps, LED traffic signal lamps, dry type transformers, commercial clothes washers, vending machines, and commercial refrigerators and freezers. By the evaluation methodology noted above, which was very conservative, PG&E was considered responsible for influencing 10 year savings of: 1920 GWh, 365 MW, and 126 million therms.

Clearly, the federal and state appliance standards processes provide very large and cost-effective savings that benefit society. The CASE initiative methodology provides a significant opportunity to further leverage these proceedings to acquire greater savings, earlier than would otherwise be possible. PG&E's CASE initiative budget is small, $750,000 annually, compared to other energy-efficiency program investments. Yet, this expenditure represented a large, cost-effective savings potential. Policy makers should assure that public purpose energy-efficiency funds and advocacy continue to be available for energy code enhancement, either through utility, non-profit, or third party implementers. Without such public funding and advocacy, excellent improvement opportunities will go un-addressed or be under-represented relative to their potential.

The CASE Process Overview

In this section, we provide an overview of the CASE approach used by IOUs in California in the most recent California Title 20 process. While some of the particulars would change when applied in the context of other states' proceedings, the basic approach should still be appropriate. To improve appliance efficiency standards, one has to identify good candidate opportunities, make the CASE or technical argument that the improvement is in the public's best interest, and meet with key stakeholders to convince them that the improvement is merited and feasible. This process generally requires a lot of time - months to more than a year of intermittent work on a given rulemaking process. More specifically, the CASE efforts must:

- Specify the opportunity being advocated.
- Quantify the per unit energy savings and demand reduction to be achieved.

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[1] This proceeding was concluded with adoption of the revised standards on February 6, 2002. Most of the standards will take effect February 6, 2003, and some are staged in at later dates.

- Research the market to:
  - Determine the market size and the market share of the efficiency improvement opportunity under consideration.
  - Extrapolate the energy-efficiency benefits and quantify the incremental costs—regulators and stakeholders must be confident about future widespread availability at modest cost.
- Demonstrate that the proposed improvement is cost-effective by any reasonable measure.
- Take into consideration the impacts on key stakeholders and attempt to minimize any negative impacts on their businesses.
- Following development and submittal of CASE study reports to the CEC, the provider must support that information in the public debate process and respond to CASE report criticisms or integrate new information provided by other stakeholders.

Generally, the effort required for a CASE initiative varies in response to stakeholder positions, existing market penetration of products meeting proposed standards levels, and the amount of technical and market data freely available for the product in question. A quick assessment of the industry structure (for example, lots of small non-organized manufacturers versus a highly consolidated manufacturer group), its position on regulation, and the product category's market penetration provide a sense of the work required.

PG&E's effort consisted of two or three full time staff managers, and four major contracts with consultants to prepare the detailed studies and conduct consensus building. It was well received by the California Energy Commission and extraordinarily successful. Although there was some compromise, all the measures PG&E advocated in the first go-around were eventually adopted, despite some industry opposition.

Key Stakeholders

Ultimately, the adoption of standards by a regulatory authority such as the CEC is a political process. No matter how strong the technical argument for adoption, how great the energy savings or demand reduction, or how cost-effective the measure, a determined and politically well-connected dissenter can often raise objections sufficient to delay, if not totally derail a proposed improvement. The ultimate decisionmakers seem most persuaded by consensus among the parties to the proceeding, or at least an outcome with which everyone can live. Despite the political overtones, well-researched CASE reports are a powerful lever in working with stakeholders and regulators in the standards development discussions, because they interject a body of well-researched facts into the deliberations.

Ironically, consumers who stand to benefit the most are often less directly and less proportionately represented in standards setting proceedings, though in California the CEC staff is presumed to represent the people's interests. Manufacturers, trade associations, wholesalers, contractors, and retailers are well represented by their attorneys and regulatory liaisons. In the 2002 California proceedings, well-represented industry entities included Carrier and Trane (major manufacturers of heating, ventilating, and air conditioning equipment), Alliance Laundry Systems (manufacturer of Speed Queen products), Air-conditioning and Refrigeration Institute (ARI), Gas Appliance Manufacturers Association (GAMA), Association of Home Appliance Manufacturers (AHAM), Coin Laundry

Association (trade association of laundromat operators), and the National Electrical Equipment Manufacturer's Association (NEMA). It should be pointed out that in some cases manufacturers who are ahead of the pack in developing more efficient products, or who otherwise see economic opportunities, may break from industry consensus and support more aggressive standards.

The stakeholder groups also included the larger utilities in addition to PG&E, energy efficiency advocates including Natural Resource Defense Council (NRDC), the American Council for an Energy Efficient Economy (ACEEE), the Appliance Standards Awareness Project (ASAP), the Alliance to Save Energy, national laboratories, and water utilities and agencies when water issues are involved. When these types of organizations participate, it is typically to support more aggressive standards, though that is not always the case. Lastly, often mediating from closer to the center but committed to improving standards, CEC staff actively solicits participation in the proceedings and seek to gather technical and market data from stakeholders to support standards development and to assess claims that are not robustly substantiated.

Manufacturers and other industry representatives usually (but not always) take a conservative view of standards. While the interests of industry organizations may align with those of consumers, they frequently do not when it comes to energy efficiency. For example, industry stakeholders tend to oppose improvements in energy efficiency standards that convert premium features to standard features, which drops the premium profit margin that had been associated with that feature. Manufacturers also generally oppose regulations that force costly changes in production processes before they have completely amortized their investments in the existing production facilities.

Industry is leery of proposed standards that drive up the base price tag of the appliance even though the life-cycle-cost is reduced. They fear higher average prices will reduce sales due to the elasticity of market demand. Instead, manufacturers prefer low cost product features that add to perceived customer value. For example, given a choice of including an expensive, more efficient compressor for which consumers will pay little more, or no added cost almond colored paint, for which consumers will pay $20 to $40, manufacturers clearly and rationally choose the investment in non-energy-efficiency features of a refrigerator.

Readiness for Adoption

Measures vary in their likelihood of adoption as a function of their readiness. In selecting products for CASE initiatives it is important to ascertain if the product is "ready" for standards adoption. Some products are slow to be ready. When assessing readiness, the key question is whether a measure is at a point in its development where standards bodies can be confident that the proposed measure can be fully deployed in three to five years. A product's development history and current manufacturing and market trends are generally used to justify standards feasibility.

For example, electronic ballasts have taken 20 years to transition from an emerging technology to a standard in the building industry. Even so, they still are not commonly used in some applications such as under cabinet task lighting in modular furniture. This task lighting measure is ready now for adoption. An appliance standard might be implemented that would require commercial under cabinet task lighting to have a minimum lamp-ballast system efficacy better than or equal to, say, 70 lumens per watt. This would effectively mandate the use of T8 or T5 lamps and electronic ballasts, which are already featured in many premium products. It would effectively eliminate the use of T12 lamps and magnetic ballasts, which are found only in the least efficient products now on the market. Those products containing Light Emitting Diodes (LED's), such as exit signs and traffic signals, represent a more rapidly deployed technology and were included in California's appliance efficiency standards in February 2002, after only ten years of diffusion into the market place and a 50 percent to 80 percent market share.

Perhaps the most extreme example of short maturation cycle is of a NEMA Type 1, dry type, low voltage transformers used to convert large building distribution voltage (typically 277/480) to 120 volts for plug loads. While readily available, this efficiency improvement opportunity will go from less than five percent market share to a statewide requirement in California starting in February of 2003. NEMA supported this improvement, and no one opposed it, during the most recent appliance standards improvement process (September 2000 – February 2002).

Key criteria for determining the preparedness of a product category for standards development include:

- Product already in the market and being sold
- Product performing well
- Considerable energy savings
- Cost-effective on a life-cycle basis
- Consensus test method available to measure the energy consumption
- Credible data on energy savings and incremental cost
- A champion or two to advocate for the standard (ideally).

While not as universally effective as appliance standards, state procurement guidelines or standards, such as those currently being developed by the state of New York, can be very influential in bringing about highly cost-effective, improved efficiency. Where state standards are not an option either generally or for a specific measure, state procurement standards and guideline opportunities should be considered. CASE studies can be influential in justifying the inclusion of high efficiency measures in these procurement guidelines or standards. Procurement standards or guidelines can then supplement resource acquisition programs and act as a stepping-stone for reducing the necessary resource acquisition incentive costs, increasing the market acceptance of a measure, and easing its adoption in more universally applicable appliance standards where they exist.

Measurement & Evaluation

Pacific Gas and Electric Company was interested in measuring and evaluating the effectiveness of its efforts to improve appliance standards. To accomplish this, it estimated its influence or involvement in several participation opportunities related to each measure that it advocated. These participation opportunities were as follows:

- Developed testing or measurement standards
- Funded research into testing and measurement
- Worked with the organization that developed test standard

- Made original suggestion for standard
- Conducted technical evaluation
- Prepared case study
- Supported market transformation or resource acquisition program
- Hosted meetings or conference calls of key stakeholders
- Drafted code language
- Appeared at public workshops in hearings in support of improvements.

Participation or involvement in each of these participation opportunities was rated as yes, no, or "contributed." "Contributed" falls somewhere between "yes" and "no." Where involvement was high across a large number of participation opportunities, PG&E claimed substantial credit for influencing the improvement and related energy savings and demand reduction for a period of two code improvement revision cycles (typically 6 years). Conversely, where participation was lower across fewer opportunities, the credit claimed was lower. This is the subject of a related paper in this conference (Stone et al. 2002).

In the recently completed proceeding on California Appliance Standards, Title 20,[2] PG&E proposed, argued for, and succeeded in achieving improvements in air conditioners, water heaters, high efficiency exit signs, incandescent torchiere lamps, LED traffic signal lamps, dry type transformers, commercial clothes washers, vending machines, and commercial refrigerators and freezers.

By the evaluation methodology noted above, which was very conservative, PG&E was considered responsible for influencing:

- 1st year savings of: 596 GWh, 16 MW, and no therms
- 10 year savings of: 1920 GWh, 365 MW, and 126 million therms

These savings, attributable to PG&E's efforts, are approximately 1/3 of the total improvement for this revision cycle, benefiting PG&E and California's public for decades to come. The CEC has formally recognized and the state's investor owned utilities for their advocacy and contribution.

Sample CASE Study Summaries

As noted above, since 1997, PG&E commissioned a number of research reports known as CASE studies that present research, analysis and support for establishing new or upgraded standards for products or practices into existing energy codes. Table 1 summarizes the California savings potential of 26 such products. PG&E has already completed CASE studies for the first group of products, is currently completing CASE studies for the products in the second group, and is considering products in the third group for future CASE studies.

CASE studies typically include discussions of the following issues:

- Technology description
- Current practice
- Economics
- Key stakeholders
- Implementation options and recommendations for inclusion into codes.

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[2] This proceeding was concluded with adoption of the revised standards on February 6, 2002. Most of the standards will take effect February 6, 2003, and some are staged in at later dates.

Table 1. Summary of CASE Studies for California

Appliance/Product	Product Life (years)	Stock (x 10^6)	Unit Energy Consumption (kWh/yr)	Annual Energy Savings (kWh/yr)	Potential Energy Savings (GWh/yr)	Incremental Cost ($)	Net Present Value ($)
CASE Studies For Recent Codes							
Commercial Clothes Washers	8	0.4	883/219	412/70	159/27	$300	$110
Efficient Exit Signs	10	1.6	350	315	504	$20	$203
Dry Type Transformers	30	0.3	-	2,552	757	$506	$3,549
LED Traffic Signals	7	4.0	330	300	1,200	$145	$13
CASE Studies For Proposed Codes							
Swimming pool pumps and motors	10	1.9	2,622	1,311	2,491	$157	$1,064
Res. portable spas and hot tubs	10	0.7	3,000	1,140	798	$750	$311
Low-voltage wall transformers	7	99	18	9	1,407	$1.40	$5
Residential furnace fans	17	6.6	990	149	980	$15	$174
Elevator fans and lighting	20	0.08	1,927	1,792	143	$200	$1,560
Consumer electronics standby losses	8	43.6	111	21	920	$5	$11
Portable room air cleaners	8.5	2.7	670	160	432	$0	$124
Gas oven glow bars	19	6.1	48	32	196	$5	$36
Vending machines	10	0.3	4,015	1,405	386	$290	$1,044
Water dispensers	15	2.4	840	252	612	$6	$323
Small residential ventilating fans	12	8.8	27	15	131	$10	$6
Residential ceiling fans	13	8.2	49	10	80	$15	-$4
Potential CASE Study Opportunities							
Water beds	10	0.4	1,070	407	163	$200	$179
Commercial ice making machines	12	0.11	6,500	1,170	129	$100	$864
Whole house fans	12	0.9	193	35	31	$0	$37
Evaporative coolers	10	1.1	580	64	70	$50	$9
Emergency egress lighting	10	0.5	88	79	39	$10	$46
Task lighting	25	1.7	66	23	39	$20	$3
Electronically ballasted HID streetlights	20	0.79	350	35	28	$30	$4
Residential recessed can fixtures	10	24	82	60	1,437	$40	$16
Air conditioner crank case heaters	13	4.8	263	131	631	$5	$136
Residential exterior lighting fixtures	10	2.3	219	164	378	$20	$133

Commercial clothes washer energy numbers are for both kWh and therms and include both electric and gas water heating and drying savings. Product Life, Unit Energy Consumption, and Annual Energy Savings are for average use. Potential Energy Savings is the technical potential savings over the life of the product using simplified assumptions, such as no growth. Incremental Cost is the difference in cost to the consumer in current dollars. Net Present Value is calculated using the CEC average statewide present value of gas and electricity savings (Martin & Holland 2001). Caution should be used when extrapolating to other parts of the country: hours, energy consumption, and utility rates vary regionally and can greatly impact the present value estimates.

The technology summaries that follow have been distilled from individual CASE studies developed by PG&E for each of these products. These are included in order to provide the reader with a sense of what is involved for each product. The reader should note that each product category is clearly different, having different economic payback periods, barriers, opponents, test method challenges, etc.

The first three summaries were completed prior to the 2002 round of California Title 20 proceedings. They each contributed to the adoption of new codes for those products. The second three summaries were completed in 2002 and will be used in the 2005 standards review beginning sometime in 2003.

Exit Signs

Product description. Law requires exit signs in virtually all non-residential buildings. The method used to illuminate the lettering and background of an exit sign determines its format: matrix, panel, stencil or edge-lit. Exit signs with incandescent, compact fluorescent, and LED light sources are all in use. In special circumstances, photo-, electro- or radio-luminescent technologies are used. Exit signs are lit continuously. Both illumination level and readability of the sign are crucial from a fire safety perspective.

Current practices. The vast majority of exit signs currently in use, however, are lighted by incandescent lamps, which need replacing at least twice per year. These present high energy and maintenance costs. Exit signs using incandescent lamps consume approximately 24 to 40 watts per sign, or up to 350 kWh of electricity per year (PG&E 2000A). With respect to the estimated 160,000 annual exit sign sales, the most common practice in the state before 1995 was to install exit signs illuminated with a 13-watt fluorescent lamp, although some installations of exit signs were still illuminated with incandescent lamps. Over the next five years, current practice had been migrating to LED technology. The first cost of LED exit signs has fallen so dramatically since 1998 that they are nearly directly competitive with incandescent exit signs on a first cost basis; they already have a lower first cost than CFL exit signs. LED exit signs require five to eight watts. Compared to an exit sign illuminated with a 13-watt fluorescent source, the LED's energy savings potential is 7 to 10 watts. Newer cold cathode T1 fluorescent exit signs also only use about five watts, but so far have a significantly higher first cost. There are at least 28 U.S. manufacturers of LED exit signs that meet the U.S. EPA/DOE ENERGY STAR specifications.

Regardless of the energy savings, if an exit sign does not meet the critical need for which it is intended, the energy savings mean nothing. The minimum visibility criteria for signs are established through the state's adoption of the National Electrical Code and reference to NFPA 101. Both ENERGY STAR requirements and the new California appliance standards extend those visibility criteria even further.

Standards opportunity. Given the market penetration of efficient exit signs in California, a good standard was ready for adoption. A PG&E survey indicated that by the year 2000, 78 percent of exits signs sold were LED. An appliance standard requiring the efficiency level of LED signs would therefore only affect the remaining 22 percent of sales. PG&E recommended that the CEC should base their standard on the LED performance level and the higher level of visual performance that was adopted for the U.S. EPA/DOE ENERGY STAR Exit Sign program. The CEC adopted this standard in February 2002. It is expected to provide an annual savings of 5.04 GWh, the first year and about 28 GWh/year by the fifth year (plus about 575kW of peak reduction the first year increasing to about 3200kW by the fifth year).

Commercial Clothes Washer Standard

Product description. In most respects commercial washers are quite similar to household washers. Commercial washers include soft mounted, top loading washers of less than 4.0 cubic foot capacity and front loading washers of less than 3.5 cubic foot capacity that are designed for use in applications such as coin laundromats and apartment common area laundries where more than one household will do their wash, or where businesses wash moderate amounts of laundry on premises. Commercial washers may or may not have vending equipment affixed.

Current practice. There are an estimated 386,000 commercial washers in service in the State of California (PG&E 2001). On average, these units annually consume approximately 883 kWh and 219 therms --and over 54,000 gallons of water. Typically, one commercial washer is provided for each twelve living units in multifamily situations where three quarters of the commercial washers are found. Coin laundromats and businesses have the remaining units. Of those units in multifamily housing, approximately 60% are actually owned and maintained by "route operators," businesses that provide and service the equipment for property owners/managers in exchange for a share of the vending revenues. Less than five percent are high efficiency (based on front-loading type) models.

Maytag and Alliance Laundry Systems (Speedqueen) together dominate the market. The other major players are General Electric, Whirlpool, and Wascomat. Route operators and coin laundromats are key stakeholders as well. The ENERGY STAR program has recently established a labeling program for commercial washers. The Consortium for Energy Efficiency has had an efficient commercial washer initiative for several years. Both programs essentially duplicate the residential program specifications. In California, water agencies have begun actively promoting high efficiency commercial washers with rebates. There has been limited support from utilities for this effort.

Standards opportunity. Commercial washers handle 20 to 25 percent of all laundry, and therefore represent a large savings opportunity. Due to the prevalence of route operators who own the washers but do not pay the utility bills, a significant split incentive has plagued the commercial laundry industry. Additionally, the interests of the water industry were not fully addressed by the federal residential standard adopted in 2001. These two concerns supported a near term adoption of a standard, despite the relatively low market share of the high efficiency technology. To accommodate the commercial washer industry, a state commercial washer standard that is consistent with recent federal residential washer standards--a modified energy factor of 1.26 cubic feet per kWh compared to a baseline of 0.87--was recommended. In addition, however, a water factor of 9.5 gallons per cubic foot (compared to a baseline of 13) was also proposed by PG&E and other parties including the CEC.

Ultimately, the CEC adopted both the proposed energy and water factors, though the implementation was phased in between 2005 and 2007 rather than in 2003. Statewide, the impact of the new standard is estimated to be 159 GWh, annually.

The inclusion of the water factor was important because embedded energy from pumping additional water is reduced. The water savings statewide once all machines changed over is quite large at 7.5 billion gallons per year. The precedent set in this rule making may facilitate inclusion of water factor requirement in subsequent rulemakings for residential washers.

Dry-Type Transformers

Product description. Transformers are used in utility, commercial and industrial facilities to step down voltages from the distribution system to levels that are appropriate for heavy machinery, lighting, plug loads, and all other end uses. Medium-voltage units reduce distribution voltages (2.4 kV to 35 kV) to building power (typically 480 V); low-voltage units take building power and reduce it to 208/110 V. Medium-voltage transformers are either dry-type or liquid immersed, while low-voltage units are almost exclusively dry-type transformers. Dry-type transformers, however, tend to be less efficient than liquid immersed models. The total transformer efficiency losses are a combination of the load and no-load losses; the load profile dictates which loss is greater. Transformers have an expected life of approximately 30 years (PG&E 2000B). Because commercial and industrial users install dry-type transformers almost exclusively, only dry-type transformers were addressed.[3]

Current practice. Most large commercial and industrial facilities use one or more dry-type low-voltage distribution transformers to reduce the building voltage (typically 480 V) to levels appropriate for plug, lighting and equipment loads. Nationally, low-voltage dry-type unit sales outnumbered medium-voltage units seven to one--about 233,000 low voltage units were sold in 1995. The efficiency of medium- and low-voltage equipment has improved little, if any, in the last 30 years.

Buyers of dry-type transformers rarely purchase based on efficiency. Efficiencies of 95 percent and higher are typical; there may only be a one to two percent difference between high- and low-efficiency units. There is a significant first-cost premium for the more efficient units. In response to regulatory interest in the early 90's, the National Electrical Manufacturers Association (NEMA) approved NEMA Standard TP 1-1996 "Guide for Developing Energy Efficiencies for Distribution Transformers. NEMA's TP 1 standard has broad acceptance among transformer manufacturers, and has already been adopted by the Consortium for Energy Efficiency and the U.S. EPA's ENERGY STAR Transformers program. About 20 manufacturers produce the majority of dry-type transformers. Three manufacturers account for 65–80 percent of the market: Square D, GE and Cutler-Hammer.

Standards opportunity. The NEMA Standard TP 1-1996 provides a good standard for the energy efficiency performance of certain single-phase and three-phase dry-type and liquid-filled distribution transformers. Over 80% of medium dry-type transformers currently meet

[3] Liquid immersed type transformers are typically only used by utilities.

or exceed Standard TP 1, while less than one percent of low-voltage dry-type units comply, though compliant models are readily available. Because most transformers are energized 24 hours per day year round, these small improvements will yield significant energy and dollar savings. The impact of the standard proposed by PG&E and adopted by the CEC is expected to be 757 GWh annually.

Portable Room Air Cleaners

Product description. Portable room air cleaners include plug-in, portable air cleaners, ranging in size from desktop models to portable air cleaners that are advertised as whole house models. They range in capacity from 50 to 1200+ square feet, with 200 to 450 square feet being the most common capacity range. (PG&E 2002A) Central HVAC in-line air cleaning devices are not included. Portable air cleaners consist of a cabinet, sometimes with wheels, that contains a high efficiency air filter, a fan and motor, which draws air through the filter, and controls to regulate the fan speed. Air cleaner capacity is defined by the floor area the unit is designed to adequately clean.

Current practice. There are an estimated 2.7 million air cleaners in California buildings. Additionally, an estimated 250,000 room air cleaners are sold annually into the California market. They have an estimated life of 8.5 years. Models currently available for sale have a rated power draw ranging from 34 to 350 watts with an estimated average of just over 100 watts. Usage patterns are the largest determinant of energy consumption, but little data on usage patterns is currently available. It is widely assumed that half of units are operated 24 hours a day year round while the other half are used only six months per year for 24 hours a day. Estimated annual usage is therefore assumed to be 670 kWh per unit.

The Association of Home Appliance Manufacturers represents manufacturers of room air cleaners and has established an air cleaning performance-rating system known as CADR. The EPA has recently begun investigating a possible labeling program.

Standards opportunity. There is little correlation between energy use and capacity. Additionally, there does not appear to be a discernable correlation between normalized power draw (power/capacity) and cost. The standard setting opportunity that may make most sense is one that would begin by removing the least efficient products. Standards may best be established in terms of normalized power (power/capacity) with a minimum air cleaning efficiency (CADR). Eliminating the least efficient 20 percent would provide a savings of approximately 160 kWh per unit per year or an annual statewide peak reduction of 65 MW and savings of 430 GWh when all units are replaced.

Consumer Electronics Power Supplies and Standby Power Use

Product description. Standby energy use is usually defined as power used while the product is performing no function. The largest contributors to this end-use category are consumer video products such as TVs, VCRs, DVDs, set-top boxes (STBs), which include cable boxes, satellite receivers, personal video recorders (PVRs), audio products including compact and portable stereos, and telephony products which include cordless phones, answering machines, and fax machines.

Current practices. There are over 100 million consumer electronic products in California that together use more than 15 billion kWh per year, 40% of which is standby energy use (PG&E 2001C). Many of these products use low-voltage wall transformers to supply low voltage DC power. These linear power supplies, in addition to having standby losses of up to two Watts, have conversion efficiencies of as low as 20 percent. Low-voltage wall transformers are used so extensively because they are cheap, eliminate power supply design time, provide a UL rating, and provide safety by eliminating high voltages from the product.

Some consumer products have exhibited enormous growth rates, such as DVDs, which have gone from zero to over eight million units nationally in two years. The change to digital TV in 2006 will provide the impetus for large growth rates in products such as digital TV converters and digital cable boxes.

Although consumer electronics manufacture is dominated by a few large multi-national corporations, the linear power supplies used by them are a commodity item, with the vast majority produced overseas by a diverse group of manufacturers.

Standards opportunity. Because low-voltage transformers are often an OEM product and offer small energy savings per device there is little incentive for manufacturers to use efficient products, unless driven by issues such as weight or size. Two standards are being considered for the consumer electronics category: 1) maximum standby power use within each category of product, and 2) minimum conversion efficiencies and maximum standby power for low-voltage wall transformers. Mandating a maximum of 1 Watt in standby mode and 80% conversion efficiency would provide a savings of approximately 3-20 kWh per unit per year or an annual statewide savings of 2,400 GWh when all units are replaced.

Water Dispensers

Product description. Water dispensers are categorized as three types: (1) bottled water dispensers, (2) point-of-use (POU) or tap water dispensers, and (3) pressurized water dispensers. Both bottled water dispensers and POU dispensers are freestanding appliances that dispense cold and sometimes hot water. The bottled water and POU types can be considered functionally identical for purposes of energy use analysis. The more important distinction is between those that provide only cold water and those that provide both hot and cold water.

Current practices. Over one hundred thousand water dispensers are sold each year in California with approximately half being cold bottled, and the rest split between hot/cold and pressurized. Water dispenser energy consumption has two components: the useful energy to heat or cool the water and the standby losses that occur when the device is not in use. For cold only units these two components are both about 0.18 kWh/day per unit. However, the hot and cold units have standby losses of over 1.9 kWh/day each due mostly to heat exchange between the hot and cold reservoirs (PG&E 2002B).

The water dispenser market is competitive but dominated by three suppliers. These are Elkay, Oasis, and Sunroc. All three are privately held companies. Bottled and POU dispensers are often leased to consumers by bottled water distributors, but pressurized water dispensers are specified during building construction and are permanently installed.

Standards opportunity. The simplest and most straightforward standard to implement is one that just addresses standby energy use. The first step towards this has been accomplished at the national level with the EPA ENERGY STAR program for water dispensers. One manufacturer, Addico, has qualified a line of hot and cold dispensers. In fact, the qualifying product uses far less standby energy than the standard allows (0.7 vs. 1.2 kWh/day respectively). A California standard of 0.16 kWh/day for cold only and 1.2 kWh/day for hot and cold units would result in an annual statewide savings of 600 GWh when all units are replaced.

Conclusions

As is clear from Table 1 and other analyses referenced above, the energy efficiency opportunities through appliance standards are large. Such standards offer an excellent exit strategy and complement to voluntary energy-efficiency programs. Yet, state appliance or procurement standards are an underutilized strategy for addressing local efficiency opportunities and filling gaps in federal standards. Relative to the cost of voluntary energy efficiency programs, stakeholder support of more aggressive state standards is quite inexpensive on a nominal and per unit of savings basis. CASE initiatives offer a way for stakeholders such as PG&E to greatly leverage the state and federal appliance standards process to acquire and lock in greater efficiencies. As experienced in California, state standards processes may have spillover effects in the national appliance standards arena, which further increases cost-efficiencies. Based on the California experience, there are numerous remaining savings opportunities as evidenced by our table and example CASE analyses. Given the magnitude of savings attributed to PG&E's Energy Codes and Standards program and the low cost, more utilities and other pro-standards stakeholders around the country should be considering CASE type strategies.

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