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Faculty of Tropical AgriSciences

Energy situation in Palestine - the prospect of agricultural residual biomass in energy marginalized areas

BACHELOR'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled «Energy situation in Palestine - the prospect of agricultural residual biomass in energy marginalized areas» independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 06.08.2021

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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BACHELOR THESIS ASSIGNMENT

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Tropical Agriculture

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Thesis title

Energy situation in Palestine – the prospect of agricultural residual biomass in energy marginalized areas

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Objectives of thesis

A major energy-goal of the Palestine government was to generate 10% of electricity from renewable sources by 2020. Most of the energy used in Palestine is imported from neighbouring countries, likewise its fossil fuel. Arguments arose for the sustainability of Palestine's energy importation as it is not cost effective as well as the environmental concerns of energy from fossil fuel. The overall aim of the present Thesis is to review the country's energy situation, challenges, development and application of renewable sources. As agriculture is the mainstay of the Palestine economy, and studies have shown that due to the predominance of agriculture, residues from agricultural processes as well as agro-industries can be a source of energy to alleviate the energy poverty in the country; therefore, the specific objective of the work is to investigate the fuel-energy potential of residual biomass.

Methodology

The majority of the Thesis will be written as a literature review based on scientific articles searched from the databases like Web of Sciences, ScienceDirect as well as Palestinian governmental sources. In order to fulfill the specific objective, this study, thus, will collate secondary data on biomass use since 2016 to assess its contribution so far and the future prospects. Other possibilities include the quantification of olive cake waste generation and the identification of the fuel properties to recommend conversion and utilization techniques for these waste materials. Other indicators for olive are hectares cultivated, yield, ration of yield to waste generation, and other statistical data.

The proposed extent of the thesis

approx. 25 pages

Keywords

State of Palestine, renewable energy, agricultural residues, energy dependency, biomass energy yield

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Recommended information sources

Abu Hamed T, Flamm H, Azraq M. Renewable energy in the Palestinian territories: Opportunities and challenges. Renewable and Sustainable Energy Reviews. 2012 (16): 1082–1088. doi:10.1016/j.rser.2011.10.011

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Juaidi A, Montoya FG, Ibrik IH, Manzano-Agugliaro F. An overview of renewable energy potential in Palestine. Renewable and Sustainable Energy Reviews. 2016 (65): 943–960. doi:10.1016/j.rser.2016.07.052

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Abstract

The situation of energy in Palestine, is an embarrassing and sensitive situation where the Palestinians suffer from terrible conditions on the political and economic stages, where the Palestinian market is monopolised by the Israeli occupation for the fossil fuels plus, the Palestinians are supplied with electricity by the Israeli electricity companies, which led them to control the market and the reason behind the high prices of traditional energy sources, and its implications for energy prices, in addition to that weakness of the network infrastructure, accompanied by the increase of population growth in Palestine is one of the most important obstacles that can lead Palestinians to seek a solution to this problem by including renewable energy, which can play an important role in Palestine to reduce the sources of energy wasted from solar energy and wind, as well as the vital mass for the production of energy from agricultural waste, which could be the future solution for two important reasons, one for energy production and the other for disposal.

The thesis describes the importance of agriculture especially olive cultivation which is one of the most important trees in Palestine of high value, here are some facts that define the calorific value of olive prunings vary between 16.7 and 19.8 MJ/kg, for olive stones 18.8 and 20.9 MJ/kg, for pomace 13.8 to 15.8 MJ/kg (García Martín et al 2020) and 13.39 to 15.90 MJ/kg (wafa 2021).

Keywords: State of Palestine, renewable energy, agricultural residues, energy dependency, biomass energy yield

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2. Introduction

The global dependency on fossil fuels has been a concern of many governments, policymakers, and researchers alike for a long time. It re-emerges more acutely with every oil price spike, and so do calls for the use of renewable sources of energy. Since Palestine is a developing nation, its reliance on energy is essential to achieve economic growth and development (Abu Hamed, Flamm, and Azraq 2012a). Palestine is faced with many challenges such as electricity not being provided through domestic means but is rather provided through Israel which controls the quantity and quality of energy imported (Ibrik 2009). The complete dependency on Israel for its energy needs puts Palestine in a vulnerable position given its complex political and security situation. Such a threat has given rise to the importance of using renewable energy such as solar, wind, geothermal, and biomass (Ibrik 2009). Renewable energy can offer Palestine many benefits which will not only reduce conventional energy consumption and harmful emissions but also will help to achieve sustainable development for Palestine which has limited natural resources (Abu Hamed, Ismail, and Alshare 2017a).

Agriculture plays a colossal role in the daily life of the Palestinian people and olive oil makes up a considerable part of it. Olive trees are well adapted to climate and soil conditions in Palestine, where they have been at the basis of economic household and commercial activity for centuries. Given the challenges, Palestine faces with its energy demands and supply due to the political conflict in the region, it has become important to realize alternative resources that would provide energy while preserving the environment. Therefore, there could be a great potential in the use of olive residues - the solid olive waste, to generate electricity and at the same time help to protect the environment by eliminating the hazardous effect of wastes when disposed of untreated (Abu Hamed, Ismail, and Alshare 2017c). Hence this Thesis targets quantifying the residual olive biomass, i.e., olive tree pruning biomass as well as olive oil processing biomass, to estimate their energy potential which will be of great value for the economy and the energy sector in Palestine (Abu Hamed, Ismail, and Alshare 2017).

3. Aims of the Thesis

This thesis aims to present the current situation of agriculture, the resulting agricultural waste, and the possibility of exploiting these wastes in generating energy. Ecology, energy, and economics are among the highest concern of the Palestinian National Authority and Palestinian society. Agriculture, the most important economic sector in Palestine should be developed by improving the use of environmentally friendly energy sources, for the significant realization of sustainable production and consumption.

With a focus on olive cultivation in Palestine, considering olives as one of the most important and valuable products in the Palestinian economy, as well as of historical importance too, where the focus has been on olive cultivation and agricultural industrialization in recent years, which created a product of waste that can be exploited and converted into energy for the benefit of the farmer, society, and industry in general in a country poor with energy sources.

Describing the Assessment of Energy potential of Agricultural biomass in Palestine by calculating the biomass which caused by the waste of the crops, concentrating on the oil waste such as prunings, olive stones, pomace that is which a high value for energy, and high value for the economy as well.

4. Methodology

The main source of data used here is Palestinian government reports and published statistics, scientific articles (obtained from searches on Web of Knowledge, Google Scholar, and Scopus databases), overviews, and data from FAO and the World Bank Group. These sources contributed to the description of the location and mapping out of the current situation and the possible energy application of the olive residues under study.

The estimation of the energy yield of olive residual biomass in Palestine per year was the main objective of this thesis and it was achieved by first quantifying the olive residual biomass. The quantity and the calorific value of the materials were used to derive the energy potential. The methods of García Martín et al (2020) are modified and adopted for this calculation. Simply put:

1ha of olive grove = 3t of prunings + 0.6t olive stones + 1.73t of pomace (1)

The equation for the energy potential/energy yield of residual biomass was designed following the methodology of Beňová et al. (2021):

$$E_{pc} = T_p \times Q \quad (2)$$

E_{pc}—annual energy potential of residual biomass of the country, TJ; T_p—total annual residual biomass production of country, t; Q—average calorific value of residual biomass, TJ/t. (1MJ/kg = 10^{-3}TJ/t). The energy potential estimates are also expressed in watthour (unit of energy consumed per hour), i.e., TWh as 1 TWh is equal to 3600 TJ.

The Palestinian Central Bureau of Statistics (PCBS), Ministry of Agriculture, (2020) gives an estimation of the number of mills in each governorate and the quantity of olives pressed. In this study, it is assumed that all the olives processed in each governorate was also harvested therein. Thus, the distribution of residue production and energy potential is estimated as shown in the table below. From the data obtained from PCBS, the ratio of quantity of olive pressed in one governorate to total pressed in Palestine was calculated. This ratio was used to estimate the quantity of residues and energy potential of each governorate using equation (3) as derived from Beňová et al. (2021).

$$E_{pr} = (T_p \times k \times Q) \quad (3)$$

where: E_{pr}—annual energy potential of residual biomass of the governorate, TJ; T_p — total annual residual biomass production of country, t; k—constant/share of residual biomass or residue ratio. Here the ratio of the total quantity of olive pressed in Palestine calculated for each governorate is used as k. i.e.,

$$k = \frac{qty.of\ olive\ pressed\ in\ a\ governorate}{total\ qty.of\ olive\ pressed\ in\ Palestine} \quad (4)$$

5. Literature Review

5.1. Palestinian location and population

Palestine's geographic location places it at the crossroads of three continents: Asia, Africa, and Europe; as it is situated in the southwestern part of Asia, on the southeastern coast of the Mediterranean, and in the northeastern part of Africa. Palestine is located on the Arab world's Asian flank, in the Levant region, which comprises Palestine, Jordan, Syria, and Lebanon. Because of its location on the Mediterranean Sea, Palestine serves as a sea link between the Middle East and Europe. Palestine's strategic importance stemmed from its geographical location allowed it to control water bodies, thus leading to rivalry between invaders and colonizers for control (Mounir et al. 2021).

Palestine is also considered as one of the most significant places in religion, geography, and archaeology; its area where the West Bank borders are surrounded by Israel is more besieged from the north and south as well as from the west, while the east is bordered by the Jordan River (World Atlas 2021; WorldAtlas 2021). See the location and division of Palestine in Figure 1.

The total area of Palestine is 6,025 km^2, its population is concentrated in the West Bank and Gaza Strip with about 5,227,193 people (Palestinian Central Bureau of Statistics 2021a). The West Bank occupies an area of 5,660 km^2 with a population of 3,120,448 inhabitants, while the Gaza Strip has a higher population density with a population of 2,106,745 and a land area of 365 km^2 (Palestinian Central Bureau of Statistics 2021).

Administratively Palestine is divided into 16 governorates, and the governorate is considered as the highest level in the administrative structure of the administrative divisions in Palestine so that one governorate includes many population centers. There are 11 governorates in the West Bank and 5 in the Gaza Strip. The West Bank region includes the governorates of Jenin, Tubas, and the northern Jordan Valley, Tulkarm, Nablus, Qalqilya, Salfit, Ramallah and Al-Bireh, Jericho and the Jordan Valley,

Jerusalem, Bethlehem, and Hebron. While Gaza Strip comprises North Gaza, Gaza, Deir al-Balah, Khan Yunis, and Rafah (Palestinian Central Bureau of Statistics 2018).

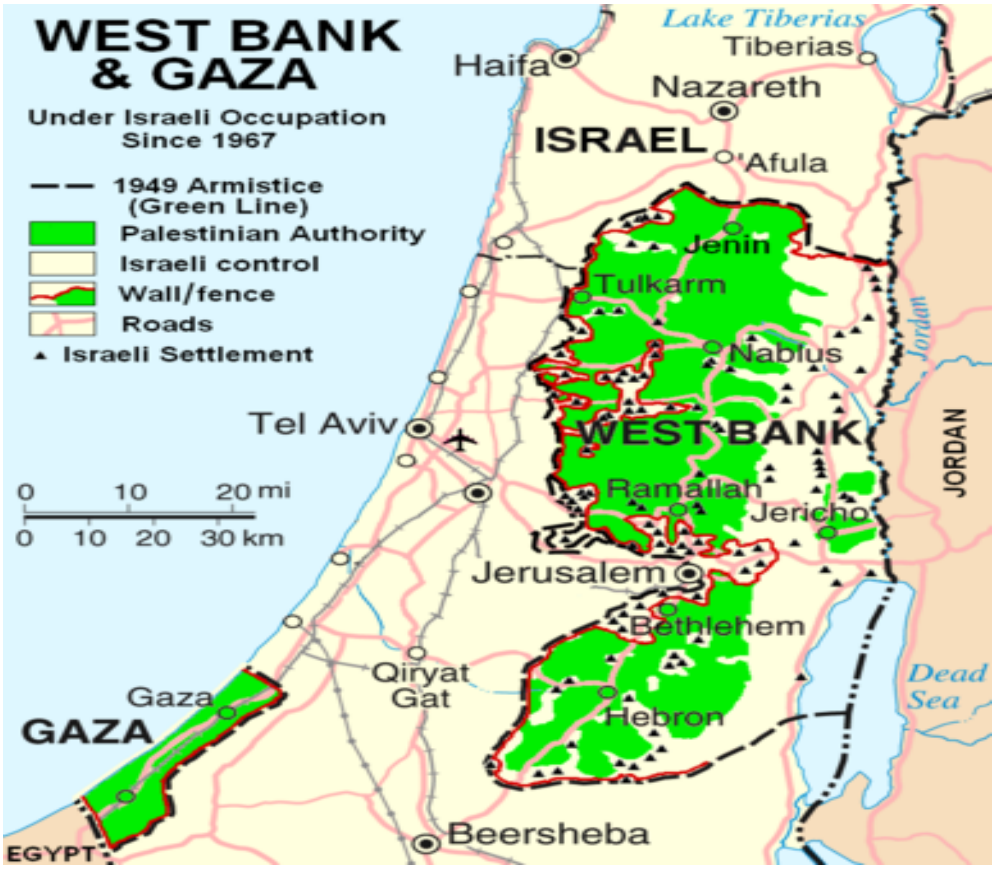

Figure 1. Map of Palestine.

(Source: (World Atlas 2021)

5.2. Economy of Palestine

The Palestinian economy relates on agriculture and fishing, by 1,091.100 $, the significance of agriculture within the economy of Palestine and other nations has measured the value include the agriculture segment as present of GDP, in the same time Palestine faces numerous challenges, basically spoken caused by the Israeli occupation, where Israeli limitations block getting to assets (water, power, information, social legacy, broadcast communications, etc.), and get to venture openings. It forces an unjustifiable attack on the Gaza Strip, segregates East Jerusalem from its environment, and works to

cut the bonds of arrival through the continuation of its settlement arrangement, and the Palestinian economy is exceedingly subordinate on Israel in terms of financial approach, in giving sources of Palestinian inputs, and as a send out the showcase. These limitations have driven to mutilations within the financial structure and the going with shortcoming within the profitable segments, counting fabricating, and the dominance of the benefits division. In expansion to its control of border intersections, traditions incomes, and the stream of trade. Despite these challenges, Palestine looks to discover choices to arrange to overcome the constrained common assets poverty (Ministry of National Economy 2020).

The destitution rate within the Palestinian domains expanded in 2017, to reach 29.2%, compared to 25.8% in 2011. Also, extraordinary destitution comes to 16.8% in 2017, compared to 12.9% in 2011, by 5.8% within the West Bank in 2017, compared to 7.8% in 2011. As for the Gaza Strip, the extraordinary destitution rate come to 33.7% in 2017, compared to 21.1% in the year 2011. Destitution information for 2017 demonstrated that destitution rates increment as the number of family individuals increments (expansive families), coming to 36.9% among families with 8-9 individuals, and rising to 61.1% among families with more than 10 members. There is closeness in destitution rates between families headed by men and women because it comes to 30.6% for family units headed by women compared to 29.2% for family units headed by men, noticing that women-headed 10.1% of Palestinian family units (Ministry of National Economy 2020).

There is a separate relationship between the increase in poverty and the increase in the number of people in captivity, which is one of the main reasons for the high poverty rate between 2011 and 2017 (see Figure 2) and also there is an important and complementary factor for the first reason which is the increase of refugees who were expelled from their lands located under the occupation which helped to raise these percentages to the highest and also higher prices with income remaining as it is (Palestinian Central Bureau of Statistics 2021b).

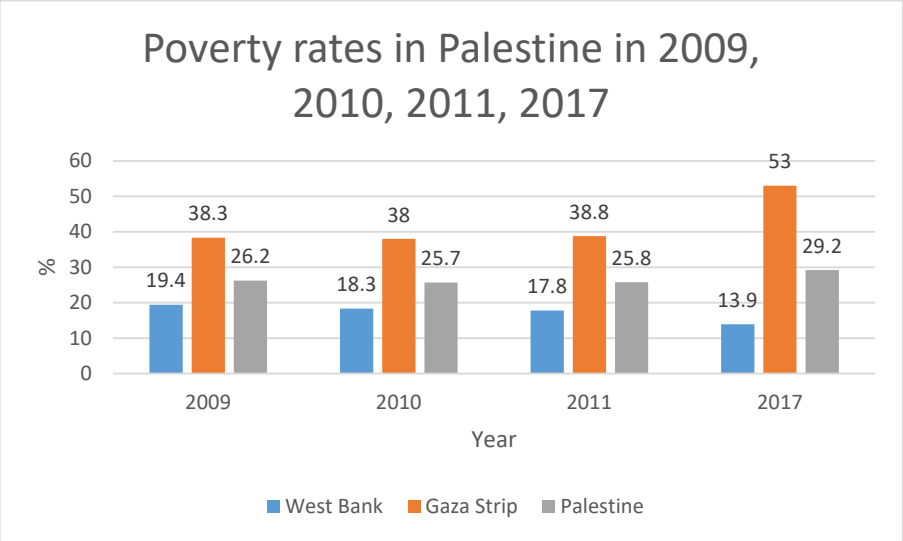

Figure 2. Poverty rates among individuals according to household monthly consumption patterns in Palestine by region and year.

(Palestinian Central Bureau of Statistics 2021b).

5.3. Energy situation within Palestine

The international world has been reliant on fossil fuel and it was a reason for many governments, and policymakers worldwide to worry about the energy and the prices and the availability of it in the world (Abu Hamed, Flamm, and Azraq 2012a).

The thesis will present renewable energy, and what is the possibility could be possible to control the developing country after following this strategy then the Palestinian Authority has the same problem and not only this problem, but the Palestinian are also facing a problem as poverty, envisage the Palestinian spending 10% of their income to imported energy for heat and cooling for the residential purpose (Abu Hamed, Flamm, and Azraq 2012a).

On the other hand, the Palestinian authority is more expensive than neighbors' countries as Jordan 46%, and countries who has wealth of oil such as Saudi Arabia and Kuwait as according to CEOWORLD (Abumaria, 2021).

Here the Figures 3 and Figure 4 below are describing how many different types of energy products does the Palestinian import such the only way to try to decrease the

cap and to improve the living standards just for the basics needs and to improve the economy and use the renewable energy as a solution to decrease the waste and second to remove the barriers from the Israel side to decrease the pressure from the occupation and to abandon or reduce the import from outside because without energy no peace (Albisher and Alsamamra 2019).

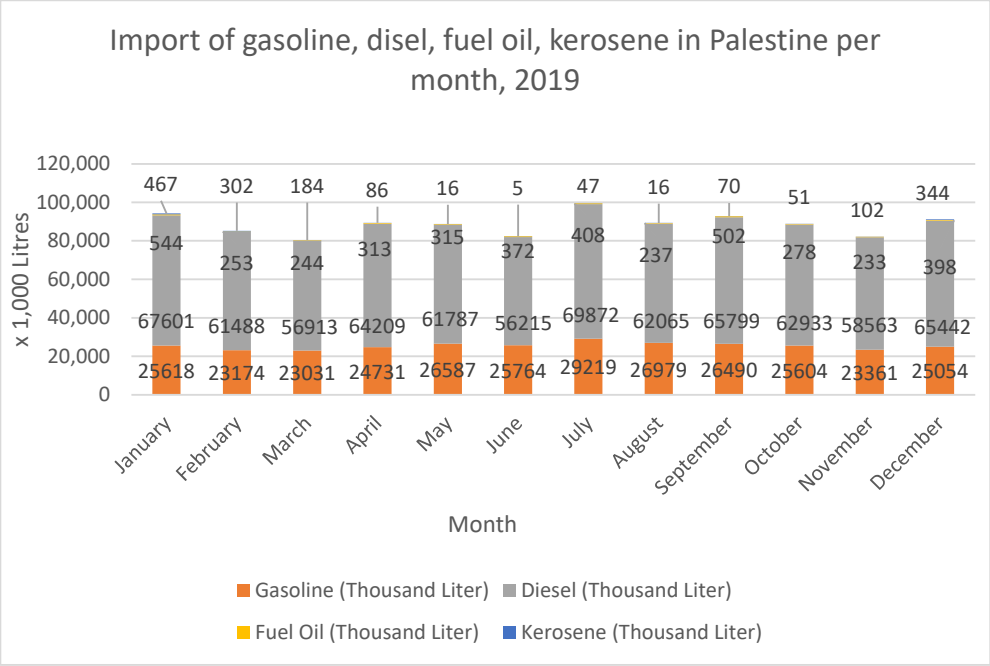

Figure 3. Import of conventional fuels for the main energy uses in Palestine. (Source: (Palestinian Central Bureau of Statistics 2021c).

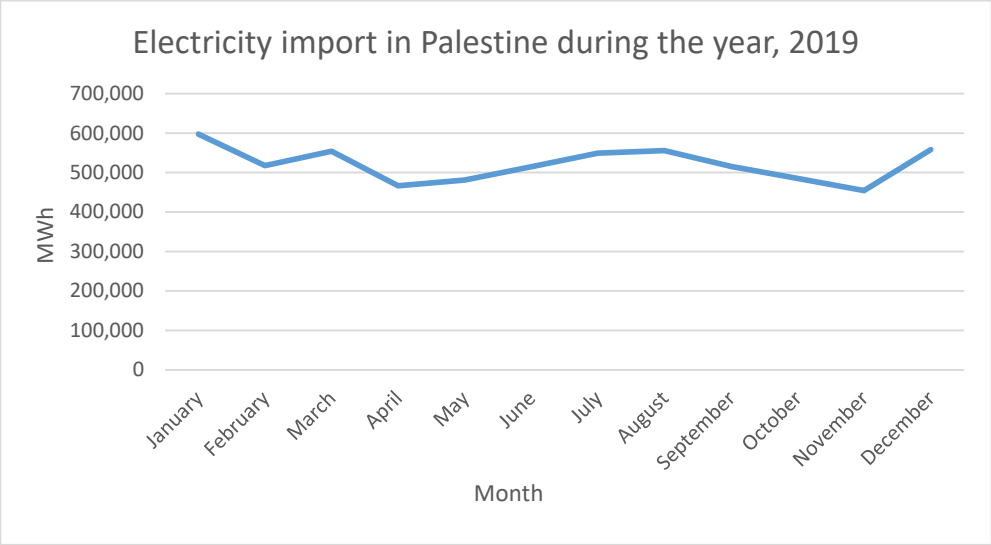

Figure 4. Import of electricity for the main energy uses in Palestine.
(Source: (Palestinian Central Bureau of Statistics 2021c)

Palestine is very different from other countries in the East for many reasons, such as the unavailability of natural resources, unstable political conditions, the financial crisis, and high population density. Palestine depends on other countries for fossil fuel and in 2013 the Palestinian imports 87% of its electricity, in recent years, there has been a large increase in electricity demand in Palestine due to the rapid growth of industry, the rising of living standards, and the high population growth in each territory of the state (Juaidi et al. 2016).

In 2018, the main electricity supply is 93.87%, which is supplied from the Israel Electric Company. Energy supply from Jordan and Egypt accounts for 2.03% of total consumption, locally generated 4.1%, in the end, renewable energy generated 166,902 MWh from the total 6,336,185 MWh (Salah, Abuhelwa, and Bashir 2021).

The main challenges for the Palestinian are the high cost of fuel and the lack of consumption of sustainable energy and as well the insecurity of energy(Abu Hamed, Flamm, and Azraq 2012b).

And here Basel and Yaseen do not forget the instruction that the Palestinian are supposed to follow as policies for energy sustainability to provide sustainable and

independent energy and to provide the readers a rich understanding of the current energy consumption (Basel and Yaseen 2007).

The absence of fossil fuels and their dependence on the Israeli occupation, at a rate of 100%, spending approximately 385 million EUR per year for covering their needs, the electricity of the Israeli market costs 500 million USD per year(Basel and Yaseen 2007). (Salah and Abuhelwa 2020; Salah, Abuhelwa, and Bashir 2021)

The Palestinian are dependent on energy from each side, the Figure 5 here presents the average of the import of electricity for the Palestinian authority from the different sectors such as the Israel electricity company, Egypt and Jordan. The Israelian company is present in Figure 5 by 93.87%, from the total the important electricity in the area and the fully independent on the Israelian company.

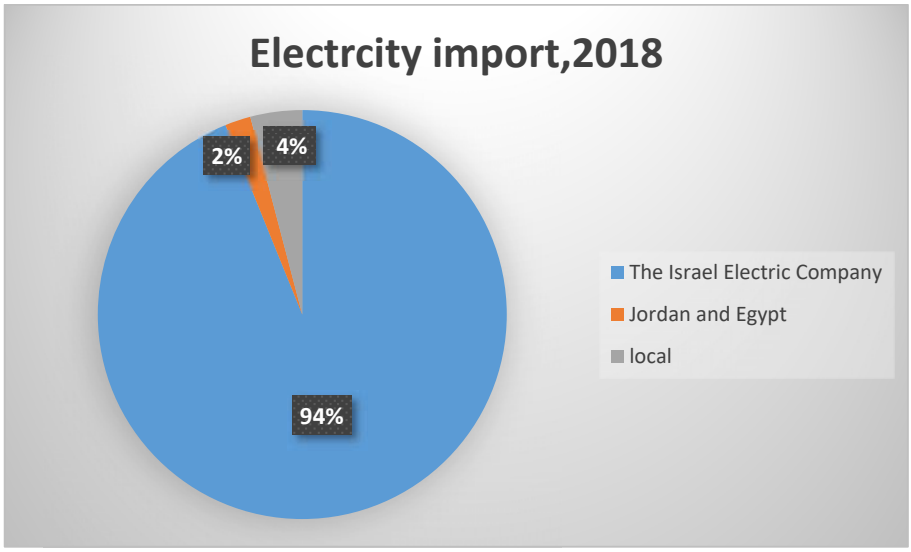

Figure 5. Electricity Imports in Palestine, 2018.
(Source: based on (Salah and Abuhelwa 2020)

The average spending rate of Palestinian person ranges from 3.5-21.6% per month of the monthly householders for heating purposes in winter, as shown here in this article that Palestinian families suffer from high prices, electricity, in addition to importing them (Al Qadi, Sodagar, and Elnokaly 2018). The Palestinians have a limitation of using energy, they do not have the independence (under occupation) to use sources of energy except using renewable energy such as photovoltaic (PV) for heating water and streetlight

and they use the biomass for cooking and heating in the rural area. Residential needs use up 61% of energy supply, 22% for commercial needs, 9% for industrial needs, 8% for other needs like streetlight and water pumping (Juaidi et al. 2016).

The fully relating on the Israel occupation to supply the energy for the Palestinian and at the same time it is a tool to pressure them from political and security side and this pressure lead the Palestinian to find any possibility to use the renewable energy for their needs as heat for cooking etc. by using the biomass, solar energy, wind, geothermal (Abu Hamed, Ismail, and Alshare 2017).

5.4. Non-renewable energy

A non-renewable energy source might be thought of as one that will run out in several hundred years and will take a long time to recover. As a result, we classified coal, oil, natural gas, and a few other energy sources as non-renewable. Coal, oil, and natural gas are the most common nonrenewable energy sources. Carbon is the main element of fossil fuels. For this reason, the time that fossil fuels were created (about 360-300 million years ago) is called the Carbonite period (Society, 2021). All fossil fuels were made in the same way. Before dinosaurs, the world had a different topography hundreds of millions of years ago. Wide shallow waters and muddy forests filled the land. In these ancient wetlands, plants, algae, and plankton flourished. Photosynthesis was used by this plankton to absorb sunlight and generate energy. When the organisms died, they sank to the ocean's depths or lakes. When the animals died, energy was stored in them, where over time the dead plants were crushed under the seabed, and stones and other deposits accumulated on them, creating high heat and pressure underground. In this environment, plant and animal residues eventually turned into fossil fuels (coal, natural gas, and oil). (Society, 2021; (Pickering 2019).

As it was mentioned before, the Palestinian are depending on the import of non-renewable/conventional fuels from other countries, and the Israel occupation is one of the players who’s controlling the fossil fuel (Abu Hamed, Ismail, and Alshare 2017).

5.5. Renewable energy

Renewable and sustainable energy technologies can play a major role in Palestine due to their reliability and security. Energy developments in Palestine are evolving, but they are still dependent on imports from other Middle Eastern countries, with the state of renewable energy in Palestine still taking shape. It can therefore be said that wind and solar energy are among the main types, where we can also include the thermal energies of biomass (Juaidi et al. 2016; Abu Hamed, Flamm, and Azraq 2012b).

Renewable technologies are considered clean energy sources and optimal use of these resources minimizes environmental impacts, produces minimal secondary waste, and is sustainable based on current and future economic and social societal needs. The sun is the source of all energies. The primary forms of solar energy are heat and light. Sunlight and heat are transformed and absorbed by the environment in many ways. Some of these transformations lead to flows of renewable energy, such as biomass and wind energy. Renewable energy technologies provide an excellent opportunity to mitigate greenhouse gas emissions and reduce global warming by replacing conventional energy sources Role renewable energy sources in Environmental Protection (Panwar, Kaushik, and Kothari 2011).

Renewable energy in Palestine is a small but important component of the national energy mix. Several issues are facing the development of renewable energy as the lack of national infrastructure and the limited regulatory framework of the Oslo Accords are impediments to investment(Assali, Khatib, and Najjar 2019). Palestine, like other countries, suffers from the problem of declining energy sources, and it also needs to move towards renewable energy to meet the community's domestic, industrial, and agricultural needs(Ibrik 2009).

Currently, Palestine is only able to produce 2.63% of its energy from renewable sources. Almost 75% of this energy is consumed in the building sector. Solar panels have already been used in this sector to at least help generate energy, but they do not have sufficient capacity to power everything. It can therefore be concluded that it is essential to adopt a new plan aimed at effectively addressing Palestine's energy dependence on other countries (Salah, Abuhelwa, and Bashir 2021; Abu Hamed, Flamm, and Azraq 2012; Abu Hamed, Ismail, and Alshare 2017).

5.5.1. Solar energy

Palestine has a high solar energy potential with a total of 3,000 hours per year of sunshine and a high annual average of solar radiation amounting to 5.4 kWh/m^2/day on the horizontal surface. The solar radiation on the horizontal surface varies from 2.63 kW h/m^2/day in December to 8.4 kW h/m^2/day in June (Juaidi et al. 2016).

Gaza strip from the areas in Palestine that surrounded and suffering, but in the same time the potential of the sunrise during the year, 3.67 kWh/m^2/day on a horizontal surface and about 6.21 kWh/m^2/day on the south-facing tilted surface, it could be a way to have energy with lack of it and the barriers that the occupation put it in the area (Abu Hamed, Flamm, and Azraq 2012b). The average sunshine duration in the West Bank is illustrated in Figure 6.

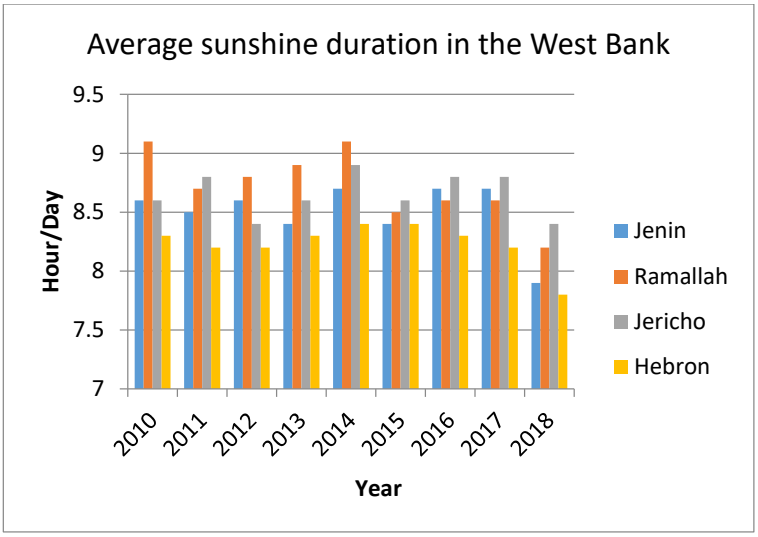

Figure 6. Mean sunshine duration in the West Bank (hour\day) by the station.

(Source: based on Palestinian Central Bureau of Statistics 2021)

Solar energy is a technology used to use solar radiation. on a much larger scale, solar thermal power plants use different techniques to concentrate solar energy as a heat source. Heat is then used to boil water to power a steam turbine that generates electricity via a generator like coal and nuclear power plants (Phillips 2018). There are typically two forms of solar power generation used in the integration of concentrated solar power (CSP)

and photovoltaic power into grid power also called thermal solar energy and concentrated thermal energy (Zhao et al. 2018).

The photovoltaic is playing important role in solar production in general in our case the impact such as the clean source of energy for the environment also the secure source for power within, Khatib here mentioned that the pollution and the emissions resulting from using other energy such as the non-renewable energy also with the comparing with others, Khatib found that to use the PV is cheaper in the same time is free energy after cover up the expanses of the solar panels, but the defect here the high prices of the solar panels and cells as well, in the end, Khatib here clearly describe that the advantage of the PV is more than the defect (Khatib et al. 2011).

5.5.1.1. The barriers of solar energy in Palestine

Even though the from the high ability for the solar energy but still the development of solar energy limited because it has to find an investor and it needs knowledge about how to use the new technology, and the Abu Hamed, Flamm, and Azraq here mentioned the lack of the education and expertness and intrafraction (grid connection) as well, and the whole process for example not just to produce also for storage it last not least supplying it in the market as well, rights of lands and the permission to build from the government(Abu Hamed, Flamm, and Azraq 2012b).

The Palestinian after the Oslo agreement they separate the country into three parts: Area A: under the Palestinian Authority, Area B: under the Israel authority, Area C: under the Israel and Palestinian Authority (I.E Jerusalem)(Salah and Abuhelwa 2020). The difficult political situation in Area C from the Israel occupation it is not allowed to build infrastructure and the problems of stool the lands from the Palestinian as well and the barriers of transforming the masterless the Abu Hamed, Flamm, and Azraq means here the lack of connection and the separation of the Gaza strip they are surrounded (Abu Hamed, Flamm, and Azraq 2012).

5.5.2. Wind energy

Wind energy or wind power is generated utilizing a wind turbine, a device that directs wind energy to generate electricity. The wind blows the turbine blades, which are

attached to the rotor. The rotor then spins the generator to generate electricity, Wind farms are becoming increasingly worldwide (Sadorsky 2021).

There are many types of wind turbines. Numerous distinctive sorts of wind-receiving units have been created. The number of licenses for them is greater than for any other sort of control unit (de Meij et al. 2016).

All together these are the tools that development inspires topsy-turvy powers within the wind stream; they can turn, interpret, or vibrate. These types are different from each other's, it depends on the direction of the wind; the level pivot opposite to the course of the wind (like water wheel); or the vertical pivot opposite to the course of the wind (Salem 2019)

5.5.2.1. Wind energy production project in Al-Ahly Hospital, Hebron

The year 2009 was the beginning of the launch of the project's work in the city of Hebron. The integrated wind energy project for Al-Ahly Hospital sits on the top of the highest hill in Hebron, serves 600,000 Palestinians; it is considered as a pilot project within the framework of the project(Salem 2019; Alwatanvoice 2012; Palestinian Energy and Natural Resources Authority 2010).

Meteorology is to measure wind strength and the possibility of using it to generate electric power. The project organizers aimed to reduce dependence on "Israel" to purchase electricity at its high cost, to adopt modern technology and mechanism in obtaining energy, and to save the electricity bill for the hospital (Salem 2019; Alwatanvoice 2012; Palestinian Energy and Natural Resources Authority 2010).

The project enables the hospital to dispense with the operation of engines that generate electric power, which run on fuel and whose gases have negative effects on patients, neighbors, and the environment, in addition to compensating for the shortage and frequent power outages in the winter (Salem 2019; Alwatanvoice 2012; Palestinian Energy and Natural Resources Authority 2010).

5.5.3. Biomass

Biomass energy, a renewable energy source, can also be a non-renewable source of energy. Biomass energy uses energy found in plants. Biomass energy depends on biomass raw materials that are processed and burned to generate electricity. In general,

biomass raw materials may include crops such as maize or soybeans, as well as wood. If people do not plant biomass raw materials as quickly as they use them, biomass energy becomes a non-renewable source of energy(de Vos 2006; Jebabli et al. 2020).

The use of the biomass methodology is considered one of the most important approaches followed globally, and here it will help the Palestinians in two important issues, the first is the power outage in marginalized areas, and the other is the disposal of materials that pollute the environment, such as olives they are not disposed of in the right way. Knowing that the region of Palestine is characterized by agriculture, in addition to that, it exports many agricultural and organic waste (Salah, Abuhelwa, and Bashir 2021). In the future, and after the spread of this methodology, which will help the Palestinian people to get rid of the waste issued by agriculture and use it for energy sources for cooking and heating, as well as to save money and solve the electricity problem (Salah, Abuhelwa, and Bashir 2021; Manzanares et al. 2017)

Biomass energy generation is more capable and efficient compared to other sources, raw materials derived from biomass are renewable, and even waste is recyclable. This has many advantages in terms of preserving the environment. Bioenergy generated from renewable resources provides heating, electricity, and fuel. Through bioenergy production, it is possible to put an end to the complete dependence on oil or coal, and thus the energy supply can be decentralized, to a new, decentralized form. The use of biomass for energy production would also represent one of the measures taken to confront the phenomenon of climate change because the amount of carbon dioxide produced by the combustion process is absorbed through growth(Abu Hamed, Ismail, and Alshare 2017b; Nunes et al. 2020; Salah, Abuhelwa, and Bashir 2021; El-Hamouz et al. 2007).

On the other hand, there are also some unavoidable disadvantages, as the cultivation of so-called "energy crops" can swallow up large areas of land and compete with the areas allocated for growing food and fodder. In addition, large areas in rich natural areas such as rainforests or swamps are subjected to excessive cutting and drying to turn into large areas for monoculture, where they are allocated to the cultivation of one crop, which may be palm oil, soybeans, or sugar cane, and here vital energy turns from a blessing to a curse. Therefore, the method used to obtain biomass plays a crucial role, and the optimal method is the sustainable method, which is compatible with nature

conservation and does not come at the expense of meeting nutritional needs(Salah, Abuhelwa, and Bashir 2021; Abu Hamed, Ismail, and Alshare 2017b; Kashiwagi 2017).

5.5.3.1. Project of biomass in Gaza Strip

Engineers from the Gaza Strip have recently converted olive oil residues (jift) into environmentally friendly flammable natural coal used for heating in winter, Thousands of tons of olive oil succulent residues are usually dumped on agricultural land or bird and animal farms to absorb deadly cold in winter but result in environmental and health damage(ARB, 2021).

The damage prompted three engineers, residents of the southern Gaza Strip city of Khan Younis, to add chemicals to the smelly jift to dispose of them and make them humanly usable, and then pressed through a hand machine, from which cylinders of 10-20 cm per cylinder would be extracted(ARB, 2021).

According to the initiative's engineers, farmers, and bird farm owners, as well as citizens, benefit the most, contributing significantly to saving money, effort, and getting the necessary warmth without environmental damage to the health of production(ARB, 2021).

Figure 7. Engineers from Gaza use olive oil waste for safe heating
(Source:(ARB, 2021)

5.5.4. Alternative energy

Alternative energy popularity is increasing worldwide especially after the growing the alternative energy in developed countries throw the developing country by supporting and sharing the experience and the awareness in this field to use renewable energy as an alternative for a lot of reasons as independent and growth the economics of the developing country and to increase the energy with saving the environment as well.

Using renewable energy as an important alternative for the Palestinian people could help the Palestinian to destroy the relating on the Israel occupation and a lot of the barriers from the occupation as well and the difficult situation presented by the political issues to the culture socio-economic as well and almost lack of the non-renewable energy as petroleum products and coal and fossil gas and the natural gas (Abu Hamed, Flamm, and Azraq 2012b).

Renewable energy is a way to beat many problems for the residential purpose, and this is a strategy as well to determine the Palestinian that this kind of resource is clean with low emission and to reduce the cost of electricity by using the possibility of sunray (Salah and Abuhelwa 2020)

While solar, wind, and geothermal energy can be helpful for the Palestinian to offer more energy, there is an extra source that can be used for energy, this alternative is the sector of agriculture because it is playing a main important role for the Palestinian daily life and from the important species such as olive trees, it can adapt in all conditions from the weather and the soil in Palestine and there is the possibility to use it as a resource for power and helping the Palestinian to protect the environment and the shortage of the energy (Ibrik 2020)(Kitaneh, Alsamamra, and Aljunaidi 2012).

5.5.5. Climate

The average daily temperature and relative humidity range from 13.3°C to 25.4°C and 67% to 75%, respectively. The West Coast region has cool winters and mild summers. The average daily temperature and relative humidity are between 8°C and 23°C, and 51% to 83%, respectively. In some regions, the temperature drops below 0°C. Therefore, a high heat load is required, and cooling is required in summer too. In Jericho and the

Jordan Valley, due to climatic conditions, heating is hardly needed in winter, and a higher cooling capacity is needed in summer (Mounir et al. 2021).

The climate diversity is high allowing for year-round crop production. For instance, the warm winter months in the Ghor area allow for the production of winter vegetables, while the moderate summer climate in the highlands and coastal areas also provides a suitable environment for vegetable production, and the utilization of greenhouses allows to produce vegetables all the year (Mounir et al. 2021)

6. Agriculture in Palestine

6.1. The reality of the agricultural sector in Palestine

The agricultural sector is one of the most important and oldest Palestinian economic sectors, and one of the elements of Palestinian steadfastness in the face of the occupation. Therefore, this sector falls into the cycle of constant targeting by the occupation authorities, which inflicted many losses on this sector, and its contribution to the Palestinian economy declined, as the numbers of the labour force decreased in this sector. The sector witnessed a decline in wages and a decrease in its contribution to the GDP(Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019; Ahmed Duweikat 2019; Ghadeer and Rami 2020).

Decrease in the number of employees: according to the report of the Palestinian Central Bureau of Statistics “Performance of the Palestinian Economy, 2018” issued in May 2019 the number of workers in the agricultural sector in 2018 reached about 51,500, including 37,000 from the West Bank and 14,500 from the Gaza Strip, while the number of workers in the agriculture sector in the year 2013 was about 82,700, including 59,900 from the West Bank and 22,800 from the Gaza Strip(Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019; Ahmed Duweikat 2019; Ghadeer and Rami 2020).

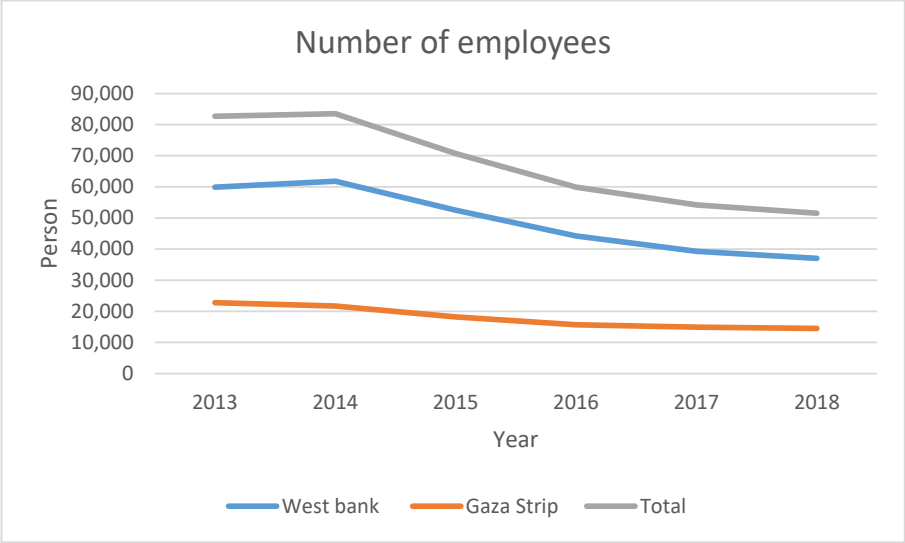

Figure 8. The number of employees in agriculture 2013-2017.

(Ghadeer and Rami 2020)

It is noticeable that the number of workers in the Palestinian agricultural sector is in a state of permanent decline, whether in the West Bank or the Gaza Strip, and this is what Figure 7 shows.

Low real daily wage rate: according to the report of the Palestinian Central Bureau of Statistics "The Performance of the Palestinian Economy, 2018" issued in May 2019 the average real daily wage in the agricultural sector in 2018 was about 47.0 shekels, at a rate of 73.1 shekels per worker in the West Bank and 21.1 shekels per worker in the Gaza Strip. And this shows the low wages in the agricultural sector, and in particular in the Gaza Strip, see the following Figure 8 (Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019; Ahmed Duweikat 2019; Ghadeer and Rami 2020).

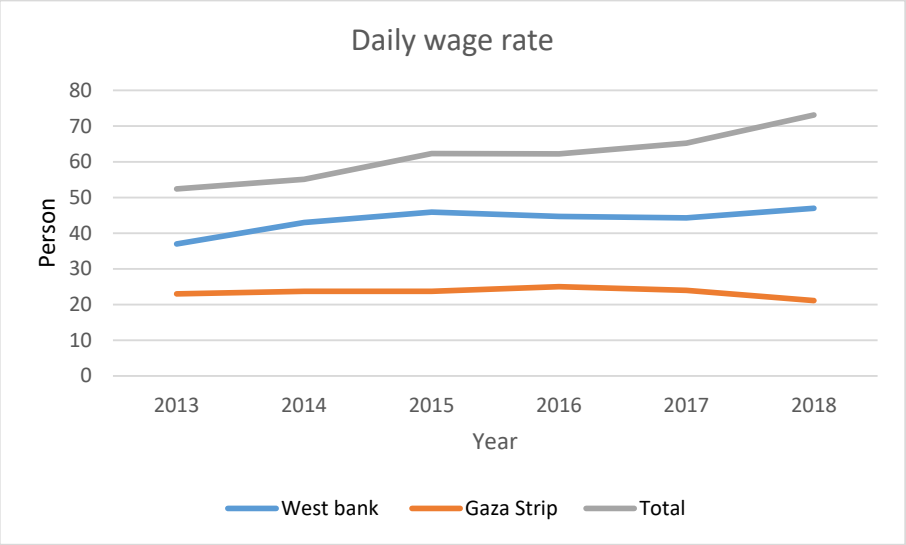

Figure 9. Daily wage rate

(Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019)

Noting that the contribution of the agricultural sector to the GDP amounted to about 36% in the mid-seventies, then it decreased to 25% in the eighties, and in 1994 it returned to 13.4%, and this percentage continued to decline until it reached 3% in 2018 and this is shown by the statistics of the Palestinian Central Bureau of Statistics (see Figure 9).

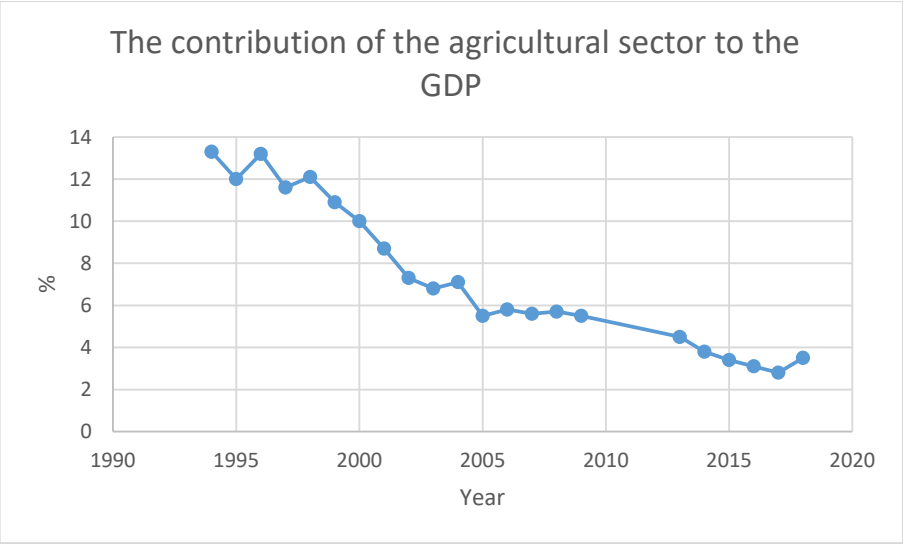

Figure 10. The contribution of the agricultural sector to the GDP

(Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019)

6.2. Land use

After read-through the types of lands between agricultural lands, arable lands, forests, and others, showing us the importance of agriculture to the Palestinian society and economy, wherein 2010 (see Figure 10), the area of agricultural lands was approximately 58% of the land of Palestine, while 7% of the lands are suitable for cultivation (arable), taking into consideration that forests and bushes constituted 1% of

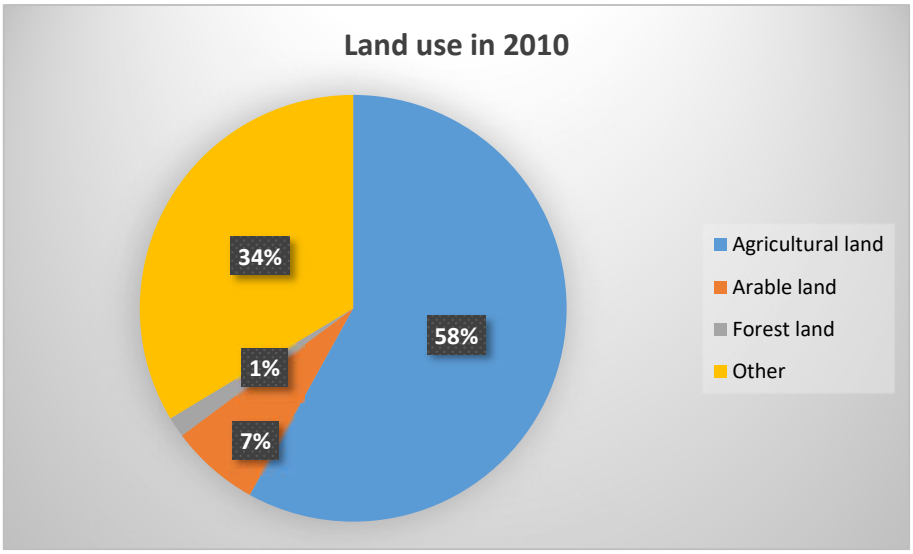

Figure 11. Land use in 2010

(Source based on (FAO, 2021)

By comparing Figure 10 and Figure 11, it is visible that in 2015 the number of agricultural lands increased to approximately 65%, and the area of unused arable lands increased to 8% compared to 2010 (FAO 2021).

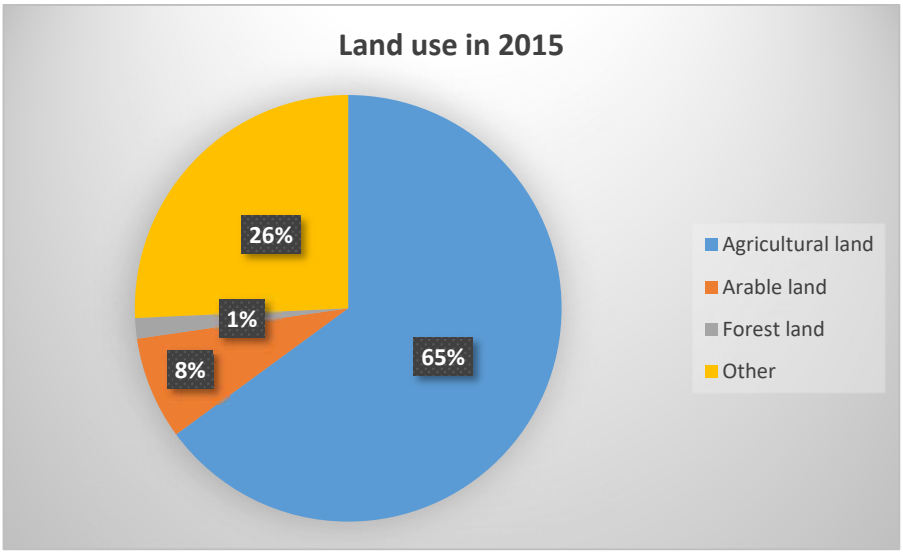

Figure 12. Land use in 2015

(Source based on (FAO, 2021)

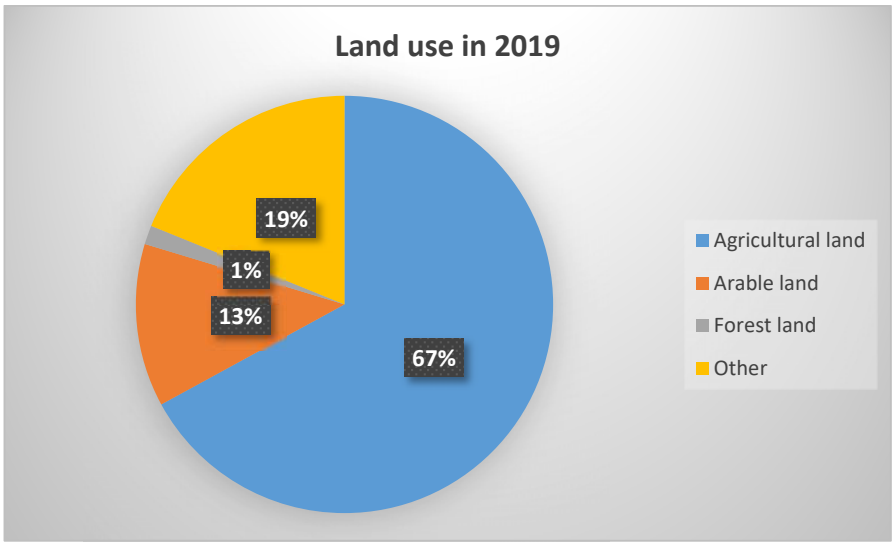

Figure 13. Land use in 2019

(Source based on (FAO, 2021)

The tendency to increase the cultivated areas in Palestine, and the increasing exploitation of lands in agricultural and animal production, can be confirmed if we look at the distribution of cultivated lands, in 2019 (Figure 12), where the area of agricultural

lands increased by approximately 67% of the area of Palestine lands, with a noticeable increase in the area of suitable lands for agriculture, it increased from 7% in 2010 to 8% in 2015, to 13% in 2019 (FAO 2021).

Table 1: The five top cultivated agricultural crops in Palestine

Crop	2011 *(t)*	2012 *(t)*	2013 *(t)*	2014 *(t)*	2015 *(t)*	2016 *(t)*	2017 *(t)*	2018 *(t)*	2019 *(t)*
Tomatoes	198,200	181,663	248,900	24,890	41,490	172,730	163,704	130,230	128,887
Cucumbers	135,067	135,485	139,954	143,978	37,794	127,628	130,098	113,866	110,050
Olives	75,530	114,070	60,630	60,900	87,000	88,000	89,793	89,723	89,445
Eggplants	48,980	49,869	54,323	54,620	41,909	47,098	49,181	49,505	48,490
Pumpkins	42,933	44,121	46,271	47,255	47,439	47,623	47,175	47,107	47,126

(Source: (FAO, 2021)

6.3. Cultivation and Processing of Olive in Palestine

In Palestine in 2019, were there 302 olive presses, 285 of which were operational and 17 of which were temporarily closed. The operating presses were divided into 275 fully automatic and 10 semi-automated or traditional machines. Palestinian Central Bureau of Statistics, Ministry of Agriculture, 2020. Olive Presses Survey 2019 – Main Results. Ramallah - Palestine. In 2019, the total amount of olives squeezed was 177,610.8 metric tons, up to 200% over the previous year. Jenin and Tubas & Northern Valleys governorates accounted for 51.8% of the total quantity, while Tulkarm governorate accounted for 13.6 %. (Ghadeer.Al-haj Ali, Rami .Sarawan, and Yousef 2019; Ghadeer and Rami 2020; Ahmed Duweikat 2019)

In 2019, about 39,609.8 metric tons of olive oil were extracted, compared to 14,740.4 metric tons in 2018, when 59,344.8 metric tons of olive oil were extracted. Palestinian Central Bureau of Statistics, Ministry of Agriculture, 2020. Olive Presses Survey 2019 – Main Results. Ramallah - Palestine(Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019; Ahmed Duweikat 2019; Ghadeer and Rami 2020). In Palestine, the extraction rate was 55.3 %. The extraction rate varies by governorate, with the maximum score of 25% in the Qalqiliya governorate and the lowest of 16.8% in Gaza and North Gaza governorates. Palestinian Central Bureau of Statistics, Ministry of Agriculture,

2020. Olive Presses Survey 2019 – Main Results. Ramallah - Palestine(Ghadeer and Rami 2020).

In 2019, the value addition of olive pressing activities was over USD 19.1 million, 177% higher comparing to the previous year, while intermediate consumption and output of olive presses were around USD 4.8 million and USD 23.9 million, respectively. In 2019, around 5,859 people were involved in the olive pressing industry, with 1,515 of them being wage workers, accounting for 81.5% of the total number of people employed. Palestinian Central Bureau of Statistics, Ministry of Agriculture, 2020. Olive Presses Survey 2019 – Main Results. Ramallah - Palestine(Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019; Ghadeer and Rami 2020). The number of wage employees in 2018 was 883, and employee compensation was around USD 2.1 million in 2019. Palestinian Central Bureau of Statistics, Ministry of Agriculture, 2020. Olive Presses Survey 2019 – Main Results. Ramallah - Palestine(Ghadeer and Rami 2020; Ghadeer .Al-haj Ali, Rami .Sarawan, and Yousef 2019).

Olive oil prices differ in the governorates of the northern West Bank from the center and south of the West Bank, while prices in the same governorate also differ from one region to another, in the absence of a uniform price binding for all farmers. The price of a kilo of oil in the northern West Bank governorates (Nablus, Tubas, Salfit, Jenin, Qalqilya, Tulkarm) ranges from 24-27 shekels, while in central governorates such as Ramallah the price of a kilo is 30-40 shekels or 500 shekels per tank, and in the southern West Bank, like Bethlehem, prices rise dramatically, which may reach 1,200 shekels for a single tank of oil, like Beit Jala. In general, the average price of a kilo of oil is 22-25 shekels, according to the Palestinian Ministry of Agriculture. One oil tank contains 15 kilos of pure oil. In turn, the Director-General of the Palestinian Olive Council, Fayyad, said that oil prices differ in the northern areas of the West Bank from the central and southern regions, according to the citizens' beliefs. (Samir Abdullah 2016).

The percentage of oil in the mill jift that uses central pressure ranges between 1.8 - 6%, and the moisture content is 38 - 60%; While the percentage of oil in the Jift presses is 4.5-9%, and the moisture content is 20-35%; However, the reality in our country is not so; due to the mismanagement of some contemporary as the proportion of oil in the dried presses of the central pressure rises from the mentioned figure. Jift plants prefer to obtain this material from pressing mills; with low moisture content, high oil content; Factories

resort to drying jift directly; To stop the oxidation process and the activity of enzymes that lead to the high acidity of the oil. The jift produced by the factories is used as fuel (3,200-3,800 kcal/kg), or it is introduced in a certain percentage as animal feed, after removing the remains of the kernel from it(Samir Abdullah 2016; wafa 2021). The jift is also referred to as olive pomace.

7. Estimation and discussion of Energy Potential of olive residual in Palestine

1ha of olive yields an estimated 3t of olives and 3t of prunings (wood, branches, and leaves). Other residuals resulting from the processing of olive include 0.6t/ha of olive stones, 0.07t olive pomace oil, and 1.73t of pomace by-product. (García Martín et al 2020). The stones and pomace are by-products obtained after the extraction of oil from olives. Hence, for every tonne of olive processed, 20% of the by-product is olive stones while 57.7% is olive pomace.

The cultivated area of olives is to be 940 000 dunums approximately 94 000ha of land. Therefore, using the estimation of García Martín et al 2020 (UNCTAD, 2015). Thus, using equation (1), 94 000ha of olives will yield

Prunings = 94 000*3t = 282 000t/ha

Stones = 94 000*0.6t = 54 400t/ha

Pomace = 94 000*1.73t = 162 620t/ha

Therefore, a total of 282 000t of biomass residue is generated in the field while 217 020t is generated from the processing of olive fruits. The calorific value of olive prunings vary between 16.7 and 19.8 MJ/kg. For olive stones 18.8 and 20.9 MJ/kg, for pomace 13.8 to 15.8 MJ/kg (García Martín et al 2020) and 13.39 to 15.90 MJ/kg (wafa 2021). The averages of these values were used in the calculations below.

Table 2: Annual energy yield of olive residual biomass in Palestine

Olive residues	Production (t)	Energy potential TJ	TWh
Prunings	282, 000	5,146.5	1.43
Stones	54, 400	1,079.84	0.30
Pomace	162, 620	2,406.77	0.67
	499, 020	8,633.11	2.40

(Source: based on (PCBS, 2020)

Table 3: Generated quantity and energy yield of olive residual biomass in Palestinian governorates

Governorate	k	Generation (t)	Energy Potential TJ	TWh
West Bank				
Jenin and Tubas	0.22063	110,098.7	1,904.722	0.529512
Tulkarm	0.153851	76,774.84	1,328.215	0.369243
Nablus	0.152908	76,304.24	1,320.073	0.36698
Qalqiliya	0.075411	37,631.5	651.0297	0.180986
Salfit	0.066763	33,315.89	576.3692	0.16023
Ramallah & Al-Bireh	0.10501	52,402.18	906.5645	0.252024
Jerusalem	0.011792	5,884.29	101.799	0.0283
Bethlehem	0.025866	12,907.59	223.3029	0.062078
Hebron	0.054849	27,370.79	473.5182	0.131638
Gaza Strip				
Gaza & North Gaza	0.017624	8,794.891	152.1527	0.042298
Deir Al-Balah	0.055968	27,928.92	483.174	0.134322
Khan Yunis and Rafah	0.059329	29,606.17	512.1906	0.142389
Palestine		499, 020	8,633.11	2.4

(Source: based on (PCBS, 2020)

While table 1 gives a summary of estimated olive residue generated and the potential of energy production from this biomass, table 3 shows the distribution of these parameters over the Palestinian governorates. Although there is still lack of data of the production of olives per governorate as well as the quantity of olive residues generated per governorate these estimate gives an illustration to the importance of more data in exploiting these resources in the future. The Table 3 indicates that the total energy

potential of olive residue in Palestine is about 2.4TWh. The West Bank region generated about 86% of this energy wherein the Jenin and Tubas governorates has over 52% of the total.

According to the World Bank 2016, the energy consumption per household in Palestine is 28.019GJ and about 11.51GJ per capita. Therefore, the olive residue has the potential to provide energy for over 308 thousand households and 750 thousand people. According to (Salah, Abuhelwa, and Bashir 2021), the locally generated electric energy in Palestine is 2018 was 6,336,185 MWh. The energy potential from olive residues (2.4 x106 MWh) is about half of this. Thus, exploring the energy potential of olive residue as well as other agricultural residue has the tendency to surpass the present energy generated locally.

This energy can be exploited for various uses both for cooking, lightening, and heating. It is important to note that this energy can be exploited in many forms such as biogas, biochar, traditional biomass etc. The review by García Martín et al (2020) shows how olive residues have been exploited in Spain and the prospects to expand its uses. This is depicted in figure 13; the solid lines stand for actual industry processes while dashed lines represent potential applications at research stage in Spain.

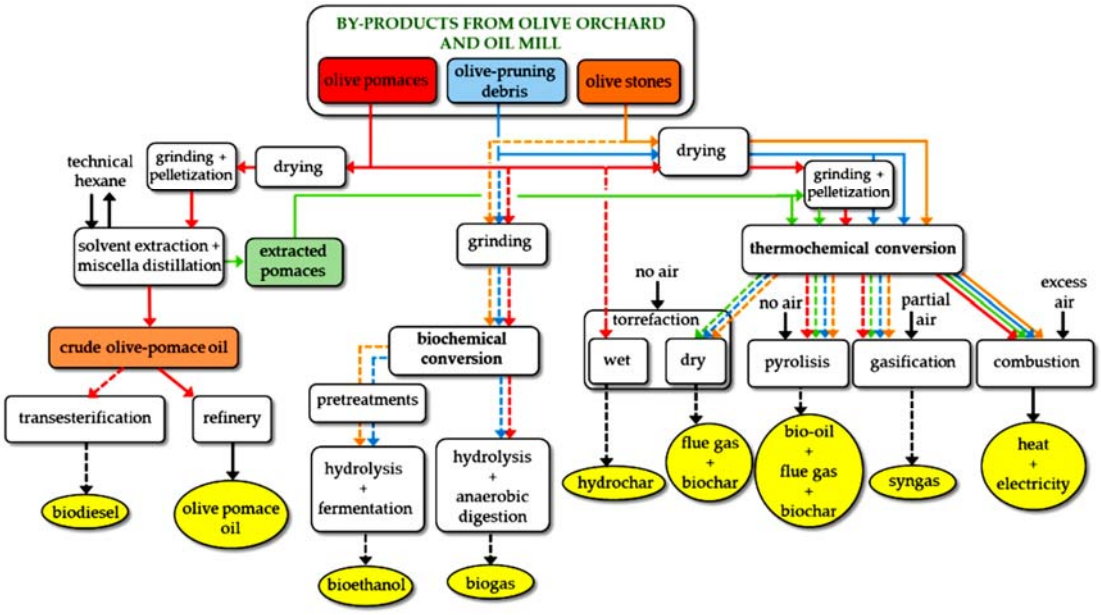

Figure 14. Energetic valorisation paths of olive residues

(Source: García Martín et al (2020)

8. Conclusions

The thesis has shown that Palestine, as a developing country, needs to import energy, to secure its own needs, due to its political situation, economic challenges, and infrastructure fragility. It is also clear, that the agriculture sector is one of the main sectors in the Palestinian economy.

The recent approach of the Palestinian government, as most of the governments of developing countries, is to decrease the depend on fossil fuels as energy sources and to replace them with renewable and sustainable energy sources. The thesis, facts, and statistics included attempt to describe the conditions of the agriculture sector in Palestine, especially olive trees, which are one of the main agricultural products that hold a high value in the economy and environment. besides the energy that contains.

The thermal value, which exists in olive by-products and residues, consists of 3 types, as presented in the methodology:

1. calorific value of olive prunings: 16.7 and 19.8 MJ/kg.

2. olive stones 18.8 and 20.9 MJ/kg,

3. pomace 13.8 to 15.8 MJ/kg(García Martín et al 2020) and 13.39 to 15.90 MJ/kg (wafa 2021).

Some results show that biomass could be an important source of energy in Palestine:

Gaza project:

1. Turn the residue of olive oil (jift) into an environmentally friendly flammable natural coal used for generating energy. This energy can be exploited for various uses for cooking, lighting, and heating.

2. The project is of high benefit, contributing significantly to reduce expenses, without efforts, and getting environmentally friendly and sustainable energy sources.

Palestine has the opportunity to solve part of the difficult issues in the energy sector by using olive residue to generate energy in the future.

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