



S&L Program Evaluation and Impact Assessment

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NIST



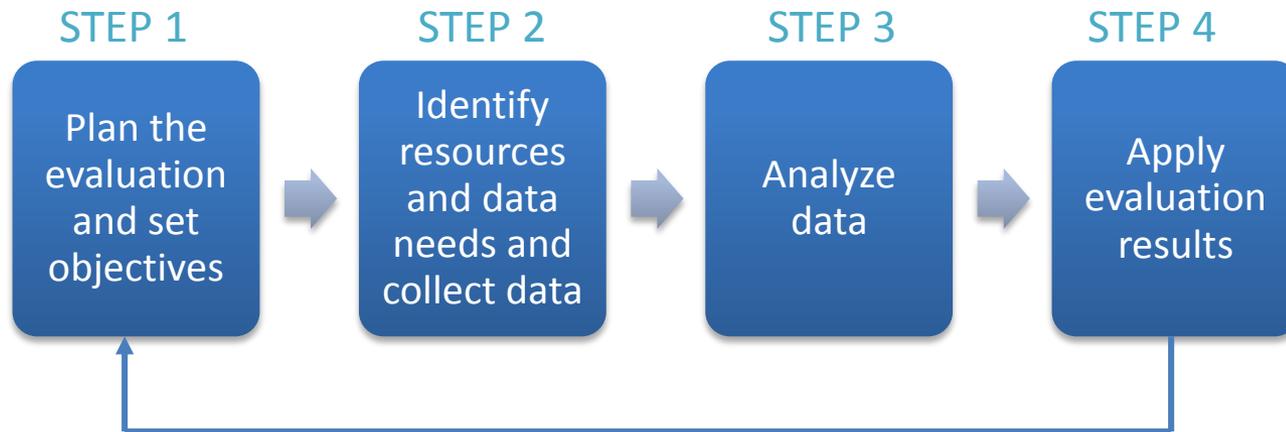
Why Evaluation is a Must

- Evaluations are needed to “prove” program impacts
 - Benefits of energy-efficiency programs need to be clear, measurable, verifiable, and transparent
 - Quantifiable benefits needed to justify funding and (government) resource allocation
- Evaluations assess the efficiency and effectiveness of the program process, revealing weaknesses in program implementation
- State of the Art
 - **Ex-ante** evaluation based on forecasted information about product shipments and customer use
 - **Ex-post** evaluation based on actual sales data and consumer behavior



Why Evaluation is a Must

- Pre-program market assessment to establish reference baseline
- Major approaches to assess program effectiveness:
 - Process evaluations: examine program operations (applications, procedures, dissemination, awareness, etc.)
 - Impact evaluations: evaluate program impacts (equipment sales, energy saved, emissions reduction)



Plan the evaluation and set objectives

- Evaluations are built on data and should be an integrated part of the overall data collection and management process of a S&L program:
 - For standards → focus on manufacturers' decisions and changes in the energy efficiency of models sold and on the effectiveness of compliance procedures
 - For labeling → assess the sales and purchase process to determine the impact of retailer and consumer decisions
- Evaluation programs should include both process evaluation and impact evaluation components
 - Process evaluation → assessing consumer priorities; tracking consumer awareness; monitoring correct display of labels; measuring administrative efficiency; checking and verifying manufacturer claims
 - Impact evaluation → determining the influence of the label on purchase decisions; tracking sales-weighted efficiency trends; determining energy and demand savings



Evaluation Data: Types and Sources

Evaluation Data: Type and Sources

Labeling and standards-setting program evaluation uses a variety of data from a variety of sources.

Data Type	Main Data Sources
Customer and retailer knowledge, awareness, understanding, and decision making	<ul style="list-style-type: none"> • Surveys of customers and retailers and in-depth interviews
Availability of products	<ul style="list-style-type: none"> • Sales data from manufacturers, trade associations, or government • Surveys of manufacturers and retailers
Prices for efficient products	<ul style="list-style-type: none"> • Surveys of customers, retailers, and manufacturers
Market penetration	<ul style="list-style-type: none"> • Sales data from manufacturers, trade associations, or government • Surveys of participant and non-participant customers • Surveys of suppliers
Energy use	<ul style="list-style-type: none"> • Manufacturer data • Independent laboratory data • Engineering specifications • Metered end-use data
GHG emissions	<ul style="list-style-type: none"> • Reported emissions factors • Utility dispatch model data



- **Baseline:** description of what would have happened to energy use if labels and/or standards would not have been implemented
 - Analyze energy use of a sample of households/facilities before and after the installation of an energy-efficient product
 - Market characterization studies for developing baseline of existing technologies and practices
- **Impacts on consumers:** degree to which the label's presence affects consumer purchasing decisions:
 - Level of awareness; relative level of importance of various consumer purchase criteria; consumer's understanding and perception of the usefulness of the label; life-cycle cost impacts
- **Impacts on manufacturers and retailers, including:**
 - Consolidation of competition; impact on features and consumer choice, manufacturing jobs, sales, direct and indirect costs to , changes in the production process, etc.



- **Program compliance, enforcement, training and education**
 - Regular evaluation studies to assess whether program requirements are met, enforcement measures are taken, retailers and distributors are trained, and consumers understand the meaning of the label and/or standard
- **Sales and market shares**
 - Evaluate the impact of a labeling program by comparing sales-weighted trends in appliance efficiency before and after the introduction of labels
 - Evaluate changes in price and technology characteristics (e.g. sizes of appliances)
- **Energy savings and greenhouse gas emissions reductions**
 - Estimate energy savings on household / facility level, applying engineering methods, end-use metering, short-term monitoring
 - Tracking changes in product and market characteristics
 - Calculate net GHG emissions reductions using emission factors (average or marginal)



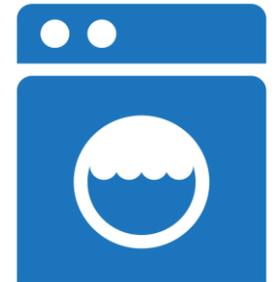
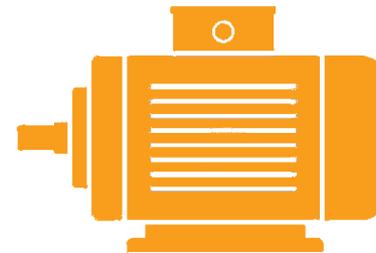
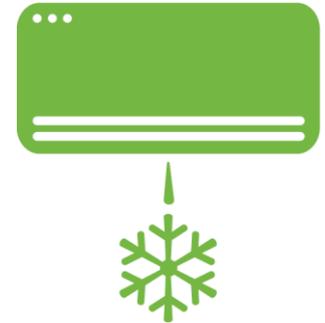
Apply Evaluation Results

- **Refine labeling and standards programs**
 - Use the results from evaluations to improve the design, implementation and future evaluations of labeling and standards-setting programs
- **Support other energy programs and policies**
 - E.g. appliance rebate programs, negotiated agreements, procurement actions, labeling programs for other appliances
- **Forecasting energy use and strategic planning**
 - Comprehensive data established by the evaluation can be used as inputs to an end-use stock model to make long-range energy consumption and emissions forecasts
- **Using evaluation results and data for other regulatory purposes**



Impacts Assessments in Mexico #1

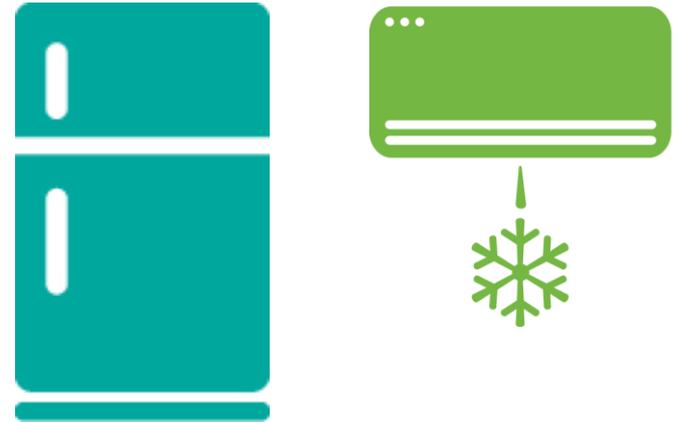
- Impacts from standards implemented between 1995 and 2004 were evaluated for 4 product categories
- These standards reduced energy consumption by **46 TWh** and avoided **30 Gt** of CO₂ emissions between 1995 and 2004
- Energy demand was reduced by 9.6% in 2005
- Impacts were found to be 25% greater than original estimates



CLASP in partnership with LBNL and IIE completed this first study in 2006

Impacts Assessments in Mexico #2

- Impacts from standards implemented between 1995 and 2014 were evaluated for 2 product categories
- National electricity savings of **5.2 TWh of electricity in 2014**, roughly equivalent to **two 500 MW power plants**
- Cumulative CO₂ emissions mitigation of **23 million metric tons through 2014**
- Avoided electricity bills of over 40 thousand million Mexican pesos (**3 billion USD**) through 2014.



Average efficiency improvement for refrigerators of 17% to 27%

Average efficiency improvement for air conditioners of 4% to 7%

CLASP in partnership with LBNL and IIE completed this second study in 2015

Harmonization History in Mexico

- Since its inception, CONAE/CONUEE sought to align its standards to the degree possible with U.S. regulations.
 - The first four major standards promulgated by CONAE in 1995 for refrigerators, air conditioners, washing machines and three-phase motors were harmonized with U.S. standards
- In early 2000s, CONAE passed a second round of standards for refrigerators and window air conditioners, harmonized with U.S. standards effective 2001 and 2000
- More recent standards in 2008 and 2012 did not harmonize with U.S. standards.

TYPE	NORMA	Recent ¹	Previous 1	Previous 2	Previous 3
Ref 1	NOM-015-ENER-2012 Energy efficiency of refrigerators and freezers. Limits, test methods and labeling.	2012	2002/3 ²	1997/7	1994/5
AC 1	NOM-023-ENER-2010 Energy efficiency of ductless split-system air conditioners. Limits, test methods and labeling.	2010/11			
AC 2	NOM-021-ENER/SCFI-2008 Energy efficiency and user for room air conditioners. Limits, test methods and labeling.	2008	2000 ³	1994/5	



Data Requirements

- Impacts evaluation required a variety of data, mostly from Mexican government agencies, gathered by IIE with help from CONUEE
- Most critical data source from certification agency (ANCE) – model-level data on product capacity and energy consumption

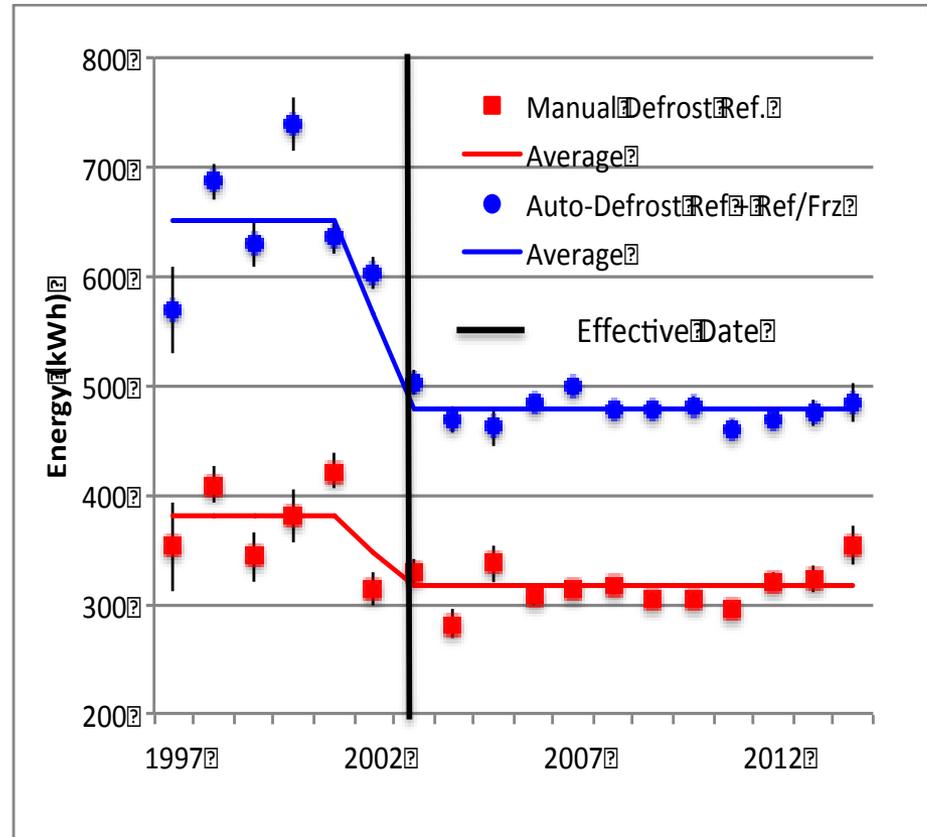
Variable	Source
Financial Variables	
Interest Rate	Banco de México
Discount Rate	SHCP, CFE
Exchange Rate	Banco de México
Power Sector Variables	
Marginal Electricity Cost	CFE
Marginal Demand Cost	CFE
Transmission and Distribution Losses	CFE
Capacity Losses in Peak Period	CFE

Variable	Source
Product Specific Market Variables	
Product Lifetime	Manufacturer Assumption/ international reference
Annual Sales	Manufacturers
Market Growth Rate	ANFAD
Product Specific Energy Variables	
Use Factor	Assumption IIE-CONUEE/ Manufacturers /CFE
Coincidence Factor	Assumption IIE-CONUEE/ Manufacturers /CFE
Unit Energy Consumption / Efficiency	ANCE ¹
Product Specific Financial Variables	
Equipment Prices	IIE
Manufacturing Costs	Manufacturers
Equipment Certification Costs	ANCE



Refrigerator Market Data

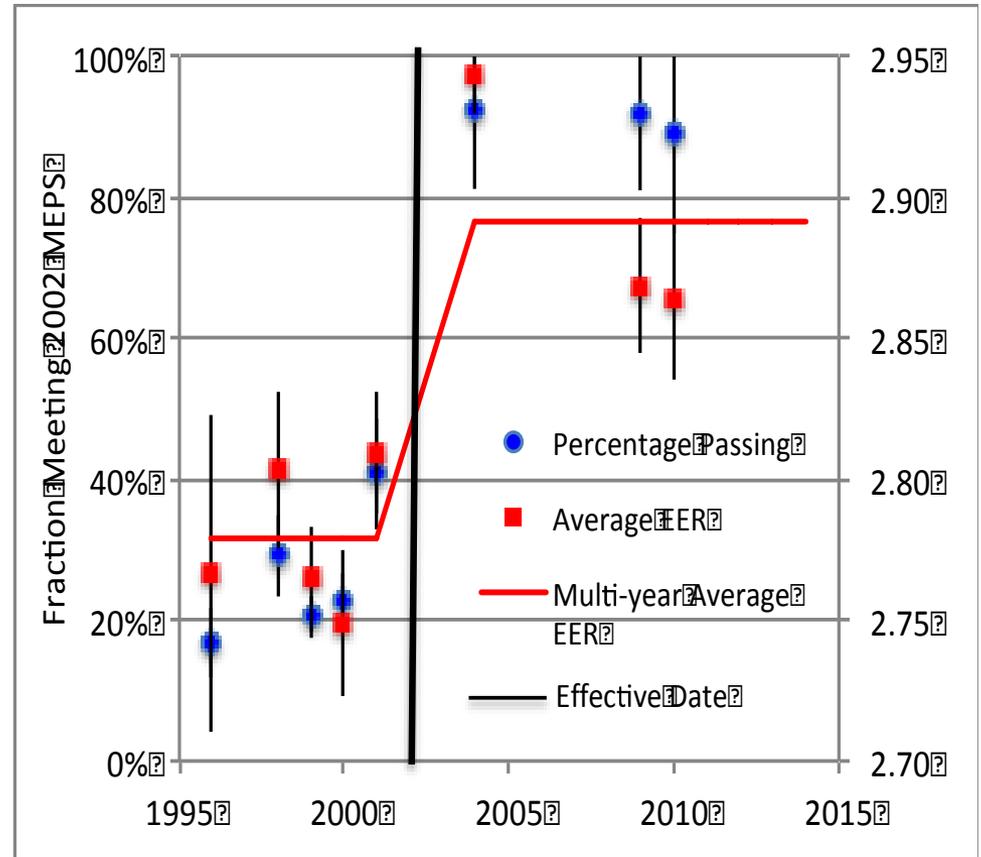
- Two main product classes
 - Product Class 1 (PC1) are manual or semi-automatic refrigerators (8% of market)
 - Product Class 3 (PC3) are automatic defrost top-mounted freezers and refrigerator only (80% of market)
- Market shows clear shift between pre- and post-effective date
- Efficiency improvement close to improvement in minimum efficiency dictated by MEPS



Between 2000 and 2002, average annual energy consumption decreased from 651 kWh to 478 kWh for a refrigerator-freezer with automatic defrost (PC3) and from 381 kWh to 316 kWh for a manual defrost refrigerator. (PC1)

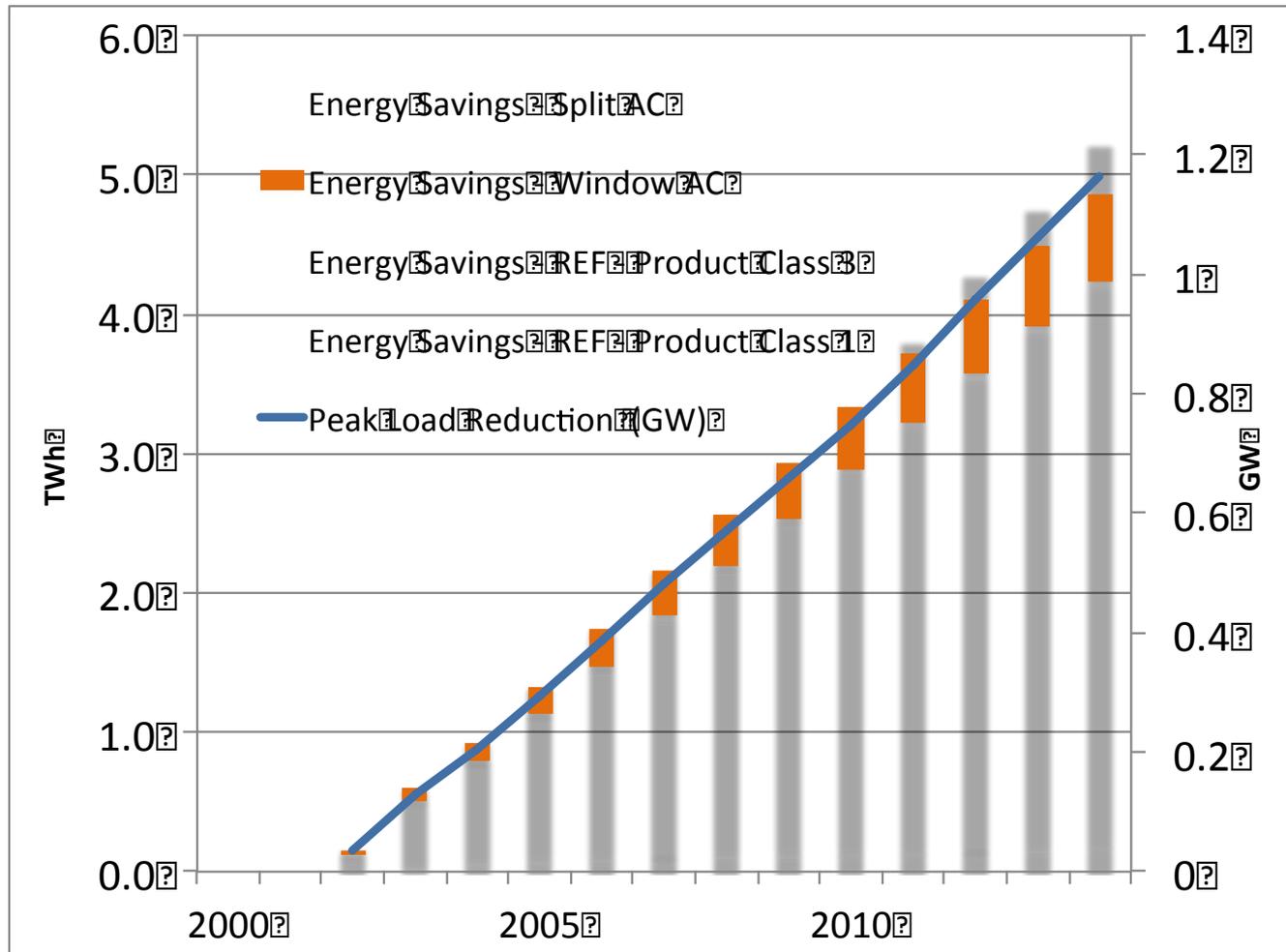
Air Conditioner Market Data

- Only Window AC harmonized with U.S.
- Much fewer data points and some years missing
- Reasonably efficiency improvement signal observed around standards implementation. Mandated efficiency improvement small (4%), consistent with observed shift.
- First Mexican split-system AC standard passed in 2011, no products in database before then.



Efficiency data for room (window) air conditioner models is sparse, but a clear transition can be seen in the 2000-2005 period, when average EER increased from 2.78 to 2.89 – a 4% improvement.

National Energy-Related Impacts



Unit level impacts were combined with sales forecasts to yield national impacts estimates for electricity savings, peak load reductions, greenhouse gas emissions mitigation and avoided consumer electricity bills

Non-Energy Benefits

In addition to calculating benefits to Mexican society directly arising from energy savings, the project also evaluated non-energy benefits through stakeholder interviews:

- Representatives from the private sector who were interviewed for this study acknowledged the introduction of standards as a positive mechanism, which creates a leveled playing field for manufacturers while sending a clear signal to industry that investments can be made safely.
- The introduction of standards has led to increased awareness of energy efficacy among Mexican consumers; energy efficiency is now one of the five most important factors considered by consumers when purchasing a refrigerator.
- The announcement or publication of efficiency standards has often resulted in technology changes, as manufacturers work to improve products by including new components or more efficient parts.
- The introduction of standards has boosted Mexico's infrastructure for compliance; Due to the program, Mexico now boasts 56 testing laboratories, 7 certification bodies and 1 accreditation agency.



Thank you!

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