



Introducing mandatory standards for select household appliances in Lebanon: A cost-benefit analysis

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HIGHLIGHTS

- ▶ We model the effect of mandatory appliance standards on electricity consumption.
- ▶ We present a refrigerator replacement program contributing to economic development.
- ▶ We show that economic efficiency favors the introduction of standards for appliances.

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ABSTRACT

Lebanon's energy sector crisis leads to a lack of access to uninterrupted, basic modern electricity services that affects all sectors of the economy. Energy conservation measures are nearly nonexistent yet they can potentially lead to substantial reductions in energy demand growth, environmental damages and public expenditures. This paper presents an analysis of the costs and benefits associated with the introduction of mandatory standards for energy efficiency for four different household appliances (refrigerator/freezers, AC split units, washing machines and lighting) over the period 2013–2027. Our results show potential savings in electricity consumption reaching 2054 GW h annually in 2027 as well as a reduction of subsidies paid to the public utility of 3.6 billion USD in 2027 while CO₂ emissions avoided amount to 8.9 million tons over the period of analysis. Furthermore, we propose a financially attractive refrigerator/freezer replacement program for low income households. If this program would cover all existing low-income households in 2013, the savings in electricity consumption would lead to a reduction in subsidies of 9 billion USD (NPV) over the period 2013–2027, while full funding for this program would cost the government 223.8 million USD. This program would thereby benefit consumers, the government and further economic development.

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1. Introduction

Lebanon is a small open, middle-income economy deriving around 97% of total primary energy, from imported fossil fuels that are mainly used in the transport and electricity sectors. The fossil fuel imports place a heavy burden on public finances primarily because of subsidized electricity prices that have not been revised in nearly two decades.

Household electricity consumption accounts for 35% of total electricity consumption in Lebanon (Mourtada, 2008) hence the introduction of energy efficient (EE) household appliances can substantially contribute to energy savings. In 2010 the Government of Lebanon has committed to reducing energy consumption by 6% by the year 2013 (MEW, 2010) and an energy-conservation law has been developed and is currently under review.

A variety of factors such as the standard of living, the climate, the technological aspects of energy efficient household appliances available on the local market, as well as the price of energy will all contribute to determining household electricity consumption. Worldwide a large number of countries have adopted mandatory standards and labels while fewer countries have adopted voluntary standards. Practice has shown that mandatory standards are much more effective (Mahlia et al., 2003).

This paper aims to show the costs and benefits for consumers, the government in terms of public finances and the environment that result from introducing mandatory EE standards for refrigerator/freezers, AC split units, washing machines and lighting. Section 2 presents a brief background review. Section 3 presents the national characteristics of the Lebanese economy and the essential features of the energy sector as they pertain to residential electricity consumption and appliance use. Section 4 highlights the methodology used. Section 5 discusses our results while Section 6 presents a refrigerator replacement program for low income households and Section 7 presents concluding remarks and policy recommendations.

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Nomenclature

A	Age (years)	SEC	Standards electricity consumption (kW h)
BEC	Baseline electricity consumption (kW h)	SECPU	Standards electricity consumption per unit (kW h)
BECPU	Baseline electricity consumption per unit (kW h)	SEIR	Standards efficiency improvement rate (%)
BPR	Baseline power rate (kW)	T	Operating time (hours per day)
EIR	Efficiency improvement rate per annum (%)	UPH	Number of units per households
GR	Growth rate (%)	0	Year Zero
H	Number of households	e	Existing
LT	Lifetime (years)	i	Year
N	Number of units	n	New
RR	Retirement rate (%)	rp	Replacements
		rt	Retired
		x	Appliance

2. Background

The literature on the benefits of introducing standards and labels is abundant. Mahlia et al. (2002) developed a theoretical approach particularly suitable for developing countries that typically lack reliable data. He further notes that the most effective way of improving the EE of the stock of appliances in a country is to introduce mandatory standards. Saidur et al. (2007), point to the importance of energy conservation for fast growing developing countries and calculate the potential energy savings and avoided emissions of greenhouse gases and other pollutants that can be achieved through policy measures such as for example standards for household appliances in Malaysia. Mahlia et al. (2003) present the electricity savings resulting from the introduction of EE standards for refrigerators in Malaysia. Rosas-Flores et al. (2011) show the advantages of energy conservation through government programs that apply to Mexico's residential sector. Lu (2006) models the impact of implementing EE standards for refrigerators in China and finds that it would lead to large savings in energy and benefit the environment. Tao and Yu (2011) in addition to environmental and direct economic effects of the standard also discuss the effects of the latter on manufacturer's costs and the uptake of new technology.

Ashina and Nakata (2008) analyze the economics of introducing EE measures for the purpose of CO₂ emissions reduction in Japan. Cardoso et al. (2010) present the economics of different options for consumers under Brazil's labeling standards for refrigerator/freezers. Furthermore, Mahlia (2004) investigates the market transformation when EE standards are introduced.

Research on Lebanon is less abundant but Chaaban and Rahman (1998) and Chedid et al. (2001) examine the potential for EE options in various sectors of the economy while Chedid and Ghajar (2004) analyze the effect of the former in the building sector. To the best of our knowledge however, no paper has been published so far that analyzes the effect of introducing EE household appliances while providing a detailed analysis of the impact on public finances, consumers and the environment as well as a refrigerator replacement program for low income households.

3. National characteristics**3.1. General**

Lebanon is considered an upper middle income developing and open economy with a per capita GDP reaching 14,400 USD in 2010 (CIA, 2011). In the same year the country's population was estimated to be around 4.2 million (EIU, 2010) and the average family counts 4.23 members (CAS/UNDP, 2007).

Data on poverty in Lebanon is sparse because not many comprehensive studies on the topic have been conducted.

Inequality, as measured by the Gini coefficient (0.37) can be considered high compared to developed countries; it is however not atypical when compared to other middle-income and/or MENA countries (Laithy et al. 2008). While the northern, southern and the Bekaa region are poorer than the remaining ones, and there exist some poverty pockets within these regions, poverty in Lebanon cannot be classified as strictly regional as intra-governorate income-inequality is dominant (Laithy et al. 2008). Around 28% of the Lebanese population is considered to be poor. The World Bank (2009) distinguishes between extremely poor individuals (living on less than 2 USD per capita per day), representing 8% of the Lebanese population and poor individuals (living on more than 2 USD but less than 4 USD per capita per day). The latter constitute around 20% of the population.

3.2. Background on appliances

In Lebanon the market for EE appliances is still in its infant stages. However, Initiative 14 of the National Energy Efficiency Action Plan issued in 2011 by the Ministry of Energy and Water, specifically addresses the promotion of energy efficient equipment through the implementation of standards for energy efficient equipment as well as public awareness campaigns (MEW, 2011). The Lebanese Center for Energy Conservation (LCEC) in cooperation with the Lebanese Standards Institution (LIBNOR) has introduced EE standards for all 4 household appliances considered in our study (refrigerators, AC-split units, washing machines and compact fluorescent lamps (CFLs)). There exist several major standard and labeling systems worldwide. The strong trade ties and the geographic proximity to the European Union (EU) has led Lebanon to adopt the 'old' EU standard and labeling system as the EU has recently replaced its first EE Directive that was issued in 1992 with a new Directive associated with a new energy label, that depending on the particular appliance, ranges from A⁺⁺⁺ to D and the ratings E, F and G have been removed (EU, 2010). This new Directive became mandatory for member states in December 2011.

While the Lebanese EE standards for refrigerators, electric/gas heaters and AC-split units are officially recognized, they are not yet mandatory and no testing facility exists and labels are not available on merchandise. So far, only CFLs are subject to mandatory standards (MEW, 2011). In fact, currently consumers shopping for new household appliances will find that most appliances available do not have any label displayed while the remainder will display labels from different parts of the world such as China, Europe, Australia or the US. The standards underlying these different labels diverge substantially. Consumers are thus unable to easily compare the energy efficiency of different appliances. Tao and Yu (2011) present an illustrative comparison of EE standards across countries for refrigerators.

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