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Mitigation Enabling Energy Transition in the MEDiterranean region

Together We Switch to Clean Energy

NATIONAL MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS) AND LABELING PROGRAM FOR APPLIANCES IN LEBANON

MED ENER

RCREEE

Regional Center for Renewable Energy and Energy Efficiency

المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

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ABOUT THE PROJECT

The Mitigation Enabling Energy Transition in the Mediterranean region "meetMED" is an EU-funded project developed by the Mediterranean Association of the National Agencies for Energy Management (MEDENER) and the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE).

With the objective of contributing to energy and climate transition Southern Mediterranean Neighbourhood through a multi-scale, multi-partner inclusive approach, meetMED II activities aim at developing a more stable, efficient, competitive, and climate-resilient socioeconomic environment in Southern Mediterranean countries, by fostering regional cooperation for Energy Efficiency measures and implementing demo actions.

CONTENTS

LIST OF NOMENCLATURES AND ACRONYMS

ALMEE	The Lebanese Association for Energy Saving & For Environment.
AMIDEAST	America-Mideast Educational and Training Services.
CEDRO	Center for Energy Conservation and Environmental Development.
CFL	Compact Fluorescent Lamps.
CoM	Lebanon's Council of Ministers.
DOC	Declaration of Conformity.
EEI	Energy Efficiency Index.
GHG	Greenhouse Gas.
IEC	International Electrotechnical Commission.
IRI	Industrial Research Institute.
ISO	International Organization for Standardization.
K-CEP	Kigali Cooling Efficiency Program.
KPIs	Key Performance Indicators.
LCC	Life Cycle Costs.
LGBC	Lebanese Green Building Council.
LIBNOR	Lebanese Standards Institution.
MAC	Mobile Air Conditioning.
MEPS	Minimum Energy Performance Standards.
MoE	Ministry of Energy.
NCP	National Cooling Plan.
NDC	Nationally Determined Contributions.
NEEAP	National Energy Efficiency Action Plan.
RAC	Refrigeration and Air Conditioning.
SEER	Seasonal Energy Efficiency Ratio.
SWH	Solar Water Heaters.
TC	Technical Committee.
UNDP	United Nations Development Programme.
USAID	United States Agency for International Development.

1. EXECUTIVE SUMMARY

Minimum Energy Performance Standards (MEPS) and appliance labeling schemes are crucial tools for promoting energy efficiency. By setting minimum energy performance requirements and providing consumers with clear information on energy consumption, these policies can drive the market towards more efficient appliances.

Household appliances, especially those for heating, cooling, and refrigeration, are major energy consumers. Lebanon, as a signatory to the Paris Agreement and the Kigali Amendment, is committed to reducing its carbon footprint and increasing energy efficiency. The country's Second National Energy Efficiency Action Plan (NEEAP) aims to transform the market for household appliances by promoting energy-efficient models.

This report analyzes the current state of MEPS and appliance labeling in **Lebanon,** identifies gaps and challenges, and proposes recommendations to strengthen the implementation of these policies. By doing so, Lebanon can reduce its reliance on fossil fuels, lower greenhouse gas emissions, and alleviate the financial burden associated with high energy costs.

2. INTRODUCTION

2.1 BACKGROUND

A Minimum Energy Performance Standard (MEPS) is a regulatory policy that defines the energy efficiency requirements for equipment or appliances, setting a limit on the maximum energy consumption per unit of output. Under a MEPS policy, appliances that do not meet the specified minimum performance requirements are prohibited from being imported or sold in the market. MEPS serves as a crucial tool to eliminate inefficient equipment from the market and reduce the number of energy-consuming units available. On the other hand, appliance labeling schemes aim to provide consumers with information about the energy efficiency of appliances. This is vital because the energy consumption of appliances often ends up costing consumers significantly more over the appliance's operational lifespan compared to the initial purchase price [1].

Household appliances, particularly heating, cooling and refrigeration, consume a substantial amount of electricity, making them pivotal in promoting energy efficiency, especially in residential areas. In countries belonging to the International Energy Agency (IEA), residential appliances account for an average of about 19% of the total energy consumption, where data is readily available [2].
Numerous important initiatives are underway to advance resource efficiency, including the Kigali Cooling Efficiency Program (K-CEP). K-CEP is a philanthropic program designed to support the Kigali Amendment to the Montreal Protocol.

This amendment commits 197 countries to reduce the production and use of hydrofluorocarbons (HFCs), which are potent greenhouse gases used in refrigeration and air conditioning, by more than 80% over the next 30 years.
K-CEP focuses on enhancing the energy efficiency of cooling systems to maximize the environmental and developmental benefits of the Kigali Amendment in phasing out HFCs.

Lebanon, as a member of the Paris Agreement and a signatory of the Montreal Protocol's Kigali Amendment, is also obligated to achieve climate targets, aiming for net Greenhouse Gas (GHG) neutrality by the middle of this century. To attain this goal, Lebanon is committed to increasing its ambition and establishing specific sector-specific goals within its Nationally Determined Contributions (NDC) [3]. Lebanon's NDC framework commits to an unconditional reduction of 3% (or a conditional 10%) in power demand through energy efficiency measures, in conjunction with renewable energy targets. In total, Lebanon pledges an unconditional reduction of greenhouse gas (GHG) emissions by 15% (or 30% under conditional circumstances) compared to the business-as-usual scenario by 2030 [4]. Achieving these targets will help Lebanon reduce its reliance on expensive fuel oil and diesel, along with the financial burdens associated with them. Lebanon's Second National Energy Efficiency Action Plan (NEEAP) addresses the need to transform the demand and supply of household appliances through various measures, as discussed in this report, to create a market for more energy-efficient appliances.

In 2021, Lebanon introduced a **"National Cooling Plan" (NCP)** emphasizing the critical role of the cooling sector in helping Lebanon meet its targets under the Paris Agreement, the Montreal Protocol, and the Kigali Amendment. The NCP outlines the transition towards lower indirect and direct emissions through enforced Energy Efficiency (EE) requirements and the gradual reduction of refrigerants and foam blowing agents with high Global Warming Potential (GWP). Additionally, the NCP aims to make cooling solutions affordable for the population, align with Lebanon's Sustainable Development Goals (SDGs), and support the country's economic development objectives [3].

In 2019, a study conducted by CEDRO focused on **"Energy Efficient Home Appliances."** This study aimed to establish the fundamental characteristics of household appliances in Lebanon and assess the willingness of Lebanese homeowners to shift towards more energy-efficient choices. The study primarily concentrated on five appliances that contribute significantly to household electricity consumption: washing machines, air conditioners, televisions, light bulbs, and refrigerators.

MEPS were integrated as a central initiative for implementation in both the initial **National Energy Efficiency Action Plan (NEEAP 2011-2015)** and the subsequent one (2016-2020). This measure centers on the proposition of establishing energy consumption standards for equipment and tools. However, it should only be put into effect when there is confidence that viable alternatives exist and when these alternatives are affordable for consumers.

MEPS should be introduced for various categories of equipment, including refrigerators, cooling and heating systems, water heaters, televisions, lighting, and electric motors. A crucial first step involves implementing an Energy Consumption Labeling Ordinance that paves the way for MEPS in Lebanon. This ordinance compels manufacturers to reduce the energy consumption of their products by setting MEPS, thereby steering the market away from the least energy-efficient products.

2.2 METHODOLOGY

To accurately assess the implementation of MEPS in **Lebanon,** a comprehensive methodology was employed. This involved a thorough analysis of energy consumption patterns for various appliances in Lebanon. Additionally, a detailed investigation into the Lebanese appliance market was undertaken, encompassing the supply chain, origin of appliances, distribution channels, and sales patterns.

Furthermore, existing awareness and scrapping campaigns were evaluated, with recommendations for improvement and expansion. A comprehensive assessment of the existing MEPS and labeling program was also conducted, examining policies, regulations, implementation plans, testing procedures, compliance mechanisms, and monitoring and evaluation processes.

By following this methodology, the report aimed to identify challenges and propose recommendations for enhancing the effectiveness of MEPS and labeling programs in Lebanon.

2.3 KEY CHALLENGES

Lack of Incentives and Awareness

A. Knowledge Gap: Lack of awareness about Life Cycle Costs (LCC) and energy-efficient practices inhibits industry motivation for using efficient appliances.
B. Reluctance to Invest: Reluctance to invest in devices conforming to norms and standards contributes to a lack of incentives for adopting energy-efficient appliances.
C. Poor Awareness: Widespread unawareness about energy performance labels and benefits hinder consumer choices and slow down the MEPS promotion process.

Communication Issues

A. Technical Challenges: Online meetings may face delays due to Lebanon's unreliable electricity and connection infrastructure.
B. Challenges: During Data Collection: Contradictory information, difficulties in questionnaire completion, and partial data disclosure by companies hinder the process.
C. Lack of Transparency: Confidentiality policies and personal interests during decision-making meetings may impede transparent information exchange.

Economic and Financial Crisis Impact

A. Consumer Behavior: The ongoing economic crisis prompts consumers to opt for cheaper appliances, undermining the adoption of MEPS- compliant products.
B. Market Dynamics: Manufacturers and importers face little motivation to introduce energy-efficient appliances due to consumer preferences for low upfront prices.

Monitoring and Evaluation Gap

A. Data Insufficiency: Lack of comprehensive programs and tools to monitor and evaluate energy efficiency measures, especially for MEPS in home appliances.
B. Limited Information: Despite existing reports, a lack of KPIs and comprehensive data for household appliances impedes effective monitoring and assessment.

3. APPLIANCES ENERGY CONSUMPTION IN LEBANON

3.1 MEPS SITUATION IN LEBANON

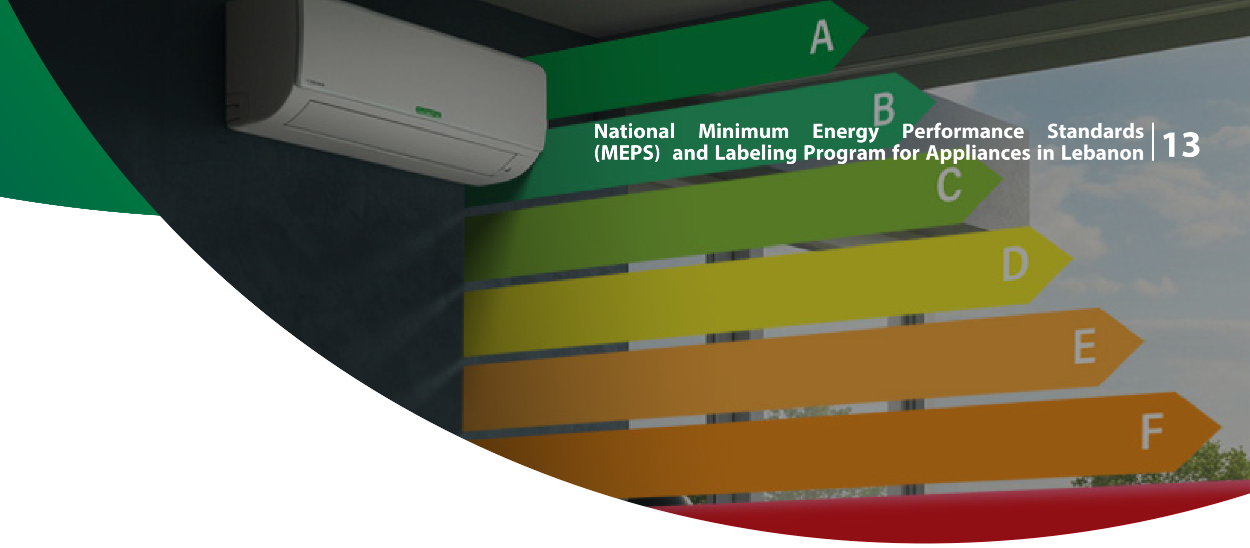
Minimum Energy Performance Standards or MEPS determine the minimum energy efficiency that products shall meet, to be sold in the market. MEPS tend to protect the consumers from products that have low energy performance. MEPS are concerned with refrigerators, cooling, heating and water heating equipment, televisions, lights, and electrical motors.

LIBNOR adopted voluntary energy efficiency standards for five household appliances: solar water heaters (SWH), LED lamps, refrigerators, A/C split units and electric and gas water heaters. In decree 5305, passed on October 28, 2010, Lebanon's Council of Ministers (CoM) made the standards mandatory for solar water heaters (SWH) and compact fluorescent lamps (CFL).

However, a done survey with **630 respondents'** results indicate that respondents would be willing to pay (WTP) more for the surveyed appliances should they actually have energy performance labels. The relative premiums for energy efficient appliances range from over **3 percent** for televisions and refrigerators, over **9 percent** for air conditioners, over **34 percent** for light bulbs, and just **under 5%** for washing machines [5,6].

Equipment	Unitary consumption in Watts	Number per household	Time usage per day in hours	Months usage	Yearly consumption in kWh	Percentage %
Lighting	10.00	7.00	4.00	12.00	102.20	1%
Refrigerator	120.00	1.00	12.00	12.00	525.60	3%
Freezer	120.00	1.00	12.00	12.00	525.60	3%
Iron	1500.00	1.00	0.75	12.00	410.60	2%
Extractor	200.00	1.00	0.50	12.00	36.50	0%
Electric Oven	2000.00	1.00	0.50	12.00	365.00	2%
Laundry Washer	1800.00	1.00	0.50	12.00	328.50	2%
Hair dryer	1500.00	1.00	0.25	12.00	136.90	1%
Radio	10.00	1.00	4.00	12.00	14.60	0%
TV	80.00	2.00	4.00	12.00	233.60	1%
Table Fan	40.00	2.00	6.00	6.00	87.60	0%
Roof Fan	75.00	2.00	6.00	6.00	164.20	1%
A/C for Cooling	1500.00	2.00	7.70	5.00	3513.10	19%
A/C for Heating	1500.00	2.00	6.00	5.00	2737.60	15%
Electric Water Heater	1500.00	1.00	4.00	12.00	2190.00	12%
Electric Heater	2000.00	2.00	12.00	4.00	5840.00	31%
Other Household	1000.00	1.00	4.00	12.00	1460.00	8%

Table 1: Yearly energy consumption of electrical household equipment 2017 [6]



3.2 AC/HEATING USAGE IN LEBANON

Air conditioners (ACs) and electric heaters potentially have the highest energy consumption rates among the different list of appliances used by people around the world (GEA, 2012). Furthermore, and based on results shown in Table 1, ACs and heaters are used by a relatively large percentage of respondents; 87% (equivalent to 545 respondents) and 92% (equivalent to 579 respondents), respectively. To this end, the usage habits of ACs and water heaters are further investigated hereafter. Respondents who own AC split units or central ACs were asked about the average use of AC for cooling in both the summer period (running from June to September) and all the other periods combined. ACs are used for space cooling during the summer period with an average of 7.7 hours per day while during the remaining months AC usage drops to an average of 3 hours per day.

Equipment	Residential			Commercial			Sum	
	Number in thousand	Unitary Consump. in kWh	Total Consump. in Tj	Number in thousand	Unitary Consump. in kWh	Total Consump. in Tj	in Tj	in %
Lighting	950	102.2	909.4	190	432.0	295.6	1204.9	8.52
Refrigerator	950	525.6	1797.7	190	51.8	35.3	873.0	6.18
Freezer	950	525.6	1797.7	190	36.3	24.8	215.3	1.52
Iron	950	410.6	903.6	190	0.0	0.0	502.2	3.55
Extractor	950	36.5	83.9	190	27.0	18.4	102.2	0.72
Electric Oven	950	365	1248.3	190	36.0	24.5	157.0	1.11
Laundry Washer	950	328.6	1123.8	190	27.0	18.4	256.3	1.81
Hair Dryer	950	136.9	468.2	190	0.0	0.0	19.8	0.14
Radio	950	14.6	65.4	190	4.3	2.9	48.6	0.34
TV Color	950	233.7	798.9	190	17.3	11.9	265.7	1.88
Table Fan	950	164.2	299.6	190	43.2	29.5	74.9	0.53
Roof Fan	950	10.5	560.9	190	16.2	11.2	36.7	0.26
A/C for Cooling	950	3513.1	12014.8	190	810.0	554.0	1876.0	13.27
A/C for Heating	950	2737.6	9360.5	190	1250	855.0	2340	9.2
Electric Water Heater	950	2190	7489.8	190	324.0	221.8	3076.9	21.77
Electric Heater	950	5840	19972.8	190	1800.0	1231.2	4403.9	31.15
Other Household	950	1460	4993.2	190	1296.0	886.3	886.3	6.27
TOTAL	950		63881	190		3386.5	67268	100.0

Table 2: Rate of household equipment in Residential and commercial sectors 2017 [6]

During winter months, ACs are commonly used for space heating and respondents were asked about their usage patterns, namely the duration. Answers pertaining to AC usage pattern over the winter season for space heating are shown in table 1, indicating an average use of 6 hours per day.
In addition, respondents were asked about the methods used to heat water around the residence; 92% (equivalent to 573 respondents) use electric boilers (electric heaters), 12% (equivalent to 75 respondents) use solar hot water, 39% use diesel boilers for heating and hot water, and only 5% (equivalent to 31 respondents) use gas boilers. 60% of respondents do not mention or read about energy efficiency in home appliances.

In topics related to energy efficient appliances, lower level of awareness is found amongst the respondents, with the majority having rarely or never been exposed to the topic at hand. With respect to 'sources of renewable energy', and due to lot of electricity rationing in the country in the past 3 years and the high cost of energy, 12% of respondents indicated that they have a solar photovoltaic system, whereas 31% indicated that they have a solar hot water system. Solar hot water systems have advanced considerably with time in Lebanon. During a study on the solar hot water market in Lebanon, based on surveys in 2010, only 13% of respondents to the then survey indicated that they have solar hot water systems [7]

The market study established Lebanon's first RAC GHG inventory for all major RAC subsectors including unitary air conditioning, chiller, mobile air conditioning, domestic-, commercial- and transport refrigeration and the in-depth assessment of the key appliance types room air conditioners and domestic refrigerators, with a proposal for the future introduction of MEPS and labels for these appliances. It combines refrigerants and energy use of RAC appliances. With its projection of business-as-usual emissions and mitigation scenarios, the RAC assessment is an important input for the development of mitigation options as serving the targets of both the Kigali Amendment (KA) under the Montreal Protocol (MP) and toward the National Determined Contributions (NDCs) under the Paris Agreement (PA) [7].

The assessment of the RAC sector provided the following key findings:

1. The RAC sector accounts currently for about 7.7 MTCO2-eq in annual GHG emission and 6,000 GWh (2018) in electricity consumptions which is about 26% of Lebanon's total electricity demand. Under the Business as Usual (BAU) scenario, the GHG emission will increase to 10 MTCO2-eq and about 8,000 GWh in electricity consumption by 2030.

2. Mobile Air Conditioning (MAC) is the third most important sector in terms of national emissions in Lebanon. This sector is controlled by the major car manufacturers, mainly located in developed economies, with limited intervention options through smaller countries to influence the choice of technology.

3. As outlined in the NCP, Lebanon has a high ownership of refrigerator and AC ownership and an above average share of cooling emissions with about 26% of total emissions.

4. APPLIANCES MARKET

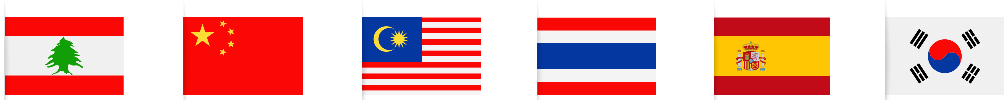
4.1 APPLIANCES SUPPLY CHAIN (APPLIANCES ORIGINS, DISTRIBUTION, SALES, ETC)

The Industrial Research Institute is the only center that can confirm that it meets the MEPS, and therefore authorize it to enter the **Lebanese market.** The appropriate label class for the product must be proposed in a "Declaration of Conformity - (DOC)" submitted by importers and local manufacturers for each model they want to sell. The DOC carries a certification attesting that the appliances' energy efficiency was evaluated in accordance with the necessary standards, including the advised IEC 62552:2015 for refrigerators and ISO 16358:2013 for air conditioners, with a laboratory that has been accredited in accordance with ISO 17025. The items cannot enter Lebanon or be sold there unless they have permission to do so. A documented justification for the rejection of a DOC will be sent to the submitter. The authorized model may be used with the approved DOC for a period of **24 months.**

Lebanon imports almost all **electrical appliances** and household goods. Lebanon Imports of Electrical, electronic equipment was US$1.65 Billion during 2022, according to the United Nations COMTRADE database on international trade. Starting **June 2023,** all imported renewable energy equipment, such as solar panels, batteries, inverters, heat recovery, wind turbines, etc... are customs free and VAT free. Customs on electrical household goods and air conditioners vary from **5 to 11%**

August 2021 reports show that Lebanon Air Conditioner (AC) Market is projected to grow over the coming years. 6W tracks air conditioner market for **over 60 countries** with individual country-wise market opportunity assessment and publishes with the report titled Global Air Conditioner (AC) Market outlook report annually [8].

In Lebanon, there are two prominent manufacturers of home refrigerators (Concorde) and of applied A/C units (UNIC). Lebanon Air Conditioner Market declined by **-3.1% in 2017- 2020** due to economic crisis and is expected to grow back at a CAGR of **6.7%** during **2021- 2027.** Lebanon occupies 10th position in terms of the market size in the Middle East Air Conditioner Market. In terms of market by types, Room Air Conditioner dominates the market and is expected to remain in a dominant position in the coming years. However, Centralized Air Conditioner is expected to have the fastest growth rate among all types. In terms of components, Chillers dominates the market and is expected to remain in a dominant position in the coming years. However, VRF is expected to have the fastest growth rate among all components.



Lebanon China Malaysia Thailand Spain South Korea

As for other electrical and electronic household goods such as refrigerators, freezers, furnaces, TVs, radios, dishwashers, washing machines, coffee machines, etc... Lebanon has reportedly relied more on imports to meet its growing demand. China, Spain, Thailand, South Korea and Malaysia were among the top players of the market in 2021, where China acquired the largest market share of 82.47% with a shipment value of 53.65 million USD in 2022. China also offered the product above the average market price, but remained at the leadership position indicating the trust it holds in the Market. In 2017 China had the largest market share of 66.71% with the shipment value of 63.22 million USD. From 2019 to 2021, the country was offering its product with an average price lower than the average market price offered in the country, and all this was due to all the banks which misappropriated funds from their depositors, leading to a significant financial crisis. All these issues lead to the Lebanese currency devaluation and to the money losses in the Lebanese banks [9].

Lebanon Air Conditioner and other electrical and electronic household goods market is expected to witness growth potential in the coming years as a result of the potential growth of the construction industry in the country. An increase in the best-in-class household infrastructure is expected to proliferate the significant demand for residential air conditioning systems along with providing a spur to these sales backed by the rapid industrialization and urbanization in the country.

Further, a proliferation in the technical advancements in the electronic industry with a substantial increase in the potential number of industrial players in the country which is expected to provide a substantial industrial expansion to the industrial players is expected to trigger the growth of Lebanon air conditioner and household goods market in the coming timeframe and widen the avenues for the potential investors of the Lebanon market to seek promising future business growth in the foreseeable future.

The Lebanon Air Conditioner and household good Market size is projected to grow during the forecast period 2020–2026. There is no doubt that the emergence of the COVID-19 pandemic has affected the majority of the market across the world.

The market has also suffered a downfall during this timeframe owing to the complete nationwide lockdown in the country to contain the spread of coronavirus which has interrupted the production and hindered demand owing to the disruptions in the income cycle of consumers which has hindered with their consumer spending and. Also, a downfall in the commercialization along with low construction activities of hotels, restaurants, and guest houses has led to a downfall in the demand for air conditioners in the country and has led to the slow growth of the Lebanon air conditioner market. Additionally, a downfall in the tourism sector interrupted the market growth of the Lebanon air conditioner market and slowed down the growth of the market in the COVID-19 timeframe [9].

On the basis of applications, the residential domain of the overall Lebanon Air Conditioner and household goods market is anticipated to register a significant growth rate in the coming years on the back of an increase in the discretionary consumer spending towards home amenities. Also, the increased technological advancements in the residential air conditioning systems embedded with both heating and cooling features along with low energy consumption is expected to bolster the potential market growth of the residential air conditioning systems in the country in the coming years and would proliferate the significant market growth of the Lebanon air conditioner market in the upcoming six years and the timeframe thereafter.

4.2 APPLIANCE OWNERSHIP AND USERSHIP IN LEBANON

A recent study has highlighted the level of awareness regarding environmental concerns, climate change, and household appliances. A preliminary list of electric appliances has been drafted and approximately 630 respondents were asked about ownership, usage patterns, purchasing cost and replacement rate, details of which are listed in the table 3 below. It needs to be noted that this data was collected prior to Lebanon's economic crisis and does not reflect the actual situation currently [5].

Appliance	% of respondents who own the appliance	Average number of items	Most Purchased Type	Average price at purchase	Average use	Average replacement rate
Refrigerator	100%	1	-	$1,202	-	Every 10 years
Light bulbs	100%	20	LED	$12	-	Every 8 months
Microwave	77%	1	-	$160	3 times/day	Every 5 years
Oven	100%	1	GAS	$555	3 times/day	Every 8 years
Clothes Washing Machine	100%	1	7-9 Kgs	$630	4 times/week	Every 7 years
Clothes Dryer Machine	22%	1	7-9 Kgs	$652	3 times/week	Every 7 years
Split AC Units	87%	2	12,000 BTU	$455	-	Every 7.5 years
Fan	84%	2	-	$51	5.5 hours/day	Every 3.5 years
Heating	92%	2	Electric heater 2000 Watts	$95	5.5 hours/day	Every 6 years
Computer	77%	-	Laptop	$931	5 hours/day at home	Every 3.5 years
TV	100%	-	32'-40'	$468	5 hours/day	Every 4 years
Dish Washer	4%	-	-	$523	2 times/day	Every 6.5 years
Electric Water Heating	92%	1	Locally Made	$400	4 hours/day	Every 8 years

Table 3: Appliances ownership and user-ship in Lebanon [5]

4.3 PROMOTION OF AWARENESS REGARDING ENERGY-EFFICIENT (EE) HOUSEHOLD APPLIANCES AND PROPER DISPOSAL (SCRAPPING)

4.3.1 AWARENESS REGARDING ENERGY-EFFICIENT (EE) APPLIANCES

Several factors, including insufficient awareness of **Life Cycle Costs (LCC)**, a reluctance to invest in devices that adhere to norms and standards, and even a lack of early education on these matters, can result in a dearth of incentives for the construction industry to adopt efficient appliances. This lack of awareness can further impede the promotion and labeling process of MEPS for electrical appliances.

The same study as mentioned in the section surveyed a total of **630 respondents,** categorizing their discussions of these critical issues-environment, climate change, and energy efficiency in relation to household appliances-as 'never,' 'rarely,' 'sometimes,' 'often,' and 'very often,' as depicted in **Figure 1 below [5].**

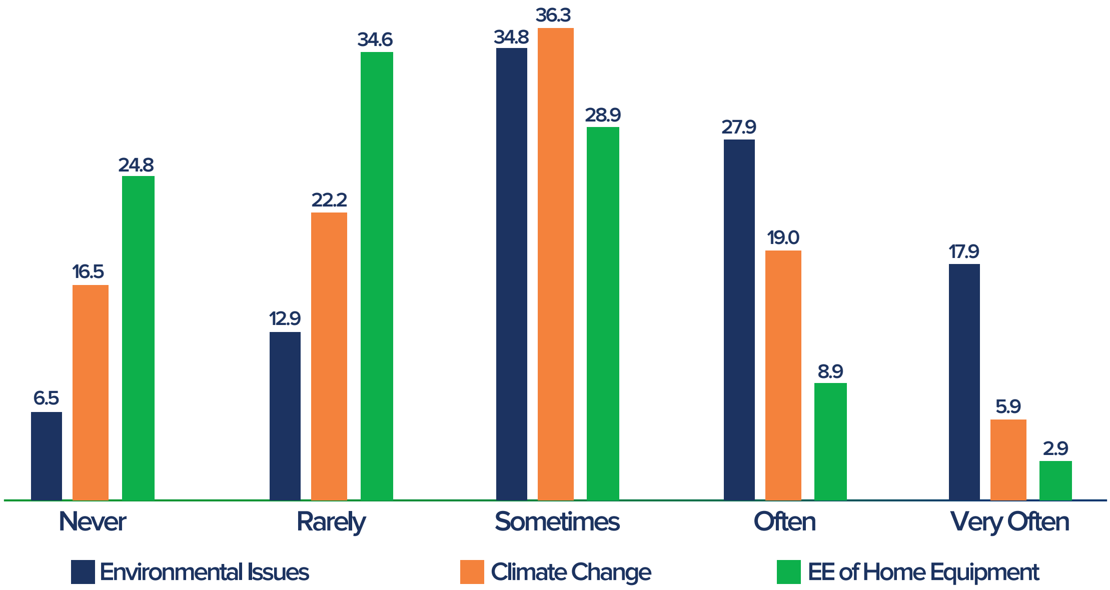


Figure 1: Awareness of 'environmental issues', 'climate change'and 'energy efficiency' in household appliances' (%) [5]

The data reveals that fewer people are familiar with the specifics of energy-efficient household appliances. In fact, around 60% of the respondents do not mention or read about energy efficiency in home appliances.

To gain a better understanding of the varied exposure among the individuals interviewed, respondents were asked about their affiliations with organizations dealing with environmental, energy, or climate issues, their connections to the market for energy-efficient appliances, and their exposure to awareness campaigns. As illustrated in Figures 2, 3, and 4, only 2% of the respondents are affiliated with such organizations. Additionally, a significant majority (95%) of the respondents have no connections (friends and/or family) in the home equipment retail market, while 21% (132 respondents) have been exposed to awareness campaigns. It's worth noting that the proportion of those exposed to awareness campaigns is slightly higher among individuals aged 18 to 30 years, likely due to their exposure through social media and workplaces.

The study also reveals that awareness levels vary across different social classes. Among these groups, social class B shows the highest level of awareness (B: Middle class; respondents in intermediate managerial, administrative, or professional roles), followed by C1 (Lower middle class; respondents with supervisory or clerical junior managerial, administrative, or professional roles), C2 (Skilled working class; skilled manual workers), and D (Working class; semi-skilled and unskilled manual workers) [5].

	Total	B	C1	C2	D
Total	630	71	196	219	138
Exposed	21	35	20	19	17
Unexposed	79	65	80	81	83

Figure 2: Awareness of “energy efficiency” in household appliances according to social class [5]

Due to the absence of a MEPS system in Lebanon, the energy efficiency of its appliances is less than that of more developed developing nations and doesn't align with international best practices. In a similar vein, the absence of a standardized labeling system in Lebanon brings about several challenges, including:

1. Limited public awareness of MEPS and labeling programs.
2. End users' lack of knowledge regarding potential savings from using efficient appliances and the associated social and environmental benefits.
3. Uninformed end customers often opt for appliances with the lowest upfront prices, reducing motivation for importers, resellers, and manufacturers to introduce more energy-efficient options.
4. The presence of counterfeit certifications on certain products, with energy performance far exceeding standards, which misleads end users without actually reducing electricity bills.
5. The availability of secondhand and informal markets that offer cheaper but inefficient alternatives to the legal market.

Furthermore, a study was conducted to assess the willingness to pay (WTP) of informed end-users for energy-efficient (EE) appliances. Approximately 28% of respondents (equivalent to 176 respondents) were unwilling to pay any additional upfront cost for EE appliances, while 33% (equivalent to 207 respondents) expressed a willingness to pay extra for EE home appliances. Another segment, comprising 39% of the total respondents, believed their willingness to pay depended on the specific appliance they needed to purchase.

Among the respondents who were not willing to pay extra for EE home appliances (about 27% of those surveyed), they were asked to explain their reasons for this lack of willingness.

As shown in Figure 37, approximately 34% of the 172 respondents cited financial constraints as their main hindrance, 44% believed EE home appliances were not significantly effective in reducing electricity bills, 13% expressed indifference towards having more EE equipment, and 9% felt that the government should first establish minimum energy performance standards (MEPS) and a labeling program before they would consider paying more for EE home appliances.

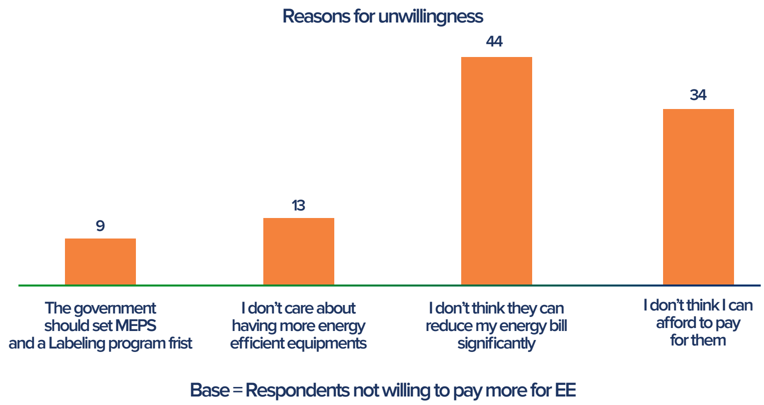


Figure 3: Reasons for not willing to pay upfront cost for EE home appliances (in %) [5]

All participants were then asked about their readiness to acquire specific appliances in the future, including: (1) washing machines (WM), (2) air conditioners (AC), (3) televisions (TV), (4) light bulbs (LB), and (5) refrigerators (RG).

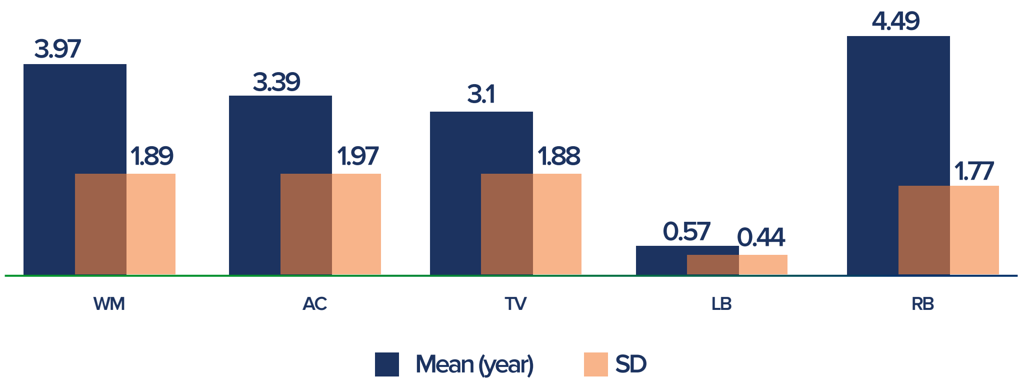


Figure 4: Mean and standard deviation of rollover of appliances purchases [5]

On average, respondents expressed their willingness to replace their washing machine every four years, air conditioners every 3.5 years, televisions every 3 years, and light bulbs every 6 months since they are frequently used and have a shorter lifespan. In contrast, respondents indicated that they would consider purchasing a new refrigerator approximately every 5 years, on average

Moreover, further investigations were conducted concerning the Willingness to Pay (WTP) in relation to the average prices of each appliance. The percentage of WTP appears to be highest for the appliance with the lowest average unit price, standing at **34.5 percent** for **light bulbs**, and decreases in magnitude as the unit price increases, reaching **3.2 percent** for refrigerators [10]

The variation in WTP in response to the disclosure of cost-saving information, if available, is, at best, modest. This suggests that informative Energy Efficiency (EE) labeling may have limited potential as a value-enhancing activity. In a broader context, the most significant variations in WTP are observed in relation to expenditures on electricity supplied by the national grid, and to a lesser extent, expenditures on backup electricity solutions, as well as the general willingness to pay more for EE appliances.

Appliance	Mean WTP	Standard. Error.	95% Conf. Int.	Average Reported Price	% WTP
Washing Machine	$29.66	$1.03	$27.64 – $31.69	$614.93	4.80%
Air Conditioner	$41.20	$1.26	$38.72 – $43.67	$451.33	9.10%
TV	$28.56	$1.08	$26.45 – $30.68	$875.08	3.30%
Light Bulb	$4.13	$0.15	$3.83 – $4.43	$11.96	34.50%
Refrigerator	$38.59	$1.33	$35.98 – $41.21	$1,205.69	3.20%

Table 4: Overall willingness to pay (WTP) estimates ($/unit) [11]

Additionally, an observable influence on WTP is the presence of EE labeling, where respondents express a positive WTP for all evaluated appliances, provided that such labeling is available to provide information on the energy consumption of household appliances. This underscores the significance of individuals' experiences and attitudes in shaping their Willingness to Pay for energy-efficient appliances.

4.3.2 AWARENESS ON APPLIANCE SCRAPPING

Electronic Waste is currently the fastest-growing waste category on a global scale, with estimates suggesting an annual growth rate of approximately **4%**. The staggering magnitude of electronic waste worldwide is demonstrated in a 2017 report by the United Nations University. In 2016, the world generated a total of 44.7 million tons of electrical and electronic waste, equivalent to 6.1 kilograms per person per year—roughly the weight of nearly 4,500 Eiffel Towers. It is projected that this volume will increase to 52.2 million tons by 2021, equivalent to 6.8 kilograms per person annually. Globally, only **20%** of this waste is collected, with **44%** being recycled. Consumer electronics make up **3%** of the waste that ends up in landfills worldwide [11]. However, the precise quantity of e-waste in Lebanon remains unknown.

In Lebanon, the e-waste value-chain has been assessed for **three common types** of electronic waste, including:

1. large and small household appliances.
2. IT and telecommunications equipment.
3. Agricultural Machinery

Recycling Electronic Waste is of paramount importance because it not only contains hazardous substances that must be kept out of the environment but also valuable materials like gold, silver, copper, platinum, palladium, iron, aluminum, indium, gallium, and rare earth metals.

These valuable materials are present in components such as control circuitry and batteries and can be recovered. However, the recycling of e-waste requires complex chemical and thermal processes in a well-equipped facility. Since such facilities are unavailable in Lebanon, this type of waste is either disposed of in landfills or the natural environment or handled by mostly unskilled individuals in the informal waste market to recover metal and plastic. Safe dismantling of e-waste is rare.

Ineffectiveness in the disposal and scrapping of electrical and electronic waste in **Lebanon** can be attributed to **Five Key Factors:**

1. The absence of legislation for e-waste disposal in Lebanon.
2. Waste collection companies not including e-waste in their scope of operations.
3. Collection by informal scrap facilities lacking environmental safety measures.
4. The burning of e-waste to recover copper and other metals, which generates toxic fumes.
5. Improper disposal by informal waste collectors. Additionally, there is a notable lack of communication with end users regarding scrap yard locations and official collection points [12].

Raising Awareness about scrapping is a vital component of appliance awareness, influencing how end users handle their appliances during and after their lifetimes. The barriers to better understanding recycling or disposal of old appliances, especially air conditioners and refrigerators, include the following [13].

The absence of programs aimed at replacing or disposing of old air conditioners with new efficient ones, encompassing proper AC disposal in line with international standards, including the capture and destruction of Freon.

Limited financial incentives to guide end users toward efficient air conditioners.

A lack of specialized centers for appliance disposal and recycling, equipped with the necessary tools for extracting and disposing of hazardous materials.

Inadequately organized collection routes for waste electronics and white goods, resulting in these items being left to deteriorate in public spaces or the natural environment.

4.3.3 SUGGESTIONS FOR ENHANCING AWARENESS

This section offers a set of recommendations with the aim of reducing household electric appliance energy consumption through the promotion of Energy Efficiency (EE) measures and actions that enhance product quality and information efficiency. These recommendations are intended to address existing barriers and facilitate a larger market share for energy-efficient appliances:

1. Implement awareness and information campaigns targeting end-users to encourage changes in behavior and raise awareness, ultimately facilitating the transition to more energy-efficient appliances. These campaigns should also aim to enhance the availability of information regarding labeling and standards, enabling end-users to make cost-effective decisions.

2. Enhance market control and supervision to ensure the compliance of both locally produced and imported appliances with market standards. Improved market control will help eliminate appliances of low quality and invalid certifications, thereby building trust with customers.

3. Establish incentive programs to motivate end-users to purchase energy-efficient appliances and create a supportive environment for businesses, including manufacturers, importers, and distributors, to become catalysts for the adoption of EE measures in appliances.

4. Raise awareness of the monetary value of scrap materials through municipal campaigns to educate the public on proper disposal methods for old appliances. Recycling scrap materials, such as metal from outdated appliances, can increase recycling awareness in local communities, as individuals become aware that some are making a living from recycling these materials.

5

Provide specialized training and awareness-building to ensure that materials in this sector are salvaged and reused before being sent to landfills.

6

Foster closer collaboration between repair service providers, municipalities, and facilities, while improving collection routes, to retain more repairable products in circulation within the economy.

7

Develop scrapping programs for old air conditioners, emphasizing the importance of proper disassembly and the recycling of metals like copper and aluminum, as well as salvaging motors and wires. The crucial aspect involves the safe removal of freon and refrigerant oils, which requires professional skills and licensing due to the high Global Warming Potential (GWP) of freon used in older AC units.

8

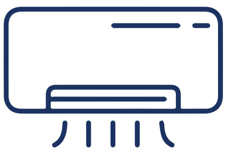
Collect old air conditioners from consumers through official collectors and ensure their transportation to scrapping centers for disassembly and refrigerant recovery. This program can be either mandatory or voluntary, with a key focus on preventing the continued use or sale of old AC units in the secondary market.

5. MEPS AND LABELS PROGRAMS COMPONENTS

5.1 POLICIES AND REGULATIONS

Lebanon has already established a technical committee (TC) responsible for developing Minimum Energy Performance Standards (MEPS) and labels. This committee, specifically focusing on Heating Ventilation & Air Condition (HVAC), includes various members such as the Ministry of Environment and private sector representatives. Currently, the committee operates under the oversight of LIBNOR, primarily concentrating on safety standards. However, they have yet to produce a detailed proposal for the issuance of MEPS and labels.

The residential sector in Lebanon accounts for 7,050 GWh/year, representing approximately 39% of the total energy consumption. The highest consumption occurs in space heating, followed by space cooling and lighting. The average electricity consumption for a typical household stands at 435.16 kWh per month.



Air conditioning (AC) contributes 12.4% to the overall energy consumption. An average household typically possesses two air conditioners with a COP (Coefficient of Performance) under three. Split-type air conditioning systems are the most common, with an average lifespan of 5-10 years. Peak consumption occurs in July, August, and September, with no existing regulations regarding the disposal of old air conditioners. This is why it is vital to develop MEPS for AC units [13].

Given that appliances, especially air conditioners (HVAC), are significant electricity consumers and considering the rapid population growth and urbanization, appliances are a primary target of the National Energy Efficiency Action Plans (NEEAPs). These NEEAPs promote engagement among stakeholders and contribute to the development of the legal framework in the energy sector. NEEAPs set out indicative energy savings goals for each country, along with policies and measures designed to overcome barriers and facilitate goal achievement. Lebanon has formulated a 2nd NEEAP spanning from 2016 to 2020 [14,15].

Robust regulatory frameworks are crucial for implementing energy efficiency measures as they provide technical guidelines for various sectors and can establish essential funds for the development of energy efficiency policies. The key policies in the realm of appliances include Minimum Energy Performance Standards (MEPS) and Energy Labeling.

All meetMED target countries have introduced policies to varying extents to promote energy efficiency in appliances. However, not all appliances are covered by MEPS policies, and such policies are not mandatory across all Southern and Eastern Mediterranean countries (SEMCs). Libnor has established a technical committee specifically focusing on Heating Ventilation & Air Condition (HVAC) that includes various members from public sector such as the Ministry of Environment and private sector representatives. This committee published several standards and can work on standards that align with the requirement of the MEPS and Labels.

Currently, in Lebanon, MEPS policies are in the planning stage and will encompass air conditioning, refrigerators/freezers, lighting, solar water heaters, and electric water heaters.

Energy-Efficiency labels are informative tags affixed to manufactured products to describe their energy performance, typically in terms of energy use, efficiency, or energy cost. These labels provide consumers with crucial information to make informed purchases. Two common types of labels are endorsement labels, which act as seals of approval based on specific criteria, and comparative labels, which enable consumers to compare performance among similar products using discrete performance categories or a continuous scale. **Similar to MEPS, Lebanon has a planned labeling policy that will cover air conditioning, refrigerators/freezers, lighting, washing machines, electric motors, and transformers.**
The current status of MEPS and labeling policies in Lebanon is detailed below [13]:

MEPS Policy

MEPS Policy Level	Voluntary
Applicable Appliances	Air Conditioning, Refrigerators/Freezer, Lighting, Solar Water Heater, Electric Water Heater.
Implementation Responsibility	Government
Enforcement Actors	Government
MEPS Policy Aspects	Technical Requirements
Missing Aspects	Legal framework Institutional setups, Implementation, Enforced Procedures, Monitoring and Evaluation Procedures.
Applicable to Imported Appliances	Yes
Barriers for Implementation	-Resistance to change the regulation -No accreditation of testing labs -Fake certification from Asia -Power black outs are a barrier for EE (appliances) -Secondhand market for appliances. -Low payback time of EE appliances (Electricity subsidies)
Measures needed to promote the market	-Strong institutional set-up and experience. -Interest to work on labelling, based on the EU Energy Performance Index -Database and voluntary system for equipment registration -Awareness of the possibility to increase EE in Appliances
Awareness of the program	Very Low

Labelling Policy

Labeling Policy Level	
Applicable Appliances	Air conditioning, Refrigerators/freezer, lighting, washing machines, Electric motors, Transformers
Implementation Responsibility	Government
Enforcement Actors	Government
Labeling Policy Aspects	None
Missing Aspects	Technical requirements (planned), Legal framework Institutional setups, Implementation, enforced procedures, Monitoring and evaluation procedures
Applicable to Imported Appliances	Yes
Barriers for Implementation	-Resistance to change the regulation -No accreditation of testing labs -Fake certification from Asia -Power black outs are a barrier for EE (appliances) -Secondhand market for appliances -Low payback time of EE appliances (Electricity subsidies)
Measures needed to promote the market	-Strong institutional set-up and experience. -Interest to work on labelling, based on the EU Energy Performance Index. -Database and voluntary system for equipment registration. -Awareness of the possibility to increase EE in Appliances
Awareness of the program	Very Low

5.1.1 CURRENT STANDARDS, POLICIES, AND REGULATIONS FACILITATING MEPS

5.1.1.1 LIBNOR EE standards [16]:

In the Table 5 below figure all LIBNOR EE standards, with the indication of them being voluntary or mandatory.

Table 5: Voluntary and Mandatory, testing and compliance standards by LIBNOR

Standard#	Mandatory	Sector	English Title	Lang.	Year
NL ASH 70 : 2006	No	Mechanical Systems and Components for General Use	Method of testing for rating the performance of air and inlets.	English	2006
NL 95 : 1999	Yes	Electrical Engineering	Tungsten Filament lamps for Domestic and Similar General Lighting Purposes: Performance Requirements	English; EN/FR	1999
NL 97 : 2001	No	Electrical Engineering	Double-Capped Fluorescent Lamps: Performance Specifications	English; EN/FR	2001
NL EN 305 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers – Definitions of Performance of Heat Exchangers and the General Test Procedure for Establishing Performance of all Heat Exchangers	French	2003
NL EN 306 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers – Methods of Measuring the Parameters Necessary for Establishing the Performance	French	2003
NL EN 307 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers - Guidelines to prepare installation, operating and maintenance instructions required to maintain the performance of each type of heat exchanger	English; French	2003
NL EN 308 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers – Test Procedures for Establishing the Performance of Air to Air and Flue Gases Heat Recovery Devices	French	2003
NL IEC 60929 : 2008	Yes	Electrical Engineering	A.C. supplied electronic ballasts for tubular fluorescent lamps. Performance requirements	EN/FR	2008

NL IEC 60969 : 2008	Yes	Electrical Engineering	Self-ballasted lamps for general lighting services. Performance requirements	EN/FR	2008
NL EN 779 : 2006	No	Mechanical Systems and Components for General Use	Particulate air filters for general ventilation. Determination of the filtration performance	EN/FR	2006
NL EN 1117 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers - Liquid cooled refrigerant condensers -Test procedures for establishing the performance	English; French	2003
NL EN 1118 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers - Refrigerant cooled liquid coolers -Test procedures for establishing the performance	English; French	2003
NL ENV 12977 3 : 2007	Yes	Energy and Heat transfer Engineering	Thermal solar systems and components - custom built systems Part 3: Performance characterization of stores for solar heating systems	English	2007
NL EN 1216 : 2003	No	Mechanical Systems and Components for General Use	Heat exchangers - Forced circulation air-cooling and air-heating coils - Test procedures for establishing the performance	English; French	2003
NL IEC 60921 : 2008	Yes	Electrical Engineering	Ballasts for tubular fluorescent lamps. Performance requirements	EN/FR	2008
NL IEC 60925 : 2006	No	Electrical Engineering	D.C. supplied electronic ballasts for tubular fluorescent lamps –Performance requirements	EN/FR	2006
NL IEC 60927 : 2008	Yes	Electrical Engineering	Specification for auxiliaries for lamps. Starting devices (other than glow starters). Performance requirements	EN/FR	2008

NL IEC 60901 : 2008	Yes	Electrical Engineering	Specification for single-capped fluorescent lamps. Performance specifications	EN/FR	2008
NL IEC 61204 6 : 2005	Yes	Electrical Engineering	Low-Voltage Power Supply D.C. Output - Part 6: Requirements for low-voltage Power Supplies of Assessed Performance	EN/FR	2005
NL IEC 61204 : 2003	No	Electrical Engineering	Low-Voltage Power Supply Devices, d.c. Output Performance Characteristics	EN/FR	2003
NL IEC 62040 3 : 2004	No	Electrical Engineering	Uninterruptible power systems (UPS)- Part 3: Method of Specifying Performance and Test Requirements	EN/FR	2004
NL EN 12977 3 : 2015	No	Energy and Heat transfer Engineering	Thermal solar systems and components - Custom built systems - Part 3: Performance test methods for solar water heater stores	English	2015
NL EN 12977 4 : 2015	No	Energy and Heat transfer Engineering	Thermal solar systems and components - Custom built systems - Part 4: Performance test methods for solar combistores	English	2015
NL IEC 60921 : 2008	Yes	Electrical Engineering	Ballasts for tubular fluorescent lamps. Performance requirements	EN/FR	2008
NL IEC 60925 : 2006	No	Electrical Engineering	D.C. supplied electronic ballasts for tubular fluorescent lamps –Performance requirements	EN/FR	2006
NL EN 12977 5 : 2015	No	Energy and Heat transfer Engineering	Thermal solar systems and components - Custom built systems - Part 5: Performance test methods for c	English	2015

NL ISO 5151 : 2008	No	Fluid systems and components for general use	Non-ducted air conditioners and heat pumps - Testing and rating for performance	English	2008
NL EN 62509 : 2016	Yes	Energy and Heat transfer Engineering	Battery charge controllers for photovoltaic systems - Performance and functioning (IEC 62509:2010)	French; EN/FR	2016
NL ISO 50015 : 2018	No		Energy management systems —Measurement and verification of energy performance of organizations — General principles and guidance	English	2018
NL EN 13771 2 : 2019	No		Compressors and condensing units for refrigeration - Performance testing and test methods - Part 2:	English	2019
NL EN 16147 : 2019	No	Energy and Heat transfer Engineering	Heat pumps with electrically driven compressors - Testing, performance rating and requirements for	English	2019

5.1.1.2 Lebanese Energy Efficient HVAC Equipment Standard (2011) [17]

This voluntary standard aims to establish minimum requirements for the selection of building air-conditioning equipment and appliances to enhance the energy-efficient performance of building systems. The standard's objectives include:

- Striking a balance between environmental responsibility, resource efficiency, occupant comfort, and community considerations.
- Responding to current market conditions and encouraging a shift in the market towards more energy-efficient equipment.

Appendix A contains Minimum Equipment Efficiency Tables, including:

- **Table 1:** Heating Family Equipment (Air Cooled)
- **Table 2:** Cooling Family Equipment (Air Cooled)
- **Table 3:** Ventilation Family Equipment

Appendix B provides insights into the Impact of Introducing MEPS from **2011 to 2030.**

5.1.1.3 EE Home Appliances [5]

This study explores the perception and willingness of Lebanese households to transition to more energy-efficient appliances. The selected appliances were chosen based on their significance within a typical Lebanese household and their usage patterns. The survey primarily **focuses on:**

1. The energy consumption of appliances in rural and urban areas, supplied by EDL and Generators.
2. Appliance characteristics per unit.
3. Levels of awareness about energy-efficient appliances by region.
4. Energy conservation behavior by region.
5. Sources of awareness.
6. Willingness to pay for energy -efficient home appliances.

5.1.1.4 GUIDANCE FOR INTEGRATING EFFICIENT COOLING IN NATIONAL POLICIES IN LEBANON-2020: Proposed Roadmap [3]

Published in 2021 by UNDP and the Ministry of Environment, this roadmap outlines the steps required to achieve emissions reduction goals. The National Cooling Plan recommends implementing mandatory Minimum Energy Performance Standards (MEPS) and labels regulation and provides the necessary adoption steps. It also offers recommendations for implementing MEPS and labels for refrigerators and air conditioners. Key elements toward the introduction of the MEPS and Labels regulation **include:**

- Establishment of Minimum Energy Performance Standards
- Establishment of the Labeling System
- Development of Testing Procedures

5.1.1.5 Energy efficiency in the "National Energy Efficiency Action Plan for Lebanon 2016-2020" (NEEAP II), [14]

The second NEEAP, spanning from 2016 to 2020, includes multiple energy efficiency initiatives dedicated to primary energy savings and end-use measures. One initiative directly related to MEPS development is:

H1-Initiative 1: Implementing Minimum Energy Performance Standard (MEPS) and Labeling Program for at least 5 Types of Equipment, such as air conditioners, lamps, refrigerators, televisions, and washing machines.

5.1.1.6 Energy efficiency in the "National Energy Efficiency Action Plan for Lebanon 2011-2015" (NEEAP I), [15,18]

Within this plan, there are 14 initiatives, some of which are related to energy-efficient appliances. Notable initiatives include:

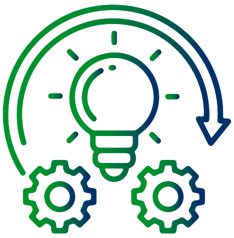
Initiative 1: Toward a ban on the import of incandescent lamps in Lebanon, aiming to prohibit incandescent lamp imports by the end of 2012. However, this goal was not achieved, and incandescent lamp imports continued.

Initiative 4: Solar water heaters for buildings and institutions, which aimed to install 190,000 square meters of solar water heaters in the residential sector through various actions, including financial and technical mechanisms.

Initiative 14: Promotion of Energy Efficient Equipment, targeting 38 GWh/year in energy savings from standards and labels. Before the NEEAP, five Minimum Energy Performance Standards (MEPS) for five types of equipment were adopted, but no enforcement or label development occurred.

5.2 IMPLEMENTATION STRATEGY

5.2.1 CURRENT IMPLEMENTATION STRATEGIES



Establishing policies like MEPS and labeling is just the initial step, insufficient to guarantee the enhancement of energy efficiency in appliances. Enforcement of these policies is of utmost importance to ensure their actual implementation. Moreover, various actors can assume responsibility for the implementation and enforcement. **In the first model,** the government takes charge of policy implementation and/or enforcement.

In the second model, a third party assumes full responsibility for the entire process; for instance, this third party may conduct appliance testing to verify compliance with the standards. The last model, on the other hand, is a hybrid approach involving a combination of government and third-party entities. In Lebanon, a multifaceted approach is employed for the implementation and enforcement of policies.

5.2.2 PROPOSED IMPLEMENTATION STRATEGY RECOMMENDATIONS

To ensure the timely implementation of MEPS and a labeling system in Lebanon, future plans should be guided by the following overarching principles, from a policy and regulatory perspective:

1 Introduce local MEPS and labels specifically aimed at household refrigerators and air conditioners (ACs).

Maintain a consistent process of reviewing and enhancing MEPS and labels.

3 Until further assessments and the introduction of mandatory energy performance labeling take place, consider the eventual prohibition of appliances lacking energy performance communication via recognized energy labeling schemes, and initiate a phased ban on the sale of particularly low-performing energy appliances.

4 Provide technical support to local manufacturers to upgrade their testing capabilities, enhance their technologies as a result, their production lines, in alignment with new energy efficiency testing standards.

5. Conduct awareness campaigns in conjunction with the introduction of energy performance labeling on appliances, tailoring them to different appliance types, regions, and various socio-economic and age groups to maximize their effectiveness.

6. Enforce mandatory safety and energy testing standards.

7. Implement mandatory MEPS levels, as indicated in Table 6 below [3]:
   - For domestic refrigerators: EEI (Energy Efficiency Index) < 140
   - For domestic room ACs: SEER (Seasonal EE Ratio) > 3.6

8. It is advisable to employ fiscal measures (e.g., tax credits or subsidies) to enhance the cost-effectiveness of efficient appliances compared to their common counterparts, for example:
   -Implement a taxation system that increases the price of inefficient appliances and high Global Warming Potential (GWP) refrigerants.
   -Introduce a tax on the import of inefficient appliances to elevate their upfront costs, making them equal to or more expensive than efficient appliances.
   -Apply a tax on the import of refrigerants with high GWP potential.

9. Maintain ongoing market surveillance and enforcement efforts.

10. Establish a product registry system for market control and as a database to facilitate MEPS review processes and monitor market progress.

11. Share relevant information from the product database with the public, including comparative data on appliance upfront prices and life-cycle costs, through a central internet portal or mobile applications.

12. Effective marketing is crucial for the successful execution of this incentive system, as end-users should understand the benefits of climate-friendly and energy-efficient appliances, comprehend appliance life-cycle costs, and be aware of additional advantages.

13. Create a robust product registration and market surveillance mechanism.

14. Implement a national product database for Refrigeration and Air Conditioning (RAC) appliances, where manufacturers and importers register their appliances and report annual sales to the Industrial Research Institute (IRI).

15 Provide access to the database for relevant government institutions to monitor the market and allow internet-based access for end-users.

16 Enhance the capacity of customs controls to monitor appliance imports below future MEPS levels and regulate the import of second-hand appliances. Customs officers' training can be coordinated with the Ministry of Environment (MoE) and the National Ozone Unit (NOU) under the Halon and CFC Phase-out Management Plan (HPMP).

17 Collaborate with the Ministry of Economy and Trade to empower the "Consumer Protection Directorate" to conduct market monitoring and ensure accurate labels on all RAC appliances.

18 Establish a working group within LIBNOR's relevant Technical Committee to meet bi-annually and discuss potential amendments or improvements to standards.

19 Develop financial support mechanisms for manufacturers and end-users to promote energy-efficient appliances

20 Launch national awareness campaigns and Green Procurement initiatives to accelerate the adoption of energy-efficient appliances with low GWP refrigerants.

MEPS and LABELS for Domestic Refrigerations				
	Label Classes	Energy Efficiency Index (EED)	Number of surveyed models	% of models in each class
MEPS	7G		79	40%
	6F	140	91	46%
	5E	114	24	12%
	4D	93	2	1%
	3C	76	0	0%
	2B	62	1	1%
	1A	50	0	0%

MEPS AND LABELS FOR SPLIT ACS					
Energy Class	EER ranges	Avg. SEER	Avg. cooling capacity (kW)	Avg. Energy consumption (KWh)	Total models consumption analysed
A	SEER>8.5	-	-	-	-
B	6.1 <= SEER < 8.5	6.29	4.86	792.76	26
C	5.6 <= SEER < 6.1	-	-	-	-
D	5.1 <= SEER < 5.6	-	-	-	-
E	4.6 <= SEER < 5.1	5.28	5.28	1318.87	1
F	4.1 <= SEER < 4.6	3.52	3.52	1019.42	6
G	3.6 <= SEER < 4.1	3.94	3.94	1253.46	59
H (MEPS)	SEER < 3.6	4.22	4.22	1568.77	44

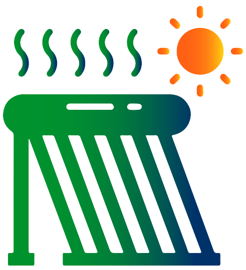
Table 6: **MEPS levels for domestic AC and Refrigerators [5].**

5.3 TESTING AND COMPLIANCES WITH ENERGY PERFORMANCE CRITERIA

Testing facilities play a crucial role in the implementation of labeling and MEPS programs. These facilities are responsible for testing appliances to ensure they comply with the established standards. After testing, the results are shared with certification bodies to issue labels and certificates. Lebanon currently has testing facilities located within the Industrial Research Institute (IRI), primarily focused on lighting and solar water heaters. However, for market surveillance and the establishment of third-party verification or certification requirements for the appliance labeling program, these actions are still in the planning stage [13].

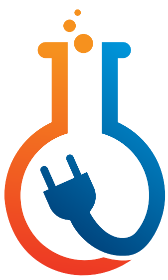
The Industrial Research Institute (IRI), established in 1953, is a Lebanese nonprofit institution with public utility status, linked to the Ministry of Industry. It operates with administrative and financial autonomy, conducting studies, industrial research, scientific testing, calibration, inspection, and certification for various systems, products, and personnel. IRI's scope of accreditation covers qualitative and quantitative inspection of new products, including electrical appliances, food, ceramic tiles, sanitary wares, oil, cosmetics, glass, diapers, notebooks, medical items, solar water heaters, fire extinguishers, gas cylinders, and boilers.

IRI's laboratories are equipped for testing various appliances, including:



Solar Water Heater (SWH) Lab:

IRI is authorized to test and certify all SWH units before they are introduced to the Lebanese market, as mandated by Decree 5305 dated October 28th, 2010. This decree outlines specific standards that are mandatory for all types of SWH, such as NL EN 12975 (Parts 1 & 2) for Thermal Solar systems and components (Solar Collectors), NL EN 12976 (Parts 1 & 2) for Thermal Solar systems and components (Factory-made systems), and NL EN 12977 (Parts 1, 2 & 3) for Thermal Solar systems and components (Custom build systems).



Electrical Lab:

IRI's electrical laboratory is equipped with a wide range of testing equipment to assess the technical operating conditions of electrical products and electronic components under various environmental conditions. All testing equipment used is of high precision and undergoes regular calibration. This lab is capable of testing electrical appliances, lamps, and luminaires, following international standards such as ASTM, AFNOR, BS, IEC, CE, and the Lebanese Standard NL. [20].

Libnor is by the law responsible for developing Lebanese standards. The implementation , conformity assessment or the market surveillance is not under Libnor authority (except within the conformity mark scheme)

The governing body like LIBNOR responsible for implementing the MEPS and labeling regulations should create a program for ensuring conformity with the applicable standards and monitoring the market for any instances of non-compliance. This program should outline parameters like sample size, accreditation prerequisites for testing labs (ISO/IEC 17025 certification), and a mechanism through which manufacturers can dispute the findings if their initial tests are deemed non-compliant.

It is advised that the Industrial Research Institute (IRI) serves as the sole central entity responsible for enforcement activities, including the potential imposition of penalties for products that do not meet the requirements within the country. This designated agency should establish documented policies that explicitly delineate its authority, processes, and penalties. All testing conducted for the purpose of compliance and market oversight should adhere to the measurement and computation methods specified in the MEPS and labeling regulations [13].

5.3.1 CURRENT TESTING STANDARDS IN LEBANON

ISO 16358: (AC EE testing standards) [3]. This family of standards is not yet adopted in Lebanon.
-There are 3 parts of this standard currently available on ISO **ISO 16358-1:2013 + COR 1:2013+ AMD 1:2019:** Air-cooled air conditioners and air-to-air heat pumps -
- Testing and calculating methods for seasonal performance factors - Part 1: Cooling seasonal performance factor.

-ISO 16358-2:2013+COR 1:2013: Air-cooled air conditioners and air-to-air heat pumps -Testing and calculating methods for seasonal performance factors -- Part 2: Heating seasonal performance factor.
-ISO 16358-3:2013: Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 3: Annual performance factor.

IEC 62552: (Refrigerators EE testing standards) [3]
This standard is not yet adopted in Lebanon.
-Internationally, there was an old version **IEC 62552:2007:** Household refrigerating appliances - Characteristics and test methods (from IEC) and EN 62552:2013: Household refrigerating appliances - Characteristics and test methods
(From the European Committee on Electrotechnical Standardization, CENELEC) which is a modified version of the **IEC 62552:2007.**
-However, the IEC standard **IEC 62552:2007** was withdrawn in 2015 and replaced by 3 new standards as below, CENELEC is working on doing the same. IEC 62552-1:2015 Household refrigerating appliances - Characteristics and test methods - Part 1: General requirements
-IEC 62552-2:2015 Household refrigerating appliances - Characteristics and test methods - Part 2: Performance requirements
-IEC 62552-3:2015 Household refrigerating appliances - Characteristics and test methods - Part 3: Energy consumption and volume.

Note that there also are Lebanese testing standards [16]:

- **NL EN 153:2008:** Methods of measuring the energy consumption of electric mains operated household refrigerators, frozen food storage Guidance for Integrating Efficient Cooling in National Policies in Lebanon 47
- Cabinets, food freezers and their combinations, together with associated characteristics. It is a voluntary standard with the reference **EN 153:2006** that was withdrawn and replaced by **EN 62552:2013** (mentioned above).
- **NL ASH 70:2006** Method of testing for rating the performance of air and inlets.
- **NL ISO 5151:2008**: Non-ducted air conditioners and heat pumps - Testing and rating for performance
- **NL EN 13771 2: 2019:** Compressors and condensing units for refrigeration - Performance testing and test methods
- **NL EN 16147: 2019:** Heat pumps with electrically driven compressors - Testing, performance rating and requirements methods
- **NL EN 1117: 2003:** Heat exchangers - Liquid cooled refrigerant condensers -Test procedures for establishing the performance
- **NL EN 1118: 2003:** Heat exchangers - Refrigerant cooled liquid coolers -Test procedures for establishing the performance
- **NL EN 12977 5: 2015:** Thermal solar systems and components - Custom built systems - Part 5: Performance test methods.

5.3.2 CURRENT AND SUGGESTED MEASURES FOR ENSURING APPLIANCES COMPLIANCE WITH ENERGY PERFORMANCE STANDARDS

When assessing the energy efficiency of air conditioners, the European SEER (Seasonal Energy Efficiency Ratio) classification system was employed to analyze their performance and serve as the foundation for developing Minimum Energy Performance Standards (MEPS) and labeling systems in Lebanon.

For domestic refrigerators, energy efficiency analysis was based on the IEC 62552:2015 standard, titled 'Household refrigerating appliances – Characteristics and test methods.' Currently, Lebanese manufacturers, test their products according to the IEC 62552:2007 standard, which also serves as the basis for the current labeling regulations applied in the EU. However, the EU is transitioning to the IEC 62552:2015 standard from 2021, and it is recommended that Lebanon follows suit to achieve international harmonization [3].

Here are some of the existing and recommended compliance measures and standards for energy performance **in different appliance categories:**

Air conditioners:
Compliance with energy performance requirements should be tested according to ISO 16358:2013, 'Air-cooled air conditioners — Testing and calculating methods for seasonal performance factors,' which references ISO 5151, 'Non-ducted air conditioners — Testing and rating for performance.' Ductless portable or single exhaust duct portable products should be tested according to ISO 18326:2018, 'Non-ducted portable air-cooled air conditioners having a single exhaust duct – Testing and rating for performance.'

Domestic refrigerators and freezers:
Compliance for domestic refrigerators should be tested according to IEC 62552:2015, and the energy performance should meet MEPS criteriaith an Energy Efficiency Index (EEI) equal to or below 140.'

Other appliances (Lamps, Heat exchangers, SWH, etc.) [6]:
-Tungsten Filament lamps: Performance requirements should be calculated according to NL 95:1999.
-Double-Capped Fluorescent Lamps: Performance specifications based on NL 97:2001.
-A.C. supplied electronic ballasts for tubular fluorescent lamps: Performance requirements are defined by NL IEC 60929:2008.
-Self-ballasted lamps for general lighting services: Performance requirements per NL IEC 60969:2008.
-Ballasts for tubular fluorescent lamps: Performance requirements according to NL IEC 60921:2008
-D.C. supplied electronic ballasts for tubular fluorescent lamps: Performance requirements are defined by NL IEC 60925:2006.
-Specification for auxiliaries for lamps: Performance requirements in line with NL IEC 60927:2008.
-Heat exchangers: Guidelines for installation, operation, and maintenance instructions are required to maintain performance, as per NL EN 307:2003.
-Particulate air filters for general ventilation: Determination of filtration performance based on NL EN 779:2006.
-Thermal solar systems and components: Custom-built systems' performance characterization, storage systems for solar heating installations, system performance characterization per relevant standards."

6. MONITORING AND EVALUATION

Despite **Lebanon** having some of the highest energy costs globally, the implementation of Minimum Energy Performance Standards (MEPS) for household appliances is remarkably low. The ongoing economic and financial crisis has compelled individuals to opt for the cheapest appliances due to the prevailing instability. A positive shift in the situation is crucial for a return to normalcy, prompting more sensible choices in energy-saving practices and the adoption of MEPS-compliant appliances.

Presently, **Lebanon** lacks comprehensive programs or tools to monitor and evaluate energy efficiency measures, particularly for MEPS in home appliances.
Presently, Lebanon lacks comprehensive programs or tools to monitor and evaluate energy efficiency measures, particularly for MEPS in home appliances.

The monitoring mechanism for MEPS in Lebanon involves several steps, but the country faces challenges in enforcement, regulation, and data collection. However, here is an overview of the general monitoring mechanism based on available frameworks and industry practices:

A. Regulatory Framework and Standards Development
In Lebanon, the **Ministry of Energy and Water (MEW)** is primarily responsible for developing and updating energy efficiency regulations, including the MEPS for appliances, buildings, and vehicles. **The Energy Efficiency and Renewable Energy (EE/RE)** Directorate within the MEW plays a key role in implementing and monitoring energy efficiency measures, including MEPS.

B. Monitoring and Enforcement by the Ministry of Energy and Water (MEW)

The MEW is responsible for ensuring that the standards are met, particularly through:

- **Periodic Inspections and Compliance Checks:** The Ministry, in collaboration with IRI, conducts inspections of imported appliances and energy-consuming products to ensure compliance with the MEPS. This is done by checking the energy performance labels on appliances and verifying that they meet the required standards for energy consumption.
- **Importation and Certification:** The Ministry works with IRI to ensure that only compliant products are allowed for import and distribution.

C. Collaboration with Standards Organizations and International Partners

- **Lebanese Standards Institution (LIBNOR):** LIBNOR plays a role in defining national standards for energy performance and efficiency in Lebanon. It works alongside the MEW to develop and implement technical standards for energy performance that align with MEPS.
- **International Cooperation:** Lebanon collaborates with international organizations, such as the United Nations Development Programme (UNDP) and the European Union (EU), to monitor and improve energy efficiency practices. This includes technical assistance, data collection on energy use, and enforcement mechanisms.

D. Data Collection and Reporting Mechanism

- **Energy Audits and Surveys:** To track compliance with MEPS and evaluate the impact of energy efficiency programs, regular energy audits and surveys are conducted across various sectors (e.g., residential, commercial, industrial). These audits help in identifying energy-saving opportunities and potential gaps in meeting the MEPS.
- **Public Awareness and Consumer Feedback:** Lebanon’s energy efficiency initiatives often include public awareness campaigns to educate consumers and industries about the benefits of energy-efficient products and the importance of meeting MEPS. Feedback from consumers, retailers, and manufacturers is also gathered to monitor market penetration of energy-efficient appliances.

E. Role of ALMEE

A significant document available is the regularly updated National Energy Efficiency Indicators report by ALMEE. This report provides valuable insights into the trends of energy efficiency indicators for appliances like refrigerators, air conditioners, and water heaters. It sheds light on the progress of specific energy consumption patterns, indicating the extent of adoption of efficient or MEPS-compliant appliances.

To extend these indicators to cover other household appliances, a concerted effort is needed to gather existing data and supplement it with surveys and measurement campaigns on representative samples. This approach will pave the way for the development of Key Performance Indicators (KPIs) essential for monitoring changes in energy performance and gauging the adoption level of MEPS in household appliances.
Regularly calculating and updating these KPIs becomes the foundation for effective monitoring and evaluation programs, providing a means to assess and enhance energy efficiency measures in **Lebanon.**

7. CONCLUSION

The MEPS promotion and labeling process in Lebanon, particularly in the realm of air-conditioning appliances, play a pivotal role in shaping the energy efficiency landscape. Minimum Energy Performance Standards (MEPS) act as a catalyst for elevating the energy efficiency of electrical equipment, lights, and appliances. Lebanon, through the National Energy Efficiency Action Plans (NEEAP 2011-2015 and 2016-2020), has underscored the importance of implementing MEPS, targeting various technologies including air conditioners. The initiation involves an Energy Consumption Labeling Ordinance, gradually paving the way for comprehensive MEPS application. The labeling process, managed by Libnor and the Industrial Research Institute (IRI), ensures compliance through a rigorous evaluation process, bolstering consumer protection and fostering market-driven energy efficiency improvements. Despite these strides, challenges such as communication issues, lack of incentives, and limited awareness pose hurdles that demand strategic interventions for a successful and sustainable MEPS implementation.
Libnor can be part of the Labeling process that must be defined and managed by the relevant authorities. In general, the relevant authorities must define the MEPS and Labels **(requirements, levels/limits of acceptance, conformity assessment, market surveillance scheme, timeline for implementation etc..)** and Libnor will then develop the needed standards for that framework such as testing and other related standards.

Addressing communication issues is imperative for efficient MEPS implementation, necessitating improvements in online communication infrastructure and fostering transparency in data collection. Overcoming technical challenges, especially in online communication, requires strategic investments in Lebanon's electricity and connection sectors. To incentivize compliance and awareness, targeted awareness campaigns are essential. Fiscal measures, such as tax credits or subsidies, can enhance cost-effectiveness for consumers, encouraging the adoption of energy-efficient appliances. The introduction of a local labeling certificate for domestically manufactured appliances, coupled with mandatory energy performance labeling, will contribute to market transformation. Additionally, a phased ban on appliances lacking energy performance labels can further drive adoption. Implementing a minimum energy performance standard (MEPS) for each appliance type is recommended to ensure a baseline for energy efficiency in the market. Tailored awareness campaigns, differentiated by appliance type and region, should run concurrently with the introduction of energy performance labeling.

The involvement of various stakeholders, including manufacturers, regulatory bodies, and consumers, is crucial for the successful implementation of MEPS. Regular updates and refinements to MEPS standards, aligned with technological advancements, are essential for a dynamic and effective energy efficiency framework in Lebanon. To consolidate efforts, comprehensive monitoring and evaluation programs, with Key Performance Indicators (KPIs) for energy performance, should be developed to gauge the impact and adoption of MEPS in household appliances.

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