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Building a Strategic Business Model for Energy Sector in Palestine (Exploratory Research)

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Dedication

"To my ever supportive persons… my parents…

Kamal & Nasreen"

Who raised me to be the person I am today

Acknowledgments

After this long period, today is a special day: Writing this acknowledgement statement is the last touch for my thesis. Today I feel that I am a step closer to what I should and will become. For I know every good thing comes at the right time.

This work would not have been completed without Allah's limitless guidance and help. Thanks Allah for giving me another day, another chance to become a better person. Thank you Allah for giving me health, for the awareness you have awaken in me...Thank you for the energy that feeds me. Because of you I become the person I am today, I thank you for giving me another day, another unused opportunity to do it right.

I would then like to thank my colleagues and friends for their wonderful support. You supported me greatly and were always ready for help. I wish particularly to thank my supervisors Drs. Mohammad Al-Sayed and Mohammad Othman. I wish to thank you for your excellent cooperation and for all of the opportunities you have given me. You generously provided me with the tools that I needed to choose the right direction and successfully complete my thesis.

I would also like to thank my parents for their wise counsel and sympathetic ear. You are always there for me.

Thank you very much, everyone!

This thesis is only the beginning of my journey.

الإقرار

أنا الموقعة أدناه، مقدمة الرسالة تحمل العنوان:

Building a Strategic Business Model for Energy Sector in Palestine (Exploratory Research)

بناء نموذج اعمال استراتيجي لقطاع الطاقة في فلسطين دراسة استكشافية

أقر 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 يقدم من قبل لنيل أي درجة علمية أو لقب علمي أو بحث لدى أي مؤسسة تعليمية أو بحثية أخرى.

Declaration

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

Student's name:	**اسم الطالبة:**
Signature:	**التوقيع:**
Date:	**التاريخ:**

Abbreviations

Abbreviation	Construct/ Variable
APEC	Asia- Pacific Energy Cooperation
CCGT	Combined Cycle Gas Turbine
EIA	Energy Information Administration's
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GICS	The Global Industry Classification Standard
GNI	Gross National Income
GoI	Government of Israel
I/O	Input /Output
IEC	Israeli Electricity Company
IIRC	The International Integrated Reporting Council
IRENA	The International Renewable Energy Agency
MLR	Multiple Linear Regression
MMR	Mixed Methods Research
NIIP	Net International Investment Position
PARC	Palestinian American Research Center
PCBS	Palestinian Central Bureau of Statistics
PENRA	Palestinian Energy and Natural Resources Authority
PERC	Palestinian Electricity Regulatory Council
PETL	Palestinian Electricity Transmission Ltd.
PMA	Palestine Monetary Authority
R&D	Research and Development
RET	Renewable Energy Technologies
SBM	Strategic Business Model
TPES	Total Primary Energy Supply
UNDP	United Nations Development Program
UNFCCC	The United Nations Framework Convention on Climate Change
UV	Ultraviolet Radiation
WEC	World Energy Committee
WER	World Energy Resources

Table of Contents

List of Tables

List of Figures

List of Appendices

Building a Strategic Business Model for Energy Sector in Palestine
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Abstract

The energy sector is commonly perceived as one crucial sector for the economy of any economy; this is particularly true in Palestine. This thesis aims to assess the current situation of traditional and renewable energy usage, examine the factors that affect energy consumption in Palestine, project future scenarios to meet the growing demand on energy resources, and develop renewable energy sector. The study relies mainly on the Mixed Method Research tools.

The energy consumption in this research is classified into five types: residential, commercial, industrial, agricultural, and consumption for transportation purposes. A primary flow of energy types was drawn in West Bank for 2015.

Additionally, the study examines the factors that affect energy consumption in Palestine. This is done in order to find ways to satisfactorily meet the energy needs of consumers and the increasingly high patterns of energy consumption. The ultimate aim is to develop projected Business Model for Energy Sector. The factor taken into consideration are: population growth, climate change, Gross Domestic Product (GDP), the standards of living, energy prices, and investment trends in the Palestinian economy.

To fulfill the objectives of this study, data were collected using interviews, focus groups, annual reports and research papers. These tools were used to determine the flow of energy resources in the various economic sectors. The regression model was built, validated and used to predict the energy consumption trends from 2016 to 2030.

The main findings of the study show that Palestine will witness highly increasing demands on energy consumption for the coming 15 years. The obtained results have been used to project feasible future energy creation scenarios, to determine the potential for building renewable energy projects. And to reduce losses in energy by employing energy management programs. The proposed scenarios are important for energy stakeholders and policymakers who seek to enhance performance in this crucial sector. Important recommendations were made to the government agencies and the private sector in order to develop the energy sector in general and the renewable resources in particular.

Chapter One

Introduction

Chapter One
Introduction

1.1 Overview

This thesis aims to assess the current situation of the energy sector in Palestine through using several engineering tools to determine the various factors that affect energy consumption in Palestine. The study uses the assessment results to forecast energy consumption trends for the next fifteen years. Proposed future scenarios for developing this important sector are also made.

This chapter provides essential background information about the energy sector, the problem statement, the main research objectives, the research questions, the scope of the study, and finally the structure of this work.

1.2 Background

In the recent years, there has been produced a good amount of research on energy production, energy consumption, renewable energy, and the implementation of sustainable scenarios. Energy has also become one of the most important priorities for the economy of any nation. Additionally, the forecasting energy usage trends is crucial to help decision makers draw informed conclusions about the energy condition, the energy sector development planning and the long-term strategy for the production and consumption of energy (Ghalehkhondabi et al., 2016).

The energy sector is considered one vital sector in any economy. In Palestine, a country whose economy and energy resources are still dependent on an occupation power, it is especially important to develop and efficiently use its energy resources. To do so it is important to conduct studies on the current conditions and the venues for developing this sector.

The new global trend is to find alternative sources of energy away from fossil fuels; World countries are developing renewable resources and sustainable solutions. Giving energy sector and renewable energy resources special attention and thinking strategically about this sector can help nations avoid potential energy crises that will likely deter the progress in their economies.

Nowadays, there are many economic and environmental challenges that affect energy globally and make the energy sector an issue of focus in almost every country. Such challenges include global warming, climate change, acid rain, the ozone layer erosion and the depletion of natural resources, etc. These problems and their consequences are discussed more thoroughly in Chapter Two below.

These problems trigger the search for more reliable alternative resources of energy. Most recent projections name the renewable energy sources among the fastest growing energy sources (Walton & Hendrix; 2012). According to the Energy Information Administration (EIA) international energy outlook in 2011, the renewable energy share was about 9.9 percent of the total consumption in 2005 but it is expected to rise up to

15 percent by 2035. These figures illustrate the growth rate in recent years and have attracted the attention of investors, researchers and economists in this increasingly competitive world (Walton & Hendrix; 2012).

Accordingly, it is evident that nations will have to respond to the increasing energy challenges by developing a clear vision, long term strategy, policy and responsive management systems to encourage all stakeholders to invest in developing new sources of energy. This can only happen through proper levels of cooperation and coordination among all stakeholders.

1.3 Problem Statement

The energy sector in Palestine faces many challenges. One of these challenges has to do with Israeli policies that control the supply of electricity to Palestine; the Israeli restrictive measures make this sector inefficient, costly, and fully dependent on the Israeli side. In addition to this political dilemma, there are four main problems which make research on energy production and consumption in Palestine both significant and timely. These are:

- The widespread misunderstanding and lack of awareness among people and investors alike as to the benefits and potentials of renewable energy in Palestine.
- The absence of any Strategic Management Role, to strategic planning or guidelines for energy usage in Palestine.

- The frequent power shortage problem trigger the need to search for solutions.

- Climate change strongly affects the size and geographical distribution of the technical potential energy sources, especially the renewable sources. Although it is widely acknowledged that the energy sources impacted and are impacted by the climate conditions, the precise nature and magnitude of these impacts are yet to be determined. Accordingly it is important to consider the role that renewable sources can play in reducing the effects of climate change; one way to do this is by increasing the share of renewable sources in the energy mix and by upgrading state policies to improve the energy systems (IPCC, 2017).

1.4 Research Objectives

The main objectives of this research are:

1. Assessing the Palestinian energy sector.

2. Identifying the factors which significantly affect energy consumption in the country.

3. Predicting future trends of demand and assessing planning requirements and the needed investment.

4. Proposing scenarios for sustainable solutions in the future and developing an appropriate strategic business model.

1.5 Research Questions

This study aims to shed the light on the current situation of the energy sector in the Palestine. This can be achieved by answering the following questions:

Q1: What are the energy types used in Palestine, and how are they divided among consumers?

Q2: What are the factors that affect energy consumption in Palestine?

Q3: How will the trend for energy consumption look like in the next 15 years?

Q4: How can the energy sector be improved in order to reduce losses and use energy more efficiently?

1.6 Scope of the Study

The thesis concentrates mainly on assessing and understanding the energy sector if different types of renewable energy technologies are utilized, in order to find appropriate and sustainable solutions in the sector.

The timeframe used to study the energy consumption and to build the forecasting model was from 2007 to 2015.

The scope of the study is the Palestinian economy. However, most of the analysis was done for the West Bank because it of mobility constraints on the Gaza strip. Therefore it was a real challenge for the researcher to collect data on energy consumption there. Finally, the energy consumption forecasting has been done on a macroeconomic level for the Palestinian Territories.

1.7 Thesis Structure

This study consists of six chapters. Chapter one is an introductory chapter that gives general overview about the energy sector in Palestine, states the problem of the study, names the research objectives, asks the research questions, and identifies the scope of the study. Chapter Two covers some of the literature about the energy sector, the renewable energy and summarizes the relevant issues that are connected to energy consumption.

Chapter Three describes the tools that are used in data collection, the methodology and the software used in analyzing the gathered data.

Chapter Four consists of findings from analyzing energy sector and used energy types for every sector. It also analyzes the factors which influence the energy usage in Palestine and explains the impact on the economic growth. Chapter Five is set for projecting and assessing potential future scenarios for enhancing the energy sector; presents and analyzes the current situation using the PENRA strategic Plan. The chapter also presents Renewable Energy Projects feasibility studies, and also suggests a solution for enhancing electricity companies' work and the problem of losses. Finally, chapter Six presents the conclusions, and recommendations of the research. Moreover, the areas for future studies are proposed to build on what has been achieved in this work.

Chapter Two

Literature Review

Chapter Two
Literature Review

2.1 Chapter Overview

This chapter presents a review of the literature about energy types, energy industry and the factors that influence the demand on energy in any country. In addition, it focuses on different energy management principles that have been established in the literature as important principles for developing this critical sector.

Moreover, it presents new concepts related to energy production that have added recently, such as sustainability and energy consumption forecasting models as a planning tool used for improving the energy sector. Finally, a brief description of the current energy situation in Palestine.

2.2 Definition of the Energy Industry

The Global Industry Classification Standard (GICS) defines the Energy Sector as "a sector that consists of companies specialized in exploring, producing, refining, marketing, storing and transporting of oil, gas, coal, and fuels, in addition to companies that offer equipment and services of oil, gas, coal, and fuels."

Although energy industry is difficult to define, it is plainly evident that the energy industry is not exclusively defined in relation oil and natural gas production only.

Tulsa's Energy Industry (2012) defined the energy sector by dividing it into two main groups. There is first the direct energy production group, which includes oil and gas exploration, extraction and support; and there is also the electric power generation, which deals mainly with support industries. These industries are the upstream, midstream and downstream supplements to direct energy production performing main activities such as manufacturing, transportation, distribution, retail/wholesale fuels, and construction.

2.2.1 Renewable & Non-Renewable Energy Sources

This section on conventional and non-conventional energy types introduces new energy trends around the world, the concept of sustainability, energy resources management, economic and non-economic drivers of energy supply, and an analysis of energy industry in Palestine.

It is obvious that the trends of energy production and consumption around world are changing rapidly. In addition, the global demand on energy is increasing dramatically; therefore, there is a need to use renewable types of energy to meet such unprecedented increases (WEC, 2013).

Demirel (2012) classified the main energy types into primary and secondary ones. Primary energy is the one that is extracted directly from the environment. He divided primary energy into three main categories. There is firstly the non-renewable energy which includes coal, crude oil, natural gas and nuclear fuel. Then there is the renewable energy which consists of hydropower, biomass, solar energy, wind, geothermal, and ocean energy. Finally comes waste.

The secondary energy is one that is transformed from the primary one; it comes in many forms like electricity, heat, or fuel, which can then be utilized in various applications as useful energy. Figure (2.1) presents a summary of the energy types.

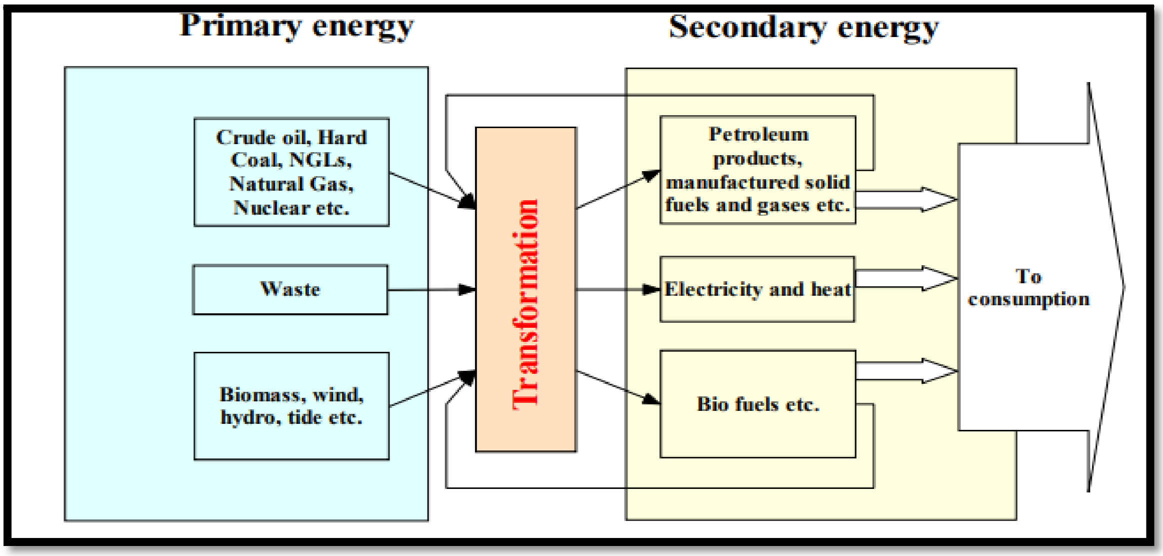

Figure (2.1): Primary and secondary energy types; Øvergaard S. (2008)

It is apparent from the literature on supply and demand trends that fossil fuels will decrease. As a result, the prices of conventional energy will increase and the demand on renewable energy supplies especially from biomass, solar and wind sources will increase.

The flow of energy is considered an important tool for economic planners. In 2010, the U.S. was considered the second consumer of energy in the world next to China (Barr, 2011). Figure (2.2) shows energy flow from supply to demand side in the US. The various categories in this figure are often taken as the basic energy users in any country.

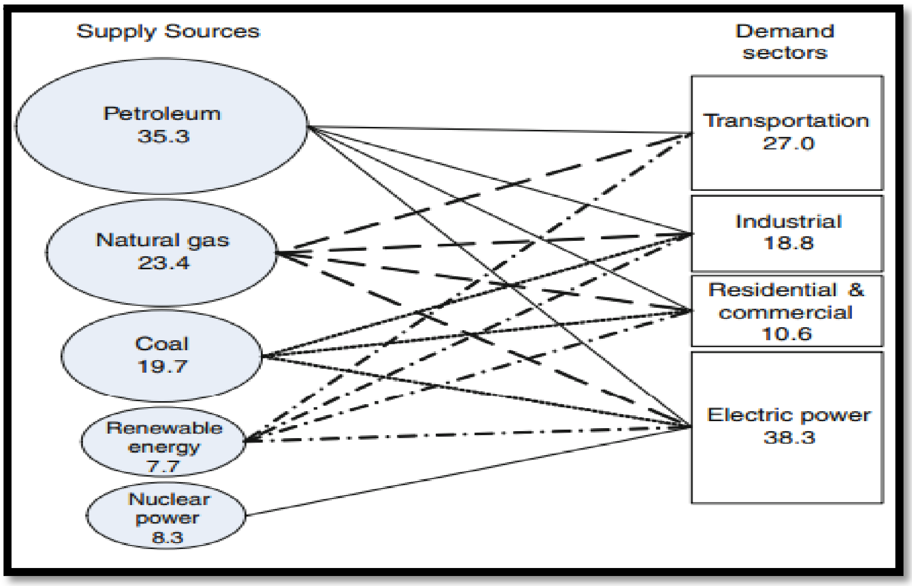

Figure (2.2): The primary energy flow in the US (Energy Information Administration; 2009).

The World Energy Committee (WEC), 2013, is recognized worldwide as the premier source of information on global energy resources. According to WEC report, the conventional energy resources are summarized as:

1- Coal

Since coal is a widespread fossil fuel, it is a critical contributor to providing energy in many countries. The report showed that the share of coal in global power generation was more than 40%; however, it is expected to significantly decline during the coming years.

Coal is considered an important source for producing energy due to its availability to a wide extent, reliability, and the relatively low production cost. Coal resources exist in many developing countries where it is used mainly for electricity supply.

Energy Information Administration (EIA) summarized the main environmental problems for using coal to produce energy. Several emissions come from burning coal, e.g. Sulfur dioxide SO_2, Nitrogen Oxides NO_x, Mercury and heavy materials, particulates, and fly ash. All these materials have harmful effects on the health humans, plants, animals, and the quality of the air.

Keating, 2001, stated that a ‘Clean coal’ is a myth. All stages in coal industry from mining to combustion to waste disposal are harmful processes and negatively affect human health and the environment. So increased reliance on coal will always cause increased release of toxic chemicals into the environment.

It is important to mention that Israel like many other energy-consuming countries has put a multi-layer energy policy, which includes encouraging local production. Coal is the main source of energy in Israel; it provides about one-third of the country's energy consumption, and is used almost exclusively in electric-power generation. All coal supplies are imported from foreign countries, e.g. South Africa, Colombia, Australia, Indonesia, Poland, China among others (Bahgat, 2014).

2- Oil

Oil is one type of non-renewable source that is mainly used in transportation, power generation, and the petrochemical sector. In the near future, oil will become at the top of the energy ladder; it has become a global sector and a source of good income for many multinational companies from around the world.

3- Natural Gas

Natural Gas is another source of traditional energy sources that plays a significant role in the world energy economy. Natural gas is the cleanest of all fossil fuel sources in addition to its abundance and flexibility. It is used in most power generation plants such as Combined Cycle Gas Turbine (CCGT). The world searches for more secure and sustainable providers of energy through focusing on new non-renewable resources of energy such as shale gas.

4- Nuclear Energy

This type of energy has a short history as the first nuclear reactor was constructed in 1954. Since the main source of this type of energy is uranium, the production of uranium around the world has been recently rising after a long period of decline (WEC, 2013).

Various surveys showed that the total uranium resources have grown by 12.5% since 2008 and that they will be sufficient for the next 100 years.

Concerning the renewable sources of energy, Pulchowk (2009) summarized them as follows:

1- Water Power

This is a type of energy which is extracted from water and is used in different forms, e.g. hydroelectric energy, tidal power, and wave power.

This type of energy can yield a great amount of energy; a relatively small flow of water can produce power.

2- Wind Power

The main source of this energy type is wind and the amount of power for this type of energy depends on wind speed. Wind energy is transformed into kinetic energy that can be used to run turbines. Although wind energy is considered as the most expensive type of energy, it is believed that the potential of the wind energy on the long-term can be 5 times of the current global energy consumption or 40 times of the current electricity demand.

3- Solar Power

The major portion of the renewable energy mix is "Solar Energy" which is extracted directly from solar radiation. Solar power is extracted by using photovoltaic solar cells. It consists of 46% of visible light, 46% of infrared radiations and 8% of Ultraviolet radiations.

The main two usages of solar energy are solar heating and solar electricity. The main disadvantage of solar energy is that its uses are limited. Subsequently, the solar cells are used for many applications such as night lightening or water pumping, etc.

4- Biomass Power

Bioenergy is a kind of energy fuels which is produced from different biological sources, such as Solid Biomass, Bio-fuel, and Biogas.

- Solid biomass

The direct way of producing this type of energy is through burning dried up plants, which are then used to heat water or to drive turbines. Currently, biomass contributes 15% of the total energy supply worldwide. The main disadvantage is that it is produced through steps that require many resources and well-designed infrastructure.

- Bio-fuel

This type of fuel is derived from living organisms such as the manure of cows. It is transformed into a type of energy to be used as biodiesel, ethanol, and biogas which are ultimately used for internal combustion and boilers.

- Biogas

This type of bioenergy is produced from waste such as paper production, sugarcane production, sewage, animal waste, and the like. Biogas has a global potential since about half of the world energy needs to be utilized for electrical productions. Additionally, the economic value is worthwhile since the payback period for a well-designed biogas production plant is around 2-3 years.

5- Geothermal Energy

This is a very clean source of power. It is produced from radiation in the earth core from which power can be generated. This type can be used in geothermal heating and geothermal electricity, directly to heat and cool things or indirectly to generate electricity by running steam turbines.

As there are many types of renewable energy, there are different types of Renewable Energy Technologies (RET) which can be used to put it into use.

2.2.2 The Advantages and Disadvantages of Renewable Energy

Renewable sources have many advantages. They are non-depleting and environmentally friendly sources of power. They were traditionally used for propelling ships, driving windmills, grinding corn, pumping water, etc. The major disadvantages for renewable sources are related to the cost of utilizing energy from its main source which is often quite high; utilizing these sources often use poor technologies; they are depletable and therefore their availability for lengthy periods is quite uncertain. Finally, The transport of these types is hard and quite costly (Bozkurt, 2010). In contrast, the non-renewable energy sources such as fossil fuel and nuclear energy types are not difficult to transport and can be made available for long periods of time; nevertheless, these types cause pollution. Actually, nuclear energy may be seriously hazardous when it is not properly controlled (Wadhwa; 1989, 1993).

Bozkurt (2010) claimed that using the free energy resource can come at no to low environmental risk; for this reason, striking a good balance between the cost factors and environmental impacts must be considered while choosing between the energy resources.

Table (2.1) shows the comparison between non-renewable and renewable energy resources (Twidell & Weir, 2006).

Table (2.1): Comparison of renewable and conventional energy systems

	Renewable energy supplies (green)	*Conventional energy supplies (brown)*
Examples	Wind, solar, biomass, tidal	Coal, oil, gas, radioactive ore
Source	Natural local environment	Concentrated stock
Normal state	A current or flow of energy. An income	Static store of energy. Capital
Initial average intensity	Low intensity, dispersed: $\leq 300\,W\,m^{-2}$	Released at $\geq 100\,kW\,m^{-2}$
Lifetime of supply	Infinite	Finite
Cost at source	Free	Increasingly expensive
Equipment capital cost per kW capacity	Expensive, commonly $\approx$US\$1000 kW^{-1}	Moderate, perhaps \$500 kW^{-1} without emissions control; yet expensive >US\$1000 kW^{-1} with emissions reduction
Variation and control	Fluctuating; best controlled by change of load using positive feedforward control	Steady, best controlled by adjusting source with negative feedback control
Location for use	Site- and society-specific	General and invariant use
Scale	Small and moderate scale often economic, large scale may present difficulties	Increased scale often improves supply costs, large scale frequently favoured
Skills	Interdisciplinary and varied. Wide range of skills. Importance of bioscience and agriculture	Strong links with electrical and mechanical engineering. Narrow range of personal skills
Context	Bias to rural, decentralised industry	Bias to urban, centralised industry
Dependence	Self-sufficient and 'islanded' systems supported	Systems dependent on outside inputs
Safety	Local hazards possible in operation: usually safe when out of action	May be shielded and enclosed to lessen great potential dangers; most dangerous when faulty
Pollution and environmental damage	Usually little environmental harm, especially at moderate scale Hazards from excess biomass burning Soil erosion from excessive biofuel use Large hydro reservoirs disruptive Compatible with natural ecology	Environmental pollution intrinsic and common, especially of air and water Permanent damage common from mining and radioactive elements entering water table. Deforestation and ecological sterilisation from excessive air pollution Climate change emissions
Aesthetics, visual impact	Local perturbations may be unpopular, but usually acceptable if local need perceived	Usually utilitarian, with centralisation and economy of large scale

The previous table illustrates the comparison between the various types of energy types; the columns give the main types of energy while the rows show the differences between them. The main differences are related to the main sources for each type, the lifetime of supply, the cost of extraction for each type, etc. It is necessary to point out the most important differences such as the context of use for each type. Normally, the renewable energy can be used to serve the rural areas and decentralized industries, while non-renewable energy is better for urban areas and centralized industries. Another important difference between the two has to do with the expected environmental effects; the renewables have a little margin for environmental harm while the non-renewable sources are considered as source of pollution for air, soil and water. Also, the air pollution produced by non-renewable sources could likely cause deforestation and climate change, while, the renewable sources are quite compatible with the natural environment.

2.3 Energy Problems and Consequences

Currently, there are many economic and environmental problems that affect energy globally. The main purpose for finding power generating sources should be to mitigate these effects through finding solutions to conserve energy for the future; among these problems are:

1- Global Warming and Climate Change

The Environmental Protection Agency (EPA) considered climate change and global warming as direct consequences for the greenhouse gas emissions, which come from burning fossil fuels. “Climate change” was defined as change in earth’s climate such as changes in weather patterns, oceans, snow and the ecosystem in the globe. The term “global warming" is commonly used to refer to the earth temperature (US EPA, 2017).

Denchak (2016) listed the main consequences of global warming and climate change as the more frequent and severe weather; higher temperatures leading to disasters such as storms, heat waves, floods, and droughts. Scientists connect higher death rates to global warming; in fact they considered global warming as the biggest global health threat in the 21st century. Indeed, extreme heat kills more Americans each year, on average, than hurricanes, tornadoes, floods, and lightning combined. Also, it has been confirmed that dirtier air can cause rising temperatures and worsen air pollution by increasing ground-level ozone which is created when pollution from cars, factories, and other sources react to sunlight and heat. Lastly, it has been proven that the oceans are becoming more acidic due, in large part, to their absorption of some of our excess emissions.

2- Ozone Layer Depletion

The ozone layer is an atmospheric layer that protects the earth from the harmful rays that come from the sun. Toxic gases which come from industries such as Chloro-fluoro carbons (CFC's) are responsible causing a hole in the ozone layer which is one of the most important current environmental concerns (Rinkesh, 2017).

Ozone depletion means less protection from the sun rays. Such depletions could bring harm to human health; cause non-melanoma skin cancer; negatively affect the developmental process of plants; badly affect the marine ecosystems by causing serious damage to the early developmental stages of fish, shrimp, crab, amphibians, and other marine animals; affect biopolymers through accelerating their breakdown.

3- Acid Rain

Acid rain is considered as one of the major problems that are triggered by fossil fuels consumption. It is considered as one source of atmosphere pollution (Rinkesh; 2017).

The US Environmental Protection Agency (EPA) reports that acid rain has damaging effects on flora, lakes, fish, and other creatures. It can also cause respiratory diseases to humans. When lakes and other forms of water become too acidic, i.e. it has a pH of 6 or less, plants and aquatic life begin to suffer abnormalities or even fatalities (US EPA, 2017).

4- Natural Resource Depletion

One of the critical environmental problems is that resources may diminished, as human use it faster than it can replenish itself. The increasing demands on fossil fuels cannot be matched without consuming more and more of these fuels. Therefore, the shift towards renewable energy sources can be the best solution (Rinkesh; 2017).

As Steer (2013) remarks, “The current patterns of energy and natural resource use, agricultural practices, and urbanization appear to be largely unsustainable and require urgent remediation”. If these patterns were left without any interventions, they will lead to dangerous climate change and reduced economic growth as a result of the increasing economic, social, and environmental costs and the decreasing productivity.

There are also many economic effects as a result of current the natural resource depletion. It will impact the agricultural output by those who are reliant on healthy soil for their income and economic livelihood. When the soil is depleted, and the proper conditions no longer exist for efficient growth, this will then lead to lower levels of output; in other words, this condition negatively impact the income of individuals, societies, and nations.

2.4 Energy Trends around the World

The World Energy Council (WEC) 2013 defined the key indicator for the world as shown in Table (2.2). It considered population growth as the main driver of energy demand and economic and social development.

Table (2.2): Energy Key Indicator for 1993, 2011 and 2020 (WEC, 1995; WEC, 2013)

	1993	2011	2020	% Growth 1993–2011
Population, billion	5.5	7	8.1	27%
GDP				
Trillion USD	25	70	65	180%
TPES Mtoe	9 532	14 092	17 208	48%
Coal Mt	4 474	7 520	10 108	68%
Oil Mt	3 179	3 973	4 594	25%
Natural Gas bcm	2 176	3 518	4 049	62%
Nuclear TWh	2 106	2 386	3 761	13%
Hydro Power TWh	2 286	2 767	3 826	21%
Biomass Mtoe	1 036	1 277	1 323	23%
Other renewables* TWh	44	515	1 999	n/a
Electricity Production/year				
Total TWh	12 607	22 202	23 000	76%
Per capita MWh	2	3	3	52%
CO_2 emissions/year				
Total CO_2 Gt	21	30	42	44%
Per capita tonne CO_2	4	4	n/a	11%
Energy intensity koe, 2005 USD	0.24	0.19	n/a	-21%

* Includes figures for all renewables, except Hydro

Over the last few decades, the global population has increased by more than 1.5 billion. However, the overall rate of population growth has decreased, so that the number of people with no access to energy resources has also decreased. As shown in Table (2.2), the contribution of renewable resources remains low.

The Key World Energy STATISTICS released in 2013 clearly indicate that electricity consumption is greater than the Total Primary Energy Supply (TPES) in all countries around the world. Coal TPS has increased by 68% for the years (1993-2011) from 4474 to 10108 Mt (Million tons). The renewable resources have shown a significant increase from 1993 by 44 TWh to 1999 TWh (terawatt-hour) in 2011. The CO_2 emissions all over the world have increased by 44% from years (1993-2011). These figures should inspire countries to search for more reliable energy sources to meet the high demand for energy.

According to the World Energy Council (2013), there are many principle drivers of energy supply and uses around the world. The first driver is the sharp increase in oil prices since 2001. The Second driver is the instable political situation in the main energy supplying countries since "the Arab Spring" in the Middle East and North Africa. The third driver is the lack of global agreements on climate change mitigation. The fourth driver is the growth in renewables especially in Europe due to greater support given to producers. The fifth driver is the deployment and utilization of smart technologies. The sixth driver is the energy efficiency potential which is still unexploited. The final driver is the public concerns about energy projects, their new infrastructure, and their impact on the decision-making process.

The most important concern while trying to deal with these drivers of the energy sector in the world is to properly define the risks and opportunities, and to try and make the energy systems more secure and sustainable. The WEO (2015) has conducted scenario analysis for energy use up to the year 2040. Energy use is expected to grow by one-third, especially in India, China, Africa, the Middle East and Southeast Asia (World Energy Outlook, 2015).

To support the conclusions from the previous literature, it might be worthwhile to take a look at the aspirations of a few major countries. In the next section, the researcher will use Jordan as examples for benchmarking reasons.

2.4.1 The Energy Situation in Jordan

Jordan is a country with big similarities to Palestine in (topography, way of living and etc.). For so it is necessary to imitate their experience toward improving energy sector.

Jordan's future energy landscape is slowly taking form. Despite a population of less than seven million and almost no conventional hydrocarbon resources, Jordan has emerged as a relatively stable market for energy investment as the small nation attempts to diversify its energy mix, increase energy independence, and meet growing demand. Investment in Jordan's energy sector, in contrast to energy sector growth in Egypt, Israel, and other regional powers, is largely fueled by the country's lack of conventional energy sources. This has propelled the nation to secure hydrocarbon imports and increase alternative energy production to protect itself from the external supply shocks it has endured in recent years (Hochberg, 2015).

Figure (2.3) shows the previous and projected domestic and imported energy in Jordan.

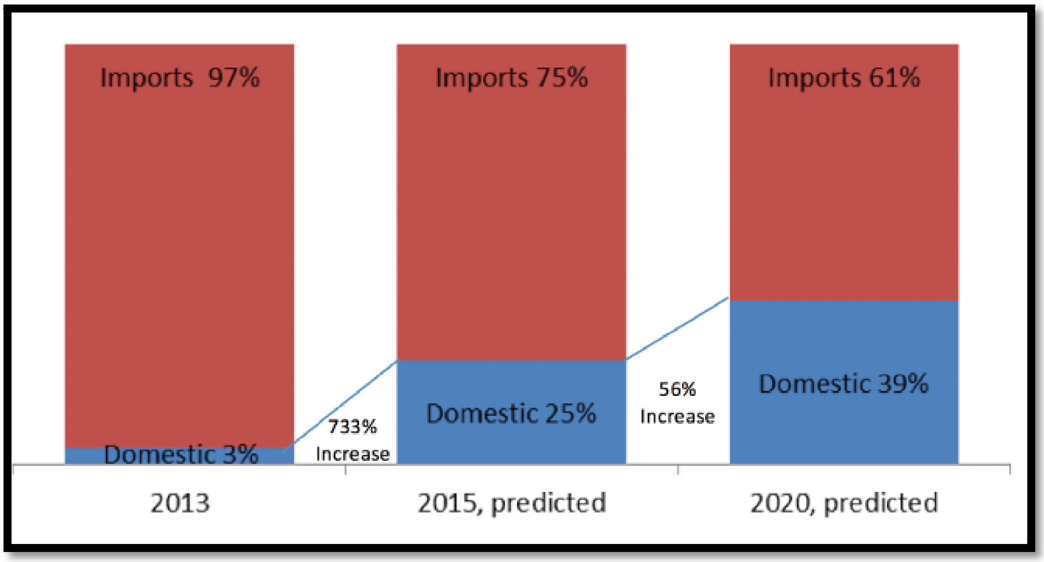

Figure (2.3): Domestic vs. Imported Energy in Jordan (Jordanian Ministry of Energy and Mineral Resources, Renewable Energy in Jordan, data adaptation.)

Jordan's target to cover 10 percent of energy demand with renewable generation by 2020. Jordan's ambitious energy diversification strategy has attracted tens of billions of dollars in investments, which will increase energy security and support economic development. In a country where energy imports have represented 16-19 percent of GDP in recent years, the government's aggressive energy scheme is welcome. Jordan will still face many challenges. New and complex fiscal and regulatory regimes require experienced technocrats for successful administration, and in an increasingly unstable region, safeguarding critical energy assets and security in general will be significant tasks. Yet if the beginning is more than half of the whole, the initial investor reaction to Jordan’s new policies and energy targets will translate into a brighter future for the nation (Hochberg, 2015).

2.5 Renewable Energy and Climate Change

Recently, the term “climate change” and mitigation reduction of climate has a subject of interest globally. The climate has been changing since the beginning of creation, but why has it gained more attention in the past few decades?

Owusu and Asumadu-Sarkodie (2016) stated that the growth rate of carbon dioxide has increased over the past 36 years; while the earth system research laboratory (2015) detected around 1.4 ppm increase per year before 1995 and 2.0 ppm per year thereafter.

The United Nations Framework Convention on Climate Change (UNFCCC) stated that climate change is either directly or indirectly related to human activities which change the atmospheric composition and cause variability in the natural climate observed over comparable similar time periods (Fräss-Ehrfeld, 2009).

Since the 1950’s, the global use of fossil fuels has increased so dramatically and dominated the energy supply, leading to a rapid growth in carbon dioxide emissions. In 2010, the data that was gathered by IPCC showed that fossil fuels consumption was responsible for the majority of global anthropogenic greenhouse gas (GHG) emissions, where concentrations had increased to over 390 ppm (39%) above preindustrial levels (IPCC, 2011).

On the other hand, Panwar et al. (2011) considered renewable energy technologies as a clean, optimal and sustainable alternative because they reduce environmental impacts and power production waste. Therefore the substitution of conventional types of energy with renewables has been endorsed as an essential step to alleviate effects of greenhouse gas emission and global warming.

Owusu and Asumadu-Sarkodie (2016) put together a package of policy recommendations to mitigate climate change effects; their recommendations include:

- Applying renewable technologies and policies in all regions and sectors to reduce climate change effects.

- Changes in lifestyles and behavior patterns will reduce carbon emission and therefore they will play an essential role in mitigating the effects of climate change.

- Using innovative technologies will reduce accidents and risks from renewable sources.

- Supporting developing countries in expanding their infrastructure and upgrading technologies for sustainable energy services.

With climate change in view, it has clearly become essential to seek new ways to monitor the future of solar radiation and to predict the conditions of solar and wind energy around the world; the researcher will present the "Solar Wind Map" as a worldwide database used for purposes of future predictions.

2.5.1 Solar–Wind Maps for Palestine

IRENA`s Global Atlas produces and circulates maps of the solar radiation and wind speeds around the world. This is considered a necessary step if renewable energy resources are to be utilized to reduce greenhouse effects. It is extremely essential to map out solar radiation and forecast wind maps for better management of renewable technologies. Figure (2.4) shows the solar irradiation in Palestine from 1995-2015. These solar maps provide the largest collection of solar resource maps for Palestine that is intended to help the solar industry with the development of their projects (IRENA.org, 2016).

Solar radiation and other parameters are provided as gridded data. These data pieces can be used for visualization, further processing, and geo-analysis in all mainstream GIS software with faster data processing capabilities.

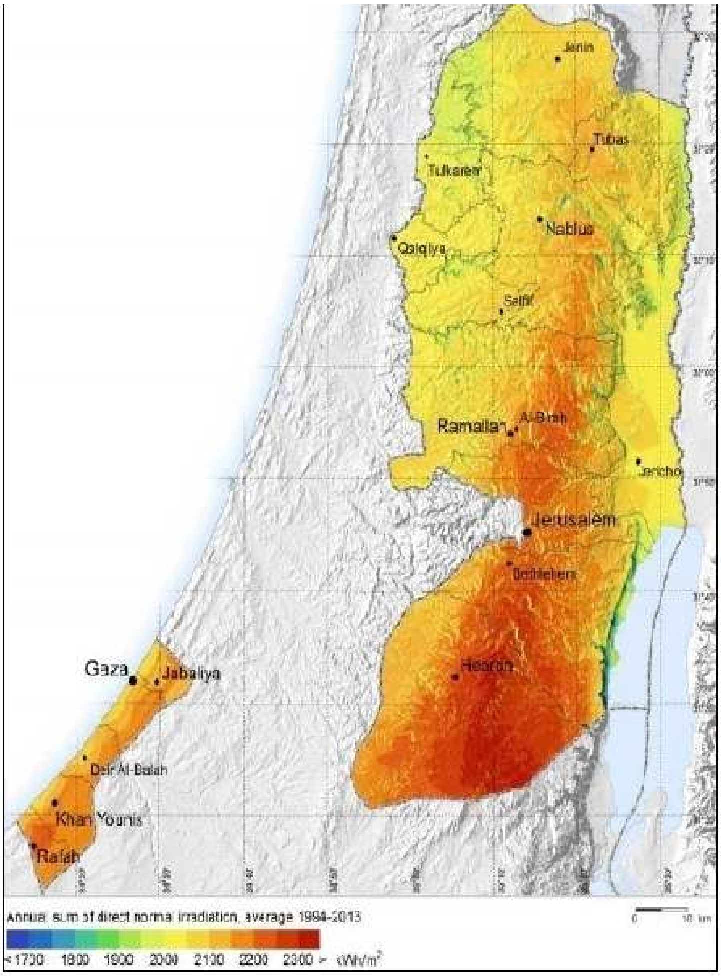

Figure (2.4): Average Solar Irradiation in Palestine (1994-2013) (Source; the World Bank, SOLARGIS)

2.6 Renewable Energy and Sustainability

One other main concern to keep in mind as we talk about energy demand is the increase in world populations which obviously has led to a proportionate increase in energy consumption. This rapid growth of the world population will bring with it many energy related challenges such as depletion of fossil fuel reserves, greenhouse gas emissions, environmental issues, and the continual fuel price fluctuations (UNFCC; 2015).

As a result of this increase, finding sustainable resources to satisfy social and economic development needs has become an urgent necessity.

When considering the potential of renewable resources, the first thing that comes to mind is the issue of "sustainability". Tester (2012) defines sustainable energy as a dynamic harmony between the equitable availability of energy-intensive goods and services to all people and the preservation of the earth for future generations. The renewable energy sources are the most prominent alternative and the only solution to the growing challenges in energy supplies (Tiwari & Mishra, 2012). They replenish themselves naturally and are sustained forever. Sustainability has been shaped by the three-pillar model which highlights three interrelated constituents- economy, ecology, and society (Ayres and Ayres, 2002).

2.7 Energy Management Principles

Few professionals consider it wise to continue to deal with energy the same way they did in the 1970s. The challenges nowadays are high stake; they include the growing population, the global warming, resources misallocation, and air pollution, among others.

Vesma (2009) defined energy management in relation to cost reduction and the reduction in carbon emissions. Rouhani & Beheshtian (2015) relate energy management is the active, organized and systematic coordination of procurement, conversion, distribution, and use of energy to achieve the stated objectives, taking into account environmental and economic considerations. Therefore, it is a common wisdom that in order to manage energy, energy consumption should be measured.

The main principles for achieving successful energy management are:

1. Identifying and tracking energy use patterns is the first step in any energy program.
2. Installing more efficient components in the system in order to obtain more energy saving.
3. Establishing and managing facilities instead of having a large number of technological equipment.
4. Improving performance through working in a parallel on improving the maintenance practices which include applying corrective and preventive maintenance for the systems.

2.8 Energy and Economic Development

As energy is needed in almost all human activity, the energy consumption patterns will have a large impact on economic development.

WEA (2000) mentioned that the demand for energy in industrialized countries is expected to grow. However, the increase of the conversion efficiency of energy services and its end use will likely lead to a reduction in the demand for primary energy. On the other hand, in developing countries, the primary energy demand is predicted to grow at 2.5% annually if compared to the developed countries. The main reason for this is the rise in the living standards. In order to meet this expected demand, developing countries should make considerable investments in the energy sector over the coming 20 years. They will also need to improve the financial and economic policies in the energy sector. The main aspects to be considered in investments are:

- Government subsidies, policies and legislation.
- Private and capital investments.
- Considering energy pricing in relation to energy projects' feasibility.
- Development of economic, technological, and environmental regulation which would help raise revenues to cover operating costs and generate returns on investment sufficient to attract large-scale private finance and investment.

The energy policy and planning will seek to: a) improve energy self-sufficiency which can result in the creation of businesses that are unlikely to relocate outside a given region; b) increase energy diversification which can result in the creation of new technologies, businesses, and jobs. On the other hand, the economic development initiatives may seek to catalyze growth through innovation, which can result in increases in energy efficiency or the creation of new technologies that will help diversify a given region's sources of direct or secondary energy (Carley et al., 2011).

2.9 Analysis of the Energy Sector in Palestine

The energy sector has a significant impact on the Palestinian economy; with the restrictions on energy supplies, it has become one of the key economic sectors that affect the Palestinian national economy. It plays a crucial role in expanding the job opportunities for the Palestinian labor force. PENRA (2014) classified Palestine climate as a Mediterranean one with long and dry summers, cool, short, and rainy winters. According to the Solar Atlas of Palestine, the temperatures over the year range between 35°C in the summer to 0°C in the winter.

The sunlight is available for more than 315 days a year in Palestine; wind speed is estimated at (6-7) m/s in the cities of Tubas, Nablus, Ramallah, Jerusalem, Bethlehem, and Hebron in the West Bank (Abu libdeh; 2014).

The Palestinian Energy Research Center (PERC) (2010) prepared an extensive report on the current energy situation in Palestine. It was noted that the electricity power suffers from huge losses in transit due to the poor infrastructure and theft. Indeed, 15% of the electricity can be saved if it were used efficiently. The Palestinian American Research Center (2014) has prepared a socio-economic analysis study of the renewable energy usage in Palestine. The study concluded that the solar energy is feasible because of the number of sunny days. It was also reported that the competing demand for alternative sources of energy and its need in different industries requires more care in understanding complex issues about energy resources management including the supply, demand, and regulations. (Daoud, 2014).

The electricity power supply in the West Bank depends mainly on Israel, whereas Gaza depends for its supplies on both Israel and Egypt. The following figure (2.5) illustrates the main sources of energy supply in Palestine; it is clear from the graph that Israel's Electricity Company is the main energy provider with 87.7% of the total consumption, 9.07% from Egypt and Jordan (Egypt supplies the Gaza strip and Jordan supplies the West Bank), and 2.6% from the Gaza Power Plant.

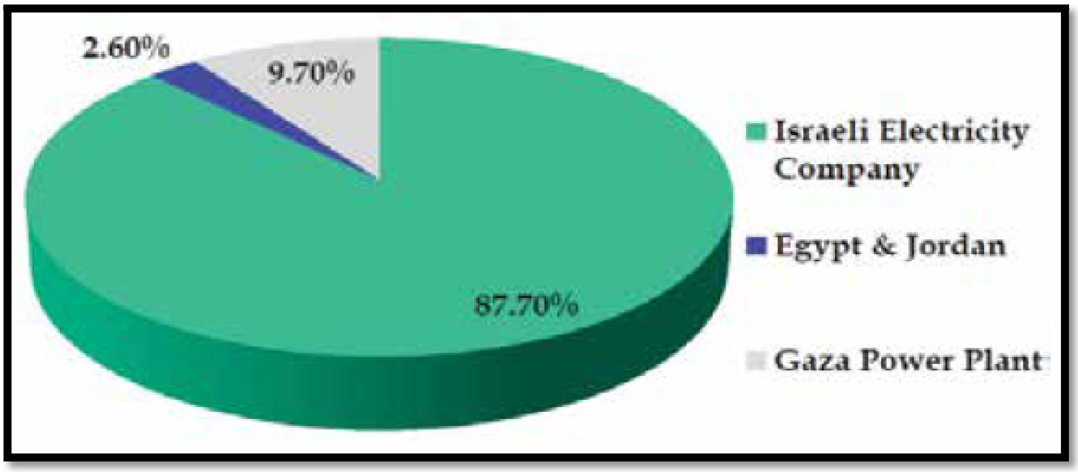

Figure (2.5): Energy dependency in Palestine (source; Abu-Libdeh, 2014)

Accordingly, the solar resources are considered as a good alternative source in the West Bank. PENRA has encouraged investors to build power stations to generate solar energy in Jericho.

Yaseen (2009) gave a brief clarification about the energy resources in Palestine. With regard to primary energy sources, there is an absence of fossil fuel resources; 100% of Petroleum products come from the Israeli market and around 92% of the electrical energy comes from the Israeli Electric Corporation. The local energy resources are limited in uses; they are being used basically for water heating while the power generated from agricultural waste and biomass is used for cooking and heating in rural areas. Regarding the potential of wind energy, it is small and is not being utilized. Biogas is also not being utilized yet; it is estimated to have a potential of 33 million cubic meters, equivalent to 10 M€.

The Total Primary Energy Supply (TPES) for the year 2007 was calculated at 1402 Ktoe (Kiloton of oil equivalent). The local production of renewable energy contributed 19% of TPES; the remaining types of energy (electricity and petroleum) were imported from Israel as shown in Figure (2.6).

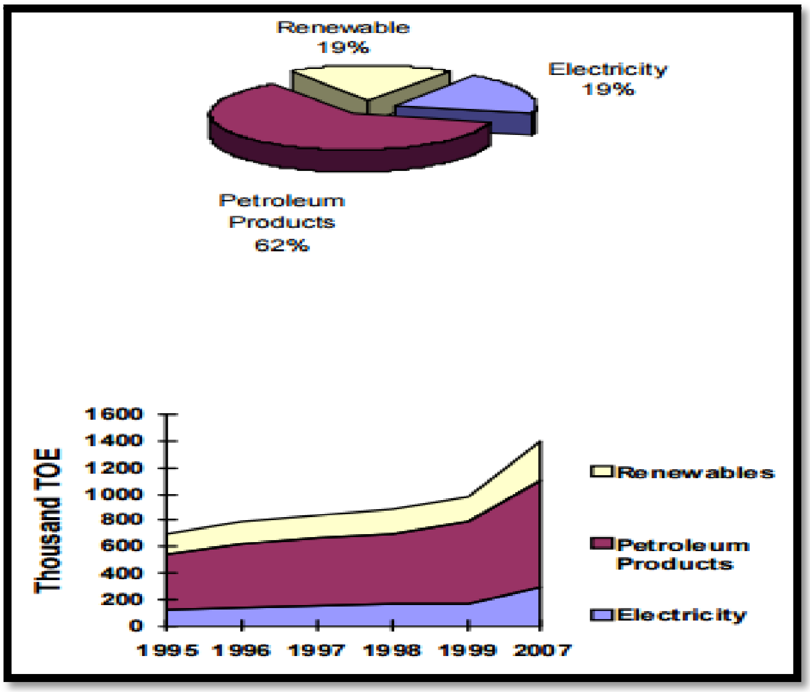

Figure (2.6): Total primary energy supply by fuel and sector, 2007.

Figure (2.6) shows a significant increase in TPES from (1999-2007). Maintaining this increase is an important issue for improving the energy sector in Palestine.

2.9.1 Energy Potential

Renewable energy must be utilized to provide a clean, cheap and sustainable sources of energy in Palestine. PENRA estimated the renewable energy in the energy mix at approximately 1.4%; the target is set to reach 10% by 2020.

Solar Energy has a high potential in Palestine since the average daily solar radiation is 5.4 kWh/m^2. The solar power can be used in many applications, such as cooking, industrial and domestic heating, water pumping, rural electrification, desalination, etc. The PENRA is in the process of drawing plans and geospatial analysis for solar and wind energy potentials in Palestine. With reference to the geothermal energy, the potential has not been measured yet and there are huge efforts invented in making it a field of interest.

Finally, as Palestine is primarily an agricultural society, it has a noticeable amount of solid waste, crop waste, and animal manure. For that reason, the biomass should be utilized for the next generation.

It is important to address the potential and possibility of adopting renewable resources, especially for the sectors with high energy consumption; renewable resources could also prove helpful in providing electricity for the remote communities which are far from the grid. Using renewable energy sources may significantly reduce the energy reliance on imported resources on the long-term and will improve the Palestinian population's access to power which will ultimately contribute to improving the quality of life and enhancing the local economy (Juaidi et al., 2016).

2.10 Forecasting as a Planning and a Strategic Tool

Planning is defined as a set of actions which aim to improve the future potentials. This description indicates that the forecasting for the future is a key element in planning. A forecast is a statement about the future conditions; and therefore is always an anticipation, rather than a statement of fact. The term ‘forecasting' is often used for both quantitative predictions of future developments and for qualitative explorations of possible future actions (Ike & Voogd, 2004).

Forecasting of energy consumption is important in the framing of energy-environment policies and future scenarios. The regression models are well-known tools that are often used to forecast energy requirements. For example, the linear and nonlinear effect of energy consumption on economic growth for Taiwan is examined by Lee and Chang (2007).The growth of electricity consumption and demand has been used as key input makes for proper planning electricity needs in order to avoid situations of electricity outages and shortages and to ensure appropriate operation of the electricity industry infrastructure. Many studies have forecasted the electricity consumption and demand using a variety of techniques (Nourpanahet al., 2012). For instance, the dynamic relationship between electricity consumption, weather, price, and consumer income are examined by Harris & Liu (1993).

The demand side management has changed during the nineties due to many global changes, such as technological advancements, communication breakthroughs, improvements in manufacturing processes resulting in better quality at lower costs. The emphasis of the demand-side management has shifted from residential load management to commercial and industrial demand management. This type of management promotes energy efficiency for sustainable development. Energy demand is found to be closely linked to energy price, GDP, and country population, among other factors. Accordingly, energy demand management should help in achieving self-sufficiency and cost-effectiveness to provide for sustainable economic development (Suganthi and Samuel, 2012).

The multiple linear regression analysis is commonly used to study the relationship between energy consumption, the number of customers, the price of electricity and the number of tourists. For example, a linear regression model was used to predict the electricity consumption for Turkey based on the population and per capita consumption rates. Tunç et al. (2006) used the regression analysis to predict Turkey's electric energy consumption.

2.10.1 Scenario Planning

Planning is about achieving goals to ensure efficient and effective management. Scenario planning is a tool for strategic thinking on long term that is used to improve a business operations (Bradfield et al., 2005). Scenario planning is a method of thinking creatively about future possibilities rather than focusing on specific prediction for a single outcome (Peterson et al., 2003).In order to make resilient policies in the face of uncontrollable and uncertain conditions; scenario planning is considered a proper technique for planning and decision making in such conditions.

Scenarios were initially developed by Herbert Kahn in response to the difficulty of creating accurate forecasts. He produced forecasts based on several constructed scenarios of the future which varied in a few key assumptions (Kahn & Wiener 1967). A scenario describes a possible situation, but the term has been used in a variety of ways. A scenario is defined as a structured account of a possible future condition. It describes futures that could be rather than futures that will be (van der Heijden 1996; Gutman et al. 1998).

In principle, scenarios are alternatives and dynamic stories that capture key ingredients of our uncertainty about the future of a study system. It is constructed to provide insight into drivers of change, reveal the implications of current trajectories, and illuminate options for action. Unlike forecasts, scenarios stress irreducible uncertainties that are not controllable by the people making decisions. Although trends, expert predictions, visions of the future, and models are all parts of scenario-building exercises, they should not be mistaken for scenarios themselves. "Scenarios may cover realistic projections of current trends, qualitative predictions, and quantitative models, but much of their value lies in incorporating both qualitative and quantitative understandings of the system and in stimulating people to evaluate and reassess their beliefs about the system" (Greeuw et al. 2000).

2.10.2 Key Factors Affecting Energy Consumption

This section aims to investigate the related factors that affect energy consumptions. Decision makers often recognize that higher energy efficiency and reduction of energy demand are the target for the next generation in order to reduce CO_2 emissions and mitigate risks of climate change. For that reason, it is essential to understand the factors that affect energy consumption.

(Jones et al., 2015) mentioned that there are about 63 factors that affect energy consumption in a domestic economy. There are many several approaches and tools to investigate the influence of socio-economic factors on electricity consumption. The researchers stated that statistical – regression- and econometric approach are the most common ones used in this domain.

2.10.2.1 Economic and Non-Economic Factors

There are many factors that have effect energy consumption in the world. There is a plethora of research studies that discussed the factors that affect energy consumption in the various energy sectors -residential, industrial, commercial, and transport. These studies are summarized below.

- **Capital investment and new construction**

The financial development influences the quality of the environment and the energy consumption. Chang (2015) claimed that there are two views regarding the effect of financial development on energy consumption. The first view argues that the growing efficiency of financial situation can support increased lending to households and firms, thus encouraging consumers to purchase and enlarge the market items. The second view argues that developed financial institutions and capital markets can provide an opportunity to lend capital to the renewable energy sector and provide debt in funding green renewable energy projects.

- **Population and demographics**

The population size is a major factor that determines energy consumption Dong & Tan (2014) note that "higher population density can magnify the production of energy pollution. Mexico City, for example, shows how a crowded metropolitan area, traffic congestion, and a substantial volume of industrial activity lacking effective pollution controls, all combined with weather inversions do pose serious environmental and public health problems." Moreover, as in numerous other developing-country cities, a significant continuation of urban in-migration, coupled with natural population growth, make the search for solutions more challenging. Specifically, with respect to energy use, these qualitative dimensions of rising demand, as much as any demographic pressures on resource availability, will require the prime attention of both researchers and policy-makers in the years ahead (Darmstadter, 2004).

- **Climate Change**

Auffhammer and Mansur (2014) stressed that hotter summers and warmer winters will change energy consumption and production patterns. There are several ways in which climate may affect energy consumption. In the residential, commercial and industrial sectors, one would, in a warmer world, expect higher cooling demand, which would lead to increased electricity consumption. On the other hand, fewer cold winter days would result in decreased heating demand, which would drive down natural gas, oil, and electricity demand.

The climate will affect energy consumption by changing how consumers respond to short-run weather shocks as well as how people will adapt in the long run by changing durable goods. According to Huaisui et al. (2004), the relationship between energy consumption and climate is one that becomes more visible over a considerably long period of time.

- **Energy Prices**

Some of the previous literature has focused directly on the relationship between energy prices and energy consumption, which can reveal a significant relationship between energy prices and its consumption. Many studies support the notion that rising energy prices will lead to reduced energy consumption (Amano 1990; Martinsen et al. 2007; Clements et al., 2018; Fei and Rasiah 2014; Li and Lin 2015).

Cornillie and Fankhauser's findings (2004) found a strong link between energy prices and energy intensity in the transition. Hang &Tu (2007) developed equation of relationship using time series analysis.

The empirical work of Martinez and Ines (2010) has found that energy prices are not a key factor in improving energy intensity; whereas most literature and research generally prove a positive relationship between energy prices and energy efficiency; in addition, various studies stress that efficiency has positive effects on industrial energy savings (Birol and Keppler 2000; Fisher-Vanden and Jefferson 2004; Sue Wing 2008; Apeaning and Thollander 2013).

- **Economic Development (GDP- Standards of Living -GNI)**

Several papers reported that an economic aggregate such as GDP has a significant positive effect on energy consumption.

The relationships of energy consumption to economic development require powerful support from the energy system; it is often the case that energy consumption is closely associated with the economic level (Qian et al., 2004).

At present, there are obvious transitions in the changing relationships of the energy consumption to economy and climate. The economic system has changed from resource-intensive industry to technology-intensive industry. It actually has changed into a technology-intensive one, i.e. economy of low energy consumption, the efficiency of energy consumption becomes GDP higher (Qian et al., 2004). The climatic driving factors of the energy consumption have altered from ones driven by the disasters of drought and flood to driven by temperature.

- **Employment status**

It is well known that economic growth is tied to job creation; so it is only logical that energy consumption would be tied to job growth. This close relationship is disconcerting because if it holds in the future, it suggests that it will be very difficult to reduce energy consumption without a lot of unemployment. It also would seem to suggest that a shortage of energy supplies (as reflected by high prices) can lead to unemployment (Tverberg, 2012).

The approach this study adopts will be Value Creation; analyzing the factors that affect energy consumption in Palestine will help predict the energy demand trends for the next generation. Once this is done, the researcher will build the strategic business model for the energy sector.

2.11 Strategic Business Model Definition

Betz (2002) mentioned that a strategic business model is futuristic business thinking. It summarizes the future policies of the business that will prepare it to perform well in the future.

There are many studies about the business models, but there is no clear definition of what a business model is (Osterwalder et al 2005, Porter 2001, and Shafer et al 2005). Many authors agreed that the business model describes how a business creates value for both management theory and practices (Chesbrough and Rosenbloom 2002; Morris et al. 2005;Wüstenhagen and Boehnke 2008). Business model analysis can help us understand and communicate the key success factors of value creation. Furthermore, it can be used to measure, compare or even change the business logic (Morris et al. 2005; Osterwalder et al. 2005; Shafer et al. 2005).

APEC Energy Working Group (2009) describes the business model as a framework for creating value. This term is used by commercial enterprises to discuss the various aspects of their business, starting with explaining its purpose, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies.

Table (2.3) below provides a summary of the main definitions of Business Modeling as mentioned in the literature.

Table (2.3): Definitions of the Business Model

Author (s) Year	Definition
Timmers (1998)	B.M. is defined as description of several business actors and their roles, benefits for these business actors to find sources of revenues through all architecture of product/services and information flow.
Chesbrough & Rosenbloom (2002)	B.M. is a kind of logic guidance that links technical capabilities with the realization of economic value
Magretta (2002)	Stories that show and explain how an institution works. The good B.M. defines who the customer is and what the customer value is. It is a fundamental tool for managers of how they can make money in this business The basic economic logic provides managers with the tools necessary for providing and presenting the value for the customers at a suitable cost.
Morris et al. (2005)	It is about creating sustainable competitive advantage through interrelated decision variables in the project strategy, architecture and economic value.
Johnson et al. (2008)	B.M. "consists of four related elements that are taken together to generate and provide value" These are customer value proposition, profit formula, key resources, and key processes.
Casadesus-Masanell & Ricart (2010)	B.M. is a firm strategy reflection.

Business model is constructed through dividing the business into nine related building blocks that are also called the business model canvas Osterwalder (2004).

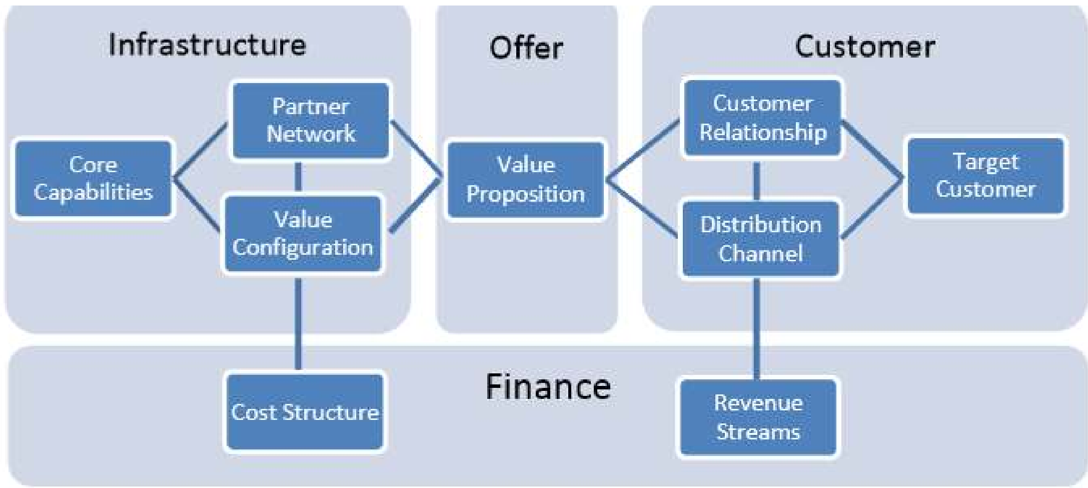

Figure (2.7): Business model chart (Osterwalder, 2004)

Figure (2.7) shows the main building blocks of a business model which are 1- the infrastructure, 2- the offerings, 3- the customers and 4- the finances.

According to Walton and Hendrix (2012), it is important to link business models to the energy sector in order to meet the global energy demand. The development of renewable energy depends mainly on having technology know-how, financing, and infrastructure to guarantee access to the abundant and low cost renewable energy sources.

Chapter Three

Research Methodology

Chapter Three
Research Methodology

3.1 Overview

This chapter deals with the methodology used to conduct this study. It explains the methods and data collection tools used to attain the study objectives; the methodology flowchart of the research is given and the thesis validity and reliability is discussed.

3.2 Research Design

"Research design is a master plan specifying the methods and procedures for collection and analyzing the needed information." William Zikmund

Since the objective of the research is to build a strategic business model for the energy sector in Palestine through studying the factors that affect energy consumption and to assess the energy sector, the Exploratory analytical approach was used to fulfill the requirements of the thesis. The researcher used mixed methods to collect research data; these methods consisted of the previous studies in the field, interviews, focus groups and analysis of official records and annual reports.

3.2.1 Types of the Research

Depending on its purpose, there are four types of research:

- Descriptive Research: it is a type of research that aims to answer sets of questions in order to describe a certain phenomenon (Finger& Dixon, 1989).

- Explanatory Research: this type is mainly used to find relationships between two variables or two phenomena and their effects on one another (MicKinnon, 1988).

- Exploratory Research: this type of research is used when the problem is not observable in order to clarify the problem and make it more comprehensible and to find new insights through assessing the phenomena (Saundraes et al., 2009).

- Analytical Research: this type of research is used when the researcher wants to critical assess existing information, data and facts (Kothari, 2004).

3.2.2 Qualitative, Quantitative Approach and the Mixed Method Research

Grinnell and Unrau (1993) defined the research as a structured investigation made for the purpose of solving problems and building up new applicable knowledge through using scientific methodology.

The qualitative approach is used to find, discover and understand the experiences, perspectives, and concepts related to a particular phenomenon or reality (Hiatt, 1986).Normally, the qualitative approach is used to understand reasons and causes of the problem statement of the study.

Lincoln & Guba (1985), and Harwell, (2011) stated that the quantitative approach is interested in prediction through putting experiences and perception aside in order to present an objective view on the study topic. The main properties of the quantitative approach are using tests and surveys and putting forth statistical hypotheses related to the questions of the research. Therefore, it is often deductive in nature.

The mixed methods research (MMR) deals with collecting and analyzing data from the quantitative and qualitative perspectives in one research or study (Creswell, 2003).

According to Rossman & Wilson (1985), the reasons for using MMR are:

1- The qualitative and quantitative types are used in mixed forms in order to confirm and validate each other.

2- A combination of quantitative and qualitative is used to provide richer data.

3- The combinations are used to give and create new ways of thinking by highlighting the paradoxes in each of the two types of research.

3.3 Data Collection Tools

Pandey & Pandey (2015) explained that the nature and types of the research tools will depend on the complexity and design of the research.

The data collection tools used in this study are:

- Interviews: These are the face-to-face encounters between the researcher and experts in order to collect expert's knowledge on the research situation (Taylor and Bogdan, 1998).

Two types of interviews were used:

a) Semi-structured interviews: Robert Wood Johnson Foundation (RWJF) defined a semi-structured interview as a formal interview during which the researcher uses a list of questions that need to be covered during the interview. The interviewer keeps the door open for collecting additional pieces of information as needed and when s/he finds it suitable. This tool can give reliable, comparable qualitative and quantitative data.

b) Structured interviews: the aim of this data collection tool is to gain quantitative data by asking a standard set of questions (Leedy & Ormrod, 2001).

c) Focus Group: Focus group is defined as a group interview that is used for gathering information about one topic; it has the advantage over an interview in that, during the focus group, all participants can give comments and statements; therefore, more depth is gained by having different perspectives from a number of participants (Tewksbury, 2009).

For the purpose of this study, a focus group was conducted for 90 minutes with ten experts in the energy field from Nablus and Ramallah to discuss and collect information about the current situation for potential improvement in the energy sector.

d) Official Records/ Documents review: This tool refers to statistics that organizations or institutions have. This type includes the existing database, annual reports, and financial records, etc. It is considered as an unbiased and inexpensive way to gather information.

Data and information were collected from authorized personnel inthese institutions:

1. Palestine Energy and Natural Resources Authority (PENRA)
2. General Directorates of Petroleum.
3. General Petroleum Cooperation.
4. Palestinian Electricity Transmission Company Ltd.
5. Palestinian Electricity Regulatory Company.
6. Palestinian Central Bureau of Statistics.

To meet the study objectives and questions, the researcher collected data in three phases. In the first phase, the researcher established links between the literature review and the selected methodology. The second phase used the analytical and Exploratory approach to collect relevant statistics about the factors that affect energy consumption in the Palestinian economy. In the third and final phase, the researcher used forecasting and building scenarios in order to formulate the strategic business model which is the ultimate target for this study.

3.4 The Research Methodology

For achieving the research objectives, the following methodology was adopted:

1- Reviewing the literature related to the local energy consumption sectors and quantities and the international contributions to the energy sector.

2- Tracing energy use in the Palestinian economy, i.e. energy mapping.

3- Studying the factors which affect energy consumption in Palestine using ANOVA to test the hypotheses.

4- Using the multiple linear regression to develop a model for energy consumption prediction.

5- Forecasting and predicting energy consumption trends between the years 2016 to 2030 using the tools developed under (4).

6- Future possible scenarios formulation and analysis as a development tool to enhance the energy sector in Palestine.

3.4.1 Research Flowchart

The schematic stages used to complete the whole thesis came as in Figure (3.1)

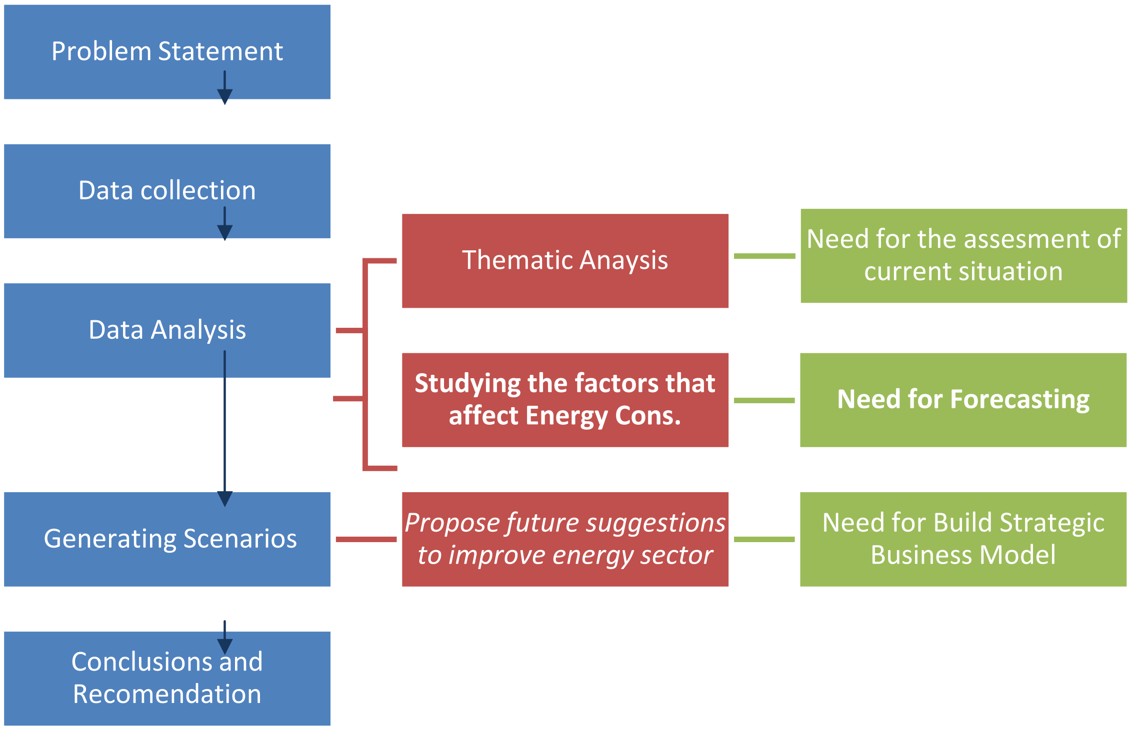

Figure (3.1): Methodology Flowchart of the Research.

3.5 Data Analysis

Several data analysis tools were used for completing the study. The analysis focused on assessing the current situation of the renewable and non-renewable energy sector in the West Bank; the energy flow diagram for all economic sectors was established by taking a macroeconomic view to find ways of improvement and provide input results to the Strategic Business Model (S.B.M).

Moreover, forecasting by using a multiple regression model was done so it can be reflected in the final strategic business model; it was also used to propose future energy scenarios in relation to the renewable energy strategy of 2012 and the Energy Management Strategy.

3.5.1 Thematic Analysis

Thematic analysis is a commonly used tool for analyzing semi-structured interviews in qualitative research. Braun and Clarke (2006) defined it as a method of identifying, analyzing and reporting data forms and outlines. They consider the thematic analysis as a first and essential method for defining and describing the qualitative research.

3.5.2 Multiple Regression Analysis

Preacher et al. (2006) mentioned that the multiple linear regression (MLR) is used for achieving better understanding of the relation and the significance of two or more predictors or independent variables. MLR is considered as predictive analysis. There is a standard requirements for conducting MLR:

1- The data must follow a normal distribution with zero mean and constant standard deviation.

2- The relations between dependent and independent variables are linear.

3- Residuals have a rectangular shape.

4- The independent variables are not highly correlated

Multiple linear regressions are used for three main reasons:

1- To explain the relationship between independent and dependent variables.

2- To show the impact of changing the dependent variable when/if the independent variables is changed.

3- To forecasting and predict future trends.

R^2 is a statistics that gives indication about the appropriateness of the model; the closer R^2 to 1, the better the model will be in representing the data.

Grégoire (2014) illustrated the equation of the MLR as follows:

$$Y = \beta 0 + \beta 1\ X1 + \ldots + \beta p\ Xp + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

- Y: response variable, dependent variable, output, endogenous variable, explained variable.

- Xi ... Xp: predictors, independent variables, exogenous variables, Exploratory variables, input.

- β0 …. βp: regression coefficient that measures the change in the unit variable when Xi changes.

- ε: Residuals (error)

3.5.3 The Time Series Data Forecasting Tools

The statistical software used to conduct the statistical analysis is the Minitab; it is commonly used for statistical, numerical, and graphical calculations. The Minitab can be used not only for academic purposes, but it is also used for marketing and sales of a business and strategic analysis for studying the competitors in the market and for geographical research (Minitab; 2017).

The sample size used to collect data is nine observations implemented in the periods from 2007 to 2015.

3.6 Research Verification

When researchers measure behaviors, validity measures are used to ensure that researchers are measuring what they intend to measure (Drost; 2011).

The validity of research was ensured through performing these measures:

- Tools have been checked and verified against historical data.
- Survey piloting was done to ensure that data the collection tools were valid and congruent with the research objective.
- Primary and secondary sources of data are used in the research and both of them are quite recent research studies.

Chapter Four

Data Analysis and Results

Chapter Four
Data Analysis and Results

4.1 Overview

The qualitative tools consisted of structured and semi-structured interviews. The main aim for suing these tools was to identify the energy usage by sector in the West Bank. The statistical quantitative tools drew mainly on annual reports and administrative records, and they were used to test the hypothesis and to determine the factors that affect energy consumption in Palestine during the period (2007-2015). The data were also used to build a regression model for forecasting purposes.

The collected data were categorized, analyzed, and interpreted in order to generate different scenarios for enhancing the performance of the energy sector.

4.2 Interview Analysis

Several interviews with key actors in the energy sector were conducted. The total meeting time came up to approximately 10 hrs. The interviews questions are given in Appendix A. Table (4.1) has the thematic analysis of the interviews.

4.2.1 PENRA, PERC and the General Directorate of Petroleum interviews

The data from the semi-structured interviews were classified into nine themes. Table (4.1) presents the main problems that the energy sector suffers from the participant's perspectives. The main problems are labelled as (Initial Code), while the researcher proposed solutions in were referred to as (Themes).

Table (4.1): Summary of Identified Themes and Codes

#	**Data Items**	**Initial Codes** *(main Problems)*	**Naming Themes** *(Solution framework)*
1	There are approximately 40 energy companies in the West Bank; most of them are licensed private companies, registered with the Ministry of Public Works and Housing (MPWH). Most of these companies do not have the suitable specific classification regarding types, size of projects, and investments funds; this situation leads to fewer investments in renewable energy projects.	• Fewer investments • No suitable company classifications • Laws and regulations	• Top management role *explained in more detail on page 74.*
2	Projects in the energy sector in Palestine can be classified into two types according to the funding scheme: - The majority of renewable energy projects are grants from international donors, such as Chinese government, Japanese government, USAID, etc. - The second type of projects is the Direct Bidding Projects. Direct Bidding in funding renewable energy projects is crucial in order to generate and create a suitable classification for Palestinian energy service companies; it is an indicator to the size of investments, qualified staff and so on. Furthermore, the allocation of these grants and funds are not well done.	• Funding & grants	• Fund allocation *(explained in more detail on page 74)*
3	A low number of qualified engineers in the Renewable Energy field and in maintenance. Generally, there are few experts in Palestine in energy management and all its related specializations.	• Lack of experience and expertise	• Capacity building *(explained in more detail on page 75)*
4	Israeli regulations which control the size and scope of the energy supply; these regulations often prevent the development of renewable energy sector.	• The political condition	• Systematic factors *(explained in more detail on page 75)*

#	Data Items	**Initial Codes** *(main Problems)*	**Naming Themes** *(Solution framework)*
5	Develop mechanisms to regulate the Energy Sector in Palestine and think about new initiatives for improving the sector and expanding its operations. - There are no alliances between different renewable energy consulting companies. - Role of the Energy and Environment Centre in Palestinian Energy and Natural Resources Authority are not well activated.	• Lack of Culture & Awareness campaigns • Need for an innovative ways of approachin g the energy challenges	• Top managemen t role • R&D importance • Synergy Strategy for energy companies *(explained in more detail on page 63,66*
6	Palestine is considered as the country with the highest prices of electricity in the Middle East: There are high potentials to utilize renewables in general and solar energy in particular; due to the diversity in its geography and climate. The returns of investment for some of these projects are high and the payback period is low to medium. The payback period is from 6 to 7 years; profits continue for 20-25 years. These figures are quite encouraging for investors in the energy sector.	• Good potential to gain profit; Quite sizable room for investment.	• The role of investors *(explained in detail on page 67)*
7	According to PENRA, not all PVs and CSP systems installed are registered with PENRA.	• Cooperatio n and procedural problems	• Synergy strategy *(explained in detail on page 65)*
8	There is no feedback from gas stations to the Directorate about distribution and consumption by sector, e.g. factories, households and transportation.	• communica tion channels among stakeholder s	• Feedback Loops *(explained in detail on page 67)*
9	The Directorate General of Petroleum is one body under the Ministry of Finance and the number of employees in their head offices in the governorates is not enough. Energy Private companies also suffer from lack of employees.	• Lack of employees	• Role Detention *(explained in detail on page 68)*

It is evident from the identified themes that developing the energy sector, in general, and the renewable energy, in particular, is a continuous process and is closely impacted by the many factors that affect this sector.

The main conclusions from the interviews are discussed below:

Theme 1: The Role of Top Management

The cooperation between PENRA and the Ministry of National Economy to classify the energy companies is an essential step that is very much needed in order to improve the renewable energy projects in Palestine. Moreover, the management of PENRA should play a key role in proposing regulations and policies which will help move the small private companies to the next level in applying modern renewable systems.

Moving to the next level in this sector can be obtained through putting clear and well-defined policy goals and communicating them periodically to the relevant stakeholders.

Theme 2: Fund Allocation

As stated in Table (4.1), the Palestinian government can obtain funds from foreign countries in order to develop this sector; if enough funds are allocated to the energy sector, observable growth will happen over a short period. The fund will bring in new technologies, modernize the management systems, and establish strong ties between the private and public sector. Some of the proposed ideas are green funding programs from the local banks to support renewable energy projects and energy efficiency programs with green loans.

Theme 3: Capacity Building

Since there are not enough skilled people in the energy field, particularly in areas like installation and maintenance of new technologies, training programs and workshops are needed. Therefore, the decision-makers should encourage participation in such training programs. Such programs will help reduce the unemployment rate in Palestine by training and hiring skilled labor. Accreditation of energy companies as training centers for skilled labors and energy management experts is lacking at the moment. The proposed solutions includes providing professional training programs for the skilled staff; the recruitment of experts in the private sector companies is also essential; monitoring their work remains important.

Theme 4: The System Factor

The system factor can be identified as an uncontrollable one as far as the Palestinian condition is concerned. This factor sometimes cannot be be predicted due to instability in the political situation. The energy sector is the most affected sector in Palestine by the political situations to the extent that till now Palestine cannot by it provide the different types of energy to its citizens. Under such condition, the energy situation in Palestine will continue to function under extremely unpredictable conditions.

Theme 5: The Synergy Strategy

This theme aims to identify how synergy among stakeholders can be achieved. There are a number of viable options which may help achieve this synergy. Firstly, creating cooperatives in energy will likely make the private sector companies work under one business model. Such cooperation will warrant success in the development of the sector, since most of the companies in the energy services work on small scale. Secondly, the Public-Private Partnership (PPP) can be one important option which will help build alliances between the government and the private sector.

Synergies between public and private sector will increase efficiency in the energy market and will help provide better structures and regulations which are necessary for planning long-term with regard to issues like climate change mitigation and the diversity in the energy sector. Synergies and cooperatives will improve investment in Palestine and open new business opportunities in the energy sector.

Theme 6: The Importance of Research and Development

A sustainable energy system is often perceive as one in which the research and development effort is animated. Research projects can focus initially on transferring knowledge to the Palestinian economy. This theme will also play a vital role in the energy sector, especially when Palestine starts a new phase of energy production and conversion processes.

Applying new technology and efficient energy management systems will help in solving the problem of losses and thefts; these modernization means can also be used addressing the problems of electricity production and energy dependence.

Theme 7: Feedback Loops

Since The General Directorate of Petroleum and Fuel in Palestine is not well structured and organized, means of communication need to be built among the fuel companies to encourage them to document their work and to give feedback to the top management at The General Directorate of Petroleum.

Feedback and documentation will ease the process of knowledge transfer and sharing, which is important to enhance performance in the energy sector. The regular feedback from stakeholders in the energy sector will help in revising goals and applying needed adjustments or even changing in actions when necessary.

Theme 8: The Role of Investors

Obviously, investors have a crucial role in improving the renewable energy sector in Palestine. They also are the key actor when planning for the environment protection.

The joint ventures between investors can make for a good arrangement to encourage investment in renewable energy projects since the costs of some of these renewable systems are extremely high.

Theme 9: Role Definition

This theme focuses on the Directorate General of Petroleum and the needed development in this important directorate. The interviews revealed that there are conflicts in responsibilities between the Ministry of Finance and the Directorate General of Petroleum. The definition of roles may lead to improving every institution alone without considering them as one body. Creating clear job description for each institutions will help better organize the energy sector. Mechanisms for monitoring, evaluation and data flow will be deployed much more easily.

The analysis of above themes has presented a list of ideas that can be implemented to address problems in the energy sector in Palestine; the analysis and recommendations for improvement were informed by the participants' experiences with the sector over the past two decades.

The following section presents the results of structured interviews with energy distributers in the West Bank.

4.2.2 Interviews with Energy Distributors and Utilities in the West Bank

Energy is important for all economic sectors. It is important for agriculture; likewise, it is equally important for all other sectors in the economy. For that reason, it is necessary to identify the current distribution of energy among sectors for planning and development purposes.

For this purpose, the researcher conducted structured interviews with the key actors in the West Bank to identify the consumption rates per sectors. The target sectors are the residential, commercial, service, industrial, agriculture, and transportation sectors.

As an initial step in the assessment, it is important to identify the important economic indicators. According to the energy industry, the import/export economic indicators show the energy sector openness to trade. The exported energy is zero while the imported energy/GDP is 21.2% of energy use. It is clear from these two numbers that the Palestinian economy suffers a deficit in trade regarding the energy sector; this can be attributed to many reasons like lack of experts in this field, funding schemes, lack of renewable energy projects, etc. However, the main reason remains that Palestine totally depends on importing electricity from neighboring countries. Figure (4.1) shows the amount of energy consumed per economic sector.

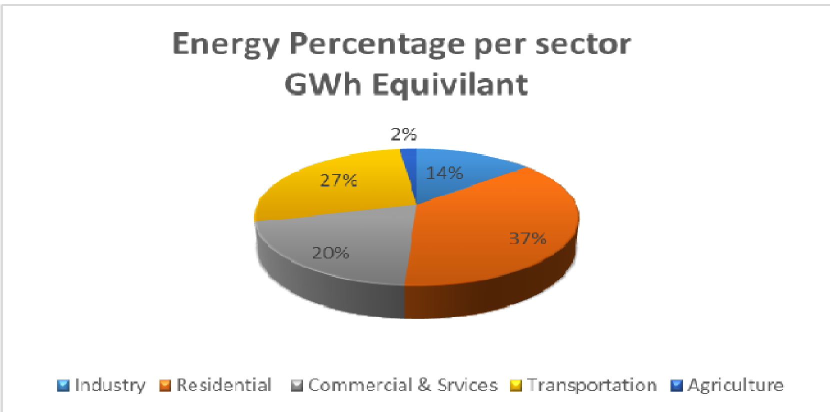

Fig. (4.1): Energy percentage consumed per sector (PENRA; 2015)

A close look on the chart would reveal that the highest energy consumption rates occur in the residential, transportation, and commercial sectors respectively. The residential and commercial sectors are responsible for 57% of the energy consumption in the country. Therefore, when planning for enhancing the energy situation in Palestine, it will be important to apply energy conservation and renewable energy systems to buildings. Such schemes will make for a good solution to improve the sector performance.

With this realization in mind, the researcher conducted structured interviews with the energy experts from PENRA, the General Directorate of Petroleum, electricity and fuel companies to collect more data on sector consumption and use it to create the primary energy flow for year 2015 in the West Bank.

First of all, a quick glance at the total consumption of petroleum types in the West Bank, distributed by governorates is shown in Figure (4.2).

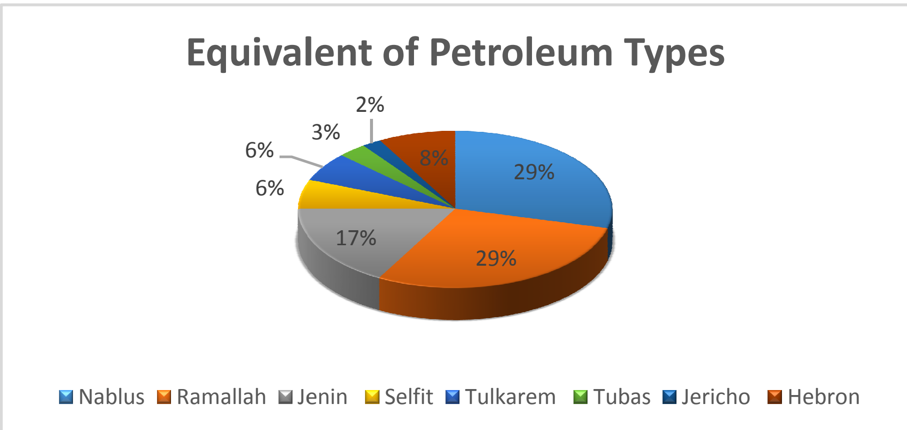

Fig (4.2): Total consumption of distributed petroleum types in the West Bank Governorates (Source: GDoP; 2015).

Figure (4.2) presents the percentage of total consumption of petroleum types in West Bank. Ramallah, Nablus, and Jenin are the largest consumers with 29% for Ramallah and Nablus, and 17% for Jenin. Most of the Petroleum goes for the transportation sector. Reducing the consumption of petroleum can be done through changing the vehicle use patterns to reach a situation where people use their cars less and opt for other means of transportation instead.

4.2.2.1 Petroleum Flow

In order to create the flow of energy in the West Bank, important information must be obtained from the petroleum sector. Petroleum types are divided according to the economic sectors as follows:

- Diesel Fuel: mainly used for transportation, heating, boilers, and electricity generation for factories.
- Gas Fuel: this type is used for heating, cooking and industrial applications in a different type of sectors excluding transportation.
- Gasoline Fuel: it is used only in the transportation sector.

Since the aim of this sub-section is to generate the petroleum flow, otherwise known as "mapping for petroleum", in every economic sector, the sectors were defined as follows:

✓ *Gas Fuel usage is distributed among sectors in the West Bank as follows:*

Residential gas cylinders had 28%; electricity power generation for water pumping and electricity came at 8%.

Commercial & Services:

Commercial buildings including offices, restaurants, hotels, etc. had a consumption percentage of 24%; organizations such as hospitals, schools, municipalities, ministries, universities, etc. used approximately 2%.

Industrial: gas used for factories and industrial regions used around 30% of gas consumption.

Agriculture: the gas generator used for animal farms such as hen farms consumes around 3%.

The total consumption rate for the previous types is 95%; the remaining 5% is distributed among commercial and industries in case of power cuts.

From the previous data, it is essential to identify energy consumers as sectors and to consider the integration between energy and economy.

4.2.2.2 The Energy Flow

The energy flow in Palestine includes energy production, import, losses, and end consumption of energy types within the energy sectors. Figure (4.3) shows the primary flow of energy. Data in the figure can be used to generate an Input-Output model (I-O model) for the energy sector in Palestine which is normally used for planning and forecasting purposes. However, it is important to note that the data about the energy sector is limited due to the lack in materials, sources and references. Therefore, it is difficult to use these data for forecasting purposes or for generating the final Matrix of I-O model; Wei et al. (2009) mentioned that it is complex to build the I/O model in developing nations because it is hard to quantify energy per unit used in industry and the jobs created per energy unit used.

Consequently, the regression analysis for forecasting was used to obtain highly reliable results.

The final data from PENRA, electricity Companies and General Directorate of Petroleum were sorted and categorized as in Figure (4.3).

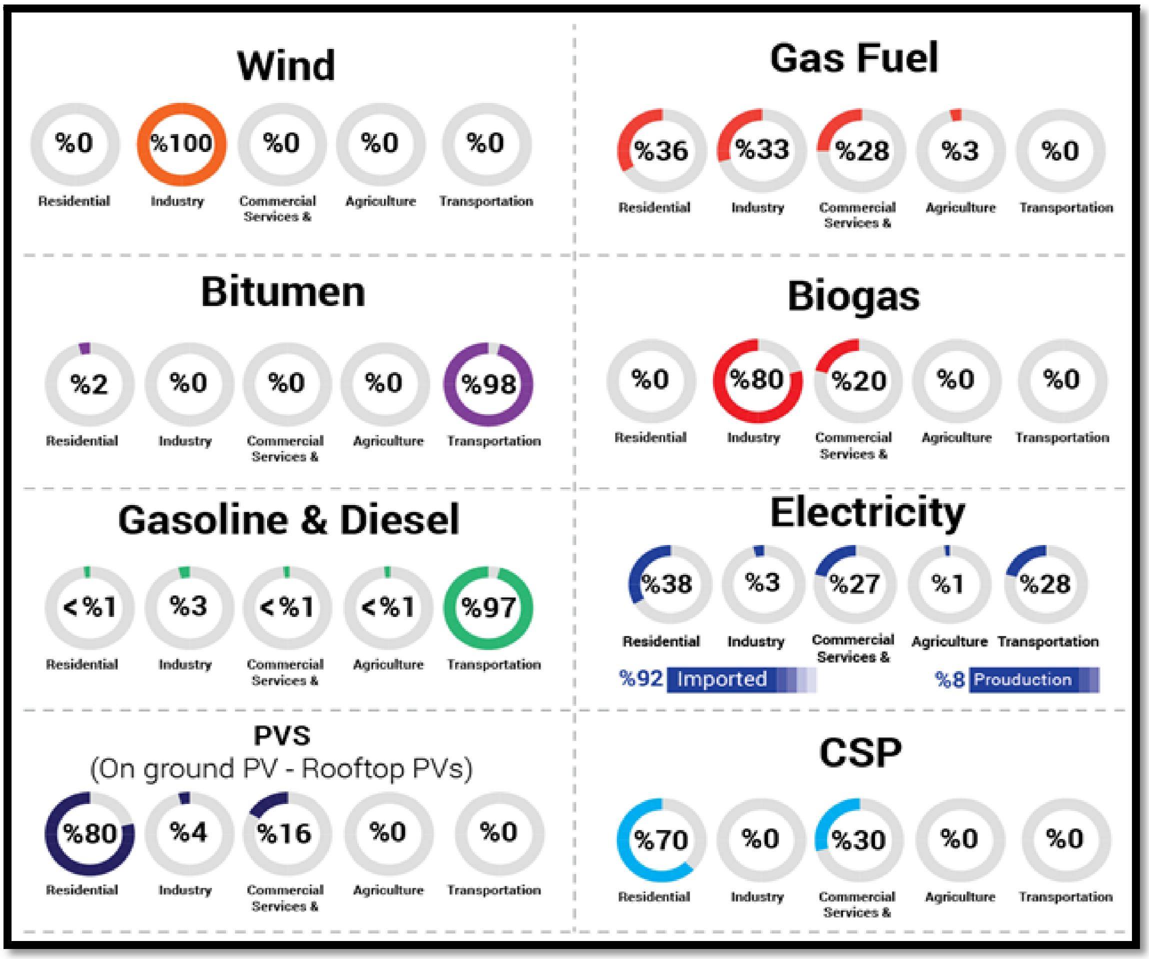

Fig. (4.3): Energy types consumption per economic sector in the West Bank for the year 2015

The previous figure shows the energy types and energy utilization per sector. It covers the “Primary Supply Side” which includes energy types, and " Demand Side” which is includes the consumption end. Table (4.2) shows how energy types (electricity and renewables) are used in Palestine.

Table (4.2): List of sectors for energy end use in Palestine.

	Sector	End use	Source
1	The Residential Sector	Lighting	PVs, electricity, diesel generators
		HVAC	PVs, electricity, diesel generators
		Space heating	PVs, electricity, diesel generators, gas heaters, diesel heaters
		Refrigeration	Electricity and PVs
		Water heating	Solar water heaters, diesel heaters, gas heaters
2	The Industrial Sector	Lighting	Electricity
		HVAC	Electricity
		Motors	Electricity
		Air compressors	Electricity
		Refrigerators	Electricity
		Lighting	PVs, electricity, diesel generator s
3	The Commercial and Services	HVAC	PVs, electricity, diesel generators
		Space heating	PVs, electricity, diesel generators, gas heaters, diesel heaters
		Refrigerating	Electricity and PVs
		Water heating	Solar water heaters, diesel heaters, gas heaters

A flow of energy types to economic sectors is a critical component in any energy development program. It allows researchers, experts and government a better look at the current situation of energy in Palestine and provide good input on how to achieve noticeable progress.

4.3 The Factors that Affect Energy Consumption and Demand Projection

In this section, the variables that possibly affect energy consumption in Palestine were identified as population growth, temperature, the Gross Domestic Product (GDP), standards of life identified through the Gross National Income (GNI), the energy prices, and the investment position of Palestine. The analysis focuses only on these factors because of data availability limitations. Examining the relationships between the dependent and independent variables is then used in forecasting for the upcoming years and in formulating the proposed interventions.

4.3.1 Hypothesis Formation

The set of variables examined in this research are converted to research hypotheses as follows:

H▪ 1: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the population growth.

H▪ 2: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the Gross Domestic Product (GDP).

H▪ 3: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the average annual ambient temperature.

H▪ 4: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the Gross National Income (GNI).

H・5: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the International Investment Position (IIP).

H・6: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the fuel prices.

H・7: There is a significant statistical relationship at (α =0.05) between energy consumption in Palestine and the electricity prices.

Table (4.4) was created using the following reports:

1- PCBS: Energy tables for years (2007-2015).

2- PCBS & PMA reports: International Investment Position for Palestine (IIP) 2009-2016.

3- Major national accounts variables in Palestine* for the years 2015, 2016 at constant prices; 2015 is the base year.

4- PCBS: Palestine in Figures (2007-2015).

5- PCBS: Annual Report (2007-2008) for Meteorological conditions in Palestine.

6- Palestinian Meteorological Authority: The Climate Bulletin (2009 - 2014).

The following table was built to examine the dependent variable (Energy consumption) and the independent variables (GDP, GNI, Energy Prices, Populations, IIP, and average temperature) over nine years.

Table (4.3): Factors that affect energy consumption in Palestine for the years (2007 - 2015)

year	**GDP (USD Million)** (PCBS' reports)	**Population** (PCBS' reports)	**GNI Per Capita** (PCBS' reports)	**International Investment Position (IIP)** (PCBS'&PMA reports)	**Average Temperature ^{0}C** (PMD reports)	**Final Energy Consumption TJ** (PCBS' reports)
2007	1,406.0	3,719,189	1,538.1	1,325	18.70	35,900.34
2008	1,449.1	3,825,512	1,605.0	1,156	20.12	33,983.38
2009	1,529.8	3,935,249	1,656.7	1,562	24.80	41,098.46
2010	1,606.4	4,048,403	1,702.1	1,286	19.50	44,277.81
2011	1,752.5	4,168,860	1,858.7	721	19.60	42,650.97
2012	1,807.5	4,293,313	1,925.3	667	19.40	50,154.43
2013	1,793.3	4,420,549	1,935.1	880	19.60	52,375.29
2014	1,737.4	4,550,368	1,899.0	1,385	20.20	67,469.73
2015	1,744.5	4,682,467	1,930.9	1,034	20.30	69,949.50

Table (4.3) shows that the GDP has an increasing trend over the years. It is important to verify whether a higher GDP correlates with the higher levels of energy consumption and vice versa. Also, the table shows an increasing trend in the population growth over the years (2007-2015). The Gross National Income per capita shows increasing trend. The GNI is often used as an indicator of living standards in Palestine. Poverty ratio and expenditures ratio for (Needs and Accessories) can be used also as a measure for the standard of living but data in Palestine about these two measures are for the year 2011 only.

The Investment Position in Palestine over years constitutes a financial indicator for the country's position. If International Investment Position (IIP) data is connected with the timeframe in years, it will give no clear trend as shown in Figure (4.4). The ambient temperature also is an important and essential factor to be studied and analyzed. The previous table doesn't show a big change in climate over years in the period from 2007 to 2015. The final column in the table shows energy consumption (Dependent Variable) in Palestine in TJ. The figures clearly indicate that energy consumption shows an increasing trend.

Fig. (4.6): International Investment Position in Million USD for Palestine for the years (2007-2015)

The last factor that needs to examine is the energy prices. Whereas energy types are limited to fuel and electricity, it is worth to mention that prices are not the same for both types. Price data was collected and sorted in the following two tables.

Table (4.4): Fuel prices in Palestine for years (PCBS's annual reports 2008-2015).

Average Fuel Prices					Fuel Consumption 1000 L
Fuel Type / Year	Kerosene	Diesel	Gasoline	AVG.	
2008	6.29	5.93	6.21	**6.14**	**284,191***
2009	5.14	4.96	5.57	**5.22**	**396,640**
2010	5.87	5.84	6.3	**6.00**	**510,048**
2011	6.42	6.42	6.89	**6.58**	**385,102**
2012	6.81	6.77	7.35	**6.98**	**439,778**
2013	6.13	6.17	6.91	**6.40**	**584,647**
2014	6.42	6.42	7.06	**6.63**	**933,655**
2015	5.41	5.41	6.11	**5.64**	**929,962**

Data in Table (4.4) relies on the PCBS's annual reports; for clarity and ese of use, a detailed calculation was given for the last two numbers in the first row and last column. The reports gives the consumption for every type of fuel separately. In order to study the effect of energy prices on consumption of these types, the following procedure were applied.

Kerosene consumption is 3,567 (m^3.); Diesel consumption is 148,755 (m^3); Gasoline consumption is 131,869 (m^3.) for the year 2008.

The total fuel consumption =131,869+3,567+148,755= 284,191.

The average prices were estimated as follows:

Average price of fuel in 2008= (6.29+5.93+6.21)/3 = 6.14 NIS.

The average prices of fuel in the previous table does not show a clear trend over the years. Figure (4.7) illustrates how the prices of fuel vary over years.

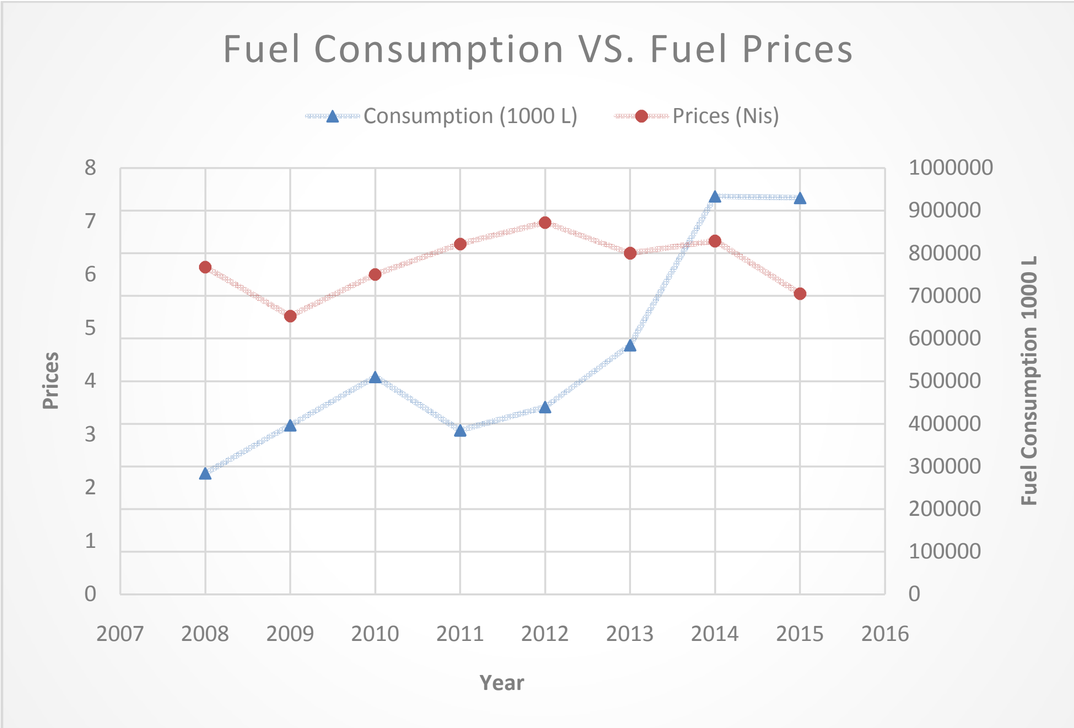

Fig. (4.5): Fuel Consumption in Palestine (2008-2015)

Figure (4.5) shows a random trend for fuel prices over the years (from 2007 to 2015). However, fuel consumption has an increasing trend in the same period. The hypothesis results of prices effect on fuel consumption will be discussed later in the coming sub-section.

In order to study electricity consumption and prices, electricity prices were collected from PERC as shown in Appendix B. The electricity prices and electricity consumption are sorted as shown in Table (4.5):

Table (4.5): Electricity Prices & Electricity Consumption in Palestine for the years (PCBS's reports 2011-2015)

Year	2011	2012	2013	2014	2015
Electricity Prices (Nis)	0.62	0.67	0.72	0.74	0.64
Electricity Consumption (GWh.)	4225.2	5531.9	53778.8	5378.1	5216.4

From Table (4.5), it is clear that the average prices of electricity have shown a slight increase from the year 2011 to 2015 in Palestine.

Figure (4.6) presents electricity consumption for the years (2011-2015) and the electricity prices over the same period.

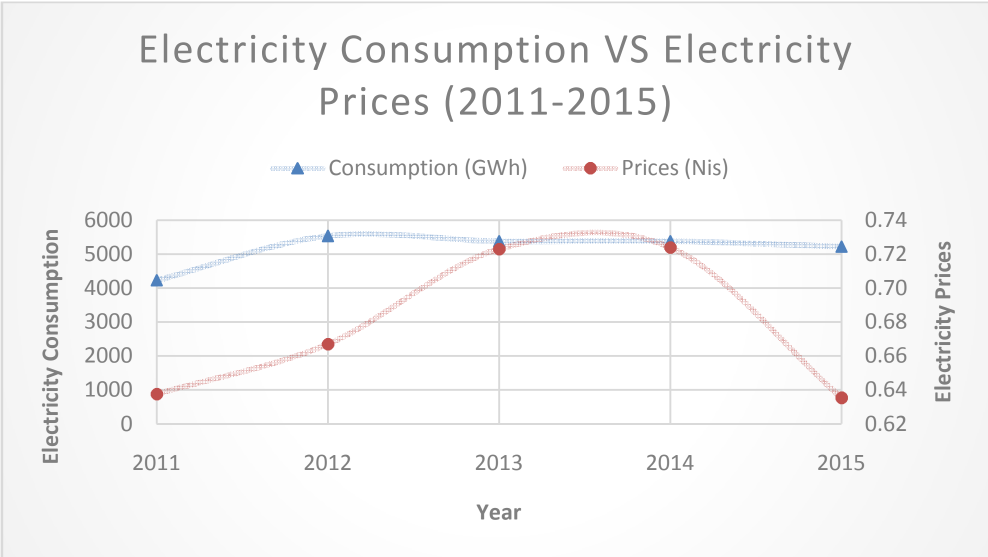

Fig. (4.6): Electricity Consumption and Prices in Palestine from years 2011 to 2015

It can be safely concluded from Figure (4.6) that the electricity prices and electricity consumption show a random trend over years.

In addition to data collection from annual reports and administrative records, and data sorting as shown in the previous tables, the collected data were processed using a Minitab software in order to examine the impact of different factors (dependent variables) on energy consumption (independent variable) in Palestine. The set of hypotheses had been tested using the Regression Analysis.

4.3.2 Study Hypotheses

The hypothesis testing was done to check whether relationships can be established; the results are discussed in two ways:

1- Studying each single factor to show how it affects energy consumption.

2- Studying the related factors to generate energy consumption forecasting model (Multiple Regression Model).

Hypothesis No 1

It is assumed that there is a significant relationship between energy consumption in Palestine and population. This test aims to show if increasing or decreasing growth rates per annum has any effect on energy consumption. The regression analysis was applied in order to examine the hypothesis. Table (4.6) shows the results.

Table (4.6): Regression Analysis of Energy Consumption vs. Population in Palestine (2007-2015)

Analysis of Variance					
Source	**DF**	**Adj. SS**	**Adj. MS**	**F-Value**	**P-Value**
Regression	1	1191745147	1191745147	68.36	0.000
Population	1	1191745147	1191745147	68.36	0.000
Error	7	122040610	17434373		
Total	8	1313765757			
Model summary					
S	**R-Sq.**	**R-Sq.(adj.)**	**R-Sq.(pred.)**		
4175.45	90.71%	89.38%	83.88%		
Coefficients					
Term	**Coef.**	**SE Coef.**	**T-Value**	**P-Value**	**VIF**
Constant	-105654	181715	-5.65	0.001	
Population	0.03689	0.00446	8.27	0.000	1.00

According to the previous table of regression analysis, it can be concluded that there is a significant relationship between energy consumption and population in Palestine since the p-value is 0.00 which is less than 0.05; this result is logical because energy is used to meet human demands and needs. So when the population increases their needs for energy also increases. Also when examining the R-sq. and R-sq. (adj.)

values; it can be concluded that the model is good and the relationship is significant as the R-Sq. is equal to 90.71% (the closer R-sq.is to 1 the better model is).

Hypothesis No 2

It is hypothesized that there is a significant relationship between energy consumption in Palestine and the Gross Domestic Product (GDP); the GDP is often taken for a measure of a country's total economic development. Since the energy sector is considered as one main part of the economy, the two are logically correlated. The regression analysis is used to test the hypothesis. Table (4.7) shows the results:

Table (4.7): Regression Analysis of Energy Consumption vs. GDP in Palestine (2007-2015)

Analysis of Variance					
Source	**DF**	**Adj. SS**	**Adj. MS**	**F-Value**	**P-Value**
Regression	1	1088340337	1088340337	33.79	0.001
GDP	1	1088340337	1088340337	33.79	0.001
Error	7	225445420	32204689		
Total	8	1313785757			
Model summary					
S	**R-Sq.**	**R-Sq.(adj.)**	**R-Sq.(pred.)**		
5675.08	82.84%	80.39%	71.29%		
Coefficients					
Term	**Coef.**	**SE Coef.**	**T-Value**	**P-Value**	**VIF**
Constant	-15174	11141	-1.36	0.215	
GDP	10.31	1.77	5.81	0.001	1.00

The previous figures show that there is a significant relationship between energy consumption and GDP in Palestine because the p-value is less than 0.05 at 0.01. Also when looking at the R-sq. and R-sq. (adj.)

values, it can be concluded that the model is good and the relationship is significant as the R-Sq. equals 82.84%.

The obtained results give an indicator of the economic performance. When there is a shortage in energy supply, it will potentially cause poor economic performance; whereas a good supply of energy types will indicate good performance in the economy.

Hypothesis No 3

It is hypothesized that there is no statistically significant relationship between ambient temperature and energy consumption in Palestine. The Regression Analysis was used to test the hypothesis. Table (4.8) shows the results.

Table (4.8): Regression Analysis of the Energy Consumption vs. the Average Annual Ambient Temperature in Palestine (2007-2015).

Analysis of Variance					
Source	**DF**	**Adj. SS**	**Adj. MS**	**F-Value**	**P-Value**
Regression	1	61828914	61828914	33.79	0.001
Ambient Temperature	1	61828914	61828914	33.79	0.001
Error	7	1251956843	178850978		
Total	8	1313785757			
Model summary					
S	**R-Sq.**	**R-Sq.(adj.)**	**R-Sq.(pred.)**		
13373.5	4.71%	0.00%	0.00%		
Coefficients					
Term	**Coef.**	**SE Coef.**	**T-Value**	**P-Value**	**VIF**
Constant	76139	46963	1.62	0.149	
Ambient Temperature	-1338	2276	-0.59	0.575	1.00

The correlation between energy consumption and the ambient temperature has repeatedly been confirmed in the reviewed literature. In the table above, there appears to be no significant differences. This result can be explained since any study of the effect of temperature on energy consumption must be done on long, extended periods of time for any significant impact to be noted. The available data on energy consumption in Palestine are in small amount; no data is available for the years before 2007. Accordingly, it was no possible to confidently reach any conclusions on this theme in particular.

Hypothesis No.4

It is hypothesized that there is a significant relationship between GNI per capita and the energy consumption in Palestine. Regression analysis was used to test hypothesis No.4. Table (4.9) shows the results of the analysis.

Table (4.9): Regression Analysis of Energy Consumption vs. GNI/ Capita in Palestine (2007-2015).

Analysis of Variance					
Source	**DF**	**Adj. SS**	**Adj. MS**	**F-Value**	**P-Value**
Regression	1	812244535	812244535	11.34	0.012
GNI/Capita	1	812244535	812244535	11.34	0.012
Error	7	501541222	71648746		
Total	8	1313785757			
Model summary					
S	**R-Sq.**	**R-Sq.(adj.)**	**R-Sq.(pred.)**		
8464.56	61.82%	56.37%	40.49%		
Coefficients					
Term	**Coef.**	**SE Coef.**	**T-Value**	**P-Value**	**VIF**
Constant	-65407	33993	-1.92	0.096	
GNI/Capita	64.0	19.0	3.37	0.012	1.00

As mentioned in Chapter Two, the GNI per capita had been chosen as a indicator of the "Quality of life". The results from Table (4.9) show that energy consumption and GNI per capita are correlated; the p-value came at 0.012. The R-Sq equals 61.82% which indicates that the relationship is not very strong, but the correlation cannot be ignored.

The correlation between the two variables is logically true; as the quality of life improves and the luxury products appear, energy consumption will increase.

Hypothesis No.5

It is hypothesized that there is no significant relationship between the Net International Investment Position (NIIP) and the annual energy consumption in Palestine. The Regression Analysis was used to test the hypothesis. Table (4.10) shows the results.

Table (4.10): Regression Analysis of Energy Consumption vs. IPP in Palestine (2007-2015).

<table>
<tr><th colspan="6">Analysis of Variance</th></tr>
<tr><th>Source</th><th>DF</th><th>Adj. SS</th><th>Adj. MS</th><th>F-Value</th><th>P-Value</th></tr>
<tr><td>Regression</td><td>1</td><td>13644400</td><td>13644400</td><td>0.07</td><td>0.794</td></tr>
<tr><td>IPP</td><td>1</td><td>13644400</td><td>13644400</td><td>0.07</td><td>0.794</td></tr>
<tr><td>Error</td><td>7</td><td>1300141357</td><td>1855734480</td><td></td><td></td></tr>
<tr><td>Total</td><td>8</td><td>1313785757</td><td></td><td></td><td></td></tr>
<tr><th colspan="6">Model summary</th></tr>
<tr><th>S</th><th>R-Sq.</th><th>R-Sq.(adj.)</th><th>R-Sq.(pred.)</th><th></th><th></th></tr>
<tr><td>13628.41</td><td>1.04%</td><td>0.00%</td><td>0.00%</td><td></td><td></td></tr>
<tr><th colspan="6">Coefficients</th></tr>
<tr><th>Term</th><th>Coef.</th><th>SE Coef.</th><th>T-Value</th><th>P-Value</th><th>VIF</th></tr>
<tr><td>Constant</td><td>53350</td><td>17921</td><td>2.98</td><td>0.021</td><td></td></tr>
<tr><td>IPP</td><td>-4.2</td><td>15.6</td><td>-0.27</td><td>0.794</td><td>1.00</td></tr>
</table>

The results show that there is no correlation between NIIP and energy consumption in Palestine since the P-Value is > 0.05. This result can be attributed to the restrictions forced on the nature and type of investments, the lack of available land and the restrictions on land ownership. All these reasons make the correlation between the investment position and international trade weak.

Hypothesis No.6:

There is no significant relationship between fuel consumption (kerosene, gasoline, and diesel) and its prices. Table (4.11) illustrates the result of the regression analysis.

Table (4.11): Regression Analysis of Fuel Consumption vs. Fuel Prices in Palestine (2007-2015)

Analysis of Variance					
Source	**DF**	**Adj. SS**	**Adj. MS**	**F-Value**	**P-Value**
Regression	1	77908102	77908102	0.00	0.975
Fuel Prices	1	77908102	77908102	0.00	0.975
Error	6	4.27E+11	71213755831		
Total	7	4.27E+11			
Model summary					
S	**R-Sq.**	**R-Sq.(adj.)**	**R-Sq.(pred.)**		
266859	0.02%	0.00%	0.00%		
Coefficients					
Term	**Coef.**	**SE Coef.**	**T-Value**	**P-Value**	**VIF**
Constant	594239	1099597	0.54	0.608	
Fuel Prices	-5844	176692	-0.03	0.975	1.00

There is no significant relation between prices and fuel consumption; the P-Value is > 0.05. The lack of correlation is due to the fact that energy uses in Palestine are limited to basic needs and life essentials; therefore it is not likely that people will reduce the amount of usage when energy prices become more expensive.

Hypothesis No.7:

There is no significant relationship between electricity consumption and its prices in Palestine. These results imply that, on the short run, there is no direct causality between electricity prices and energy usage.

Table (4.12): Regression Analysis of Electricity Consumption vs. Electricity Prices in Palestine (2007-2015).

Analysis of Variance					
Source	**DF**	**Adj. SS**	**Adj. MS**	**F-Value**	**P-Value**
Regression	1	3.37950E+11	3.37950E+11	1.32	0.335
Electricity Prices	1	3.37950E+11	3.37950E+11	1.32	0.335
Error	3	7.70624E+11	2.56875E+11		
Total	4	1.10857E+12			
Model summary					
S	**R-Sq.**	**R-Sq.(adj.)**	**R-Sq.(pred.)**		
506828	30.49%	7.31%	0.00%		
Coefficients					
Term	**Coef.**	**SE Coef.**	**T-Value**	**P-Value**	**VIF**
Constant	662024	3915863	0.17	0.877	
Fuel Prices	6619841	5771413	1.15	0.335	1.00

The table above shows that no correlation exists between electricity prices and the consumption of electricity in Palestine; the P-Value is > 0.05. As explained previously in relation to hypotheses 6, the energy consumption by the Palestinian citizens will not change if the price changes.

The hypotheses testing proved that there is no effect of temperature, energy prices and the investment position on energy consumption in Palestine during the study period (2007-2015). However, population, GDP, and GNI are correlated with the energy use. To accomplish the main goal of using regression for prediction and planning purposes, the next section will explain the Multiple Regression Equation for energy consumption and the prediction results for the upcoming ten years.

4.3.3 Energy Consumption Regression Equation and Forecasting:

This section explains how the energy equation is formulated and presents the time series forecasting for energy consumption in Palestine for the next decade. However, before accomplishing the goal, the normality test for residuals should be made.

4.3.3.1 Normality Tests for Residuals

Before starting with the analysis of regression results, the normality tests for residuals should be performed. The data used in the study is the data available in the energy sector; however, the sample is considered relatively small. To solve the problem of small samples, the normality test for residuals has been conducted. Rush (1996), mentioned that if the sample size is less than 15, P-Value will be more sensitive to non-normal residuals, then normality becomes a critical issue to be studied.

According to (J.Frost, 2014) normality test for residuals is important in order to make the result trustworthy. Frost considered that one of the main assumptions for regression analysis is that the residuals are normally distributed. Typically, assessing this assumption can be conducted by using the normal probability plot of the residuals as shown in figure (4.11). Anderson Darling test (AD) shows that P-Value is >0.05 and the means of data are near to zero; therefore, the data are normally distributed and trusted.

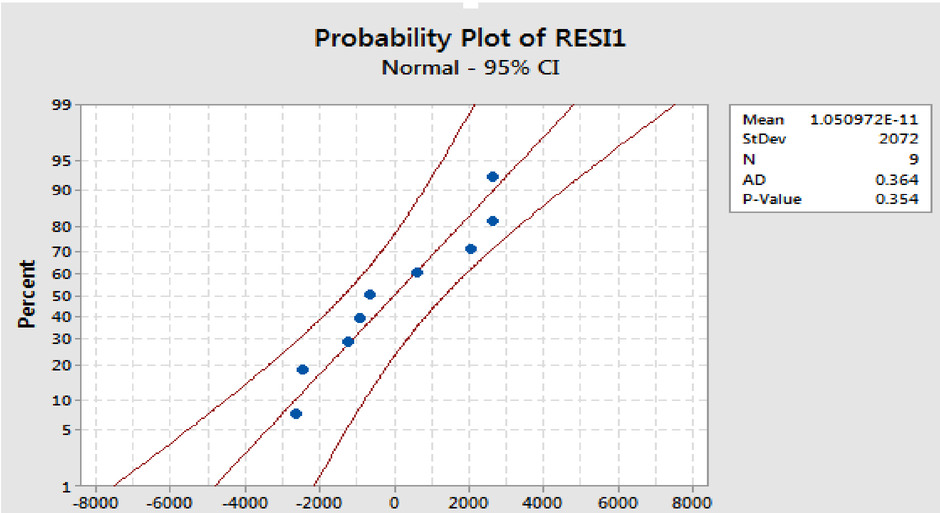

Figure (4.7): Normality test for residual of independent variable (GDP).

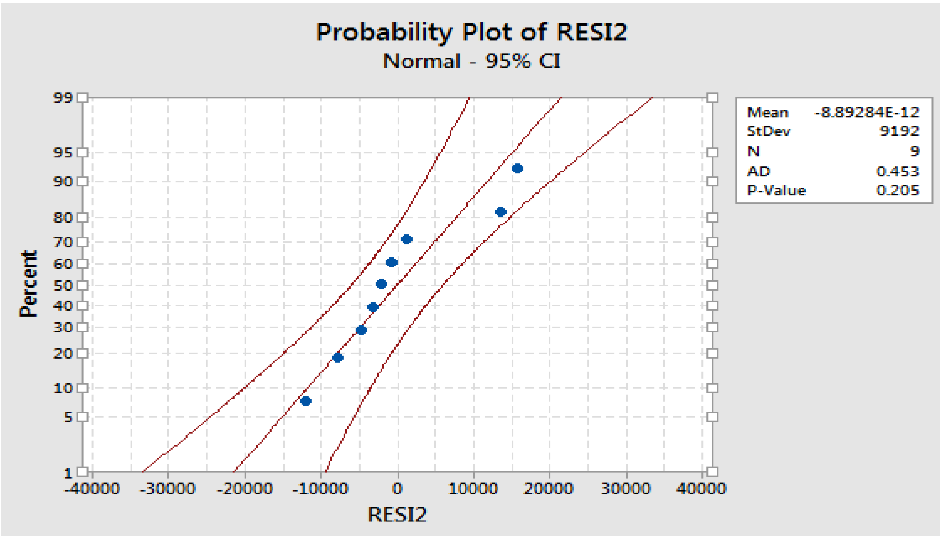

Figure (4.8): Normality test for residuals of independent variable (GNI).

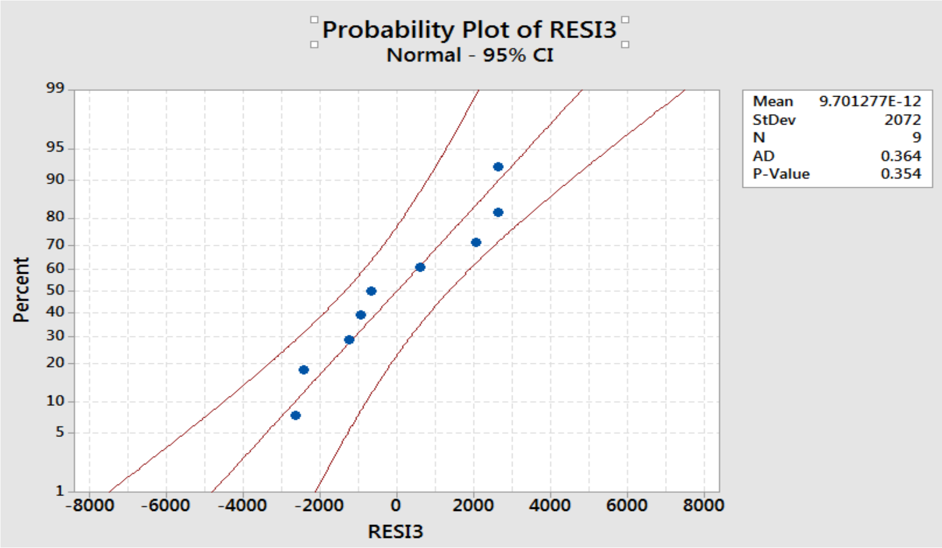

Figure (4.9): Normality test for residual of independent variable (Population).

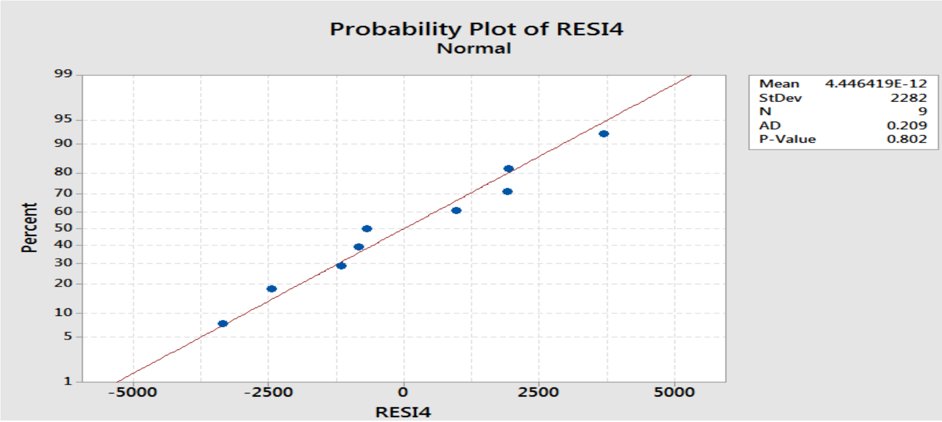

Figure (4.10): Normality test for residual of dependent variable (Energy Consumption).

4.4.3.2 The Correlation Test of Variables

The multiple regression models were used in this study in order to examine the factors that affect energy consumption in Palestine which are population, GDP, GNI, ambient temperature, and the investment position. Before exploring the model, it is essential to conduct a correlation test among the study variables. Figure (4.12) presents a matrix plot of correlation between variables which was conducted using Minitab software.

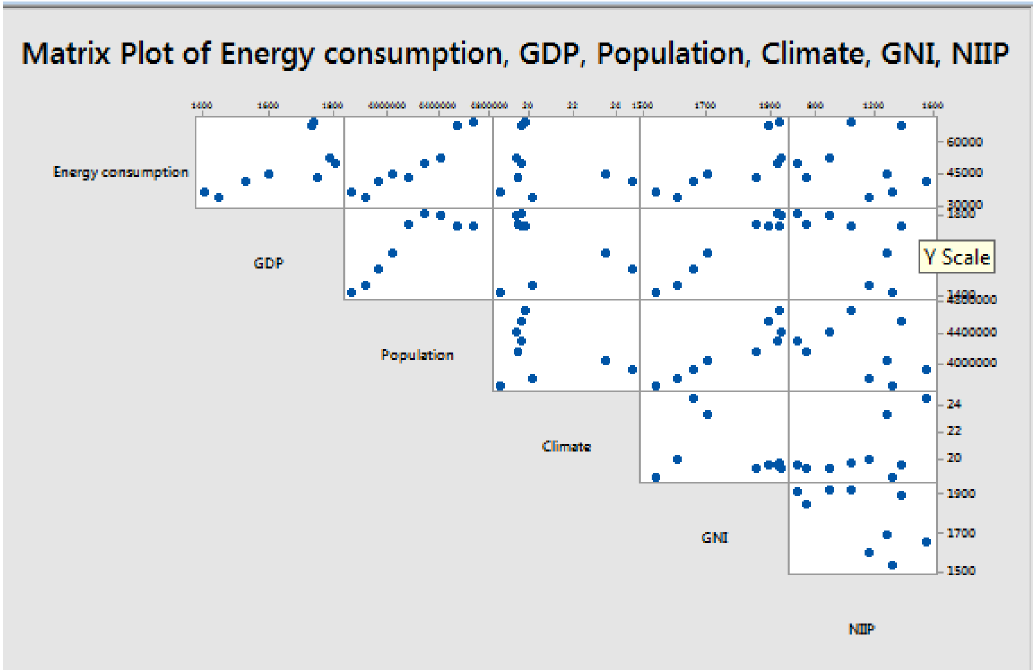

Figure (4.11): Matrix Plot of Variables.

In order to understand the correlation between variables, four hypothetical scenarios were generated in which one variable is plotted along the X-axis and the other one along the Y-axis. The results vary between positive strong correlation, positive weak correlation, strong negative correlation and no correlation.

Figure (4.11) shows that there are positive strong correlations between energy consumption and population; a positive weak correlation was detected between energy consumption and GDP and energy consumption and GNI. From the Matrix Plot, it is evident that there are correlations between GDP and population, GDP and GNI, and GNI and GDP. The regression equation was formulated in congruence with the preceding results in order to predict future energy consumption.

4.4.3.3 Multiple Linear Regression Model Equation

It is important to determine if the x-variables are helpful in predicting the y-variable (energy consumption)? The following equation was created using Minitab software to illustrate this relationship.

$$EnergyConsumption = \beta 0 + \beta 1 * GDP + \beta 2 * population + \beta 3 * GNI$$

Whereas;

β0 = is a free Parameter of the model

β1 = is a GDP parameter

β2 = is a population parameter

β3 =is a GNI parameter

The energy consumption is the (y) value or the predicted value of the model; the β values are calculated using MINITAB software, and (x) values (GDP, GNI, and population) are the values named in the study. The equation is used to carry out the forecasting for the energy consumption in the coming two decades. From the previous section, GDP, Population, and GNI are considered as model variables because they are the only factors that affect energy consumption. The following table shows the model statistics.

Table (4.13): Coefficient of the Model & Statistics.

Variable	Value	95% confidence	Statistics	
β0	-110672	3.037E+04	R^2	**97.52%**
β1(Million $)	25.33	124.8122	R^2 adj.	**96.03%**
β2 (Capita)	0.0659	0.0280819	R Msd.	**633.8851**
β3 (Million $)	-88.65	165.1166	Variance	**6.509E+06**

Table (4.13) clarifies the number of independent variables is three while the number of observations is nine. It is assumed that the free parameter is not set to zero in the regression model ($\beta0 \neq 0$). R^2 is a measure of the adequacy of the regression model. Its values vary between 1 and zero ($0 \leq R^2 \leq 1$); the higher R- squared is, the better the model will be. It is equal to 97.52% for the model in this study. Adjusted R^2 is also one measure for the appropriateness of the model; its value increases when more variables are added to the model. Table (4.14) summarizes the model of multiple regression.

Table (4.14): Source and model calculated data points

	GDP (USD Million)	**Population (Capital)**	**GNI (USD Million)**	**Energy Consumption (TJ) (actual)**	**Energy Consumption (TJ) (estimated)**	**Delta Energy Consumption (TJ)**	**Error %**
2007	1406	3719189	1538.1	35900.3	3.374E+04	2163.99	6%
2008	1449.1	3825512	1605	33983.4	3.591E+04	-1922.036	6%
2009	1529.8	3935249	1656.7	41098.5	4.06E+04	498.6997	1%
2010	1606.4	4048403	1702.1	44277.8	4.597E+04	-1696.238	4%
2011	1752.5	4168860	1858.7	42651	4.373E+04	-1081.108	3%
2012	1807.5	4293313	1925.3	50154.4	4.742E+04	2730.051	5%
2013	1793.3	4420549	1935.1	52375.3	5.458E+04	-2207.035	4%
2014	1737.4	4550368	1899	67469.7	6.492E+04	2546.398	4%
2015	1744.5	4682467	1930.9	69949.5	7.098E+04	-1032.722	1%

The following equation was used to calculate the last column in table (4.15)

$$Error\ \% = \frac{actual - estimated}{estimated} * 100\%$$

The Statistical indicators such as Graph & Residuals Plot were presented in Figures (4.12) & (4.13) respectively.

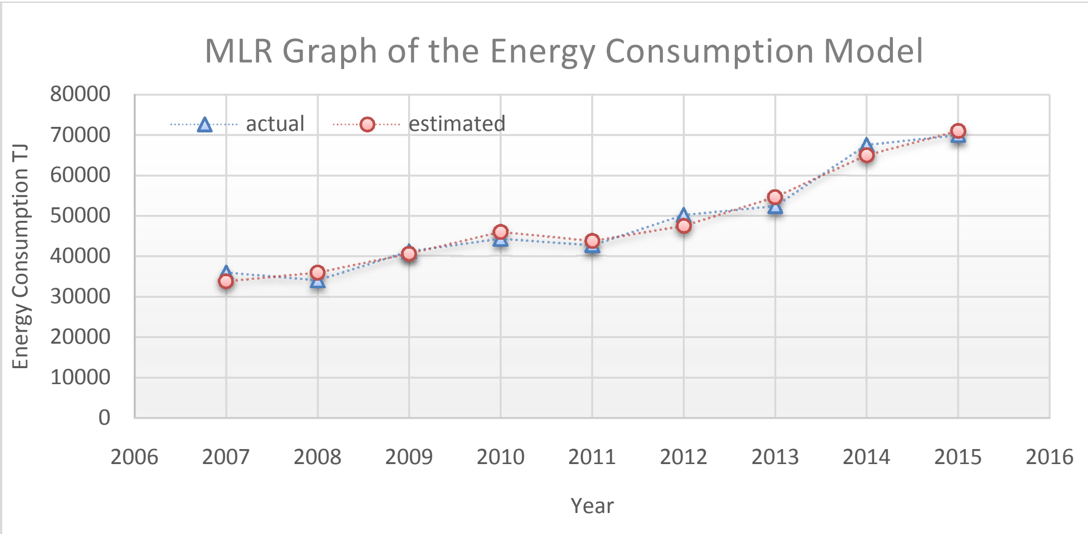

Fig. (4.12): Multiple Linear Regression Graph of the Energy Consumption Model

Figure (4.12) shows the energy consumption values on Y-axis and the year on X-axis. The graph shows the same trend for the calculated and experimental values of the dependent variables, which means that the model is appropriate. If the differences between estimated and experimental values were big or reveal unclear plot, this would indicate that an excessive experimental error had occurred which cannot be modeled.

Figure (4.13) shows the residual plot. It also gives the indicator of the difference between calculated and measured values of the dependent variables.

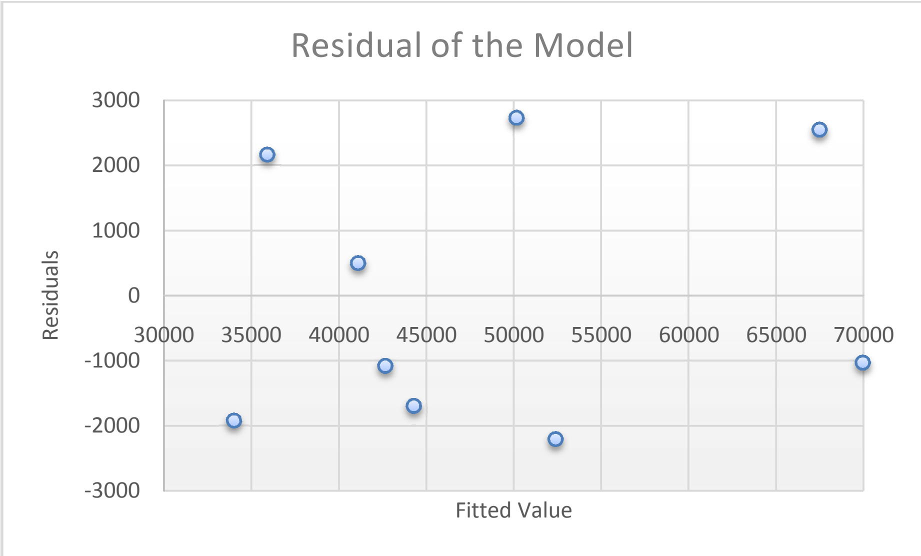

Fig. (4.13): Multiple Linear Regression Residual of the Model

Figure (4.13) shows the residuals on Y-axis and the fitted value on X-axis; it can be concluded that the residuals are randomly distributed around the line of zero error, which means the model correctly represents the study data. Normally, if the graph gives a clear trend, then the regression model is considered inappropriate.

The energy consumption forecasting is a critical and necessary input for planning and controlling energy use in the various economic sectors. It provides projections of the possible future trends for energy demand and the prospects for meeting these demands in different ways. Normally, it gives a proper understanding of the current consumption patterns, the potential supply alternatives, and the changes in technologies. The following table (4.16) shows the projected energy consumption for the years (2016-2030) in Palestine.

Using the regression equation, the researcher predicted the consumption for the upcoming years from 2016 to 2030. The formulated equation was performed using Minitab 17 software. Formula number (4.1) was used to create table (4.15) for the years (2016-2030).

Table (4.15): Energy Consumption Forecasting for Palestine for the years (2016-2030).

Year	Population	GNI (million USD)	GDP (million USD)	Energy Consumption TJ(Regression Model)
2016	4799528.675	2115.482	1746.659	71318.03091
2017	4919516.892	2111.348	1745.117	76152.9367
2018	5042504.814	2112.123	1752.202	81115.72003
2019	5168567.435	2103.121	1749.868	86736.03608
2020	5297781.62	2112.363	1752.408	93410.45114
2021	5430226.161	2104.203	1762.615	99096.47345
2022	5565981.815	2096.224	1765.988	104303.3183
2023	5438141.181	2099.931	1759.460	109607.1501
2024	5469565.875	2101.176	1757.474	116086.4153
2025	5479950.164	2099.990	1759.346	123285.3779
2026	5484971.093	2098.356	1759.043	130101.9361
2027	5479990.479	2098.097	1759.241	137096.0535
2028	5477093.116	2099.078	1759.387	144220.6129
2029	5472076.293	2099.199	1758.720	151565.2557
2030	5470689.257	2099.653	1758.498	159424.5619

The energy consumption shows an increasing trend in the next upcoming years. It shows sharp increases starting from the year 2016 with 71318.03TJ to the year 2030 with 121565.26 TJ. By looking back at the energy consumption in the previous period from 2007 to 2015, it shows increasing trends and in close proximity to the case of the multiple linear regression model.

Figure (4.14) shows energy consumption forecasting trends in Palestine for the upcoming years.

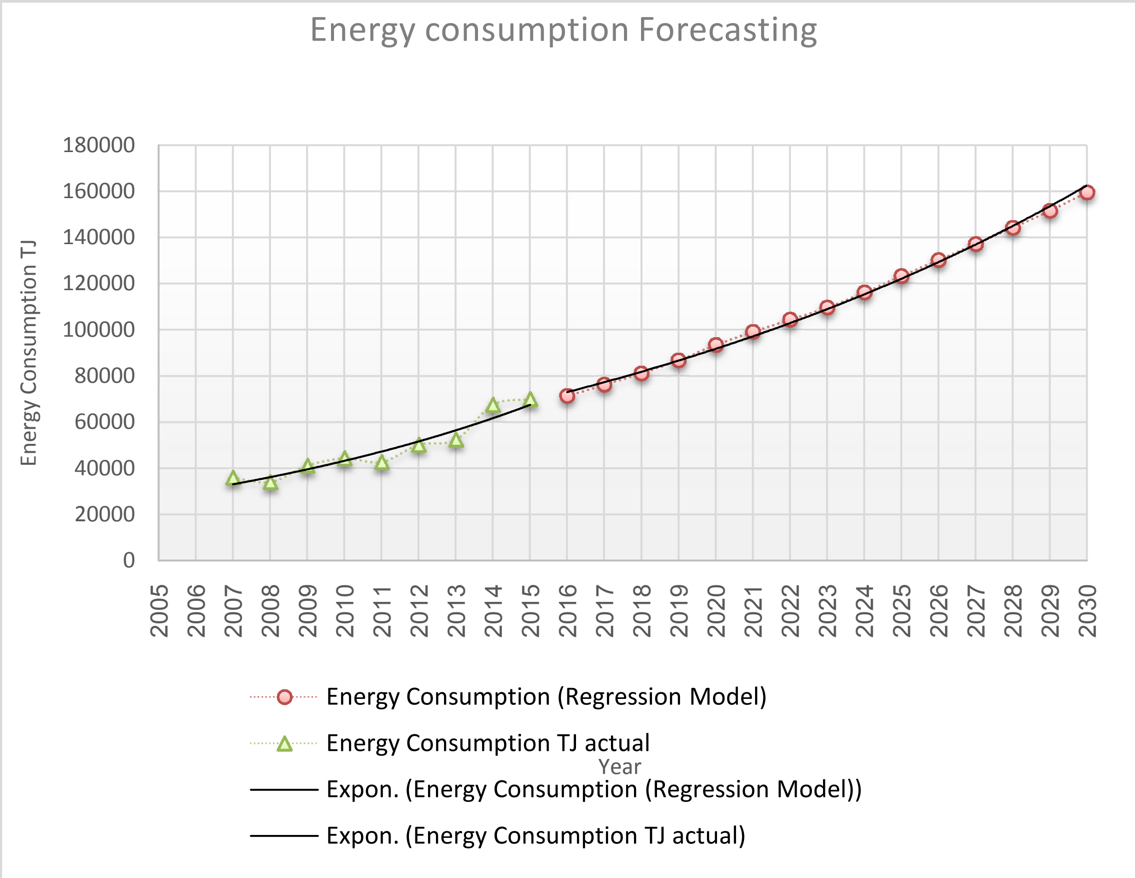

Fig. (4.14): Energy Consumption Forecasting for Palestine (2016-2030) in Tera Joule.

The forecasted data in figure (4.18) comes in close proximity to the cases of (2007-2015). When comparing the previous two lines for the forecasted figures with the actual energy consumption, we notice increases by 100,000 TJ in 15 years.

In the end, the forecasting of energy consumption is important at the strategic, tactical, and operational levels; it can be used for development purpose, investments decision and setting policies to improve the sector.

Chapter Five

Creating Future Scenarios for the Energy Sector

Chapter Five
Creating Future Scenarios and the Strategic Business Model

5.1 Overview

The previous chapter provided increase patterns for energy consumption in Palestine during the next two decades. It is essential to search for new techniques and generate future scenarios to meet these needs and manage the consumption trends. Good practices, energy management tools, and using alternative resources such as renewable sources are good solutions.

The electricity market, efficiency improvement plans, environmental legislation, renewable resources penetration, energy costs and developments in the economy will all have a major impact on the future of the sector. PENRA devised plans and implemented studies in the renewable energy and energy efficiency to meet the increasing demand and develop the sector; PENRA strategy and the National Energy Efficiency Action Plan (NEEAP) will be discussed later in this chapter.

Building future energy scenarios is the responsibility for all stakeholders, including the government, investors, consumers, and the private sector; they all should join efforts to manage and control the expected growth and to develop the energy resources and policies.

This chapter provides proposed energy scenarios starting with the Renewable Energy Strategy and the Energy Management Assessment of

Palestinian Electricity Companies, gap analysis of the current NEEAP, and finally, the proposed Strategic Business Model to be adopted by PENRA.

5.2 The Renewable Energy Future Scenarios

Clean and secure energy future scenarios will be drawn assuming high commitment from businesses, investors, governments, and policymakers.

5.2.1 RE Projects Potentials and Requirements

In this section, the researcher defines the primary requirements for implementing renewable energy projects that are economically feasible and technically viable.

With regard to area availability, it is important to locate the available area in Palestine before searching for ways of investments in renewable energy projects.

The following assumptions show how renewable energy can be exploited by launching new projects; they represent different types of technologies which can mainly be used in Palestine. The data about needed areas for every renewable technology is taken from the energy systems experts and installers in Palestine:

1- Rooftop PVs

Rooftop space ranges between 150 -200 m^2/ roof. The number of available roofs is about 40-60% of the total rooftops. The area needed to produce 1 MW is 10,000 m^2

2- On Ground PVs

The area needed to produce 1 MW is 10,000 m².

3- Concentrated Solar Power CSP:

To produce 10 MW, 30,000 to 40,000 m² are needed.

4- Wind Energy:

To produce 1 MW, 140 to 160 m² are needed.

Another important input which should be taken into consideration when deciding the required area for establishing RE Projects is the area categories for lands which are under Israeli control and the ones under the Palestinian control. Table (5.1) shows categories of lands and the maximum capacity in MW for each type of technology; it also gives the needed investments, operational and Maintenance costs.

Table (5.1): Max Capacities & Costs for Renewable Energy Technologies

R.E.T.	Max Capacity in MW	Investment Cost $/kW	Operation &Maintenance costs $/kWh
Rooftop Solar System	163 in Gaza & 535 in W.B.	(1000-2000) [3]	35
On Ground PVs	Area A& B: 35 (W.B) Area C: 3200 (W.B.)		
CSP	Area C:2425 (W.B.)	(3500-4500)[2]	200
Wind (100 kW)	Area C: 45 (W.B.)	200,000[1]	673.1[1]
Biogas	27 in W.B.	13462.5 [4]	200

[1]: According to the American Wind Energy Association (AWEA).

[2]: Quora for Business. [3]: Green Econometric Research. [4]: PENRA

5.2.1.1 Pre-Feasibility study for RE Projects

Before launching and implementing a new project, it is essential to run a feasibility study. It is often taken as an indicator of the project's success or failure from financing perspectives. This section presents summaries of the feasibility of some renewable energy projects. The feasibility for R.E.Ts in Palestine was performed based on the data in Table (5.1).

R.E.Ts are used for electricity generation purposes in the commercial sector. In order to estimate electricity produced from each technology, certain assumption must be addressed regarding every type of renewable technology. The important assumptions and calculations are as follows:

1- PV Assumptions

There are many important features for on-ground PV technologies. Not only does it need low initial investment cost, but it also does not incur much maintenance cost. Much of the maintenance work can be accomplished remotely; therefore, the operation and maintenance costs are very low.

The main concern for these units is that the efficiency of the PV system because it is the first constraint in determining amounts of power generated. Assuming that the efficiency of installed PV is 12%; the solar radiation in Palestine is 5.14 kWh/m^2/day; Palestine has 300 sunny days per year; and the electricity price in Palestine is 0.6 Nis which equal 0.167 $.

Assuming that 1 USD = 3.6 Nis.

The efficiency (η) equation is:

$$\eta = (\text{output} / \text{input}) \times 100\%$$

The output energy = 1750 kWh /yr. (based on data for Palestine)

The electricity produced = 1750*0.167 = 291.7 $ /kW /yr.

Table (5.2): Feasibility analysis for 1 kW PV rooftop or on ground installation

Years	year 0	year 1	year 2	year 3	year 4	year 6
PV Income Cash flow $	-2000	256.6	256.6	256.6	256.6	256.6
Years	year 7	year 8	year 9	year 10	year 12	year 13
PV Income Cash flow $	256.6	256.6	256.6	256.6	256.6	256.6
Years	Year 14	year 15	year 16	year 17	year 18	year 19
PV Income Cash flow $	256.6	256.6	256.6	256.6	256.6	256.6

Sample calculation of table (5.2):

Year 0 = investment Cost (-2000 $/KW)

Year 1 = electricity Produced (291.7) – O&M cost (35) =256.6 $/K

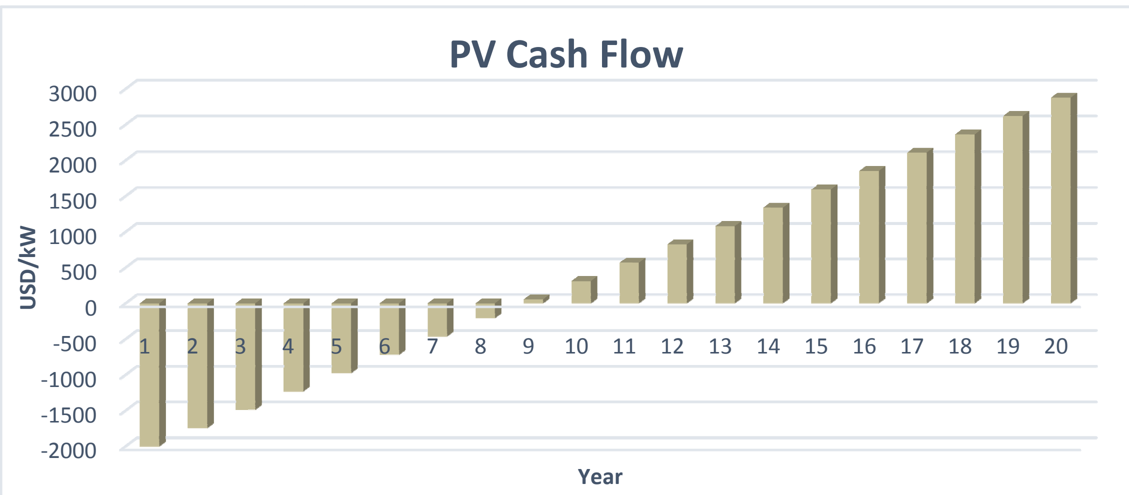

Fig. (5.1): Lifetime Cash Flow for installing PV system for 1 kW.

2- Wind Turbine Assumptions

There are two types of wind energy projects: small scale and large scale projects. For the purposes of building the feasibility study, it was assumed that the wind systems will be installed in Ramallah, Hebron, and Tubas, three cities in the West Bank. These cities have the highest wind speed with approximately 6 m/s as reported by data for Palestine, and so they have the highest power generation potential. According to data in Palestine, the average electricity output for the given cities is = 224.3 MWh/ year. Assuming the installation of a wind turbine with a capacity of 100 kW and a height of 32.5 m, the calculations in such case will be as in following two figures:

Table (5.3): Feasibility analysis for 1 kW wind turbine installation.

Years	year 0	year 1	year 2	year 3	year 4	year 5
Wind Income Cash flow $	-200000	37183.3	37183.3	37183.3	37183.3	37183.3
Years	year 6	year 7	year 8	year 9	year 10	year 11
Wind Income Cash flow $	37183.3	37183.3	37183.3	37183.3	37183.3	37183.3
Years	year 12	year 13	year 14	year 15	year 16	year 17
Wind Income Cash flow $	37183.3	37183.3	37183.3	37183.3	37183.3	37183.3
Years	year 18	year 19	year 20			
Wind Income Cash flow $	37183.3	37183.3	37183.3			

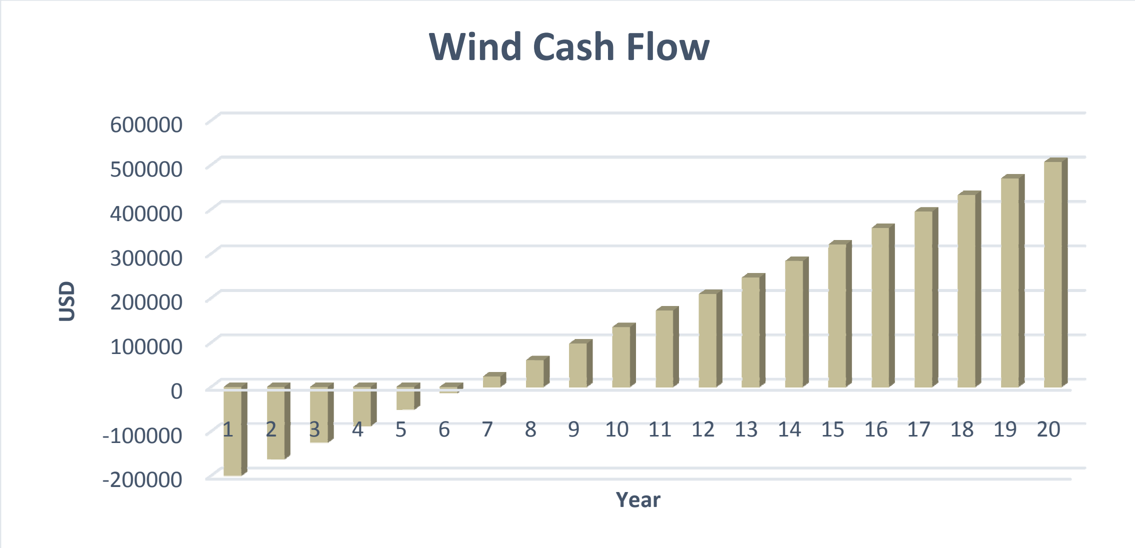

Fig. (5.2): Lifetime Cash Flow for 1 kW Wind Turbine.

3- Biogas Assumptions

The biomass is considered as one of the cheapest available renewable energy sources which can be used to generate electricity. Moreover, the conversion from biomass to electricity is a low-carbon process since the resulting CO_2 is absorbed by the plants. The generated bioenergy types have many uses and features.

If a large system of biogas digester is installed, it is estimated to produce 54 kWh/ day of power. The initial investment for the system is 13462.5 $/ kW. Accordingly, the output electricity ($/yr. kW) is estimated as follows:

Electricity Produced = 54 kWh/day *0.2 $/ kWh *30 day *12 month

= 3333 $/yr. kW

Table (5.4): Feasibility analysis for 1 kW biogas installation.

Years	year 0	year 1	year 2	year 3	year 4	year 5
Biogas Income Cash flow $	-13462.5	2659.8	2659.8	2659.8	2659.8	2659.8
Years	year 6	year 7	year 8	year 9	year 10	year 11
Biogas Income Cash flow $	2659.8	2659.8	2659.8	2659.8	2659.8	2659.8
Years	year 12	year 13	year 14	year 15	year 16	year 17
Biogas Income Cash flow $	2659.8	2659.8	2659.8	2659.8	2659.8	2659.8
Years	year 18	year 19	year 20			
Biogas Income Cash flow $	2659.8	2659.8	2659.8			

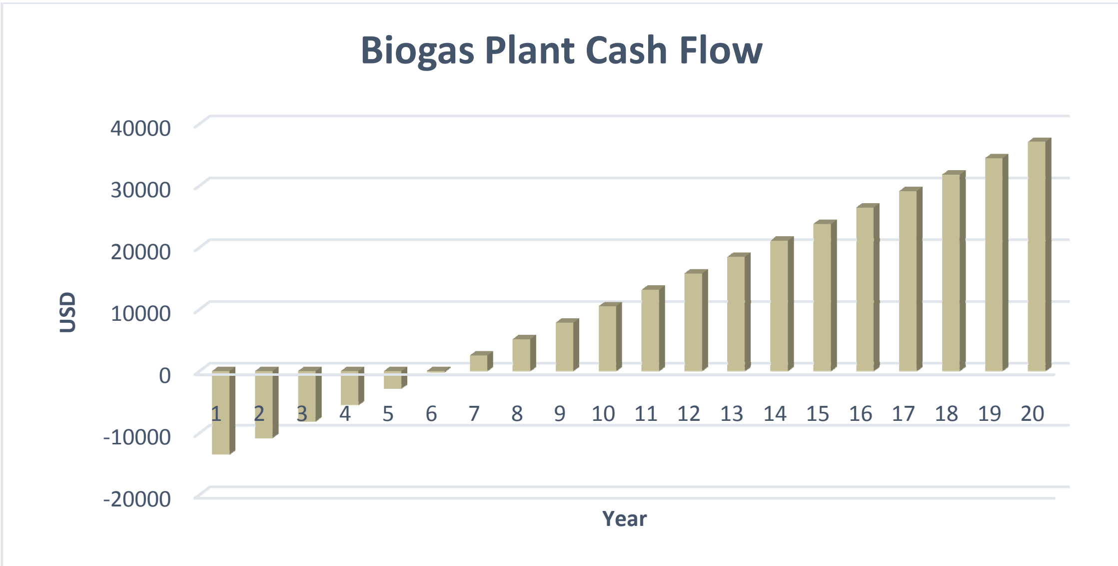

Figure (5.3): Lifetime Cash Flow for 1 kW Biogas System.

4- Concentrating Solar Power (CSP) Assumptions

The Concentrating Solar Power (CSP) systems are divided into many types; these are parabolic trough, solar power tower, enclosed trough, Fresnel reflectors and, Dish Sterling. Assuming that the Parabolic trough CSP is the one to be installed for commercial uses with an efficiency of

CSP is 20%, the electricity produced by CSP considering the price of electricity 0.2 $/kWh is 500 $/yr.

According to these assumptions and calculations, the cash flow for each system, the financial indicators such as the Internal Rate of Return (IRR), and the payback period were calculated. The analysis was accomplished using the Excel software functions. The following graphs and table show the results of the feasibility study. Assuming the project lifetime is 20 years for all technologies.

Table (5.5): Feasibility analysis for 1 kW CSP installation.

Years	year 0	year 1	year 2	year 3	year 4	year 5
CSP Income Cash flow $	-4000	480	480	480	480	480
Years	year 6	year 7	year 8	year 9	year 10	year 11
CSP Income Cash flow $	480	480	480	480	480	480
Years	year 12	year 13	Year 14	year 15	year 16	year 17
CSP Income Cash flow $	480	480	480	480	480	480
Years	year 18	year 19	Year 20			
CSP Income Cash flow $	480	480	480			

Figure (5.4): Lifetime Cash Flow for CSP System.

The summary of the financial indexes, Internal Rate of Return and the payback period of the renewable energy projects is given in table (5.6).

Table (5.6): IRR & PB of renewable energy technologies

Renewable Energy Technologies	IRR%	PP
PV (on ground or rooftop)	**11%**(a)	**7.8**(b)
Wind Turbine	**18%**	**5.4**
Biogas	**19%**	**5.1**
CSP (Parabolic Trough)	**10%**	**8.3**

It can be concluded that the projects are viable since the percentage is less than 20% and the payback period is classified as moderate (6 to 8 years).

The sample calculation of (a) & (b) respectively is as follows:

(A):

$$0 = P0 + P1/(1+IRR) + P2/(1+IRR)2 + P3/(1 + IRR)3 + \ldots + Pn/(1+IRR)n$$

where P_0, P_1 . . . P_n equals the cash flows in periods 1, 2 . . . n, respectively.

In this case P_0, P_1 . . . P_n are extracted from table (5.2); because of complexity of the equation, Excel was used to do the calculation. In this case, IRR =11%

(B):

$$Payback\ period\ (PP) = \frac{Initial\ Investment}{Net\ Annual\ Cashflow}$$

For PV system PP is = $\frac{2000}{256.6}$ =7.8 yrs.

5.2.2 National Renewable Energy Strategy for 2020 Gap Analysis

The Palestinian Energy and Natural Resources Authority (PENRA) developed its strategy document for 2020. According to this document, the required renewable technologies used in Palestine as in the following table (5.7):

Table (5.7): PENRA Strategy for Renewable Energy Installations.

#	Renewables Technology	2020 (MW)	Current Situation 2017 (MW)	Gap (MW)
1	On Ground PV`	25	12	13
2	Rooftop PVs	20	8	12
3	Concentrated solar plants	20	0	20
4	Biogas from landfills	18	0	18
5	Biogas from animal waste	3	0.5	2.5
6	Small-scale wind	4	0	4
7	Wind farms	40	0	40

The last column in the above table shows the difference between the target values in 2020 and the current situation in terms of MW. The values mark a serious gap in adopting renewable technologies.

In order to install renewable projects, it is essential to provide appropriate manpower and investments; therefore, new job opportunities will open to when/if these projects are to be implemented.

When examining the gap between what is projected for 2020 and the current situation, it is important to measure to which extent the goal was **S. M. A. R. T.** The goal is **Specific** and its scope is clear. It is also **Measurable** since the progress in achieving the goal can be meaningfully tracked. However, the goal may not be **Achievable** as the legislation and regulations for encouraging investments are lacking, especially for the on-ground PVs. The goal is **Rationale**; it is clearly evident that in most cases the projected goal is higher than the actual value during the five years (2012-2017). This may mean that it is not reasonable to meet the goal by the end of 2020. The goal is **Time-bounded;** specific dates are set for accomplishing the goals; however, the timeframe does not account for the time needed for the monitoring and evaluation.

The reasons for the wide gap between the current situation and the set goal are:

1- The Political Situation: Israel, an occupying power, prevents importing wind technologies; there are also issues related to land use like the use of highways for transport, checkpoints, and land acquisition difficulties.

2- The Scarcity of Water Resources: as mentioned before in the feasibility study, the CSP is feasible, but the cost remains high compared with PV. Additionally, the CSP needs large spaces and a huge amount of water, which is considered a limitation as Palestine suffers from scarcity in water resources.

3- Biogas: Though this type of projects is feasible but most of the projects remain small. A more "official bidding mechanism" for such projects will open the door for new, large scale investments in biogas thus make the necessary move from planning to the execution phase.

This section has summarized the essential requirements for launching renewable energy projects; it also presented the feasibility of the main types of projects that are suitable for Palestine. This was done with the aim of filling the gap resulting from the PENRA 2020 strategy. The next section will introduce the "Job Creation Opportunities" through renewable energy technologies as one proposed scenario for the future.

5.2.2.1 Employment impact scenario

Job is creation is considered one effect of positive economic and social performance. It allows people to earn income and attain better lifestyle. Like in the case of other developing nations, Palestine suffers from poverty and high unemployment rates. The renewable projects can play a significant role in the social and economic development. In fact, it was claimed previously that the renewable energy projects will contribute to sustainable development. Normally, every new system or technology needs new skill and therefore it creates the need for a new type of job.

Jobs are often divided into two main types:

1- Direct Jobs: these include manufacturing companies and manufacturers who are the suppliers of the components of any system, system developers in the installation and operation phases, maintenance staff, the companies selling electricity, R&D as knowledge transfer, and, finally, the engineering services for the system.

2- Indirect Jobs: these include periodic work for system related activities, e.g. system importing and trading.

New job opportunities can be opened if the strategy were to be implemented, assuming the following:

1- The solar energy can be a major source of career creation. Every Mega Watt Power of solar photovoltaic creates 13 job/yrs. in installation, and 5 in Operation and Maintenance. These jobs vary between white and blue labor, engineers and sale representatives.

2- The CSP generating 1MW will open 6 jobs / MW in installation and 0.3 in Operation and maintenance annually.

3- Wind Farms producing 1MW will open 15 job-yrs. in development and installation.

4- Biogas producing 1 MW will open 11-15 jobs in Plant Management, waste sorting labor, waste transportation labor, operation Management, and maintenance.

Accordingly Palestine could improve its economic situation through the "Green Job Plan" which will contribute not only to developing the energy sector but also to the economic growth on the long run.

According to Sooriyaarachchi, et al. (2015), there are 2 ways to find out about job creation for different RE: 1- the Input/ Output Model. 2- The Analytical/ Employment Factor Method. In order to find out how many jobs RE technology will create, it is important to determine the employment factors, which vary from country to another and often depend on the project size and the value chain for the RE.

The previous assumptions related to job creation were borrowed from Sooriyaarachchi et al. (2015); the researchers reported on the job potentials in RET for Abu Dhabi.

To accomplish the Strategy of the Palestinian Energy and Natural Resources Authority and the future scenarios, it is important to:

1- Develop new regulations and legislation that aim to enhance the renewable energy design and implementation.

2- Design and implement educational and awareness programs about the importance of RET uses from economic, environmental and future security.

3- Apply special funding schemes such as:

   a) Network Agreements such as those forged between the Public and Private sectors.

   b) Cost sharing Contracts: The commercial types of renewable energy projects need large amounts of money which calls for specific cost sharing arrangement from different parties and institutions.

4- Apply capacity building programs for the human resources who will be responsible for installing, manufacturing and managing these systems.

5- Adopt plans for monitoring, evaluation, and strategy tracking: monitoring and evaluation capacity need to be in place in order to make sure that plans are being appropriately implemented.

5.2.2.2 Suggested Scenarios

The proposed scenarios for adopting renewable technologies include:

1- Availability of land areas, especially in area C, will provide the needed space for building the energy projects.

Area C amounts to 61% of the land area in the West Bank area. This area is abundant with natural resources, such as water; it also has potential for new industries like mining and chemical industries because the area is rich in stone and marbles. There is a great potential for new investments and future economic development if it is well exploited.

a) The plans for area C must continue to encourage people to move and live and to encourage industries to relocate in this area.

b) When this materializes, there will be great potential for new job creation in the agriculture, construction, and services sectors

c) If more people move to live there, the opportunities for opening new markets and exporting of products will expand.

d) Road construction and other infrastructure projects will help connect area C to the urban centers, and thus lead reduce inner migration trends from rural to urban areas.

e) These areas will need investment in the electricity and telecommunication infrastructure.

f) The government and the private sector could provide containers for solid waste, which can, in turn, be used in the biomass plants projects.

2- Renewable energy projects will mitigate climate change:

As stated earlier, the ratio of renewable to the total primary energy supply (TPES) is still low not only in Palestine but in the whole world. Increasing the investments in renewable resources will be a an important future scenario for mitigating climate change.

3- Employment impact analysis:

By promoting renewable energy technology, “Green Jobs” will open. The shift towards skilled and professional labor will be the key to success in making the shift to renewable energy production.

5.3 Energy Management Scenario

Energy is not limited to renewable energy; it is important to consider better management options for the electricity sector. In order to reach informed conclusions about this field and to generate future scenarios, the researcher collected data from the Palestinian Electricity Companies about its purchases and sales. A semi-structured interview with PERC was held to collect needed data for further analysis and to examine the challenges facing this sector. The generated data was used to propose solutions for improving the sector.

Table (5.8) shows information about the electricity distribution companies in Palestine; a more detailed table was attached under Appendix C.

Table (5.8): General Information about the Palestinian Electricity Providers

Company Name	Areas Covered by the Company	Number of Subscribers
JEDCO	Jerusalem, Ramallah, Bethlehem, Jericho	230,494
NEDCO	Nablus, Jenin (32 Local Organizations)	98,982
HEPCO	Hebron (6 local org.)	46,497
SELCO	Dora, Yatta, Al-Thahreia (37 local org.)	28,864
TEDCO	Tubas (15 local org.)	17,655

The number of subscribers is the highest in JEDCO with 230,494 subscribers, followed by NEDCO and HEPCO respectively.

Purchases and sales for electricity companies will be studied in this section as important finance indicator and a means to enhance good management practices. The losses in electricity are an important indicator of units lost in distribution and transmission. Losses in Palestine refer to losses in the grid due to transmission and distribution In addition to the losses through thefts. The figures can be extracted from sales and purchases.

Purchases and sales for the Palestinian electricity companies for the years (2013-2016) are presented in the table (5.9):

Table (5.9): Electricity companies purchases and sales for years (2013-2016) in NIS

Year	Electricity Companies	JDECO	NEDCO	HEPCO	SELCO	TEDCO	Total
2016	Sales	1,680,577,874	488,971,860	347,748,434	123,324,016	96,926,400	2,737,548,584
	Purchased	2,200,611,135	594,916,672	428,611,010	180,572,429	122,180,682	3,526,891,928
2015	Sales	1,119,953,304	457,607,545	363,272,131	112,939,511	87,343,621	2,141,116,112
	Purchased	1,497,699,695	548,798,409	411,243,600	168,333,255	104,126,079	2,730,201,038
2014	Sales	1,029,536,156	434,542,751	305,573,781	N.A.	80,897,471	1,850,550,159
	Purchased	1,354,233,484	502,423,864	379,030,800	N.A.	95,569,680	2,331,257,828
2013	Sales	995,568,591	416,414,913	298,962,141	N.A.	73,401,804	1,784,347,449
	Purchased	1,331,372,228	480,234,860	373,086,120	N.A.	85,428,560	2,270,121,768

In table (5.9), the annual losses were calculated for every company in order to examine whether losses are within the acceptable range; it was calculated by using these equations:

Losses (Money) = Purchases –Sales …………………………… (1)

Losses % = (Purchases –Sales) / Purchases ………………………. (2)

Figure (5.5) presents the losses as percentages for the last four years.

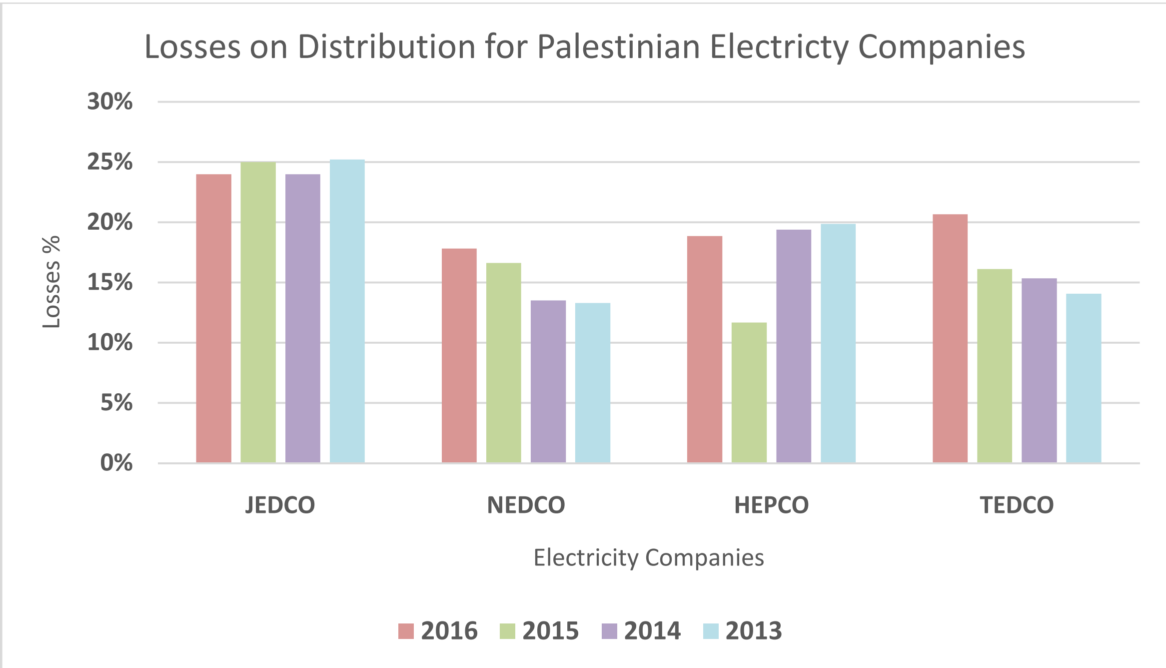

Fig (5.5): The Percentage of Losses for electricity companies in Palestine (2013-2016)

From the figure above, TEDCO and NEDCO losses show increasing trend in the years (2013-2016); The 2015 figures for HEPCO show that it is the closest to the acceptable range of losses.

The electricity purchases percentage for the Palestinian companies for the years (2013-2015) are presented in the following pie chart.

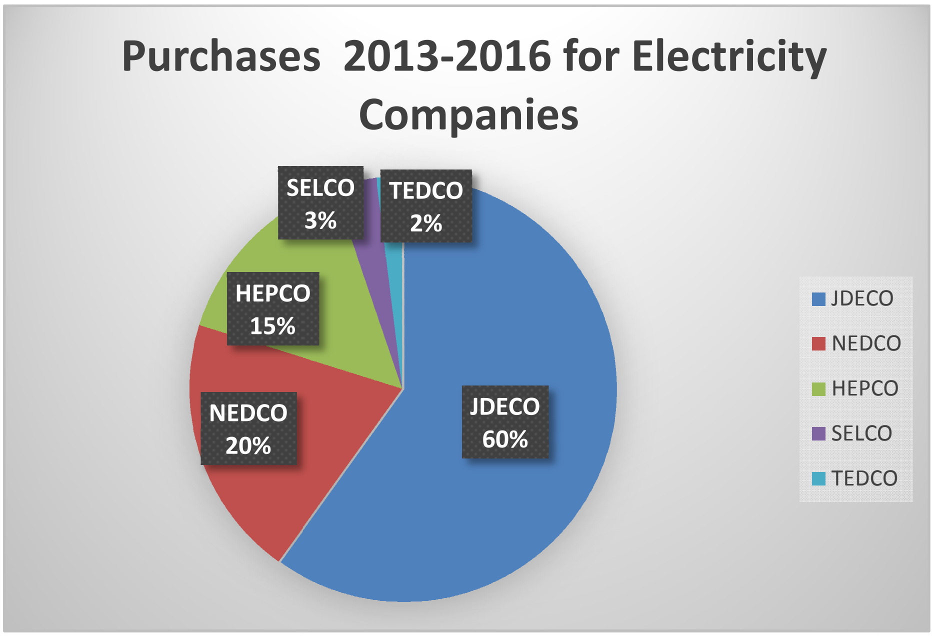

Fig (5.6): Purchases of Electricity in Palestine (2013- 2016)

Figure (5.6) shows that the highest figures of purchases are for JEDCO, NEDCO, and HEPCO respectively. These differences in purchases are attributed to the beneficiaries segment for each company.

The ratio of sales to losses is given in figure (5.7).

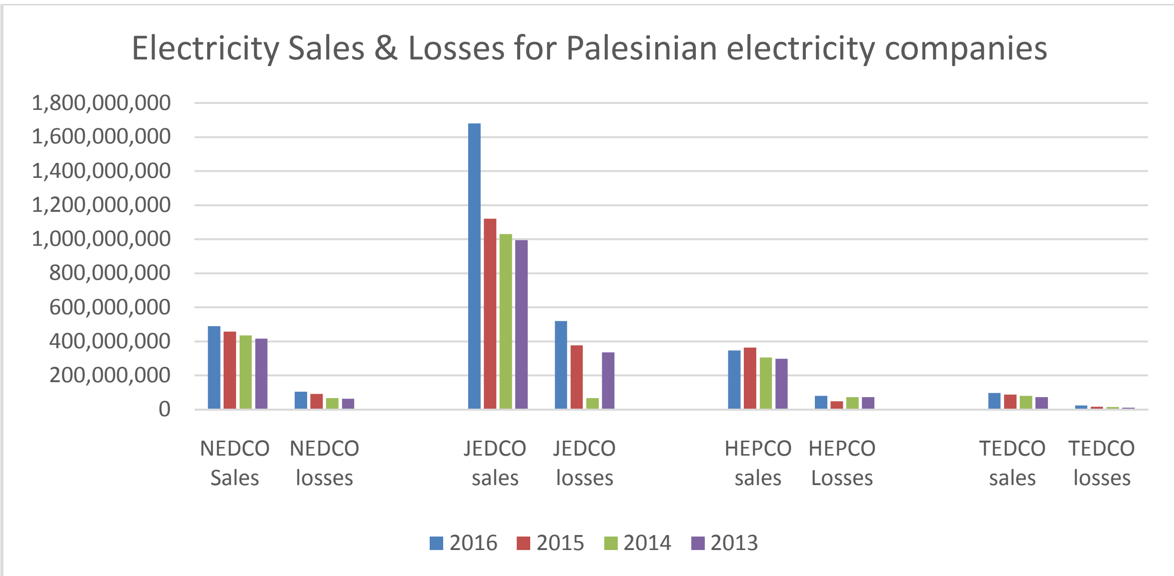

Fig. (5.7): losses to Sales in Palestinian Electricity Companies (2013-2016)

I is important to note that when sales increase, losses also increase. The losses for the year 2016 are estimated at 23% The weighted average is presented in table (5.10)).

Table (5.10): Palestinian electricity companies as weighted average.

	JEDCO	**NEDCO**	**HEPCO**	**SELCO**	**TEDCO**
Sales %	61.4%	17.9%	12.7%	4.5%	3.5%
Purchases%	62.4%	16.9%	12.2%	5%	3.5%

When converting these losses to money, they are equal to 330 million NIS; the number is a big one when compared to the total sales. Therefore, several ways to reduce losses must be implemented. The acceptable range of losses vary between 8% and 12%; if the companies put in place policies and procedures for reducing the 11% losses from thefts and worn out the grid, the savings from this type of loss alone are estimated at 172,173,913 NIS.

The **Obstacles facing the electricity sector in Palestine**

There are several areas in most of northern governorates and Jerusalem that suffer from lack of electricity supply. Al Jalma Power Plant was established to solve the problem of electricity outages; this plant will partially serve Jenin, Tubas, and Tulkarem.

One of the main tasks for the Palestinian Electricity Regulating Council (PERC) is to organize and control electricity supply for the cities. But it is facing many obstacles that prevent it from improving the electricity sector; these obstacles are:

1- Administrative problems

It can be solved through establishing unified administrative procedures and/or through linking PETLE to PERC and establishing a special portal for PERC, PETL, and PENRA that can be used as a tool to better organize the electricity sector.

2- Financial problems

The electricity companies suffer from collection problem; most of the unpaid annual sales are accumulated for several years; these debts are classified as bad liabilities and they constitute a drain on the company assets, especially the unpaid sales from the camps.

3- Technical Problems

The major technical issues that electricity companies suffer from are:

- Power shortage: Diesel generators, gas generator, or renewable energy can solve this problem; but it is still not a far reaching solution and the problem is not totally solved.
- An aging electricity grid: Some of the grids, for example in Jenin, are almost worn out. The Palestinian government and the International Bank must invest more in upgrading the grid.
- Losses and black losses: Losses happen in transmission and distribution processes. In Palestine, the losses are attributed to thefts and losses in

electricity distribution. The acceptable range of losses is estimated at 8% to 12%; however, in Palestine it is estimated at 23%.

4- Legislation and Regulations:

There is lack in the regulations needed to better organize the sector; for example, the regulations for the licensing and the registration of companies are lacking.

Proposed solutions for the losses in the Palestinian electricity companies:

In electricity supply to final consumers, losses are the amounts of electricity related to the transmission and distribution grids that are not paid by users; there are two types of losses:

1- Losses due to distribution and transmission: these can be reduced by using “Power Factor Correction Device” The best scenario ranges from 85% to 90%; when it is less, the losses will increase.

2- Losses from thefts and the worn out Grid:

- Replacement strategy for all worn out grids.
- Replacement for all worn out gages.
- Installing a system that measures the power of the electricity company on the entrance of all buildings, and calculates any variance. In case

there is a difference in the readings of the systems, that means something is going wrong. The company can identify the line causing it

- A judicial system to impose penalties for theft.

5.4 The Palestinian National Energy Efficiency Action Plan (NEEAP) Gap Analysis:

The NEEAP strategy was approved in 2012; its goal is to achieve the target of 5% reduction in electricity consumption by 2020. The action plan will be executed in three phases. Each phase will be achieved by dividing the target supply of energy in GW over a specific period of years.

In Chapter four, it was established that 50% of energy consumption is used for the residential sector. The forecasting model of energy consumption (2016-2030) shows an increasing trend in the amounts used for residential use. For these two reasons, it is an essential step to search for energy efficiency tools to achieve savings from the building sector; table (5.11) below shows that the significant savings will come from commercial and industrial buildings.

Table (5.11): Energy savings allocated to target sectors (NEEAP, 2010; Unpublished Data)

Sector	Target Savings form total energy consumption GWh		
	Phase 1 (2012-2014)	Phase 2 (2015-2017)	Phase 3 (2018-2020)
Building	38	130	195
Industrial	5	6	8
Water Pumping	-	1	1
Total	43	137	204

The table (5.11) represents the target for saving in GWh across sectors. The expected savings will be implemented over three phases, which extend for the period of six years. An interview was made to examine the achievements from the action plan. Phase 1 was met, with an extra 10 GWh in savings. The target for phase 2 was partially completed at 75% (about 103 GWh). The final phase (2018-2020) was delayed until phase two is completed.

The following figure shows the current and desired future state to identify gaps in implementation; best practices are projected.

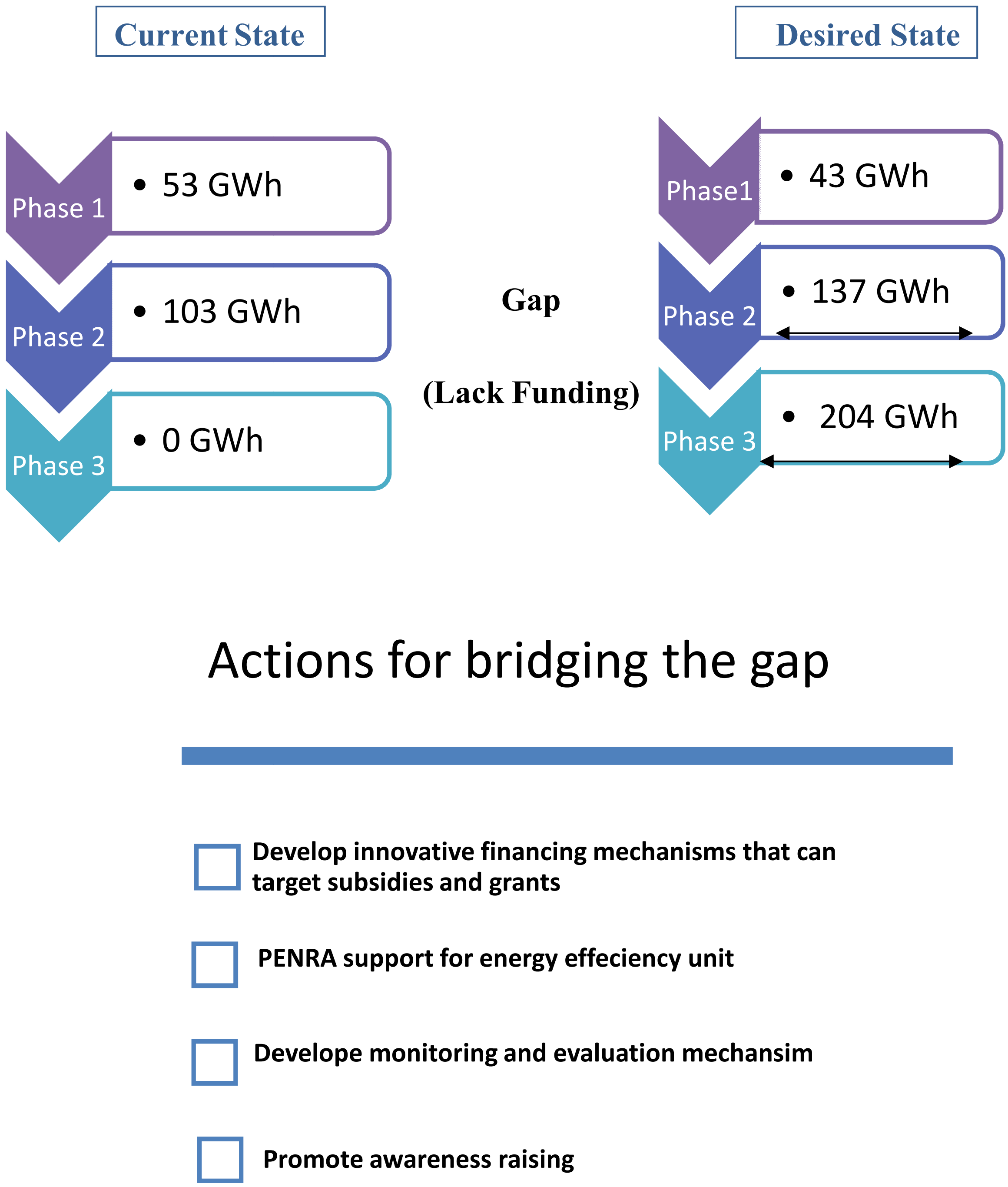

Fig. (5.8):Gap Analysis of the NEEAP

From the figure (5.8), it's apparent that the main difficulty in achieving NEEAP target is the shortage in funding. The main action to bridge this gap is supporting PENRA to speed up the implementation by allocating more resources. This step should be accompanied by a comprehensive public education and awareness campaign about the methods and benefits of energy conservation.

Also the “Losses in Distribution Network” was mentioned in the NEEAP. The percentage of losses for 2010 was estimated at 20%; it is expected to reach 16% by 2020. In a previous section, the losses were estimated at 23% in 2016; there is a high deviation between the current amount of losses and the target value, the deviation was calculated at 30.4%.

The 30.4% was calculated using the formula of Percent Deviation:

$$Deviation = \left(\frac{V1}{V2}\right) * V2$$

Thus, the actions to bridge this gap should take first priority on the agenda for PENRA, PERC, and the Energy Efficiency Unit. Much effort should go into improving and implementing energy efficiency programs.

5.5 Developing a Strategic Business Model for the Energy Sector

In this section, the researcher developed a strategic business model for the energy sector in Palestine. As mentioned in the literature review, the main elements to be taken into consideration when developing a business model are the value proposition, key resources for enhancing the energy sector, market characteristics, value chain/architecture, and the revenue model.

The suggested strategic business model will help PENRA build a more systematic process for delivering better services and implementing energy projects, especially those focusing on utilizing the renewable energy resources.

This model consists of the futuristic and suitable value chain for renewable energy types in Palestine. The revenue model was drawn by listing the possible ways to gain more from selling energy and the setting up of guides and policies to better organize it. The model also takes into consideration the consumers relations as well as PENRA capabilities; finally, the value architecture /proposition was drawn using a number of value creation steps for the energy sector..

The proposed Strategic Business Model is given in Figure (5.9) below.

The Value Chain for Renewable Energy

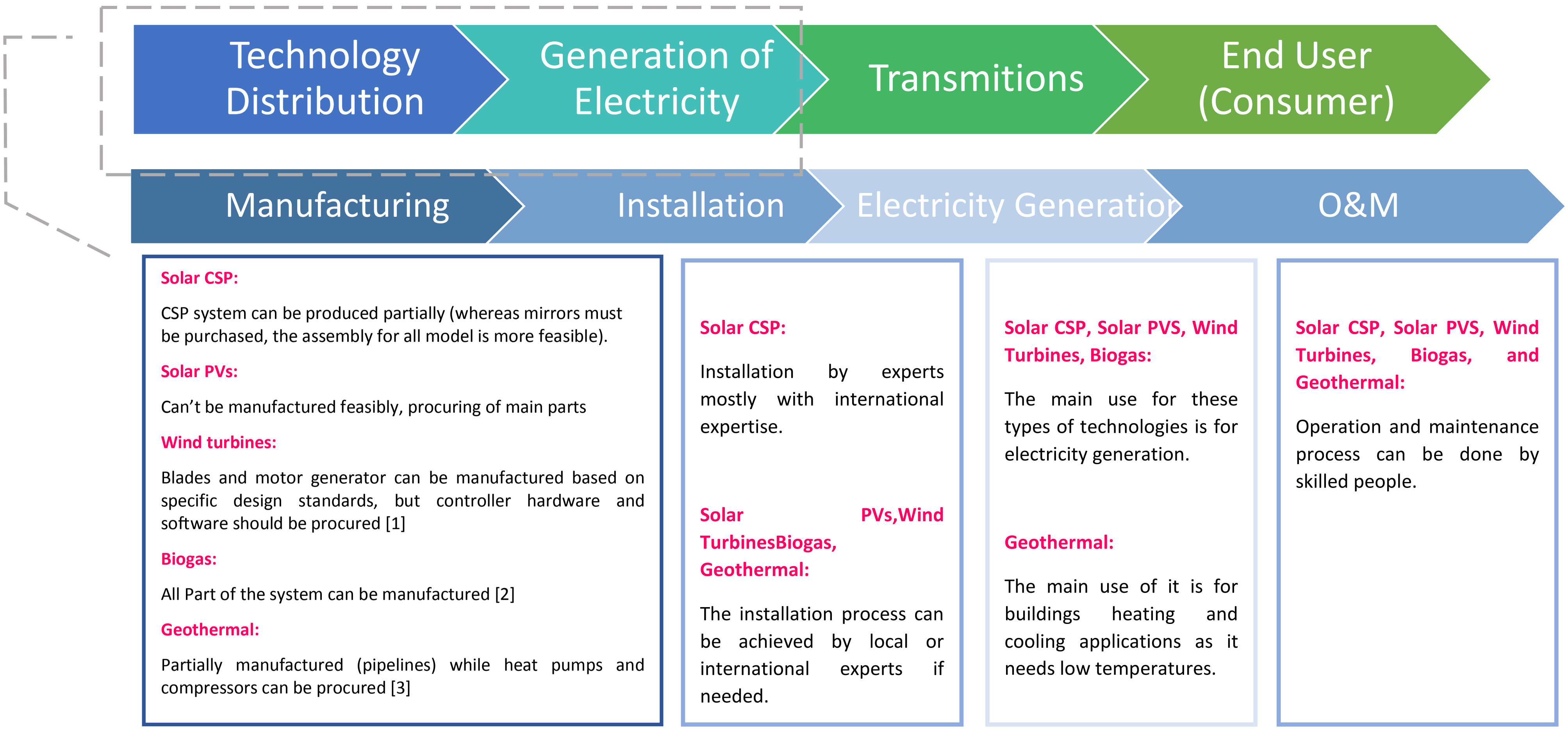

Fig. (5.9): Proposed value chain of the renewable energy sector in Palestine.

[1]: Blades manufacturing requires high professional experts; accordingly, the best solution is to open markets for manufacturing some parts and purchasing blades. This way the assembly process is considered more feasible. R&D is needed for continuous improvement and effective utilization.

[2]: The biomass generator cannot be manufactured; therefore, purchasing it is more feasible. While the Digester and the Diesel engine can be produced locally.

[3]: Geothermal has potential in Palestine but there is low demand on it; the geothermal is better suited for rural and cold areas rather than urban cities. Ramallah rural areas are the best location for this type of R.E.T.

Figure (5.9) mentioned the overall energy value chain in every economy but it focused on the renewables that have potential in Palestine. The value chain for renewables covers the manufacturing, operation and maintenance phases. It is obvious that new investments in renewable energy projects will open new markets for manufacturing; special assembly firms will be open as operation and maintenance work must be done on periodic basis; Skilled labor is needed; therefore, there will be permanent or temporary .job creation possibility for these new projects.

The core value proposition for PENRA is to regulate renewable and electricity Sector by devising relevant laws, policies, standards and best practices for the electricity companies in Palestine.

The main aim is to generate energy locally, which will lead to sector independency and reduce the national bill. The end result will lead to:

- Creating more Green Jobs.
- Recruiting more skilled people.
- Linking taxes to consumption system where less consumption means more incentives.
- producing investment guide for renewable energy projects.
- Conducting R&D activities as knowledge transfer.

It is not only the feasibility and IRR index which are considered as indicators of value proposition; the values that boost clean energy can also help investors make decisions about project selection and implementation. The value system is essential to provide a complete framework for effective business evaluation.

Values

VALUES TO BE SPREAD:

◊ ENCOURAGING LONG-TERM ACTIONS AND INITIATIVIES

- ✓ ECONOMIC VALUES (WRITTEN LEGISLATIONS)
- ✓ ENVIRONMENTAL VALUES (ENVIRONMENTAL RULES)
- ✓ AWARENESS CAMPAIGN
- ✓ BENEFITS OF STAKEHOLDERS RELATIONS
- ✓ BENEFITS OF REDUCING FEES FOR EMISSIONS
- ✓ BENEFITS OF REGULATORY CHANGE.

Figure (5.10): Values to be adopted by PENRA and policymakers in Palestine. (Part of S.B.M)

Regulatory change is a necessary step that can help obtain new technologies. The soft and hard skills of people who work with the energy sector must be included in these changes.

Regarding emissions reduction; it is well known that renewable energy sources produce lower emissions. The proposed scenario is to set the legal frames which make it compulsory for firms to gradually reduce emissions to reach the target percentage standards. Another way of dealing with emissions can be achieved by giving priority to the utilities which have lower emissions to sell their excess power production to the market. To achieve higher profits and less environmental damage taxes must be imposed on higher emissions which exceed the Threshold for CO_2 emissions.

Revenue Model (PENRA Perspectives)

THE COST STRUCTURE SHOULD BE DEFINED BY **PENRA** FOR:
RENEWABLE ENERGY COMPANIES AND **ELECTRICITY COMPANIES** THROUGH DEFINING CLEAR PRICING STRATEGY AND SPECIAL NATIONAL LAWERENCE LEAFLETS.

THE TARGET: NATIONAL BILLS REDUCTION → LOSSES REDUCTION THROUGH:

◊ APPLYING **NATIONAL ENERGY EFFICIENCY PLAN**TO CREATE COMMITMENT TO REDUCE ENERGY USE IN HOMES, SCHOOLS AND OTHER ORGANIZATIONS; A SET GUIDES FOR BEST PRACTICES FOR CUSTOMERS REGARDING ENERGY USES AND COSTS.

◊ STATE **REAL NATIONAL STRATEGY** TO REGULATE THE SECTOR AND PREVENT THEFT OF ELECTRICITY

◊ **RENEWABLE ENERGY PROJECTS:** DEFINED UNIFIED TARIFF STRUCTURE ESPECIALLY FOR SOLAR PROJECTS AND ENERGY MANAGEMENT PROJECTS.

Figure (5.11): The proposed revenue model for energy sector in Palestine (Part of S.B.M).

Another value that influences the sector is recognizing the importance of stakeholder relations and developing corporate responsibility practices to be adopted by energy utilities. Strong relationships with stakeholders lead to higher productivity, lower turnover rates, and enhanced trust between stakeholders.

PENRA should focus on an awareness campaign which targets consumer and producer values. Awareness can be raised by implementing educational programs for schools, climate change effects programs for companies, and programs about the potentials of renewable energy sources at homes.

In the energy sector, the revenue streaming comes from selling electricity to the grid. Increasing the savings in the sector should become one main priority.

New collection arrangements and establishing a suitable tariff system can help improve the revenue stream. Devising special collection schemes for rural and poor areas can also help better manage the rising debt figures.

Chapter Six

Conclusions, Recommendations, and Future Studies

Chapter Six
Conclusions, Recommendations, and Future Studies

6.1 Overview

This chapter presents the main conclusions of this research. In addition, it gives recommendations for adopting alternative scenarios to improve the energy sector in Palestine; it also summarizes the factors that affect energy consumption. Finally, the research contributions to current literature and suggestions for future studies are discussed in this chapter.

6.2 Research Conclusions

Firstly, the main factors which affect energy consumption and demand in Palestine are the GDP, GNI, and population growth. The multiple linear equations in Chapter Five have shown how these factors influence each other, the equation is then used to forecast future energy demand in Palestine for the next two decades.

The employment status in Palestine is another factor that can be studied in addition to the six factors which were examined in this research; the standard of living in Palestine is yet another important indicator. These two factors deserve further attention in future studies.

Additionally, the energy primary flow of the input-output model was generated for the West Bank for the year 2015. This diagram could be imitated to provide important data about the consumption of different energy types in a region. Further studies are needed on applying the input-output matrix at regional or country level; the matrix could be used as a planning tool at a macroeconomic level.

Main Conclusions

1- From energy sources mapping over economic sectors, it was clear that renewable energy sources have a low contribution; the proposed pre-feasibility estimated the payback period from 6 to 8 years for new renewable energy projects.

2- Decision makers and investors have a main role in improving the energy sectors by making regulations and initiating awareness campaigns.

3- The forecasting model shows an increasing trend that will reach to 159,424.6 TJ in 2030.

4- The main scenarios for improving the energy sector are to exploit the availability of area C which covers approximately 60% of The West Bank area.

5- The renewable energy projects will create new type of jobs, especially for skilled labor. Therefore the job impact analysis is topic which is worth investigation in future research.

6- Energy management tools such as power factor correction device should be adopted, as electricity losses in Palestine need a root solution.

7- If losses are decreased to the acceptable level at 12%, savings can be estimated by 172,173,913 NIS.

8- A strategic business model should be adopted by PENRA for future development of the energy sector.

6.3 Research Recommendations

The first essential recommendation is to establish a database for energy and renewable resources which could provide researchers with essential statistics about this sector. It is recommended that the database should contain energy use per dollar worth for Palestinian economy sectors, institutional data about PENRA, PERC, PETLE and the electricity companies in Palestine, in addition to other relevant data about the energy sector.

Another recommendation has to do with providing further classification of the uses of energy. For example, there is data about the residential uses, but the energy uses in food industry is not available. Further classification of the energy uses can make it easier for researcher to prepare useful studies about the energy sector.

A third recommendation for PENRA is to establish a policy unit or department.

Finally, it is recommended to generate **wind- solar atlas** for the coming 30 years; this resource will allow the government and researchers to predict the potential sources of renewable energy.

6.4 Limitations and Challenges

The Energy Project barriers are:

1- Financing difficulties, e.g. power purchases agreements, ownerships problem, sustainable implementation of technology, funding for infrastructure, etc.)

2- Poor economic of scale

3- Securities regulations

4- Political challenges

5- Unfavorable power payback rates for some types of energy

6- Communication and alliances requirements

There are many limitations that the researcher faced in her work:

1- The scarcity of references on energy and renewables, especially when it comes to the context in Palestine.

2- Sources and raw material and data are dispersed; this point affects the study; it causes a gap between key stakeholders in the energy sector.

6.5 Future Studies Overlook

The ideas for future research and work can be summarized as follows:

1- The Input-Output Model is an old model but it can provide for a new trend in studying the Palestinian economy in general and the energy sector in particular. This is due to the fact that energy in our country needs more investigations as an issue of interest.

2- Studying the factors that affect the energy sector in Palestine for every sector on its own.

3- The Public and Private Partnerships and their role in enhancing the energy sector is another rich area for scientific research.

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Appendices

Appendix (A)

Interview questions for PETLE

1- Date of the establishment?

2- What is the added value of establishing the company?

3- What are the current and future vision of the company?

4- What are the risks that company face (economically, politically, and technologically)?

5- How are R.E. projects funded?

6- Geographical coverage area in providing company services?

7- What is the futuristic development plan regarding energy Projects?

8- What are the total capacity for the year 2015 for the following?

- PVs:
- Wind Projects:
- CSP:

And how these capacities distributed in the economic sectors (Residential-Industrial –Agricultural and commercial)?

- Question (8) is a repeated question for **PENRA** and **General directorate of Petroleum.**

Appendix (B)

Electricity tariff in Palestine for years (2011-2015)

Electricity Prices					
Consumption Category	**Tariff 2011**	**Tariff 2012**	**Tariff 2013**	**Tariff 2014**	**Tariff 2015**
Residential	-	0.67	0.73	0.73	0.65
from 1-100 kWh	0.50	-	-	-	-
from 101-200 kWh	0.56	-	-	-	-
More than 200 kWh	0.59	-	-	-	-
Commercial	0.64	0.75	0.80	0.80	0.71
Industrial	0.55	0.60	0.65	0.65	0.59
Agriculture	0.53	0.55	0.60	0.60	0.55
Temporary	0.87	0.95	0.99	0.99	0.90
Street Lightening	0.52	0.54	0.58	0.58	0.52
Water Pumps	0.59	0.54	0.65	0.65	0.52
Villages and jointing points	0.56	0.58	0.65	0.65	0.54
Medium Voltage	0.51	0.54	0.59	0.59	0.50
Residential Prepaid	0.57	0.62	0.68	0.68	0.57
Commercial Prepaid	0.63	0.72	0.76	0.76	0.68
Temporary Prepaid	0.87	0.95	0.99	0.99	0.90

Appendix (C)

General Information about Palestinian Electricity Companies

Company Name	Year of Establishment	Areas Covered by the Company	Linkage Points	Number of Subscribers	License
JDECO	1914	Jerusalem, Ramallah, Bethlehem, Jericho	48 from the Israeli National Power Company and one from a Jordanian transferring company	230,494	Permanent License
NEDCO	2008	Nablus, Jenin (32 Local Organizations)	13 from the Israeli National Power Company	98,982	Temporary License
HEPCO	2005	Hebron (6 local org.)	7	46,497	Not Licensed
SELCO	2004	Dora, Yatta, Al-Thahreia (37 local org.)	17	28,864	Not Licensed
TEDCO	2006	Tubas (15 local org.)	1	17,655	Temporary licensed

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قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

2018م

بناء نموذج أعمال استراتيجي لقطاع الطاقة في فلسطين

دراسة استكشافية

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الملخص

يعتبر قطاع الطاقة المحرك الأساسي في اقتصاد الدول، و ذلك لتقاطعه مع القطاعات الصناعية والخدماتية و قطاع الاسكان. إن التطور المتنامي و اللامتناهي في قطاع الطاقة و اللجوء إلى مصادر طاقة نظيفة ومستدامة و معرفة العوامل التي تؤثر على استهلاك الطاقة في فلسطين، يعتبر الهدف الأساسي لهذه الدراسة.

تهدف هذه الدراسة لتقييم قطاع الطاقة سواء (الأحفورية أو المتجددة) في فلسطين، لدراسة أوجه و فرص استخداماتها المختلفة.

يواجه قطاع الطاقة في فلسطين عدة مشاكل بسبب غياب الوعي العام لأهمية التحويل الى استخدام أنظمة كفاءة الطاقة، وإنشاء مشاريع الطاقة المتجددة كالطاقة الشمسية و تحويل النفايات العضوية إلى طاقة و بحث الفرص و الامكانيات لتنفيذها، إذا ما تكاتفت العوامل و المستثمرين المحليين و الدوليين للنهوض بالقطاع و التي تم توضيحها مفصلا بهذه الدراسة.

كما وتم إلقاء الضوء على العوامل المؤثرة في استهلاك الطاقة في فلسطين وهي عدد السكان، و جودة الحياة على اعتبارأن معدل الدخل القومي الاجمالي مؤشر لتقييم جودة الحياة، بالضافة إلى الناتج القومي الاجمالي. و بناء معادلة التنبؤ في استهلاك الطاقة في فلسطين للسنوات القادمة (2016–2030).

بالتزامن مع الهدف الأساسي، فقد تم دراسة أهم المشاكل التي تعيق التطور في قطاع الطاقة و بحث فرص إنشاء مشاريع طاقة متجددة من خلال دراسة الجدوى. كما تهدف إلى تقييم مدى تنفيذالخطة الاستراتيجية للطاقة و خطة عمل كفاءة الطاقة، و وضع الممارسات الأمثل للتطوير.

وأخيرا تم بناء نموذج أعمال استراتيجي يدمج بين سلاسل القيمة في الطاقة و طرق زيادة عائدات القطاع جنبا الى جنب لمحاولة تقليل الاستهلاك و وضع التشريعات و القوانين اللازمة لتتبناها الجهات المسؤولة.

تم استخدام المنهجية المختلطة، الكمي و النوعي في البحوث العلمية. والتي تم تنفيذها من خلال اجراء عدة مقابلات مع خبراء في قطاع الطاقة و مدراء تنفيذين في شركات الكهرباء و سلطة الطاقة والموارد الطبيعية الخ.

من خلال هذه الدراسة تم التوصل إلى أن استهلاك الطاقة في السنوات القادمة متزايد بشكل واضح، مع وجود عدة مشاكل لإدارة هذا القطاع لهذا السبب تم تطوير نموذج استراتيجي يبحث طرق التطوير لمواكبة هذا التزايد في الطلب على مختلف أنواع الطاقة.