FINAL TECHNICAL REPORT

REP. No. 12933 ITF FN LBNL 001

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

January, 2006

Itha Sánchez, Henry Chu

CONAE
COMISION NACIONAL PARA EL AHORRO DE ENERGIA

CLASP

FINAL TECHNICAL REPORT
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INSTITUTO DE INVESTIGACIONES ELÉCTRICAS
DIVISIÓN DE SISTEMAS ELÉCTRICOS
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Itha Sánchez Ramos, Henry Anli Chu Pulido

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

"USAID IS THE PRIMARY FUNDER OF THIS REPORT. USAID FUNDED THIS WORK VIA THE OFFICE OF ENERGY AND INFORMATION TECHNOLOGY WITHIN THE GLOBAL BUREAU FOR ECONOMIC GROWTH, AGRICULTURE AND TRADE, THROUGH LAWRENCE BERKELEY NATIONAL LABORATORY VIA THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO., DE-AC03-76SF00098."

"DOCUMENTO CONSIDERADO COMO RESERVADO DE ACUERDO AL ARTÍCULO 14, FRACCIÓN II DE LA LEY FEDERAL DE TRANSPARENCIA Y ACCESO A LA INFORMACIÓN PÚBLICA GUBERNAMENTAL, CON FUNDAMENTO EN LOS ARTÍCULOS 82 Y 83 DE LA LEY DE PROPIEDAD INDUSTRIAL Y ARTÍCULO 5 DE LA LEY FEDERAL DE DERECHOS DE AUTOR Y ARTÍCULO 210 Y 211 DEL CÓDIGO PENAL FEDERAL"

Prepared by:
IIE under project 12933.

Prepared for:
LAWRENCE BERKELEY NATIONAL LABORATORY
Under subcontract: 6720261

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ACKNOWLEDGEMENTS

We are specially grateful for the assistance and guidance provided by Ike Turiel and Michael Mc Neil of Lawerence Berkeley National Laboratories (LBNL) who managed the spreadsheets and final report revision. In addition Mirka dellaCava who helping out administratively with contract management.

We would also like to thank Fernando Hernández Pensado and Francisco Javier Moreno of Comisión Nacional para el Ahorro de Energía (CONAE) for their constant support and review.

Likewise we want to give our appreciation to industrial chambers CANAME and ANFAD for provide information for this study.

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EXECUTIVE SUMMARY

This document describes the data, the methodology and the results of the assessment of the economic and energy impacts by the application of energy efficiency standards of four appliances: household refrigerators, clothes washing machines, three phase electric motors and room air conditioners. The analysis impact is made in the period of time since the application of the corresponding standards in México, 1994 until present time.

This analysis is developed in acordance with the methodology reviewed and validated by LBNL and it considers the impact on the following participants:

- Manufacturer
- Utility
- Consumer
- Environmental

Historic data of economic and energy parameters applicable to Mexico such as real interest rate, inflation, energy prices and electric tariffs were used for this evaluation.
The results of the impact on each participant are presented in the following table, the energy and power savings are presented through a period of 10 years of implementation the standardization program; these savings were obtained from the consumption and efficiency values reported on ANCE certificates during the period from 1995 to 2005. Such values are taken by manufacturers as real consumption values as a result of energy efficiency standards programs.

Summary of global results of assessment of the impact of energy efficiency standards in Mexico

Energy and Power savings				
	TOTAL TO 2004			
	Motors	Refrigerators	Room air conditioners	Clothes Washers
MWh Not billed	10,002,926	22,999,865	11,470,412	1,401,663
Energy saving in generation MWh	11,499,164	26,440,185	13,186,156	1,611,324
MW avoided	899	1,266	679	-

Economic benefits (k$MEX)				
	TOTAL TO 2004			
	Motors	Refrigerators	Room air conditioners	Clothes Washers
Users Analysis NPV	5,588,220	7,912,328	7,237,908	(621,055)
Utility Analysis NPV	(828,368)	(10,738,360)	(3,913,261)	(875,370)
Manufacturer Analysis NPV	702,510	9,358,671	1,679,183	1,208,506
Net Total Benefit NPV	5,462,362	6,532,639	5,003,829	(287,920)

Environmental analysis (ton)				
	TOTAL TO 2004			
Avoided emissions of:	Motors	Refrigerators	Room air conditioners	Clothes Washers
Ton of SO x	85,227	195,964	97,731	11,942
Ton. of NO x	22,177	50,993	25,431	3,108
Ton. of CO 2	5,614,462	12,909,409	6,438,135	786,728
Ton. of CO	1,294	2,976	1,484	181
Tons of suspended Particles	49,259	113,262	56,486	6,902
Tons of hydrocarbons	1,363	3,135	1,563	191

The global energy savings to 2004 for the four products comparing with those originally outlined are higher:

	Updating analysis	Original analysis
MWh Not billed	45,874,867	36,489,264
Energy saving in generation MWh	52,736,830	41,770,097

These results are compared exclusively in terms of energy saving and both are calculated with the same methodology, however the values of unitary saving has changed. The economic results cannot be compared because the economic conditions have changed, it means that there were adaptations to the methodology for economic calculations.

The standard setting program has allowed obtain an important energy saving besides of the equipment introduced in the marketplace.

In fact, energy saving began with implementation of the standards program; these products have entered the national electrical network, have lower consumption values or higher efficiency than those originally outlined in standards (in refrigerators until of the order of 50% less), and their improved efficiencies have been incorporated to the national market and they are still in operation.

The saving obtained in this evaluation is larger than saving projected in the original study, so one conclusion is that the standards program joined to other factors of national market have contributed to improve the level of efficiency of national equipment.

1. INTRODUCTION

This study of the impact evaluation of energy efficiency standards analyzes the effects and reactions of the participants to the equipment and appliances standardization process since 1994 until 2004.

The methodology for evaluation considers the impacts on the product, the manufacturers, the utility, the users, and the country; in the past this evaluation was limited by the available information and results obtained for each one of the participants of the program were estimated.

In order to improve the process of evaluation of the standards setting program, as well as to obtain an international validation of the methodology of energy evaluation, this methodology was revised with the CLASP staff of LBNL and the IIE in a first stage and run with the revised model with updated information in a second stage.

Information and data required for the impact evaluation model were collected from manufacturers (Mabe, Vitro, Daewoo LG, Trane, York, Carrier, WEG etc), manufacturers associations (ANFAD, CANAME), an independent certification laboratory (ANCE), electric utility (CFE) and CONAE as the government agency and the main promoter of Mexican energy efficiency standardization programs.

The results obtained will determine if the projections of saving of the standards program have been conformed or to apply the necessary adjustments.

2. OBJECTIVE AND SCOPE

2.1. OBJECTIVE

To obtain an evaluation of the energy and economic impacts of energy efficiency standards by applying the evaluation model, validated and agreed by CONAE and LBNL in Stage I to four products standardized in Mexico (room air conditioners, three-phase electrical motors, household electric clothes washers and household electric refrigerators)

2.2. SCOPE

This study was carried out for the energy efficiency standards of the products above mentioned and include since standards setting until their updating:

Official Mexican standards	Title
Original NOM-072-SCFI-1994 Update NOM-015-ENER-1997 Update NOM-015-ENER-2002	"Eficiencia energética de refrigeradores y congeladores electrodomésticos" Households Refrigerators and Freezers energy efficiency Standard
Original NOM-073-SCFI-1994 Update NOM-021-ENER/SCFI/ECOL-2000	"Eficiencia energética de acondicionadores de aire tipo cuarto" Room air conditioners energy efficiency standard
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" C.A. Induction motors, squirrel-cage energy efficiency standard
Original NOM-005-ENER-1996 Update NOM-005-ENER-2000	"Eficiencia energética de lavadoras de ropa electrodoméstica" Households electric clothes washers energy efficiency standard

3. METHODOLOGY

The methodology of the assessment of the economic and energy impacts by the application of energy efficiency standards in Mexico was development through the years to carry on an economic technical study for the implementation and enforcement of the energy efficiency standards.

The model is based on energy consumption differential of an efficient equipment against one that is not efficient, and the unitary savings are projected to national production, these energy savings are calculated in two points of the electrical network, the first one is the point where the equipment is connected (plug in) to the electric

network (point of view for final user energy savings) and the second point is in the electric generation (pont of view for utility energy saving). Both energy savings have their economic components that are given for the first point (final users) with the maximum price of the electric rate (billing) and for the utility it is given by the marginal cost of energy (generation cost).

In the appendix A can find the values of the variables necessary for the evaluation.
In the appendix B can find this evaluation model's wider explanation.

4. STUDY RESULTS

Global results for four products analyzed until 2004:

	Global results to 2004
Energy and Power savings	
MWh Not billed	45,874,867
Energy saving in generation MWh	52,736,830
MW avoided	2,844
Economic benefits (k$MEX)	
Users Analysis NPV	20,117,400
Utility Analysis NPV	(16,355,359)
Manufacturer Analysis NPV	12,948,870
	-
Net Total Benefit NPV	16,710,911
Environmental assessment	
Avoided emissions	
Ton of SO x	390,864
Ton. of NO x	101,708
Ton. of CO 2	25,748,733
Ton. of CO	5,935
Tons of suspended Particles	225,910
Tons of hydrocarbons	6,253

The energy savings results are bigger than originally projected in the economic analysis in first version of standards setting, this is because through the years the efficiency values have had revisions like refrigerator's standard with three revisions or washing machine's standard, which first version took values that were in national manufacturing in that time. Nevertheless, manufacturers have transformed the market introducing improved products with consumption values lower than values established in the standard.

	Updating analysis	Original analysis
MWh Not billed	45,874,867	36,489,264
Energy saving in generation MWh	52,736,830	41,770,097

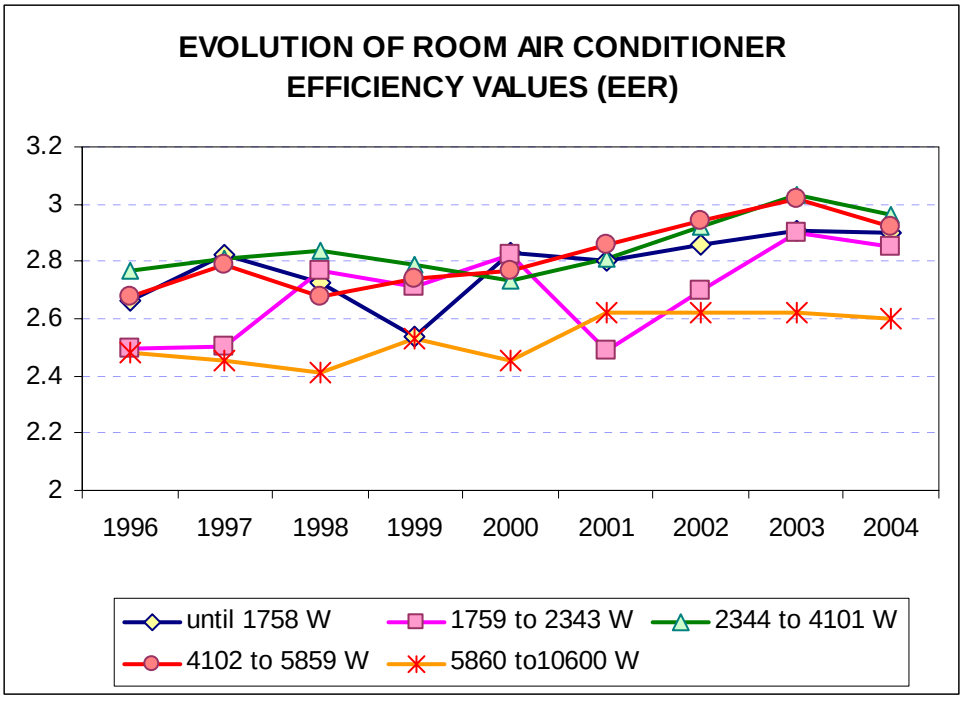
These results are compared exclusively in terms of energy saving and both are calculated with the same methodology, however the values of unitary saving has changed. The economic results cannot be compared because the economic conditions has changed, it means that there were adaptations to the methodology for economic calculations,

4.1. ROOM AIR CONDITIONERS

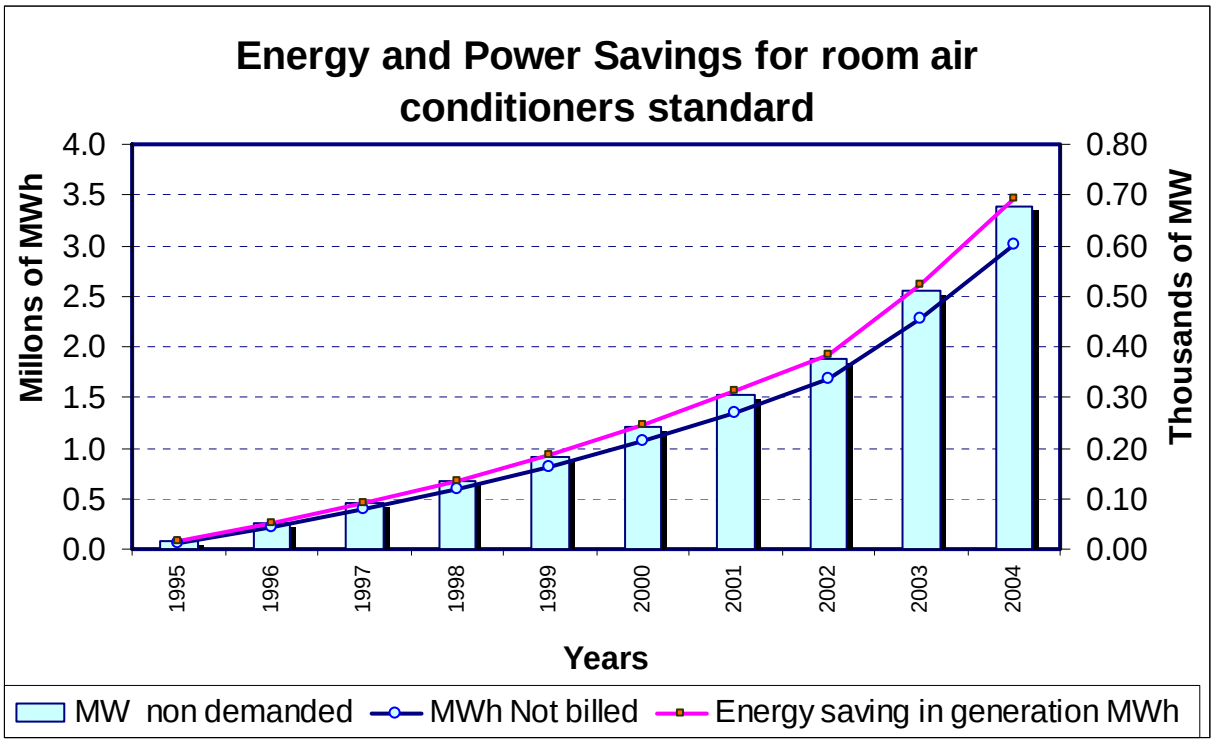
Room air conditioner energy efficiency standard, was originally named NOM-073-SCFI-1994 and its update version is NOM-021-ENER/ SCFI/ecol-2000. their Publication and effective dates are:

Official Mexican standards: "Eficiencia energética de acondicionadores de aire tipo cuarto" (Room air conditioners energy efficiency standard)		
Name	**Publication in DOF**	**Effective date**
Original NOM-073-SCFI-1994	September 8th, 1994	January 1st , 1995
Update NOM-021-ENER/SCFI/ECOL-2000	april 24th, 2001	after 60 natural day (july 23th, 2001)

The input information and update data for the evaluation were obtained from manufacturers and retailers of air conditioner equipment through the ANFAD; the efficiency values are according to products certified by ANCE in accredited laboratories, which is the entity authorized (by law) to expedite the products certificates and its compliance with energy efficiency standards, if the equipment have not certificate it cannot be sold in the national market. In the graphic is shown the evolution of efficiency values.



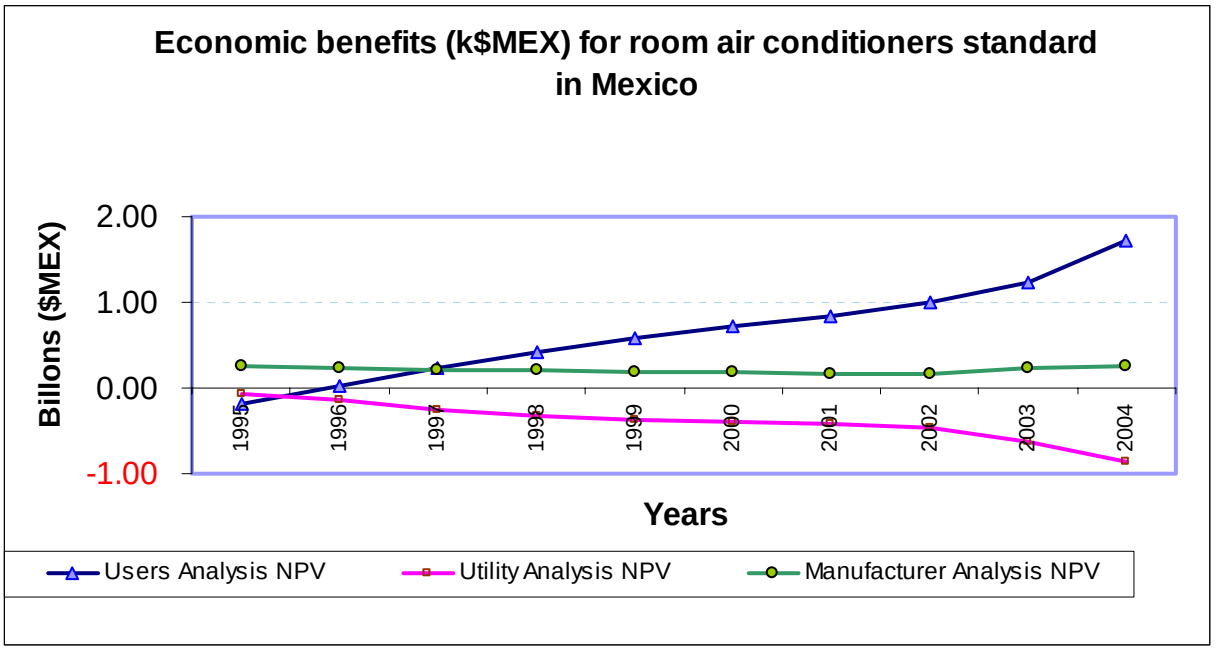
At present the average air conditioner equipment efficiency that exists in the Mexican market surpasses an EER of 2.9, the value established in the standard is 2.6, that's why energy savings are higher than estimated for implementing standards.



In the graphic energy savings values during first stage of standard setting shows a soft slope, then when enter second stage on 2002, energy savings are bigger and it reaches saving values more than expected.

The manufacturers reported their investments, products certification costs and incremental costs due to efficiency improvement; the benefit for manufacturers was determined and it resulted positive for the period considered because the cost of improvement efficiency has been lower than equipment price increment.

For utilities impact analysis, CFE and CLFC, the energy savings (avoided energy generation and avoided power) were estimated taking into account the transmission and distribution losses, capacity loss in peak period. Power and energy marginal national cost and discount rate used to calculate their investments. The economic impact has been negative during the period considered because energy savings benefit is bigger than non billed energy.

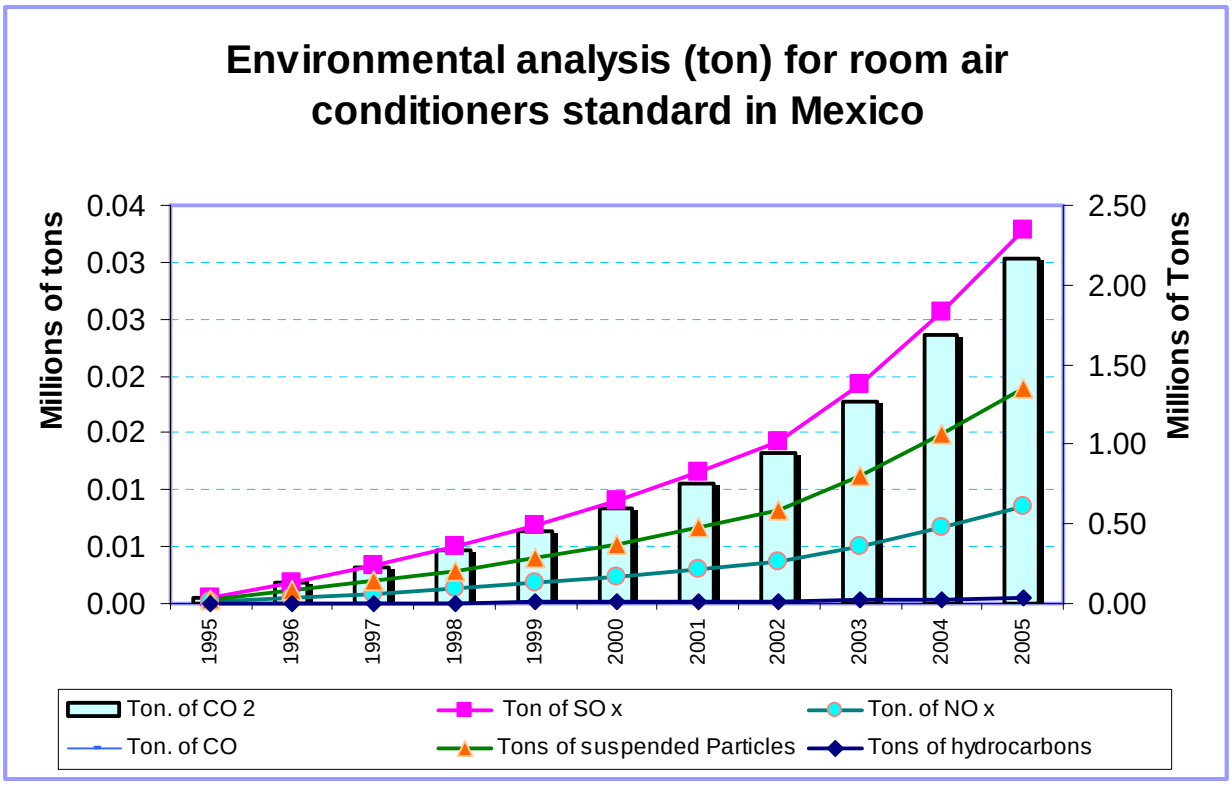


Note:This values are acumulatives in the year

For users analysis incremental prices were determined using prices obtained in departamental stores and webs sites for national manufacturers and the higher price of domestic electric tariffs was used for each year of the study; the interest and discount rates were estimated according with the rate of mutual funds that guarantee a profit on the real inflation from Banco de Mexico´s WEB, the cost incremental rate was determined using consumer price index reported by Banco de Mexico.

The economic benefit for users due to energy efficiency standards program in room air conditioners has resulted positive since its implementation because users saved more using efficient equipments than extra price they paid.

Environmental impact was determined taken into consideration avoided energy generation, primary fuels composition for electrical generation and applying a factor of equivalence value in tons of contaminant emissions.



Note: The secondary axis is only for Ton. of CO2

This results are indicatives the emission factors values were provided by Environmental Protection Area of CFE, and they are based on EPA AP-42

The following table shows a summary of impacts as results for room air conditioners energy efficiency standards in Mexican market in the last ten years. Results of three periods of analysis, one year, five years and ten years are presented besides saving estimated to 20 years.

Assessment of the impact for room air conditioners standard in Mexico. Summary results

Energy and Power savings				
	TOTAL TO			
	1995	1999	2004	2014
MWh Not billed	65,914	2,094,928	11,470,412	109,381,113
Energy saving in generation MWh	75,774	2,408,287	13,186,156	125,742,340
MW avoided	15	184	679	4,012

Economic benefits (k$MEX)				
	TOTAL TO			
	1995	1999	2004	2014
Users Analysis NPV	-137,742	1,285,750	7,237,908	50,486,505
Utility Analysis NPV	-69,020	-1,166,737	-3,913,261	-18,793,890
Manufacturer Analysis NPV	227,956	939,454	1,679,183	2,983,186
Net Total Benefit NPV	21,194	1,058,467	5,003,829	34,675,801

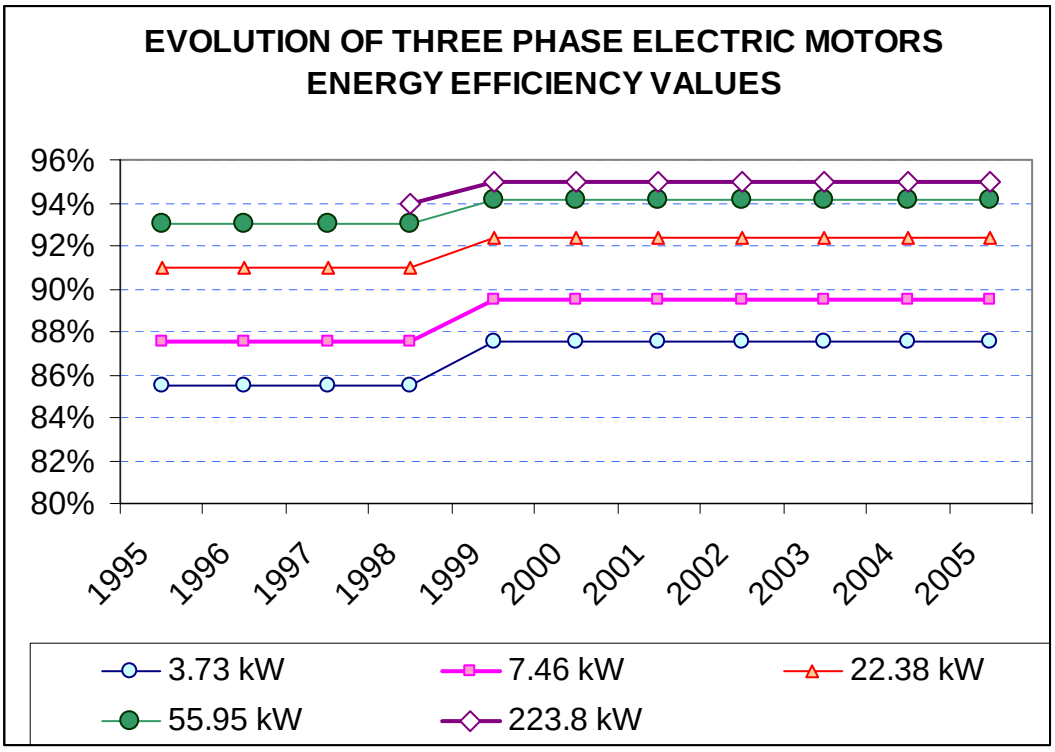
Environmental analysis (ton)				
	TOTAL TO			
Avoided emissions	1995	1999	2004	2014
Ton of SO x	562	17,849	97,731	931,952
Ton. of NO x	146	4,645	25,431	242,507
Ton. of CO 2	36,997	1,175,845	6,438,135	61,393,641
Ton. of CO	9	271	1,484	14,151
Tons of suspended Particles	325	10,316	56,486	538,645
Tons of hydrocarbons	9	282	1,563	14,945

4.2. THREE-PHASE ELECTRIC MOTORS

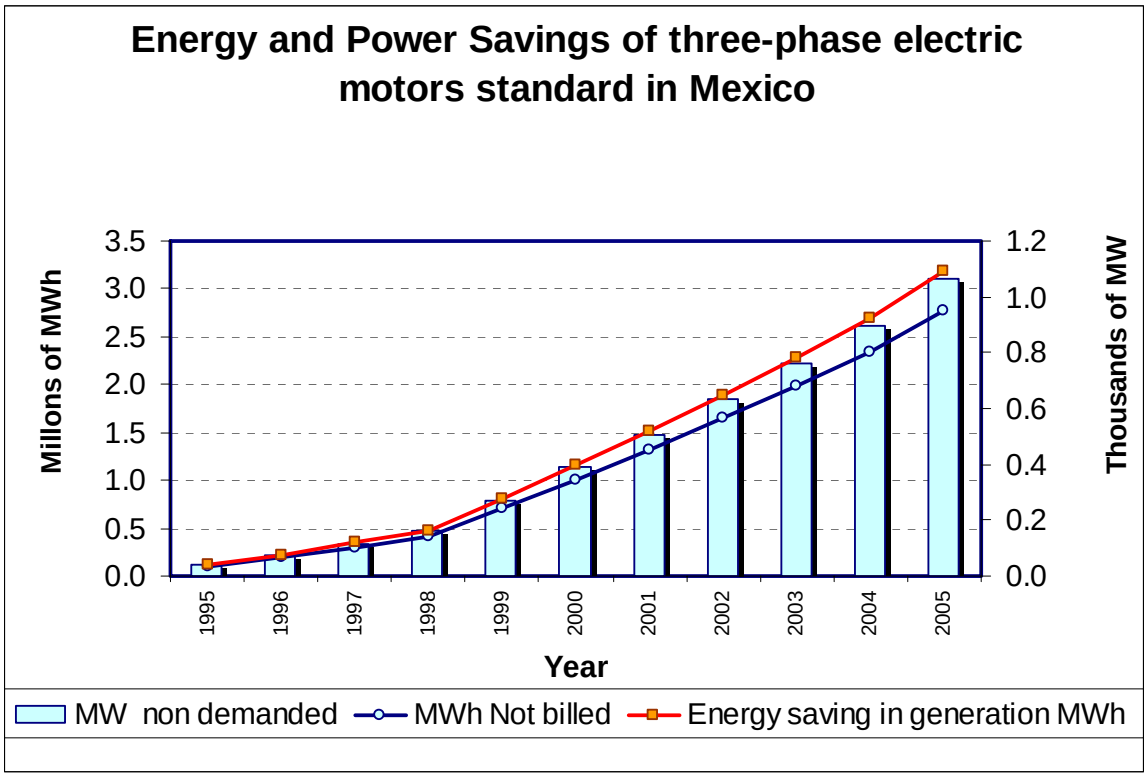
The three-phase electric motors standard in México, was originally name NOM-074-SCFI-1994 and its update version is, NOM-016-ENER-2002, their Publication and effective dates are the following:

Official Mexican standards: "Eficiencia energética de motores de inducción de corriente alterna, tipo jaula de ardilla" (C.A. Induction motors, squirrel-cage energy efficiency standard).		
Name	**Publication in DOF**	**Effective date**
Original NOM-074-SCFI-1994	September 8th , 1994	January 1st , 1995
Update NOM-016-ENER-1997	June 17, 1998	June 18, 1998
Update NOM-016-ENER-2002	January 13th, 2003	after 60 natural day (march 14, 2003)

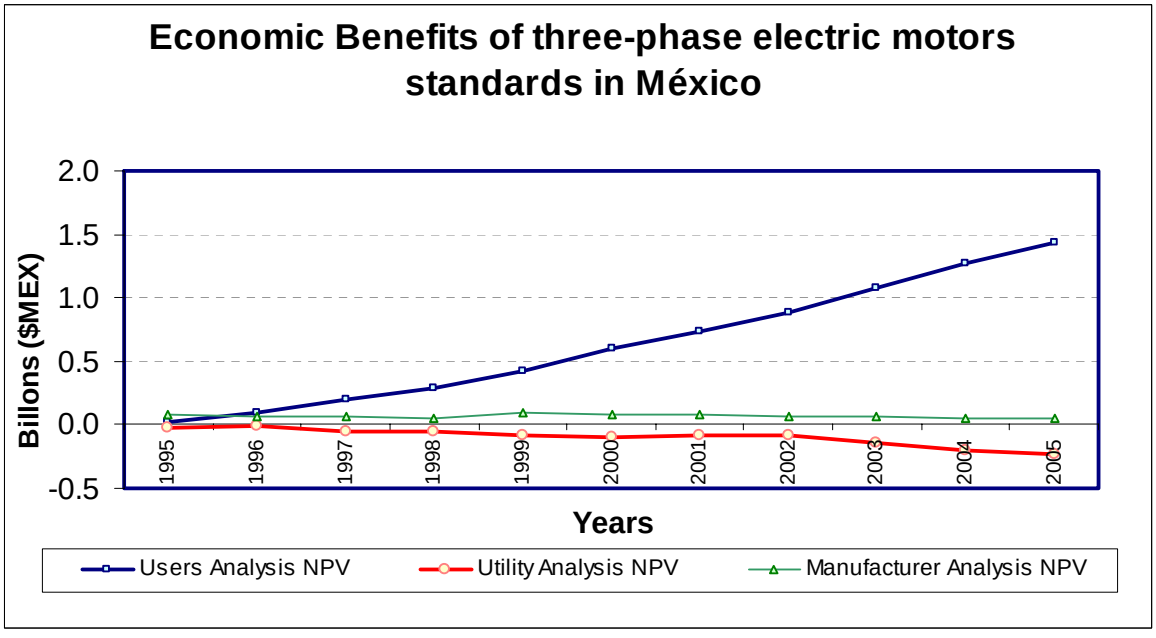
The input information and updating data for the evaluation were obtained from 2002 evaluation, from Mexican manufacturers, and values of ANCE certification.



The current efficiency of electric motors that exists in the Mexican market is similar to the values established in the current standard. Its value was taken from ANCE certificates for each year. We considerate these values represent the energy efficiency consumption that were introduced in the market each year.



In the graphic energy savings values until 1998 shows a soft slope, because in these first years had problems for implementing standards, then in 1999 the problems were overcome and energy savings are bigger and it reach saving values expected.



Note:These values are acumulatives in the year

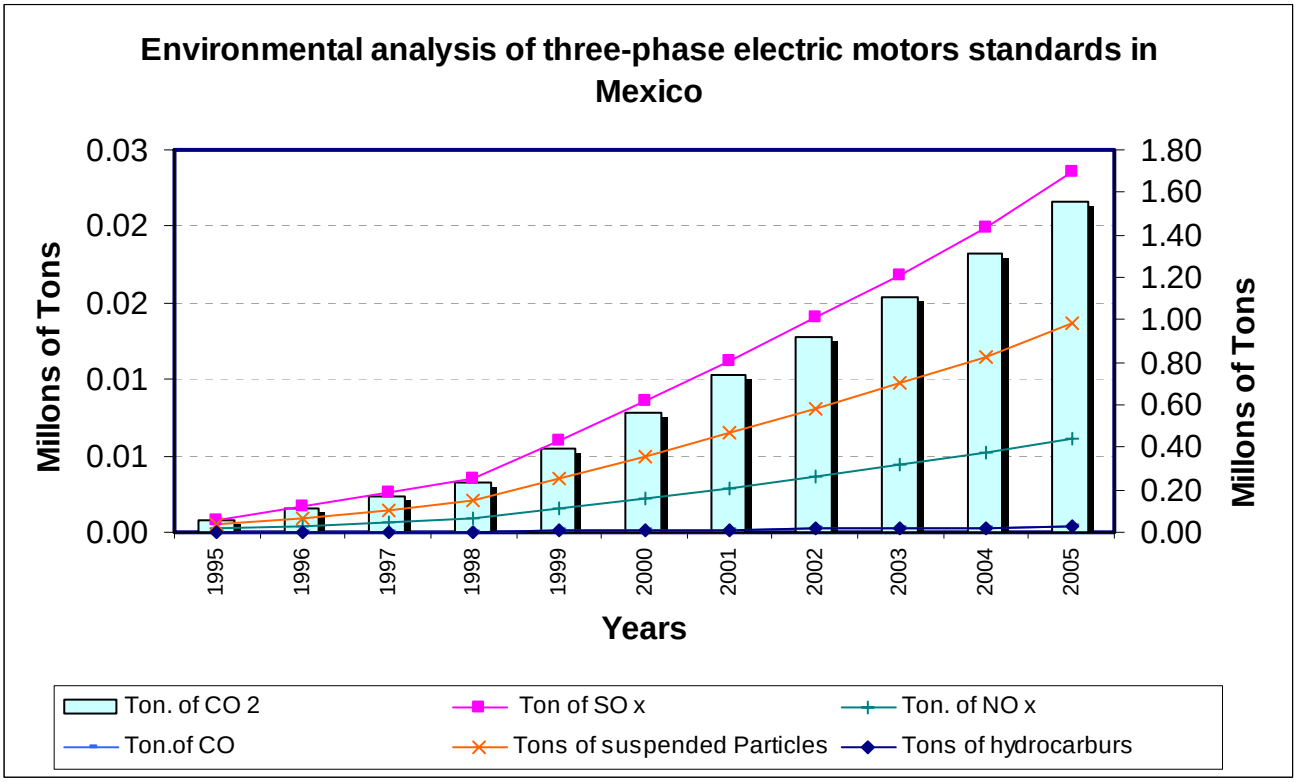
The manufacturers reported lower investments, products certification costs and incremental costs have been very low too; the benefit for manufacturers was determined and it results positive but not significant for the period considered because the cost of improvement efficiency and the equipment price increment has been not significant relative to the efficiency improvement obtained during this period.

For utilities impact analysis, CFE and CLFC, the energy savings (avoided energy generation and avoided power) were estimated taking into account the transmission and distribution losses, capacity loss in peak period. Power and energy marginal national cost and discount rate were used to calculate their investments. The economic impact has been near to zero during the first step of the standard but after 2002 this became negative because the energy savings benefit is larger than non-billed energy.

For users analysis incremental prices were determined using prices obtained in department stores and webs sites for national manufacturers and the higher price of industrial electric tariffs was used for each year of the study; the interest and discount rates were estimated according with the rate of mutual funds that guarantee a profit on the real inflation from Banco de Mexico's WEB, the cost incremental rate was determined using consumer price index reported by Banco de Mexico.

The economic benefit for users due energy efficiency standards program in motors has resulted positive since 1998 because users saved more using efficient equipment than extra price they paid.

The environmental impact was determined by taking into consideration avoided energy generation, primary fuels composition for electrical generation and applying a factor of equivalence value in tons of contaminants emissions, these results are indicative.



Note: The secondary axis is only for Ton. of CO2

The following table shows a summary of impact as results for motors energy efficiency standards in Mexican market in the last ten years. Results of three periods of analysis, one year, five years and ten years are presented besides saving estimated to 20 years.

Assessment of the mpact for three-phase electric motors standard in México.
Summary results

Energy and Power savings				
	TOTAL TO			
	1995	1999	2004	2014
MWh Not billed	97,288	1,718,725	10,002,926	61,117,321
Energy saving in generation MWh	111,841	1,975,812	11,499,164	70,259,250
MW avoided	37	272	899	2,992

Economic benefits (k$MEX)				
	TOTAL TO			
	1995	1999	2004	2014
Users Analysis NPV	17,815	1,020,537	5,588,220	24,755,906
Utility Analysis NPV	-22,655	-221,822	-828,368	-3,469,912
Manufacturer Analysis NPV	79,351	364,902	702,510	1,056,607
Net Total Benefit NPV	74,511	1,163,617	5,462,362	22,342,601

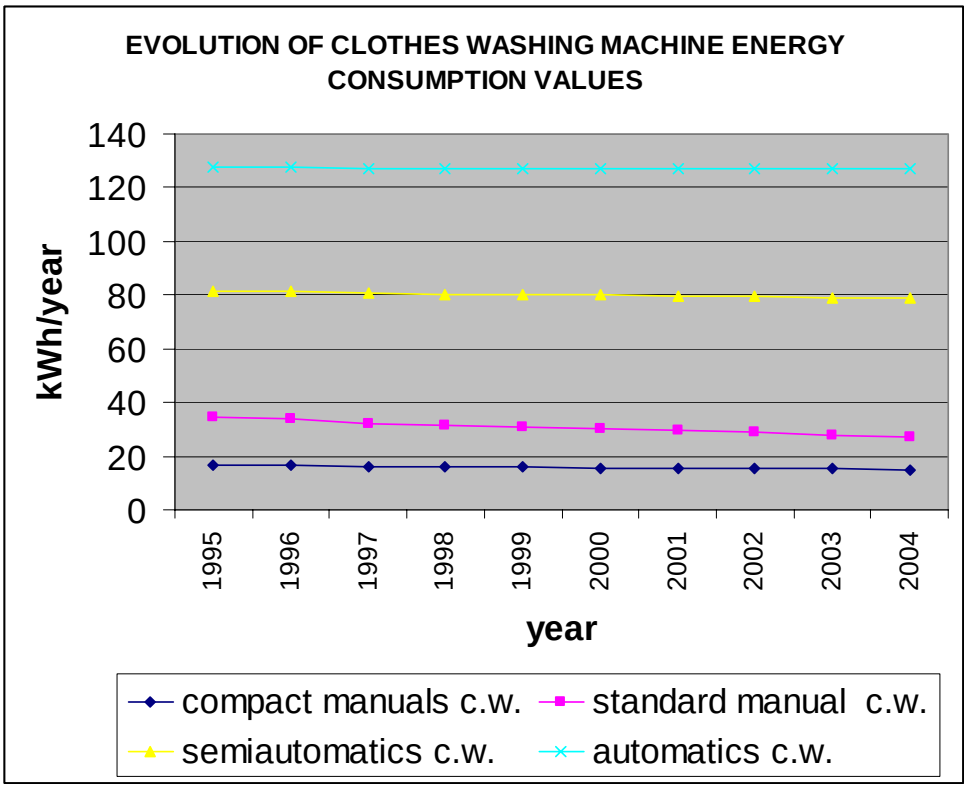
Environmental analysis (ton)				
	TOTAL TO			
Avoided emissions	1995	1999	2004	2014
Ton of SO x	829	14,644	85,227	520,734
Ton. of NO x	216	3,811	22,177	135,502
Ton. of CO 2	54,606	964,689	5,614,462	34,304,047
Ton. of CO	13	222	1,294	7,907
Tons of suspended Particles	479	8,464	49,259	300,971
Tons of hydrocarbons	13	231	1,363	8,349

4.3. HOUSEHOLD ELECTRIC CLOTHES WASHER MACHINES

Clothes washer machines energy efficiency standard, was originally name NOM-005-ENER-1996 and its update version is NOM-ENER-005-2000 their Publication and effective dates are the following:

Official Mexican standards: "Eficiencia energética de lavadoras de ropa electrodoméstica" (Households electric clothes washers energy efficiency standard).		
Name	**Publication in DOF**	**Effective date**
Original NOM-005-ENER-1996	July 11th, 1996	After 10 months (may 11th , 1997)
Update NOM-005-ENER-2000	August 28th, 2000	After 60 natural day (october 27th, 2000)

The input information and update data for the evaluation were obtained from manufacturers and retailers of air conditioner equipment through the ANFAD; the consumption values are according to products certified by ANCE in accredited laboratories, which is the entity authorized (by law) to expedite the products certificates and its compliance with energy efficiency standards, if the equipment have not certificate it cannot be sold in the national market. Here is shown the evolution of consumption values:



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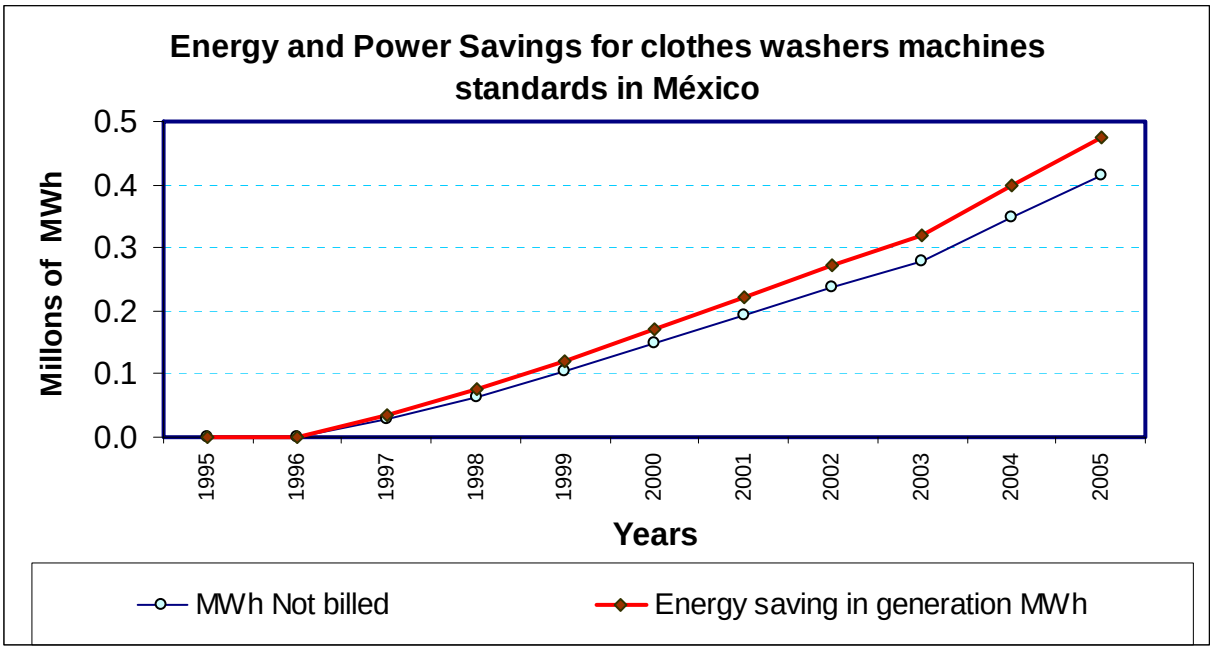
The norm NOM-005-ENER-1996 contemplated consumption values similar to those in current production, but energy consumptions reported were below the values

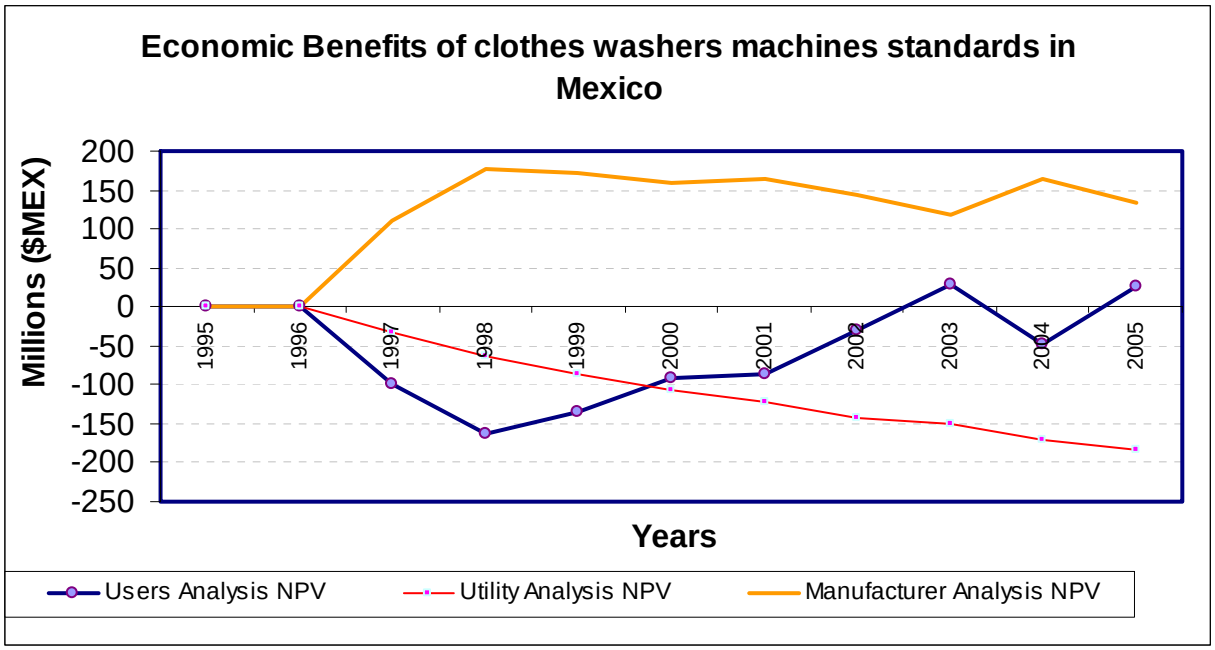
established in standard, so the manufacturers reported investments carried out to increase the efficiency, as incremental prices in the products



In the graphic energy savings values start in 1997, then when enter second stage on 2000, this tendency remained constant until 2003, when energy savings increase.

For this product there were no savings to peak power demand in the national electricity network, because this product is operated in off-peak hours.

The manufacturers reported their investments, products certification costs and incremental costs due efficiency improvement; the benefit for manufacturers was determined and it resulted positive until 2001, in 2002 there was another important investment for the period considered because the cost of improvement efficiency has been lower than equipment price increment.

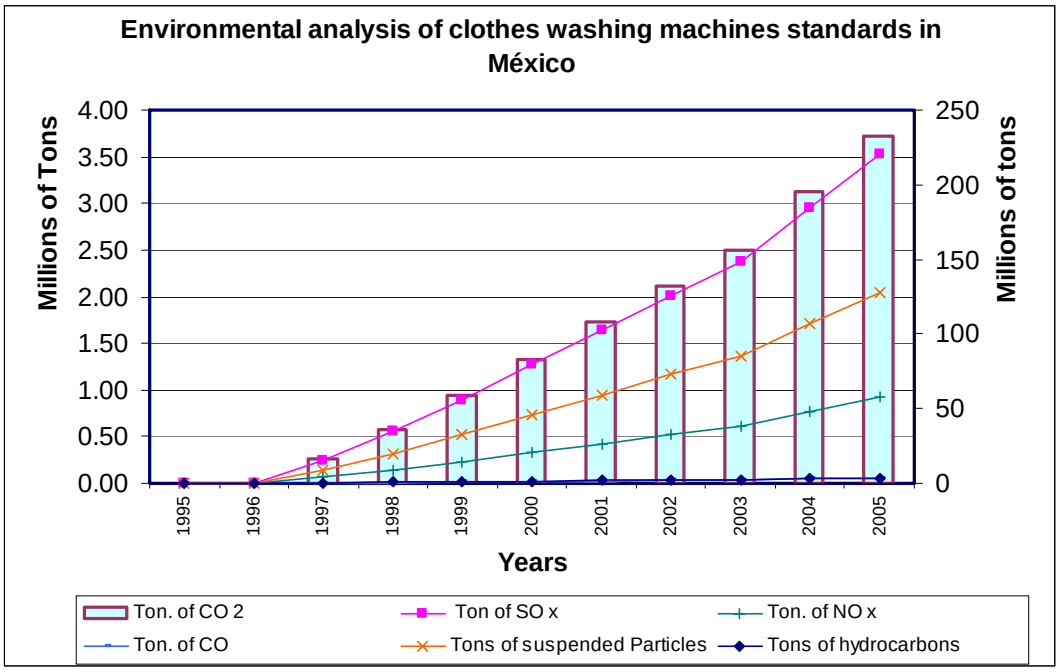


Note:These values are acumulatives in the year

For utilities impact analysis, CFE and CLFC, the energy savings (avoided energy generation) took into account the transmission and distribution losses, capacity loss during the peak period. Power and energy marginal national cost and discount rate used to calculate their investments. The economic impact has been negative during the period considered because energy savings benefit is bigger than energy non billed

For users analysis incremental prices were determined using prices obtained in department stores and webs sites for national manufacturers and the higher price of domestic electric tariffs was used for each year of the study; the interest and discount rates were estimated according with the rate of mutual funds that guarantee a profit on the real inflation from Banco de Mexico's WEB, the cost incremental rate was determined using consumer price index reported by Banco de Mexico.

The economic benefit for users due energy efficiency standards program in washing machines has resulted positive since 2001 because users saved more using efficient equipments than extra price they paid.



Note: The secondary axis is only for Ton. of CO2

Environmental impact was determined taken into consideration avoided energy generation, primary fuels composition for electrical generation and applying a factor of equivalence value in tons of contaminants emissions. This result is indicative and this factors source from “Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources”, EPA “Factores de Emisión”, GPA de CFE “Balances de Energía”,Secretaría de Energía “Estadísticas del Sector Eléctrico”, CFE.

The following table shows a summary of impact as results for washing machines energy efficiency standards in the Mexican market in the last ten years. Results until three periods of analysis, one year, five years and ten years are presented besides saving estimated to 20 years.

Impact assessment for clothes washer machines standard in Mexico.
Summary results

Energy and Power savings				
	TOTAL TO			
	1995	1999	2004	2014
MWh Not billed	-	199,376	1,401,663	9,460,743
Energy saving in generation MWh	-	229,199	1,611,324	10,875,881
MW avoided	-	-	-	-

Economic benefits (k$MEX)				
	TOTAL TO			
	1995	1999	2004	2014
Users Analysis NPV	0	-396,087	-621,055	1,106,648
Utility Analysis NPV	0	-179,852	-875,370	-3,023,108
Manufacturer Analysis NPV	0	459,551	1,208,506	2,126,858
Net Total Benefit NPV	0	-116,388	-287,920	210,398

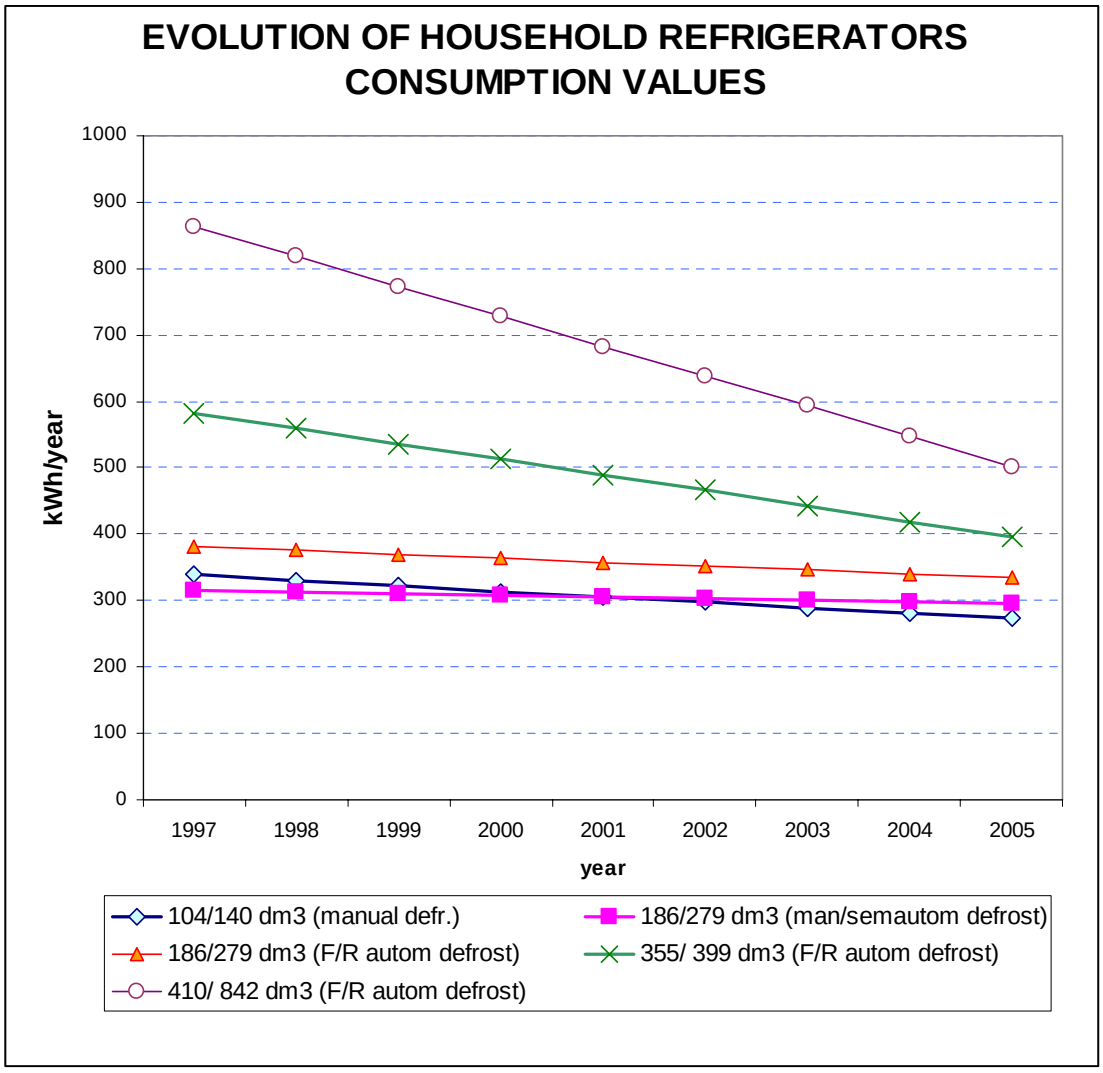
Environmental analysis (ton)				
	TOTAL TO			
Avoided emissions	1995	1999	2004	2014
Ton of SO x	-	1,699	11,942	80,608
Ton. of NO x	-	442	3,108	20,975
Ton. of CO 2	-	111,906	786,728	5,310,144
Ton. of CO	-	26	181	1,224
Tons of suspended Particles	-	982	6,902	46,589
Tons of hydrocarbons	-	27	191	1,292

4.4. HOUSEHOLD REFRIGERATORS

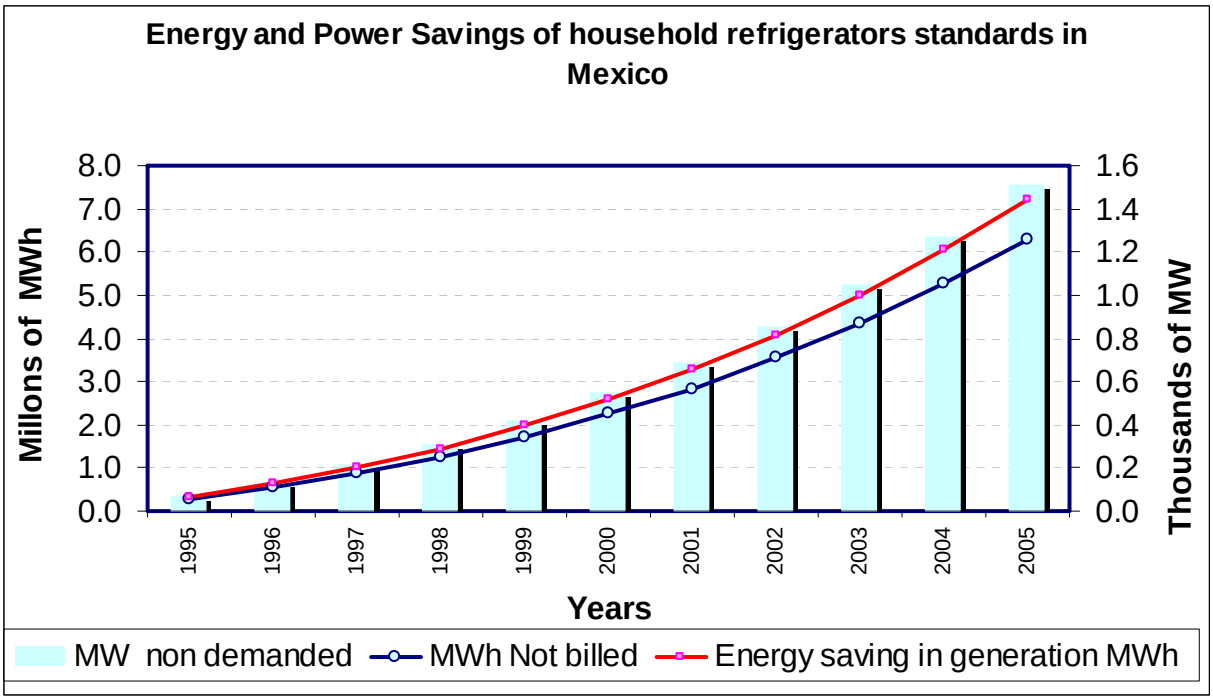
The first household refrigerators energy efficiency standard, was originally name NOM-072-SCFI-1994, the first update version was NOM-015-ENER-1997, and the second and last version is NOM-015-ENER-2002 their Publication and effective dates are the following:

Official Mexican standards: "Eficiencia energética de refrigeradores y congeladores electrodomésticos" (Households Refrigerators and Freezers energy efficiency Standard).		
Name	**Publication in DOF**	**Effective date**
original NOM-072-SCFI-1994	September 8th , 1994	January 1st , 1995
update NOM-015-ENER-1997	July 11, 1997	August 1, 1997
update NOM-015-ENER-2002	January 13th, 2003	after 120 natural day (march 14, 2003)

The input information and update data for the evaluation were obtained from manufacturers and retailers of air conditioner equipment through the ANFAD; the consumption values are according to products certified by ANCE in accredited laboratories, which is the entity authorized (by law) to expedite the products certificates and its compliance with energy efficiency standards, if the equipment have not certificate it cannot be sold in the national market. Here is shown the evolution of consumption values:



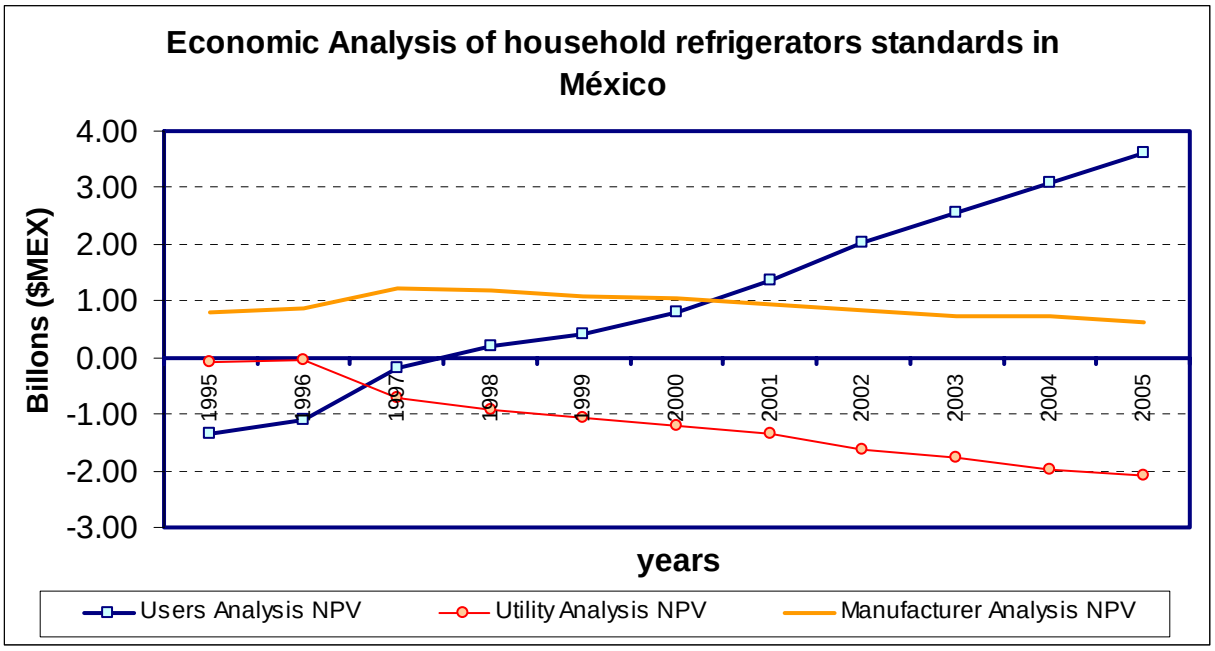
In this study was determined the energy saved with values of energy consumption have introduced to national market; These are the energy savings estimated until 2005:



In the graphic energy savings values during all period of study shows the same tendency, this is because average of values of consumption was taken by model, and was project through all period of analysis.

The manufacturers reported their investments, products certification costs and incremental costs due efficiency improvement; the benefit for manufacturers was determined and this results positive for the period considered because the cost of improvement efficiency has been lower than equipment price increment.

For utilities impact analysis, CFE and CLFC, the energy savings (avoided energy generation and avoided power) were estimated taking into account the transmission and distribution losses, capacity loss during the peak period. Power and energy marginal national cost and discount rate used to calculate their investments. The economic impact has been negative during the period considered because energy savings benefit is bigger than non billed energy.

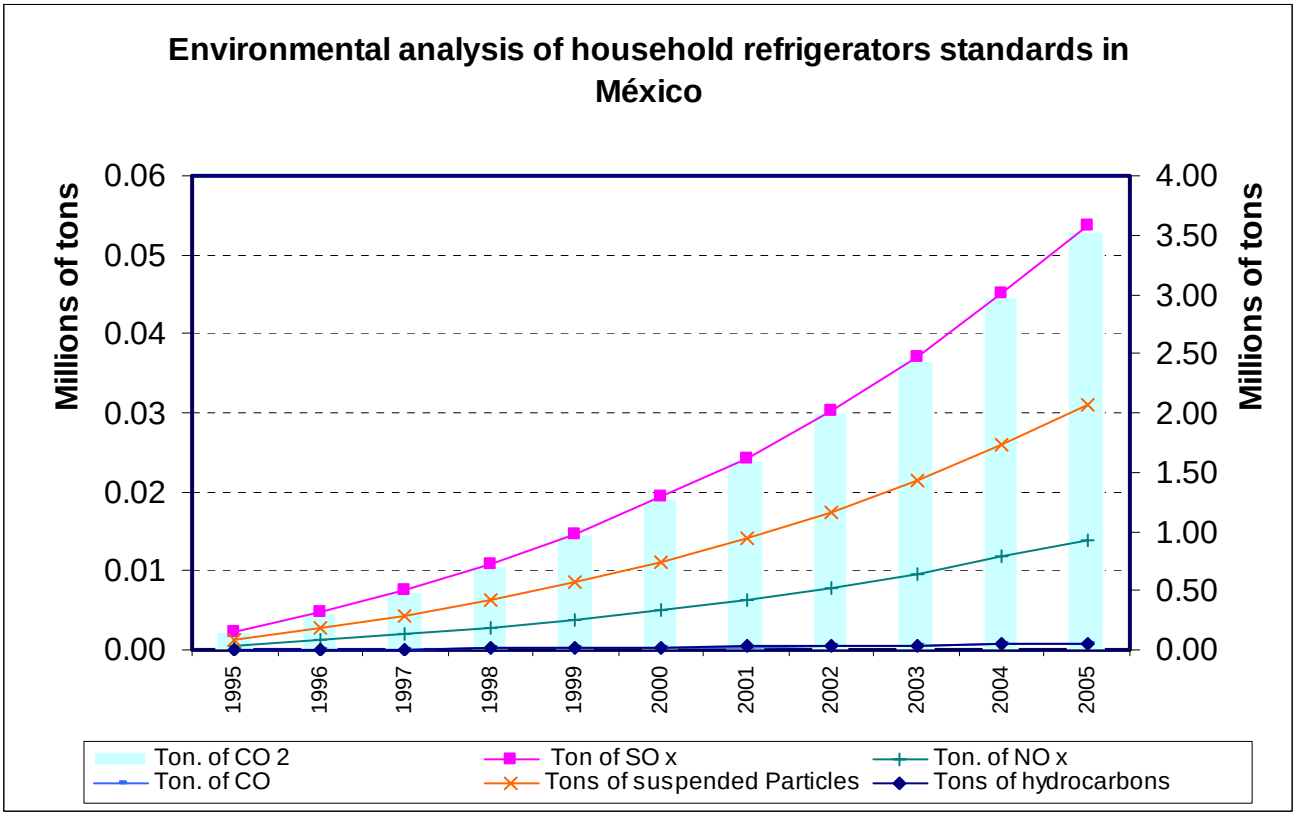


Note:These values are acumulatives in the year

For users analysis incremental prices were determined using prices obtained in department stores and webs sites for national manufacturers and the higher price of domestic electric tariffs was used for each year of the study; the interest and discount rates were estimated according with the rate of mutual funds that guarantee a profit on the real inflation from Banco de Mexico's WEB, the cost incremental rate was determined using consumer price index reported by Banco de Mexico.

The economic benefit for users due energy efficiency standards program in refrigerators has resulted positive since its implementation because users saved more using efficient equipments than extra price they paid.

Environmental impact was determined taken into consideration avoided energy generation, primary fuels composition for electrical generation and applying a factor of equivalence value in tons of contaminants emissions.



Note: The secondary axes is only for Ton. of CO2

The following table shows a summary of impact as results for household refrigerators energy efficiency standards in the Mexican market in the last ten years. Results of three periods of analysis, one year, five years and ten years are presented besides saving estimated to 20 years.

Assessment of the impact for household refrigerators standard in Mexico. Summary results

Energy and Power savings				
	TOTAL TO			
	1995	1999	2004	2014
MWh Not billed	268,906	4,689,629	22,999,865	136,390,941
Energy saving in generation MWh	309,129	5,391,104	26,440,185	156,792,297
MW avoided	64	414	1,266	4,022

Economic benefits (k$MEX)				
	TOTAL TO			
	1995	1999	2004	2014
Users Analysis NPV	-1,358,650	-2,002,081	7,912,328	61,521,981
Utility Analysis NPV	-62,956	-2,808,192	-10,738,360	-33,637,124
Manufacturer Analysis NPV	796,173	5,138,722	9,358,671	13,139,497
Net Total Benefit NPV	-625,433	328,449	6,532,639	41,024,355

Environmental analysis (ton)				
	TOTAL TO			
Avoided emissions	1995	1999	2004	2014
Ton of SO x	2,291	39,957	195,964	1,162,082
Ton. of NO x	596	10,397	50,993	302,390
Ton. of CO 2	150,932	2,632,204	12,909,409	76,553,769
Ton. of CO	35	607	2,976	17,646
Tons of suspended Particles	1,324	23,094	113,262	671,654
Tons of hydrocarbons	37	632	3,135	18,631

5. CONCLUSIONS

The Mexican energy efficiency standards program has been strengthened over time, for that reason to 10 years of their implementation these standards have two and three revisions as their values limits as test methods. The most dramatic case is refrigerators where the consumption values required by standard have been reduced by 58%; (NOM-072-SCFI-1994 vs. NOM-015-ENER-2002) and inside Mexican market this improvement is reflected with a consumption of up to 62 lower% than the baseline. It is comprehensible that the efficiency has moved quickly since the manufacturers have made an important effort for not having two lines of production for its Markets in order to accomplish with them to fulfill both Mexican and North American standards, and they have to compete in a Market with higher values of efficiency in a short time, this, also has transformed the market.

The test procedures of three standards are harmonized with their American 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); for washing machines, the test method has been different basically because the product is different, and comparison is not possible.

The information of consumption values or efficiency was obtained from the certificates of standard's compliance, emitted by the Mexican Entity of accreditation of standards ANCE (normalization association and certification A.C). It is the authorized entity to issue certificates of compliance with energy efficiency standards. It is necessary to take into account that if the equipment doesn't have that certificate the product cannot be sold in the Mexican Market; these energy values are a good indicator of the efficiencies that are present in the national stock.

The benefits of energy efficiency standards programs have different focus for each actor: for the users it is the benefit for the reduction in their electric bill; for the utility it is the reduction of its investment, and for the manufacturer it is the extra price of the product.

Concerning energy efficiency current values set in NOM´s for refrigerators, room air conditioners and motors are equal to US levels.

For users, their economic savings are calculated with the higher price electric tariff that they pay in the electric bill. For forecast price we will use the electricity rate growth that CFE considered in the POISE report. That is a real rate of 1.3%

The values of energy and power savings, avoided emissions and economic benefits calculates are result of applying the IIE-CONAE-LBNL methodology.

The global energy savings to 2004 for the four products are:

	Updating analysis	Original analysis	% Difference
MWh Not billed	45,874,867	36,489,264	26
Energy saving in generation MWh	52,736,830	41,770,097	26

The standard setting program has allowed obtain an important energy saving besides the equipment introduced in the marketplace.

In addition to the energy savings implied by implementation of the standards program, equipment has been introduced to the electricity network that is even more efficient as standards require. The savings obtained in this evaluation is therefore larger than that projected by the original study. It may be concluded that the standards program contributed along with other market factors to improve the level of efficiency of equipment in Mexico.

6. REFERENCES:

6.1. WEB sites:

BDINEGI BANCO DE INFORMACIÓN ECONÓMICA
http://dgcnesyp.inegi.gob.mx/bdiesi/bdie.html

BANCO DE MEXICO
http://www.banxico.org.mx/eInfoFinanciera/FSinfoFinanciera.html

SRIA. DE HACIENDA Y CRÉDITO PÚBLICO
http://www.shcp.gob.mx/ieo/index.html

CFE COMISIÓN FEDERAL DE ELECTRICIDAD
http://www.cfe.gob.mx/es/

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

Comisión Nacional para la protección y defensa de los usarios de serviciós financieros CONDUSEF
http://www.condusef.gob.mx/

6.2. References:

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

Costos y parámetros de referencia para la formulación de proyectos de inversión en el sector eléctrico; Transmisión y transformación; 2002; Subdirección de programación; CFE.

Costos y parámetros de referencia para la formulación de proyectos de inversión en el sector eléctrico; Generación; 2004; Subdirección de programación; CFE.

Informe Anual 2004, Banco de México, Abril de 2005

Informe Anual 2004; CFE.

Quinto informe de labores 2004-2005, CFE.
Programa de obras e inversiones 2004 -2013; CFE (POISE)

Appendix A: Entrance data

1. Data needed for evaluation

1.1. Financial Variables

1.1.1. Interest rate

Definition:

A 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:

1.1.2. Discount rate

***Definition*:**

It is the interest rate that an 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 it was used the rate for 2004.

1.1.3. Rate exchange

***Definition*:**

Rate which is used to settle liabilities denominated in foreign currency

Source:

Bank of Mexico

Considerations

It is 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 use 2004 rate exchange

1.1.4. Time line analysis

***Definition*:**

It is the period in which the equipment is useful and energy savings are generated.

Source:

Manufacturers.

Considerations:

It is considered the same value as used in the Standard draft

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 are calculating, the energy savings for 16 year like the annual production of year 16 minus annual production of year 1.

1.1.5. Market growing rate

Definition:

It is production market growing, 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:

1.2. Electric Market Variables

1.2.1. Marginal electricity cost

***Definition*:**

It is cost of generating a kWh more than the installed capacity

Source:

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

Considerations:

Generating cost of a kWh considering a combination of different technologies in México : petroleum, gas, coal, renewable , etc

The cost data is updated.

Values:

A cost of 0.034 USD / kWh.

Reference:

CFE

Comments:

None

1.2.2. Marginal demand cost

***Definition*:**

It is 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 is updated

Value:

133.83 USD/ kW

Reference:

CFE

Comments:

None

1.2.3. 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

1.2.4. 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

1.2.5. Use Factor

***Definition*:**

Average time in which the refrigerator is operating

Source:

IIE –CONAE study

Considerations:

This is original value from standardization process.

Values:

Refrigerators: 40%

Room air conditioners: 25%

Electric motors: 30%

Clothes washers: 7%

Reference:

Comments:

1.2.6. Coincidence Factor

***Definition*:**

Percentage of equipments operating at the same time during the peak hour

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:

1.3. Product data

1.3.1. 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

1.3.2. Energy consumption after standards implementation

***Definition*:**

It is the 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:

1.3.3. Equipment's prices (before implementation standards)

***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

1.3.4. Equipment's prices (after implementation Standards)

***Definition*:**

Equipment's 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:

1.3.5. Manufacturing costs

***Definition*:**

Costs for modifying processes to manufacture efficient equipments

Source:

Data obtained from manufacturers for supporting the study to implement standards

Considerations:

Refrigerators

Values: (k$)

	1994	2002
Compressors line	722,500	
Redesign		24,000
Compressor		12,000
Plant layout		200,000
Others		10,000

Room air conditioners

Values: (k$)

	1994	1998
Design		1,500
Production line		500
Evaporator and compressor redesign		2,125

Motors

Values: (k$)

Adjust in models	300
Investment in machinery for the process (improves)	9,920
New factory is built	20,120

Clothes washers:

Values: (k$)

	1997
Motor redesign	1,020
Transmission system	150
New plant layout	68,000

Reference:

Comments:

1.3.6. 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:

1.3.7. 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:

.

1.3.8. Electric tariffs

***Definition*:**

Electric 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:

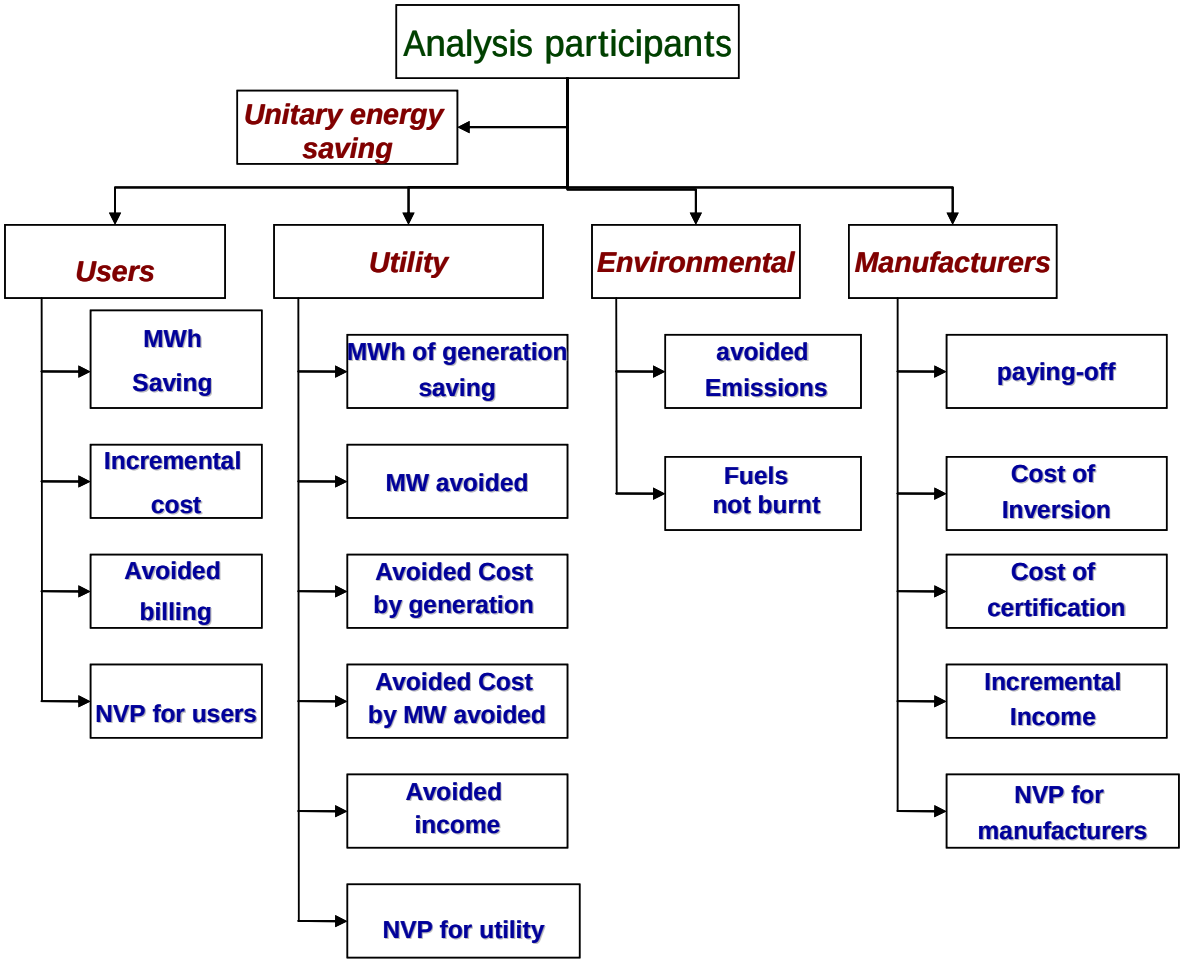
(1997-2005 data Website CFE)

Comments:

Appendix B. Methodology of evaluation

Methodology used in this analysis are 4 different impacts to be evaluated they are the impact to the users, the impact to utility, the impact to the manufacturer and the environmental impact (to see figure 1).

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



The analysis modules are interrelated among if, having entrances and shared exits of information, like it is shown in the figure 2.

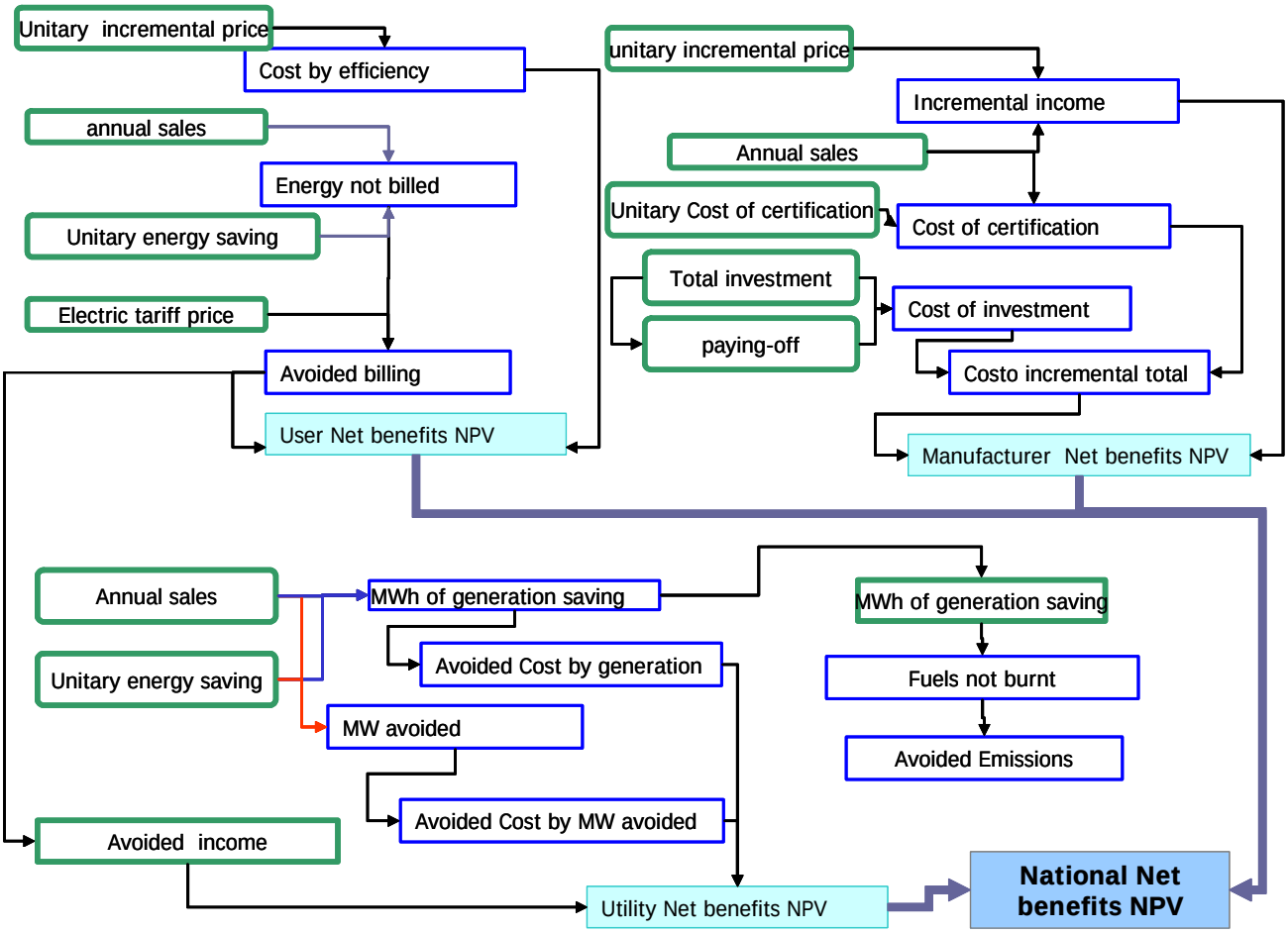


Figure 2. Interrelation of the analysis modules

The analysis modules share entrances of data and results of processes that in turn are entered of information for other modules or processes; however the structure of the calculation allows to enter 26 variables of entrances that are of four types:

a) financial Variables:

b) Variables of the electric market:

c) Variables related with the product:

d) other Variables

For each one of the equipments has a different treatment. In the apendix A is defined what is the variable, the source of information, the considerations to obtain the value that represents to the variable, 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