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Review

# The impact of energy efficiency standards on residential electricity consumption in Mexico

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ABSTRACT

Minimum Energy Efficiency Standards (MEES) for residential appliances have been part of the Mexican national energy policy since the early nineties. This study analyzes the impact of MEES on residential electricity consumption and the carbon dioxide ($CO_2$) emissions related to refrigerators, washing machines, air conditioners, televisions and lighting products in Mexico. The paper presents estimated achievements of MEES from 1990 to 2012 and future scenarios until 2030 by implementing stricter MEES based on the best technology available. A replacement technology model was developed to estimate, saved energy and avoided $CO_2$ emissions for different appliances' lifetimes. Considering a 16-year average lifetime of appliances and 80% penetration of efficient lighting technologies, in 2013 energy savings were estimated to be 16.06-TWh (emission reduction of 9.5 Tg $CO_2$). Different scenarios are presented assuming different average lifetimes of appliances as well as an increase in renewable energy sources in electricity production.

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## Introduction

Energy efficiency measures have been important since the 1973 oil embargo, and they have taken on renewed importance with global climate change (Gillingham et al., 2009). Within this context, Minimum Energy Efficiency Standards (MEES) for appliances have been a key strategy for increasing energy security, and mitigating climate change (Van Buskirk et al., 2014). Energy efficiency programs for appliances started in the US (Meyers et al., 2014), with the Energy Policy and Conservation Act (EPCA) in 1975 that established a program consisting of labeling and energy conservation targets for different types of consumer products. Later on, in 1987 with the National Appliance Energy Conservation Act (NAECA), EPCA was amended to establish the first US national energy conservation standards for consumer products (Meyers et al.,

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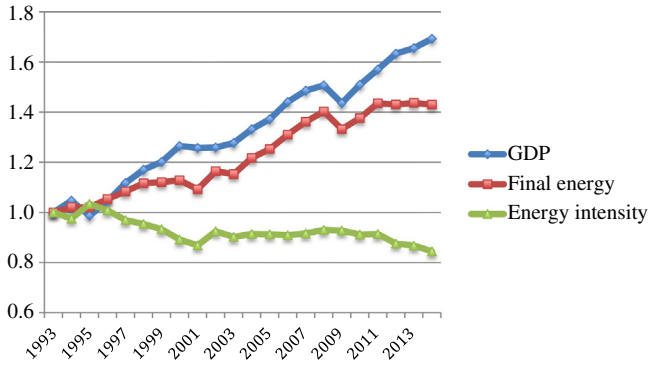


**Fig. 1.** Changes in Mexican indicators considering 1993 as base year.
Source: INEGI (2016) and SENER (2016).

2014). Since then, subsequent modifications have been made, as well as other energy efficiency programs such as Energy Star, a voluntary program to identify and promote energy-efficient consumer products.

In the case of Mexico, MEES for appliances have been part of Mexican national energy policies since the early nineties (Masera et al., 1993; Friedmann and Sheinbaum, 1998). MEES in Mexico, remote to 1989 with the creation of The National Commission for Energy Savings (today CONUEE — Comisión Nacional para el Uso Eficiente de la Energía), the Electricity Sector's Energy Saving Program (Programa de Ahorro de Energía del Sector Eléctrico — PAESE) and the Revolving-loan trust Fund to Save Electricity (Fideicomiso Para el Ahorro de Energía — FIDE). In 1995 the first mandatory MEES for water pumps, gas heaters and refrigerators were published. By now, 27 MEES are in place in Mexico (CONUEE, 2013; SENER, 2008; SENER; 2010; 2012a; 2012b).

Since the establishment of MEES, several academic papers have analyzed their importance and their impacts. Some of the most recognized studies are Shipper and Meyers (1992), Levine et al. (1995), Koomey et al. (1995), Turiel (1999), Nadel (2002), and Meyers et al. (2003). Recent studies that analyze the benefits and weakness of MEES after 20 years of the application are for example Davis (2011), who examines the saturation of Energy Star appliances using US Residential Energy Consumption Survey; Shimoda et al. (2010) that featured greenhouse gas reduction potential in Japanese residential sector by residential energy end-use model and the application of MEES; Dixon et al. (2010), who summarize the history of US energy conservation and efficiency policies; Jiang (2011) that develop an analysis of national and local energy-efficiency design standards in the public building sector in China. Meyers et al. (2013) estimated the key impacts of Federal energy and water conservation standards adopted from 1987 through evaluating the reduction in $CO_2$ emissions associated with their application. The last publication estimated a reduction of 198 million metric tons of $CO_2$ emissions, equivalent to 3% of total U.S in 2012.

Also, Van Buskirk et al. (2014) developed a retrospective investigation of energy efficiency standards and the declination in appliance costs. Parry et al. (2010) developed an analytical framework for comparing the welfare effects of energy efficiency standards and pricing policies for reducing gasoline, electricity, and nationwide carbon emissions. Borg and Kelly (2011) also studied the effect of appliance energy efficiency improvements on domestic electric loads in European households; and Kalavase et al. (2012) projected impacts of global energy efficiency standards for appliances implemented in Super-efficient Equipment and Appliance Deployment Initiative (SEAD) countries. Also, Nogueira et al. (2015) studied the impact of energy efficiency measures in Brazil.

In the case of Mexico, Masera et al. (1993) presented the first end use analysis of residential sector in Mexico and the possibilities of energy efficiency standards, followed by Sheinbaum et al. (1996). Friedman et al. (1995) developed one of the first studies on residential lighting energy efficiency opportunities, and Friedmann and Sheinbaum (1998) analyzed energy efficiency policies in Mexico. Years later, Arroyo-Cabañas et al. (2009) analyzed saving potential for refrigerators, Ruchansky et al. (2011) evaluated energy efficiency programs in different Latin-American countries including Mexico; Gopal et al. (2014) studied self financing of energy efficiency incentives in Mexico and recently CONUEE (2013) developed a balance of MEES in Mexico.

The aim of this paper is to estimate the impact of MEES for different appliances in residential electricity consumption in Mexico and estimate future energy savings due to the scaling up of energy standards. The appliances analyzed are refrigerators, washing machines, and air conditioners; televisions are also included in the analysis, because of its importance in residential energy consumption, although there are no MEES for them. Lighting is also included in the analysis; in this case a standard published in December 2010 (SENER, 2010) established a ban to sold incandescent bulbs of 100 W in December 2011; 75 W in December 2012 and 40 to 60 W in December 2013.

As mentioned above, there have been some studies on the analysis of appliance energy efficiency standards in Mexico; the novelty of this

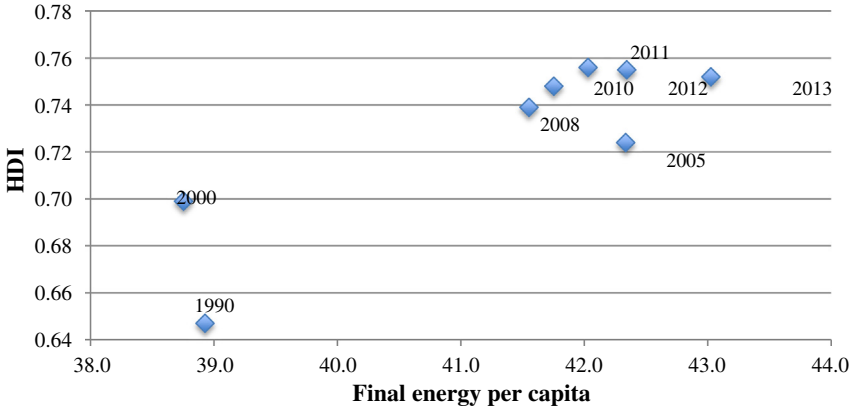


**Fig. 2.** Final energy per capita and Human Development Index.
Source: SENER (2016) and UNDP (2016). Final energy per capita in GJ/cap.

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