

An-Najah National University

Faculty of Graduate Studies.

**The Technical and Economic Impacts of Applying
Palestinian & International Standards on Electrical
Household Appliances in Palestine.**

By

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This Thesis is submitted in Partial Fulfillment of the requirements for the Degree of Master of Clean Energy and conservation Strategy Engineering. Faculty of Graduate Studies, An-Najah National University, Nablus – Palestine.

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III

Dedication

To my father, mother, wife, son, sisters, and brothers

.....

To all friends and colleagues

.....

To all my teachers

.....

To my institute (Palestine Standards Institution)

.....

To every one working in this field

.....

To all of them.

I dedicate this work.

Acknowledgement

I would like to thank my family for constant love and support that have always given me.

My furthestmost appreciation goes to my supervisor, Dr. Imad Ibrik for his exceptional guidance and in rightful comments throughout the duration of this project.

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الإقرار

أنا الموقع أدناه مُقدِّم الرسالة التي تحمل العنوان:

The Technical and Economic Impacts of Applying Palestinian & International Standards on Electrical Household Appliances in Palestine.

أقرُّ بأن ما اشتملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وأن هذه الرسالة كاملة؛ أو أي جزء منها لم يُقدم من قبل لنيل أي درجة أو لقب علمي أو بحثي لدى أي مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researchers own work, and has not been submitted elsewhere for any other degree or qualification.

Student's name:

إسم الطالب:

Signature:

التوقيع:

Date:

التاريخ:

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List of Abbreviations

ANEC	European Association for the Co-ordination of Consumer Representation in Standardization
ANER	AGENCE NATIONALE DES ENERGIES RENOUVELABLES (Renewable Energies National Agency) – Tunisia
BEUC	Bureau Européen des Unions de Consommateurs (European union consumers Bureau)
BTU	British Thermal Unit
CETIME	Mechanical and Electrical Industries Technical Center-Tunisia
CFL	Compact fluorescent lamp
CFR	Code of Federal Regulation
CNIS	China National Institute of standardization
CO ₂	Carbon Dioxide
CRT	Cathode Ray Tube
dB(A)	Loudness of Sounds in Decibels
DOE	Department of Energy - USA
DVD	Digital Video Disc
EC	European commission
EER	Energy efficiency rating
EHA	Electrical Household appliances
EIA	U.S Energy Information Administration
EISA	Energy Independence and Security Act
EPA	Environment Protecting Agency - USA
EU	European Union
EUEB	European Union Eco Labelling Board
FEMP	Federal Energy Management Program - USA
FTC	Federal Trading Commission - USA
GEF	Global Environment Facility
GHG	Green House Gases
GWH	Giga Watt Hour
GWP	Global warm potential
HE	High efficient appliances
IEA	International Energy Agency
IEC	Israeli Electric Corporation
IEC	International Electrotechnical commission
IL	Israel
ILAC	International Laboratory Accreditation Cooperation
JSMO	Jordan Standards and Metrology Organization
kW	kilo Watt

kWh	kilo Watt hour
LE	Low efficient appliances
LED	Light Emitting Diode
MEPS	Minimum Energy performance Standard
MONE	Ministry of National Economy - Palestine
Mtoe	Million tons of oil equivalents
NAFTA	North America Free Trade Agreement
NERC	National Energy Research Center in Jordan
n	Appliance Life Cycle
NIS	New Israeli Shekel
NIST	National Institute of standards and technology - USA
OECD	Organization for economic cooperation and development
P	Present value
PCBS	Palestinian Central Bureau of Statistics
PENRA	Palestinian Energy and Natural Resources Authority
PNA	Palestine National Authority
PS	Palestine Standard
PSI	Palestine Standards Institute
PW	Present Worth
SC	Sub Committee
SCOP	Seasonal coefficient of performance
SEER	Seasonal Energy efficiency rating
SII	Standards Institute of Israel
SME	Small and medium-sized enterprises
STD	Standard efficiency appliances
TC	Technical Committee
TDS	Total Dissolved Solids
TWH	Terra Watt Hour
US	United states
VCR	Video cassette recorder
\$	US Dollar
€	European Euro

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Abstract

Palestine has a rapid increase on the number of electrical household appliances (EHA) in the last few years, as a result of increase the life level standards, which increase hugely the national electrical energy consumption; and this increase caused national energy crisis, energy unbalance, and energy discontinuity. Palestine has to legislate and implement EHA minimum energy efficiency performance standards (MEPS) to lower the electrical energy consumption, to achieve the electrical energy stability. Calculations output prominently show and approve the household's feasibility of using high efficient appliances (HE) and a huge opportunity of energy conservation and saving on the households and on the national level in addition to the environment protection through the huge mitigated amount of carbon dioxide (CO₂) to be emitted to Palestine atmosphere, a face to face forty surveyed households; energy classification labels of EHA knowledge and households behavior in addition classifications of owned EHA studied. EHA quantities and classifications statistics and records in Palestinian ministries and institutions are very weak as a result of Palestine government no control on the borders. Some of the world countries status in the field of EHA energy efficiency and classification label overviewed, and studied through the

international paper research, reports, and books, these references showed the positive impacts of implementing MEPS and energy classification label on the economical, and environmental aspects.

Introduction

Energy used every day for getting from one place to another, cooking, heating and cooling rooms, making products, lighting, heating water, and entertainment, using a lot of energy to make life comfortable, productive, and enjoyable, most of that energy is from nonrenewable energy sources, for example the United states of America is more than 4.4 percent of the world's population, it consumes about 18.6 percent of the world's energy resources.

Energy growth rates will vary among nations according to structural differences (demographics, industrial composition, and economic growth) and differences in the pattern and amount of energy services that each energy consumer is willing to purchase. In the building sector, these differences stem from different construction methods and uses of energy consuming products, each country can accommodate its natural growth in demand for energy services by some combination of supplying more energy and improving the efficiency of energy consumption.

In all sectors, improving energy efficiency before increasing energy supply is generally the more economically efficient national strategy. A portfolio of energy policies is available to governments for this purpose, including strategic energy pricing, financing and incentive programs, regulatory programs, government purchasing directives, and consumer education.

In the year 2020, 31% of energy use in developing countries is expected to occur in residential and commercial buildings, so reducing energy inefficiency in this sector deserves to be as high a priority in any nation's portfolio of energy policies as are parallel policies in the industrial and transportation sectors.

Energy efficiency labels and standards for appliances, equipment, and lighting offer a huge opportunity to improve energy efficiency and are especially effective as an energy policy, government labeling and standards-setting programs can affect most of the energy that will be used in buildings just two decades from now.

Well-designed, mandatory energy-efficiency standards remove inefficient products from the marketplace, increasing the overall economic welfare of most consumers without seriously limiting their choice of products; energy labels empower consumers to make informed choices about the products they buy and to manage their energy bills, labels and standards are appropriate for most cultures and marketplaces; therefore, we must believe that energy-efficiency labels and MEPS deserve to be the cornerstone of any country's energy balance [1].

This thesis aims to define the Palestine EHA energy efficiency status in comparison with some world countries status, allocating the accomplished and the unaccomplished steps in the stroke of legislating and implementing MEPS, specifying the needs to implement MEPS, studying the national statistics and records of EHA otherwise it manufactured in Palestine or

imported in the field of energy efficiency classifications, prominently show the feasibility range of using HE EHA instead of low efficient (LE) EHA, and to show the amount of households energy conservation and saving by using HE EHA instead of LE EHA, the amount of total national conservation and saving, and its impacts on the environment.

Structure of thesis:

Chapter one talks about the methods of preparing and detailing the thesis, in addition to detailed calculations equations that used in the thesis calculations and the approach used to prepare this thesis.

In chapter two, it talks about the Palestinian life and the energy resources shortage especially the electrical energy, and how to minimize the dependence on the Israel by conserving energy by using efficient electrical appliances.

Chapter three talks about the status of Palestinian standards in comparison to the world countries standards status and also the historical standards develop to improve EHA energy performance and efficiency.

Chapter four talks about the needed elements to establish the Palestinian energy classification label and the importance of establishing testing laboratories.

Chapter five talks about the impacts of legislating and implementing MEPS and energy classification label of EHA on energy conservation, consumer protection, environment protection, and on the society.

Chapter six talks and summarizes MEPS and EHA energy classification label impacts and the feasibility of using HE EHA instead of LE EHA.

Chapter seven talks about the whole thesis outputs and the recommendations in accordance to it.

Chapter one

Methodology of thesis

This thesis conducted an overview and study of literatures, research papers, books, and testing facilities test reports of EHA energy efficiency classifications and its impacts on the energy consumption, conduct a full consumption and saving comparison and calculations between HE EHA and STD & LE EHA.

Overview of the world countries status and the achieved stroke in EHA legislated and implemented MEPS, in comparison with Palestine status of EHA energy efficiency through the government ministries and institutions regulations, statistics and records; general directorate of trade and consumer protection in ministry of national economy (MONE), department of custom in ministry of finance (MOF), Palestine central bureau of statistics (PCBS), and Palestine standards institution (PSI) were visited.

A weak Palestinian regulations, statistics, and records were found of EHA energy classifications, forty households face to face questionnaire as a result of national statistics deprivation.

This questionnaire aimed to assess the household's knowledge and behavior towards the EHA energy efficiency and energy classification labels in addition to quantitatively the owned EHA regarding energy classification labels.

A conducted visit to the local markets to investigate and evaluate the EHA cost regards the energy classification labels so as to perform calculations and to estimate the feasibility range of using HE EHA instead of STD & LE EHA, and demonstrate energy conservation and saving on the households, on the national level, and impacts on the environment .

All the quantities of EHA of energy classifications lower than STD class 'D' in addition to (without label) EHA had assumed to be STD to accurate the feasibility estimation.

Simple payback period (SPBP) calculated for each EHA so as to show feasibility of using HE instead STD according to the following equation:

The annual consumed energy cost (running cost) = the consumed energy kWh/year * energy cost¹ NIS/kWh (1)

1) The cost of energy consumption approximated to be the average tariffs of Palestinian electrical distribution companies = 0.57230 NIS / kWh.

Δ Investment of using HE instead of STD = initial cost of HE – initial cost of STD(2)

Δ saving of using HE instead of STD = STD annual running cost – HE annual running cost ...(3)

Total annual cost of HE and LE EHA calculated according to the following equation, to determine and to show the total annual saving and also the saving along the life cycle of using HE EHA.

The total annual saving of using HE instead of STD EHA = total annual cost of STD – total annual cost of HE (4)

Where the total annual cost of appliance = (annual energy consumption kWh * cost of 1kWh¹ NIS/kWh) + Initial cost NIS * (A/P, i, n) (5).

Whereas 'A/P' is the capital recovery, 'i' is the interest rate and it used with a value of 12%, and 'n' is the estimated appliance life cycle.

SPBP = Δ investment of using HE instead of LE/ Δ saving of using HE instead of LE (6)

The total appliance's life cycle saving = result of equation (4) * n (7)

Energy conservation and saving of using main heavier consumption HE instead STD EHA concluded also on the national level according to previous equations calculations and results in relation with PCBS statistics and results of questionnaire.

The conducted questionnaire determined the percentage of STD EHA therefore,

The national annually energy conservation of using HE instead STD = the conserved energy of using one HE appliance * the total number of this appliance type in Palestine according to PCBS statistics * % of STD appliances according to the questionnaire (7).

In the same manner, the annual national saving = result of equation (4) of a specific type of appliance * total number of this type of appliance according to PCBS statistics * % of STD appliances of this type according to questionnaire (8).

Environmental impacts of using HE EHA instead of STD EHA investigated and estimated on the main heavier consumption EHA and also on the national level, the estimated mitigation of emitting CO₂ gas to atmosphere calculated and estimated on the national level.

Each 1kWh generated in the natural gas generating station in Israel will emits 0.75 kg CO₂ to atmosphere; the total annual estimated mitigated CO₂ = the annual total national conserved energy kWh/year * 0.75 kg/kWh (9)

Conclusions and recommendations determined according to all this thesis inputs, calculations, and outputs and allocated at the end of this thesis.

Chapter Two

Problem Definition

Palestinians lives in this land under the pressure of occupation in many or nearly all their lives needs, the occupation control all this land's resources, imports, Palestinians needs from the outside world, it control the inside and outside of Palestine world by stealing the inside resources and limiting and restraining the need from outside.

Palestinians suffer from the occupation conditions since the beginning of 19th century by taking over all internal natural resources (land, water...etc) by force, limiting the Palestinians outside needs by boarders control; they control, limit, security check, customs check, and others which result in limiting the imports by sometimes some products types rejection, quantity control, customs receipt and this cause increasing the products prices, so all these conditions will negatively affect Palestinians life development.

Palestinians as others, need all different types of energy to continue and proceed them lives activities and one of these sources is the electricity but as known to all Palestine's cities, villages, municipalities, and electricity distribution companies are fed from the Israeli's electricity company (IEC) connection points, and this energy sold to Palestinians with high prices in comparison with the neighbors countries prices and in addition to electricity high price they pressurize Palestinians life by limiting the amount of given power in all feeding points to slow or to prevent Palestinian life development, and from the other side the world now look

deeply forward use clean energy sources, lower the carbon effect from the non-renewable sources use like petrol, natural gas, and coal to assist environment protection.

Electrical energy consumption in Palestinian life mostly is residential consumption and almost consumption depends on the household appliances and lighting.

House hold appliances is the most percentage of residential loads like (refrigerators, washing machines, space heaters, split air conditioners, ovens, microwaves ovens, vacuum cleaners, dishes washer, food mixers, cookers, toasters, water heaters, ironing, bakers, lights and others) [2].

Buying, & using efficient household appliances will assist in preserve the environment because it consume less electrical energy and this result in less energy generated at generating stations this will also result in less exhausted gases like CO₂ to atmosphere and to the environment, and this will also lengthen the end moment time of finishing the coal and petrol sources.

So do choosing; buying, using efficient household appliances are really feasible for the end consumers, and the environment?

This question will be answered in following pages upon the full study of different efficiency household appliances classes and its cost effects on the end consumer.

2.1. Existing Palestinian standards

Palestine standards institute “PSI” established in Palestine in 1994 which is coincided with the coming of Palestine national authority (PNA) to west bank and Gaza by presidential decree no. 6/2000 and since that time Palestine standards institute working on preparing the national technical regulations and standards and this mission is one of its whole work, in addition to that Palestine standards institute its work extended to many other fields like certifications, testing, inspection, metrology and calibration [3].

According to the situation on the Palestine ground and Palestinian people conditions which under the occupation; Palestine standards institution started its work at that time by focusing on the safety, protection, and health of the people and according to these focus points, it prepared, legislated, and issued the products and services standards which route the producer and provider to achieve the minimum quality requirements in order to secure the consumer’s protection.

Since that time PSI prepared and issued many of electrical household appliances safety standards which assess the safety of consumer operate and use of these appliances through the laboratory test, one hundred percent of the available PS are safety standards and its IEC’s and EN’s adopted standards, at that beginning safety was the priority and no one care about the appliances efficiency, performance, and energy conservation. many injuries, burst, and death accidents occurred in the past because of

unsafe electrical appliances and these accidents still continue till these days because of unsafe appliances in the market, newly and according to population inflation, the rapid demand increase on the electrical energy, and the over loading of the connection points between Israel and Palestine and the shortage, frequent drop of electrical supply sources, the related Palestinian ministries, institutions and authorities started to think about solutions of this crisis, so newly starts hearing of the these statements (energy management, energy conservation, and energy label).

The Palestinian market is an open market for all the come in products and it's totally out of PNA control, no representative staffs on the borders, and according to Paris protocol which signed between PNA and Israel (IL) which declared that all the imported products to Israel and Palestine must conform to the Israeli technical regulations, and this protocol in spite of its disadvantages on the free import to Palestine it implicitly ensure that all the products import to Palestine are safe and efficient but this is not totally correct [4].

Now days still there are no requirements or technical obligations on the importers and local manufacturers that they must achieved before selling and distributing their products in the local market in front of PSI In the field of appliances energy performance, efficiency, and energy classification label and the high efficient properties of appliances still voluntary and the final decision to choose between the efficient and the lower efficient appliances is the consumers his self only.

2.2. International Labels and their impacts

The building sector accounts for more than 35% of the world's total energy demand, "Of which 75% is for space heating and domestic water heating", according to the IEA (International Energy Agency). Heating is still mainly provided by burning fossil fuels, whereas cooling and ventilation systems rely primarily on electricity – the production of which is also largely reliant on the burning of these same non-renewable resources. Renewable energies are set to play a growing role in the heating and cooling of buildings as all countries try to cut their dependence on fossil fuels. Many of Technical committees of IEC TCs are involved in the preparation of International Standards for components and systems used in heating, cooling and ventilation installations [5].

Using efficient appliances is one of the ways to conserve energy and to minimize the energy losses to the lowest level in the residential loads. In China For example, the mandatory appliance labeling system now covers 30 types of household appliances. It requires manufacturers to register each product at China National Institute of Standardization (CNIS) website before introducing it to the market and to attach a China Energy Label to each model revealing its energy efficiency grade as compared to the appliance standard, appliance standards on the other hand set the minimum allowable energy efficiency levels. Refrigerators and air-conditioners were the first appliances to be regulated. They are two of the largest components of residential electricity consumption (consuming 17% and 24% of the electricity in the residential sector) [6, 7].

To control the household appliances in the market and to focus and encourage the consumers on the efficient household appliances sold in Europe market, EU since 1992 started this step by arising the care of directing the consumer sight to the efficient appliances by finding the energy label, and so what is it? It is axiomatic that the market for household energy services would be enhanced where buyers are able to take into account not just the cost of the appliance but the otherwise invisible factor of energy consumption. Energy labels improve the market's operation by displaying accurate energy consumption information on products, which is useful in the purchase decision; there are two main types of labels: endorsement and comparison labels [8].

Endorsement labels indicate that products belong to the “most energy efficient” class of products or it meets a specified product standard. Products generally display a logo or mark which identifies they have met the standard or product class and the labels generally contains little or no comparative energy efficiency information. Endorsement labeling programs are mostly of a voluntary nature. An endorsement label may be specifically for energy efficiency or it may be an “Eco” label. Eco label programs endorse products that have low impact across a wide range of environmental factors [8].

Comparative labels allow consumers to form a judgment about the energy efficiency (or energy consumption). The comparative labeling programs in OECD countries are primarily mandatory; Endorsement and comparative labels can coexist. The most commonly used comparison labels use a scale

with absolutely defined efficiency categories. This type of label allows consumers to easily assess the efficiency of a product in relation to an absolute scale, by means of a simple numerical or ranking system. The concept is that it is much easier for a consumer to remember and compare a simple ranking scale (such as 1, 2, 3 or 1 star, 2 stars, 3 stars or A, B, C) than to remember and compare energy consumption values [8].

Minimum Energy Performance Standard (MEPS) (also called just “Standards” or “efficiency standards” in some countries) are the specified minimum energy efficiency levels that products must meet before they can be legally sold. These mandatory standards are set at levels that balance the technical possibility with economic viability and competitive forces within a particular market. MEPS are usually not static but are revised over time to reflect improving levels of energy efficiency. MEPS rely on test procedures (often also called “Test Standards”) which are used to determine appliance performance, energy consumption and hence energy efficiency [8].

In 1992, the EU adopted the Energy Labeling Directive for household appliances; it compelled retailers to display a label to consumers. The label rated the energy efficiency of these appliances in a scale ranging from energy class A to energy class G. The message was reinforced through an easy color coding, ranging from dark green for the most efficient class to red for the most inefficient class [8].

The clarity and straightforward of this scheme made it very popular among consumers. This resulted in a rapid market transformation as manufacturers were very keen to provide top-rated products to consumers. Simplicity, clarity and comparability of information that is meaningful to consumers are elements that rendered this labeling scheme one of the few truly effective consumer information tools, enjoying widespread acceptance and trust amongst consumers [9].

In 2003, the scaling system was expanded to include new energy efficiency categories on top of energy class A - such as A+ and A++ - for refrigerators and freezers. Although this extension was intended as an interim solution until a comprehensive revision of the scheme would be achieved, in 2010, the EU opened the door to the introduction of A 'plus' classes to all product groups with the revised EU Energy Labeling Directive. Since this loss of the simple 'buy A' message, the positive impact of the EU Energy Label on consumers' decisions and transformation of the market has been significantly weakened [9].

In 2012, further research from the University of St. Gallen re-confirmed that the A to G scale had a stronger influence on consumers' final purchasing decisions, and readiness to invest more for the top classes of the A to G scale, than for the top classes of the 'A plus' to G scale [9].

The International Energy Agency (IEA) estimated that, even with a continuation of all existing appliance policy measures, the appliance

electricity consumption will grow by 13% from 2000 to 2010, and by 25 by 2020, as shown in figure 1.1[9].

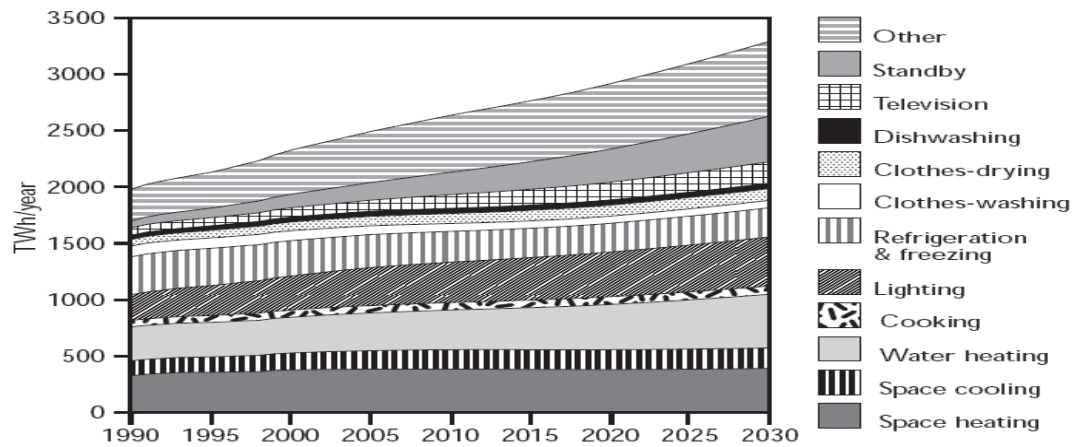


Figure 2.1: Projected IEA residential electricity consumption by end-use with current policies [9].

Examples on some countries energy labels:

1. European Union:

The European Union (EU) is now of 25 member countries, they are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. These countries are required to implement harmonized regulations, including those covering energy efficiency requirements (MEPS and labeling).

1.1. Comparative Label:

This label is mandatory in EU gives the consumer the ability to judge and to decide which of EHA will buy and use through comparative quantities,

numbers, and colored arrows, dark green for class A HE EHA and the green color becomes lighter as the efficiency become lower till reaching the red color for class G LE EHA, in washing machines the comparative quantity is kilo Watt hour per cycle (kWh/cycle) and water consumption quantity of liter per cycle (L/cycle), whereas the unit used for other EHA is kWh/year.

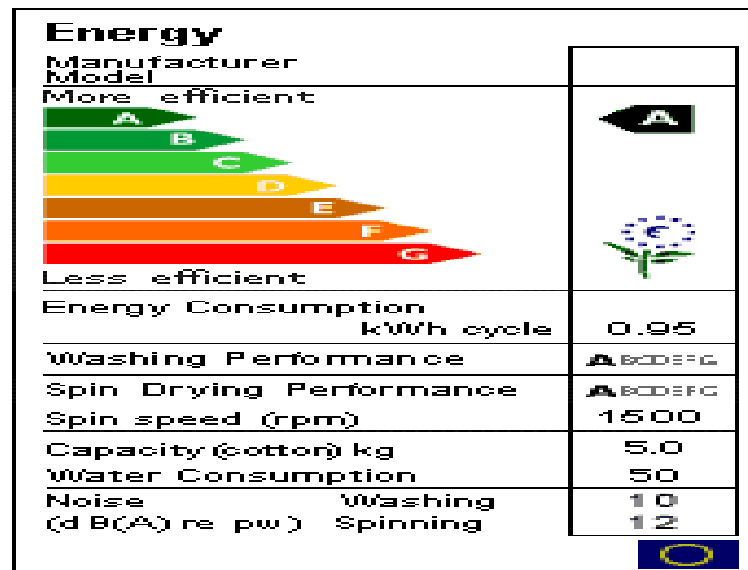


Fig. 2.2: EU Comparative Label [8, 9].

1.2. Endorsement Label:

This label is voluntary, gives the consumer the attention that this appliance belongs to the most efficient appliances or environment friendly appliance.



Fig. 2.3: EU Endorsement label [8, 9]

2. Israel:

Energy classification label and MEPS have been in place in Israel since 1985. Initially a professional committee that included members from various ministries, professional organizations, the standards institute and the consumer association developed the first phase of the project.

The Standards Institute was given responsibility for developing and implementing labels and standards for all residential appliances. Since then standards and labels have been introduced for 13 products, including cars. While all of the standards are mandatory, some of the labels are voluntary. A difficulty with the program is that the standards and labels are not backed by regulation, making enforcement difficult. Hence since 1996 the Ministry of National Infrastructures has begun presenting legislation to the parliament clarifying the standards and labeling requirements. As each piece of legislation is passed control will become the Ministry's responsibility, room air conditioners were the first regulation to be passed

by parliament with standards approved in 1999 and labels in January 2001, regulations for Refrigerators and Freezers have already been presented to parliament and draft legislation has been prepared for Clothes Washers, Clothes Dryers, Ovens, Water Heaters and Fans [8, 9].

2.1. Comparative Label:

The following figure 1.4 is an example of Israeli comparative label for air conditioners, its mandatory, legislated and implemented by standards institution of Israel (SII); it shows the energy consumption kWh con both cooling and heating that gives the consumer the opportunity to decide which class to buy.

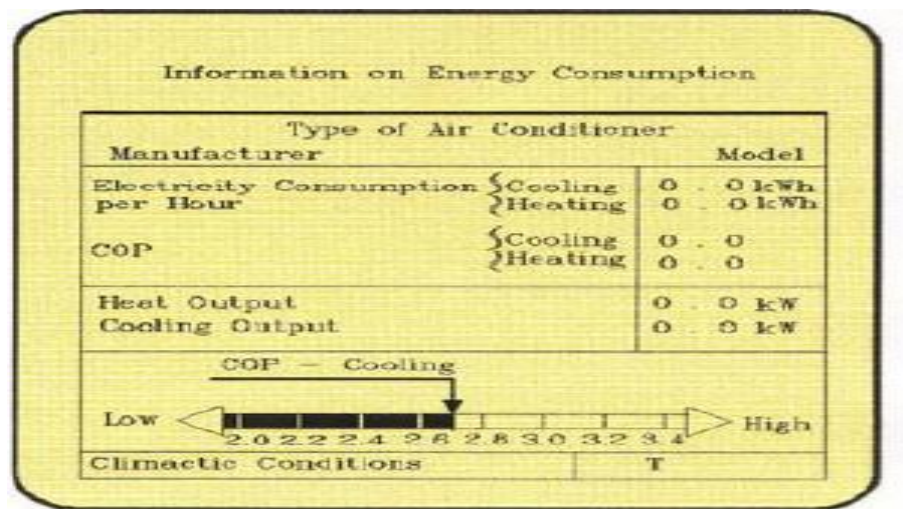


Fig. 2.4: Israeli Energy comparative label [8, 9].

3. Tunisia:

The comparative label is mandatory in Tunisia since 2004 gives the consumer the ability to judge and to decide which of EHA will buy and use through comparative quantities, numbers, and colored arrows, dark green

for class 1 HE EHA and the green color becomes lighter as the efficiency become lower till reaching the red color for class 8 LE EHA, in refrigerators the comparative quantity is (kWh/year).

The class 1 corresponds to the A+ level in the EU label and the other seven classes correspond to the A to G classes in the EU label, it has one half in Arabic and the other in French to reflect the bilingual nature of Tunisian society. Field tests of the label design have shown that more than 70% of consumers correctly interpret the label without having previously seen it. Prior to its introduction the label was tested in a six month pilot program involving a number of retailers and manufacturers. The requirements of MEPS are to be phased so that from 2007 all appliances sold on the market must attain a class 4 (EU label class C), or better and from 2010 at least a class 3 (EU label class B), or better.



Fig. 2.5: Tunisian Energy comparative Label [8, 9].

4. USA:

4.1. Comparative Label:

This comparative label implemented by US Federal Trade Commission (FTC), it was mandated the first time in 1980 on room air conditioners, this label gives the consumer comparative judgment between different energy classification labels through reading the value of yearly consumption kWh/year and yearly energy consumption cost in dollar per kWh (\$/kWh).



Fig. 2.6: U.S Energy comparative Label [8, 9].

4.2 Endorsement Label:

This is USA energy star endorsement voluntary label, its first used in 1992 on computers and monitors, it indicates the appliance is in the most efficient category, it was implemented by US Department of Energy (DOE) and the US Environmental Protection Agency (EPA).



Fig. 2.7: U.S Energy Endorsement Label [8, 9].

2.3. The importance of Palestinian energy label of electrical appliances:

All world countries fast going in legislating and implementing their MEPS and energy labels especially the EHA, they enforced and mandate these MEPS to regulate the markets because of its positive impacts on the total energy consumption, residential sector in Palestine has the big impact on the electrical energy consumption in Palestine, and as mentioned before the Palestine market is an open market to imported products, sold products from Israel, and also for the locally assembled products because of weak control or no existence of Palestinians on the borders and this activity is practiced by the Israeli on the main borders like air ports, sea ports, and bridges and the borders of cities, villages, and camps are weakly supervised by Palestine customs police, legislating and implementing the Palestinian MEPS and energy label for the different types of appliances

will lead the huge positive impact on the Palestine total energy consumption, consumers electrical bills, and Palestine environment protection and this label need the power and support from Palestine ministers council to mandate it to be labelled on all household appliances in order to permit it in the market and to penalizing agents, retailers, and manufacturers for unmarked show or trade electrical appliances, in addition to that Palestinian consumer need a lot of guidance and awareness leaflets and literatures to aware him of importance of choosing the most efficient appliances according to Palestinian energy label which will be beneficial and feasible on his saving firstly and on the environment than the cheap and LE, arriving to a point that consumer select only the most efficient appliances will lead to no inefficient appliances in the market and this will result in residential energy consumption efficiently which impact the total national energy consumption, generating capacity, grid capacity, grid losses, conserving the environment, and also conserving the petrol and coal resources.

Chapter three

Palestinian existing standards comparing with international standards.

PSI is the unique body in Palestine responsible for legislating standards in Palestine as mentioned in the presidential decree, it has the options in which route it will go to prepare the standards and these route divided into two mains routes, the first is prepare a pure Palestinian standards upon and depend the actual Palestinian life conditions and it can be referenced to some national, regional, or international standards, the second route is to prepare a Palestinian standards which are regionally or internationally adopted standards.

Electrical appliances standards are mostly internationally issued by IEC, ISO, EN, and some other bodies, PSI mostly adopt these standards to be PS, this method is well known on the national level of countries and the same method is used in neighbor countries like Israel and Jordan.

PSI focused on the consumer protection and safety as a priority of its work since establishment date and this priority came from that Palestinians began to gained their freedom since the coming of PNA, it started to remove up the restraints on them so PNA aimed to protect them as first priority, PSI is one of the authorized bodies to assist in protect people, in that time necessity of energy conservation and energy efficiency weren't the priority of PSI work, since that time it crossed over a good stroke in the electrical appliances safety through different ways, cooperation with ministry of

national economy to control the imported products and EHA, ministry of national economy “MONE” has the responsibility of granting the import licenses for the imported products in list A1 and A2 in the Paris protocol which called “Qotas”, some of these electrical appliances come under these two lists for example ‘room air conditioner, clothes washing machines, refrigerators, ovens’ and according to this protocols there is annually a determined quantities of these kind of appliances from Israeli government to PNA are permitted to be imported without the laboratory test according to the related standard in SII and this urged PSI and MONE to cooperated together to assess the electrical appliances conformity before let it in the Palestine market, it also contacts with SII for cooperation for the mandated products conformity assessment in SII laboratories, in this way PSI aimed to regulate products and to help the Palestinians importers to immediate shipments release and lowering the storage costs at the ports.

Nonetheless what mentioned, PSI still faces the obstacles, that weaken it to spread its hands on the borders points and on the internal level too and occupation control the borders is the most weaken factor on the whole Palestinian authority and PSI especially, it also can strengthen its existence on the Palestinian land by constructing the different types of laboratories so as to assess conformity locally, and since the year 2014 PSI cooperates with European commission (EC) through a funded project and part of it is to establish laboratories for safety testing and conformity assessment of electrical appliances, and laboratories in metrology and calibration.

PSI ambitious to find a fund of the second stage of the electrical testing laboratory in the energy efficiency and performance conformity assessment and the system can be started by legislating MEPS and EHA energy classification labels, this will result in consumer saving, energy conservation, encourage of importers and local manufacturers to innovate for the most efficient appliances, attain fair trade, and environment protection.

3.1. Israeli standards:

Many countries around the world started since tenths of years energy efficiency and energy conservation programs and EHA one of the important points to be covered by these programs, Israel one of the countries which also started because of population growth and the accelerated increase of life level requirements, this result in power demand increment too, the rapid increment in power demand result in quick action of the governments to take the required decisions to preserve their energy resources and to lower the annual bill of imported fuels.

In 2008 the Israeli government passed a resolution to promote the energy efficiency and to reduce the energy consumption by 20% in the year 2020, In accordance with the resolution Ministry of Energy and Water published in 2010 a National Energy Efficiency Plan for 2010-2020, the plan which is being updated contributed key inputs into the national greenhouse gases (GHG) plan, and also suggested establishing an energy efficiency fund of approximately NIS 200 million, Ministry of Energy and Water also carried

out a scheme to subsidies replacement of inefficient refrigerators, solar water heating tanks and air conditioners, in Israel Solar water heating has been mandatory for residential buildings since the 1980s, these measures are applied in addition to mandatory energy labeling for appliances and MEPS requirements for light bulbs [10].

Energy efficiency is the fastest and cheapest way to establish energy security, cope with environmental challenges and avoid market expenditure. Around the world, energy efficiency is considered a virtual energy source since it saves the need to increase electricity generation while providing the necessary energy. Energy efficiency is achieved by reducing energy wasting (correct use) and through consumption management, using energy efficient appliances and planning new building (as well as refurbishing existing ones) based on energy conservation principles.

Israel much like other developed countries understands the many benefits of energy efficiency and acknowledges its responsibility to reduce electricity demand and improve efficiency. For that reason, it has committed to achieve a national target of reducing the electricity consumption by at least 17% by 2030, Israel follows efficiency measures and recommended policy tools for the residential sector and examples on residential appliances is improving the efficiency of white appliances like refrigerators, washing machines, dryers, and dishwashers by replacing 90% of the existing low efficiency to most efficient appliances by a replacement rate of 7% of the appliances yearly and the potential saving till 2030 will be

NIS 323.7 million which equal to 493GWh, and one of the other important examples is replacing 90% of the room air conditioner for the most efficient air conditioner and this will potentially save NIS 289 million which equal to 441 GWh till 2030 [11].

3.2. EU standards:

The earliest programs began in the 1960's, with France introducing Energy Performance Standards, and in the mid 1970's with France and Germany both implementing labeling programs, in the 1980's a voluntary common EU label was developed for ovens, but none of the Member States introduced the system due to a range of concerns by 1990 Denmark, the Netherlands, and the United Kingdom also had legislation in place pertaining to energy labels and standards, while other countries such as Ireland were running voluntary labeling programs, it was

Denmark's desire to introduce a mandatory energy labeling scheme that led to the introduction of a common mandatory EU label [12].

In 1990, Denmark announced it wished to implement a Mandatory Energy Labeling Program, EC declared that this would present an obstacle to "Free Trade" and so requested that Denmark not proceed. However, given the interest across Europe in labeling programs the Commission developed the Directive for Mandatory Energy Labeling of Household Appliances (Directive 92/75/EEC) which made comparative labeling compulsory in all member countries once a product directive had been passed, the Directive

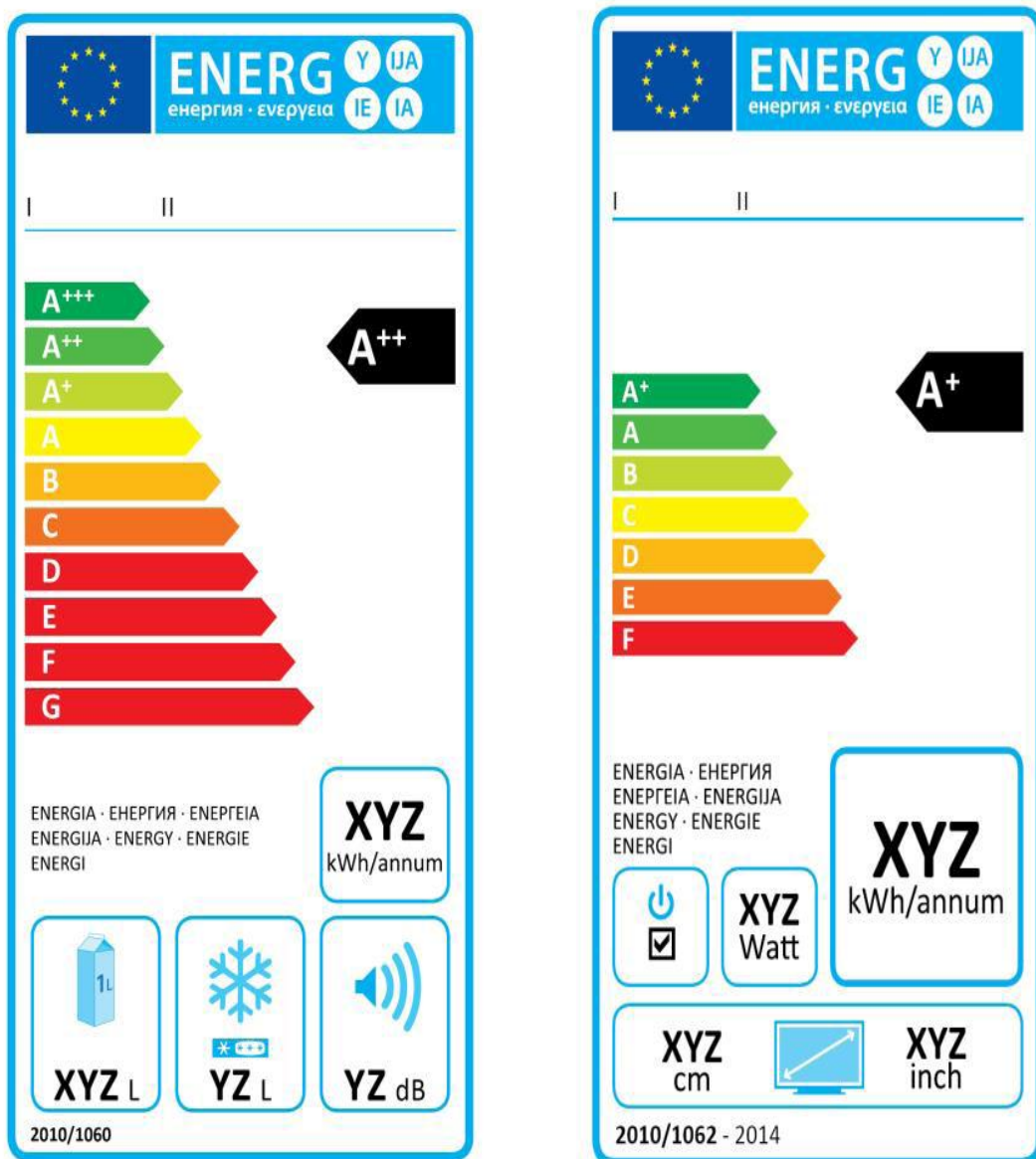
came into force in 1992, with the first labels becoming effective for refrigerators in 1995. The label for refrigerators and freezers was amended in 2003, with the inclusion of A+ and A++ categories (Directive 2003/66/EC). On 19 May 2010, EU adopted the Directive 2010/30/EU on energy labels and 25 October 2012, it also adopted the Directive 2012/27/EU on energy efficiency amending Directives 2009/125/EC, and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC [12].

Energy label program (comparative label) is a mandatory label in EU to be stickered on most electrical appliances in EU and this program implemented by National bodies of EU member Countries and the labeled appliances are:

1994 - refrigerators, refrigerator-freezers and freezers (94/2/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 1060/2010) 1996 - clothes washers (95/12/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 1061/2010), clothes dryers (95/13/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 392/2012) 1997 - combination washer-dryers (96/60/EC) 1998 – dishwashers (97/17/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 1059/2010), lighting systems (92/75/EEC), 2000 – electrical lamps and luminaires (98/11/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 847/2012) 2003 - air conditioners (2002/31/EC), electric ovens (2002/40/EC) 2010 – Commission Delegated Regulations: 1062/2010 televisions (updating 2010/30/EU), 2011 – Commission Delegated

Regulations: 626/2011 air conditioners (updating 2010/30/EU) 2013 – Commission Delegated Regulations: 811/2013 space heating equipment, 812/2013 water heaters, 665/2013 vacuum cleaners [12].

Figure 3.1, is the mandatory EU comparative label, the first mandated time was in 1992, it shows the estimated annual consumption in kWh, that gives the consumer the ability decide what the appliance classification to buy.



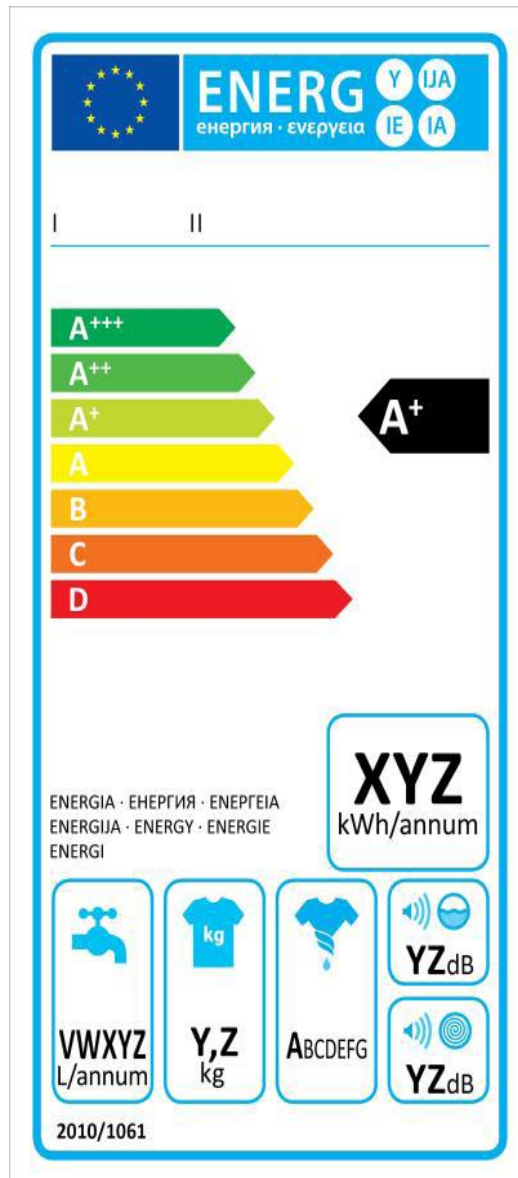


Fig. 3.1: Sample on EU comparative labels [12].

On the other hand there is the voluntary energy label program (energy endorsement label - European Eco-label award scheme) which implemented by European Union Eco Labelling Board (EUEB) Launched in 1992, the European Eco-label award scheme operates across the European Union, Norway, Liechtenstein and Iceland. The EUEB was formed recently to improve the administration of the program and has representatives from all participant countries. Criteria are set by the EC in consultation with the

member states, and are reviewed every three years to ensure the label stays relevant. If an eco-label is awarded, it can be displayed on the comparative label, and as with many eco-label programs, energy efficiency is just one criterion. Manufacturers need to apply to the accredited National organisation to be awarded the label, with the onus of proof of the claim on the manufacturer. The national body then informs the EUEB, and if there are no objections, then the label is awarded [12].

Figure 3.2, is the EU voluntary endorsement label, implemented the first time in 1992, indicates the appliance labeled to is efficient and friendly to the environment.



Fig. 3.2: EU Endorsement Label [12].

Eco-label began in 1992 - computers (including portables), lamps (cfls, double ended tubes), computer monitors, televisions, (Products originally included, but no longer included in the scheme - refrigerators, refrigerator-freezers, clothes washers, dishwashers, freezers, vacuum cleaners) & electrical equipment and household appliances: 2007 – heat pumps

2009/2013 – televisions 2011 – notebook computers, light bulbs, household appliance [13].

3.3. American standards:

The US Federal government has passed several major pieces of legislation that set a solid framework for appliance labelling and standards. In 1975, the Energy Policy and Conservation Act required FTC to establish a labelling program and DOE to set voluntary efficiency targets. The labelling program, Energy Guide, became effective since 1980 when manufacturers were obliged to place energy labels indicating energy consumption on their appliances [12].

DOE is required by legislation to set MEPS for a wide range of nominated products. However, MEPS can only be set after a prescribed process of research and consultation, and the levels must be demonstrated to be technically feasible and cost-effective.

Table 3.1, shows the historical profile of legislated EHA and lighting products, includes date of initial legislation, current date and the coming MEPS update in USA.

Table 3.1: U.S Legislated appliances MEPS.

Product description	Initial legislation	Current standard date	Standard update date
Clothes dryers	1987	2015	2020
Clothes washers	1987	2015	2021
Dishwashers	1987	2013	2021
Microwave ovens	1987	2016	2022
Refrigerators and freezers	1987	2014	2021
Room air conditioners	1987	2014	2020
Water heaters	1987	2015	2021
Clothes washers	2005	2013	2018
Refrigeration equipment	2005	2012	2017
Ceiling fans and ceiling fan light kits	2005	2007	2018
Compact fluorescent lamps	2005	2006	2020

Figure 3.3, shows the implemented, mandated US comparative energy efficiency label in USA, the consumer can judge the appliance annual consumption in kWh, in addition to the annual estimated consumption cost in \$.

**Fig. 3.3:** US Energy Comparative Label [12].

The technical requirements are set out in the Code of Federal Regulations 16CFR305. NIST is responsible for development and maintenance of test procedures. Test procedures are specified on the Code of Federal Regulations 10CFR430. The label originally showed only the annual cost of operation however; problems arose when national average electricity price changed from year to year and the range of prices was so wide. In

1994, the FTC decided to revise the Energy Guide label so that annual energy use in kWh, rather than average annual operating cost became the main comparative indicator [12].

Figure 3.4, is the US voluntary star energy endorsement label, implemented the first time on computers and monitors in 1992.



Fig. 3.4: U.S Energy Star Endorsement Label [12].

Chapter Four

The elements necessary for establishing energy labels and MEPS in Palestine.

PSI has the responsibility to assess the products conformity according to its law, and it generally follows its work procedure in two choices to assess products conformity firstly, selecting samples randomly from the local manufacturer or from the importer warehouse, then it test these samples in its laboratory but unfortunately this case isn't available because of inexistency of this laboratory, so PSI can send these samples to competence laboratory to perform the needed tests according to the product standard and then a test report issued by this laboratory and according to the test report PSI can issue a test certificates approve that these samples with a specific energy classification and this test certificate sent to the client in order to classify his product with correct energy classification label, but this choice has a negative results on the client by obligation to accept the external laboratory which usually has a higher test cost comparatively with the local test laboratory if it exists, and in addition to the samples transport cost which these samples must be transported to Jordan or Israel if the contracted laboratory is in these two countries.

Secondly, the second way which PSI follows is requests the client to submit a competent accredited 3rd party test documents for the product models in his warehouse, PSI study, evaluate, investigate the submitted documents and then the PSI's engineers take the decision of accepting or rejecting these documents and according to this decision PSI will inform

the client of documents rejection and request him again to complete the test documents, or PSI will inform him that these documents are accepted and issuing the test certificate which is equivalent to the 3rd party test documents , according to this certificate the client will mark his product quantities with required and the correct energy classification label, for the clarity and actuality the mentioned two ways are followed by PSI's engineers and specifically the technical services department's engineers and employees, and as mentioned previously, PSI is only legislative body, so before three years PSI cooperated with the directorate of consumer protection in ministry of economy to train the directorate's inspectors how to inspect electrical appliances specially EHA and what the required documents must be clearly appear by the traders, but this activity weaken after a period of time .

In future and by the support and cooperation with all responsible entities like MONE - general directorate of trade and the general directorate of consumer protection, MOF - general directorate of custom, the general directorate of custom police and with traders and manufacturers PSI will play its role to control the local market in the field of EHA energy classification which aim to energy conservation and consumer protection and this assessment and test will be in the PSI testing laboratory which will be the second phase of the PSI electrical laboratory, PSI construct and establish the safety electrical household test laboratory as a funded project by the EU as Palestine need and priority and at the end of 2019 PSI will launch it in the honor of prime minister, and PSI's chairman board.

4.1. Testing equipment:

Supervisory bodies in countries all over the world, their work depend basically on the testing bodies in these countries to carry out this mission which can able them to decide whether they allow many products to get in the country and to reject the others.

Testing bodies need testing equipment in order to perform their activities, in some tests the needed equipment are special to perform specific tests.

Testing laboratory of air conditioner appliances need some special equipment and devices like:

- Refrigerant flow meter for R404 which used for laboratory refrigeration system and this not for the sample under test itself.
- Electrical power meter for each of (the sample under test, refrigeration compressors, and for the electric heaters).
- Dry bulb and wet bulb temperature readers with PT 100 sensors to cover (indoor room, outdoor room, condenser and evaporator of laboratory refrigeration system).
- Balance weight to weigh water condensation coming from the sample under the test.

Testing laboratory of washing machines need some special equipment and devices like:

- Water flow meter.
- Electrical power meter.
- Water quality meter to measure the TDS.
- Temperature reader with PT 100 sensors.
- Relative humidity meter.
- Balance weight.

Testing laboratory of refrigerators need some special equipment and devices like:

- Electrical power meter.
- Temperature reader with thermal couple sensors.
- Relative humidity meter.

Surely as mentioned above as examples of the needed equipment for testing some main EHA, there still many EHA and it need specific testing equipment and these equipment are expensive so generally private sector laboratories start with small and limited testing activity and they expand step by step using part of their profit to invest in new equipment and new testing activity and start to grow.

4.2. Laboratory needs:

Any laboratory and from the beginning it needs to start its testing activity, some of these needs are basic and some of these needs are secondary, but it need it to be fully active.

Each and any laboratory needs employees to perform different testing activities, actually it starts with small number of engineers and technicians, these employees also need the specific training to operate and to use laboratory equipment and to conduct the different types of tests according to the related standards.

Laboratories still need supplementary items to operate the laboratory with its full power like laboratory accreditation certificate and this process can be locally or internationally, the local accreditation is under the responsibility of the directorate of laboratory accreditation in MONE or internationally by international laboratories accreditation cooperation (ILAC) or any other body is authorized by them, also laboratory equipment specially the measuring equipment need to be calibrated periodically and this calibration is done by directorate of metrology in PSI.

Lastly, laboratory need some other simple requirements like desktop computers, printers, scanners and other and it need also environmental conditions like temperature, moisture, ventilation, and lighting .

4.3. Data base certificates:

Information technology make the testing operations in these days more easier by connecting laboratory equipment to computers so all equipment and test results with details can be recorded on the computer.

Chapter Five

Impacts of legislating & implementing Palestinian energy classification label and MEPS.

It's important for Palestinians to find their MEPS which enforce the local manufacturers and importers to go with its requirements in order to announce their electrical products energy classification and this will result in fair trade and consumer protection.

Palestinians need energy classification label implementation to help the consumer to judge what to choose between wide range of trademarks of EHA and this judgment will depend on the price of the appliances and its consumption that impacts his monthly electrical bill.

5.1. Energy conservation Impacts.

Energy conservation is the most important necessity for Palestinians these days in order to lower the energy consumption bill specially the monthly electricity bill which must paid to Israel, and to decrease dependency on them, and this opportunity of energy conservation can be used in any other useful sectors like developing and enlargement the factories production lines, workshops, residential and commercial loads.

talking about energy conservation on the level of EHA, means lowering the consumer monthly electrical bill, the consumer decide what is the energy class to buy of EHA, will determine how much to pay initially and monthly running consumption bill cost.

Overview and investigation on the local market, focusing on some main dealers, distributors, and importers of EHA, conduct meeting with them asking about EHA, a manager in one of the biggest dealers in the local market, declared that the average life time of refrigerators and freezers are 15 years, washing machines 10 years, split air conditioners 10 years upon question of EHA estimated life cycle, the cost of EHA will increase by 5% as the energy efficiency class jumps one grade in A to G scale, whereas the estimated energy conservation is 25%.

There is no testing facility on the national level that approve these values, but a thankful efforts of national center for energy research (NERC) in Royal scientific society (RSS) in Jordan approves this estimated value of conservation.

NERC fully equipped to perform EHA performance and energy efficiency classification tests of air conditioners, washing machine, and refrigerators and freezers.

If a comparative assessing of EHA consumption with different energy classification and same EHA specifications and in addition to identical operating conditions, then the estimated conservation percentage is 25% for example; if two 12000 BTU/hr air conditioner units and the first is energy class is A HE and the second is efficient (E) class B then the estimated energy conservation of class A is 25% more than class B, and this can be applied to refrigerators, washing machines, ovens, vacuum cleaners , and others of appliances [13, 14, 15].

Palestine till 2017 the registered imported and manufactured quantities of some EHA, according to the Palestine custom is 100,000 air conditioner units, 200,000 units of refrigerators, 190,000 units of washing machine, and 250,000 units of fans.

According to 2017 population statistics report issued by PCBS, its clearly shows the number of families have at least one EHA as per the household appliance name and it was as follows in the table 5.1.

Table 5.1: 2017 statistics of number of families have at least one appliance by PCBS [16].

House hold appliance	Number of families
Refrigerators	836071
Washing machine	815744
Fans	700279
Split air conditioner	208515
Vacuum cleaner	342716
Gas/electrical oven	846369
Microwave oven	303472
Dish washer	38596
Television	800000

But in fact and while reading these numbers and compare it on Palestinian families now days status, it prominently show that household own more than one electrical fans, space heater, television, air conditioner so these families may numbers doubled or tripled.

A lot of imported EHA are without energy label show its annual consumption to able and guide the consumer buying decision, electrical fans one of non-energy labeled appliances in spite of its most use by most of Palestinians people in homes, apartments, shops, schools, universities , and offices, it has a real impact on the monthly residential consumption.

Many traders and shops around Palestine started their works since 1990, and till these days they still working in buying-selling the used EHA and office appliances, like refrigerators, air conditioners, televisions, multifunction printers and many other appliances, its directly bought from Israel to Palestine market, there is demand on it from the Palestine consumer because of its competitive price in comparative with dealers appliances price for the same products, and there is no any restraints from the Palestinian government to control its come in to Palestine market, these appliances are totally consumed or depreciated in Israel.

Implementing energy classification labels and MEPS will yearly conserve energy with around 175 million tons of oil equivalents (Mtoe) by 2020, roughly equivalent to the annual primary energy consumption of Italy. The average saving of up to 500 euro (€) per year on household energy bills. Moreover, energy efficiency measures will create €55 billion in extra revenue for European companies; in order to make this possible EU has put in place regulations and directives, in particular as regards energy labelling and Eco-design for products [13].

There is world-wide demand for more efficient products to reduce energy and resource consumption, the EU legislation on Eco-design is an effective tool for improving the energy efficiency of products, it eliminates the least performing (non-efficient) products from the market, significantly contributing to the EU's 2020 energy efficiency objective, it also supports industrial competitiveness and innovation by promoting better

environmental performance of products throughout the Internal Market [13].

The eco-design requirements for individual product groups are created under the EU's eco-design Directive in a process also coordinated by the European Commission [13].

EC also announced values of consumption for class 'A' EHA, for example energy consumption is 1.2 kwh /cycle or 0.15 kWh/kg, annual consumption 234.26 kWh/year based on 220 cycle/year, and 56 L/cycle or 12320 L/220 cycles water consumption for 8 kg washing machine [13].

Annual energy consumption is 157 kWh / year of 255 liters refrigerator-freezer appliance with 236 liters of refrigerator and 19 liters four stars freezer, 33 dB(A) noise level and T (tropical) climate class [13].

The annual consumption of vacuum cleaner is less than 43 kWh for class 'A' [13].

Class 'A' air conditioner is not less than 8.50 is the seasonal energy efficiency ratio (SEER), 5.10 is the seasonal coefficient of performance (SCOP), and global warm potential (GWP) ≤ 20 [13].

There is no statistics or records in Palestinian institutions, ministries on energy classifications of EHA, as a result of this exist situation a questionnaire has conducted on random forty households as a representative sample of Palestine households, these forty questioned households selected to represent the most common Palestinian households.

EHA in Palestine are mainly imported from world countries and a small percentage of local new industrial sectors are opened, Palestine area is under the occupation and since the coming of Palestine national authority its main goal was to support the people on the ground and to achieve their safety, PSI is the body who responsible on legislating the standards and the technical regulations and its priority since the beginning is to legislate the technical directives and standards for the people safety, recently PSI worked on preparing the technical directive for the electrical appliances energy efficiency classification label but still not approved and published.

Palestine national authority responsible ministries haven't any control on the boarders to regulate the import products to Palestine and the expired Paris protocol gave Israeli government's ministries the authority to regulate and to control this process [4].

while also its important to mention that the Israeli authorities don't restraints the transfer and trade of products from Israel areas to Palestine area so the Israeli manufactured, and imported products and its famous for Palestinian the appliances statement (group B) which mostly factory defect or lower quality products and the used products, are easy to be sold in the Palestine area and these activities are well known, people demand it because of its competitive price in comparison with the new appliances, some of these appliances are dumping the market like the used split air conditioner and others, this type of appliances deeply affect the residential and commercial energy consumption and its actually harm the consumer saving.

Statistics of imported electrical appliances and its energy classification and its quantities to Palestine almost nothing as a result of non-control Palestinian government ministries on the borders and the available records are general and partially, a conducted face to face questionnaire on random forty households to create some data that can be used to outcome some calculation later on, in this questionnaire the household questioned into two parts, the first part was questions about knowledge and behavior of households to be answered by yes or no.

The second part ask questions about the owning the main EHA if it's new or old, and the energy classification label.

This questionnaire conducted on different household's areas, different households educational levels, it conducted on five households in Ramallah city, five households in Al-Birah city, five households in Al-Ama'areh camp, five households in Tulkarem city, five households in Jenin city, ten households in Hebron city and it's villages, and five households in Nablus, whereas the questioned households educational levels were one household Ph.D. degree, three households master degree, ten households bachelor degree, fifteen households high secondary grade, seven households tenth grade, two households primary grade, and two households non educated, the questionnaire form shown in (Appendix A).

5.1.1. The collected data of the first part of the Questionnaire

The questionnaire first part questions outputs are detailed in the following table 5.2.

Table 5.2: 1st part of questionnaire outputs.

Question details	# of household positively answer	% of household positively answer
Knowing the details and have the ability to read the energy classification label	17	42.5 %
Watched, read literature about electrical appliances label classification	9	22.5 %
Knowing the difference between the H. efficient and low efficient appliances	29	72.5 %
Ready to pay 15-25 % more to buy H. efficient appliance instead of low efficient one	19	47.5 %
Have a doubt about the energy label on the existed appliances in the market	34	85 %

5.1.2. Data of the second part of questionnaire (EHA data)

5.1.2.1. Split Air conditioner

The demand increased on the split air conditioner in the last 15 years in Palestine as result of climate change, the temperature and relative humidity is higher than past and it reach 40c and 90% respectively in some Palestine areas, the new and famous trademarks of air conditioner still costly and part of households still unable to own it, they buy old cheap air conditioner, 20.7 % of questioned households bought old air conditioner, as it shown in figure 5.1.

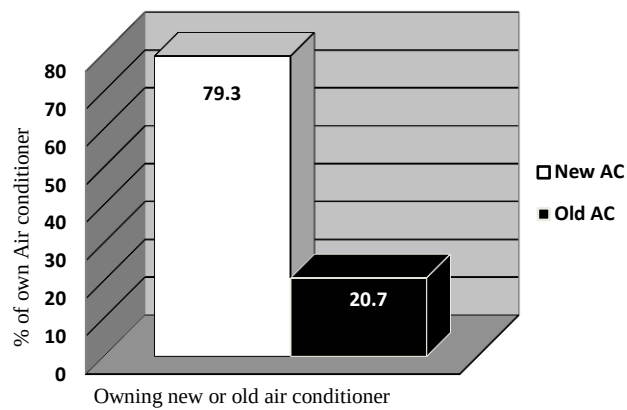


Fig. 5.1: percentage comparison of households own old and new air conditioner.

The Air conditioner energy classification percentages according to its energy label shown in figure 5.2:

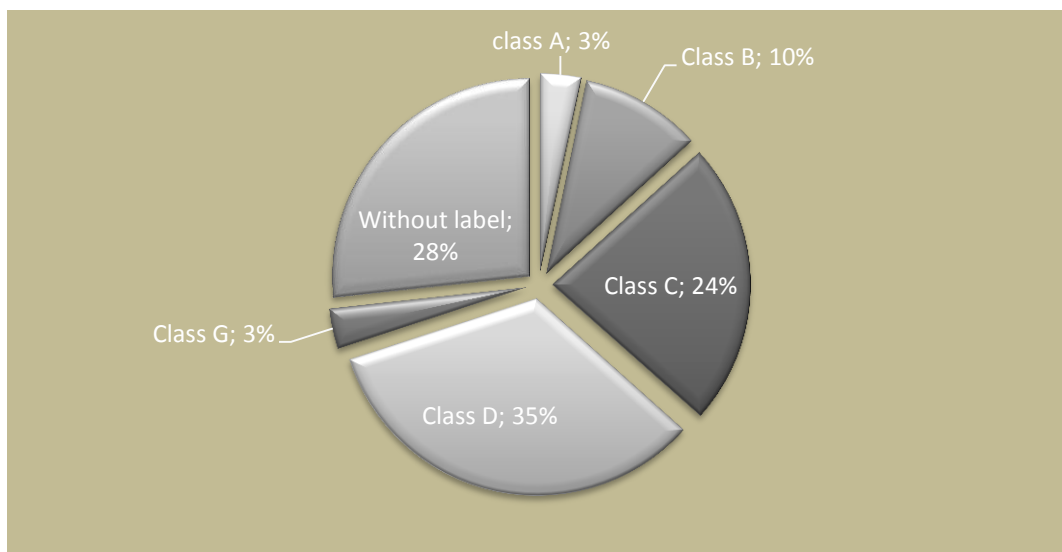


Fig. 5.2: Percentage comparison of air conditioner energy classification label.

According to the previous figures of air conditioner, it show the high percentage of the questioned households bought air conditioners without energy classification label and it approximately 27%, in addition to 34% of air conditioners are class D which are STD, therefore a good opportunity

for energy conservation can be achieved if these air conditioners replaced by HE.

5.1.2.2. Refrigerators

Refrigerator is essential and basic white appliance in every house of Palestinian people, no matter where are the Palestinians the urbanization reach them and they already transform from the farming life into the trade and business life, their lives transferred from simplicity to accelerated life, it depends on frozen and fast food, and according to this questionnaire results clearly approved 100% of the questioned households own refrigerator, results of this questionnaire part about refrigerator are detailed figures 5.3 and 5.4.

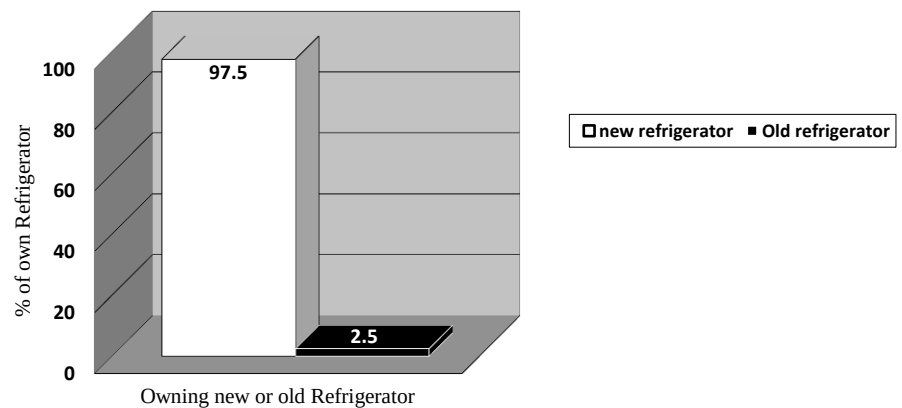


Fig.5.3: Percentage comparison between households owning new and old refrigerators.

Data collected according to this questionnaire of the energy classification label are Figure.5.4:

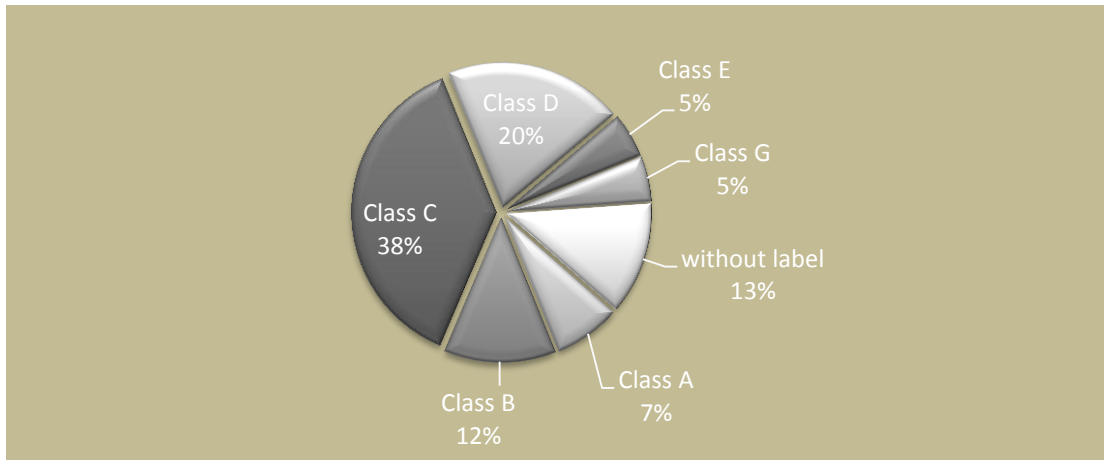


Fig. 5.4: refrigerator percentage comparison of the energy classification label.

A good percentage of no label and LE refrigerator percentages, and a good opportunity to conserve energy if the LE replace with HE refrigerators.

5.1.2.3. Washing Machines

Washing machine is one of the prior Palestinian EHA, the handy clothes wash disappeared and almost percentage of people and house wives depend on this appliance to wash the family clothes.

The performed questionnaire revealed that the household's percentage owning wash machine is 97.5%, the results of the questionnaire about the washing machine detailed in figures 5.5, and 5.6.

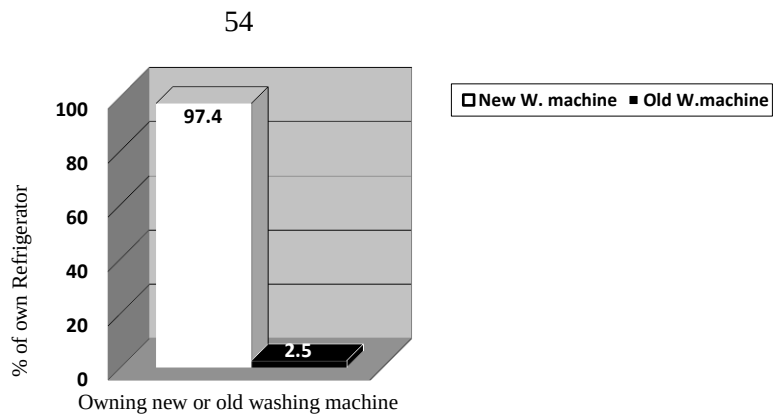


Fig.5.5: percentage comparison of owning new and old wash machine.

The collected results of the energy classification label percentage of washing machine are detailed in Fig. 5.6:

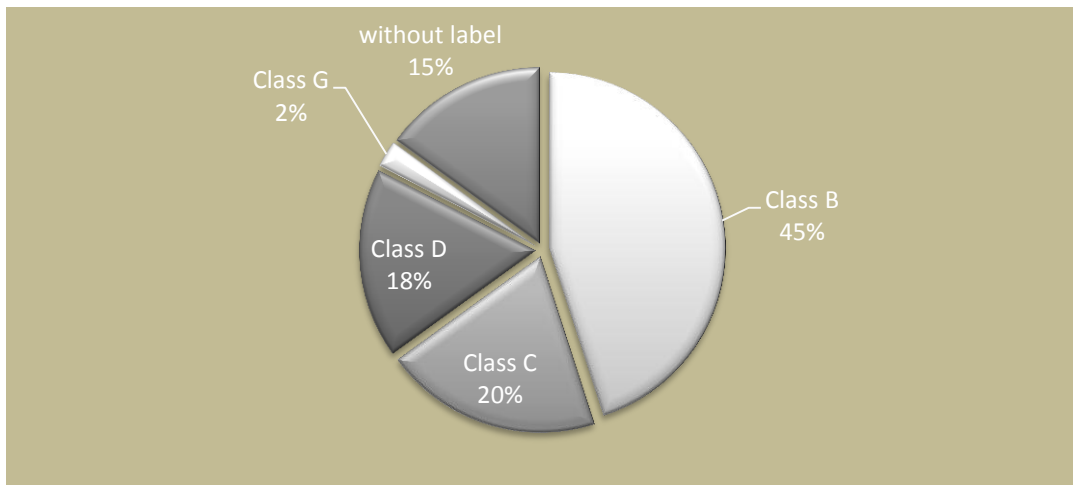


Fig.5.6: The percentage comparison of energy label classifications of washing machine.

5.1.2.4. Food Freezers

Some of houses and families especially the big families prefer to have food freezer to available a sufficient space for their frozen food like the chickens, meat, and seasonal vegetables can be used along the year.

The data collected from the performed questionnaire are shown in figure 5.7 that shows the percentage of owning old and new food freezer.

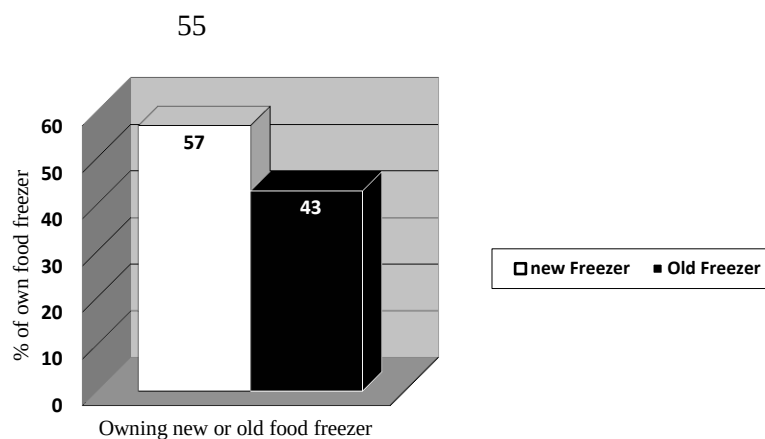


Fig. 5.7: percentage comparison of purchasing new or old freezer.

The data collected comparing the percentages of food freezer according to energy label classification are shown in figure 5.8.

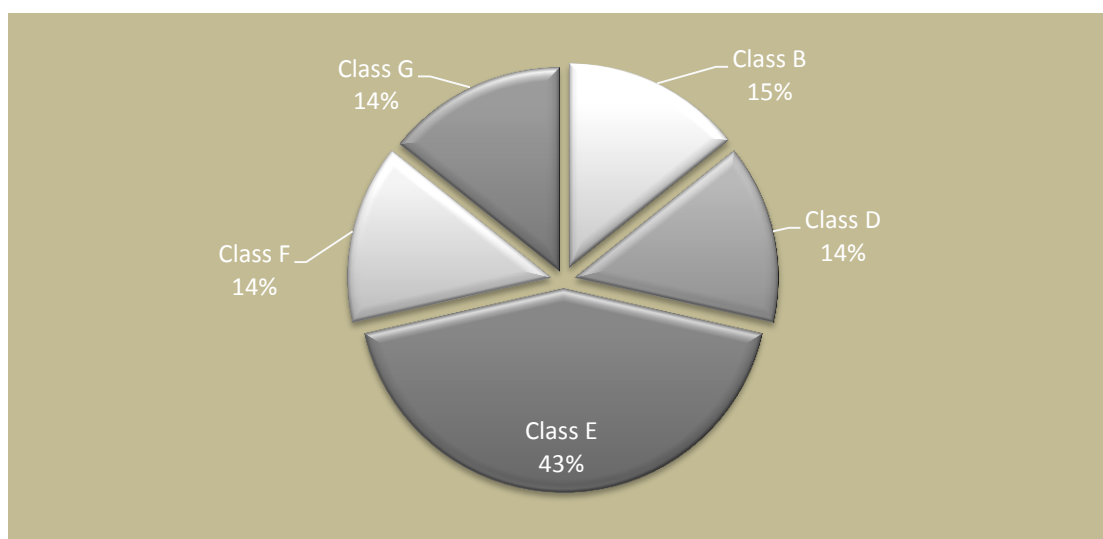


Fig.5.8: The percentage comparison of energy classification label of food freezer.

5.1.2.5. Clothes Dryer

Demands increasing on this type of appliances because of urbanization and vertical building expansion and areas available for drying washed clothes become small especially in winter.

47.5% of questioned households own clothes dryer, Fig.5.9 will show the comparison between owning new and old clothes dryer.

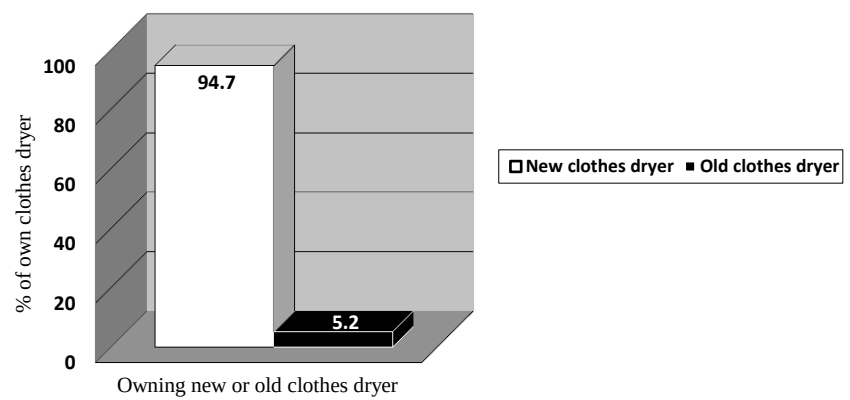


Fig.5.9: percentage comparison between owing new or old clothes dryer.

The energy label classification percentages detailed in the Fig.5.10.

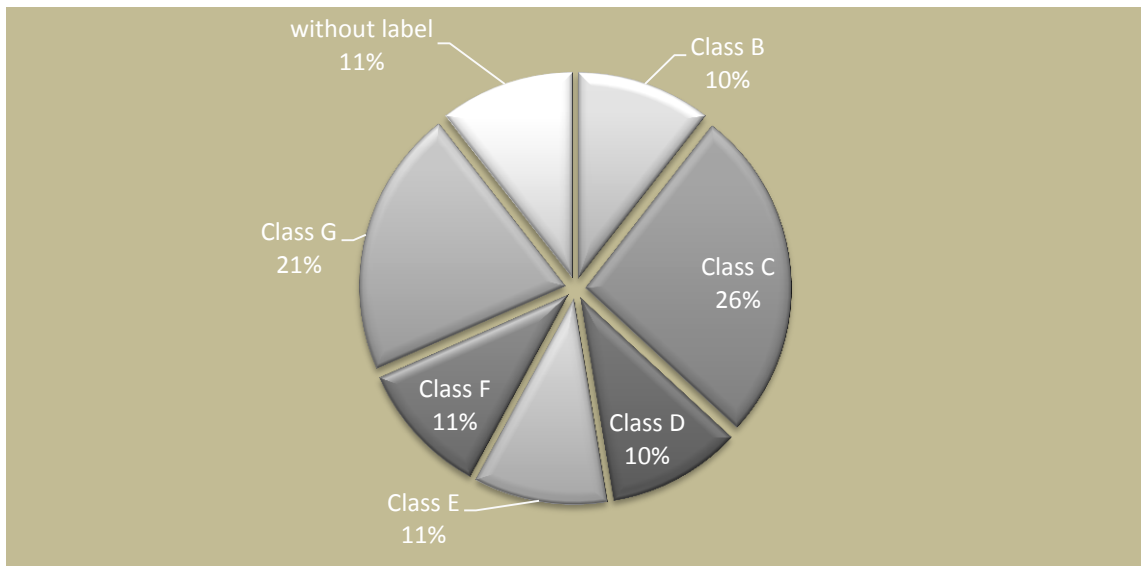


Fig.5.10: percentage comparison of energy label classifications of clothes dryer.

5.1.2.6. Dish Washer

Demand on Dish washer started increasing but it still not an essential household appliance, 7.5% of the questioned households have a new Dish washer only, in figure 5.11 shows the energy classifications percentages of dish washer.

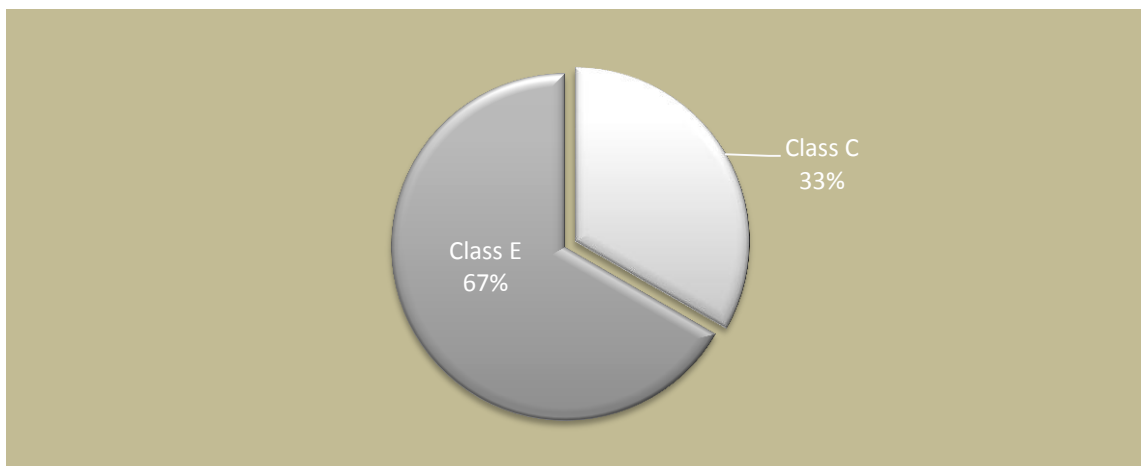


Fig.5.11: percentage comparison between energy classifications of Dish washer.

5.1.2.7. Electrical Oven

This appliance is household basic and essential appliance for cooking, some households owning both electrical and LPG ovens, the questionnaire revealed that 87.5 % of the questioned households owning electrical oven, all the questioned households own new ovens, in the following Fig. 5.12 shows the energy classifications percentage.

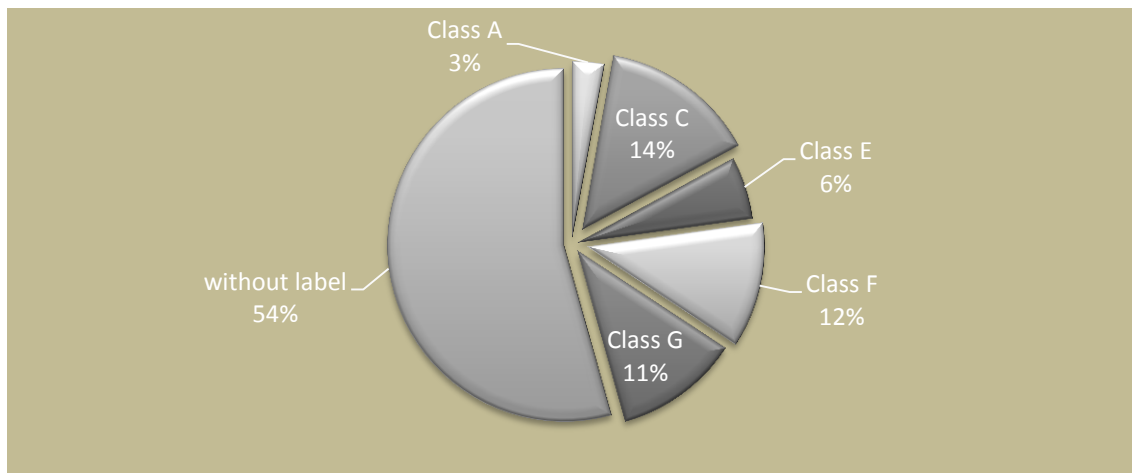


Fig. 5.12: Percentage comparison of energy label classifications of electrical oven.

5.1.2.8. Microwave Oven

Microwaves ovens became one of essential EHA, it quickly warm and heat food meals, 97.5% of the questioned households have Microwave oven.

A small percent have bought old microwave oven and the details in the Figure 5.13.

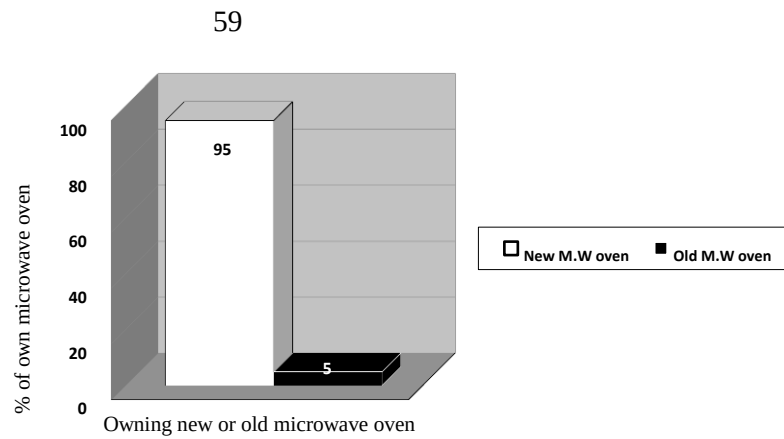


Fig. 5.13: percentage comparison between owning new and old M.W oven.

Also in the following Figure 5.14 showing the energy classifications percentages of microwave oven.

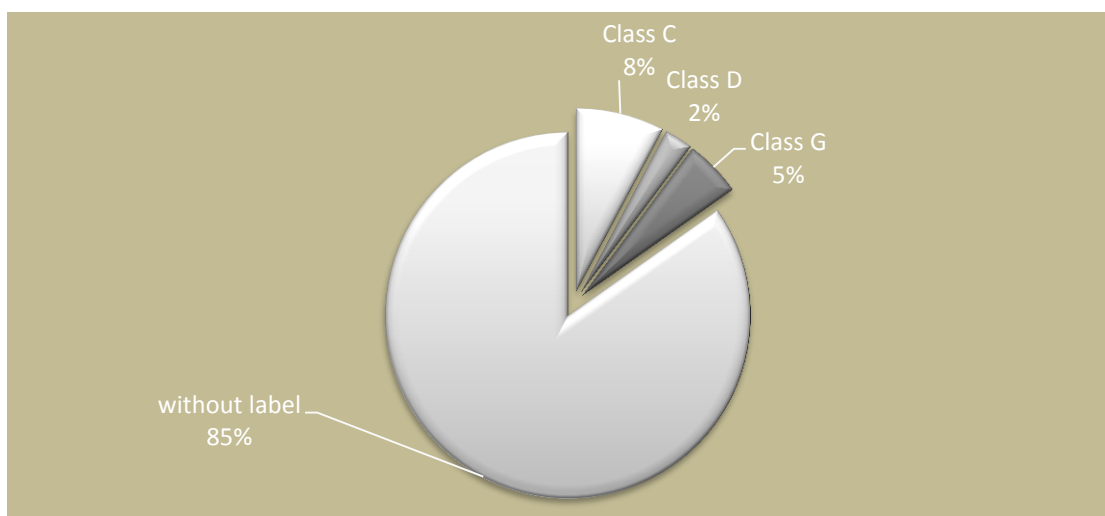


Fig. 5.14: percentage comparison of energy label classifications of M.W oven.

According to the conducted questionnaire on the Palestine EHA and its energy classification labels, the following table 5.3 summarizes the results of the existed energy label in Palestine regarding the appliance type and energy label:

Table 5.3: percentage of existed appliances according to energy classification labels in Palestine.

No.	Appliance	Label existence percentage							
		A	B	C	D	E	F	G	Non
1.	A/C	3	10	23	34	-	-	3	27
2.	Refrigerator	8	13	37	19	5	-	5	13
3.	Wash. machine	-	46	20	17	-	-	2	15
4.	Food freezer	-	14	-	14	44	14	14	-
5.	Cloth dryer	-	11	25	11	11	11	20	11
6.	Dish washer	-	-	33	-	67	-	-	-
7.	Electrical oven	3	-	14	-	6	11	11	55
8.	Micro wave oven	-	-	8	3	-	-	5	84

5.2. Economic impacts.

Producing and using EHA will impact on energy consumption level of the country, and as the population increase year by year all over the world result in increased the demand on the energy resources, which mainly depends on non –renewable resources like oil and coal, and a little dependence on the renewable resources like sun and wind, this situation obliged the different countries ministers council, leaderships, scientists, universities, researchers, manufacturers and standards bodies to look for enact laws and legislations, inventions, and implementing solutions for increased demand on energy, and for example European commission played and still plays an important role in enact legislations, technical regulations and MEPS in manufacturing products impact the energy sources starting from motors which are the basis of many types of machines and appliances, in the sector of EHA they obliged manufacturers

by mandating MEPS to produce appliances with high performance and low energy consumption .

HE EHA plays an important role in lowering the total country energy consumption which affects the rate of energy resources consumption, enlargement of grid capacity infrastructure and finally the consumer monthly bill.

To evaluate the economic impacts of different energy classifications of main heavier consumption EHA on the consumer, the evaluation will be on the appliance life cycle (n), to judge where it's feasible for the consumer to buy and use HE appliances instead of STD and LE EHA, and if these HE EHA are feasible, estimating how much money these EHA will save on the consumer.

The table 5.4 shows the Palestine local market of main EHA appliances average cost and energy consumption according to energy classifications:

Table 5.4: Palestine market average prices & consumption of some types of appliances.

8 Kg washing and spin machine							
Energy class	A	B	C	D	E	F	G
Average price (NIS)	2250	2100	1995	1890	1790	1700	1600
Annual consumption (KWh)	234	292.5	365.62	457.02	571.27	714.08	892.60
Annual water consumption (L)	12320	15400	19250	24062.5	30078.12	37597.65	46997
255 liter refrigerator with 19 liters freezer up							
Energy class	A	B	C	D	E	F	G
Average price (NIS)	1750	1660	1570	1490	1415	1345	1270

Annual consumption (KWh)	157	218.75	273.43	341.78	427.22	534.02	667.52
home Vacuum cleaner							
Energy class	A	B	C	D	E	F	G
Average price (NIS)	400	380	360	340	320	300	280
Annual consumption (KWh)	43	53.75	67.18	83.97	104.96	131.20	164
12000 Btu/hr split air conditioner							
Energy class	A	B	C	D	E	F	G
Average price (NIS)	1700	1600	1520	1440	1370	1300	1230
Annual consumption (KWh)	545	681.25	851.56	1064.45	1330.56	1663.20	2079
16 liters microwave oven							
Energy class	A	B	C	D	E	F	G
Average price (NIS)	650	615	580	550	520	495	470
Annual consumption (KWh)	60	75	93.75	117.18	146.47	183.08	228.85
40 liters built in electrical oven							
Energy class	A	B	C	D	E	F	G
Average price (NIS)	2750	2612.5	2482	2358	2240	2128	2022
Annual consumption (KWh)	160	200	250	312.5	390.6	488	610

The following table 5.5 showing the estimated life cycle of some household appliances:

Table 5.5: The estimated life cycle of some EHA [13].

product	Product life "year"
Washing machines	10
Refrigerators and freezer	15
home Vacuum cleaner	8
split air conditioner	10
Microwave oven	8
Built in electrical oven	13

EHA it consumes energy whether its energy classification G or A, economically the least expenses product is the most feasible product, so the lowest total annual expense choice of energy class of EHA will be the most

feasible choice, the following calculations and figures will show the economically impacts of different energy classification of EHA.

The following tables and figures show the feasibility study of EHA, according to appliance size and comparing STD EHA class 'D' with high efficient (H.E) class 'A' appliances:

5.2.1. Refrigerators with freezer on top:

Table 5.6 shows the estimated comparison between HE and STD refrigerator through the refrigerator size's initial cost, annual saving, total annual saving, and total saving of using HE instead of STD refrigerator.

Table 5.6: Economical comparison between STD and HE refrigerators

Refrigerator size (L)	Initial cost (NIS)		Annual running cost (NIS) ¹		Total annual cost ² (NIS)		Annual saving (NIS) ³	Total saving (NIS)
	STD	HE	STD	HE	STD	HE		
255	1490	1750	195.6	89.9	414.36	346.83	67.53	1012.95
308	1800	2113.7	236.3	109.3	500.6	419.6	81	1215
603	3530	4138.2	463.6	207.2	981.9	814.7	167.2	2508

- 1) The annual cost of energy consumption.
- 2) The annual cost of energy consumption + initial cost (capital recovery A/P, 12%, 15).
- 3) Annual saving = STD annual total cost - HE annual total cost.

Note:

– The cost of energy consumption approximated to be the tariff's average of Jerusalem district electricity co. "JDECO" NIS / kWh = 0.57230.

The results in the table 5.6 are out put according to the following calculations:

The annual consumed energy cost (running cost) = the consumed energy kWh/year * energy cost NIS/kWh (1)

The annual running cost of 255 L STD refrigerator = 341.78 kWh/year * 0.57230 NIS/kWh = 195.6 NIS/year.

The annual running cost of 255 L HE refrigerator = 157 kWh/year * 0.57230 NIS/kWh = 89.9 NIS/year.

The total annual cost of appliance = (annual energy consumption kWh * cost of 1kWh¹ NIS/kWh) + Initial appliance cost NIS * (A/P, i, n) (5).

Whereas 'A/P' is the capital recovery, 'i' is the interest rate and it used with a value of 12%, and 'n' = 15 year, is the estimated appliance life cycle.

Total annual cost of 255 liters STD refrigerator = 195.6 + 1490 * 0.14682 = 414.36 NIS/year.

Total annual cost of 255 liters HE refrigerator = 89.9 + 1750 * 0.14682 = 346.83 NIS/year.

Total annual cost of 308 liters STD refrigerator = $236.3 + 1800 \times 0.14682 = 500.6$ NIS/year.

Total annual cost of 308 liters HE refrigerator = $109.3 + 2113.7 \times 0.14682 = 419.6$ NIS/year.

Total annual cost of 603 liters STD refrigerator = $463.6 + 3530 \times 0.14682 = 981.9$ NIS/year.

Total annual cost of 603 liters HE refrigerator = $207.2 + 4138.2 \times 0.14682 = 814.7$ NIS.

The figure 5.15, shows the annual energy consumption of different sizes of STD and HE refrigerator

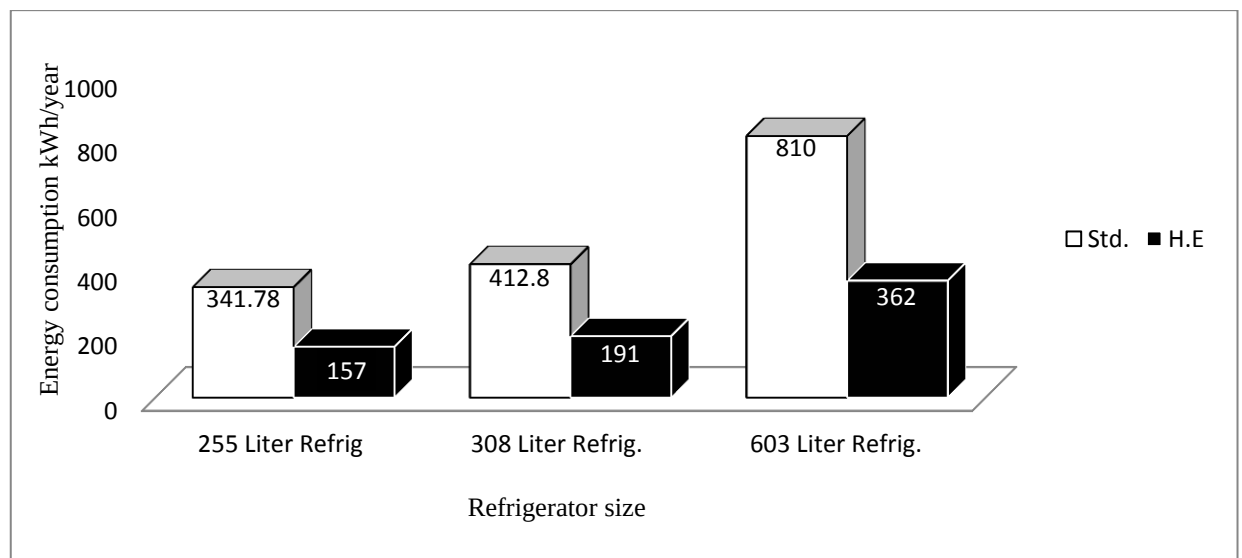


Fig 5.15: Annual STD and HE Refrigerators energy consumption (kWh/year).

The annual energy consumption cost of using STD and HE refrigerators shown in figure 5.16

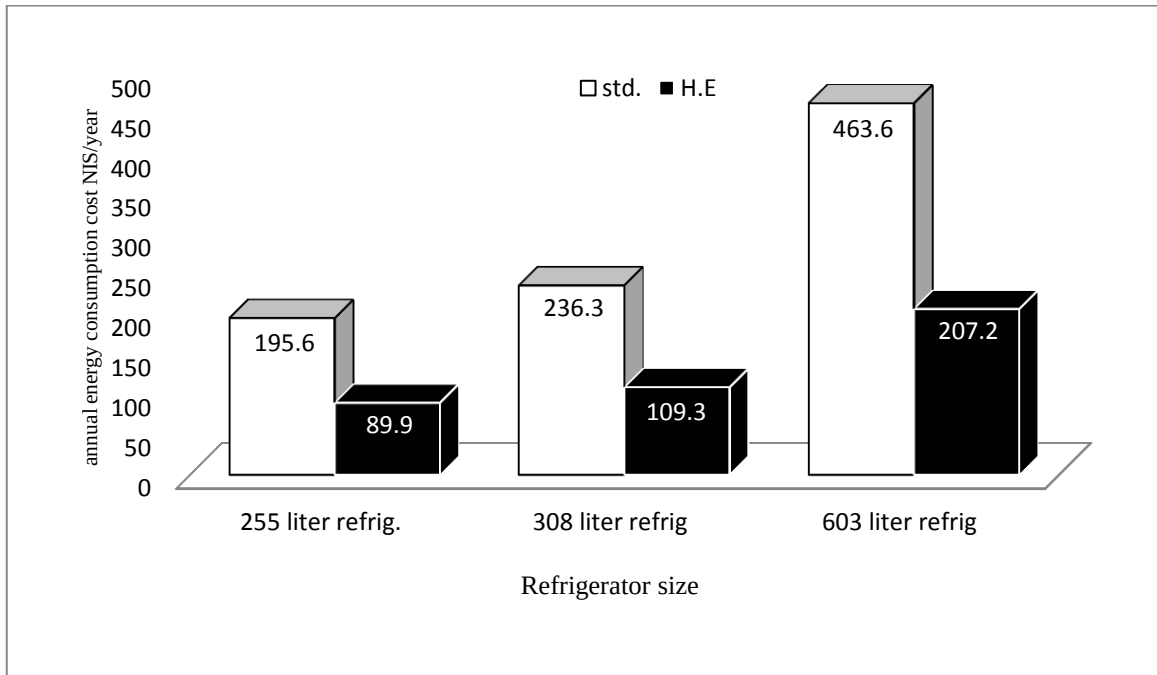


Fig 5.16: Annual STD and HE refrigerators energy consumption cost (NIS/year).

The total annual saving of using HE instead of STD EHA = total annual cost of STD – total annual cost of HE (4)

The total annual saving of using HE refrigerator instead of STD = total STD refrigerator annual cost – total HE refrigerator annual cost.

The total annual saving of using HE 255L refrigerator instead of STD = 414.36 NIS/year - 346.83 NIS/year = 67.53 NIS/year.

The total annual saving of using HE 308L refrigerator instead of STD = 81 NIS/year.

The total annual saving of using HE 603 refrigerator instead of STD = 167.2 NIS/year.

Figure 5.17 shows the annual saving of using HE refrigerator instead of STD.

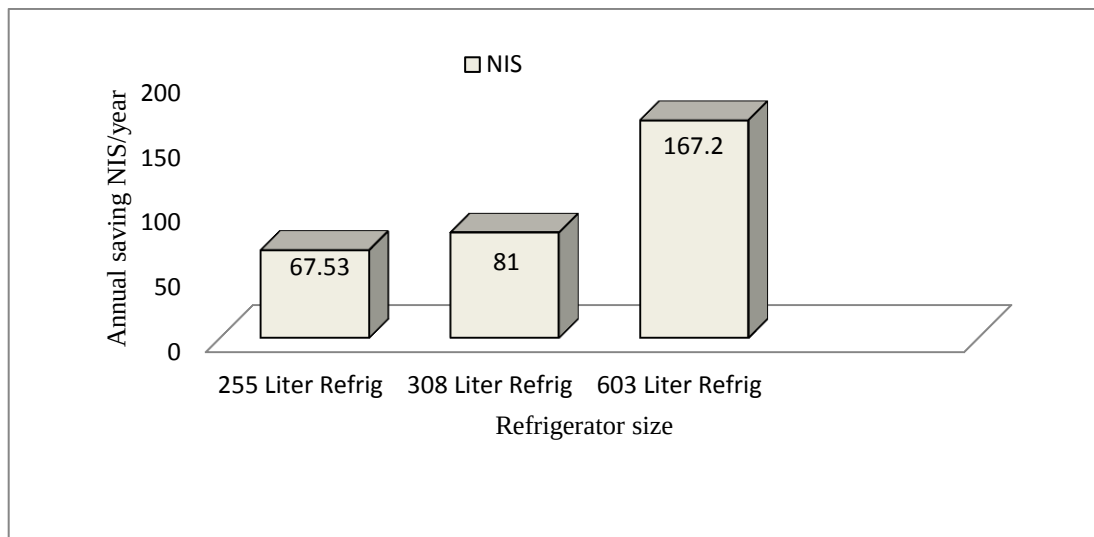


Fig.5.17: Annual cost saving when use H.E instead of Std. refrigerators.

According to previous table and calculations of STD and HE Refrigerators comparison, the SPBP of using H.E instead of STD = Δ Investment / Δ saving....(6)

SPBP = (HE initial cost – STD initial cost) / (STD annual running cost – HE annual running cost).

The SPBP of using H.E Refrigerator 255L instead of STD 255L = (1750 - 1490) NIS / (195.6- 89.9) NIS / year = 260/ 105.7= 2.46 year.

The SPBP of using HE Refrigerator 308L instead of STD 308L = (2113.7 - 1800) NIS / (236.3- 109.3) NIS / year = 313.7/ 127= 2.47 year.

The SPBP of using HE Refrigerator 603L instead of STD 603L = $(4138.2 - 3530) \text{ NIS} / (463.6 - 207.2) \text{ NIS} / \text{year} = 608.2 / 256.4 = 2.37 \text{ year}$.

Figure 5.18, shows the SPBP of using different sizes of HE refrigerators instead of STD.



Fig.5.18: S.P.B.P in years of using H.E instead of Std. Refrigerator.

5.2.2. Washing Machine:

Table 5.7 shows the annual details of STD and HE washing machine energy and water consumption:

Table 5.7: Annual consumption and consumption cost comparison between Std. & H.E washing machine

class	Washing machine size (Kg)	Annual energy consumption (KWH)	Annual energy consumption cost (NIS)	Annual water consumption (L)	Annual water consumption cost (NIS) ¹
STD	8	457	261.5	24062.5	108.3
	12	686	392.6	36095	162.4
	16	917	524.8	48130	216.6
HE	8	234	122.4	12320	55.4
	12	350	200	18400	82.8
	16	465	266	24600	110.7

1) The cost of water consumption $\text{NIS} / \text{m}^3 = 4.5$ according to Jerusalem water undertaking Ramallah and Al-Birah district.

Table 5.8: Economical comparison between STD and HE washing machine.

Washing Machine size (Kg)	Initial cost (NIS)		Annual running cost (NIS) ¹		Total annual cost ² (NIS)		Annual saving ³ (NIS)	Total saving (NIS) n=10
	STD	HE	STD	HE	STD	HE		
8	1890	2250	369.8	177.8	704.3	576	128.3	1283
12	2850	3350	555	282.8	1059.4	875.7	183.7	1837
16	3800	4400	741.4	376.7	1413.9	1155.4	258.5	2585

1) The cost of energy consumption annually + the cost of annual water consumption

2) Annual running cost + initial cost (capital recovery A/P, 12%, 10 = 0.17698).

3) Annual saving = STD total annual cost - H.E total annual cost.

Figure 5.19 shows different sizes of HE and STD washing machines annual energy consumption.

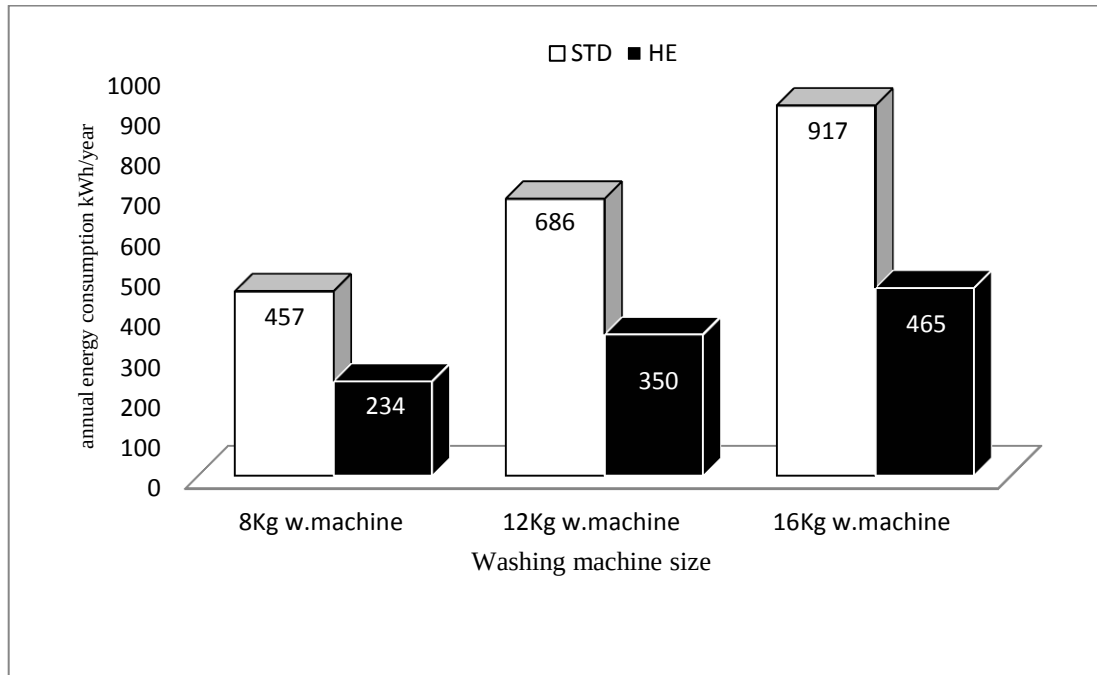


Fig 5.19: Annual STD and HE washing machine energy consumption (kWh/year).

The energy classification label of washing machines not only depends on the electrical energy consumption but also on water consumption, the average cost of water consumption $\text{NIS} / \text{m}^3 = 4.5$ according to Jerusalem water undertaking Ramallah and Al-Birah district.

Figure 5.20 shows the comparison annual washing machine water consumption.

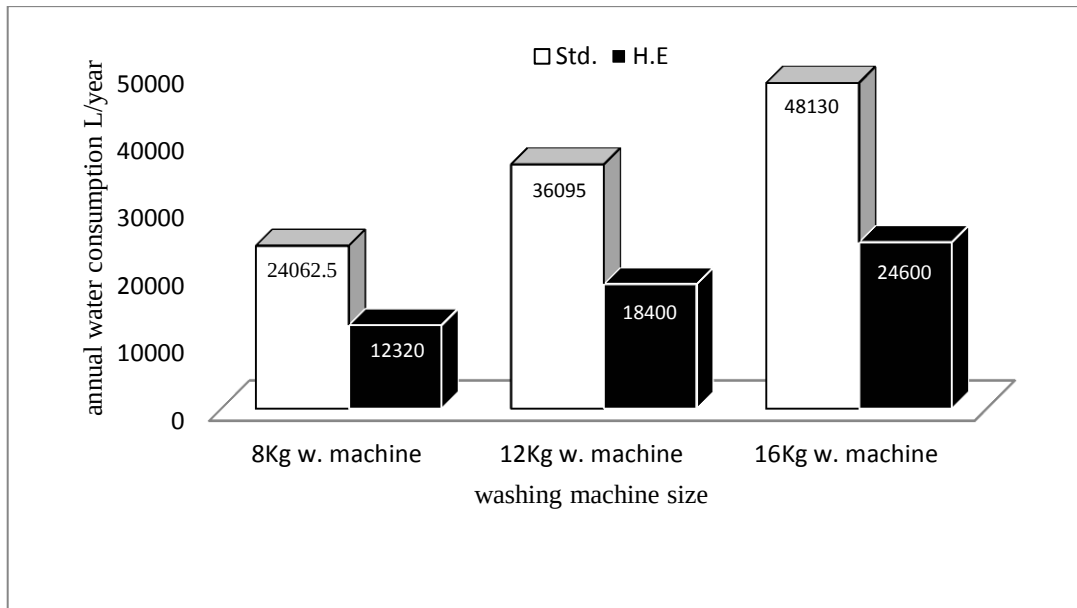


Fig 5.20: Annual STD and HE washing machine water consumption (L/year).

Figure 5.21 shows the total annual running cost of different STD and HE washing machines sizes.

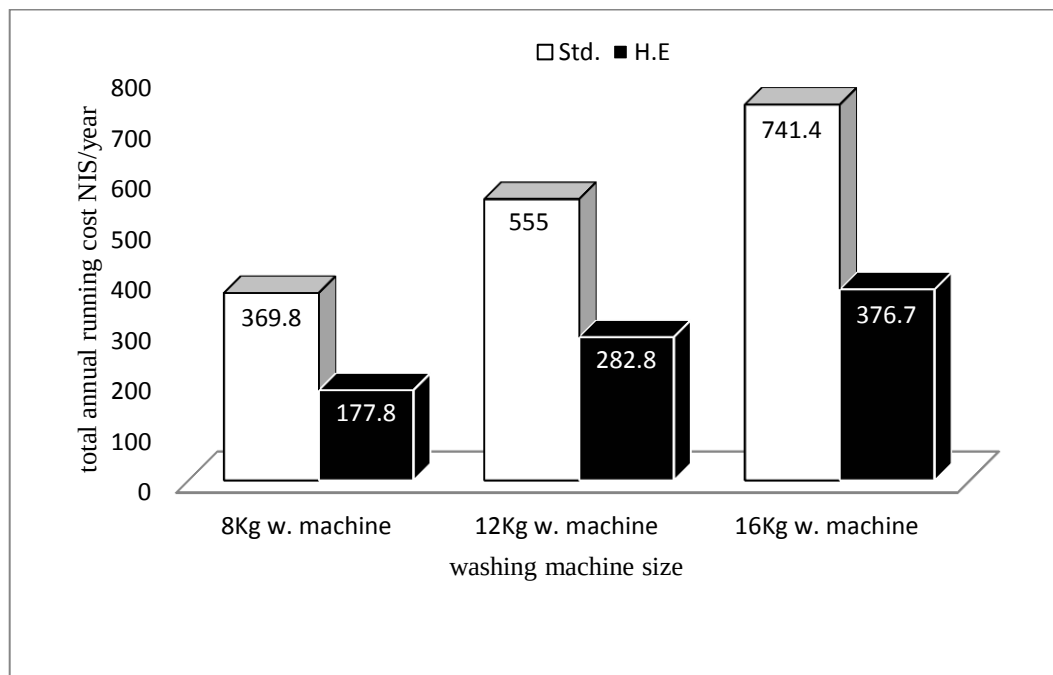


Fig 5.21: Annual STD and HE washing machine running cost (NIS/Year).

Figure 5.22 shows the total annual saving of using HE washing machine instead of STD.

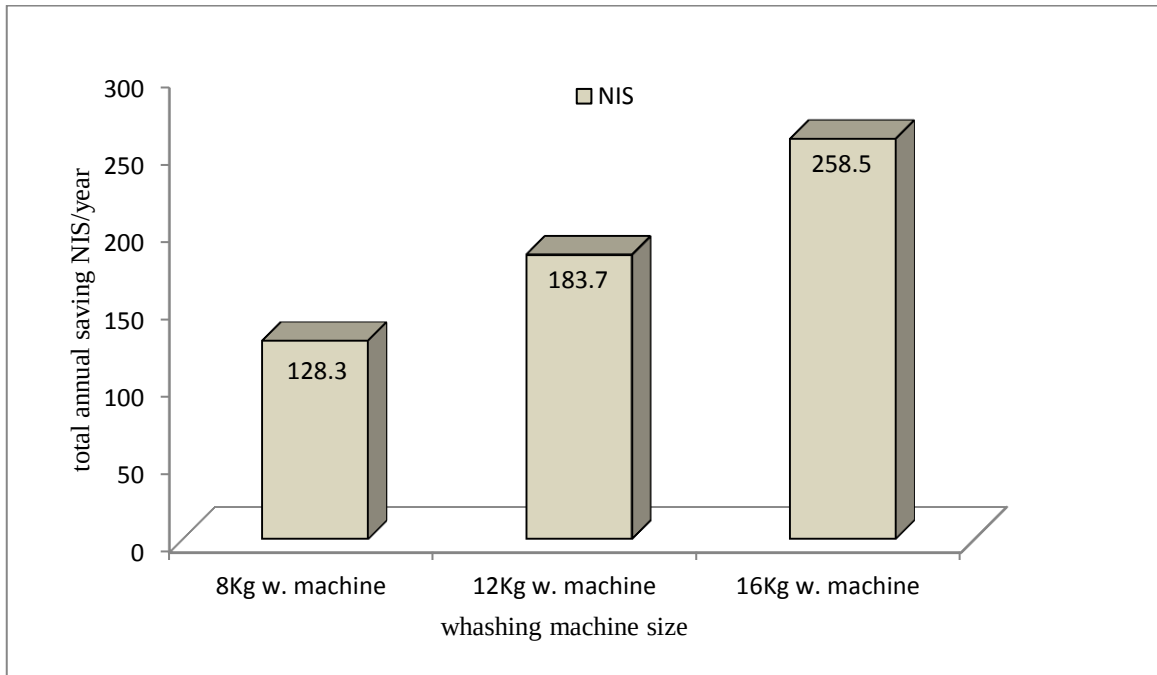


Fig. 5.22: Total annual costs saving when use HE instead of STD Washing machine.

According to previous tables 5.7 and 5.8 of STD and HE washing machines comparison, the SPBP is shown in Figure 5.23

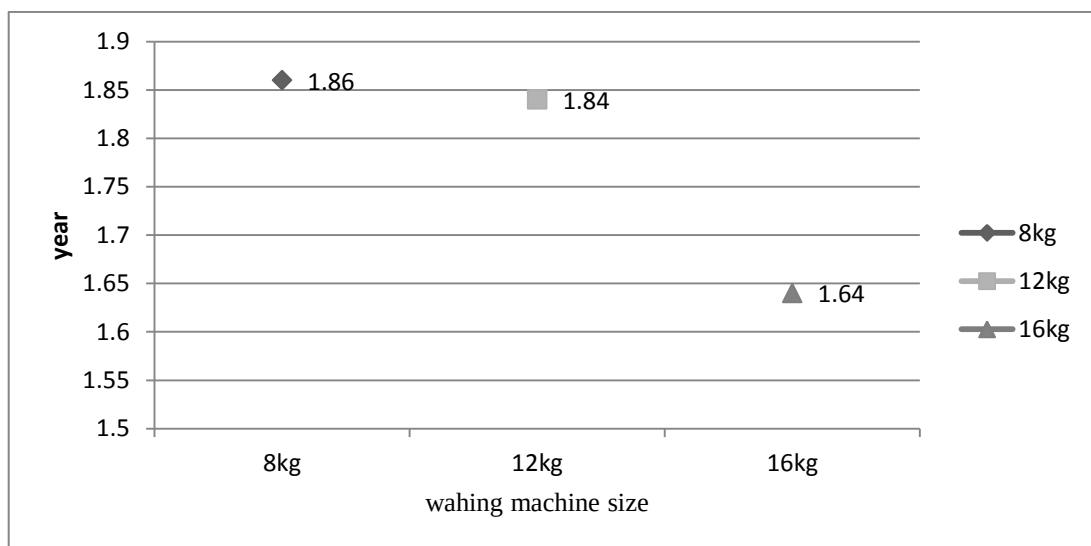


Fig.5.23: S.P.B.P in years of using HE instead of STD washing machine.

5.2.3. Vacuum cleaner:

Table 5.9 shows the comparison cost and saving differences between HE and STD vacuum cleaner.

Table 5.9: Economical comparison between STD and HE Vacuum cleaner.

Vacuum cleaner size (W)	Initial cost (NIS)		Annual running cost (NIS) ¹		Total annual cost ² (NIS)		Annual saving ³ (NIS)	Total saving (NIS) n=8
	STD	HE	STD	HE	STD	HE		
1800	340	400	48	24.6	116.4	105	11.4	91.2
2300	450	520	63	31.5	153.6	136.2	17.4	139.2

- 1) The cost of energy consumption annually.
- 2) The cost of annual energy consumption + initial cost (capital recovery A/P, 12%, 8).
- 3) Annual saving = - H.E total annual cost – -Std. total annual cost.

Figure 5.24 shows the annual energy consumption of STD and HE vacuum cleaner.

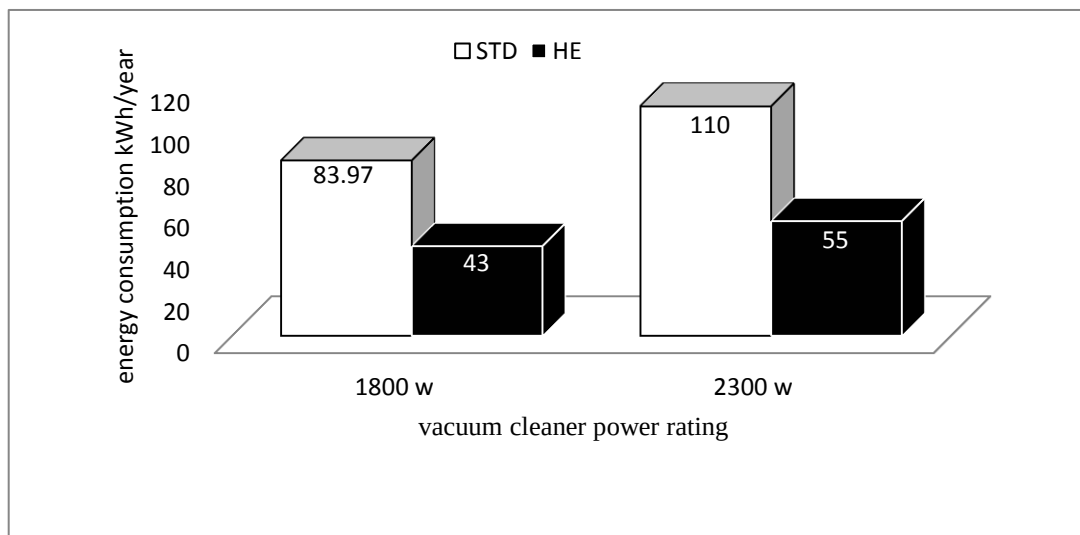


Fig 5.24: Annual STD and HE vacuum cleaner energy consumption (kWh/year).

Figure 5.25 shows the annual running cost of STD and HE of different rating vacuum cleaner.

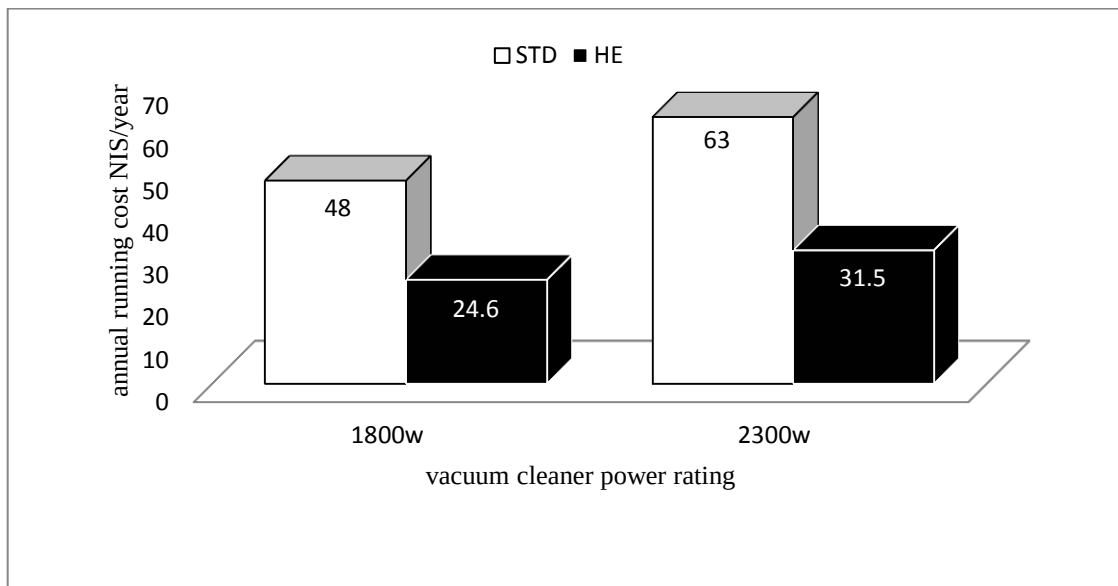


Fig 5.25: Annual STD and HE vacuum cleaner running cost (NIS/year).

The figure 5.26 shows the total annual saving of using HE instead of STD vacuum cleaner.

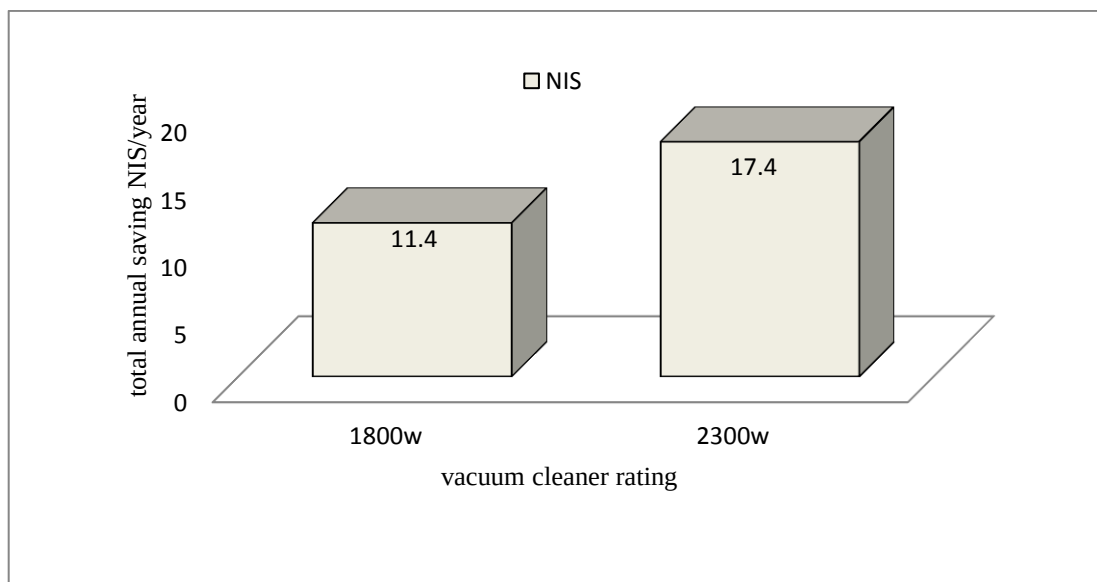


Fig 5.26: Total Annual cost saving (NIS/Year) if use H.E instead of Std. vacuum cleaner.

According to previous table 5.8 of STD and HE vacuum cleaner comparison, the SPBP of using HE instead of STD is shown in figure 5.27

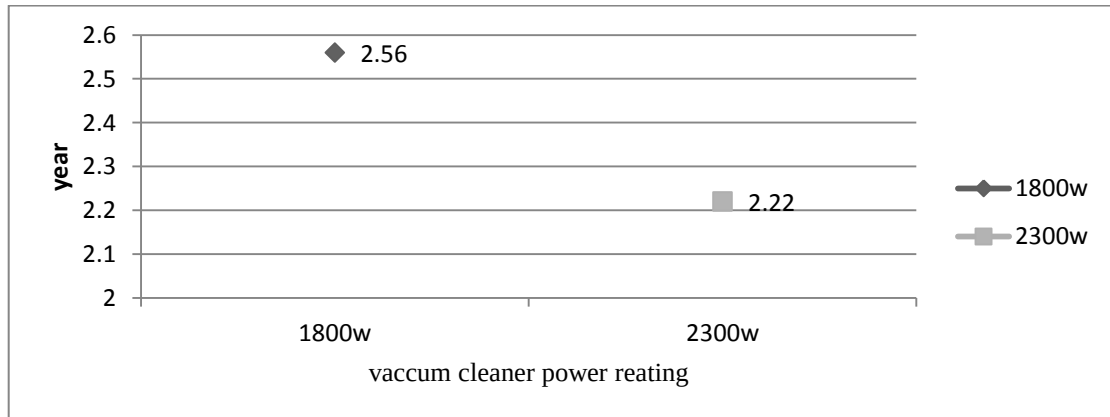


Fig.5.27: SPBP in years of using HE instead of STD Vacuum cleaner.

5.2.4. Split air conditioner:

Table 5.10 shows the initial cost, the annual running cost, and the annual saving comparison of using different capacities of STD and HE air conditioner.

Table 5.10: Economical comparison between STD and HE air conditioner.

Air conditioner size (BTU/h)	Initial cost (NIS)		Annual running cost (NIS) ¹		Total annual cost ² (NIS)		Annual saving ³ (NIS)	Total saving (NIS)
	STD	HE	STD	HE	STD	HE		n=10
12000	1440	1700	609.2	312	864	612.9	251.1	2511
18000	2200	2550	915.7	466.4	1311.3	917.7	393.6	3936
24000	2900	3400	1230.4	618	1743.6	1219.7	523.9	5239

- 1) The cost of energy consumption annually.
- 2) The cost of annual energy consumption + initial cost (capital recovery A/P, 12%, 10 = 0.17698).

3) Annual saving = Std. total annual cost - H.E total annual cost.

Figure 5.28 shows the annual energy consumption of different capacities of STD and HE air conditioner.

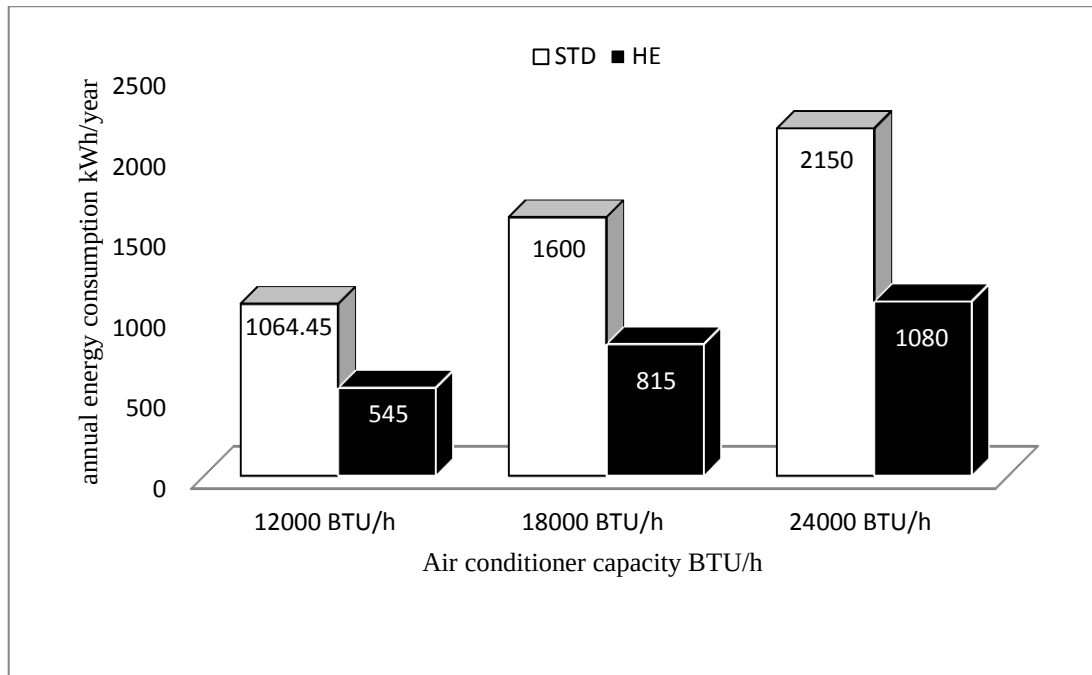


Fig 5.28: Annual STD and HE Air conditioner energy consumption (kWh/year).

Figure 5.29 shows the annual running cost of using different capacities STD and HE air conditioner

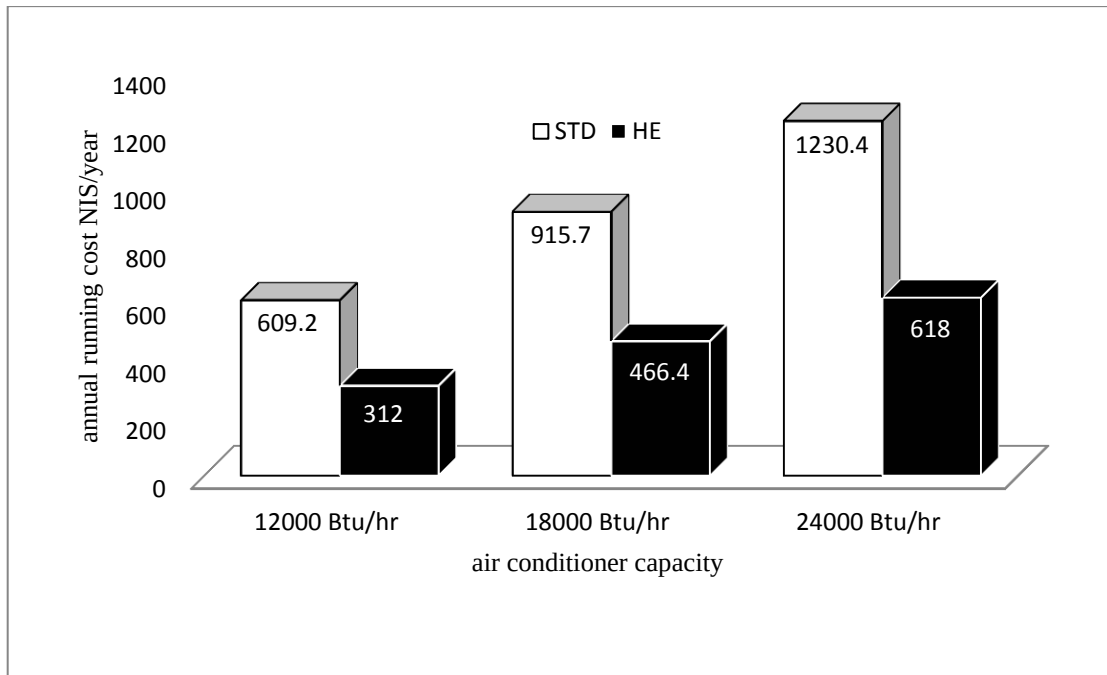


Fig 5.29: Annual STD and HE Air conditioner running cost (NIS/year).

Figure 5.30 shows the annual saving of using different HE air conditioner capacities instead of STD.

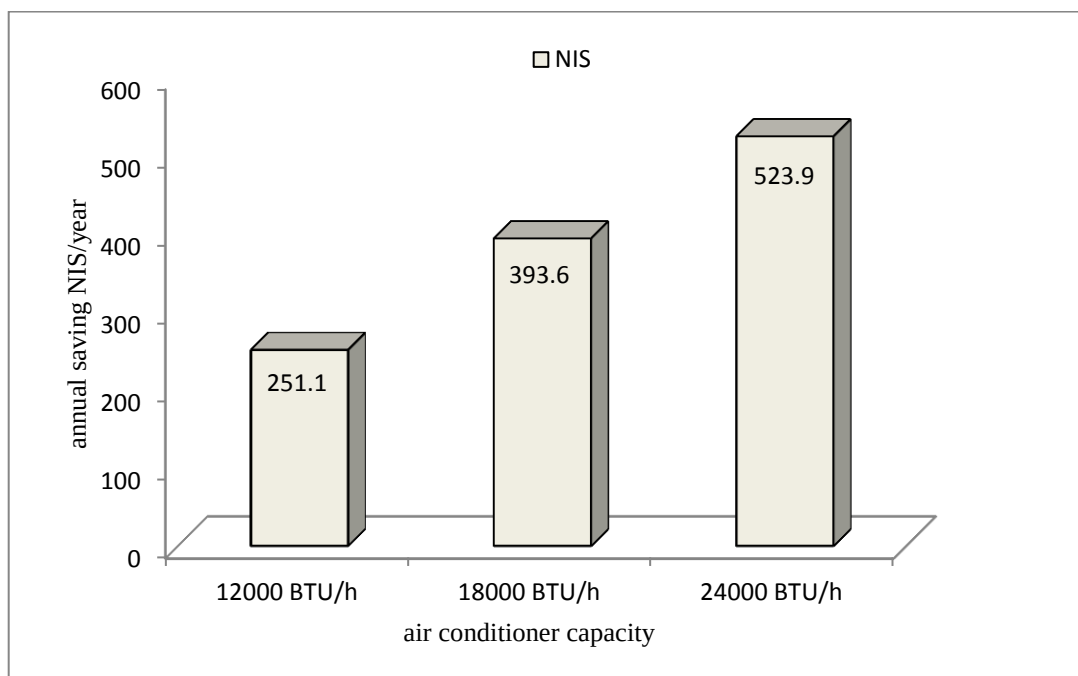


Fig 5.30: Total Annual cost saving (NIS/year) of using HE instead of STD air conditioner.

According to previous table 5.9, the SPBP for the three capacities are shown in figure 5.31

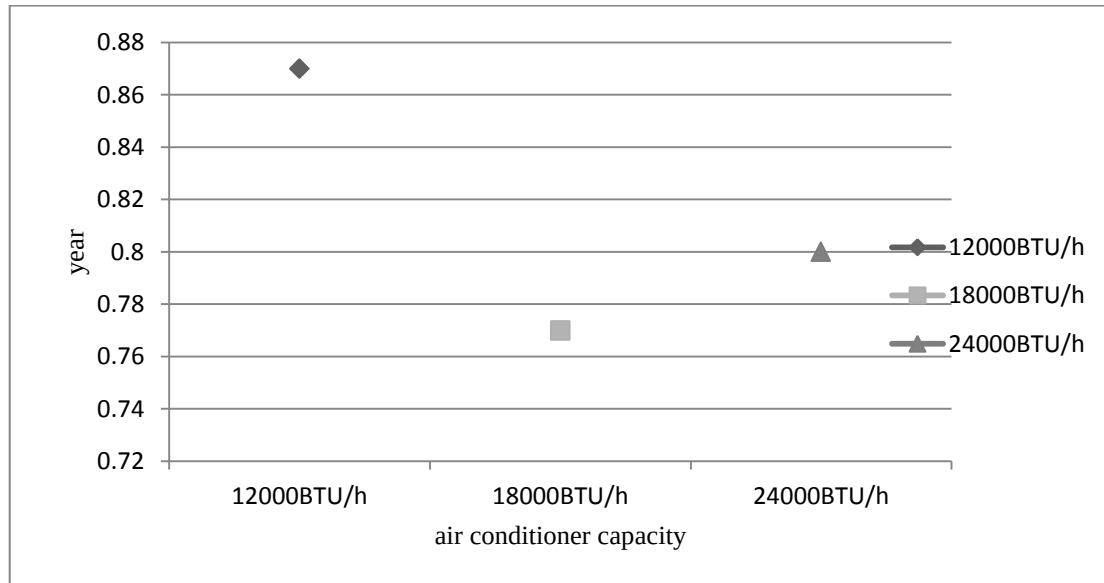


Fig.5.31: SPBP in years of using H.E instead of Std. Air conditioner.

5.2.5. Microwave Oven:

Table 5.11 shows the initial cost, annual running cost, total annual cost, and annual saving of using of STD and HE of different microwave oven sizes.

Table 5.11: Economical comparison between STD and HE microwave oven.

Microwave oven size (L)	Initial cost (NIS)		Annual running cost (NIS) ¹		Total annual cost ² (NIS)		Annual saving ³ (NIS)	Total saving (NIS)
	STD	HE	STD	HE	STD	HE		n=8
16	550	650	67	34.3	177.7	165.1	12.6	100.8
25	800	1030	114.5	57.2	275.5	268.5	7	56

- 1) The cost of energy consumption annually.
- 2) The cost of annual energy consumption + initial cost (capital recovery A/P, 12%, 8 = 0.20130).
- 3) Annual saving = - H.E total annual cost – -Std. total annual cost.

Figure 5.32 shows annual energy consumption of STD and HE microwave ovens.

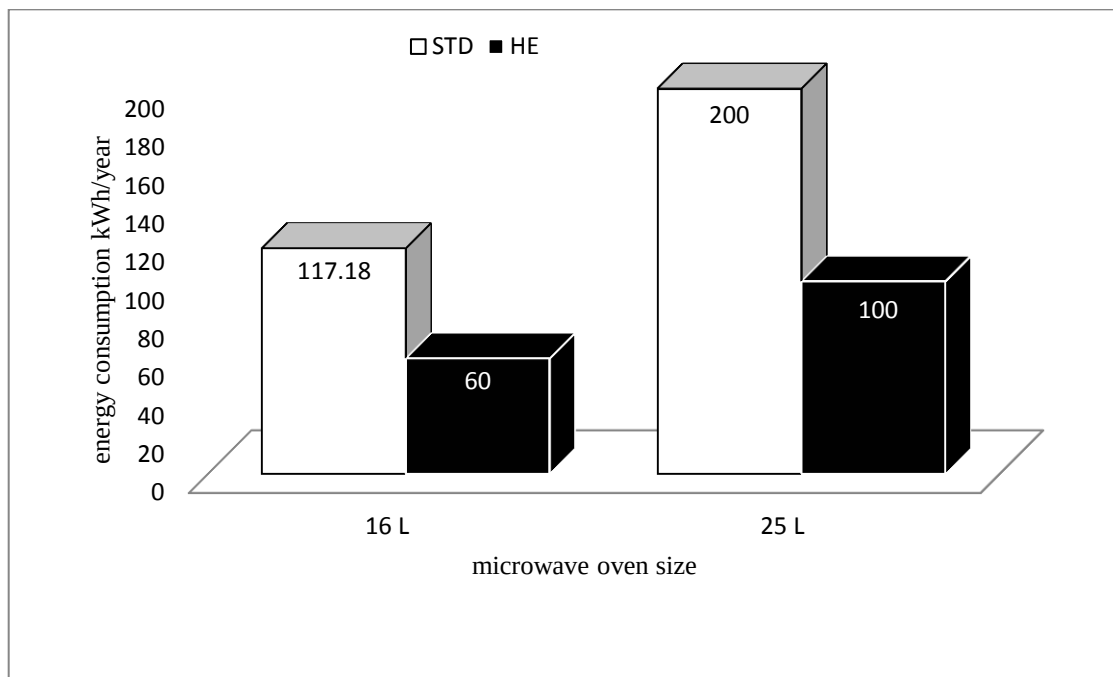


Fig 5.32: Annual STD and HE Microwave oven energy consumption (kWh/year).

Figure 5.33 shows the annual running cost of STD and HE microwave ovens

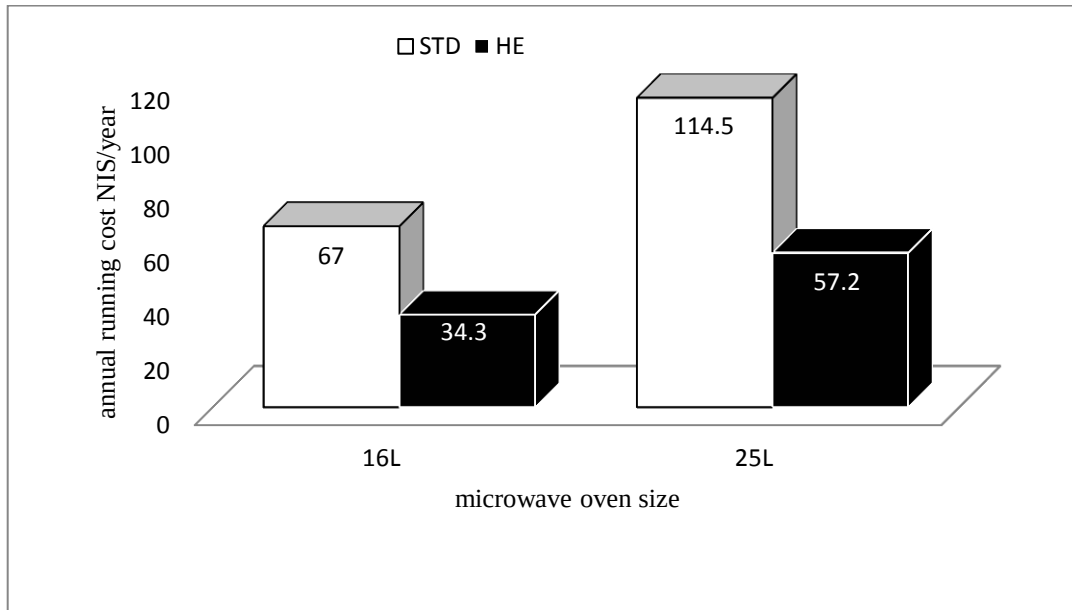


Fig 5.33: Annual Std. and H.E Microwave oven running cost (NIS/year).

Figure 5.34 shows the total annual saving of using HE microwave oven instead STD.

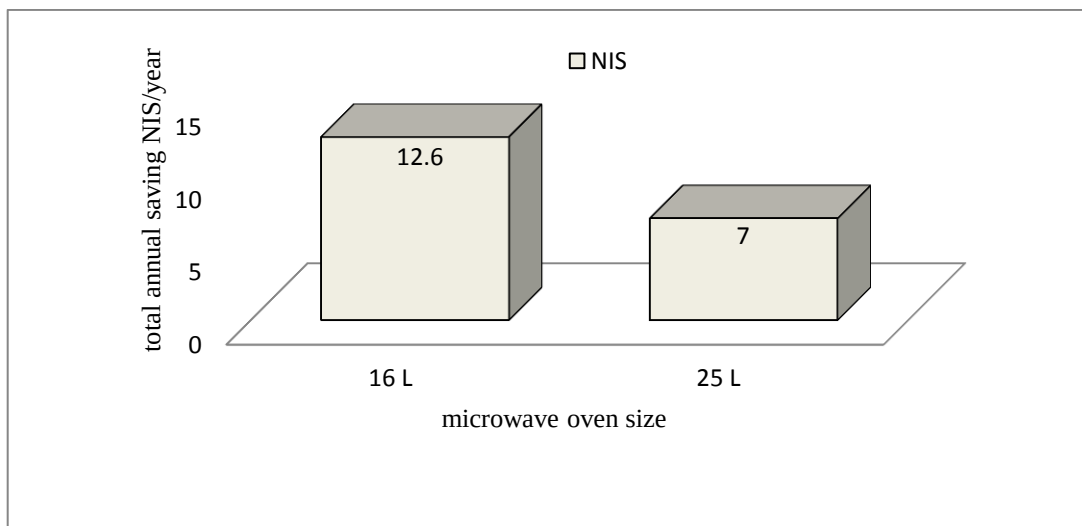


Fig 5.34: Total Annual cost saving (NIS/year) of using HE instead of STD Microwave oven.

According to previous table 5.10, the SPBP of using HE microwave oven instead of STD shown in figure 5.35.

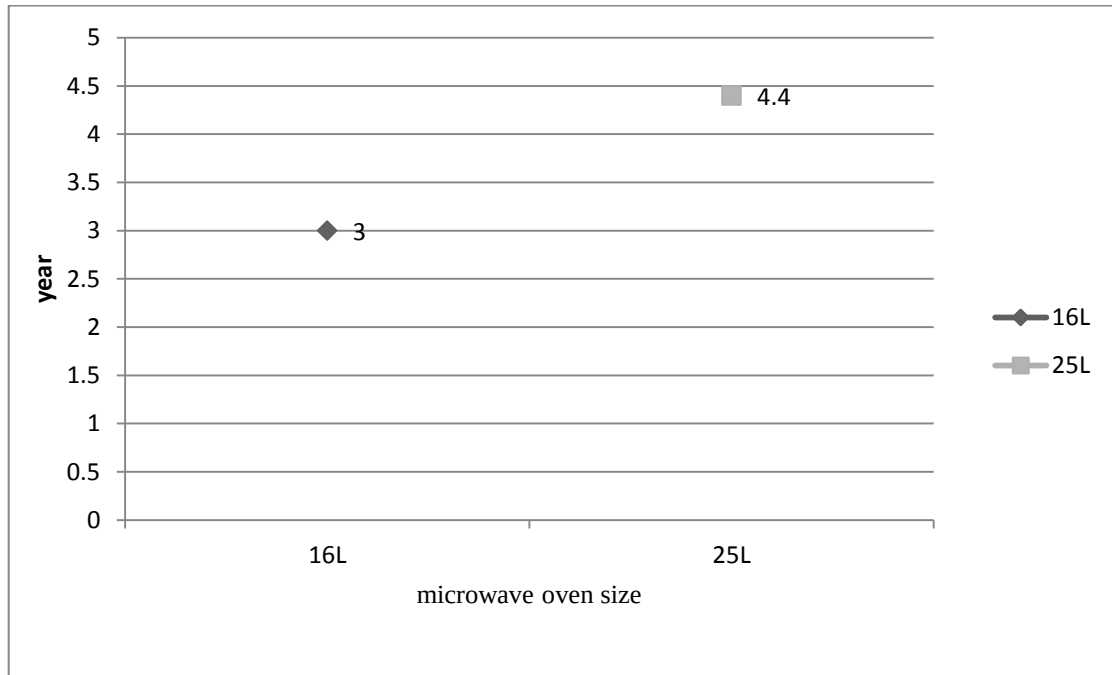


Fig.5.35: SPBP in years of using HE instead of STD Microwave oven.

5.2.6. Electrical Built in Oven:

The table 5.12 shows the economic comparison between STD and HE electrical oven.

Table 5.12: Economical comparison between STD and HE built in oven.

Electrical Built In oven size (L)	Initial cost (NIS)		Annual running cost (NIS) ¹		Total annual cost ² (NIS)		Annual saving ³ (NIS)	Total saving (NIS)
	STD	HE	STD	HE	STD	HE		
40	2358	2750	178.8	91.5	545.9	519.6	26.3	341.9
70	4150	4820	314.7	160	960.7	910.3	50.4	655.2

- 1) The cost of energy consumption annually.
- 2) The cost of annual energy consumption + initial cost (capital recovery A/P, 12%, 13 = 0.15568).
- 3) Annual saving = Std. total annual cost - H.E total annual cost.

Figure 5.36 shows the annual STD and HE energy consumption of different electrical oven sizes

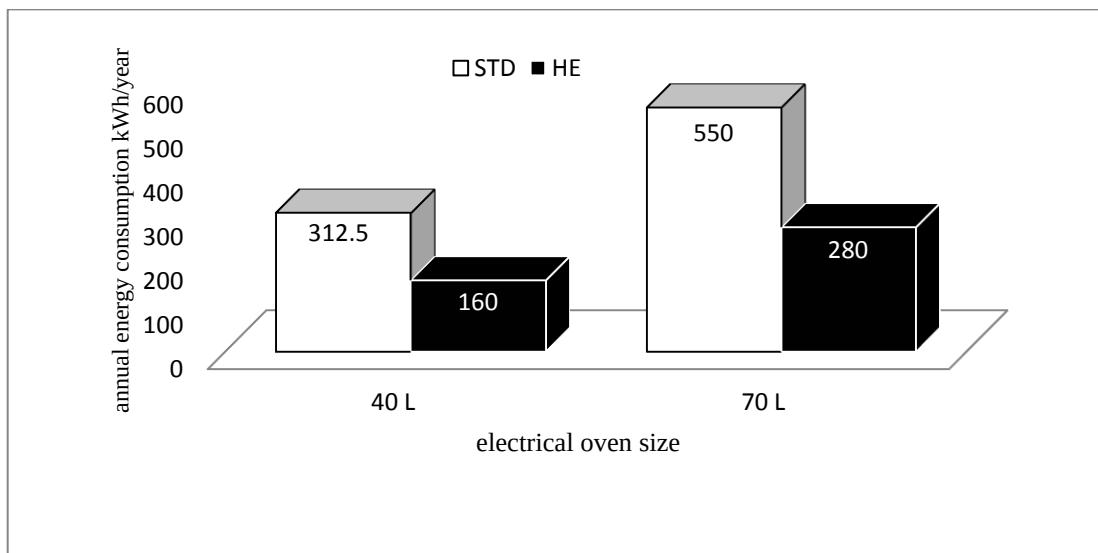


Fig 5.36: Annual STD and HE Electrical oven energy consumption (kWh/year).

Figure 5.37 shows the annual running cost of electrical oven

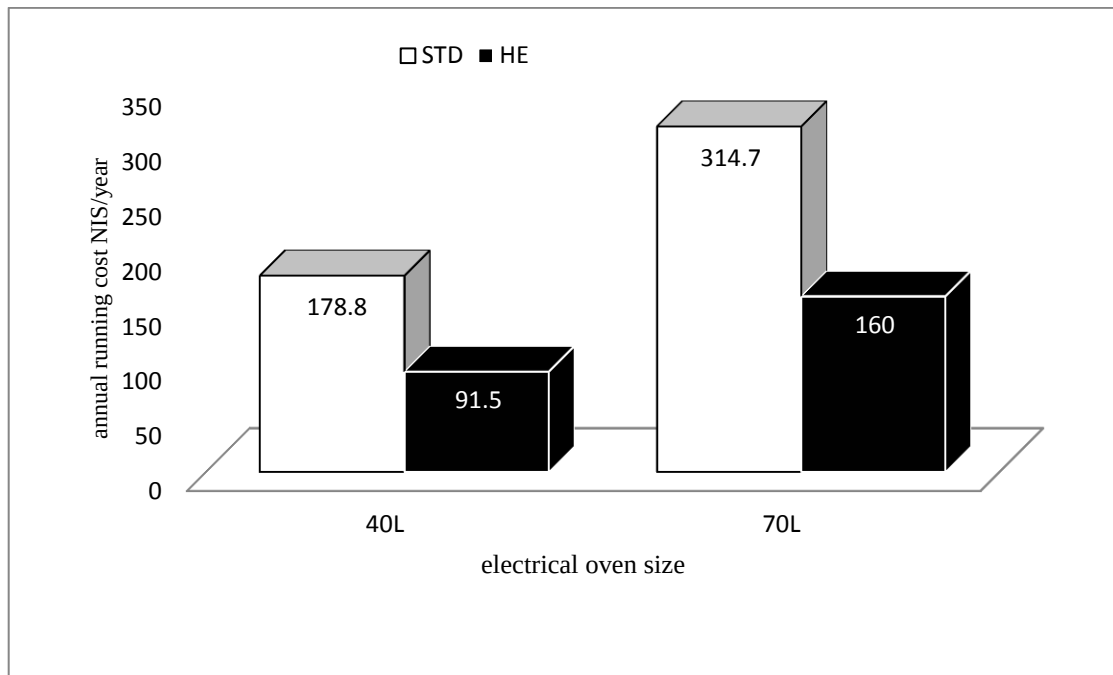


Fig 5.37: Annual STD and HE Electrical oven running cost (NIS/year).

Figure 5.38 shows the total annual saving of using HE electrical oven instead of STD.

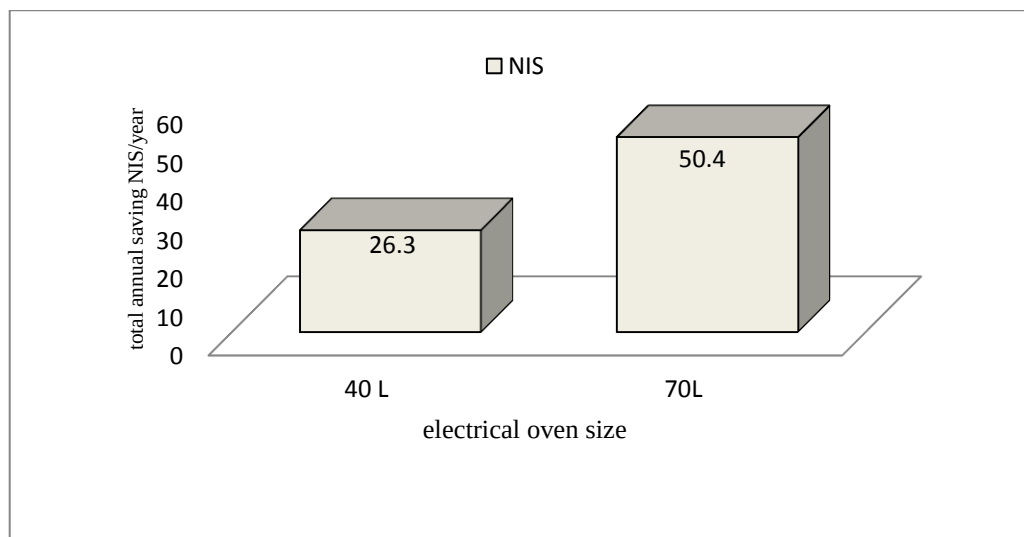


Fig 5.38: Total Annual cost saving (NIS/year) of using HE instead of STD Electrical oven.

According to previous table 5.11, the SPBP of using HE electrical oven instead of STD shown in figure 5.39.

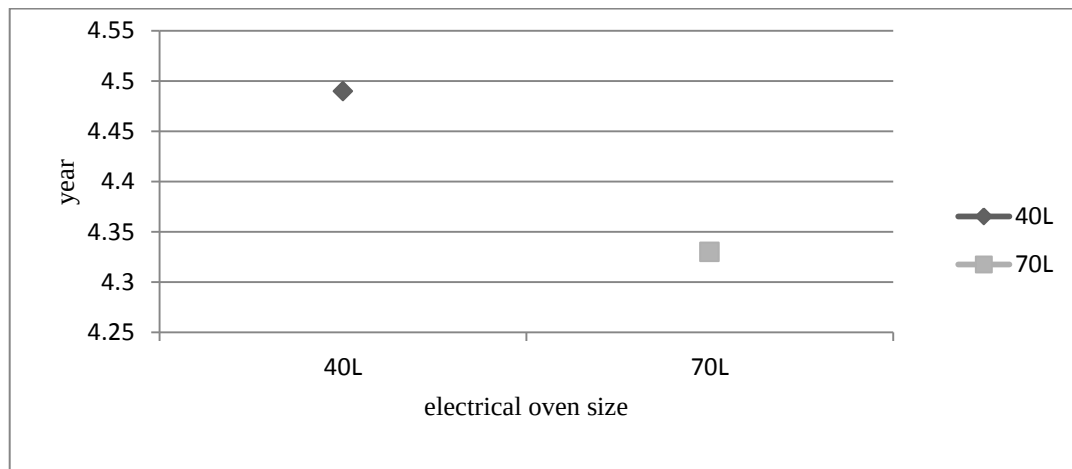


Fig.5.39: S.P.B.P in years of using HE instead of STD Electrical oven.

From the previous economic analysis, and calculations it's clearly prominently approved that buying and using HE EHA is feasible than using and buying STD EHA

5.3. Environmental impacts.

Palestine consume electrical energy in all life sectors like residential, commercial, industrial and this energy mainly imported from Israel with about 88 % and the other 12 % are generated in the Gaza generation station, solar – electrical generation projects and small diesel generating units.

The main fuel used to generate electricity in Israel generating plants is natural gas and the emergency stand by generating units are diesel operated, and also in Palestine the small generating units are operated by diesel but the generating station in Gaza is operated by natural gas [17].

Burning fuel to operate and drive the generating stations turbines will generate CO_2 , release it to atmosphere of a value 0.75 kg/ kWh generated [18].

Releasing CO_2 to atmosphere enhance the greenhouse effect and contribute the global warming, depending on the fossil fuel type and the way of burning can also cause other atmosphere emissions like ozone, SO_2 contribute the smog, NO_2 contribute acid rains, in addition to particulate matters [18].

PENRA and Palestine statistics PCBS published data in 2016 the total supplied electrical energy is 5,515,808 MWh, which divided into two parts, 5,473,308 MWh imported from Israel, and 42,500 MWh where generated locally with 721,246 MWh as losses of the total electrical energy [16, 19].

The calculated CO_2 emitted to atmosphere in 2016 according to the total supplied energy in previous paragraph is $0.75 \text{ kg/kWh} * 5,515,808,000 \text{ kWh/year} = 4,136,856,000 \text{ kg CO}_2/\text{year} = 4,136,856 \text{ tons CO}_2/\text{year}$, which is a huge negative impact on the environment and health.

5.4. Social Impacts.

Energy is the key that positively impacts the poverty relief; increase the human welfare, and improving the living standards.

Energy placed at the center of nature, society, and economy. Energy demand continue increasing as population increase, nonetheless all the used

keys to decrease the demand, these keys help to use the energy in the best and efficient way.

Investment in energy sector has a potential to contribute the economy, employment, innovation, and environment protection.

Legislating, mandating, and implementing MEPS and EHA energy classification label in Palestine, will potentially contribute the society, by creating new opportunities of employment, as a necessity of new innovations, quality control of local manufacturers to make new and advanced efficient EHA technology; so as to make efficient EHA with competitive cost.

Surveillance on local market will eliminate the used, and LE EHA, this will secure the consumer safety, and saving, this will raise the consumer satisfaction.

Implementing MEPS by PSI through testing the imported EHA and local manufacturer's EHA samples in the testing laboratory will prevent consumer deception; this will also raise the consumer trust of EHA in the local market.

Implementing energy classification label and MEPS will decrease the energy demand on the connecting points, decrease the grid losses and this will stabilize the power continuity to the consumers.

Chapter six

Performance analysis of legislating & implementing Palestine's MEPS & energy label.

Palestine still under occupation, Palestinian government's ministries and institutions try to carry and implement their responsibilities and missions, but it face a lot of obstacles that prevent it control the whole Palestinian's land, Palestine's market is an opened market for imported products and all the sold products from Israel to this market, no Palestinian control on the Palestinian areas gates and entries, in the field of EHA, a lot of these appliances are LE, used, defected, and a lot of safety hazards by using these EHA.

On the ground, PSI is the sole standards legislated body, it focused on consumer safety through all its duties, till these days still no MEPS legislated in addition to no technical directives of energy classification label.

The PCBS statistics data in the table 5.1 can be used together with the questionnaire out puts in table 5.3, and the data in table 5.4 to estimate the annual national energy conservation, the total national saving, and the total CO₂ mitigated if replacing the STD and LE EHA with HE EHA.

According the conducted questionnaire on the Palestinian households, the percentage of STD, LE, and no label main EHA shown in the table 6.1.

Table 6.1: Percentage of STD and LE of main heavier EHA in Palestine.

Appliance type	% of class D, E, F,G, no label
Washing machine	35
Refrigerator	42
Air conditioner	64
Microwave oven	91
Electrical oven	81

If using the main EHA percentages in the table 6.1 with the PCBS statistics in table 5.1, then the STD, LE, and no label main heavier EHA quantities are in table 6.2

Table 6.2: the total Palestine quantities of STD, LE, and no label main heavier consumption appliances

Appliance type	Quantity of STD, LE, and no label appliance (unit)
Washing machine	285,510
Refrigerator	351,150
Air conditioner	133,450
Microwave oven	277,677
Electrical oven	685,559

Table 6.3 shows the annual national energy conservation and saving if replacing the quantities mentioned in table 6.2 by HE appliances according to table 5.4 and the results of conservation and saving for each appliance type in the clause 5.2.

The annual national energy conservation of using HE washing machine instead of STD = quantity of STD washing machine in Palestine * (annual energy consumption of STD washing machine – annual energy consumption of HE washing machine) = 285,510 * (457-234) = 63,668,730 kWh/year.

The annual national saving = the annual national energy conservation kWh/year * 0.5723 NIS/kWh = 36,437,614.179 NIS/year.

Table 6.3: the annual national energy conservation and saving of replacing STD appliances with HE.

Appliance	Annual Energy conserved (KWH)	Annual Cost saved (NIS)
Washing machine	63,668,730	36,437,614.179
Refrigerator	64,885,497	37,133,969.9
Air conditioner	69,320,602.5	39,672,181
Microwave oven	15,877,571	8,086,734
Electrical oven	104,547,747	59,832,676
Total annual energy conserved and money saved	291,300,147.5	181,163,175

Table 6.4 shows the estimated annual mitigated CO₂ that it will not be emitted to atmosphere when using HE EHA instead of STD.

Table 6.4: Total annual estimated CO₂ mitigated when using HE instead of STD appliances in Palestine.

Appliance	Total energy conserved KWh/year	CO ₂ mitigation Kg/year
Washing machine	63,668,730	47,751,547.5
Refrigerator	64,885,497	48,664,123
Air conditioner	69,320,602.5	51,990,451.8
Microwave oven	15,877,571	11,908,178.2
Electrical oven	104,547,747	78,410,810.25
	Total CO₂ Mitigated	238,725,110.75 Kg/year

Palestine government will be ambitious to start a project to replace the LE EHA, according to the tables 6.3, & 6.4 results which impact the national energy conservation, the national saving, and environment protection.

It's important for all parties to know how to start this project, how much it will cost the project's parties, for replacing the LE EHA, and how much time required performing it.

Palestine houses are full of old and LE EHA, all parties (government, households, electrical distribution companies, and municipalities) required to fully supporting this project to success it.

The Palestinian government will be the project leader represented by PENRA, this project can be started in the Palestinian high population areas like the main cities, it will enforce every house hold to replace the LE EHA which tenth years old, with replacement rate of 5% per year.

This project will enforce the heavier EHA consumption replacement like (washing machines, refrigerators, air conditioners, microwave ovens, and electrical ovens), the number of STD and LE appliances in Palestine is approximately 1,733,346 units as detailed in table 6.2.

This project can be conducted on 20 years period with EHA replacement rate of 5% per year, the EHA quantity to be replaced yearly is 86,667 units, the project can be started in 2021 and ends up in 2041, the total project cost is detailed in table 6.5.

Table 6.5: the total project cost of replacing STD and LE EHA

Appliance type	Quantity of STD, LE, and no label appliance (unit)	Unit cost (NIS/unit)	Total cost NIS
Washing machine	285,510	1967	561,598,170
Refrigerator	351,150	1529.5	537,083,925
Air conditioner	133,450	1487.5	198,506,875
Microwave oven	277,677	567	157,442,859
Electrical oven	685,559	2404.5	1,648,426,615
		Total (NIS)	3,103,058,444

This project will yearly costs 155,152,922.2 NIS, replacing main heavier consumption EHA will feasible and beneficial as detailed in chapter 5, these main EHA items can be replaced equally each year, the replacement quantity of item detailed in table 6.6.

Table 6.6: the number of units to be replaced annually according to EHA type.

Appliance type	Quantity of STD, LE, and no label appliance (unit)	Number of units to be replaced yearly (unit)
Washing machine	285,510	14,276
Refrigerator	351,150	17,558
Air conditioner	133,450	6673
Microwave oven	277,677	13,884
Electrical oven	685,559	34,276

Replacement of these appliances will be beneficial; it will impact households saving by lowering the monthly bills to be paid, it will also benefit the electrical distribution companies and municipalities by lowering the grid loads, decreasing the grid loses, and lowering the grid maintenance and infrastructure cost, lowering the energy crisis on the national level and monthly bill to be paid to IEC.

The cost of this project can be covered by divide it on three parties, Palestinians households will pay 40% of the EHA cost, government will pay 50% of the EHA cost and it can find an external fund to assist this project cost, and electrical distribution companies and municipalities will pay 10%.

Activating the role of the surveillance bodies and PSI will be cornering stone to success this project to control the market in parallel with this project.

Palestinian government starts announcing about the project on the official media, private media, and social media to aware households about the importance and the project contribution on the energy conservation, the saving, and the environment.

Chapter Seven

Conclusions and Recommendations

7.1. Conclusions

All countries around the world started legislating and implementing MEPS and energy classifications label since tenth of years, because of its importance to achieve the national energy balance.

Using HE EHA is more feasible than STD or LE EHA, and this use will positively impact the household's energy bills and monthly saving, decreasing the national energy consumption, decreasing the grid overloading and losses, decreasing the feeding points overloading and this ensure the supply continuity, it impacts the society by increasing the employment opportunities to innovate technology, in addition to positive impact on the environment protection.

A huge amount of energy conservation, saving, and mitigated CO₂ can be achieved when using HE EHA instead of STD and LE EHA according to thesis calculations and outputs.

7.2. Recommendations

PSI is the sole authorized body according to law to legislate standards and directives, therefore it has to start legislating, publishing MEPS and energy classification label directives.

Palestinian government has to activate the role of surveillance bodies (consumer protection directorate, custom police, and PENRA) through the

full training, and employment; to implement energy classification labels, and to control the local market.

Granting the surveillance bodies and PSI the full support through many paths; one of these paths is enforcing and mandating these MEPS and energy label by the minister's council decrees.

PSI playing a main role to implement MEPS and energy labels through testing facilities in the field of EHA energy efficiency, PSI ambitious to establish the EHA energy efficiency laboratory, to assist manufacturers, importers, and surveillance bodies to assess the EHA samples compliance to MEPS.

Raising the household's awareness of buying and using HE EHA instead LE EHA and its impacts on energy conservation, on the saving, and the environment through the whole official and nonofficial media in addition to social media, holding lectures, and publishing brochures.

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Appendices

Appendix A: The questionnaire in Arabic language

إستبيان

الاجهزة الكهربائية المنزلية ودورها في ترشيد الاستهلاك

إنّ هذا الاستبيان هو عبارة عن دراسة لعينة عشوائية من المجتمع الفلسطيني لبيان مدى ونسبة الاجهزة الكهربائية ذات الكفاءة العالية الموجودة لدى المُستهلك الفلسطيني ومدى وعيه حولها ومدى إهتمامه بشرائها واستعمالها والمعوقات لشرائها إن وجدت.

إن هذا الاستبيان لغايات الدراسة والبحث العلمي، كما ستُعكس نتائجهُ على ورقة البحث من إعداد الدكتور "عماد بريك" والطالب "تحسين سليمان" وكذلك رسالة الماجستير الخاصة بالطالب : "تحسين سليمان" والمشرف عليها الدكتور "عماد بريك" والتي بعنوان " الاثر الفني والاقتصادي لتطبيق المواصفات الفلسطينية والعالمية على الاجهزة الكهربائية في فلسطين"

نأمل من حضرتكُم ونشكر لكم تعاونكُم في الاجابة بموضوعية على الاسئلة الواردة في هذا الاستبيان لانه من خلال إجاباتكم سوف نكون قادرين على تقييم الوضع الحالي للاجهزة الكهربائية في فلسطين من حيث الاستهلاك وكفاءة الطاقة.

❖ أرجو تعبئة المعلومات الخاصة بك وفق الاتي:

1. اسم المدينة او القرية او المخيم الذي تسكنه.....
2. الدرجة العلمية التي تحملها
3. هل دخلك الشهري من: - وظيفة (عمل) حُر - وظيفة براتب شهري ثابت
4. ما معدل فاتورة منزلك او محلك التجاري الشهرية..... شيكل.

❖ أسئلة عن الاجهزة الكهربائية:

1. هل تعلم ما معنى بطاقة تصنيف الطاقة على الاجهزة الكهربائية: - نعم - لا
2. هل لديك مكيف هواء: - نعم - لا ، ما حجمه..... طن، ما تصنيفه في بطاقة الطاقة.....، هل اشتريته - جديد أو - مستعمل
3. هل لديك ثلاجة: - نعم - لا ، ما تصنيفها في بطاقة الطاقة.....، هل اشتريتها - جديدة أو - مستعملة
4. هل لديك غسالة: - نعم - لا ، ما حجمها..... طن، ما تصنيفها في بطاقة الطاقة.....، هل اشتريتها - جديدة أو - مستعملة
5. هل لديك مجمد طعام: - نعم - لا ، ما تصنيفها في بطاقة الطاقة.....، هل اشتريتها - جديدة أو - مستعملة
6. هل لديك مجفف ملابس(نشافة): - نعم - لا ، ما حجمها..... طن، ما تصنيفها في بطاقة الطاقة.....، هل اشتريتها - جديدة أو - مستعملة
7. هل لديك غسالة صحون: - نعم - لا ، ما تصنيفها في بطاقة الطاقة.....، هل اشتريتها - جديدة أو - مستعملة
8. هل لديك فرن كهربائي: - نعم - لا ، ما حجمها..... طن، ما تصنيفه في بطاقة الطاقة.....، هل اشتريته - جديد أو - مستعمل
9. هل لديك فرن ميكرويف: - نعم - لا ، ما تصنيفه في بطاقة الطاقة.....، هل اشتريته - جديد أو - مستعمل
10. هل استمعت أو قرأت من قبل لنشرات او برامج توعوية حول الاجهزة الكهربائية واستهلاكها وكيفية استخدامها للحد من استهلاكها والتقليل من الفاتورة الشهرية: - نعم - لا

11. هل تعلم ما الفرق بين جهاز كهربائي ذو كفاءة عالية (عالي التوفير) وجهاز ذو كفاءة منخفضة (قليل التوفير): - نعم - لا

12. هل انت مستعد لدفع مبلغ أكبر بنسبة تصل ما بين 15 الى 25% من سعر الجهاز ذو الكفاءة المنخفضة عند شراء الاجهزة الكهربائية لتشتري جهاز ذو كفاءة عالية: - نعم - لا

13. هل عندك شكوك بصحة البطاقة الملصقة على بعض الاجهزة التي اشتريتها حيث انك لم تشعر بانخفاض بالفاتورة الشهرية: - نعم - لا

اخيرا شكرا جزيلا على تعاونكم .

جامعة النجاح الوطنية

كلية الدراسات العليا

الآثار التقنية والإقتصادية لتطبيق المواصفات الفلسطينية والعالمية على الاجهزة الكهربائية المنزلية في فلسطين.

إعداد

تحسين سلمان "حسن سلامة" سليمان

إشراف

د. عماد بريك

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في هندسة الطاقة
النظيفة وإستراتيجية الترشيد، بكلية الدراسات العليا، في جامعة النجاح الوطنية،
نابلس-فلسطين.

2019

ب

الآثار التقنية والاقتصادية لتطبيق المواصفات الفلسطينية والعالمية على الأجهزة الكهربائية المنزلية في فلسطين

إعداد

تحسين سلمان "حسن سلامة" سليمان

إشراف

د. عماد بريك

المُلخَص

لقد إزدادت أعداد الأجهزة الكهربائية في فلسطين في السنوات الأخيرة إزدياداً مُتسارعاً، نتيجةً لإرتفاع وتحسُّن مستوى المعيشة ومقاييس الحياة، وقد أدى ذلك لإرتفاع كبير في استهلاك الطاقة الكهربائية على المستوى الوطني، مما نتج عنه أزمة وطنية في الطاقة الكهربائية، وعدم إتزان في الطاقة الكهربائية ، وفصل مُتكرر للطاقة الكهربائية على مستوى الوطن.

لا بد لفلسطين من البدء في تشريع وسن مواصفات الحد الأدنى لكفاءة الطاقة للأجهزة الكهربائية في فلسطين وكذلك البدء في تنفيذها وتطبيقها، وذلك بهدف تقليل هدر واستهلاك الطاقة غير الكفؤ، وذلك لتحقيق التوازن الطاقى في فلسطين.

ان نتائج الحسابات التي اجريت في هذه الاطروحة تبين وتؤكد جدوى شراء واستخدام الأجهزة الكهربائية المنزلية الاعلى كفاءة من مثيلاتها ذات الكفاءة القياسية العادية او من تلك ذات الكفاءة المتدنية، وهناك فرصة كبيرة لحفظ الطاقة المُهدرة باستخدامها وكذلك توفير المالى على المستويين المنزلي والوطني، بالإضافة الى حماية البيئة من الكميات الكبيرة من غاز ثاني أكسيد الكربون المُنبعث من محطات توليد الطاقة الكهربائية.

لقد نُفذ إستبيان على اربعين بيتاً فلسطينياً، أُختيرت بطريقة عشوائية وبمقابلتهم وجهاً لوجه للسؤال عن معرفة ورأي أرباب هذه الأسر حول بطاقة تصنيف الطاقة للأجهزة الكهربائية المنزلية وكذلك حول بطاقة الطاقة للأجهزة التي يمتلكونها وهل كانت جديدة او مستعملة عند شراؤها، وقد جاء هذا الاستبيان بناءً على الضعف الشديد وعدم توفر الاحصائيات والمعلومات لدى كافة وزارات ومؤسسات الحكومة الفلسطينية حول بطاقة تصنيف الطاقة للأجهزة الكهربائية في فلسطين، وقد

كان سبب هذا الضعف وقلة المعلومات هو الاحتلال حيث لا يوجد حدود ومعايير مُستقلة تُسيطر عليه الحكومة الفلسطينية.

دُرِسَ وضع كفاءة الطاقة وبطاقة تصنيف الطاقة للأجهزة الكهربائية لبعض دول العالم من خلال الاطلاع ودراسة الابحاث والتقارير والكتب العالمية الخاصة بذلك، وقد بينت هذه المراجع التقدم البارز لهذه الدول في مجال كفاءة الطاقة وبطاقة تصنيف الطاقة وآثار تطبيقها على الاجهزة الكهربائية المنزلية الايجابي على النواحي الاقتصادية والبيئية.

