Consensus Efficiency Standards for Refrigerators and Freezers—Providing Engineering/Economic Analyses to Aid the Process

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The proposed 1998 refrigerator/freezer energy efficiency standards updates are unique in that they were arrived at by a consensus between the refrigerator manufacturers and representatives from various environmental groups, state energy offices, and utilities. A de facto moratorium on any new appliance energy efficiency standards will likely delay any final standard to a later date than 1998. A two year process was required to come to this agreement. Before standards were discussed, industry and the U.S. DOE spent many months reviewing and revising a refrigerator simulation program, gathering technical and economic data, and drafting and critiquing engineering analyses. The process involved close participation among the various parties to the agreement and by the DOE and its contractors. The latter parties provided technical and economic analyses which provided the basis for the standards discussions.

This paper discusses the two year long review process which narrowed the uncertainties inherent in any analysis of such complexity. Some sample results are also presented.

INTRODUCTION

The National Appliance Energy Conservation Act (NAECA) of 1987 established energy efficiency standards for refrigerators and freezers and other residential appliances (NAECA, 1987). The first standards for refrigerators and freezers took effect in 1990. In addition to establishing initial standards, the Act required the Department of Energy (DOE) to consider new or amended standards for all of these appliances. The DOE revised the 1990 refrigerator and freezer standards in 1989 and these updated standards took effect in 1993 (Federal Register, 1989). Table 1 shows both the 1990 and 1993 maximum allowable energy use in kWh per year for each product class regulated. Allowable energy use is a linear function of adjusted volume (AV). The revised 1993 standards require about a 25% reduction in maximum energy use relative to the 1990 standards for most refrigerator-freezer product classes.

The proposed 1998 refrigerator/freezer energy efficiency standards updates are unique in that they are the first standards update to be arrived at by a method other than the formal rulemaking process that is described later in this paper. A consensus was reached between the industry and representatives from various environmental groups, state energy offices and utilities. A de facto moratorium on any new appliance energy efficiency standards will likely delay any final standard to a later date than 1998. Two years of analyses and negotiations were needed to come to this agreement. Before standards were discussed, industry and the U.S. DOE spent many months reviewing and revising the ERA (EPA refrigerator analysis) computer program (Merriam, 1993), gathering technical and economic data, and drafting and critiquing detailed engineering analyses. At the request of the parties to the negotiation, these analyses were made available to all parties as the basis for standards discussions. All standards considered and the final standards are based primarily on these analyses (Joint Comments, 1994). The process involved close participation among the various parties to the agreement and the DOE and its contractors. The latter parties provided technical and economic analyses as the basis for the standards discussion and manufacturers provided data and expertise on many aspects of refrigerator manufacturing.

METHODOLOGY

General procedure

We begin our discussion of the methodology used by DOE to establish the 1998 refrigerator and freezer proposed standards with a description of the procedure used for all previous DOE analyses. The first step in the DOE rulemaking process is the publication of an Advance Notice of Proposed Rulemaking (ANOPR). The purpose of this notice is to inform all interested parties of the product types (and classes) for which DOE intends to consider energy conservation standards. Additionally, the designs to be analyzed, and computer models to be utilized are described. Information received by the DOE during a 75 day comment period is considered in the preparation of the Notice of Proposed Rulemaking (NOPR). The NOPR presents the proposed policy, the results of the analysis, and the alternatives considered. While the NOPR is being prepared by DOE, there is

Table 1. *Maximum Allowable Energy Use for Refrigerators and Freezers*

Product Class	1990 (kWh/yr)	1993 (kWh/yr)
Manual Defrost Refrigerator and Refrigerator-Freezer	16.3AV + 316	13.5AV + 299
Partial Auto-Defrost Refrigerator-Freezer	21.8AV + 429	10.4AV + 398
Top-Mount A-D Refrigerator-Freezer	23.5AV + 471	16.0AV + 355
Side-Mount A-D Refrigerator-Freezer	27.7AV + 488	11.8AV + 501
Bottom-Mount A-D Refrigerator-Freezer	27.7AV + 488	16.5AV + 367
Top-Mount A-D with TTD Features	26.4AV + 535	17.6AV + 391
Side-Mount A-D with TTD Features	30.9AV + 547	16.3AV + 527
Upright Manual Defrost Freezer	10.9AV + 422	10.3AV + 264
Upright A-D Freezer	16.0AV + 623	14.9AV + 391
Chest Freezer	14.8AV + 223	11.0AV + 160

AV means adjusted volume; for refrigerator-freezers, AV = fresh food volume + 1.63 times the freezer volume. For freezers, AV = 1.73 times the freezer volume.
A-D equals auto defrost.

no opportunity for interested parties (called stakeholders) to be informed as to the direction of the engineering and economic analyses being carried out by DOE and its contractors. For previous rulemakings, it has taken from one to three and a half years, after publication of the ANOPR, to perform the necessary analyses and to publish the NOPR.

During another public comment period, stakeholders are given an opportunity to respond to the proposed policy, and all oral and written comments received on the NOPR are considered in preparing a final rulemaking which contains any new energy conservation standards. In previous rulemakings, a large number of comments were received from stakeholders. Typically, industry representatives comment that the proposed standards are too stringent and the energy efficiency advocates comment that they are too weak. Such situations created difficulty, as there was—previous to the 1998 proposed standards analysis—no forum for resolving the differences between these two groups of stakeholders. Again, during the period that DOE and its contractors are reviewing and responding to comments and performing a standards reanalysis, there is no process whereby stakeholders can learn whether and how their comments are being considered by DOE and its contractors. Additionally, there is no mechanism for an interchange of industry, stakeholder, and DOE views on important issues.

Statistical and engineering/economic analyses. There are two widely used approaches to developing information needed for setting energy efficiency standards, these are statistical or engineering/economic in nature. Both of these approaches are discussed below. In addition to these two methods, there are other arrangements (e.g., in Japan) where a less formal process is used to establish standards. This could be accomplished by a consensus group of industry and government participants using limited analyses but having expert knowledge of the marketplace and state of the art for a particular product.

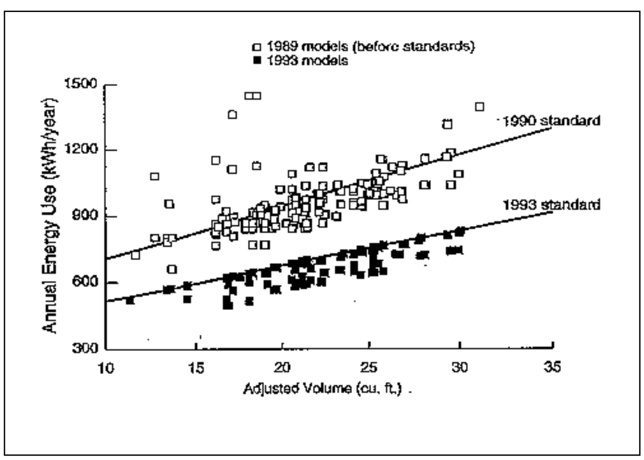
Statistical approach. The statistical approach requires fewer data and less analysis than the engineering/economic approach. The data required are those that give a current characterization of the marketplace for the products of interest. A standard level can then be selected after a decision is made as to the energy savings goal and/or the number of models that it is acceptable to eliminate from the current marketplace. The costs of achieving energy savings are not explicitly determined. This approach has been utilized in the European Union (EU) and in Australia.

Figure 1 shows two sets of data for refrigerator-freezer models available in 1989 and in 1993. Also shown are the 1990 and 1993 standards (for this one product class) which resulted from the two types (statistical and engineering/economic) of analyses. The standards are seen to be a function of adjusted volume (AV).

The 1990 U.S. standard was a consensus standard arrived at by efficiency advocates and manufacturers. It can be seen that the 1990 minimum efficiency standard eliminated the higher energy users from the marketplace. This approach to standards setting could be considered to be a statistical approach; that is, one looks at the models available at a particular time and either performs a regression analysis to determine the dependence of energy use on adjusted volume or visually draws a line through the cloud of points to set the maximum allowable energy use for each adjusted volume. Using such an approach, policy makers can decide on the percentage of models they are willing to have eliminated or the desired overall energy savings from standards (this was not explicitly done for the U.S. standards that became effective in 1990).

The second approach to standards setting, which is engineering/economic in nature, is described below, as is the rest of Figure 1.

Figure 1. *Statistical and Engineering/Economic Approaches to Refrigerator Standards*



Source: *From the Lab to the Marketplace* (1995) 14.

Engineering/economic analysis. There are several parts to an engineering/economic standards analyses; this approach has been widely used by the Lawrence Berkeley Laboratory (LBL) for the U.S. Department of Energy (DOE). It has also been used to propose future efficiency standards in the EU (GEA 1992). First, an engineering analysis is carried out for each product type; it produces manufacturing costs for improving the efficiency of a baseline model. Installation and maintenance costs are also calculated during the engineering analysis. The engineering analysis is performed in seven steps (see Table 2).

Once the engineering analysis is completed, a number of other parameters are calculated, such as life-cycle cost, payback period, national energy savings and net present value of consumer energy cost savings. Additionally, electric utility, manufacturer, and environmental impacts are assessed. The results of these analyses are utilized by the DOE to set efficiency standards. The 1993 efficiency standards utilized the engineering/economic approach. It can be seen that in 1989 no models met the 1993 standard; such a standard could not be developed through a statistical approach. In 1993, a number of models exceeded the standard by more than 10% (Figure 1) and a few models exceeded the standard by 20%.

New Approach

The new approach is a hybrid between a pure consensus approach and the more formal approach described above. The hybrid consensus approach is much more collaborative than combative in nature. In addition to assessing the current state of the art, engineering and economic analyses are per-

Table 2. *Steps for Engineering Analysis*

1. Select appliance classes
2. Select baseline units
3. Select design options for each class
4. Calculate efficiency improvement from each design option
5. Combine design options and calculate efficiency improvements
6. Develop cost estimates (include installation and maintenance) for each design option
7. Generate cost-efficiency curves

formed. Ample opportunity is given for stakeholder input and feedback on the analyses being performed by DOE and its contractors. DOE provides the stakeholders with periodic updates on its progress with the standards analysis. The interactions among the participants (e.g., through working groups, presentations at meetings and telephone communications) is less formal and more frequent than with the previously described regulatory approach. Even though all the participants may not agree on all the technical issues, these frequent interactions and feedback opportunities allow the number of contentious issues to be reduced in number and in scope. This hybrid consensus approach was used to develop the proposed 1998 refrigerator and freezer standards.

RESULTS

In this section, the proposed 1998 efficiency standards are presented and some of the main issues that were considered during the two year negotiation period are discussed. Table 3 shows the proposed 1998 efficiency standards; they are the standards agreed to by the parties to the consensus and are very similar to one of the alternative energy efficiency levels evaluated in the DOE/LBL analysis (TSD 1994). Some of the more significant issues that arose during the technical meetings included: accuracy of ERA modeling, cost of several design options, potential efficiency improvements for several design options (e.g., more efficient compressors), impact of increased wall thickness on consumer utility and impact on efficiency of elimination of HCFCs from use in insulation.

Modeling Accuracy

The ERA model was used to estimate energy use under different design option scenarios; therefore, an understanding of the accuracy of these estimates is crucial. There will be inaccuracies in the predictions of any such model because of errors in the inputs and because of errors in its simulation of the operation of a refrigerator or freezer. A significant amount of time was spent by participating companies in preparing input files for almost 100 models of refrigerators and freezers. We ran these input files with the ERA program and discovered a number of input errors. After corrections were made with assistance from the individual companies, the energy consumption prediction was compared to the actual measured energy use. For top-mount refrigerator-freezers, it was found that for about 60% of 27 models simulated, the predicted energy use was within 6% of the measured energy use. For side-by-sides, for about 70% of 17 models simulated, the predicted energy use was within 6% of the measured energy use. The greatest difference for any single model was about 16%. When baseline models were chosen for each product class, it was decided to choose a model that had energy use close to the 1993 standard, showed relatively good agreement with measured energy use (see Table 4) and had typical characteristics relative to other models in its class. For most compact classes, agreement between measured and predicted energy use was poor; therefore, modeling was performed only for the manual defrost refrigerator class. A calibration factor was calculated by comparing the ERA estimate to the measured energy use for the baseline model, later ERA runs under different design option combinations were adjusted with that calibration factor. The NAECA engineering task force came to this decision through many discussions which considered the alternative approach of changing the value of some particular input parameter to calibrate the predicted energy use to the measured energy use (NAECA Engineering Task Force).

The ERA modeling work could not have been accomplished as efficiently or as well without the cooperation of the many engineering representatives that attended the task force meetings and participated both at the meetings and back at their places of employment. There were several others who assisted in this process in addition to the manufacturer representatives. Another aspect of the ERA analyses was the difficulty of the ERA model to simulate non-conventional technologies such as certain gasket improvements, vacuum insulation and dual evaporators (Bullard, 1993). For such technologies, measured data were used where available rather than relying on the ERA model.

Increased Insulation Thickness

Several design options that were analyzed considered increases in the thickness of door or wall insulation (see Table 5). While significantly reducing energy use, such an increase in thickness would cause either a decrease in internal volume or an increase in outside dimensions. The former reduces the value of the product while the latter reduces the size of the market for the product. There were many discussions at engineering task force and consensus group meetings concerning the impacts of increased insulation thickness, particularly if outside dimensions increased, which was the LBL assumption in the analyses. Table 5 shows the energy use and manufacturer cost impact of adding various design options (including increased insulation thickness) to the baseline for a top-mount auto-defrost refrigerator-freezer. An alternative to increasing the thickness of insulation, vacuum panels, was also evaluated and that design option is shown in Table 4 as part of a separate branch of options. After lengthy analyses and discussions, DOE decided that in some cases increases of less than one inch in the insulation thickness (of any one side or door) is acceptable and that production capability in 1998 would be insufficient for vacuum panel insulation to be considered as a design option for all classes of refrigerator products (NOPR 1995).

Table 3. ***1998 Consensus Standards for Refrigerator/Freezers and Freezers***

Product Class	Energy Standards Equation (kWh/y)	Energy Standards Equation (kWh/y)
Standard Units		
Manual/Partial Defrost Refrigerators and Refrigerator/Freezers		
Manual Defrost	E = 0.31AV* + 248.4	E = 8.82AV** + 248.4
Partial Automatic Defrost	E = 0.31AV + 248.4	E = 8.82AV + 248.4
Automatic Defrost Refrigerator/Freezers		
Top-Mount Automatic Defrost Without Dispenser	E = 0.35AV + 276.0	E = 9.80AV + 276.0
Top-Mount Automatic Defrost With Dispenser	E = 0.36AV + 356.0	E = 10.20AV + 356.0
Side-Mount Automatic Defrost Without Dispenser	E = 0.17AV + 507.5	E = 4.91AV + 507.5
Side-Mount Automatic Defrost With Dispenser	E = 0.36AV + 406.0	E = 10.10AV + 406.0
Bottom-Mount Automatic Defrost	E = 0.16AV + 459.0	E = 4.60AV + 459.0
Freezers		
Upright Automatic Defrost	E = 0.44AV + 326.1	E = 12.43AV + 326.1
Upright Manual Defrost	E = 0.27AV + 258.3	E = 7.55AV + 258.3
Chest Manual Defrost	E = 0.35AV + 143.7	E = 9.88AV + 143.7
Compact Units		
Refrigerators and Refrigerator/Freezers		
Manual Defrost	E = 0.38AV + 299.0	E = 10.70AV + 299.0
Partial Automatic Defrost	E = 0.25AV + 398.0	E = 7.00AV + 398.0
Top-Mount Automatic Defrost	E = 0.45AV + 355.0	E = 12.70AV + 355.0
Side-Mount Automatic Defrost	E = 0.27AV + 501.0	E = 7.60AV + 501.0
Bottom-Mount Automatic Defrost	E = 0.46AV + 367.0	E = 13.10AV + 367.0
Freezers		
Upright Automatic Defrost	E = 0.40AV + 391.0	E = 11.40AV + 391.0
Upright Manual Defrost	E = 0.35AV + 250.8	E = 9.78AV + 250.8
Chest Manual Defrost	E = 0.37AV + 152.0	E = 10.45AV + 152.0

*AV means the adjusted volume in litres.
**AV means the adjusted volume in ft^3.

Costs of options

Many of the costs of design options were obtained from manufacturers. However, for some options, such as more efficient compressors and fan motors, suppliers estimates were used by LBL. Industry members felt that these incremental cost estimates were too low. LBL polled manufacturers of these components twice over the two year process and used the later estimates in their analyses.

Compressor performance

Since the compressor is the major energy-consuming component in a refrigerator, advances in compressor efficiency

Table 4. Comparison of Measured and Predicted Energy Use for Baseline Units

Product Class	Measured Energy Use (kWh/y)	ERA Predicted Energy Use (kWh/y)	Difference (%)
Standard Units			
Manual/Partial Defrost Refrigerators and Refrigerator/Freezers			
Manual Defrost	No Data	No Data	—
Partial Automatic Defrost	No Data	No Data	—
Automatic Defrost Refrigerator/Freezers			
Top-Mount Automatic Defrost Without Dispenser	689.9	686.2	0.5
Top-Mount Automatic Defrost With Dispenser	799.4	733.7	8.2
Side-Mount Automatic Defrost Without Dispenser	737.3	788.4	− 6.9
Side-Mount Automatic Defrost With Dispenser	793.1	733.7	7.5
Bottom-Mount Automatic Defrost	612.1	543.9	11.1
Freezers			
Upright Automatic Defrost	878.0	939.5	− 7.0
Upright Manual Defrost	598.0	655.0	− 9.5
Chest Manual Defrost	615.9	701.2	− 13.8
Compact Units			
Refrigerators and Refrigerator/Freezers			
Manual Defrost	308.0	350.0	− 13.6
Partial Automatic Defrost	433.0	565.4	− 30.6
Top-Mount Automatic Defrost	No Data	No Data	—
Side-Mount Automatic Defrost	No Data	No Data	—
Bottom-Mount Automatic Defrost	No Data	No Data	—
Freezers			
Upright Automatic Defrost	558.8	830.4	− 48.6
Upright Manual Defrost	400.0	461.7	− 15.4
Chest Manual Defrost	371.3	407.7	− 9.8

have a significant effect on overall refrigerator efficiency. Most models today have compressor COPs ranging between 0.73 (2.50 EER) for a small 57 liters (2 ft^3) all-refrigerator to 1.58 (5.40 EER) for the larger 629 liter (22 ft^3) refrigerator-freezer. Conversion to a high-efficiency compressor is fairly straightforward for manufacturers to implement as long as the compressors are available or can be produced at a reasonable cost.

Data were obtained on projected 1998 efficiency and costs of HFC-134a compressors from four compressor manufacturers, from refrigerator manufacturers, and other sources. The first set of efficiency estimates indicated that a 5.8 EER compressor was possible for the large capacity refrigerators and freezers. Representatives of refrigerator and freezer manufacturers stated that compressor manufacturers had been too optimistic and that the conversion from CFC-12 to HFC-134a as the refrigerant was going slower than expected. A second updated set of efficiency estimates were obtained from the compressor manufacturers that caused the 1998 estimates to be lowered somewhat. Information (see Table 6) collected in this later analysis suggested that a 1.64 COP (5.6 EER) compressor for large capacity refrigerators will be available in sufficient quantities by 1998.

Table 6 shows the maximum COP of the compressors expected to be available to the refrigerator manufacturers before the standard goes into effect. Costs were obtained by

Table 5. *Energy Use of a Top-Mount Auto-Defrost Refrigerator-Freezer*

Design Opt. Level	Option	Mfg. Cost (1992$)	Duty Cycle (%)	Cab. Heat Load (W)	Comp. Power (W)	Evap. Fan Power (W)	Cond. Fan Power (W)	Ann. Energy Use (kWh/y)
0	BASELINE	259.53	43	86.32	145.15	9.10	12.00	700.86
1	0 + 1.60 COP (5.45 EER) Compressor	270.59	43	86.30	125.36	9.10	12.00	620.13
2	1 + Reduce Condenser Fan Motor Power	275.09	43	86.30	125.36	9.10	4.50	594.45
3	2 + Add 1.27 cm (½″) Insulation to Doors	278.71	42	83.32	123.45	9.10	4.50	572.43
4	3 + Reduce Evaporator Fan Motor Power	285.21	41	81.23	123.45	4.50	4.50	543.07
5	4 + Improve Evaporator Fan Efficiency	286.02	40	81.18	124.73	4.50	4.50	539.40
6	5 + Add 1.27 cm (½″) Insulation to Walls	297.37	37	74.06	123.79	4.50	4.50	495.37
7	6 + Reduce Gasket Heat Leak	300.34	36	72.23	123.82	4.50	4.50	484.36
8	7 + Add 1.27 cm (½″) Insulation to Doors	303.45	35	70.40	123.85	4.50	4.50	473.35
9	8 + Add 1.27 cm (½″) Insulation to Walls	312.35	33	65.79	123.92	4.50	4.50	444.00
10	9 + Increase Condenser Area	315.61	32	65.74	125.27	4.50	4.50	436.66
11	10 + Adaptive Defrost	322.76	32	64.91	123.99	4.50	4.50	425.65
12	11 + Increase Evaporator Area	325.86	31	64.80	125.38	4.50	4.50	421.98
13	7 + Increase Evaporator Area	303.45	35	72.08	126.22	4.50	4.50	477.02
14	13 + Increase Condenser Area	306.71	34	72.02	127.55	4.50	4.50	469.69
15	14 + Adaptive Defrost	313.86	34	71.14	125.15	4.50	4.50	458.68
16	2 + Reduce Evaporator Fan Motor Power	281.59	42	84.15	124.43	4.50	4.50	561.42
17	16 + Improve Evaporator Fan Efficiency	282.40	42	84.09	123.66	4.50	4.50	557.75
18	17 + Reduce Gasket Heat Leak	285.37	41	82.30	123.68	4.50	4.50	546.74
19	18 + Increase Evaporator Area	288.47	40	82.13	124.76	4.50	4.50	539.40
20	19 + Increase Condenser Area	291.73	39	82.06	125.90	4.50	4.50	532.07
21	20 + Vacuum Panels on Walls & Doors	338.48	32	66.05	124.02	4.50	4.50	432.99
22	21 + Adaptive Defrost	345.63	31	65.25	126.70	4.50	4.50	421.98

averaging the data received from compressor manufacturers. All the compressor data used for the ERA simulations were either maps of actual compressors using HFC-134a or extrapolations from such maps.

Eliminate HCFCs

The Joint Comments proposed additional product classes for HCFC-free refrigerator products, both full-size and compact. Presently, HCFC-141b is used as the blowing agent for polyurethane foam. However, the EPA plans to phase out its use by January 1, 2003. The Joint Comments stated that current data from Europe, Japan and the U.S. indicate approximately a 10% energy penalty in the shift from HCFC-141b to proposed hydrofluorocarbon and hydrocarbon substitutes. There are several substitutes being evaluated such as, HFC-356, the fluorinated ether E245, cyclopentane, and HFC-365. The Environmental Protection Agency (EPA) submitted a comment on the ANOPR that contained a report (Appendix 8) which found that the high density, molded foam produced with the fluorinated ether, E245, has a thermal conductivity similar to that of CFC-11 (EPA 1994). The EPA also stated that the commercial viability and energy performance of many of these alternatives is uncertain at this point. Based on the uncertainty of the availability of HCFC-141b replacements with equivalent thermal properties, the DOE decided to develop new product classes for products that do not use HCFC-141b or other HCFCs in the foam insulation. More recent data show that foams blown with HFC-245fa can be produced that have equal thermal conductivity to HCFC-141b (Doerge 1995). Toxicity testing needs to be completed for this compound. A decision was made by the parties to the Joint Comments (and accepted by DOE) to allow a 10% energy use relief relative to 1998 standards for HCFC-free products. These more lenient efficiency standards for HCFC-free products would remain in place for six years followed by a return to the standards established for products containing HCFCs.

Table 6. *Estimated 1998 Compressor COPs (using HFC 134a)*

Product Class Served	Capacity Range (W)	Capacity Range (Btu/h)	Maximum by 1998 COP	Maximum by 1998 EER
The Five Standard Auto-Defrost Refrigerator-Freezers	220 to 278	750 to 950	1.64	5.60
	176 to 205	600 to 700	1.60	5.45
Auto Defrost Upright Freezers	250 to 278	850 to 950	1.64	5.60
Manual Defrost Upright Freezers	161 to 176	550 to 600	1.51	5.15
Manual Defrost Chest Freezers	147 to 161	500 to 550	1.45	4.95
Compacts	117	400	1.38	4.70
	103	350	1.26	4.30
	59	200	1.04	3.55
	41	140	0.76	2.6

CONCLUSIONS

In the opinion of the authors and many others who participated in the engineering task force and in the consensus process, this new more open approach (hybrid consensus) to setting standards was successful. Working together with the same data, with many opportunities for feedback, and in a more collegial atmosphere, allowed the contentious issues to be reduced in number and in their degree of uncertainty. The process review that DOE is currently carrying out in order to look at methods for improving the present regulatory procedures may look favorably on the hybrid consensus approach as a model for other products which may be regulated in the future. This approach works well in cases where interested parties are motivated to attempt to agree and are willing to compromise. Where such motivations are not present, it still should be possible to conduct rulemakings in a more open and consultive manner. This open process would differ from the hybrid consensus approach in that there would be no group of stakeholders trying to reach consensus.

It may be possible to apply this hybrid consensus approach described here to other rulemakings, or to other government interventions such as market conditioning. In many cases, technical analyses are the basis of decision making for programs other than mandatory efficiency standards, for example rebate or utility incentive programs. The revised analysis for fluorescent lamp ballasts has been proceeding in a manner similar to that used for the refrigerator/freezer standards, albeit in a less intensive manner. It has been a more open and consultive process (than for previous rulemakings) that has so far been focused on improving analyses but not on developing consensus among interested parties. New extensive data have been provided by the National Electrical Equipment Association (NEMA) and the ballast industry and draft analyses have been provided by DOE to the industry and other stakeholders. Several meetings and a public workshop have been held with DOE, NEMA, ballast manufacturers, LBL representatives and others. A revised draft report has been completed and circulated to all stakeholders (DOE 1996).

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