FINAL TECHNICAL REPORT

INSTITUTO DE INVESTIGACIONES ELECTRICAS

BERKELEY LAB

ASSESSMENT OF THE IMPACTS OF STANDARDS AND LABELING PROGRAMS IN MEXICO (FOUR PRODUCTS)

Under Subcontract No. 6720261with
Lawrence Berkeley National Laboratory

Gerencia de Uso de Energía Eléctrica (IIE)

Cuernavaca, Morelos, México

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Itha Sánchez, Henry Chu

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The Collaborative Labeling and Appliance Standards Program (CLASP)
provided technical review to IIE for this report.

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TABLE OF CONTENTS

0. EXECUTIVE SUMMARY

This study analyzes impacts from energy efficiency standards and labeling in Mexico from 1994 through 2005 for four major products: household refrigerators, room air conditioners, three-phase (squirrel cage) induction motors, and clothes washers. It is a retrospective analysis, seeking to assess *verified impacts* on product efficiency in the Mexican market in the first ten years after standards were implemented. Such an analysis allows the Mexican government to compare actual to originally forecast program benefits. In addition, it provides an extremely valuable benchmark for other countries considering standards, and to the energy policy community as a whole.

The methodology for evaluation begins with historical test data taken for a large number of models of each product type between 1994 and 2005. The pre-standard efficiency of models in 1994 is taken as a baseline throughout the analysis. Model efficiency data were provided by an independent certification laboratory (ANCE), which tested products as part of the certification and enforcement mechanism defined by the standards program. Using this data, together with economic and market data provided by both government and private sector sources, the analysis considers several types of national level program impacts. These include:

- Energy savings;
- Environmental (emissions) impacts, and
- Net financial impacts to consumers, manufacturers and utilities.

Energy savings impacts are calculated using the same methodology as the original projections, allowing a comparison. Other impacts are calculated using a robust and sophisticated methodology developed by the Instituto de Investigaciones Eléctricas (IIE) and Lawrence Berkeley National Laboratory (LBNL), in a collaboration supported by the Collaborative Labeling and Standards Program (CLASP).

Overall Impacts of Mexico's Minimum Efficiency Performance Standards (MEPS) for Refrigerator/Freezers, Air Conditioners, Motors and Clothes Washers

The impact of MEPS of the four products focused on in this report (Refrigerator/Freezers, Air Conditioners, Motors and Clothes Washers) on the Mexican electricity system has been significant. Taken together, standards for these four products reduced electricity demand by 13.3 TWh in 2005, or 15.3 TWh of gross generation. Total gross generation in Mexico in 2005 was 160 TWh. Therefore, standards for these products accounted to a 9.6% reduction in demand in this year. In terms of capacity, standards reduced the need for total generating capacity of 3440 MW, or 6.4% of capacity installed by 2004 of 53561 MW.

Standards Covered and Dates Implemented

The first set of MEPS implemented by the Mexican government was promulgated in 1994, and took effect on January 1, 1995. Effective dates for initial standards and subsequent updates for the products studied in this report are as follows:

- Refrigerators: Original standard in 1995. Updates in 1997and 2003.
- Air Conditioners: Original Standard in 1995. Update in 2001.
- Three Phase Electric Motors: Original Standard in 1995. Updates in 1998 and 1993.
- Clothes Washers: Original Standard in 1997. Update in 2000.

Relative Stringency of Standards

Mexican Minimum Efficiency Performance Standards (MEPS) for refrigerators, air conditioners and motors, are now fully harmonized with the U.S Department of Energy (DOE) standards. Stringency varies with product, but these standards are among the most stringent in the world, making the Mexican program among the world's most aggressive in terms of energy efficiency.

Success of Enforcement and Monitoring

Testing data performed by the national certification body shows that manufacturers largely complied with the testing requirements. Further, the data shows that manufacturers met, and in most cases exceeded the energy efficiency requirements. As a side-effect of the success of the certification program, the Mexican program is outstanding in its ability to retrospectively verify the originally projected impacts of the program.

Efficiency Impacts of Standards

In the early years of the standards program, products largely just met the standards, but since then, the market has shown a continued improvement in average efficiency over time. This can be interpreted as largely driven by a desire to meet impending harmonization requirements, meet the needs of a regional and global consumer market, and possibly as arising from improved technological and production practices encouraged by the implementation of standards.

Site Electricity Savings

Savings in cumulative avoided consumption from 1995 through 2005 are:

- 29.3 TWh from Refrigerator Standards;
- 15.3 TWh from Air Conditioner Standards;
- 12.8 TWh from Motor Standards; and
- 1.8 TWh from Clothes Washer Standards.

Consumer Financial Savings

Net savings to consumers, discounted to 1995 for products shipped between 1995 and 2004 (where operating cost impacts projected over the life of the product) are:

- 4.5 Billion $US from Refrigerator Standards;
- 2.8 Billion $US from Air Conditioner Standards;
- 1.7 Billion $US from Motor Standards; and
- 0.2 Billion $US from Clothes Washer Standards.

National Environmental Impacts

Greenhouse gas emissions mitigation, in terms of cumulative carbon dioxide emissions avoided from 1995 through 2005 are:

- 20.3 megatons CO_2 from Refrigerator Standards;
- 10.6 megatons CO_2 from Air Conditioner Standards;
- 8.8 megatons CO_2 from Motor Standards; and
- 1.3 megatons CO_2 from Clothes Washer Standards.

Comparison to Original Projections

The analysis presented in this report can be compared to a projection of standards impacts made during the early years of the standards regime. This analysis finds that impacts were greater than expected, by about 25% in terms of consumer electricity consumption. This is due to the continual increase in energy efficiency of products beyond the minimum requirements of the standards.

1. INTRODUCTION

This study analyzes impacts from the equipment and appliances standardization process since 1994 through 2005. It is a retrospective analysis, seeking to assess *verified impacts* on product efficiency in the Mexican market in the first ten years after standards were implemented. Such an analysis allows the Mexican government to compare actual to originally forecast program benefits. In addition, it provides an extremely valuable benchmark for other countries considering standards, and to the energy policy community as a whole.

The methodology for evaluation begins with historical test data taken for a large number of models of each product type between 1994 and 2005. The pre-standard efficiency of models in 1994 is taken as a baseline throughout the analysis. Model efficiency data were provided by an independent certification laboratory (ANCE), which tested products as part of the certification and enforcement mechanism defined by the standards program.

Using this data, together with economic and market data provided by both government and private sector sources, the analysis considers several types of national level program impacts. These include energy savings, environmental (emissions) impacts, and net financial impacts to consumers, manufacturers and utilities. Energy savings impacts are calculated using the same methodology as the original projections, allowing a comparison. Other impacts are calculated using a robust and sophisticated methodology developed by the Instituto de Investigaciones Eléctricas (IIE) and Lawrence Berkeley National Laboratory (LBNL), in a collaboration supported by the Collaborative Labeling and Standards Program (CLASP). The analysis also benefited greatly from the availability of a wide range of data sources, many of which were provided by significant stakeholders (manufacturers, industry groups, utilities and government agencies) in the standards process itself.

2. STANDARDS ANALYZED

This study was carried out for four major products: household refrigerators, room air conditioners, three-phase (squirrel cage) induction motors, and clothes washers. The period analyzed, from 1995 to 2004 covered implementation of the first MEPS for each product, and subsequent updates. The MEPS regulations (Normas Officiales Mexicanas, or NOM) are summarized in Table 1.

Table 1 – Regulations for Products Analyzed

Official Mexican standards	Spanish Title	English Title
Original NOM-072-SCFI-1994 Update NOM-015-ENER-1997 Update NOM-015-ENER-2002	"Eficiencia energética de refrigeradores y congeladores electrodomésticos"	Energy Efficiency of Household Refrigerators and Freezers
Original NOM-073-SCFI-1994 Update NOM-021-ENER/SCFI/ECOL-2000	"Eficiencia energética de acondicionadores de aire tipo cuarto"	Energy Efficiency of Room Air Conditioners
Original NOM-074-SCFI-1994 Update NOM-016-ENER-1997 Update NOM-016-ENER-2002	"Eficiencia energética de motores de inducción de corriente alterna, tipo jaula de ardilla"	Energy Efficiency of AC Squirrel Cage Induction Motors
Original NOM-005-ENER-1996 Update NOM-005-ENER-2000	"Eficiencia energética de lavadoras de ropa electrodoméstica"	Energy Efficiency of Household Electric Clothes Washers

Mexican MEPS for these products significantly improved the efficiency of the market when they were originally implemented. With the recent updates, they are among the most stringent in the world. The Mexican government has made an explicit policy to harmonize its efficiency standards with those of the United States and Canada, which are generally quite stringent. Some of the initial standards were set to be equal to U.S. standards implemented several years earlier. By 2002, the Mexican standards for these four products were all in line with the current U.S. standards. Mexican standards use efficiency test procedures identical to those mandated by the U.S. Department of Energy for its standards program whenever practicable.

3. METHODOLOGY

In Mexico, the Federal Law of Metrology and Standardization (LFMN) established the characteristics of a mandatory standard. This legislation requires that any new standard be technically feasible and economically beneficial for those likely to be impacted, as well as for the country as a whole. To address this requirement, the Electric Research Institute (IIE) and the efficiency standards implementation agency CONAE (Comisión Nacional para el Ahorro de Energía) have worked together since the beginning of the program on the development of an assessment impact methodology for energy efficiency standards.

The preliminary results from the impact assessment model concerning energy savings addressed the need to validate the model through the participation of a third party, preferably an international organization specializing in the energy efficiency field. CONAE obtained the support of United States Agency for International Development (USAID) for financing the first part of the project, which consisted of validating the model. In this first phase, PA Consulting Group was assigned as USAID's administrative

representative, and Lawrence Berkeley National Laboratory (LBNL) and the IEE were involved in the technical aspects of the effort.

The second phase of this project included using computer models to update the data in order to project the potential impact of implementing the proposed energy efficiency standards for the four products mentioned above. IIE made an analysis of the evaluation methodologies in collaboration with LBNL. In this analysis, the Mexican methodology was compared to those used in the analysis of the US standards program. The result of this phase was a revised, validated model. For the development of the second phase of this project, the input data required to run the evaluation model was updated in order to obtain the energy and economic impacts.

The assessment of program impacts compares baseline unit energy consumption in 1994 to energy consumption in subsequent years, which is lower due to the impact of standards. National impacts are calculated by scaling unit values according to the number of units entering the stock in each year, according to product sales figures (shipments).

3.1. Analysis Perspectives

In addition to national energy savings impacts, this analysis considers impacts from four distinct perspectives: 1) the consumer perspective; 2) the utility perspective; 3) the manufacturer perspective; and 4) the environmental perspective.

Consumer Perspective – We calculate energy savings to end-users (households and businesses) by multiplying per unit annual savings for each product cohort by the total remaining stock in each year. End-user operating cost savings equals site energy savings multiplied by per unit energy costs. Tariff structures were used to evaluate marginal per unit energy costs, according to the customer type (residential, commercial or industrial) appropriate to each product. Finally, we calculate the net financial benefit by subtracting additional first costs from operating cost savings. These costs are given by the average increase in retail price from more efficient products, multiplied by the shipments in each year. Operating costs are summed over remaining stock in each year. Stock is calculated according to a simple retirement model, which assumes that all products are retired at an age corresponding to the mean product lifetime. In order to calculate Net Present Value (NPV) of financial savings, the user viewpoint analysis uses consumer interest rates.

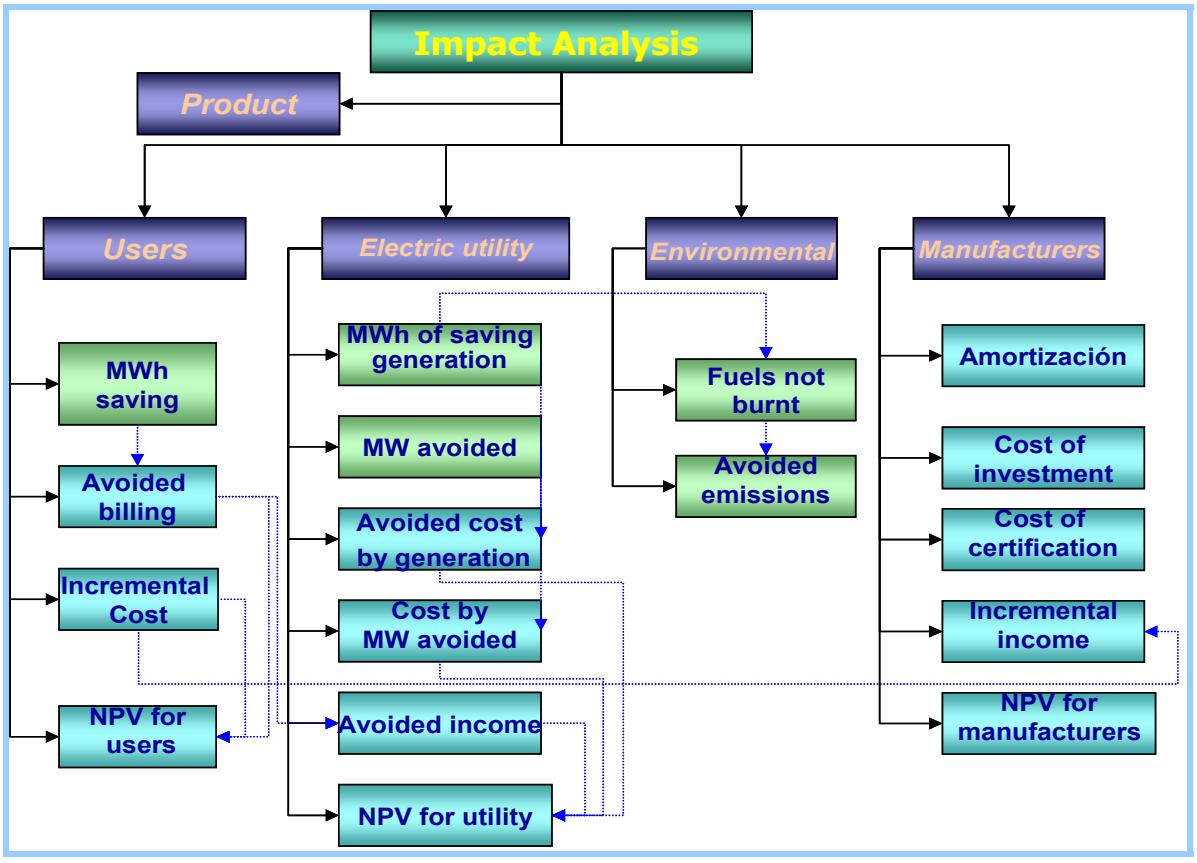
Utility Perspective - The utility viewpoint differs from that of the end-user in two important aspects. First, utility energy savings and operating cost savings are calculated in terms of primary energy, that is, fuel input avoided due to energy savings in the home or business. Second, impacts on generating capacity are estimated by assessing the effect of end use savings on peak load. Financial impacts include the avoided cost of production, revenue losses from lower electric bills, and the avoided capital costs of increasing generation capacity.

Manufacturer Perspective - The impacts of standards on manufacturers are that they are required to produce products utilizing a higher degree of efficiency technology. This generally increases per-unit costs, in the form of materials and labor. In addition, production of high-efficiency models may involve retooling and redesign costs. On the other hand, high-efficiency products generally demand a higher price in the market, thus increasing revenue to manufacturers. Finally, financial impacts of the program on manufacturers include a per-unit cost of certification.

Environmental Perspective - This analysis explicitly considers the environmental impacts of standards. These are evaluated in the form of greenhouse gas emissions and other pollutants, namely CO_2, NO_x and SO_x emissions.

The impacts calculated for each viewpoint are summarized in the flow chart in Figure 1. In order to improve the evaluation process of the standards setting program, as well as obtain an international validation of the methodology for energy evaluation, this methodology was revised by the CLASP staff of LBNL and the IIE in a first stage, and then it was run with the revised model equipped with updated information in a second stage. An expanded flowchart describing the details of the impacts analysis can be found in Appendix B.

Figure 1. Analysis Modules for Perspectives Considered



3.2. Input Data

The current analysis represents a validation and refinement of the impacts forecast performed in 1997, which necessarily relied on a number of assumptions regarding market trends, prices, etc. Part of the refinement is due to the improved methodology described above. Another significant improvement is that the current analysis gains considerably from the use of data that has become available over the first 10 years of standards in México. These data can now be accessed because of the Mexican government's program of tracking energy efficiency of certified products. In addition, however, a great deal of data was gathered from stakeholders in the standards-setting process, which now participate as part of an energy efficiency network centered around the standards program. Input data gathered as part of this study are described in the following subsections, and tabulated in Appendix A.

3.2.1. Efficiency Data

The efficiency values correspond to products certified by the Mexican National Electrical Standards and Certification Association (ANCE), the entity authorized by law to expedite the certification of products and its compliance with energy efficiency standards. All products were tested in accredited laboratories. Equipment not having a certificate cannot be sold on the national market. Efficiency values taken from certification data from 1995 to 2004 included:

- 2167 refrigerator and refrigerator/freezer models;
- 620 room air conditioner models;
- 666 three-phase electrical motor models; and
- 1350 clothes washer models from 1995 until 2004.

Efficiency trends are described for each product in the sections below.

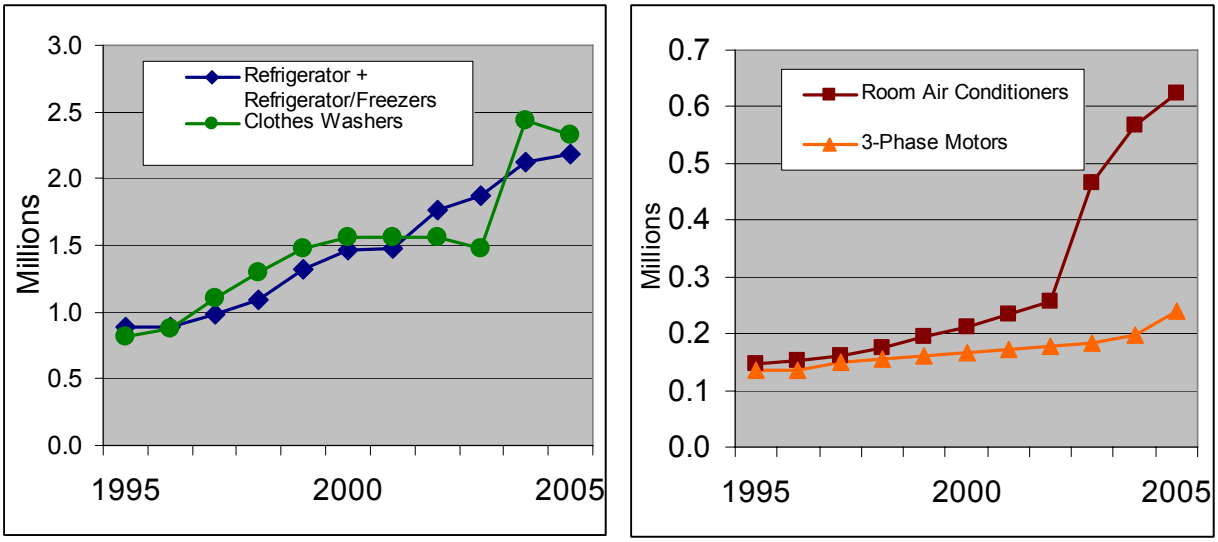
3.2.2. Market Data

Shipments data (units sold) for each product throughout the analysis period were provided by individual manufacturers (Mabe, Vitro, Daewoo LG, Trane, York, Carrier, WEG, etc.), and manufacturer associations (Asociación Nacional de Fabricantes de Aparatos electrodomésticos (ANFAD) and Camara Nacional de Manufacturas eléctricas (CANAME)).

All of the products studied showed significant growth in unit sales (shipments) during 1995-2004. Shipments for refrigerators and clothes washers each exceeded two million by 2005. Sales growth in each of these products was significant – about 7% and 8% for refrigerators and washing machines, respectively. Air conditioner shipments grew at a rate of over 30% between 2002 and 2005, while it was about 15% for the ten year

period between 1995 and 2004. Industrial motors grew at a rate of 5% per year over the years studied. Shipment trends for these four products are shown in Figure 2.

Figure 2 – Product Shipments 1995-2004



3.2.3. Financial Data

Electricity tariffs and other financial data were collected year-by year throughout the analysis period in pesos. In order to provide an equivalent current value of costs and savings, all historical data were converted into constant 2005 pesos according to the inflation rates shown in Table 2. Financial values are then quoted in constant 2005 dollars, by multiplying by the peso to dollar exchange rate in 2005.

Table 2 – Inflation Rate and Exchange Rate

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Inflation Rate (%)	52.0	27.7	15.7	18.6	12.3	9.0	4.4	5.7	4.0	5.2	N/A
Exchange Rate pesos/dollar	6.6	7.7	8.1	9.9	9.5	9.6	9.1	10.3	11.2	11.3	10.9

Source: Banco de México

Discount rates were calculated separately for end-users, utilities and manufacturers. For end-users, we used the average interest rate for investments (inflation adjusted mutual funds rate), as provided by the Comisión Nacional para la Protección y Defensa de los Usuarios de Servicios Financieros (CONUSER). For manufacturers, a typical expected rate of return was used, as estimated by the industry group ANFAD. For utilities, the interest rate on capital investments was used, as provided by the Comisión Federal de Electricidad (CFE), Subdirección de programación. Discount rates are summarized in Table 3.

Table 3 – Discount Rates used in Financial Impacts Analysis

Perspective	Rate Used	Source	Value
Consumers	Mutual Funds	CONUSER	8.51%
Manufacturers	Typical ROI	ANFAD	17%
Utilities	Capital Investment Rate	CFE	12%

Retail prices for each product class were collected by a study performed by IIE. These data are detailed below in specific sections relating to each of the four products. Financial impacts to consumers are based on utility bill savings, less incremental equipment costs. Incremental retail equipment prices were determined using prices obtained in department stores and webs sites for national manufacturers. Retail price data was collected before the implementation of standards in order to establish baseline equipment cost. Retail prices were then surveyed again, in 1998 and in 2002.

In order to assess the financial impacts of MEPS on manufacturers, these firms provided detailed financial data on costs to move production to higher efficiency products. Cost data provided included: component costs, costs to modify or add production lines, and redesign costs. Per unit costs to manufacturers for certification were provided by ANCE. Costs for each product are detailed in sections below.

3.2.4. Power Sector Data

Electricity prices were evaluated in each year according to tariff schedules provided by the Federal Electricity Commission (CFE). Marginal rates were estimated as unit price per kWh for the highest usage block, according to the appropriate schedule: residential for refrigerators and washing machines, commercial for air conditioners, and industrial for motors. In estimating billing savings for commercial and industrial for users, a weighted average tariff was calculated for each product class, taking into account likely customer types for each type of equipment. Marginal rates for each customer type used are summarized in Table 4, for 1995-2005. For years after 2005, a growth rate of 1.3% per year was applied. This growth rate is an estimate provided by CFE.

Table 4 – Marginal Electricity Prices – 2005 US cents per kWh.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Residential	9.8	8.2	18.0	17.9	17.2	17.1	17.2	17.9	18.1	18.4	18.5
Commercial Tariff 2	22.7	18.5	17.0	16.8	16.2	15.3	14.5	14.2	15.6	17.5	18.2
Commercial Tariff 3	20.0	16.4	9.4	9.3	8.9	8.4	8.0	7.8	8.6	9.6	10.0
Commercial Tariff 6	12.1	9.7	14.3	14.8	14.3	14.2	14.1	14.4	14.5	14.8	14.9
Industrial Tariff OM	8.4	8.2	8.5	9.2	8.9	8.9	8.8	8.9	9.0	9.1	9.2
Industrial Tariff HM	7.9	7.3	5.8	5.1	5.0	5.4	5.2	5.3	6.1	6.8	7.1
Industrial Tariff HS	6.0	6.1	15.2	14.3	13.7	14.3	13.4	13.6	15.6	17.3	17.9

In addition to electricity tariffs, CFE also provided several other important parameters used in the analysis. Energy impacts at the power plant due to efficiency improvements are higher than those at the end user's household or facility, since reductions also include electricity lost in transmission or distribution. In order to account for this in calculation of impacts from the utility perspective, we used transmission and distribution loss rates provided by CFE, and shown in Table 5. The average loss rate of 15.0% was used throughout the forecast. In order to calculate peak generation impacts, a peak transmission and distribution loss of 18.95% was used, as provided by CFE.

Table 5 – Transmission and Distribution Loss Rate – 1994-2004

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Average
14.4%	15.2%	15.2%	14.9%	14.9%	15.0%	14.0%	15.1%	15.2%	15.7%	**15.0%**

Electricity savings has two main impacts on utilities. In the short term, it reduces the total amount of electricity that must be generated and delivered in a given year, thus reducing fuel costs. In the longer term, the installation of high efficiency equipment may slow the growth of overall electricity demand. Therefore, the number of power plants required in the future may be lower than would be the case in the absence of the program. Financial impacts from these two effects are quantified by two critical parameters. First is the marginal cost of production, representing the cost of fuel needed to produce the last kWh of electricity delivered. CFE estimated this cost to be 0.34 $US per kWh through 1998, after which the inflation adjusted cost is expected to rise at a rate of 1.3% per annum.

Second, is the investment cost for marginal demand, that is, the avoided cost of new generation capacity. CFE estimated an annualized cost of 133.83 $US per kW/year. The impact of efficiency improvement on generation capacity requirements depends on the product's *use factor* and *peak coincidence factor*. Use factor is the fraction of time the product is in use or, equivalently, the percentage of products in operation at any given time. Peak coincidence is the percentage of product use hours that correspond with peak mid-day hours, where generation is at a maximum. Use factors and peak coincidence factors are given in Table 6 for all products.

Table 6 - Use Factor and Peak Coincidence Factor

	Use Factor	Peak Coincidence Factor
Refrigerator	40%	68%
Air Conditioner	25%	40%
Motor	30%	82%
Clothes Washer	7%	0%

3.2.5. Emissions Data

Environmental impacts are assessed in terms of emissions avoided by reduction in energy consumption. For each GWh not consumed, a certain amount of pollutants are not emitted, including greenhouse gases (CO_2, NO_x, SO_x), carbon monoxide, and suspended particles. A single factor for each of these pollutant types was calculated according to the national electricity generation fuel mix. For each fuel used, a factor relating tons of pollutant to GWh consumed was calculated. Pollutant factors for each fuel, as well as the generation fuel mix were provided by the Environmental Protection Department (Departamento de Protección Ambiental) of the Federal Electricity Commission (CFE).

Table 7 shows the contribution to Mexican electricity generation by fuel type. For each fuel type, emissions factors for each pollutant type are given, and a weighted average generation factor is calculated.

Table 7 – Emissions factors for Electricity Generation

Primary Fuel	Gross Generation	Fraction	SO_x	NO_x	CO_2	CO	Suspended particles	Hydro - carbons
	(GWh)	%	Tons/GWh					
Fuel Oil	61297	38%	15.7	2.0	669	0.14	1.1	0.29
Natural Gas	33729	21%	0.003	2.0	539	0.19	0.00	0.01
Hydro	24155	15%						
Coal	23431	15%	8.6	4.9	1542	0.13	26.3	0.03
Nuclear	9194	6%						
Endogenous Vapor	6577	4%						
Diesel	1144	1%	15.7	2.0	669	0.14	1.1	0.29
Wind	6	0.004%						
Total	**159533**	**100%**	**7.4**	**1.9**	**602**	**0.1**	**4.3**	**0.1**

4. PROGRAM IMPACTS

The energy savings for each product class was calculated individually according to average efficiency levels provided by certification data from ANCE. National level savings were then calculated by comparing the consumption of stock in each year to the consumption no improvement in average efficiency. Units installed in each year were derived from unit sales figures provided by manufacturers. The sections below describe the efficiency trend for each product class, incremental prices, and results of the application of the methodology described above.

4.1. Household Refrigerators

The first MEPS for household refrigerators and refrigerator-freezers was originally named NOM-072-SCFI-1994. The first update to this standard was NOM-015-ENER-1997, and the second and last update is NOM-015-ENER-2002. The standards and update schedule is shown in Table 8.

Table 8 – MEPS Schedule for Household Refrigerators and Freezers

Official Mexican standards: "Eficiencia energética de refrigeradores y congeladores electrodomésticos" (Energy Efficiency of Household Refrigerators and Freezers).		
Name	**Publication in DOF**	**Effective date**
Original NOM-072-SCFI-1994	September 8 , 1994	January 1, 1995
Update NOM-015-ENER-1997	July 11, 1997	August 1, 1997
Update NOM-015-ENER-2002	January 13, 2003	After 120 days (March 14, 2003)

4.1.1. Energy Savings

Domestic refrigerators and refrigerator/freezers are an attractive target for minimum efficiency standards, because they are large consumers of electricity, and usually allow for cost-effective efficiency improvement. The Mexican case is no exception. In fact, these products provided the most energy savings, financial and environmental benefit of any product covered by the program.

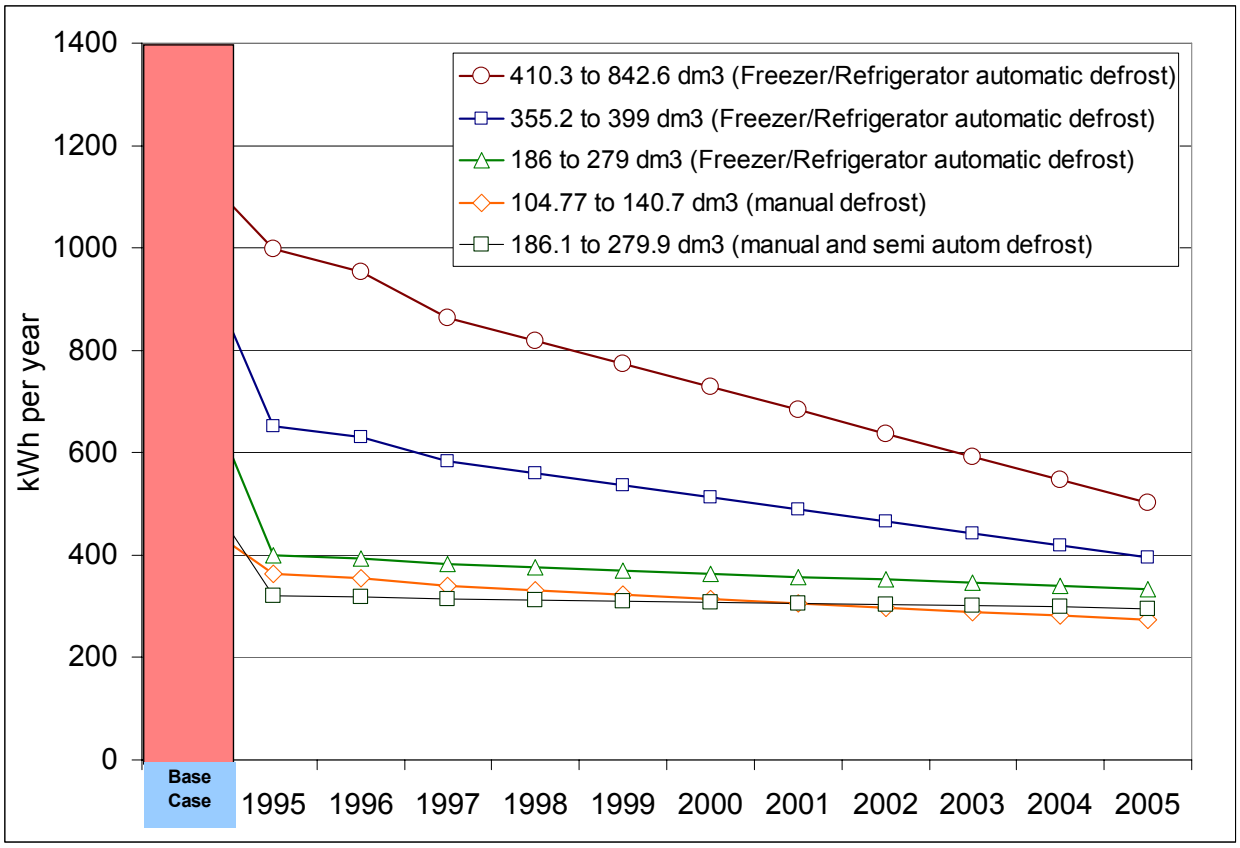
Table 9 – Consumption Level Trends – Refrigerator Product Classes

Product Class	Market Share[1]	Baseline UEC[2]	Consumption		% Improvement	
			1995	2005	1995	2005
104.77 to 140.7 dm^3 (manual defrost)	6%	483	364	273	25%	43%
186.1 to 279.9 dm^3 (manual and semi automatic defrost)	43%	579	321	296	44%	49%
186 to 279 dm^3 (Ref/Frz automatic defrost)	11%	812	400	334	51%	59%
355.2 to 399 dm^3 (Ref/Frz automatic defrost)	14%	1050	653	396	38%	62%
410.3 to 842.6 dm^3 (Ref/Frz automatic defrost)	27%	1178	999	502	15%	57%
Total	**100%**	**828**	**564**	**369**	**32%**	**55%**

[1] As of 1998.
[2] 1994 efficiency values, provided by manufacturers.

Table 9 shows dramatic improvement in efficiency as a result of the program. Upon implementation of the initial MEPS in 1995, efficiency improvement was most pronounced in the two classes of refrigerators between 186 and 280 dm^3 (liters), which together compose over half the market. By 2005, however, improvement was dramatic across all classes. Efficiency Trends are presented graphically in Figure 3.

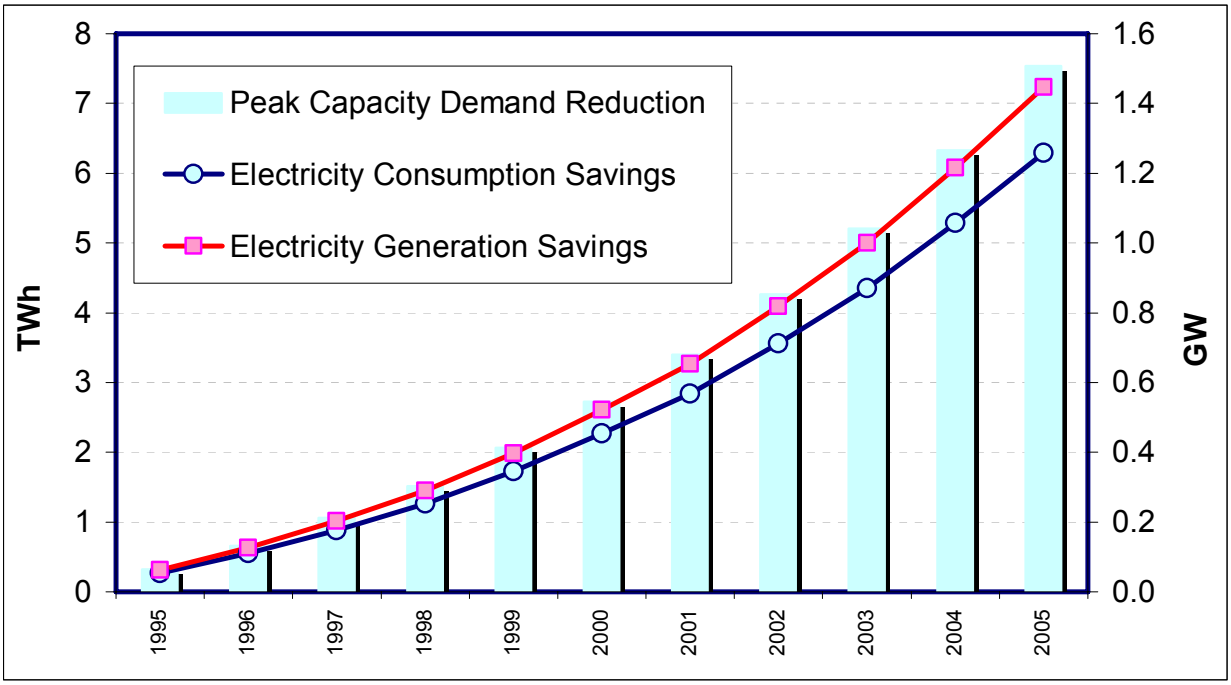
Figure 3 - Consumption of Refrigerator Product Classes



Source: ANCE

In the ten years between 1995 and 2005, about 16 million domestic refrigerators were sold in México. In 2005, we assumed that all of these units are still in operation, and calculated that on average they use between about 250 and 450 kWh per year less than they would have in the absence of MEPS. The resulting consumer electricity savings is shown in Figure 4. Peak power reductions (in MW) are calculated for refrigerators assuming a load factor of 40%, and a peak coincidence factor of 68%.

Figure 4 – Energy and Power Savings of Household Refrigerator MEPS



4.1.2. Financial Impacts

Refrigerator prices from 1998 are assumed to prevail between 1995 and 2002, after which the 2002 prices were used. Table 10 shows the retail price evolution for each class of refrigerator. As might be expected, the implementation of MEPS caused a significant rise in retail prices. The initial incremental retail price was $183, averaged over all product classes. By 2002, however, inflation-corrected incremental prices had dropped to $155, indicating technological improvements in the production of either high-efficiency refrigerators, or refrigerators as a whole. National Equipment costs in each year are equal to the incremental retail price multiplied by annual shipments for each product class.

Table 10 – Retail Price of Household Refrigerators and Refrigerator/Freezers.

Product Class	Market Share	Baseline Price	Price		Δ Price	
			1998	2002	1998	2002
	%	2005 $	2005 $	2005 $	2005 $	2005 $
104.77 to 140.7 dm^3 (manual defrost)	6%	$243	$287	$304	$44	$60
186.1 to 279.9 dm^3 (manual and semi automatic defrost)	43%	$295	$482	$427	$187	$132
186 to 279 dm^3 (Ref/Frz automatic defrost)	11%	$584	$754	$553	$170	-$31
355.2 to 399 dm^3 (Ref/Frz automatic defrost)	14%	$614	$866	$651	$252	$37
410.3 to 842.6 dm^3 (Ref/Frz automatic defrost)	27%	$1,253	$1,426	$1,594	$174	$342
Total	**100%**	**$630**	**$813**	**$785**	**$183**	**$155**

Utility bill savings for refrigerators were calculated from unit reductions in annual electricity consumption, in combination with the marginal tariff for residential customers presented in Table 4. National user operating cost savings equal utility bill savings multiplied by the number of units of each cohort remaining in the stock. Both incremental equipment costs and utility bill savings were discounted at a rate of 8.51% for consumers, back to 1995.

In the utility perspective, there are two elements of cost savings. Standards reduce expenditures both in the form of reduced utility costs and avoided capital expenditures to increase generation capacity. Production costs are calculated taking into account transmission and distribution losses, and according to the production unit cost given in Section 3.2.3. Avoided capital costs are calculated according to the use factor and coincidence factor for refrigerators, and by applying the annualized cost of generation capacity. Revenue losses to utilities are taken into account according to marginal electricity prices. Since residential consumers pay quite high rates for electricity at the margin, electricity purchase reductions in this sector generally result in net losses in revenue to utilities. Utility financial impacts are discounted at a rate of 12% back to 1995.

Finally, there are several financial impact components from standards from the perspective of appliance manufacturers. Improving the efficiency of products incurs costs to manufacturers in terms of components, redesign, and facility costs. Manufacturer costs for refrigerators are given in Table 11.

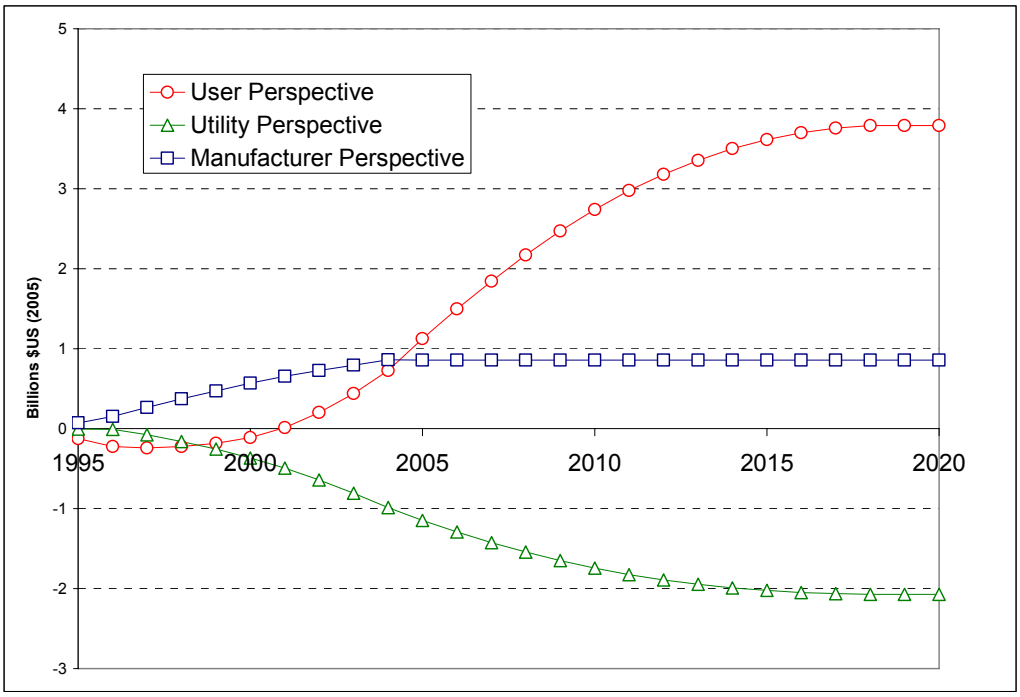
Table 11 – Manufacturer Costs Associated with Refrigerator MEPS

	1994	2002
	Millions 2005 $US	
Compressor line	66.3	
Redesign		2.2
Compressor		1.1
Plant layout		18.4
Others		0.9

In addition, manufacturers paid for testing and certification estimated at about $2 per unit sold. On the other hand, manufacturers gained in revenue from higher prices paid for high efficiency equipment.

The Cumulative Net Present Value (NPV) from each perspective is shown in Figure 5. Cumulative financial impacts are calculated through 2020, since products shipped through 2005 continue to produce energy savings as long as they are still operating. We assume that products remain in the stock for 15 years.

Figure 5 – Cumulative Net Present Value of Financial Impacts for Refrigerators



4.1.3. Environmental Impacts

Environmental impacts were determined from avoided electricity production according to the generation mix and emissions factors given in Table 7. Mitigation of each form of

pollution from 1995 to 2005 is given in Figure 6. The right-hand axis on the chart refers to CO_2 emissions only.

Figure 6 – Emissions Mitigation from Refrigerator Standards

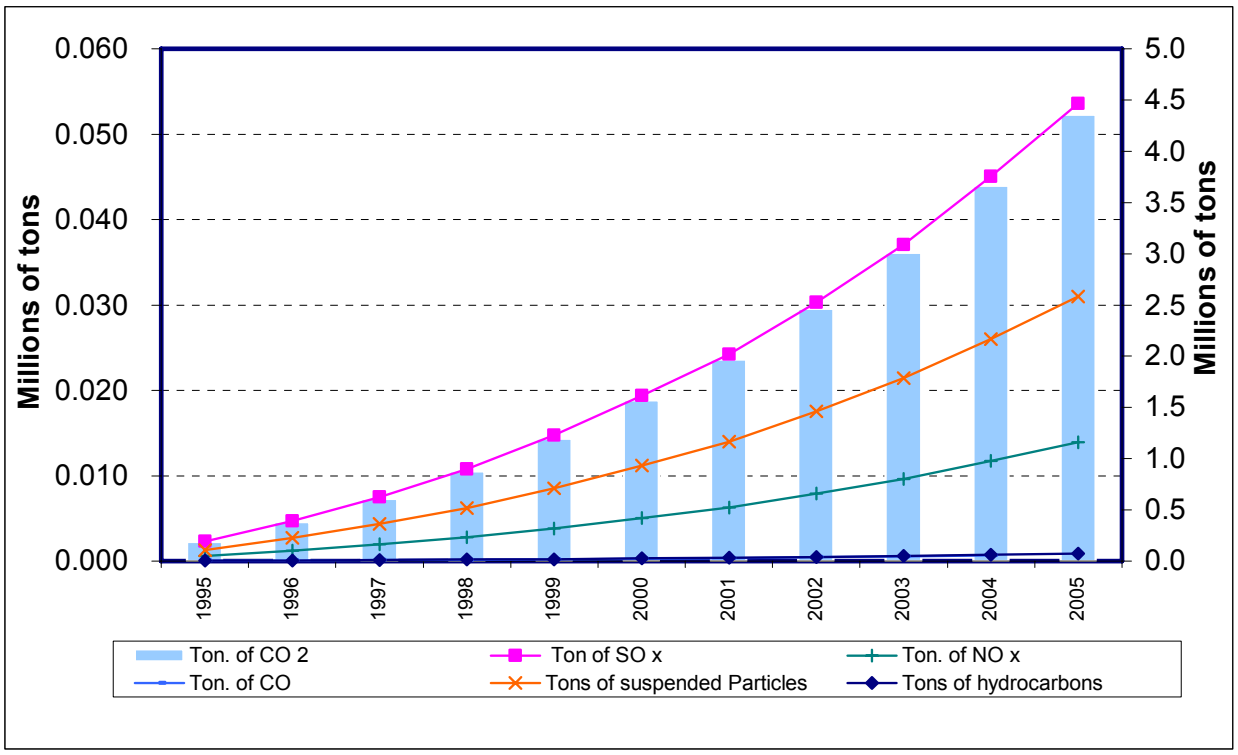


Table 12 shows a summary of impacts as a result of household refrigerator energy efficiency standards in the Mexican market in the last ten years. The results consider impacts only from products shipped through 2005, but consider future savings resulting from the use of these products. Savings continue to accumulate after 2005, while products shipped between 1995 and 2005 remain in the stock. Peak demand reduction, in MW, is at its maximum in 2005.

Table 12 – Summary Impacts for household refrigerators MEPS in Mexico.

	TOTAL THROUGH		
	2000	2005	2015
Energy and Power savings			
Cumulative Avoided Consumption (TWh)	6.96	29.29	85.25
Cumulative Avoided Production (TWh)	8.00	33.67	98.01
Reduced Demand (MW)	544	1,507	
Economic benefits (Millions $2005 US)			
Cumulative NPV - Users	-0.11	1.20	4.22
Cumulative NPV - Utilities	-0.37	-1.18	-2.24
Cumulative NPV - Manufacturers	0.57	0.86	0.86
Cumulative NPV - Net	0.09	0.88	2.84
Environmental Savings - Avoided Emissions (kton)			
Cumulative SO_x Avoided	59	250	796
Cumulative NO_x Avoided	15	65	207
Cumulative CO_2 Avoided	4,819	20,279	64,645
Cumulative CO Avoided	1	4	12
Cumulative Suspended Particles Avoided	34	144	460
Cumulative Hydrocarbons Avoided	1	4	13

4.2. Room Air Conditioners

The first room air conditioner energy efficiency standard was NOM-073-SCFI-1994 and its update version is NOM-021-ENER/ SCFI/ecol-2000. Their publication and effective dates are:

Table 13 – MEPS Schedule for Room Air Conditioners

Official Mexican standards: "Eficiencia energética de acondicionadores de aire tipo cuarto" (Energy Efficiency of Room Air Conditioners)		
Name	**Publication in DOF**	**Effective date**
Original NOM-073-SCFI-1994	September 8, 1994	January 1, 1995
Update NOM-021-ENER/SCFI/ECOL-2000	April 24, 2001	After 60 days (July 23, 2001)

4.2.1. Energy Savings

Air conditioning is not extremely common in Mexican households, but is a widely used product in the commercial sector. As in many developing countries, air conditioning use is growing rapidly with economic growth.

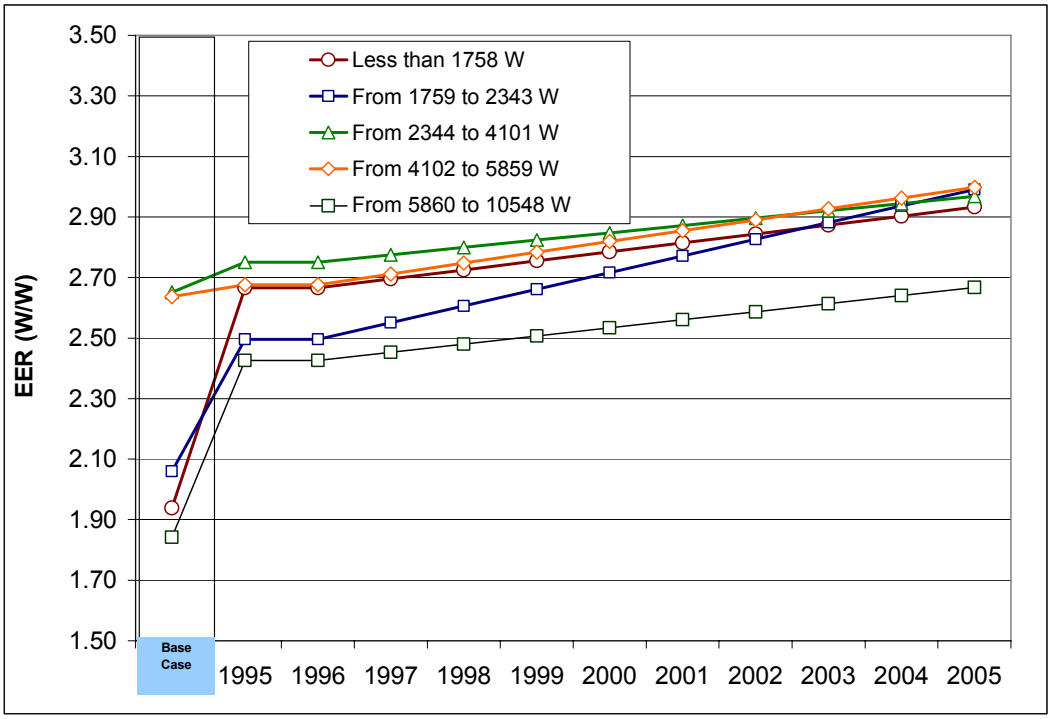
Table 14 – Consumption Level Trends – Air Conditioner Product Classes

Product Class	Market Share[3]	Baseline UEC	Consumption		% Improvement	
			1995	2005	1995	2005
Less than 1758 W	15%	1690	1242	1129	27%	33%
From 1759 to 2343 W	11%	2256	1769	1476	22%	35%
From 2344 to 4101 W	39%	3382	2407	2231	29%	34%
From 4102 to 5859 W	24%	5072	3712	3313	27%	35%
From 5860 to 10548 W	11%	10146	8189	7449	19%	27%
Total	**100%**	**4162**	**3118**	**2822**	**25%**	**32%**

Table 14 shows significant improvement in efficiency as a result of the program. Upon implementation of the initial MEPS in 1995, air conditioner efficiency improved by 20%-30% relative to the baseline. By 2005, efficiency showed further improvement in all capacity categories, corresponding to a 25%-35% improvement relative to 1994 levels. Air conditioning efficiency trends are shown graphically in Figure 7.

[3] As of 1998

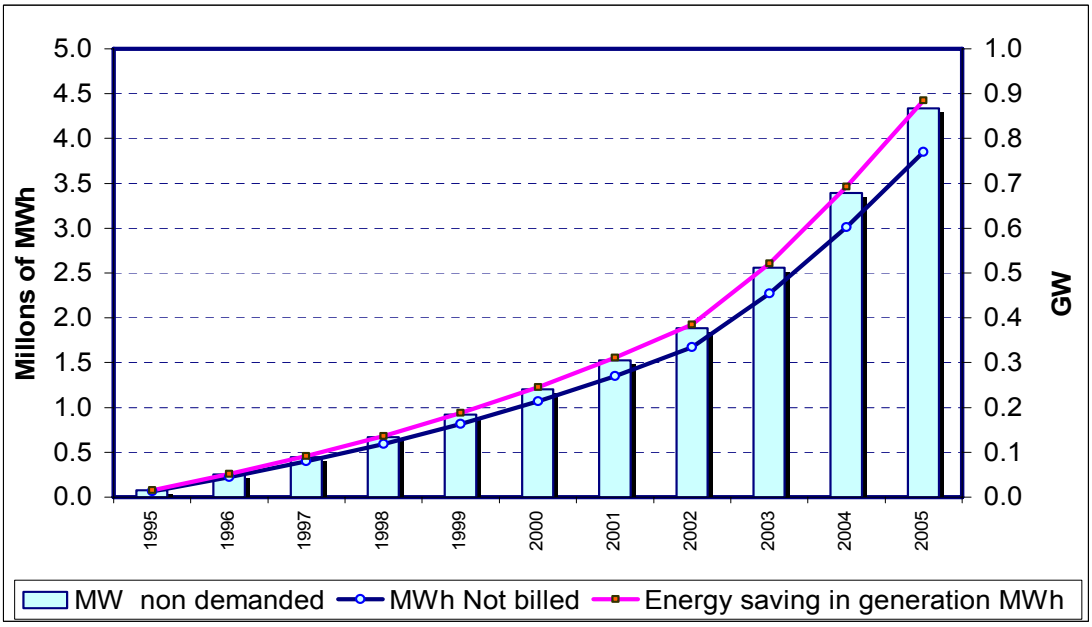
Figure 7 – Efficiency of Air Conditioner Product Classes (Watts/Watt)



Source: ANCE

Room air conditioner sales in Mexico were about 160,000 in 1994, but grew rapidly during the first ten years of the standards program, reaching 568,000 in 2004. The average annual growth rate during the full 10 year period was about 15%, but exceeded 30% in the last three years of the analysis period. The resulting consumer electricity savings for room air conditioners are shown in Figure 8.

Figure 8 – Energy and Power Savings of Room Air Conditioner MEPS



4.2.2. Financial Impacts

Table 15 shows the retail price evolution for each category of room air conditioners. After the implementation of MEPS, there was only a small rise in retail prices. By 2004, however, inflation-corrected incremental prices had increased by $240 per unit, averaging over all product classes, indicating improvements in product quality beyond efficiency improvement. National Equipment costs in each year are equal to the incremental retail price multiplied by annual shipments for each product class.

Table 15 – Retail Price of Room Air Conditioners.

Product Class	Market Share	Baseline Price	Price		Δ Price	
			1998	2004	1998	2004
	%	2005 $	2005 $	2005 $	2005 $	2005 $
Less than 1758 W	15%	$290	$303	$437	$13	$147
From 1759 to 2343 W	11%	$370	$383	$558	$13	$188
From 2344 to 4101 W	39%	$483	$506	$732	$23	$249
From 4102 to 5859 W	24%	$532	$556	$797	$24	$264
From 5860 to 10548 W	11%	$584	$610	$915	$26	$331
Total	**$1**	**$465**	**$486**	**$705**	**$21**	**$240**

Utility bill savings for air conditioners were calculated using the same methodology as for refrigerators. In the case of air conditioners, however, marginal rates used are according to commercial, rather than residential tariff schedules, since air conditioning is largely a commercial product in Mexico. Air conditioners also have a somewhat lower use function and peak coincidence factor than refrigerators. They are assumed to operate 25% of the time (half of each day in a 6 month cooling season), and with a peak coincidence factor of 40%.

Since commercial consumers pay quite high rates for electricity at the margin, electricity purchase reductions in this sector generally result in net losses in revenue to utilities. Utility financial impacts are discounted at a rate of 12% back to 1995.

Finally, there are several financial impact components from standards from the perspective of appliance manufacturers. Improving the efficiency of products incurs costs to manufacturers in terms of components, redesign, and facility costs. Manufacturer costs for refrigerators are given in Table 16.

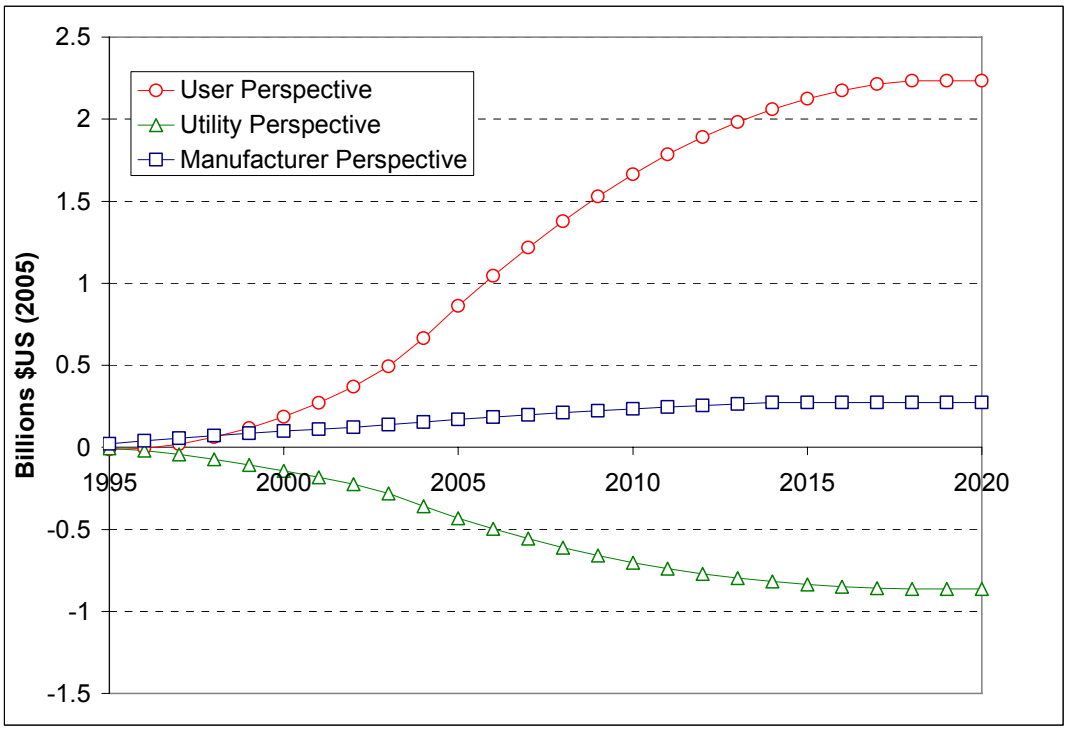
Table 16 – Manufacturer Costs Associated with Air Conditioner MEPS

	1998
	Millions 2005 $US
Design	0.14
Production line	0.05
Evaporator and compressor redesign	0.20

In addition, manufacturers paid testing and certification costs estimated at about $2 per unit sold. On the other hand, manufacturers gain in revenue from higher prices paid for high efficiency equipment.

The Cumulative Net Present Value (NPV) from each perspective is shown in Figure 9. Cumulative financial impacts are calculated through 2020, since products shipped through 2005 continue to produce energy savings as long as they are still operating. We assume that products remain in the stock for 15 years.

Figure 9 – Cumulative Net Present Value of Financial Impacts for Room Air Conditioners



4.2.3. Environmental Impacts

Environmental impacts were determined from avoided electricity production according to the generation mix and emissions factors given in Table 7. Mitigation curves for each

form of pollution from 1995 to 2005 are given in Figure 10. The right-hand axis on the chart refers to CO_2 emissions only.

Figure 10 – Emissions Mitigation from Air Conditioner Standards.

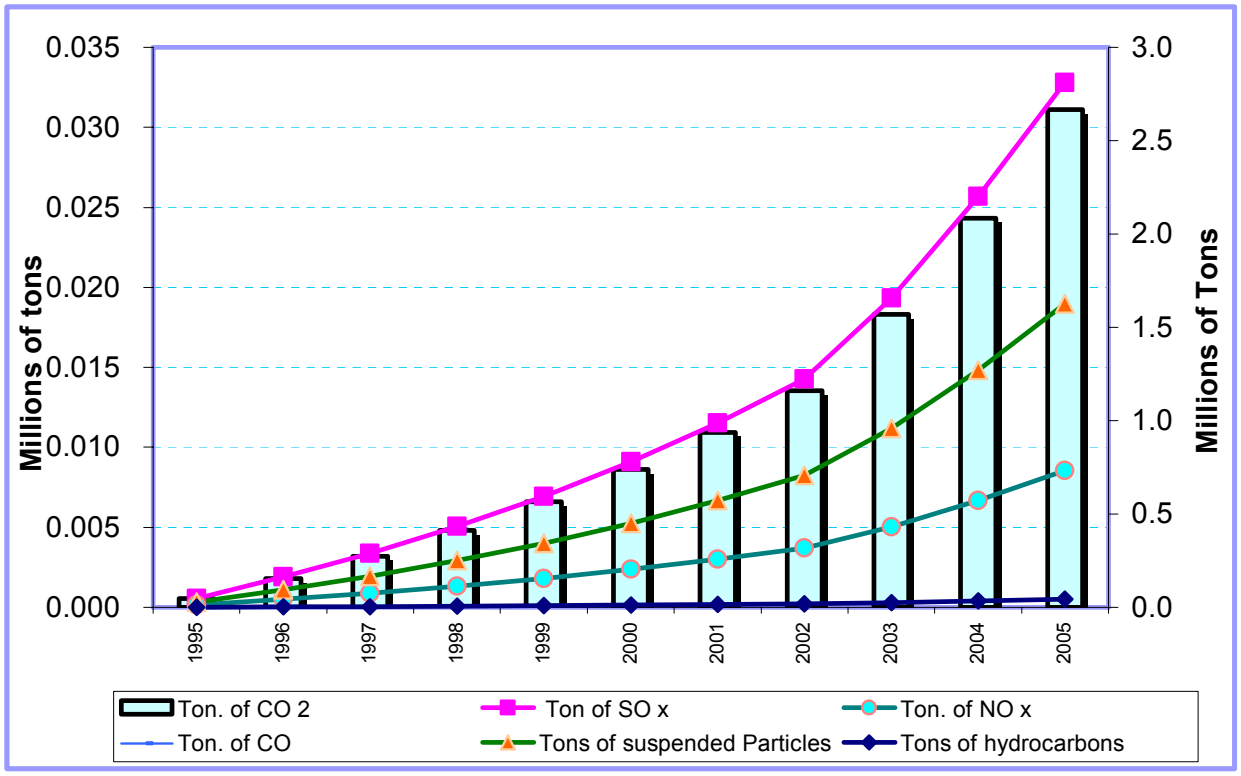


Table 17 shows a summary of impacts as a result of room air conditioner energy efficiency standards in the Mexican market in the last ten years. The results consider impacts only from products shipped through 2005, but consider future savings resulting from the use of these products. Savings continue to accumulate after 2005, while products shipped between 1995 and 2005 remain in the stock. Peak demand reduction, in MW, is at its maximum in 2005.

Table 17 – Summary Impacts for Room Air Conditioner MEPS in Mexico.

	TOTAL THROUGH		
	2000	2005	2015
Energy and Power Savings			
Cumulative Avoided Consumption (TWh)	3.16	15.32	50.66
Cumulative Avoided Production (TWh)	3.64	17.61	58.24
Reduced Demand (MW)	241	868	
Economic Benefits (Millions $2005 US)			
Cumulative NPV - Users	0.19	0.92	2.56
Cumulative NPV - Utilities	-0.14	-0.45	-0.98
Cumulative NPV - Manufacturers	0.10	0.17	0.27
Cumulative NPV - Net	0.14	0.63	1.86
Environmental Savings - Avoided Emissions (kton)			
Cumulative SO_x Avoided	27	131	485
Cumulative NO_x Avoided	7	34	126
Cumulative CO_2 Avoided	2,189	10,606	39,400
Cumulative CO Avoided	0.4	2	7
Cumulative Suspended Particles Avoided	16	75	280
Cumulative Hydrocarbons Avoided	0.4	2	8

4.3. Three-Phase Electric Motors

The first three-phase electric motors standard in México was NOM-074-SCFI-1994 and its update version is, NOM-016-ENER-2002. Their publication and effective dates are:

Table 18 – MEPS Schedule for Three-Phase Electric Motors

Official Mexican standards: “Eficiencia energética de motores de inducción de corriente alterna, tipo jaula de ardilla” (Energy Efficiency of AC Squirrel Cage Induction Motors.		
Name	**Publication in DOF**	**Effective date**
Original NOM-074-SCFI-1994	September 8, 1994	January 1, 1995
Update NOM-016-ENER-1997	June 17, 1998	June 18, 1998
Update NOM-016-ENER-2002	January 13, 2003	After 60 days (March 14, 2003)

4.3.1. Energy Savings

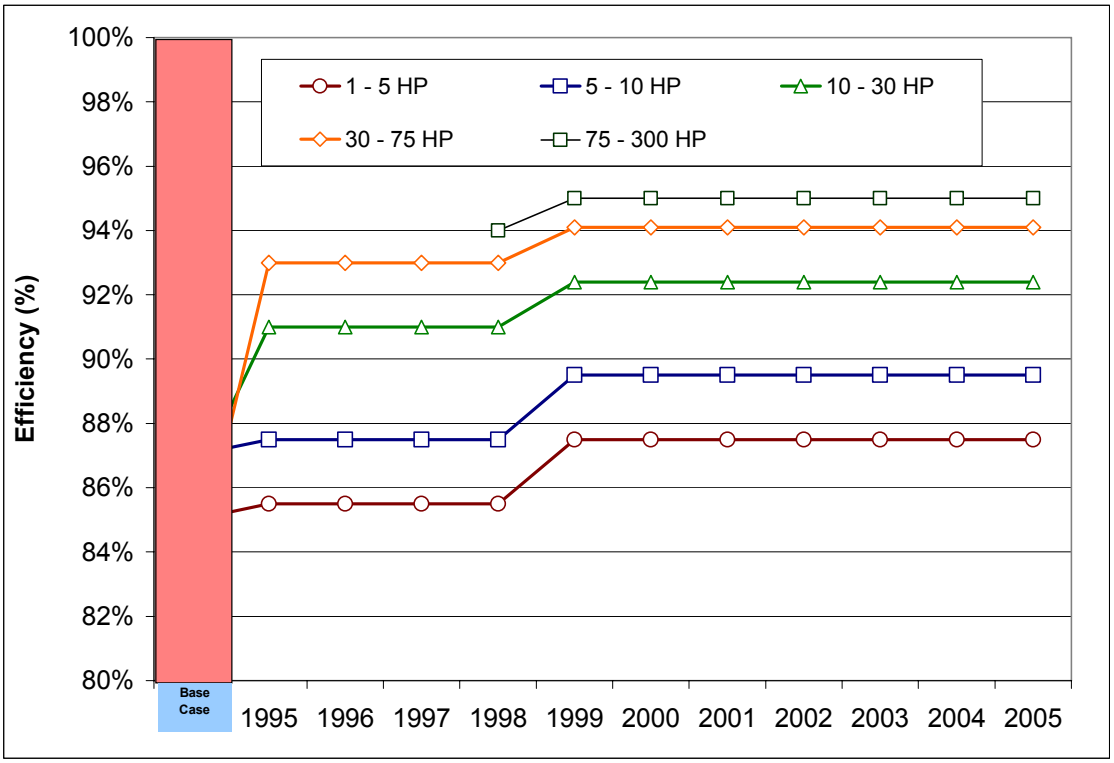
Compared to other products, electric motors are generally quite energy efficient, and additional efficiency incurs a significant incremental cost due to increased material costs. Nevertheless, these improvements are typically found to be quite cost-effective, due to the high intensity of use of this type of equipment. For the same reason, motor efficiency improvement can be significant on the national level, since this end-use represents a large fraction of electricity consumption in the industrial sector.

Table 19 – Consumption Level Trends – Three-Phase Motor Product Classes

Product Class	Market Share		Baseline UEC	Consumption (kWh)		% Improvement	
	1998	2002		1998	2005	1998	2005
1 - 5 HP	68%	64%	11532	11465	11203	0.6%	2.9%
5 - 10 HP	26%	25%	22534	22406	21905	0.6%	2.8%
10 - 30 HP	5%	9%	68389	64631	63652	5.5%	6.9%
30 - 75 HP	3%	1%	177153	158104	156256	10.8%	11.8%
75 - 300 HP	0%	1%	740285	740285	732492	0.0%	1.1%
Total	**100%**	**100%**	**21037**	**20313**	**19918**	**3.4%**	**5.3%**

Table 19 shows significant improvement in efficiency as a result of the program. Upon implementation of the initial MEPS in 1995, efficiency improvement was most pronounced in the capacity ranges from 10-30 HP and 30-75 HP. Efficiency improvements were over 10% in the larger of these classes. Efficiency standards did not cover very large motors (over 75 HP) until 1999. Efficiency trends for all motor capacity categories are presented graphically in Figure 11.

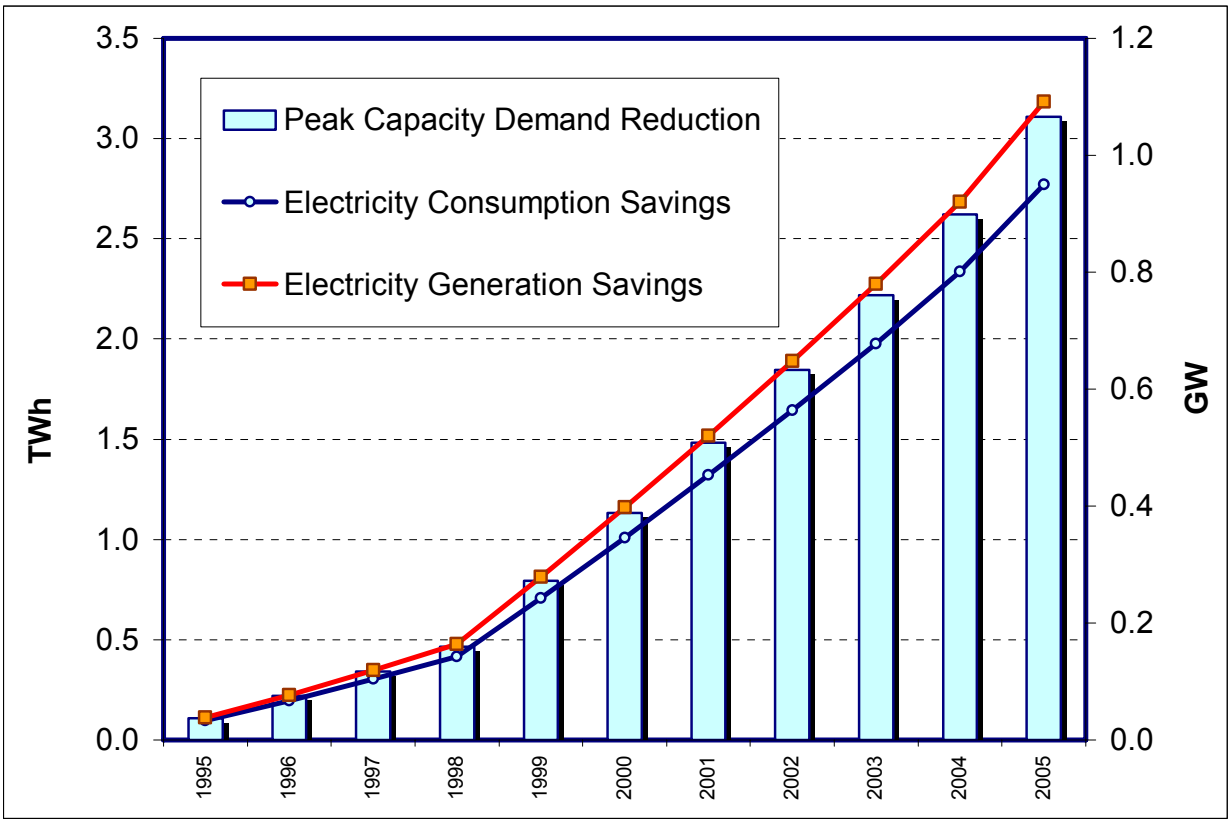
Figure 11 - Efficiency of Three Phase Motors Product Classes



Source: ANCE

In the ten years between 1995 and 2005, about 2 million three-phase electric motors were sold in México. We assumed that all of these units were still in operation in 2005, and calculate that on average they use between about 1100 kWh per year less than they would have in the absence of MEPS. The resulting consumer electricity savings is shown in Figure 12.

Figure 12 – Energy and Power Savings of Three-Phase Motors MEPS



4.3.2. Financial Impacts

Financial impacts to consumers are based on utility bill savings, less the incremental equipment costs. Incremental retail equipment prices were determined using prices obtained from distributor catalogs. Retail price data was collected before the implementation of standards in order to establish the baseline equipment cost. Retail prices were then surveyed again, in 1998 and in 2002. Prices from 1998 are assumed to prevail between 1995 and 2002, after which the 2002 prices were used. Table 20 shows the retail price evolution for each motor capacity category. As might be expected, the implementation of MEPS caused a significant rise in prices to the end user. The initial incremental retail price was $188, averaged over all product classes. By 2002, however, inflation-corrected incremental prices had dropped to $72, indicating technological improvements in the production of either high-efficiency motors, or motors as a whole. National equipment costs in each year are equal to the incremental retail price multiplied by annual shipments for each product class.

Table 20 – Retail Price of Three-Phase Motors.

Product Class	Market Share (%)		Baseline Price	Price		Δ Price	
				1998	2002	1998	2002
	1998	2002	2005 $	2005 $	2005 $	2005 $	2005 $
1 - 5 HP	68%	64%	$400	$268	$407	-$132	$7
5 - 10 HP	26%	25%	$621	$835	$633	$214	$11
10 - 30 HP	5%	9%	$531	$2,596	$1,902	$2,065	$1,371
30 - 75 HP	3%	1%	$5,000	$10,180	$5,093	$5,179	$92
75 - 300 HP	0.0%	0.6%	$15,406		$15,690		$284
Total	**100%**	**100%**	**$577**	**$765**	**$748**	**$188**	**$ 72**

As shown in Table 4, utility rates for industrial consumers are generally lower than for other sectors. Therefore, while industrial consumers see less of a financial benefit for each unit of energy saved, utility losses are also lower, since the tariff is closer to the utilities' cost of production.

Industrial motor energy savings also benefited utilities in terms of reduced capital costs to increase generation, as motor use coincides largely with peak demand (coincidence factor of 82%).

Finally, there are several financial impact components from standards from the perspective of motor manufacturers. Improving the efficiency of products incurs costs to manufacturers in terms of components, redesign, and facility costs. Manufacturer costs for motors are given in Table 21.

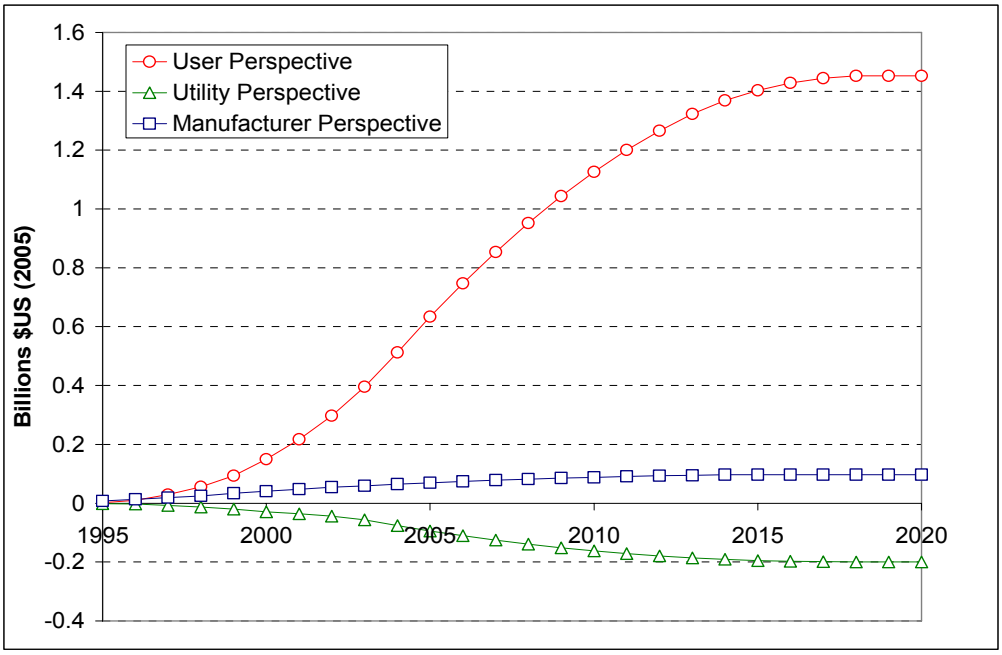
Table 21 – Manufacturer Costs Associated with Three-Phase Motor MEPS

	Millions 2005 $US
Adjust in models	0.03
Investment in machinery for process improvement	0.91
New factory is built	1.85

In addition, manufacturers paid testing and certification costs estimated at about $2 per unit sold. On the other hand, manufacturers gain in revenue from higher prices paid for high efficiency equipment.

The Cumulative Net Present Value (NPV) from each perspective is shown in Figure 13. Cumulative financial impacts are calculated through 2020, since products shipped through 2005 continue to produce energy savings as long as they are still operating. We assume that products remain in the stock for 15 years.

Figure 13 – Cumulative Net Present Value of Financial Impacts for Three-Phase Motors



4.3.3. Environmental Impacts

Environmental impacts were determined from avoided electricity production according to the generation mix and emissions factors given in Table 7. Mitigation of each form of pollution from 1995 to 2005 are given in Figure 14. The right-hand axis on the chart refers to CO_2 emissions only.

Figure 14 – Emissions Mitigation from Three-Phase Motors Standards.

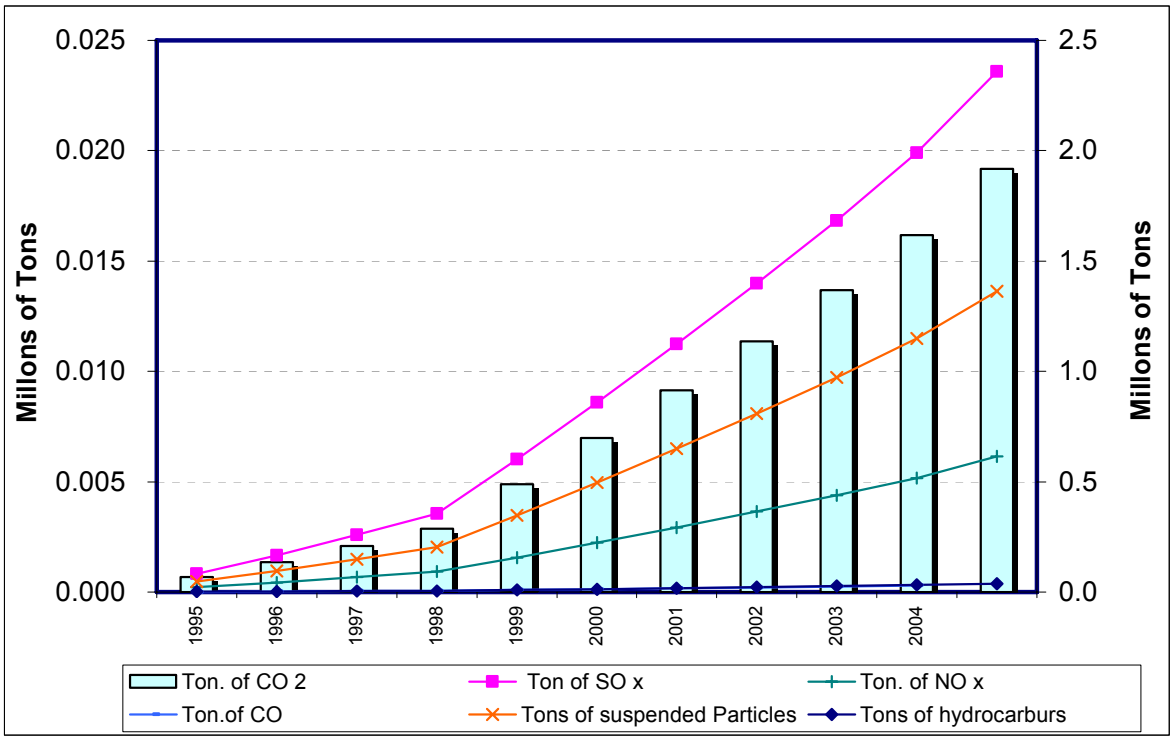


Table 22 shows a summary of impacts as a result of three-phase motor energy efficiency standards in the Mexican market in the last ten years. The results consider impacts only from products shipped through 2005, but consider future savings resulting from the use of these products. Savings continue to accumulate after 2005, while products shipped between 1995 and 2005 remain in the stock. Peak demand reduction, in MW, is at its maximum in 2005.

Table 22 – Summary Impacts for Three-Phase Motors MEPS in Mexico.

	TOTAL THROUGH		
	2000	2005	2015
Energy and Power Savings			
Cumulative Avoided Consumption (TWh)	2.73	12.77	37.74
Cumulative Avoided Production (TWh)	3.14	14.68	43.38
Reduced Demand (MW)	388	1,066	
Economic Benefits (Millions $2005 US)			
Cumulative NPV – Users	0.15	0.66	1.58
Cumulative NPV – Utilities	-0.03	-0.10	-0.22
Cumulative NPV – Manufacturers	0.04	0.07	0.10
Cumulative NPV – Net	0.16	0.63	1.46
Environmental Savings - Avoided Emissions (kton)			
Cumulative SO_x Avoided	23	109	350
Cumulative NO_x Avoided	6	28	91
Cumulative CO_2 Avoided	1,888	8,842	28,458
Cumulative CO Avoided	0.4	2	5
Cumulative Suspended Particles Avoided	13	63	202
Cumulative Hydrocarbons Avoided	0.4	2	6

4.4. Household Electric Clothes Washers

The first electric clothes washer energy efficiency standard was called NOM-005-ENER-1996 and its updated version is NOM-ENER-005-2000. The publication and effective dates of these standards are shown in Table 23:

Table 23 – MEPS Schedule for Household Electric Clothes Washers

Official Mexican standards: "Eficiencia energética de lavadoras de ropa electrodoméstica" (Energy Efficiency of Household Electric Clothes Washers).		
Name	**Publication in DOF**	**Effective date**
Original NOM-005-ENER-1996	July 11, 1996	After 10 months (May 11th , 1997)
Update NOM-005-ENER-2000	August 28, 2000	After 60 days (October 27, 2000)

4.4.1. Energy Savings

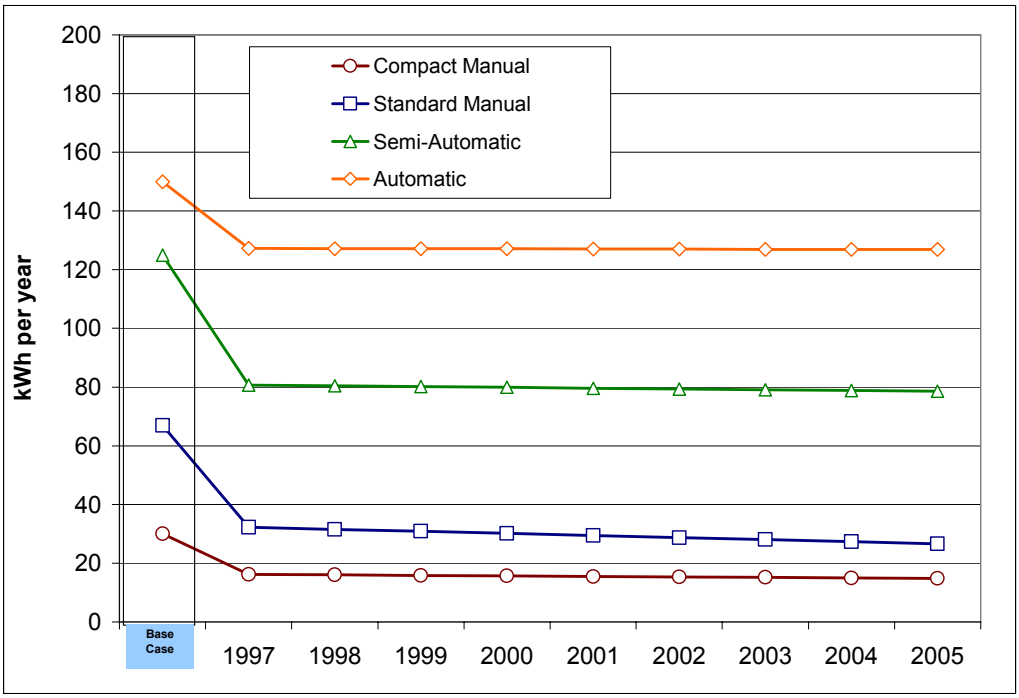
Clothes washers consume less energy than the other products covered by this study, but these products generally allow for significant energy savings in the residential sector.

Table 24 – Consumption Level Trends – Washing Machine Product Classes

Product Class	Market Share[4]	Baseline UEC	Consumption 2005	% Improvement 2005
Compact Manual	29%	30	15	49%
Standard Manual	6%	67	40	40%
Semi-Automatic	29%	125	46	63%
Automatic	36%	150	23	85%
Total	**100%**	**103**	**29**	**72%**

Table 24 shows the improvement in efficiency as a result of the program. Efficiency improvement was most dramatic in the two most energy intensive product classes, the semi-automatic and automatic classes (63% and 85% respectively). Overall, energy efficiency improvement of washing machines was also quite large (72%) due to the large market share of these two classes. Efficiency trends of all product classes are presented graphically in Figure 15.

Figure 15 - Consumption of Washing Machine Product Classes

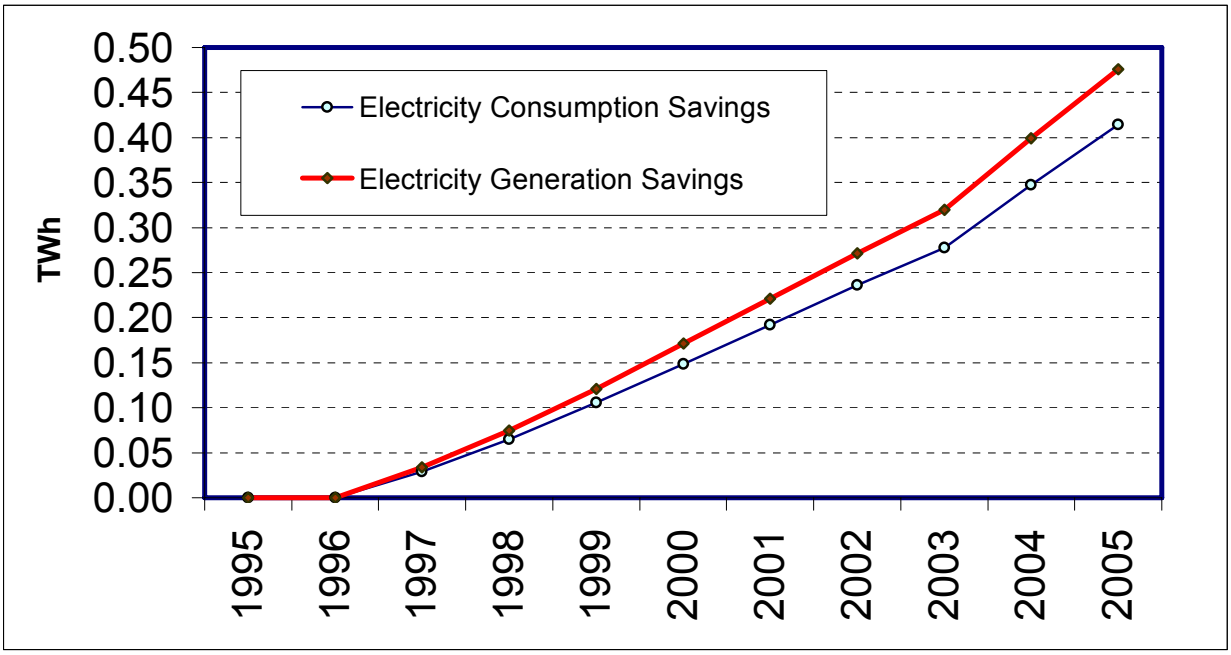


Source: ANCE

In the ten years between 1995 and 2005, about 3.2 million washing machines were sold in México. We assume that all of these units were still in operation in 2005, and calculated that on average they use between about 70 kWh per year less than they would have in the absence of MEPS. The resulting consumer electricity savings is shown in Figure 16.

[4] As of 1998

Figure 16 – Energy and Power Savings of Washing Machine MEPS



4.4.2. Financial Impacts

Financial impacts to consumers are based on utility bill savings, less incremental equipment costs. Incremental retail equipment prices were determined using prices obtained in department stores and web sites for national manufacturers. Retail price data was collected before the implementation of standards in order to establish baseline equipment cost. Retail prices were then surveyed again in 1998 and in 2002. Prices from 1998 were assumed to prevail between 1995 and 2002, after which the 2002 prices were used. Table 25 shows the retail price evolution for each class of washing machine.

Table 25 – Retail Price of Household Washing Machines.

Product Class	Market Share (%)		Baseline Price	Price		Δ Price	
				1998	2002	1998	2002
	1998	2002	2005 $	2005 $	2005 $	2005 $	2005 $
Compact Manual	40%	29%	$209	$212	$225	$3	$16
Standard Manual	35%	6%	$359	$367	$367	$7	$8
Semi-Automatic	15%	29%	$418	$489	$496	$72	$78
Automatic	10%	36%	$819	$827	$826	$8	$8
Total	**100%**	**100%**	**$354**	**$369**	**$530**	**$15**	**$ 22**

Implementation of MEPS caused only a small rise in retail prices. The initial incremental retail price was $354, averaged over all product classes. By 1998, however, inflation-corrected incremental prices were $15 higher, and these continued to increase slightly, to $22, in 2002.

Utility bill savings for washing machines were calculated from unit reductions in annual electricity consumption, in combination with the marginal tariff for residential customers presented in Table 4. National user operating cost savings are calculated as unit annual utility bill savings multiplied by the number of units of each cohort remaining in the stock. Both incremental equipment costs and utility bill savings are discounted at a rate of 8.51% for consumers, back to 1995.

In the utility perspective, production costs are calculated taking into account transmission and distribution losses, and according to the production unit cost given in Section 3.2.3. Washing machine efficiency improvement was not assumed to contribute to reduction of utility capital costs to install additional capacity, as the use of this product is assumed to occur in off-peak hours (peak coincidence factor of 0%). Revenue losses to utilities are taken into account according to user marginal electricity prices. Since residential consumers pay quite high rates for electricity at the margin, electricity purchase reductions in this sector generally result in net losses in revenue to utilities. Utility financial impacts are discounted at a rate of 12% back to 1995.

Finally, there are several financial impact components from standards from the perspective of washing machine manufacturers. Improving the efficiency of products incurs costs to manufacturers in terms of components, redesign, and facility costs. Manufacturer costs for refrigerators are given in Table 26.

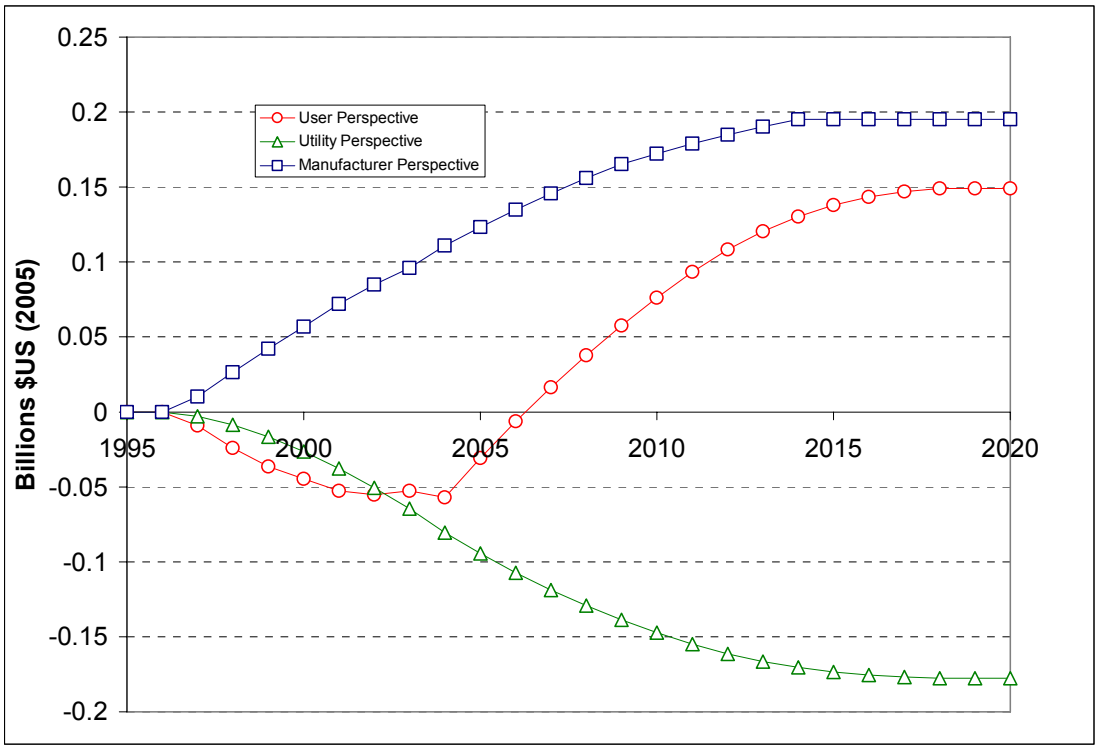
Table 26 – Manufacturer Costs Associated with Washing Machine MEPS

	1997
	Millions 2005 $US
Motor redesign	0.09
Transmission system	0.01
New plant layout	6.24

In addition, manufacturers paid testing and certification costs estimated at about $2 per unit sold. On the other hand, manufacturers gain in revenue from higher prices paid for high efficiency equipment.

The Cumulative Net Present Value (NPV) from each perspective is shown in Figure 17. Cumulative financial impacts are calculated through 2020, since products shipped through 2005 continue to produce energy savings as long as they are still operating. We assume that products remain in the stock for 15 years.

Figure 17 – Cumulative Net Present Value of Financial Impacts for Washing Machines



4.4.3. Environmental Impacts

Environmental impacts were determined from avoided electricity production according to the generation mix and emissions factors given in Table 7. Mitigation of each form of pollution from 1995 to 2005 is given in Figure 6. The right-hand axis on the chart refers to CO_2 emissions only.

Figure 18 – Emissions Mitigation from Washing Machine Standards.

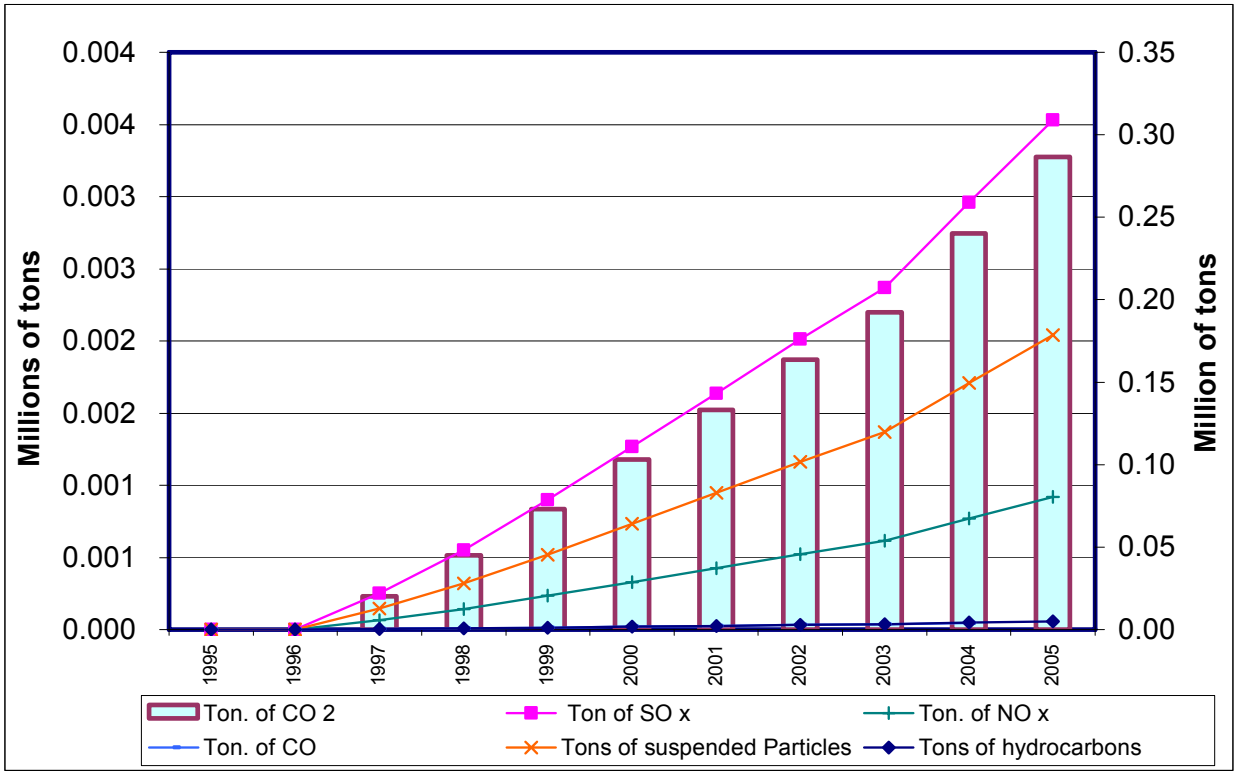


Table 27 shows a summary of impacts as a result of washing machine energy efficiency standards in the Mexican market in the last ten years. The results consider impacts only from products shipped through 2005, but consider future savings resulting from the use of these products. Savings continue to accumulate after 2005, while products shipped between 1995 and 2005 remain in the stock. Washing machines are not expected to significantly reduce peak demand, since this product is generally used during off-peak hours.

Table 27 – Summary Impacts for Household Electric Washing Machine MEPS in Mexico.

Energy and Power savings			
	TOTAL THROUGH		
	2000	2005	2015
Energy and Power Savings			
Cumulative Avoided Consumption (TWh)	0.35	1.82	5.61
Cumulative Avoided Production (TWh)	0.40	2.09	6.45
Reduced Demand (MW)	0	0	
Economic Benefits (Millions $2005 US)			
Cumulative NPV - Users	-0.04	-0.03	0.18
Cumulative NPV - Utilities	-0.03	-0.10	-0.19
Cumulative NPV - Manufacturers	0.06	0.12	0.20
Cumulative NPV – Net	-0.01	0.00	0.18
Environmental Savings - Avoided Emissions (kton)			
Cumulative SO_x Avoided	3	15	52
Cumulative NO_x Avoided	1	4	14
Cumulative CO_2 Avoided	241	1,257	4,254
Cumulative CO Avoided	0.0	0.2	1
Cumulative Suspended Particles Avoided	2	9	30
Cumulative Hydrocarbons Avoided	0.0	0.2	1

5. CONCLUSIONS

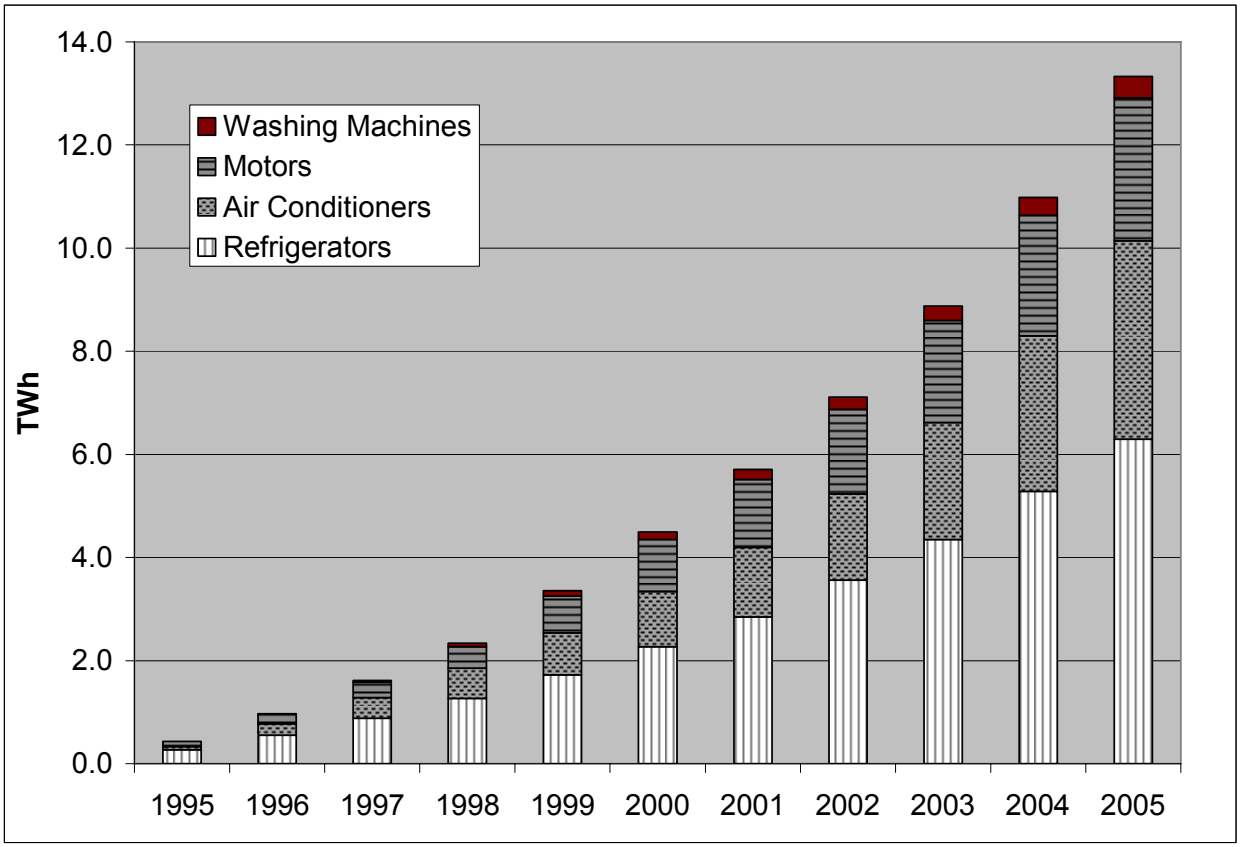
Mexican energy efficiency standards have been strengthened over time through a process of periodic updates. Standards for the products discussed in this report have had one or more revisions since their implementation in 1995, with each revision requiring higher energy efficiency than the previous one. This process has brought Mexican efficiency requirements in line with some of the most stringent standards in the world. The most dramatic case is refrigerators where the consumption values required by the most recent standard imply a 62% improvement relative to the 1994 baseline.

In fact, efficiency improvements of the four products studied generally exceeded the requirements of minimum efficiency standards. A possible explanation for this effect is the desire of manufacturers to market their products in the U.S. and Canada, and to avoid maintaining separate lines of production for these foreign markets and the Mexican domestic market.

Test procedures for three of the standards (refrigerator/freezers, air conditioners and motors) are harmonized with their U.S. counterpart, so consumption values can be compared directly (in fact, an initiative exists to recognize the certificates of compliance of standards in all the three countries of NAFTA). The only exception is washing machines, for which the product classes differ significantly from those common in the

U.S. and Canada, and the test method differs accordingly. As a further aspect of harmonization, the current Mexican MEPS for refrigerators, room air conditioners and motors are equivalent to those in the US and Canada.

Figure 19 Electricity Consumption Avoided (Delivered Energy) – All Products



The results for all products show that Mexican MEPS had significant impacts for all products. Impacts are most dramatic for refrigerators, due to the high saturation of this product, and the relatively large opportunities for efficiency improvements. Air conditioners are also high energy consumers, and sales of this product increased rapidly during the first 10 years of the standards program. By 2005, the savings from air conditioners approached that of refrigerators, demonstrating that the standards program took very good advantage of the growth in this end use, since the majority of the air conditioner stock in 2005 was installed under the standards regime.

Savings from three-phase motors are also significant, but less so than the other products. Finally, savings from washing machines are relatively small, since these products are generally lower energy consumers in the first place.

Figure 19 illustrates the avoided electricity consumption for all products and Table 28 summarizes program impacts for all products. Energy and environmental impacts are cumulative for the period from 1995 through 2005. Financial impacts are included only

for products shipped in this period, but include operating savings to 2015, to account for the full life of most products. Financial savings are discounted to 1995.

Table 28 Summary of Impacts of Mexican MEPS – All Products

Energy and Power savings through 2005					
	Refrigerators	Air Conditioners	Motors	Washing Machines	**Total**
Cumulative Avoided Consumption (TWh)	29	15	13	1.8	59
Cumulative Avoided Production (TWh)	34	18	15	2	68
Reduced Demand (MW)	1,507	868	1,066	0	3,440
Economic benefits through 2015 (Millions $2005 US)					
Cumulative NPV – Users	4.2	2.6	1.6	0.2	8.5
Cumulative NPV – Utilities	-2.2	-1.0	-0.2	-0.2	-3.6
Cumulative NPV – Manufacturers	0.9	0.3	0.1	0.2	1.4
Cumulative NPV – Net	2.8	1.9	1.5	0.2	6.3
Environmental Savings - Avoided Emissions (kton) through 2005					
Cumulative SO_x Avoided	250	131	109	15	504
Cumulative NO_x Avoided	65	34	28	4	131
Cumulative CO_2 Avoided	20,279	10,606	8,842	1,257	40,984
Cumulative CO Avoided	4	2	2	0.2	8
Cumulative Suspended Particles Avoided	144	75	63	9	292
Cumulative Hydrocarbons Avoided	4	2	2	0.2	8

In the original analysis performed in the initial years of the program, total delivered electricity consumption for all four products through 2004 was projected to be 36.5 TWh. In the updated analysis, savings through 2004 is estimated at 45.9 TWh, or 26% higher. These two analyses utilized the same methodology for assessing impacts; the only difference is between projected per unit efficiency of the market in the initial study, compared to actual retrospective efficiency data in the updated study. The difference between the two studies therefore clearly shows that the efficiency of the market significantly exceeded the requirements of the Mexican regulations. This suggests that manufacturers had a market-driven motive for improving efficiency. It seems unlikely, however, that efficiency improvement would have occurred as dramatically, or as rapidly, without the impetus provided by the MEPS program.

The impact of MEPS on the Mexican electricity system has been significant. Taken together, standards for these four products reduced electricity demand by 13.3 TWh in 2005, or 15.3 TWh of gross generation. Total gross generation in Mexico in this year was 160 TWh. Therefore, standards for these products accounted to a 9.6% reduction in demand in this year. In terms of capacity, standards reduced the need for total generating capacity of 3440 MW, or 6.4% of capacity installed by 2004 of 53561 MW.

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SRIA. DE HACIENDA Y CRÉDITO PÚBLICO
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CFE COMISIÓN FEDERAL DE ELECTRICIDAD
http://www.cfe.gob.mx/es/

CONAE, COMISIÓN NACIONAL PARA EL AHORRO DE ENERGÍA
http://www.conae.gob.mx/

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http://www.condusef.gob.mx/

References:

Estadísticas del sector eléctrico nacional, 1994 -2003; CFE.

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Programa de obras e inversiones 2004 -2013; CFE (POISE)

Appendix A: Input Variables

Financial Variables

Interest rate

Definition:

The rate which is charged or paid for loans obtained by manufacturers for modifying its production lines.

Source:

Bank of Mexico.; WEBsite

Considerations:

The information of Bank of Mexico is expressed as percentage annual base.

Values:

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
TIIE (%)			48.85	28.64	21.91	26.89	24.10	16.96	12.89	8.17	6.83	7.15

Reference:

TIIE . The Interbank Equilibrium Interest Rate.

Comments:

Discount rate

***Definition*:**

The interest rate that a depositary institution is charged to borrow short term funds. Also is used to determine the present value of future cash flows.

Source:

Consumers: Comisión Nacional para la Protección y Defensa de los Usuarios de Servicios Financieros CONDUSEF, Website

Manufacturers: Personal communication ANFAD

Electric Utility: Costs and references parameters for investments projects in electric sector; Subdirección de programación, 2004 ; CFE

Considerations:

Consumers: It is the rate of mutual funds that guarantee a profit on the real inflation, short term investment instrument

Manufacturers: Rate used for projecting their investments.

Electric Utility: Rate used by CFE to project future investments (COPAR)

Values:

	Discount rate
Consumers	8.51%
Manufacturers	17%
CFE	12%

Reference:

Comments:
For Electric Utility the rate for 2004 was used.

Exchange Rate

***Definition*:**
Rate which is used to settle liabilities denominated in foreign currency

Source:
Bank of Mexico

Considerations
Reported by Bank of Mexico

Values:

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Rate exchange	3.26	3.41	6.6	7.65	8.08	9.86	9.51	9.57	9.14	10.31	11.23	11.26

Reference:

Comments: We used the 2004 exchange rate.

Stock Turnover

Time line analysis

***Definition*:**
The period in which the equipment is useful and energy savings are generated.

Source:
Manufacturers.

Considerations:
Same value as used in the initial study

Values:
Refrigerators: 20 years
Room air conditioners: 20 years
Electric motors: 20 years
Clothes washers: 15 years

Reference:
Original assumption made by manufacturers

Comments: For clothes washers we calculated the energy savings for 16 years as the annual production of year 16 minus annual production of year 1.

Market growth rate

Definition:
Production market growth, in percentage, year by year during the considered timeline.

Source:
Data provided by Manufacturers and associations (ANFAD and manufactures).

Considerations:

Values:
Refrigerators: 3%
Room air conditioners: 10%
Electric motors: 5%
Clothes washers: 9.85%

Reference:
These values are used to project the growth of the production of 2006 forward.

Comments:

Electric Market Variables

Marginal electricity cost

***Definition*:**
Cost of generating a kWh more than the installed capacity

Source:
Programa de obras e inversiones 2004 -2013; CFE (POISE)

Considerations:
Cost of generation of one kWh considering a combination of different technologies in México : petroleum, gas, coal, renewable , etc
The cost data was updated for this study.

Values:
A cost of 0.034 USD / kWh.

Reference:
CFE

Comments:
None

Marginal demand cost

***Definition*:**
The avoid cost in capital investment of generating plants as result of peak reduction in the period of maximum demand.

Source:
Comisión Federal de Electricidad.

Considerations:
The cost was updated for this study

Value:
133.83 USD/ kW

Reference:
CFE

Comments:
None

Transmission and distribution losses

***Definition*:**
Percentage of electric losses in transmission and distribution lines.

Source:
Comisión Federal de Electricidad and Luz y Fuerza del Centro.

Considerations:
This value was provided by year

Values:

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
14.38%	15.23%	15.15%	14.92%	14.91%	14.98%	14.04%	15.10%	15.18%	15.69%

Average
14.93%

Reference:
Annual report CFE

Comments:
None

Capacity Losses in peak period

***Definition*:**
Percentage of losses in generation capacity in standby, during maximum demand period.

Source:
Comisión Federal de Electricidad (CFE)

Considerations:
Data provided by CFE

Values:
18.95 %

Reference:
CFE Communication.

Comments:
None

Use Factor

***Definition*:**
Average time in which the refrigerator is operating

Source:
IIE –CONAE study

Considerations:
This is original value from the standardization process analysis.

Values:
Refrigerators: 40%
Room air conditioners: 25%
Electric motors: 30%
Clothes washers: 7%

Reference:

Comments:

Coincidence Factor

***Definition*:**
Percentage of equipment operating during peak hours

Source:
Manufacturers/IIE.

Considerations:
This factor was taken from original study about forecasting impacts of energy efficiency standards.

Values:
Refrigerators: 68%
Room air conditioners: 40%
Electric motors: 82%
Clothes washers: 0%

Reference:

Comments:

Product data

Energy consumption (before standards implementation)

***Definition*:**
There are data of the annual consumption of refrigerators (kWh) manufactured without energy efficiency Standard specifications

Source:
Base study (IIE)

Considerations*:*

Refrigerators

Values: kWh/year for 1994

Model 1	482.5
Model 2	579.0
Model 3	812.0
Model 4	1050.0
Model 5	1178.0

Room air conditioners

Values: kWh/year for 1994

Less than 1758 W	1690
From 1759 to 2343 W	2256
From 2344 to 4101 W	3382
From 4102 to 5859 W	5072
From 5860 to 10548 W	10146

Electric motors

Values: kWh/y for 1994

3,73 kW	11532
7,47 kW	22534
22,38 kW	68389
55,95 kW	177153

Clothes washers:

Values: kWh/year for 1994

Clothes washers (Manual compacts)	30
Clothes washers (Semi - manual)	67
Semiautomatic Clothes washers	125
Automatic Clothes washers	150

Reference: Cost – benefit study to support for publishing standards in (DOF) Diario Oficial de la Federación.

Comments: The consumption data was obtained to test methods establish in reference norm

Energy consumption after standards implementation

***Definition*:**

Annual energy consumption of refrigerators manufacturers based upon energy efficiency Standard.

Source:

ANCE database and electric motors manufacturers

Considerations:

Values reported on energy efficiency labels and certified by ANCE in accredited laboratories

Refrigerators: Values in kWh/year

	1997	1998	1999	2000	2001	2002	2003	2004	2005
104 a 140 dm^3 (less than 6 ft^3) manual defrost refrigerators	339	331	323	314	306	298	289	281	273
186 a 279 dm^3 (manual and semi automatic defrost	315	312	310	308	305	303	301	298	296
220 a 330 dm^3 (semiautomatic freezer refrigerators	382	376	370	364	358	352	346	340	334
350 a 410 dm^3 (10 to 15 ft^3) automatic defrost)	583	559	536	513	489	466	443	419	396
> 410 dm^3 (> a 15 ft^3) automatic defrost	863	818	773	728	683	638	593	548	502

Room air conditioners : ***REE*** values

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Until 1758		2.82		2.54	2.83	2.80	2.86	2.91	2.90	2.94
1759 to 2343		2.50	2.77	2.71	2.82	2.49	2.70	2.90	2.85	3.20
2344 to 4101	2.77	2.81	2.84	2.79	2.73	2.81	2.92	3.03	2.96	2.94
4102 to 5859	2.68	2.79	2.68	2.74	2.77	2.86	2.94	3.02	2.92	2.97
5860 to10600	2.48	2.45	2.41	2.53	2.45	2.62	2.62	2.62	2.60	2.69

Electric motors: Values of efficiency (%)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1 - 5 hp	86%	86%	86%	88%	88%	88%	88%	88%	88%	88%
5,1-10 hp	88%	88%	88%	90%	90%	90%	90%	90%	90%	90%
10,1-30 hp	91%	91%	91%	92%	92%	92%	92%	92%	92%	92%
30,1 - 75 hp	93%	93%	93%	94%	94%	94%	94%	94%	94%	94%
75-300 hp			94%	95%	95%	95%	95%	95%	95%	95%

Clothes washers: kWh/year

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Manual Compacts	16.20	16.03	15.85	15.68	15.50	15.33	15.16	14.98	14.81
Manuals	32.28	31.57	30.87	30.16	29.45	28.75	28.04	27.33	26.63
Semiautomatic	80.72	80.45	80.18	79.91	79.64	79.37	79.1	78.83	78.56
Automatic	127.3	127.2	127.2	127.1	127.1	127	127	126.9	126.9

Reference:

Comments:

Equipment prices (before standards implementation)

***Definition*:**

Price before implementation energy efficiency standards

Source:

Base study (IIE)

Considerations:

Values:

Refrigerators

Values: pesos (2005)

Model 1	2,648
Model 2	3,216
Model 3	6,365
Model 4	6,688
Model 5	13,648

Room air conditioners

Values: pesos (2005)

Less than 1758 W	3,157
From 1759 to 2343 W	4,031
From 2344 to 4101 W	5,264
From 4102 to 5859 W	5,796
From 5860 to 10548 W	6,360

Electric motors

Values: pesos (2005)

1 - 5 hp	4,356
5,1-10 hp	6,766
10,1-30 hp	5,781
30,1 - 75 hp	54,474
75-300 hp	167,835

Clothes washers:

Values: pesos (2005)

Clothes washers compacts manuals	2,275
Clothes washers manuals	3,912
Clothes washers semiautomatics	4,549
Clothes washers automatics	8,917

Reference:

Comments: This prices was converted to 2005 pesos by inflation rate

Equipment prices (after standards Implementation)

***Definition*:**

Equipment price after implementation energy efficiency standards

Source:

Manufacturers and Bank of Mexico.

Considerations:

Inflation index was applied to the equipment cost for carried it out to pesos 2004. These indexes are the following:

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Inflation Index	8.01%	7.05%	51.97%	27.70%	15.72%	18.61%	12.32%	8.96%	4.40%	5.70%	3.98%	5.19%

Refrigerators

Values: pesos (1998 y 2002)

Model 1	1,541	2,860
Model 2	2,592	4,028
Model 3	4,054	5,212
Model 4	4,652	6,134
Model 5	7,664	15,024

Room air conditioners

Values: pesos (1998 y 2004)

Less than 1758 W	2,232	4,525
From 1759 to 2343 W	2,827	5,780
From 2344 to 4101 W	3,735	7,580
From 4102 to 5859 W	4,098	8,249
From 5860 to 10548 W	4,496	9,473

Electric motors

Values: pesos (1998 y 2004)

1 - 5 hp	2916	4,436
5,1-10 hp	9093	6,891
10,1-30 hp	28276	20,718
30,1 - 75 hp	110899	55,478
75-300 hp		170,927

Clothes washers:

Values: pesos (1998 y 2004)

Clothes washers compacts manuals	1,137	2,305
Clothes washers manuals	1,970	3,994
Clothes washers semiautomatics	2,630	5,332
Clothes washers automatics	4,441	9,004

Reference:

Comments:

Manufacturing Costs

***Definition*:**

Costs for modifying processes to manufacture efficient equipments

Source:

Data obtained from manufacturers for supporting the standards implementation study

Considerations:

Refrigerators

Values: (Million 2005 $US)

	1994	2002
Compressors line	66.3	
Redesign		2.2
Compressor		1.1
Plant layout		18.4
Others		0.9

Room air conditioners

Values: (Million 2005 $US)

	1994	1998
Design		0.14
Production line		0.05
Evaporator and compressor redesign		0.20

Motors

Values: (Million 2005 $US)

Adjust in models	0.03
Investment in machinery for the process (improves)	0.91
New factory is built	1.85

Clothes washers:

Values: (Million 2005 $US)

	1997
Motor redesign	0.09
Transmission system	0.01
New plant layout	6.24

Reference:

Comments:

Equipment certification costs

***Definition*:**

Costs for testing and certifying equipment

Source:

laboratories and ANCE

Considerations:

Number of certificates delivered each year by ANCE and assigned a cost for product

Values:

Refrigerators

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of certified equipments	139	417	209	103	373	249	342	286	49

Testing cost: $13,000

Certification cost: $ 2,854

Room air conditioners

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of certified equipments	41	12	64	146	95	59	0	20	158	25

Testing cost $20,800:

Certification cost: $ 5,863

Electric motors

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of certified equipments	3	0	41	206	4	25	31	242	114	

Testing cost: $18,000

Certification cost: $4,922

Clothes washers

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of certified equipments	139	87	81	165	398	151	185	94	50

Testing cost: $4,000

Certification cost: $ 2,711

Reference:

Information from ANCE database

Comments:

Annual sales

***Definition*:**

Estimated sales by year

Source:

Manufacturers.

Considerations:

.

Refrigerators

Values: Unit sales * (000´s) by year

	1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005
Sales ANFAD	1,134	887	891	990	1,094	1,316	1,470	1,471	1,763	1,872	2,125	2,189

Room air conditioners

Values: Unit sales * (000´s) by year

	1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005
Sales ANFAD	156	147	151	160	176	194	213	234	258	465	568	347

Electric motors

Values: Unit sales * (000´s) by year

	1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005
Estimated sales	150	134.4	135	150	155.3	160.7	166.3	172.1	178.2	184.4	190.8	197.6

Clothes washers

Values: Unit sales * (000´s) by year

	1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005
Sales ANFAD	1,144	820.6	871.2	1,100	1,299	1,474	1,566	1,555	1,565	1,475	2,431	2,333.8

Reference:

Comments:

.

Electricity Tariffs

***Definition*:**

Electricity Tariffs for domestic and industrial users

Source:

Comisión Federal de Electricidad (Website).

***Considerations**:*

Maximum values from Electric tariff for domestic and industrial users

Values:

Electricity domestic tariffs

Tariff	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1A	0.2702	0.3433	0.9660	1.1140	1.2720	1.4170	1.5480	1.6900	1.8010	1.9070	2.0160
1B	0.2702	0.3433	0.9660	1.1140	1.2720	1.4170	1.5480	1.6900	1.8010	1.9070	2.0160
1C	0.2702	0.3433	0.9660	1.1140	1.2720	1.4170	1.5480	1.6900	1.8010	1.9070	2.0160
1D	0.2702	0.3433	0.9660	1.1140	1.2720	1.4170	1.5480	1.6900	1.8010	1.9070	2.0160
1E	0.2702	0.3433	0.9660	1.1140	1.2720	1.4170	1.5480	1.6900	1.8010	1.9070	2.0160

Electric Industrial tariffs

Tariff	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.6289	0.7783	0.9156	1.0450	1.1915	1.2653	1.3073	1.3342	1.5571	1.8118	1.9786
3	0.5549	0.6884	0.5051	0.5803	0.6591	0.6981	0.7217	0.7358	0.8571	0.9954	1.0874
6	0.3360	0.4092	0.7685	0.9221	1.0555	1.1764	1.2736	1.3573	1.4409	1.5281	1.6183
OM	0.2316	0.3446	0.4555	0.5744	0.6599	0.7354	0.7950	0.8432	0.8939	0.9448	1.0040
HM	0.2182	0.3061	0.3109	0.3163	0.3654	0.4456	0.4724	0.4994	0.6069	0.7034	0.7743
HS	0.1672	0.2584	0.8169	0.8888	1.0087	1.1827	1.2122	1.2776	1.5518	1.7966	1.9488

Reference:

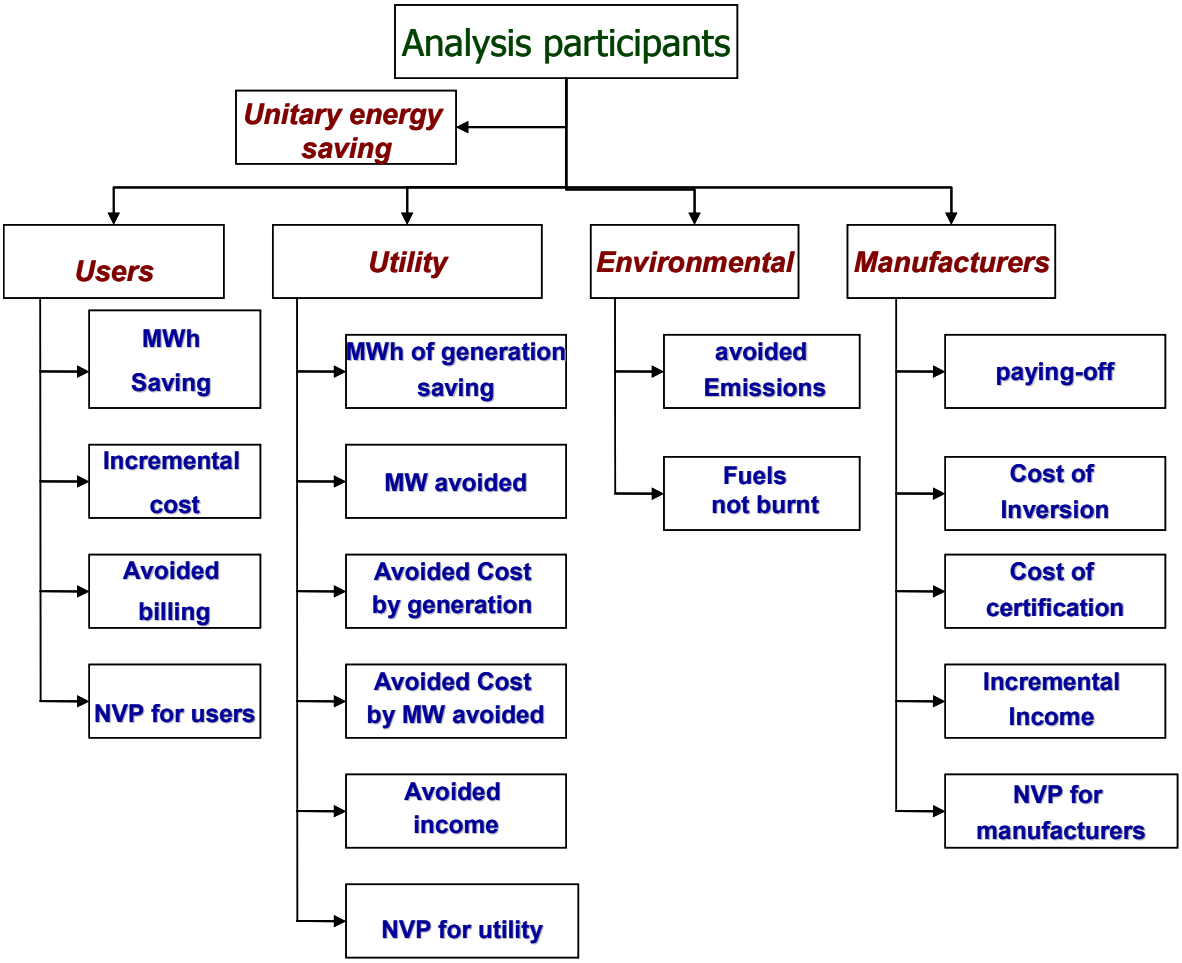
(1997-2005 data Website CFE)

Comments:

Appendix B.Evaluation Methodology

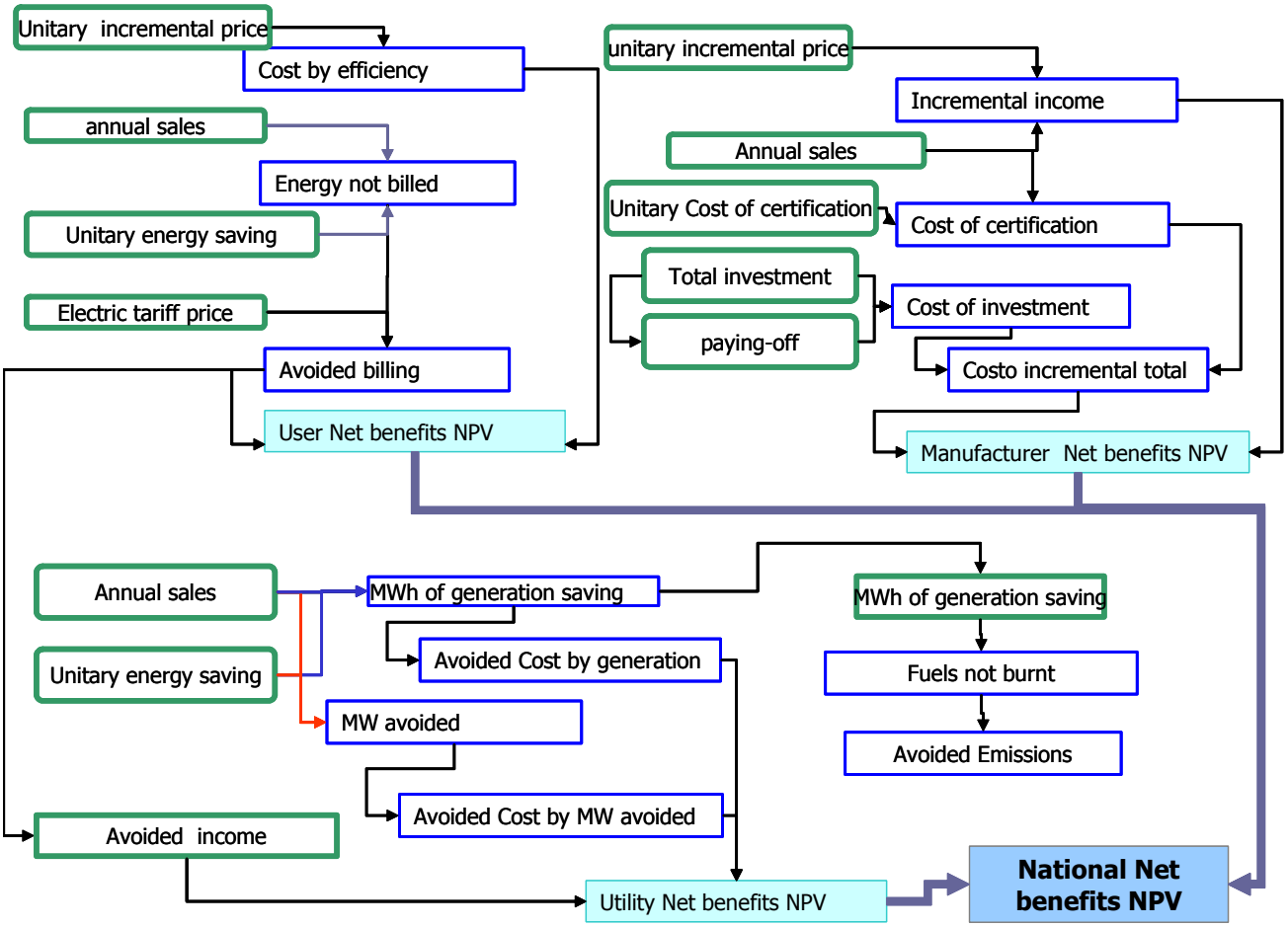
The methodology used in this analysis addresses four different impacts to be evaluated. They are: the impact to the users, the impact to the utility, the impact to the manufacturer and the environmental impact (See figure 1).

Figure 1. Analysis Modules for the evaluation of energy efficiency standard program



The analysis modules are interrelated by shared inputs and outputs, as shown in Figure 2.

Figure 2 – Interrelation of Analysis Input and Outputs



The analysis modules share input data and results of calculations that in turn are input into other modules or processes. The structure of the model allows input of 26 variables of four types:

a) Financial Variables:

b) Electricity Market Variables:

c) Product specific Variables:

d) Other Variables

Each equipment type uses a different set of calculations and input variables. Appendix A summarizes input variables, the source of information, the considerations to obtain the value that represents to the variable, and some characteristic values.

(ref: Documento No. 12074ITPBBCONAE.001; REVISIÓN DEL MODELO PARA EVALUACIÓN DEL IMPACTO DE NORMAS DE EFICIENCIA ENERGÉTICA; INFORME TÉCNICO FINAL; GERENCIA USO DE ENERGÍA ELÉCTRICA (IIE), LAWRENCE BERKELEY NATIONAL LABORATORY (LBNL), COMISIÓN PARA EL AHORRO DE ENERGÍA (CONAE), PA CONSULTING GRAU)P