The major energy characteristics of energy in Palestine are non-availability and extraction of natural resource, unstable political, financial issues and population growth which means that there is no security energy situation in Palestine. There is no developed domestic energy resource; it is heavily depending on important of energy sources from other countries. The Israel Electric Company (IEC) has dominated imported of electricity by 95.72% of the total of electrical energy imported in 2015. In general, lightly subsidized of energy sources and it can be comparison with neighborhood countries. In this paper taking research on three renewable energy sources are solar energy, wind energy, geothermal energy in many considerations are geography characteristics, projects are implemented, the strategy for 2020 are prepared by the Palestinian Energy Authority (PEA), drawbacks of this energy sources. Finally, the recommendations can be taken in consideration to development the renewable energy sector in Palestine to ensure security energy sources and may significant decrease importing energy from neighborhood countries and sustainable development and growth of socio-economics.

George Michael Kreitem
Issam A. Al-Khatib

Renewable Energy Exploitation in Palestine: Current Practice & Future

Eng. George M. Kreitem Has a Master Degree in Water and Environmental Engineering. He graduated from the Master Program at Birzeit University. Prof Issam A. Al-Khatib is working at the Institute of Environmental and Water Studies, Birzeit University, Palestine. Al-Khatib has an extended experience in the solid and hazardous waste management, etc.

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Renewable Energy Exploitation in Palestine: Current Practice & Future Potential

2018

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Forward

Palestine is a development country, which means that needs of all types of energy to great growth of quality life, economic development, and sustainable development. The energy consumption situation in Palestine is that the diesel fuel is dominant of total energy consumption. The major energy characteristics of energy in Palestine are non-availability and extraction of natural resource, unstable political, financial issues and population growth which means that there is no security energy situation in Palestine. There is no developed domestic energy resource; it is heavily depending on important of energy sources from other countries. The most market purchase is from Israel due to the political and logistical factors. The most electric power supply to Palestinian regions is dominated by imported from other countries. The Israel Electric Company (IEC) has dominated imported of electricity by 95.72% of the total of electrical energy imported in 2015. In general, lightly subsidized of energy sources and it can be comparison with neighborhood countries. For an example, the price of electricity in Palestine is much higher than the 2 % of Jordan, Lebanon, and Syria. In this paper taking research on three renewable energy sources are solar energy, wind energy, geothermal energy in many considerations are geography characteristics, projects are implemented, the strategy for 2020 are prepared by the Palestinian Energy Authority (PEA), drawbacks of this energy sources. Finally, the recommendations can be taken in consideration to development the renewable energy sector in Palestine to ensure security energy sources and may significant decrease importing energy from neighborhood countries and sustainable development and growth of socio-economics.

Keywords: Energy Structure, solar energy, wind energy, geothermal energy, strategy sustainable development, strength, and drawbacks.

1. Introduction

According to International Energy Agency's (IEA) renewable information 2017 report, The fuels share in world Total Primary Energy Supply (TPES) in 2015 was 13,647 million tons of oil equivalent Mtoe, the fossil fuels has continuously dominated fuel shares in world TPES, representing 81.7% (11150 Mtoe) of global energy supply (IEA, 2017). The energy resources can be classified into three main categories: fossil fuels, renewable resources, and nuclear resources (Alemán-Nava, 2014; Demirbas, 2000). Energy is one of main factors and continuous driving force for improved quality life, economic development, sustainable development, and social improvements (Juaidi et al., 2016; El Chaar et al., 2010). Without sustainable energy, the development is impossible (WHO, 2013). So the energy plays a significant role in economy and social development, national security, international trade, and human and physical environment (WHO, 2013). According to the global energy business (Bp)'s statistical review of world energy 2017, the Global primary energy consumption increased by just 1% in 2014, following growth of 0.9% in 2015 and 1% in 2016. This can be compared with the 10-year average of 1.8% a year (Bp, 2017). In the International Energy Outlook 2017 (IEO2017) projects assessment by the U.S. Energy Information Administration of the outlook for international energy markets through 2050, that the growth of world energy consumption between 2015 and 2040 is 28%, from 575 quadrillion British thermal units (Btu) to 736 quadrillion Btu (US EIA, 2017). The countries outside of the Organization for Economic Cooperation and Development (OECD) are dominant most of the world's energy growth. The demand of energy will increases due to strong, long-term growth. The half increase in energy consumption of the world's total between 2015 and 2040 of the world's total will be by non-OECD Asia (including China and India) (US EIA, 2017). In non- OECD Asia is projected to increase of energy demand between 2015 and 2040 by 51% while the increases of energy demand in OECD countries between 2015 and 2040 by 9% (US EIA, 2017). Non-OECD countries in Africa and Middle East are expected to increase of energy demand between 2015 and 2040 of around 45% and 51% due to these countries has access to ample domestic energy resources and fast-paced growth of population (US EIA, 2017).

Due to the continuous world's energy consumption increase and rapid technological developments, they have encouraged growing to use of renewable energy (RE) sources (Juaidi et al., 2016; Abu-Madi and Rayyan, 2013). Due to accelerated technology developments, so decreases the production cost of RE sources, especially in wind and solar equipment production which means that increase in green equipment manufacturing and the degree of investment in the world

(Alemán-Nava, 2014; REN21, 2013). Also using energy is important for process of production and manufacturing, so increasing attention to use of renewable energy sources which can be used without exhausting the energy source (Juaidi et al., 2016; Manzano-Agugliaro et al., 2012). In addition, the reserves of fossil fuels are limited and continuous depletion of these reserves fossil fuels and political instabilities, so highly volatile prices and soaring of the fossil fuels, and more dependence on fossil fuels with their large-scale negative ecological impacts (climate change issues) are leading to insecurity and risk for economic development (Bundhoo, 2017; Alemán-Nava, 2014; Balat, 2011). There are three known major international environmental problems: depletion of stratospheric ozone, acid precipitation, and the global climate change (Alemán-Nava, 2014; Kalogirou, 2004). Results in increasing in level of greenhouse gas concentration into the atmosphere as well as increase in fuel price (Alemán-Nava, 2014; Hernandez-Escobedo et al., 2011). These are the main reasons leading and encourage towards utilizing renewable energy sources (Alemán-Nava, 2014; Baños et al., 2011).

Renewable energy (RE) sources can be defined as energy derived from natural processes (indigenous resources) with zero or near zero emissions of both air pollutants and greenhouse gases (Demirbas, 2009), RE sources do not involve the consumption of exhaustible resources such as fossil fuels and uranium (Bp, 2017). RE sources include solar, biomass, geothermal, hydropower, wind, and marine energies (Alemán-Nava, 2014; Fridleifsson I., 2001; Demirbas, 2006). The RE sources supply 13.8% of the fuel world TPES in 2015 (IEA, 2017). In 2015, product shares in world RE supply is distributed to 70.7% coming from biofuels and waste (due to it's being used primarily for residential heating and cooking in developing countries), hydropower represents 18.3%, geothermal represents 4.1%, wind power represents 4.0%, solar represents 3.0%, and tide represents 3.0% (IEA, 2017). The IEQ2017 reference case projects for long term, world consumption of marketed energy will be increasing from all fuel sources-except coal, where demand is essentially flat through 2040 (US EIA, 2017). The world's first fastest-growing energy source is coming from RE sources, with 2.3% average consumption increasing between 2015 and 2040 (US EIA, 2017). The nuclear power is the second world fastest-growing source of energy, with 1.5% average consumption increasing between 2015 and 2040 (US EIA, 2017). The fossil fuels will still dominating, accounting for 77% in 2040, although it is projected for consumption of non-fossil fuels to grow faster than fossil fuels in the projections (US EIA, 2017).

In 2016, renewable energy power generation continued towards rapid growth, with an increase of 14% in 2016 (Bp, 2017; REN21, 2017). The RE sources share in the world electricity production are estimated in 2016 was 24.5% and it distribution as follow: 16.6% from hydropower energy, 4% from wind energy, 2% from bio-power energy, 1.5% from solar PV energy, and 0.4% from ocean, concentration solar thermal power (CSP) and geothermal power energy (REN21, 2017). According to the volume terms, the largest increased was in China, followed by the U.S, Japan, India, and Brazil, placing these countries as top five in 2016 (Bp, 2017). In the European countries, in the Denmark, the RE sources leads 59% of power generation countries in 2017. Among the larger EU economies, 26% of renewables share is in Germany, 25% renewables share in Spain, and 23% in both Italy and the United Kingdom of Great Britain (Bp, 2017). The expected share of renewables in European energy is 20% in 2020. By the end of the 21st century, the European Union (EU) wants to be fully dependent on renewable energy sources (Rezec, M. and Scholtens, B., 2016, EEA, 2016). There are various initiatives and proposed projects to turn North Africa into renewable energy producer and an extension to supply electricity to the European countries, its need to demands access the RE- Readiness (Hawila, D. et al., 2014). According to the IEO2017 Reference, the world electricity generation from coal sources is expected to decline from 40% in 2015 to 31% in 2040 sources (US EIA, 2017). The renewable energy is expected to share of the world generation of electricity by 31% and it is as same share from coal in 2040 (US EIA, 2017). In 2015, the hydropower's share of renewable energy generation of electricity was 71% and it is expected to decrease to 53% in 2040 due to the limit the number of new mid-large scale of hydropower projects (US EIA, 2017). The IEQ2017 also expected that the electricity generation coming from non-hydropower renewable energy resource such as wind and solar sources rises as average 4.0% per year between 2015 and 2040 (US EIA, 2017). 2.5 trillion Kilowatt-hours (KWh) of electricity generation from Wind and solar energy sources in 2015, and it's expected to reaching 1.4 trillion KWh at 2040 due to their technologies become more cost competitive over time (US EIA, 2017).

Palestine is divided into two separate geographical areas are the Gaza Strip and West Bank. According to the Palestinian Central Bureau of Statistics (PCBS), the total area of Palestine is 6,020 square kilometers, whereas, the area of West bank is approximately 5,655 square kilometers, Gaza Strip is 365 square kilometers (PCBS 2017; Juaidi et al., 2016). In 2017, the approximately population of 4,952,168 in Palestine; and it's distributed as follow: the population in West Bank is 3,008,770 and 1,943,398 in Gaza Strip (PCBS, 2017). So the population density in Palestine is 823 inhabitants per square kilometers and 532 inhabitants per square kilometers for West

Bank, and 5324 inhabitants per square kilometers for Gaza Strip (PCBS, 2017). By the Oslo II Accord in 1995 is divided the West Bank into three administrative divisions are the Area A, Area B, and Area C so it's made complex geographical and administrative situation of Palestine since these areas aren't contiguous. The full civil and security control in Area A is responsibility on the Palestine, For Area B, the civil control belongs to the Palestine but for security control is belongs to Joint Israel and Palestine. For Area C, Israel has completely responsibility on full civilian and security control (Juaidi et al., 2016; Abu Hamed et al., 2012). Area C has dominated the area in the West Bank by approximately 60%. So in the West Bank has a complex geographical distribution of these areas. For an example, for Area B have 253 different enclosures. Since Israel control of these areas so it severely hinder and affect the development initiatives and the potential development of infrastructure energy sectors, regulation, and policies. For an example, West Bank almost of their electrical energy needs depending on Israel, so it's major play role to obstacle for their development (Juaidi et al., 2016; Abu Hamed et al., 2012). For Gaza Strip, has obstacle for their energy need due to its facing challenges of technical and political situation for transporting, storing, and importing energy since Gaza Strip isolation due to there is no physical continuity between Gaza Strip and West Bank and East Jerusalem (Juaidi et al., 2016; Abu Hamed et al., 2012). Therefore, the energy sector in Palestine is insecurity situation due to it has not developed domestic resources and it is heavily depending on important of energy sources from other countries. Especially from Israel due to the political and logistical factors by control of the energy import into Palestine by the quantity and condition of energy by deny or limit trade across international borders (MNSSD, 2007). So the Palestinians rely almost totally of their energy needs on Israel (Ibrik, 2009), which means that the costs of energy in Palestine through consumers and Palestinian power generation companies are exploited (MAS, 2015). In addition, it is very high than neighborhood countries such as Lebanon, Jordan, and Egypt (The Portland Trust, 2010). Since Palestine is a development country, which means that needs of all types of energy to great growth of quality life, economic development, sustainable development (Juaidi et al., 2016; Hasan, 1992). So it is facing in growth of energy demand, especially in electrical energy, across all sectors and by necessity future generation expansion will rely substantially upon increasingly expensive fossil fuels (Ibrik, 2009). Therefore, RE sources in Palestine are necessary nowadays and in future, to support sustainable development and socio-economic development. As one of many strategies Palestine can take RE sources to development their domestic energy resources needs since the political and logistic situation in Palestine by Israeli control on their energy sources importing especially most importing the fuel derivatives, and Palestine facing the population growth so it is future energy generation expansion (Juaidi et al., 2016; MoPAD, 2011; Ibrik, 2009; MNSSD, 2007).

2. Geographical and demographic conditions in Palestine

The location of Palestine is on Asia; it is considered the linking point between Africa and Asia (MoLG, 2009). The West Bank is situated on the central (Nazer et al., 2008). The extension of West Bank is from the Jordan River in the east to the cease-fire line in the north, west, and south (Nazer et al., 2008). The location of Gaza Strip is on the western side of Palestine adjacent to the Mediterranean Sea (Juaidi et al., 2016; Kitaneh et al., 2012). The location of Palestine is between $34^{0}20^{'}$-$35^{0}30^{'}$ E & $31^{0}10^{'}$-$32^{0}30^{'}$ N (Juaidi et al., 2016; Valipour, M., 2015). The elevations of Palestine is ranges from 200m-300m below sea level in Jericho, to sea elevation level at along the Gaza Strip seashore, and in some regions exceeding an elevation 1000m above sea level in the West Bank (Juaidi et al., 2016; Valipour, M., 2015; Hadid, 2002). The climate in Palestine is mainly liable to Mediterranean region climate, which means that, it is cold and rainy on winter, warm and dry on summer (PCBS, 2017; MoLG, 2009). The climate in Gaza Strip is coastal climate, which means that, it is hot and humid on summer, mild rainy on winter (PCBS, 2017). Respectively in Gaza Strip, the daily average temperatures vary in the ranges of 13.3^{0}C to 25.4^{0}C and daily relative humidity vary in the ranges of 67% to 75% (Juaidi et al., 2016). In Gaza Strip areas has low heating loads are required during winter, while during summer is needed cooling to achieve thermal comfort (Juaidi et al., 2016). The climate in West Bank is warm to hot dry on summer seasons, mild rainy on winter season (PCBS, 2017). Respectively in West Bank, the daily average temperatures vary in the ranges of 8^{0}C to 23^{0}C and the ranges of daily relative humidity vary is between 51% to 83% (Juaidi et al., 2016, PCBS, 2016a). In West Bank areas has high heating loads required during winter, while during summer is needed little cooling (Juaidi et al., 2016). Due to special climate conditions in Jericho, which is the highest temperature is 42.8^{0}C during summer; it is needed to cooling to achieve thermal comfort while is not required heating during winter (Juaidi et al., 2016; MoLG, 2009).

Figure 1: Regions of Palestine, *(PCBS, 2015a).*

2.1. Governorates, localities, and demographic conditions

Palestine is divided into two separate geographical areas from each other, are the Gaza Strip and West Bank. The total area of Palestine is 6,020 square kilometers, whereas, the area of West bank is approximately 5,655 square kilometers, Gaza Strip is 365 square kilometers (PCBS 2017; Juaidi et al., 2016). The total localities in Palestine are 557, and it is distributed as follow: 524 localities in West Bank and 33 in Gaza Strip (PCBS, 2015a). The administration in West bank by 374 local authorities and it is distributed as follow: 103 municipalities, 242 village councils, 10 local councils, and 19 refugee's camps. For Gaza Strip, the administration by 33 local authorities and it is distributed as follow: 25 municipalities, and 8 refugee's camps (PCBS, 2015a). In 2017, the approximately population of 4,952,168 in Palestine; and it is distributed as follow: the population in West Bank is 3,008,770 and 1,943,398 in Gaza Strip (PCBS, 2017). Therefore, the population density in Palestine is 823 inhabitants per square kilometers and 532 inhabitants per square kilometers for West Bank, and 5,324 inhabitants per square kilometers for Gaza Strip (PCBS, 2017).

3. Energy structure

Palestine is a development country, which means that needs of all types of energy to great growth of quality life, economic development, and sustainable development (Juaidi et al., 2016; Hasan, 1992). In Palestine, the small energy market limits achieving economies of scale (MNSSD, 2007). The electricity has not access the whole day to all Palestinian people (Juaidi et al., 2016; Hasan, 1992), especially in Gaza Strip. For an example, destruction of Palestinian power system facilities by Israel military action, such as destruction of Gaza Power Plant in June 2006 (MNSSD, 2007). There is no developed domestic energy resource; it is heavily depending on important of energy sources from other countries. The most market purchase is from Israel due to the political and logistical factors (MNSSD, 2007). By electricity and petroleum products are provided the nearly all energy in Palestine, most of this energy has been purchased from Israel due to its control of the energy import into Palestine by the quantity and condition of energy by deny or limit trade across international borders, which means insecurity of energy in Palestine (Juaidi et al., 2016; MNSSD, 2007). Therefore, the costs are expensive through consumers and Palestinian power generation companies (MAS, 2015). In 2013, the bill of electricity was around US$650 million. The annual import of oil and its derivatives is around US$800 million (MAS, 2015). So more than 12% of the Palestinian grosses domestic product (GDP) depletion due to oil and electricity imports prices (MAS, 2015). These reasons, the RE's are important to growth of socio-economics in Palestine and get more security of energy sources and sustainable development (Juaidi et al., 2016; Hasan, 1992).

3.1. Energy sector profile

The energy sources in Palestine are consists as follow: first energy generated by derivatives of natural gas and petroleum, second energy generated by electricity, and renewable energy (including solar power, wind power, and energy generated from burning wood, peat, etc.) (PCBS, 2015b; MoPAD, 2011). Figure 2, shown the percentage of energy balance in Palestine in 2015, illustrate that the diesel fuel was dominant of total energy consumption in Palestine is 33.86%, the electricity also has high share was 26.07%, and other fuels are also has high shares in total energy consumption such as gasoline, liquefied gas petroleum (LPG) (PCBS, 2016b).

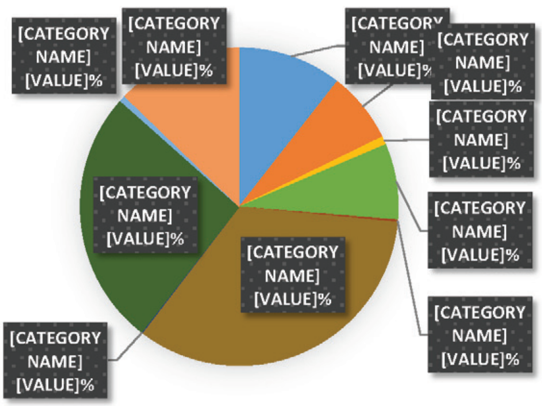


Figure 2: Diagram of Energy Balance in Palestine in 2015, *(PCBS, 2016b).*

With the exception of renewable energy, the Palestinian energy sector situation suffers of scarcity of sources and inability to fully exploit currently available ones, so the most of energies are largely depending on importation form Israel. Therefore, the Palestinian energy sector objectives are to ensure the security of supply and minimizing the dependence upon foreign sources it was put in Palestinian National Plan (2011-2013) (Juaidi et al., 2016; MoPAD, 2011). Since the energy consumption in Palestine has risen rapidly in the last 10 years due to various political and economic factors, also the residential sector has risen so it has the main cut in energy consumption elevation. It is expected to rise of energy consumptions in future

(Mubarak, 2008). So it is necessary to growing the renewable energy sector in Palestine to improving energy efficiency in the sectors of industrial, commercial, and residential (Juaidi et al., 2016; Ibrik and Mahmoud, 2005). So RE sources can be play to rise of the security of energy sector in Palestine by increase the generation for energy mix and enhance energy independence (Juaidi et al., 2016).

3.2. Energy demand

According to PCBS, the primary production of energy supply in Palestine in 2015 are wood and charcoal is 5,357.98 Terajoule is equivalent to 343,240 Tons, solar energy is 5,393.15 Terajoule is equivalent to 1,498,096 MWh, , olive cake is 637.45 Terajoule (38,057 Tons), and electricity is 33.3 Terajoule (9,250 MWh) (PCBS, 2016b). The supply of oils and petroleum derivatives in Palestine is fully depends on importer from Israel (Mubarak, 2008). Table 1 shows the imported energy sources in the Palestine in 2015, the share of imported of energy sources in both West Bank, and Gaza Strip (PCBS 2016b). It illustrates that Palestine is highly depending to importer of their most energy sources.

Table 1: Imported energy in Palestine, 2015, *(PCBS, 2016b).*

Region	Type of Energy								
	Electricity (MWh)	Gasoline (1000 Liter)	Diesel (1000 Liter)	Fuel Oil (1000 Liter)	Kerosene (1000 Liter)	LPG (Ton)	Bitumen (Ton)	Oils & Lubricants (Ton)	Wood & Charcoal (Tons)
Palestine	5,413,088	292,257	677,774	3,556	1,868	167,213	11,680	1,083	27,917
West Bank	4,281,615	243,473	464,813	3,556	1,646	108,210	10,899	1,015	27,917
Gaza Strip	1,131,473	48,784	212,961	-	222	59,003	781	68	-

Table 2 shows the average consumption prices in Palestine for different types of energy in 2015. In general, lightly subsidized of energy sources and it can be comparison with neighborhood countries. In 2009, The Palestinian Authority was spent US$374 million on energy (The Portland Trust, 2010). The price of electricity in Palestine is much higher than the 2 % of Jordan, Lebanon, and Syria (The Portland Trust, 2010). In 2015, the total energy consumption in Palestine was 66,414.35 Terajoule, and its distribution to sectors as followed: 33,961.01 Terajoule for households and other sectors (households, agriculture, and commerce and public services) and which is distributed as follow: 27,485.04 Terajoule for households, 5,647.29 Terajoule for commerce and public services, 828.68 Terajoule for agriculture, 28,985.99 Terajoule for transport sector, then 3,467.35 Terajoule for industry sector (PCBS, 2016b). The percentage share of energy consumption of sectors in Palestine in 2015 is illustrated in figure 3.

Table 2: Average annual consumption prices in Palestine by type of energy, 2015, *(PCBS, 2016b).*

Region	Type of Energy				
	Diesel (NIS/Liter)	Gasoline (NIS/Liter)	Coal (NIS/Kg)	Kerosene (NIS/Liter)	LPG (NIS/Kg)
West Bank (With Exclude of Jerusalem)	5.41	6.11	6.61	5.41	4.92
Jerusalem	6.57	6.37	14.00	6.57	10.06
Gaza Strip	5.41	6.11	6.25	5.41	4.70

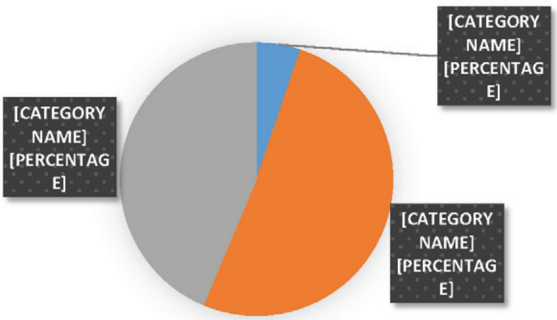


Figure 3: Energy cosumption by sectors in Palestine in 2015, *(PCBS, 2016b).*

3.3. Electric power sector

The regulator of electrical energy in Palestine for area A and B is by Palestinian Energy Authority (PEA) (Juaidi et al., 2016). The electric power productions for Palestinian regions are from Palestine Electric Co. (Gaza Electricity Distribution Co.) and imported from other countries. In Palestine, the quantity of available electrical energy in 2015 was 5,918,455 MWh and it is distributed as follow: 150,397 MWh from self – generation produced electricity and it represent 2.54%, 5,413,088 MWh (91.46%) from imported electricity, and 354,970 MWh (6%) from purchased from Palestine Electric Company (Gaza Electricity Distribution Co.) (PCBS, 2016b). The quantity of electricity imported and purchased in Palestine in 2015 is illustrated in table 3, that the total of electrical energy imported was 5,413,088 MWh, so the Israel Electric Company (IEC) has dominated imported of electricity by 95.72% (PCBS, 2016b). The IEC supplies electricity for West Bank and Gaza Strip, the Jordan supplies electricity for West Bank, Egypt for Gaza Strip, and the Gaza Electricity Distribution Co. supply for Gaza Strip (PCBS, 2016b). From 2010 to 2012, the electricity bill of imported is around US$500 million (MAS, 2015). In 2013, the bill of electricity was around US$650 million so it means that there is raised in bill of electricity due to Israel raised prices by 33% and it means that is exorbitant cost (MAS, 2015).

There is no agreement between Palestinian National Authority (PNA) and Israel about purchase of electricity from Israel, but this is arranged through bilateral contracts between the Palestinian providers and IEC (MAS, 2012). The IEC supply the electricity for West Bank in three main substation (161/33 KV); first substation in the north of West Bank in the Ariel settlement Area C near Salfit town close to Nablus. Second substation in the Atarot industrial Area C near Jerusalem, and third in the south of West Bank in the Area C near Hebron (Rabi and Ghanem, 2016; Juaidi et al., 2016; Abulkhair, 2007). Table 4 and figure 4 are shown that the Jerusalem District Electricity Co. (JDECO) is largely distribution electricity in the West Bank (43%) (PCBS, 2015a; PERC, 2011). JDECO distribution electricity via 33 KV and 11 KV distribution lines of power at several connection points with the IEC including Jericho, Ramallah, East Jerusalem, and Bethlehem (Rabi and Ghanem, 2016; Juaidi et al., 2016; Abulkhair, 2007). Two Agreements were done by the PEA at end of 2006 as following: first agreement has done that Jordan supply electricity Jericho by 33 KV power line 20 MW via King Hussein Bridge, JDECO had submit a new request to upgrade the power line to 132 KV to compatible with the voltage supplied by the Jordanian Electricity Company. Second agreement has done that Egypt supply electricity to Rafah in south of Gaza Strip by 33KV power line 17 MW (Juaidi et al., 2016; Abulkhair, 2007).

Table 3: Quantity of electricity imported and purchased (MWh) in Palestine in 2015, *(PCBS, 2016b).*

Region	Israel Electric Company (IEC)	Jordan	Egypt	Palestine Electric Company (Gaza Electricity Distribution Co.)	Total
Palestine	5,181,507	41,390	190,191	354,970	5,768,058
West Bank	4,240,225	41,390	-	-	4,281,615
Gaza Strip	941,282	-	190,191	354,970	1,486,443

Table 4 shown that 20 localities in Palestine without electricity network and this localities are in West Bank, 64 localities in Palestine are classified as not stated (38 localities in West Bank and 26 localities in Gaza Strip), The IEC has dominated to supply electricity in Palestine which that supplied for 254 localities, JEDCO has high local distribution in Palestine that it is supplied for 106 localities (PCBS, 2015a). There are many electricity problems in Palestine in 2015 is illustrated in table 5. It distributed as follow: 229 localities has problem with electrical current weakness and it represent as 28.45% of all problems, old electricity network was in 226 localities (28.07%), non-served areas was in 164 localities (20.37%), electrical current disconnection was in 153 localities (19.0%), and others was in 33 localities (4.10%) (PCBS, 2015a). As shown in table 5, that main problems in Gaza Strip is electrical current disconnection due to their political situation and Israel restriction in Gaza Strip for control import energy by the quantity and condition of energy by deny or limit trade across international borders (; Juaidi et al., 2016; PCB, 2015a; MNSSD, 2007). Palestinian Cabinet was published in 2015, the electricity tariff for residential, commercial, industry and low and medium voltage participate, agriculture sector, and pumping of water for domestic uses and wastewater treatment plant by Palestinian Water Authority, Municipalities, and Local Councils and is illustrated in table 6. In 2012, the percentage of electricity consumption by household and services was around to 75%, and 25% of electricity consumption by economic and productivity activities (MAS, 2012).

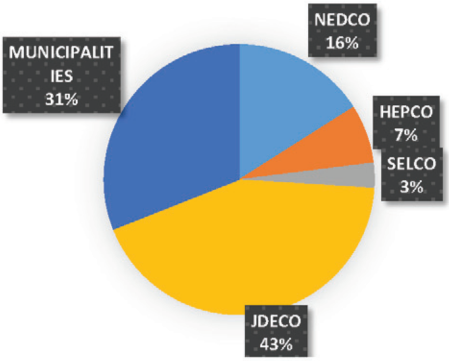


Figure 4: Percentage of consumers in Distribution Company in West Bank, 2011, *(PERC, 2011).*

Table 4: The main of electricity supplied to localities in Palestine by governorate, 2015, *(PCBS, 2015a).*

Governorate	Not Available	Main Electricity Source										
		Not Stated	Others	TE-DC O	JSC	NE-DCO	IEC	GE-DCO	JE-DCO	SE-LCO	HE-PCO	Local Authority
Palestine	**20**	**64**	**9**	**20**	**4**	**29**	**254**	**7**	**106**	**19**	**6**	**19**
West Bank	**20**	**38**	**9**	**20**	**4**	**29**	**254**	**-**	**106**	**19**	**6**	**19**
Jenin	1	2	7	10	2	10	47	-	-	-	-	1
Tubas	6	1	-	10	-	-	2	-	-	-	-	2
Tulkarm	-	1	-	-	1	3	30	-	-	-	-	-
Nablus	-	3	1	-	-	16	40	-	-	-	-	4
Qalqiliya	2	1	1	-	-	-	30	-	-	-	-	-
Salfit	1	1	-	-	-	-	18	-	-	-	-	-
Ramallah & Al-Bireh	1	14	-	-	-	-	13	-	47	-	-	-
Jericho & Al Aghwar	1	3	-	-	-	-	5	-	5	-	-	-
Jerusalem	-	4	-	-	-	-	12	-	19	-	-	19
Bethlehem	1	5	-	-	-	-	4	-	35	-	-	-
Hebron	7	3	-	-	1	-	53	-	-	19	6	3
Gaza Strip	**-**	**26**	**-**	**-**	**-**	**-**	**-**	**7**	**-**	**-**	**-**	**-**
North Gaza	-	5	-	-	-	-	-	1	-	-	-	-
Gaza	-	4	-	-	-	-	-	1	-	-	-	-
Deir Al-Balah	-	8	-	-	-	-	-	2	-	-	-	-
Khan Yunis	-	6	-	-	-	-	-	2	-	-	-	-
Rafah	-	3	-	-	-	-	-	1	-	-	-	-

TEDCO: Tubas Electricity Distribution Co., JSC: Joint Services Council, NEDCO: Northern Electricity Distribution Co., GEDCO: Gaza Electricity Distribution Co., SELCO: Southern Electric Co., HEPCO: Hebron Electricity Power Co.

Table 5: The main of electricity problems in localities in Palestine by governorate in 2015, *(PCBS, 2015a).*

Governorate	Main Electricity Problems				
	Electrical Current Disconnection	Electrical Current Weakness	Old Electricity Network	Non Served Areas	Others
Palestine	**153**	**229**	**226**	**164**	**33**
West Bank	**120**	**224**	**224**	**162**	**33**
Jenin	21	32	21	14	6
Tubas	6	6	2	2	-
Tulkarm	7	11	16	6	5
Nablus	11	25	30	12	4
Qalqiliya	3	9	18	10	2
Salfit	4	11	7	10	-
Ramallah & Al-Bireh	14	31	30	23	2
Jericho & Al Aghwar	8	10	11	7	-
Jerusalem	4	13	11	9	3
Bethlehem	3	18	26	23	3
Hebron	39	58	52	46	8
Gaza Strip	**33**	**5**	**2**	**2**	**-**
North Gaza	5	1	-	1	-
Gaza	5	1	-	1	-
Deir Al-Balah	11	-	-	-	-
Khan Yunis	8	3	2	-	-
Rafah	4	-	-	-	-

Table 6: Electricity Tariff in Palestine in 2015, *(PERC, 2015).*

Electricity Tariffs	NIS/KWh
Residential(with exclude of Jericho & Al Aghwar)	0.4366-0.6417
Residential for Jericho & Al Aghwar)	0.4275-0.4513
Commercial	0.5684-0.5956
Industry & Low and Medium Voltage	0.4136-0.5238
Agriculture Sector	0.44
Pumping of Water	0.46

4. Renewable energy sources

The interest in RE energies that don't involve the consumption of exhaustible resources such as fossil fuels and uranium (Bp, 2017), due to that its energies derived from natural processes (indigenous resources) with zero or near zero emissions of both air pollutants and greenhouse gases (Demirbas, 2009), so reducing depletion of reserves fossil fuels and their environmental deterioration (Bundhoo, 2017;. Juaidi et al., 2016; Alemán-Nava, 2014). The Characterized of renewable energies is given flexibility to the power supply system. (Juaidi et al., 2016). The RE in Palestine would be solar system, wind power, biomass, and geothermal, especially in solar system is using to generate electricity in rural areas and villages in Palestine which is mainly isolated areas that haven't electricity available during 24 hours a day (Juaidi et al., 2016). The renewable energies in Palestine are solar power, wind power, and energy generated from burning wood, peat, etc.) (PCBS, 2015b; MoPAD, 2011). The share of renewable in total power production in Palestine is a negligible (small) share by comparing it with neighborhood countries and is illustrated in table 7 (Mas, 2015). In 2009, the share of renewable energy sources in domestic energy use in Lebanon is less than 2% (Comair, 2009).

Table 7: Shares of renewable in total power production in neighborhood countries, *(MAS, 2015).*

Country	Palestine	Jordan	Egypt	Israel
Share (%)	0.2	2	3	5

4.1. Solar energy

The features of solar energy technologies are renewable, clean, domestic energy source, and are main components of sustainable energy future (Gunerhan et al., 2008). Solar energy systems such as solar thermal and solar photovoltaic (PV) panels provide significant positive impacts on environment in comparisons to the traditional energy sources such fossil fuels sources (Kaygusuz, 2009; Gunerhan et al., 2008). There are minor negative impacts on environmental during production and operation of these systems (Gunerhan et al., 2008). For an example, noise and visual intrusion, labor accidents, and affect archaeological sites (Kaygusuz, 2009). Therefore, it is necessary to improve of technologies with innovations and good practice to reduce the minor negative impacts on environmental of this system for wide scale deployment future (Kaygusuz, 2009). There are two main types of solar energy are in Palestine are solar water heaters, solar photovoltaic (PV) panel (PCBS, 2015b; MoPAD, 2011).

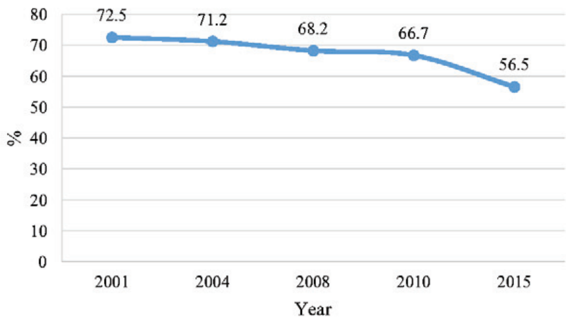


Figure 5: The percentage of households having solar water heater in Palestine are decreasing between 2001 and 2015, *(PCBS, 2015b).*

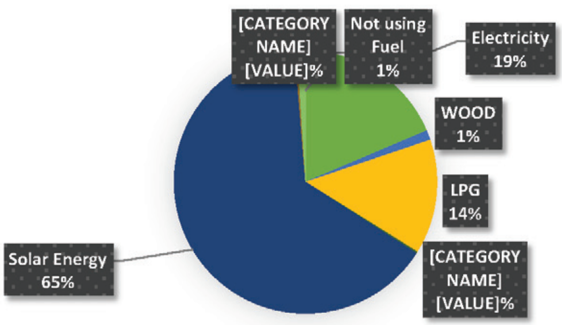


Figure 6: Distribution of energy consumption for water heating by households in Palestine, July 2010, *(PCBS, 2010).*

4.1.1. Solar water heaters

In 2016, the total global capacity from solar thermal heating and cooling is approximately 456 gigawatts-thermal (GW_{th}) by increasing 36.7 GW_{th} (5%) of new solar thermal capacity was commissioned (REN21, 2017). The sales is raise up in several emerging markets in many countries are Argentina, the Middle East, and parts of Central and Eastern Africa so its global expansion due to continued development of solar thermal heating and cooling technologies (REN21, 2017). Larger established market has challenged for several reasons in 2016, especially in low oil and gas prices. China had accounting approximately 75% of global additions (REN21, 2017).

The Palestinians using wood, coal, and peat for water heating in their residential buildings also they are using solar thermal system (solar power) to generate it (MoPAD, 2011). In 2015, the share of solar energy is around to 7.2% of total energy consumption in Palestine (PCBS, 2016b). According to Palestinian Energy Authority (PEA), about 62% of households had solar water heater had using in 2013 to obtain hot water which is providing more than 600GWh which is estimated value of this energy more than US$100 million is provided from electricity (PCBS, 2014). The percentage of households having solar water heater in Palestine are decreasing from 2001 to 2015 is illustrated in figure 5 (PCBS, 2015b). The major causes of decline using a solar water heater by households due to the price of electricity is decreasing over the past years and most house building are commercial residential type so there is narrow area which is not enough to installation of this system for all apartments (Yaseen, 2017). In 2015, the West Bank had 63.1% of households having solar water heater and in the Gaza Strip was 43.8% (PCBS, 2015c). For an example to compare situation in Palestine with neighborhood countries that Israel was 90% of households having solar water heater, Cyprus had 90% while Jordan had 15% (PCBS, 2015b). Figure 6 shows the distribution of energy consumption for water heating by households in Palestine, July 2010 (PCBS, 2010). Also in Palestine, approximately 40% of hospitals are using solar water system and 25% of hotels (The Portland Trust, 2010; Yaseen, 2009). Cost of solar water heater system in Palestine is cheaper due to 90% of these system are manufactured locally (The Portland Trust, 2010).

4.1.2. Solar Photovoltaic (PV) Panel

The total world capacity from solar PV system was 303 gigawatts (GW) in 2016 and 228 GW were in 2015, which means that 75GW of solar PV was added worldwide during 2016 and its equivalent to 31,000 solar PV panels every hour (REN21, 2017). The Solar PV system had around 47% of the total additions in the world (newly installed renewable power) (REN21, 2017). The top five countries had using of this system according to their total capacity of generation in the end of 2016 are China, Japan, Germany, United States, and Italy (REN21, 2017). In addition, the top five countries according to solar PV capacity per capita in the end of 2016 are Germany, Japan, Italy, Belgium, and Australia and Greece (REN21, 2017). The solar PV capacities in Middle East are comparatively small, but there are many countries in this region were building new solar PV system project (REN21, 2017). In 2016, there are projects more than 200 megawatts (MW) by solar PV are planned or under construction in Middle East countries are Jordan, Oman, Palestine, the United Arab Emirates (UAE), and Saudi Arabia (REN21, 2017). Jordan announced tendering for

200 MW solar power; Saudi Arabia launched tender for 100 MW solar power; Palestine has launched first tenders in 2016 by the Palestinian Energy Authority for installed 100MW solar PV (REN21, 2017). The 100 MW solar PV for electricity generation in Jericho is planned as one of strategies provided from Palestinian National Plan (2011-2013), to modification of energy sectors to becoming securing it, to meet Palestinian's sufficient of energy consumption needs, get sustainable development (MoPAD, 2011). The first of this project will provide 10-20 MW (Juaidi et al., 2016; MoPAD, 2011). The implementations the project of 100 MW for electricity generation from solar PV system is not yet start (Yaseen, 2017).

The main factors for calculations of power generation by solar PV panels are clearance of the sky and cloudy hours due to sky clearance index are primary attenuation factors of solar radiation (Rabi and Ghanem, 2016). The annual rate of daily shinning in Palestine is 3000 hours (Juaidi et al., 2016; Yannopoulos et al., 2015). The period from May to September has the maximum values of the clearance index with maximum shinning hours so can be obtaining the highest utilization of solar power during this period (Rabi and Ghanem, 2016). Also can be obtaining high solar power in March, April, and October (Rabi and Ghanem, 2016). The low solar power can be obtaining in January, February, November, and December (Rabi and Ghanem, 2016). Palestine has high average annual solar irradiation characteristics is 5.4 KWh/m2 per day on horizontal surface (Rabi and Ghanem, 2016; Mubarak, 2008). In June, some areas has maximum solar irradiation is reaches to 8.4 KWh/m2 per day while the minimum solar irradiation is reaches to 2.8 KWh/m2 per day on December (Rabi and Ghanem, 2016; Juaidi et al., 2016). Figure 7 shows the three global titled irradiation areas can be classified in Palestine (Rabi and Ghanem, 2016):

1. Areas colored in red with highest irradiation are above 2300 KWh/m^2 per year. As shown in figure7, the area with this irradiation covers the middle and southern areas of Palestine. These areas in the West Bank include Ramallah, Jerusalem, Bethlehem, and Hebron, and all of Gaza Strip areas.

2. Areas colored in brown with medium irradiation are between 2200-2300 KWh/m^2 per year. As shown in figure7, the areas with this irradiation mainly cover Jordan valley and northern hill areas in Palestine. These areas include Jericho and the southern part of the Jordan valley, Tubas governorate, and some areas in the north of West Bank.

3. Areas colored in yellow with low irradiation are less than 2200 KWh/m^2 per year. As shown in figure7, the areas with this irradiation are covering in most

north of West Bank. These areas are Jenin, Tulkarm, Qalqiliya, and other rural areas to the west of West Bank.

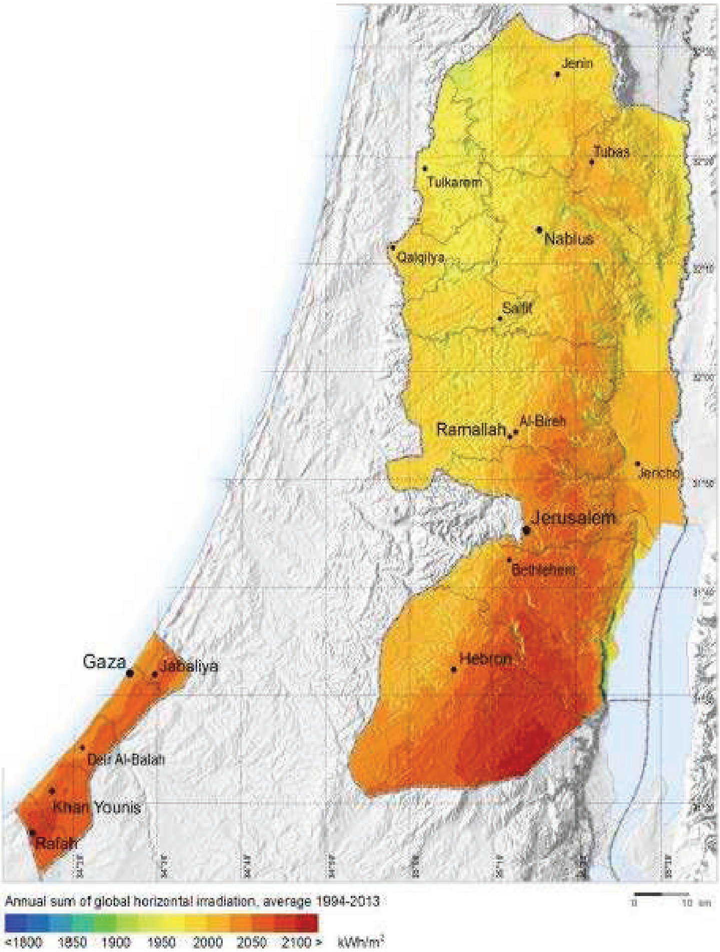


Figure 7: Average global titled irradiation of Palestine (1994-2013), *(Rabi and Ghanem, 2016)*.

In Gaza Strip and east of West Bank areas has higher wind speed, so it's bring pollution or dust from deserts, urbanized, and agriculture areas which mean increasing dirt on solar PV modules surface so reducing efficiency of these system and increases of operation and maintenance (O&M) costs in these areas (Rabi and Ghanem, 2016). The optimal efficiency of solar PV system is fixed with optimum angle is 27^0 and orientation of this system to the south. Figure 8 and table 8 are shown for typical open space solar PV, the specific solar PV electricity output per year with a nominal peak power of 1 KW peak (KWp) system. It can be observed from figure 8 and table 8 that possible makes it to any size of projects in Palestine by scale the estimate of solar PV power production plant. It can be obtaining that varies values of annual average of electricity yield from fixed PV power production plant are 1703-1765 KWh/KWp annually at optimum angle. South of West Bank and Gaza Strip has maximum value of solar PV power production that is higher than 1800 KWh/KWp (Rabi and Ghanem, 2016).

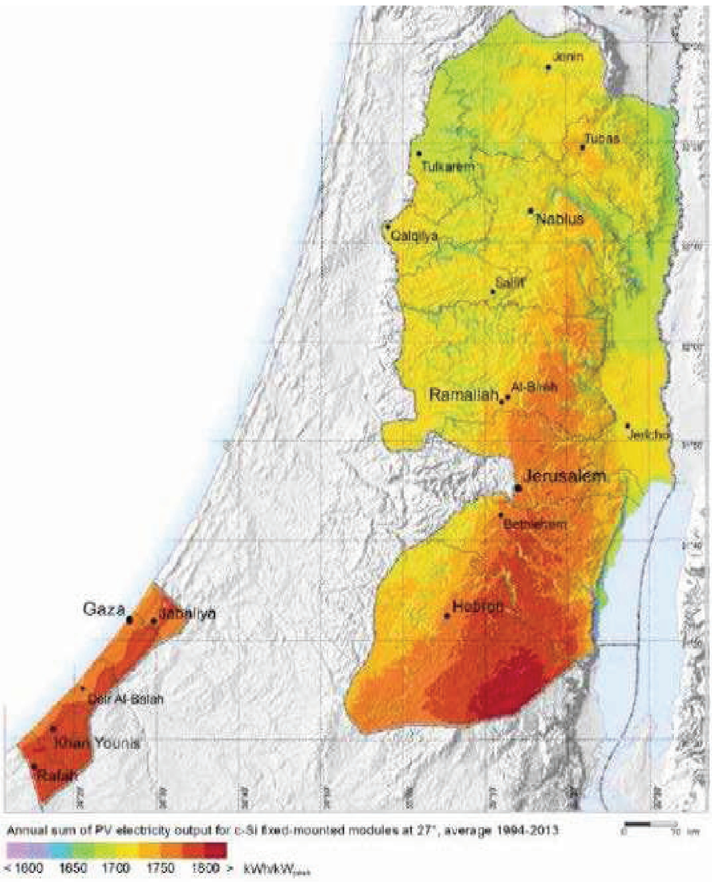


Figure 8: Annual solar PV electricity output from an open space fixed PV system with a nominal peak power is 1KWh/KW, *(Rabi and Ghanem, 2016).*

Table 8: Annual average of solar PV electricity output from an open space fixed PV system with a nominal peak power is 1KWh/KWp at optimum angle, *(Rabi and Ghanem, 2016)*.

	Palestinians Areas with Different Solar Irradiation Levels		
	Level A	Level B	Level C
Solar PV electricity yield for Fixed-Mounted Modules at Optimum Angle (27^0) (KWh/KWp)	1765	1715	1703
System Performance Ration (PR) for Fixed – Mounted PV Modules (%)	78.1	76.5	78.0

In general, the high and stable production from solar PV system during period from May to August since solar PV system depends on irradiation (Rabi and Ghanem, 2016). The solar irradiation has not differ significantly between different Palestinian areas due to the Palestine area is small (Rabi and Ghanem, 2016; Mubarak, 2008). South of West Bank and Gaza Strip has highest solar PV electrical production, and the lowest production in Jericho is 1703 KWh/KWp due to location of Jericho in Jordan rift valley. In addition, reducing of electricity generation by high air temperature, so it can be increasing of electricity generation from solar PV system by 40% by using tracking systems (Rabi and Ghanem, 2016). According to the analysis of solar irradiation in Palestine and other factors such as sky clearance index, that can be using solar PV system in many applications. For an example, using for drying of crops vegetables and fruits, water heating, pumping of water, desalination of water, electricity generation for street lighting, electricity in buildings such as residential, schools, clinic centers, and industries, etc. In addition, it can be supplied with electricity despite being remote locations isolated from main electrical networks (Juaidi et al., 2016; Yannopoulos et al. 2015; Mubarak, 2008). Since the cost of electricity and fuel is relatively high, so the application of solar PV system in Palestine economically profitable (Juaidi et al., 2016; Yannopoulos et al. 2015; Mubarak, 2008). For an Example, using of solar PV solar in the rural areas and villages in Palestine for electricity purpose is economically profitable due to extension of high voltage electric grid or using diesel generators and reducing CO_2 emissions to atmosphere when using diesel generators so improving ecosystems in these areas (Juaidi et al., 2016; Yannopoulos et al. 2015; Mubarak, 2008). The example of application of using this system in rural areas and villages for water desalination purpose especially in Jordan Valley by using solar PV system coupled to reverse osmosis (RO). As an economically feasible alternative for desalination of brackish water that it can be uses reclaimed water for irrigation water, therefore, ensure security agriculture land availability, and preventing its abandonment (Taha and Al-Sa'ed, 2017). The results and information about solar PV system in Palestine, it will be factors to helpful to encourage decision makers and energy sectors planers to use these system for sustainable development, rise the security of energy sector, improve ecosystem by reducing CO_2 emissions to atmosphere such as using diesel generators to generate electricity, especially in rural areas and villages in Palestine which is mainly isolated areas that haven't electricity available during 24 hours a day (Juaidi et al., 2016; Yannopoulos et al. 2015; Mubarak, 2008).

4.2. Wind energy

The total world capacity from wind power system was 487 GW in 2016 and 433 GW were in 2015, which means that 54GW of wind power was added worldwide during 2016 (REN21, 2017). The potential of wind power has satisfied to both systems types are large-scale energy production and stand-alone systems (Juaidi et al., 2016; Nan et al., 2013; Zhou et al., 2010). The wind power had around 34% of the total additions in the world (REN21, 2017). The top five countries had using of this system according to their total capacity of generation in the end 2016 are China, United States, Germany, India, and Spain (REN21, 2017). In addition, the top five countries according to wind power capacity per capita in the end of 2016 are Denmark, Sweden, Germany, Ireland, and Portugal (REN21, 2017). The situations of wind power system in Middle East countries are comparatively small (REN21, 2017). In 2016, Jordan had offered tender in 2016 for 100 MW capacity of wind power, and it has a target to achieved 1.2 GW capacity from wind power at 2020 (REN21, 2017). The German Aerospace Center and European Wind Energy Association was making RE sources scenario that 80% of Europe's entire electricity demand by 2050 is supplied from wind power farms. In addition, the National Renewable Energy Laboratory in the USA (NREL) that could cover 20% of the entire US electricity demand by 2030 from wind power (Juaidi et al., 2016; Harvey, 2013).

The wind speed is major factor requirement for studying the electricity generation from wind power system based on the available data and topographical and elevation features of site specific in different locations (Juaidi et al., 2016; Kitaneh et al., 2012; Shabaneh and Hasan, 1997). In Palestine, there are no sophisticated and professional measurements of wind speed to determine available wind resources (PCBS, 2015b). The wind speeds in Palestine are moderate (Juaidi et al., 2016; Ibrik, 2009; Mubarak, 2008). The characteristic of wind speed in Gaza Strip is coastal region is a very low throughout the year, with an annual average wind speed around to 2.5-3.5 m/s, also the annual average wind speeds in Jordan Valley (represented in Jericho) are around to 2-3 m/s which means that the Jordan valley has a very low wind speed characteristic. While in the hilly regions of the West Bank, Nablus, Ramallah, Jerusalem, and Hebron have average wind speeds varying in the range of 4 to 8 m/s annually (Juaidi et al., 2016; Kitaneh et al., 2012; Ibrik, 2009; Mubarak, 2008). Since the electricity generation from wind, power requires annual mean wind speeds are between 6-20 m/s (Ibrik, 2009; Mubarak, 2008), so the mountains with height about 1000 meter above sea level have suitable for operating wind turbine. These mountains regions are in Nablus, Ramallah, and Hebron which is have the wind speed reaches 5 m/s (Juaidi et al., 2016; Kitaneh et al., 2012; Yaseen, 2009). For an example, Al-Ahli hospital is located in the western part of Hebron at 1000 meter above sea level, can install wind turbine to generate around 700KW of total production power capacity (Juaidi et al., 2016; Kitaneh et al., 2012; MoPAD, 2011; Yaseen, 2009). This region could be the average wind speed reaches 6.2 m/s at 10 meter the ground level (Juaidi et al., 2016; Kitaneh et al., 2012). The obstacle was coming from Israel, on implementation and installation of wind turbine for Al-Ahli hospital's wind energy project, which is restricted for import wind turbine equipment, and regulations for wind installation such as can't install wind turbine with elevation not greater than 40 meters which is not enough to generate electricity from this system due to need of at least 100 meters elevation of wind turbine from ground to generate electricity effectively (Yaseen, 2017). Figure 9 shows the mean monthly wind speed in Gaza Strip based on climatology (2000-2011), it has the average annual wind speed is 3.34 m/s, and it has the maximum wind speed in winter season are Jan, February, and March (De Meij et al., 2016). According to the table 9, shows that Ramallah has higher annual average wind speeds other than six cities in the West Bank. In 2013, Ramallah has recorded highest annual average wind speed is 3.11 m/s, then Hebron is recorded 2.92 m/s, then Jenin is recorded 2.00 m/s, Nablus is recorded 1.69 m/s, Jericho is recorded 1.28 m/s, and Bethlehem is recorded 0.97 m/s (PCBS, 2016c). According to the figure 10 & 11, shows that in Ramallah has maximum wind speed during winter and spring season, Hebron has maximum wind speed during winter season, Jenin and Nablus has maximum wind speed during spring season, Jericho has maximum wind speed during spring and summer season (PCBS, 2009).

In general, the wind speeds in Palestine are moderate (Juaidi et al., 2016; Ibrik, 2009; Mubarak, 2008). It can be using small wind turbine to electricity generation in the hilly areas in West Bank, which have annual average wind speed 4-6 m/s especially for areas are far from the grid (Juaidi et al., 2016; Mubarak, 2008). In addition, can using small wind turbine by multi-blade windmill for pumping of water, where there are using diesel generators for this purpose due these areas are is isolated areas that have not electricity available during 24 hours a day (Juaidi et al., 2016; Ibrik, 2009; Mubarak, 2008). For Gaza Strip, there are restricted to use small wind turbine for pumping of water thus for it's using for pumping from shallow wells due to it has relatively low wind speeds (Ibrik, 2009; Mubarak, 2008).

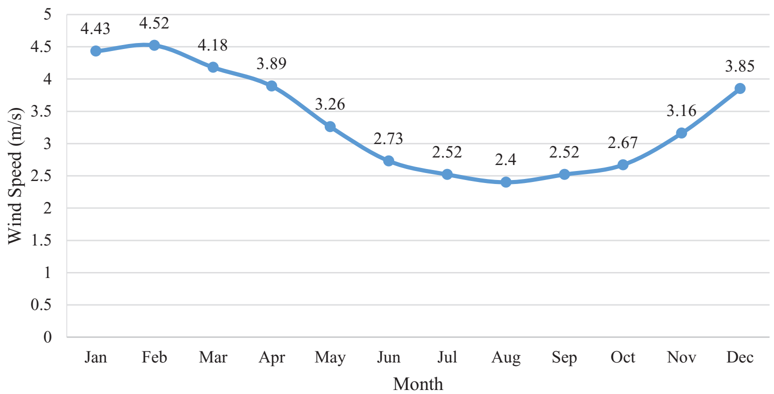
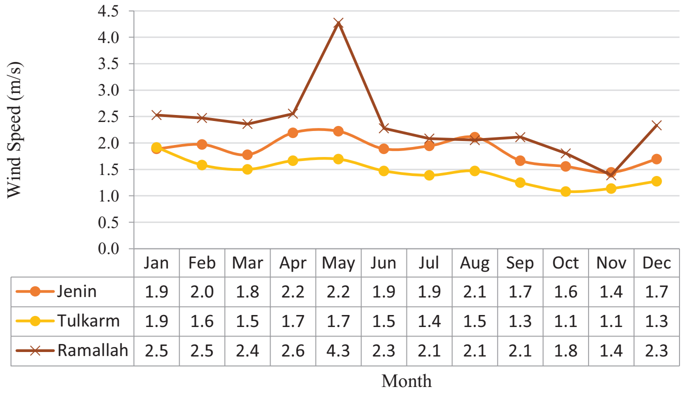


Figure 9: Mean monthly wind speed in Gaza Strip based on climatology (2000-2011), *(De Meij et al., 2016).*

Table 9: Mean wind speed (m/s) in West Bank by station location and year.

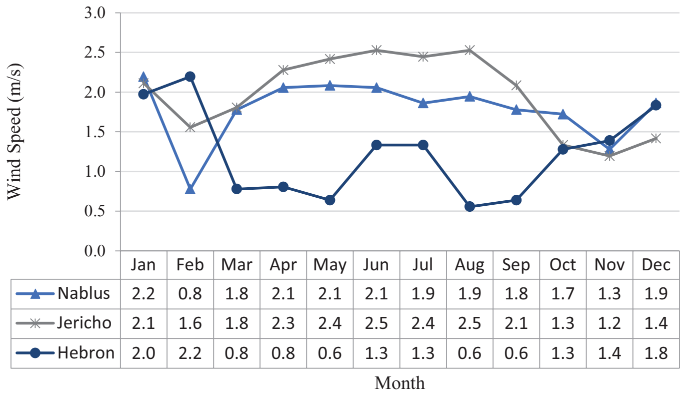
	Year					
	2008*	2012**	2013**	2014**	2015**	2016**
Jenin	1.86	2.00	2.00	1.69	1.69	0.88
Tulkarm	1.45	-	-	-	1.50	0.72
Nablus	1.78	1.64	1.69	1.50	1.44	0.75
Ramallah	2.35	3.08	3.11	2.72	2,67	1.53
Jericho	1.97	1.39	1.28	1.28	1.14	0.56
Bethlehem	-	0.92	0.97	1.56	1.64	0.89
Hebron	1.23	2.81	2.92	2.36	2.00	1.00

*Source: *Meteorological Conditions in the Palestinian Territory, Annual Report 2008 by Palestinian Central Bureau of Statistics (PCBS, 2009), **Mean wind speed in Palestine by station location and year by Palestinian Central Bureau of Statistics (PCBS, 2016c)*



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jenin	1.9	2.0	1.8	2.2	2.2	1.9	1.9	2.1	1.7	1.6	1.4	1.7
Tulkarm	1.9	1.6	1.5	1.7	1.7	1.5	1.4	1.5	1.3	1.1	1.1	1.3
Ramallah	2.5	2.5	2.4	2.6	4.3	2.3	2.1	2.1	2.1	1.8	1.4	2.3

Figure 10: Mean monthly wind speed in some locations in West Bank in 2008, *(PCBS, 2009)*.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nablus	2.2	0.8	1.8	2.1	2.1	2.1	1.9	1.9	1.8	1.7	1.3	1.9
Jericho	2.1	1.6	1.8	2.3	2.4	2.5	2.4	2.5	2.1	1.3	1.2	1.4
Hebron	2.0	2.2	0.8	0.8	0.6	1.3	1.3	0.6	0.6	1.3	1.4	1.8

Figure 11: Mean monthly wind speed in other locations in West Bank in 2008, *(PCBS, 2009)*.

4.3. Geothermal energy

Geothermal energy is renewable, clean energy source (green), reliable, and a cheap domestic energy resource so it's need encourage and supported of these energy by development studies and increases of investments in this sector (Juaidi et al., 2016; Fridleifsson , 2001). The main advantages of geothermal resources that its offer energy constant, available on demand, as alternative energy to fossil fuels (Juaidi et al., 2016; Schiermeier et al., 2008). The geothermal energy has minimal construction and maintenance resource requirement due to the current existing energy technologies. Therefore, the geothermal energy has one of the lowest environmental impacts (Hanbury and Vasquez, 2018). The definition of geothermal energy that it is uses heat from deep under the earth surface as an energy source (Rudiyanto et al., 2017). The resources provide from geothermal are thermal energy and electricity (REN21, 2017). In Japan, the geothermal energy for heating and cooling is still popular for bathing facilities (Rudiyanto et al., 2017). In modern era, the most of geothermal energy uses for electricity generation due to sustainable and low emission energy source (Rudiyanto et al., 2017). The growth of these power is relatively small due to the geothermal industry is facing challenges were in 2016 are burdened by project development and the inherent high risk to exploration of geothermal, the associated lack of risk mitigation, and the financing constraints and disadvantage of competitive relative to low cost of natural gas. However, the industry made progress in key markets with new project developments, and enhanced by the leaders of industry partnership to achieve the new opportunity (REN21, 2017). The constraints of geothermal development energy around the world due to lack clear of resource assessment standards, so the UN Framework for Fossil Energy and Mineral Reserves and Resources had complete the new geothermal specifications in 2016 (REN21, 2017). The objective of this framework for benefits of investors, regulators, and the general public by harmonies standards for reporting resources of geothermal in manner similar to other extractive industries in the worldwide (REN21, 2017). The total world capacity from geothermal power system was 13.5 GW in 2016 and 13.1 GW were in 2015, which means that 0.4 GW of geothermal power was added worldwide during 2016 (REN21, 2017). Estimated of geothermal power is 78 Terawatt-hour (TWh) is equivalent to 282 petajoules (PJ) during 2016 (REN21, 2017). The top five countries had using of this system according to their total capacity of generation power in the end 2016 are United States, Philippines, Indonesia, New Zealand, and Mexico (REN21, 2017). In, 2016, the Indonesia and Turkey has largest installed of generation power in the world, where each of these two countries added about 200 MW of power capacity (REN21, 2017). Mexico, Kenya, and Japan had complete projects during 2016 (REN21, 2017). The top five countries according to their total capacity of generation heat in the end of 2016 are China, Turkey, Japan, Iceland, and India (REN21, 2017). In 2015, the geothermal direct use were an estimation 89 TWh (286 PJ), and these system continued expansion in 2016, including used several district heat systems in Europe countries with it had more 260 plants (REN21, 2017).

Geothermal energy is depending on the difference the temperature between surface of earth and under the surface of earth. For an example, Palestine and Jordan have the temperature of earth is around to 17 ^{0}C and its constant throughout the year (PCBS, 2015b). The temperature of earth during winter period is constant to 17^{0}C and this temperature is above the temperature of air around to 4^{0}C during the peak time. So water pumping through under earth surface by deeply installed piping system under the ground which means that it can be suction of warm earth temperature, and transfer it to thermal pump and heat pressure by this pump and transfer heat to building around to 45^{0}C to supply the all heating system (PCBS, 2015b). The process during summer period is opposite than process during winter period. The earth temperature earth during summer period is constant to 17^{0}C while the temperature of air is around to 36^{0}C, so the system absorbs the heat of the building and returns it to the coldest ground (PCBS, 2015b). Because the land is limited in Palestine, the most appropriate method is to use the closed vertical loop by digging holes in the ground vertically around to 150 meters deep (Yaseen, 2009). It can be recover the cost of this system in between 4.2-6.3 years according to operation of system in between 16-24 hours per day (PCBS, 2015b). The Palestinian lands is attractive for utilization of geothermal energy, especially in Gaza Strip and north of Palestine are mainly very high geothermal energy sources (Juaidi et al., 2016; El-Kilani and Zaid, 2015). Just few projects has implemented in Palestine due to high capital cost of these system operation as sources of renewable energy (PCBS, 2015b). Only known in Palestine implementation of this system is, by Mena Company for heating and cooling in residential buildings at Ramallah in West Bank, according to Mena Company that by this system can be payback during period of 4.5 years due to reduction in paid for heating and cooling by more than 70% (Juaidi et al., 2016; Yaseen, 2009).

4.4. Renewable energy projects in Palestine

The most used of solar systems in Palestine are solar water heater and PV systems (PCBS, 2015b; MoPAD, 2011). The Palestinian using wood, coal, and peat for water heating in their residential buildings also they are using solar thermal system (solar power) to generate it (MoPAD, 2011). According to Palestinian National Plan (2011-2013), The RE share of energy consumption in Palestine is around to 18%, and the annual growth rate of solar power is 1% (Juaidi et al., 2016; MoPAD, 2011). The percentage of renewable energy in total energy consumption is very low, especially solar power system in comparison to available capacities (Juaidi et al., 2016; MoPAD, 2011). As mentioned in section 5.1.1 in this report for solar water heater in

Palestine, the major causes of decline using a solar water heater by households is due to the price of electricity decrease over the past years and most house building are of commercial residential type, with there is narrow area that is not enough to installation of this system for all apartments (Yaseen, 2017). The solar PV system is most using for electricity generation in Palestine since the concentrated solar power (CSP) is very expensive and needs the expertise of engineers and labors to installing, operation, and maintenance of this system and wide of land area needs and huge water for this system (Yaseen, 2017). The most application of solar PV in Palestine are small scaled pilot power for electricity generation such as residents, schools, clinic centers, and industries, etc. that it can be electrification for rural areas and villages especially areas which have remote locations isolated from the electrical networks (Juaidi et al., 2016; Yannopoulos et al. 2015; Mubarak, 2008). The example for small village is solar power for Atuf village in north of West Bank and Imneizil village in southern Hebron governorate. The total solar power capacity of these projects is near to 50 KW (Juaidi et al., 2016; MoPAD, 2011). According to Palestinian National Plan, there are initial agreement has been reached between the PNA and Japan to supply the Industrial-Agricultural zone in the Jericho by implement a solar call-based electricity generation with a 300-500 KW capacity (Juaidi et al., 2016; MoPAD, 2011). As mentioned in previous that there are planned 100 MW solar PV project for electricity generation in Jericho. The first of this project will provide 10-20 MW (Juaidi et al., 2016; MoPAD, 2011). The implementations the project of 100 MW for electricity generation from solar PV system is not yet start (Yaseen, 2017).

There were planning by Palestinian Nation Plan (2011-213) for electricity generation around 700KW by wind turbine in Al-Ahli hospital in Hebron (Juaidi et al., 2016; Kitaneh et al., 2012; MoPAD, 2011; Yaseen, 2009). But there are obstacle was coming from Israel to implementation of installing wind turbine for Al-Ahli hospital's wind energy project, which it's restricted for import wind turbine equipment, and regulations for wind installation such as can't install wind turbines with elevation not greater than 40 meters which is not enough to generate electricity from this system due to need of at least 100 meters elevation of wind turbines from ground to generate electricity effectively (Yaseen, 2017). So there were replace, the wind energy to solar PV system project for Al-Ahli hospital to solar PV project and it was implemented (Yaseen, 2017). About geothermal energy system projects in Palestine, the only known implementation of this system is, by Mena Company for heating and cooling in residential buildings at Ramallah in West Bank. According to Mena company that by these system can be payback during period of 4.5 years due to reduction in paid for heating and cooling by more than 70% (Juaidi et al., 2016).

4.5. Renewable energy scenarios in 2020

The PEA has prepared strategy for renewable energy as important parts of the resources matrix, where Palestine needs clean and more secure supply of electrical power. The PEA has developed a clear goal for the year 2020 is as follows: Achieve generate electricity from renewable resources at least 240 GWh, which is equivalent to 10% of the power that will be produced locally by 2020, and achieve 25% from renewable resources (Thermal) of the total energy consumption in Palestine by 2020. Currently the estimated exploitation of renewable resources (thermal) is about 18% of the total consumption in Palestine, which represents 2,287 GWh (of the power produced) which will be used in particular in heating (Yaseen, 2017).

There are five requires for achieve this goal are apply the necessary regulations and legislations for the development and promotion of the use of this technology, securing funding sources to cover the required costs and provide incentives for private sector investors, Approving a plan to develop local human resources to be capable of manufacturing, installing and managing the renewable energy systems, applying the Palestinian solar initiative (PSI) for the period between 2012 and 2015, and adopting a development plan for the renewable energy resources until 2020 (Yaseen, 2017). Table 10 shows the required technology needed have been identified in terms of application and investment until 2020, this data has done according to the Energy Authority, which has prepared the assessment studies of renewable energy resources. It can be observed from table 10, that the solar energy represents 50% of total capacity, so this strategy contains the initiative of solar energy in order to disseminate and promote the use of renewable solar energy technology to generate electricity (Yaseen, 2017).

Table 10: Renewable resources technology expected installed until 2020, *(Yaseen, 2017)*.

Technology Used	2020 (MW)
On Ground PV	25
Rooftop PV (Palestinian Solar Initiative)	20
Concentrated Solar Power Plants (CSP)	20
Biogas from Landfills and Animal Wastes	21
Small-Scaled Wind	4
Wind Farms	40
Total	130

The institutions that will participate in order to achieve this goal are Palestinian Cabinet, the PEA, Ministry of Finance, PERC, the Palestinian Energy and Environment Research Centre (PEC), Electricity distribution companies, the private sector (which constitutes a key role in reaching this goal), institutions for standards and metrology, and universities and research centers. There are two phases for implementation this strategy are (Yaseen, 2017):

1- The first phase, which is considered the starting point in the promotion of renewable energy technologies and their uses Through conducting feasibility studies, preparation of tenders, especially in emerging markets such as Palestine, where such studies will promotes awareness campaigns and training activities, implementation of projects with small capabilities, and implementation of the Palestinian Solar Initiative (PSI).

2- The second phase, which comes after the maturity of the domestic market towards renewable energy technologies and their applications, through the implementation of projects with high capacity enables us to reach the desired goal by the year 2020.

The first phase of the renewable energy (2012-2015):

The technologies of renewable energy for first phase that it can be used directly within the possibilities that are available which include solar energy, wind power and biogas produced from landfills and animal waste.

Table 11: Renewable resources technology expected (MW) installed for 2012-2015, *(Yaseen, 2017)*.

Technology Used	2012	2013	2014	2015	Total
On Ground PV	0.7	1	1.3	2	5
Rooftop PV (Palestinian Solar Initiative)	0.3	1.2	1.5	2	5
Concentrated Solar Power Plants (CSP)	-	-	-	5	5
Biogas from Landfills and Animal Wastes	-	0.1	0.2	6.2	6.5
Small-Scaled Wind	-	0.1	0.3	0.6	1
Wind Farms	-	-	1	1.5	2.5
Total	1	2.4	4.3	17.3	25

In this Phase will include Palestinian solar initiative, which is an unprecedented initiative to spread the concepts of solar energy. This initiative consists of the rooftop PV aim to achieve 5 MW of solar energy by 2015. This project divided to three phases over a period from mid-2012 to mid-2015. This initiative aims to set up small businesses with a capacity up to 5 kW for each house and this projects will be installed through cells on the roofs of 1000 houses throughout the West Bank and it's distributed as follow: 1.5 MW in north of West Bank is equivalent to installing for 300 houses, 2 MW (400 houses) in center of West Bank, and 1.5 MW (300 houses) in south of West Bank (Yaseen, 2017). The first year of project will be installed for 100 houses to generate 0.5 MW, then second year of the project will be installed for 300 house to generate 1.5MW, and then last year of the project will be installed for 600 houses to generate 3MW to reach a total of 5 MW at the end of three years (Yaseen, 2017). Until now, the Palestinian Energy Authority was implemented rooftop PV in first 100 houses (Yaseen, 2017).

The second phase of the renewable energy (2016-2020):

This phase of the renewable energy will commence after evaluating the first phase and the market in Palestine in terms of the application and use the technologies of renewable energy. This will open the door for investment in the renewable energy by the private investors through incentives and preferable tariff that will be approved by the government; it would be help to some extent to reach the potential target in 2020.

Table 12: Renewable resources technology expected (MW) installed for 2016-2020, *(Yaseen, 2017).*

Technology Used	2016	2017	2018	2019	2020	Total
On Ground PV	2	3	5	5	5	20
Rooftop PV (Palestinian Solar Initiative)	3	3	3	3	3	15
Concentrated Solar Power Plants (CSP)	-	5	-	-	10	15
Biogas from Landfills and Animal Wastes	0.5	0.5	6.5	0.5	6.5	14.5
Small-Scaled Wind	0.5	0.5	0.5	0.5	1	3
Wind Farms	5	5	7.5	10	10	37.5
Total	11	17	22.5	19	35.5	105

5. Analysis of the strengths and drawbacks of current RE situation in Palestine

For reviewing about renewable energy in Palestine and their position and direction based on the analysis of the strength and drawbacks of the current situation. The strengths of renewable energy is identification according to the Palestinian environment which is more capable of RE applications, and the Palestinian policy about law of RE and their goal and achievements in Palestine. The drawbacks of RE in Palestine are according to political, land surface availability, technical, market, and social.

5.1. Strengths

Palestine has high a high potential of RE sources deployment, especially for solar energy. The strength solar conditions in Palestine according to geographically situated in an area that The annual rate of daily shinning in Palestine is 3000 hours and high average annual solar irradiation characteristics is 5.4 KWh/m2 per day on horizontal on horizontal surface (Rabi and Ghanem, 2016; Juaidi et al., 2016). This is encouraged to use this energy to many applications. For an example, there are two major application of solar energy are solar water heater and solar PV systems panel (PCBS, 2015b; MoPAD, 2011). For wind energy situation in Palestine according to geography area characteristics that moderate wind speeds in Palestine (Juaidi et al., 2016; Ibrik, 2009; Mubarak, 2008). It can be using small wind turbine by multi-blade windmill for pumping of water, using small wind turbine to electricity generation in the hilly areas in West Bank, which have annual average wind speed 4-6 m/s especially for areas are far from the grid (Juaidi et al., 2016; Mubarak, 2008). The geothermal situation in Palestine that its attractive for utilization of geothermal energy, especially in Gaza Strip and north of Palestine are mainly very high geothermal energy sources (Juaidi et al., 2016; El-Kilani and Zaid, 2015).

In 2015, the Palestinian government are put law about the renewable energy sources and efficiency of energy based on their basic law 2003 and its amendments, general electrical law 2009 and its amendments, and upon the recommendation of the Palestinian Cabinet on 19/5/2015 (Yaseen, 2017). The sectors based on this law are PEA, electrical distributers are National Electricity Transmission Company established in accordance with the provisions of the general electricity law and its amendments, The Palestinian Center for Energy and Environment Research, Electricity Sector Regulatory Council (Yaseen, 2017). The installations will be uses renewable energy sources systems to produce energy according to the requirements and standards determined by the PEA of this particular. The PEA gives the initial general license for facilitating the development of renewable electricity generation facilities, and the PEA gives the general license based on general electrical law and approval of the Palestinian Cabinet for the development of renewable energy facility (Yaseen, 2017). The network code system for project put by Transmission Company after taken approval from the PEA (Yaseen, 2017). The PEA put the distribution code and relationship agreement between the electrical distribution company and distribution network users to ensure the stability, efficiency and economic distribution network (Yaseen, 2017). The first of the main three goals of this law is to encourage the exploitation and development of renewable energy sources and benefit from their applications to increase the proportion of their share in the total energy in the energy balance, and achieve security supply in line with the strategy of renewable energy. The Second goal is to maintain energy through optimal use in different sectors, contributing to meeting the requirements of sustainable development, environmental protection, and their conservation. While the third goal is for encourage local manufacturing and use of equipment especially high-energy efficiency equipment and equipment and implementing renewable energy applications (Yaseen, 2017).

In 2015, the Palestinian Cabinet has authenticated of structured instructions for renewable energy projects connected to the net metering, In order to cover part of the self-need of electrical energy only based on put law about the renewable energy sources and efficiency of energy (Yaseen, 2017). According to this authenticate, that any person whose is supplied with electricity continuously can use this system, and the distributors of this system are any licensed company distributing electricity to the subscribers (Yaseen, 2017). A distribution code system established by the PEA which is defines the conditions and regulations for the design, construction, modification, operation and maintenance of distribution network assets and the relationship between distribution companies and all subscribers of electricity distribution network to ensure the stability, efficiency and economical distribution network (Yaseen, 2017). The net metering is considered an incentive for Palestinians to use renewable energy sources as electrical energy production for cover their part of the self-need that the distributor shall recycle the exported energy balance to the following month's account of subscriber of this system. This is in case of the amount of electricity consumed is less than the exporter, without the fees for the transmission and distribution of the recycled energy according to the tariff system appendix issued by the Palestinian Cabinet, but If the amount of energy consumed is greater than the amount of energy exported to the electricity network, the subscriber pays the monthly net amount of electrical energy resulting from it (Yaseen, 2017).

5.2. Drawbacks

The drawbacks of RE development and investment in Palestine from the most perspective are political, land surface availability, technical, market, and social.

- *Political*

The political and logistic situations in Palestine that Israel control on their energy sources importing so most of energy in Palestine imports from Israel by the quantity and condition of energy by deny or limit trade across international borders (MNSSD, 2007). impeded the technical, transportation, storing, and importing energy due to difficult connection between Gaza Strip and West due to there is no physical continuity between them and Israel control impeded to connection between (Juaidi et al., 2016; Abu Hamed et al., 2012). In addition, the separation of Gaza Strip and West Bank is impeded the development of RE sources in Palestine.

- *Land surface availability*

The land surface availability is small for installation of RE system, especially for large-scale RE projects. Palestine lacks of terrain, which is most area is not possible to installation of RE system or the most area is applicable for agriculture and its primary sector than RE sector (Juaidi et al., 2016).

- *Technical*

The terms of human and institutional is relatively weak, and needs engineers and labors expertise to install, operate, and maintain RE system especially for CSP system. There is not professional training for new applications and design. In addition, there is no professional technical handbook for aspects of sizing, design, installations of RE technologies. There are no regulations and provisions related to implementing standards or quality control, no professional labs, testing & certification facilities. There are no fully implemented pilot projects and expertise for new applications of different types of RE system, which is causing inexperience to develop this sector in Palestine (Yaseen, 2009).

The major drawback of technical situation of RE system in Palestine that trade and industry of RE technologies is connected strongly to the Israeli market, due to the current political situation and Israel's monopolizing practices on trade movement across the area, and obstacles on importing and exporting of material and products (Yaseen, 2009).

- *Market*

The market of energy sector in Palestine is small which is limit to achieving scale of economies (MNSSD, 2007). The markets of RE sector situation in Palestine are Absence of independent local distributors and importers, insufficient industrial processing, and inadequate production quantity to cover market demand, due to lack of energy so it's difficult to develop the industry sector and lack of private sector involvement, and government initiatives to develop this sector. The export of production is difficult situation due to absence of export's regulations, restrictions and obstacles imposed by Israelis (Yaseen, 2009). The major characteristic of RE system is a high initial investment. The users and suppliers have lacking to awareness program for the RE system and efficient technologies. The market in Palestine is for small-scale projects due to small country nature, and unfortunately is not concern of the regional supporting program (Yaseen, 2009).

- *Social*

Lack of awareness to selective their proper energy system, and lack of awareness about the benefits of energy conservation and clean technology from RE applications (Yaseen, 2009). The income of family is role-play to investment of RE application to obtain their energy, especially for electricity generation due to low their income to cover the investment cost of the efficient energy system, especially for the new and efficient of RE technologies (Yaseen, 2009).

6. Conclusions

In this paper, a review of the research, use and potential of renewable energy sources in Palestine especially for solar energy, wind energy, geothermal energy. The Renewable energy sources play an important in Palestine that it's necessary nowadays and future to sustainable development and socio-economic development, and reducing environmental deterioration since decreasing in level of greenhouse gas concentration (CO_2 emissions) into the atmosphere which means improve ecosystem in Palestine. The renewable energy sources is one of strategies taken in consideration to development of Palestine domestic energy resources needs since Palestine facing the population growth so it's future energy generation expansion. A major problem that Palestine facing the political and logistic situation by Israel control on their energy sources importing so there are strategies prepared by the PEA about developed a clear goal for renewable energy to achieve generate electricity from this energy at least 10 % of the power equivalent to 240 GWh will be produced locally by 2020, and achieve 25% from renewable resources (Thermal) of the total energy consumption in Palestine by 2020. This strategy is divided to two phases as follow: first phase for 2012-2015 and second phase for 2016-2020. In this strategy contains the initiative of solar energy in order to disseminate and promote the use of renewable solar energy technology to generate electricity due to the solar energy represents 50% of total capacity. The strength solar condition that the annual rate of daily shinning in Palestine is 3000 hours and high average annual solar irradiation characteristics is 5.4 KWh/m2 per day on horizontal on horizontal surface. Meaning that can be using this energy for many application especially for water heater and solar PV systems especially reducing diesel generation for electricity generation in isolated rural areas and villages so the solar PV system is improvement the ecosystem by reducing CO_2 emissions to atmosphere. The characteristic of wind speed in Palestine is moderate speed that can be using by this energy such as small wind turbine by multi-blade windmill for pumping of water, using small wind turbine to electricity generation in the hilly areas in West Bank, which have annual average wind speed 4-6 m/s especially for areas are far from the grid. For Gaza Strip, there are restricted to use small wind turbine for pumping of water thus for it's using for pumping from shallow wells due to it has relatively low wind speeds. The Geothermal energy situation in Palestine it is attractive for utilization of geothermal energy, especially in Gaza Strip and north of Palestine are mainly very high geothermal energy sources. Only known in Palestine implementation of this system is by Mena Company for heating and cooling in residential buildings at Ramallah in West Bank. In this paper also taking the major perspective of drawbacks of renewable energy development and investment in Palestine are political, land surface availability, technical, market, and social. There are recommendations taken in consideration to development this energy sector in Palestine to improvement the ecosystem, sustainable development and socio-economic development to ensure security of domestic energy resources uses in Palestine. Especially energy generation electricity since Palestine facing the population growth so it's future energy generation expansion and decreasing import fuel derivatives from other countries especially from Israel since the political and logistical situation in Palestine, by Israeli control on their energy sources importing to modification the prices of electricity since currently prices of this energy is higher than neighborhood countries are:

- Legislation to increase the use of solar heaters as required Install solar heater for each new building.

- Encouraging investment in electricity generation projects by using solar PV system by provide the facilities and support needed.
- Encourage the utilization of wind energy through measurements specializing for the best places that the speeds are available big.
- Encourage investment in geothermal energy for example in institutions that operate more than work hour usual.
- Increase funding for researches about renewable sources especially from Palestine government, donors such as NGOs, banking sector is role play engorgement investment in implementation renewable energy projects especially given loans to people for install this energy application in their domestic uses such as electricity generation.
- Regulations and provisions to implement standards or control quality, professional labs, testing and certification facilities. Especially for CSP system since this system is more complex than other application such as solar PV system.
- Excessive training courses for labor, engineers to modification their skills, and become expertise to plan, design, implementation, and operation and maintenance of renewable energy applications especially for CSP system.
- Teaching the scientific subject about the renewable energy sources in different stages education.
- Reducing the real estate costs of housing used renewable energy.

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