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Engaging ordinary people in sustainability transition: introducing elasticity and plasticity model for social change

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Abstract: Joining between engineering and social sciences approaches, this paper introduces a model for social change, based on concepts of elasticity and plasticity of sustainability behaviour to engage the public in sustainability transition and achieve a better quality of life. The paper discusses how successful transition to renewable energy (RE) system can impact individual's quality of life and social development, and how to encourage ordinary people to engage in energy transition through daily sustainability behaviour. The paper also discusses the social strategies that lead community to sustainability, the RE indicators and the impact of RE on social behaviour. Eventually, some actions are suggested as solutions if applied can drive the society to the appropriate sustainability level. The focus area is Palestine, but the model can apply elsewhere. The data used were both primary and secondary data.

Keywords: renewable energy; RE; elasticity; plasticity; sustainability behaviour; social change; sustainability societal transition; sustainable social change.

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Biographical notes: Halima Abu Haneya holds a PhD in Social Sciences from Birzeit University, Palestine. He specialised in research on social change, having solid experience in socio-economic studies, and environmental sociology under conflict condition. He is mainly interested in convergence of social sciences with STEM and other disciplines in the study of social change.

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Renewable Energy Management) and Acts as a Palestinian Higher Education Reforms Expert (HERE) since 2015 till now. He participated in the judgement of several local and international innovation competitions. He is author of two books, more than 20 journal articles and more than 30 conference papers and volunteer reviewer for more than 17 international specialised journals and conferences.

1 Introduction

In recent years the higher education institutions in Palestine showed an increasing interest in the issue of renewable energy (RE), which reveals the increasing trends towards the adoption of RE technologies and sustainability measures and behaviour in Palestine in general. For example, in 2015 Birzeit University introduced a master program in sustainable engineering and in 2021 it introduced another master program in renewable energy management. Annajah University has the energy research centre that is concerned with research and training in conventional and RE fields.

Palestine fulfils its energy demand by imported conventional sources such as oil, natural gas, charcoal, and wood, which are expensive, and pollute the environment. Moreover, the dependency on Israel in providing electricity with the many cuts, requires from the Palestinians to think of more viable, sustainable and cheap resources of energy and power. RE resources are to be taken into consideration seriously for many reasons, including economic affordability, environmental-friendly and ensuring energy security. The main RE resources that can be taken into consideration in Palestine are: solar, wind, hydropower, biomass, and geothermal energy.

Palestine is rich in natural RE resources, especially solar energy, which can be affordable, environmental-friendly and can add to social development and mitigate global warming effect, however, many obstacles face investment in RE in Palestine, including political instability, institutional regulations, financial, economic, and technical impediments.

With the increasing calls for the adoption of RE policies and practices in the world in general and Palestine in particular, there became a need to assess the social impact of the implementation of RE policies and strategies and how individuals and household can engage in sustainability behaviour through their daily practices.

The social impact concerns the negative or positive consequences of RE adoption on the society and ordinary people both individuals and household. It also concerns the changes in people's daily practices and behaviour as a result of the use of RE technology. Assessing the social impact of sustainability behaviour in Palestine is important for decision makers to ensure public awareness, support and acceptance of the installation of RE technologies.

This study focuses on how successful transition to RE system can impact individual's quality of life. The main objective of the study is to identify the consequences of the sustainability behaviour on social development and place that within a suitable conceptual framework, which will be the main contribution of this study.

The following text will present a review of previous literature to be followed by an overview of the RE situation and sustainability behaviour in Palestine. The next sections will focus on ordinary people's daily sustainable behaviour and practices to reduce their

dependency on conventional energy resources and reduce the related expenses. This will be followed by a discussion of the conceptual framework and related indicators.

2 Literature review

A lot has been written about the environmental and economic impacts of RE, whilst the social impact did not receive much attention [Karytsas et al., (2020), p.1]. The literature on social or socioeconomic impact of RE ranged between reviewing social outcomes whether positive or negative on both the long and short terms of social change (European Commission et al., 2013), assessing and predicting the likely or potential social consequences in advance of the adoption and implementation of RE systems (Burdge and Vanclay, 1995; Gentile, 2000) and measuring the resulting tangible social results of already implemented RE systems (SEEE, 2010).

However, the few reviewed literature on socioeconomic impact of RE showed social and economic improvements on communities, where RE projects are implemented or expected to be implemented which means that RE can contribute to improving conditions and quality of life of the energy poverty communities. Byrne and Taminiu (2016) reviewed the role of sustainable energy and energy services utility in social development, and alleviation of poverty without environmental risk. They cited several impediments in front of the achievement of a social change based on sustainable energy utility, including the limited investment in the field to cover the high costs of infrastructure and installations of RE technology. They also stressed on the importance to overcome the negative perceptions of risk and utilisation, related to the adoption of RE. However, Ioannou et al. (2017) found a rapid increase in investments in RE over the last decade, but cited several associated uncertainties and risks throughout planning, constructing and operating the RE technology. Amongst these risks are several socioeconomic factors such as the lack of acceptance at the social level, health risks, demand fluctuations on the technology, high generation costs, the taxation system, and failure to obtain the required licenses to install the system.

Rachmawatie et al. (2019) studied the socioeconomic impact of RE hybrid power plants in rural areas in Baru Beach of Indonesia by evaluating average income of households beneficiaries of electricity pre and post the utilisation of electrical energy hybrid electricity. The results showed a positive impact of RE system including having better electricity, better access to infrastructure, and improved average income of household electricity beneficiaries.

Meanwhile, Shoaiba and Ariaratnam (2016) evaluated social and economic improvements that have taken place on two targeted towns in Afghanistan after the implementation of community based RE projects. In order to reach their goal, they identified several indicators to measure the socioeconomic impacts of RE projects at the household, and community levels. The social indicators at the household level included the personal security, entertainment opportunities, learning conditions for children, access to information, family interaction, time flexibility for domestic and productive tasks, working hours for undertaking domestic activities, time saving for doing domestic work, hygiene and health conditions. The economic indicators at the household level included energy expenses, household income and diversity of source of income as a result of RE projects. The social indicators at the community level included the improvements on health services, education services, government services and veterinary services.

Meanwhile, the economic indicators at the community level included jobs created as a result of RE projects and small enterprises that flourished as a result of RE projects. Their research found out that the RE projects in the two towns brought about significant improvements at the household level, whilst modest improvements at the community level.

Garcés-Gómez et al. (2021) focused on solar energy in studying the social impact of RE system in San Sebastian neighbourhood in Manizale in Colombia. They found out that the high-costing installation of photovoltaic lighting system limited people's access to the system, which is concentrated in families with high purchasing power. However, assessing the functionality of the solar system, and its social impact on rural development in India, Buragohain (2012), found positive outcomes on people's quality of life for the solar home lighting system in remote villages. The households reduced their dependence on Kerosene, women found it easier to do domestic work, and children had enough light to study at night. The lighting of the village at night also contributed to lower crime rate.

At the Palestinian level, the produced literature in this regard is also modest, but reveals a high interest in promoting the adoption and implementation of RE technology in the Palestinian Territory and getting rid of the high dependency on Israel in the provision of energy resources. Palestinian scholars assessed the potentiality of several types of RE, including solar energy (Ibrik, 2020), wind energy (Shabbaneh and Hasan, 1997; Salem, 2019; Khatib et al., 2020; Alsamamra and Shoqeir, 2020; Badawi et al., 2019), geothermal energy (Beithou and Abu Al-Ganam 2017; Yaseen, nd), and biogas energy (Ouda, nd).

Beithou and Abu Al-Ganam, (2017) considered using geothermal energy as a source of RE for heating and cooling purposes in Palestine. It can also be used for agricultural purposes for heating greenhouses and drying crops. According to them geothermal energy can best be implemented in the densest areas of the Gaza Strip and Northern Palestine.

Using wind energy in Palestine is also assessed by several scholars. Shabbaneh and Hasan (1997) concluded that electricity from wind can be generated in several locations in Palestine, confirming the feasibility of using wind turbines to generate electricity. Other scholars assessed different models to measure wind energy generation in different parts of Palestine. Badawi et al. (2019) assessed a model to measure wind energy generation in the city of Asdod. Khatib et al. (2020) assessed several other models to predict and measure wind energy generation in five Palestinian cities: Nablus, Hebron, Ramallah, Jenin and Jericho. They stated that the models can be applied to any other location in Palestine with acceptable accuracy. Meanwhile, Alsamamra and Shoqeir (2020) assessed other models to predict the potentiality of producing wind energy in Eastern Jerusalem, based on 11-year wind speed data from January 2008 to December 2018. These research efforts were aimed at promoting investment in the generation of wind energy in Palestine and mitigating dependency on the conventional energy resources that are mainly controlled by Israel.

Ouda (nd) discussed prospects of RE in the Gaza Strip, focusing on biogas energy. He found potential for producing biogas energy in the strip, exploiting the treatment of solid waste and wastewater.

Other studies were conducted to identify the solar PV technologies appropriate for Palestine to encourage policy makers and individuals to consider installation of grid-tied PV systems on buildings (Ibrik 2020). Comparing three energy supply alternatives in remote villages in Palestine (diesel generators, electric grid and PV system), Mahmoud

and Ibrik (2006) found that PV system is more economical and feasible of the three alternatives for rural electrification.

Few literatures also focused on impediments of the implementation of RE technologies in Palestine. In addition to the financial barriers and lack of investment in the RE technologies, political instability forms a principal barrier, sabotaging any development towards the implementation of RE projects (Beithou and Abu Al-Ganam, 2017; Abboushi and Alsamamra, 2021). Abboushi and Alsamamra (2021) considered the Oslo Agreement, signed between the PLO and Israel in 1993 as the main barrier for Palestinians' utilising RE resources. Dividing the Palestinian Territory into A, B, and C areas formed a geopolitical obstacle, preventing the Palestinians from benefitting from natural resources in Area C, which remained under complete Israeli control. According to the research, Area C possesses 62 % of solar energy potential in Palestine, taking into consideration that solar energy comprises 98 % of the total RE potential in Palestine.

Alsamamra et al. (2021) tackled the direct and indirect impact of the separation wall on the investment in RE in Palestine. The wall separates people from their land, forcing them to abandon it, in addition to Israel's confiscation of lands, abutting the separation wall. These lands could have been used to operate wind turbines.

Yaseen (nd) cited several barriers for development of RE technology in Palestine, including the absence of a general energy policy at the national level, lack of technological human and institutional capabilities in the RE field, financial barriers due to the high cost of RE technology, and the lack of public awareness.

The previous literature at the Palestinian level, though limited in amount, showed serious attempts by Palestinian scholars to lead the country towards the adoption of RE technology in order to mitigate dependency on imported energy resources, protect the Palestinian environment from poisonous emissions and provide Palestinians with a better quality of life. The previous literature mostly targets policy makers to adopt policies and regulations to organise the process towards the adoption of RE technology. However, they did not pay much attention to the engagement of ordinary people in sustainability behaviour and dependency on RE resources in their daily life. Moreover, nearly all the previous works lack a conceptual framework through which we can define ways to engage ordinary people in sustainability actions and adoption of RE behaviour. This will be our main contribution in this study.

3 Overview on the state of energy in Palestine

Although Palestine is relatively rich in natural energy resources, it cannot have a full control of them, mainly because the Palestinian Authorities are restricted by the political Oslo Agreement, by which the Palestinian Territory was divided into three A, B, and C areas (See Abboushi and Alsamamra, 2021), each of which is placed under a different political status, thus complicating the geopolitical situation of the country.

The Palestinians have always performed traditionally inherited sustainability behaviour, exploiting the available natural resources of energy such as the sun, wind, and water. They used these resources in drying harvest, fruits and vegetables and in drying clothes. In areas where water is scarce families are forced to recycle the little water available, using it sparingly in order to meet their needs. For example, after they finish hand-washing of clothes, they used the same water to clean the floors of the house.

The main resources of energy in Palestine include electricity, oil products (gas, kerosene, gasoline), RE (sun, water and wind), biofuel (charcoal and wood) and biomass.

3.1 Conventional energy resources

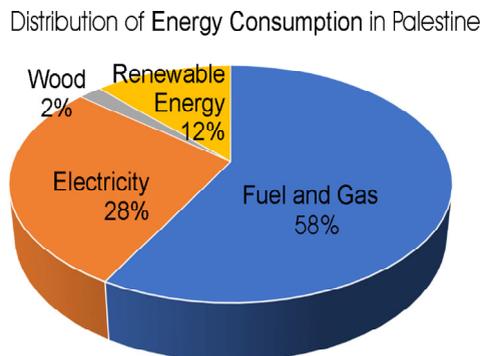
Palestine buys its needs of oil and electricity from Israel. Palestine's total imported electricity in 2019 reached 6249104 MWh and its total imports of fuel oil in the same year reached 4,097 thousand litre, whilst its total imports of wood and charcoal in the same year reached 4,003 tons (PCBS: Imported energy in Palestine, 2021).

3.1.1 Electricity

In its electricity imports, Palestine depends mainly on Israel, then Jordan and Egypt. In 2019, Palestine imported about 6,025 GWh from Israel, comprising 89.86 %. The Jordanian share of electricity imports in 2019 reached 88.28 GWh to feed Jericho grid. Meanwhile, the electricity grid, feeding southern Gaza Strip from Egypt has been disconnected since 2018. There is one electricity generation station in the Gaza Strip, which is operated with diesel that is imported from Israel [PCBS, (2015), p.2]. In 2019, the station generated a total of 591.275 GWh, comprising 10 % of the consumed electricity in Palestine and 38% of consumption in the Gaza Strip [PENRA: Electric Power in Palestine, (2016–2019), p.7].

The annual electricity consumption per capita in Palestine reached 1280 KWh/capita in 2019, an increase of about 240 KWh/capita from 2014. According to the Palestinian Central Bureau of Statistics (PCBS), the total energy consumption in the Palestinian Territory in 2018 was about 75,178 TJ, of which 58% is fuel and gas, 28% imported and generated electricity and 12% RE as shown in Figure 1. The situation is not the same in the West Bank and the Gaza Strip. The latter suffers from very dire conditions as the electricity supply meets no more than half the demand with long hours of blackouts [MeetMED, (2020), pp.18–19].

Figure 1 Distribution of energy consumption in Palestine in 2018 by type of energy source (see online version for colours)

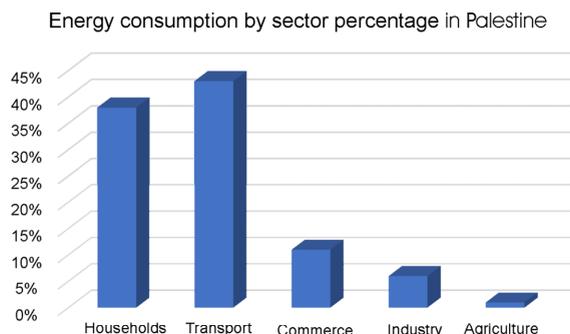


Source: Source of data: MeetMED (2020, p.18).

The growing population, accompanied by the rapid urbanisation with a growing number of housing and businesses, increases the demand on power. This means a more pressure

on electricity grids. According to the 2019 statistics of the PCBS, the largest sector to consume energy in Palestine is transport, followed by household as shown in Figure 2.

Figure 2 Energy consumption by sector percentage in Palestine in 2019 (see online version for colours)



Source: Source of data: PCBS (2019)

3.1.2 Petroleum

Palestine is an oil-poor country and it purchases its needs of petroleum from Israel. According to the PCBS, Palestine's total 2019 imports of gasoline reached 305,612 thousand litres, of diesel 752,887 thousand litres, and of kerosene 1,690 thousand tons (for more details see Table 1).

Table 1 Imported energy in Palestine by type of energy and month in 2019

Month	Electricity (MWh)	Gasoline (Thousand litre)	Diesel (Thousand litre)	Kerosene (Thousand litre)	LPG (Ton)	Wood and charcoal (Ton)
January	59,7608	25,618	67,601	467	20,493	320
February	51,7696	23,174	61,488	302	17,113	277
March	553,711	23,031	56,913	184	14,542	307
April	466,427	24,731	64,209	86	14,115	483
May	481,043	26,587	61,787	16	14,771	350
June	514,426	25,764	56,215	5	9,932	382
July	549,272	29,219	69,872	47	11,281	347
August	55,595	26,979	62,065	16	14,316	267
September	515,335	26,490	65,799	70	11,493	341
October	485,208	25,604	62,933	51	16,204	389
November	454,272	23,361	58,563	102	14,688	286
December	558,151	25,054	65,442	344	18,723	254
Total	6249104	305,612	752,887	1690	177,674	4,003

Source: Source of data: PCBS (2019)

This in turn urges for looking for more sustainable resources of power. The Palestinian Energy and Natural Resources Authority (PENRA) is studying the possibility of

diversifying electricity resources with the goal to improve energy security as Palestine's need of energy is expected to increase six times by the year 2030 (Milhem, nd).

3.2 Renewable energy resources

RE is defined as the 'energy that is derived from natural processes (e.g., sunlight and wind) that are replenished at a higher rate than they are consumed. Solar, wind, geothermal, hydro, and biomass are common sources of RE.' [UNECE, (2016), p.4]. PCBS showed an increasing supply of RE in Palestine in the year 2019 to reach 6,369 TJ. This promises of more dependency on RE resources in the future (see Table 2).

Table 2 Total energy supply by year and type of energy in Palestine, 2009–2019

<i>Year</i>	<i>Renewable energy (TJ)</i>	<i>Oil products (TJ)</i>	<i>Electricity (GWh)</i>
2009	3,983	29,865	8,438
2010	4,159	29,703	10,503
2011	4,622	33,088	11,285
2012	4,909	31,787	10,734
2013	4,736	35,733	10,350
2014	4,938	41,443	11,827
2015	5,422	43,562	11,807
2016	5,516	47,569	12,098
2017	5,622	47,883	96,60
2018	5,976	43,941	97,25
2019	6,369	48,219	11,187

Source: Source of data: PCBS (2019)

3.2.1 Solar energy

Solar energy in particular has been used in Palestine for long, especially for water heating, using solar collectors that are installed on the rooftops of houses. A PCBS report on RE survey in Palestine in 2015 showed that about 57% of Palestinian household use solar water heaters. Nonetheless, the report showed a decrease in the usage of solar heating from previous years due to the increase in the vertical construction and increased dependency of families on electric heaters [PCBS, (2015), pp.2–3].

Photovoltaics are expensive and this is why their use is still limited in Palestine though witnessing a slow increase. Photovoltaic system is restricted to several small schemes, mainly those that were implemented by the PENRA and several individual schemes. By 2020, the PENRA installed photovoltaics on rooftops of 82 government schools in the different governorates of the West Bank. A study Alsamamra and Shoqir (2021), found out that if photovoltaic system is installed on all the Palestinian 3,074 schools, it can provide 5.12% of the total annual consumption of energy in Palestine, taking into consideration the low energy consumption in schools with low working hours.

This means that using solar energy in Palestine is promising on the way to provide the country's need of sustainable energy, taking into consideration Palestine's warm climate with about 300 days of sunshine a year. Although using photovoltaics for private houses is very limited due to the high prices of the panels, the people have the desire to use them

at a more extensive scale, but they need promotion, knowledge and financial affordability.

3.2.2 *Biofuel*

Biofuel is used at a large scale for heating in Palestine, including wood, charcoal and olive cake. Palestine's total imports of wood and charcoal reached 4,003 tons in 2019 (see Table 1).

4 Method

Focusing on the energy situation in Palestine, this paper discusses how to encourage ordinary people to engage in energy transition through daily sustainability behaviour and to achieve successful transition to RE system with the ultimate goal to impact individual's quality of life and social development. This study supports the calls for increasing the amount of social science research to encourage the world's transition towards RE and clean energy resources (Dunlop, 2019; Sovacool et al., 2015) in order to achieve a more in-depth analysis. Thus the study serves as an interdisciplinary work, integrating between social sciences and engineering analytical methods.

The data that is used in this paper were both primary and secondary data and it builds on the results of previous literature and gets the help of energy statistical surveys of the PCBS, benefitting from both qualitative and quantitative approaches.

The paper also discusses the social strategies that lead community to sustainability, the RE indicators and the impact of RE on social behaviour. Eventually, some actions are suggested as solutions if applied can drive the society to the appropriate sustainability level. Although the focus area is Palestine, the model can apply elsewhere.

The two authors of the paper, who are of different backgrounds, took part in the process of writing the paper. One of them is a mechanical engineering specialist and the other is a social sciences specialist.

5 Conceptual frame: elasticity and plasticity of sustainability social behaviour

The model for social change in this paper is based on two main concepts: elasticity and plasticity of change. Social behaviour of human beings can be compared to material structural behaviour. Any material exposed to external stress (force per unit area) undergoes strain (elongation per unit length) (Hibbeler, 2017). The behaviour of materials under stress is divided into two stages; the first stage is the elastic stage where the material returns back to its original shape after stress release, and the second stage is the plastic stage where the material takes the final deflected shape after releasing stress. Similarly is social change of human communities.

Elasticity and plasticity behaviour in social sciences has been mentioned by Steg et al. (2018) that discusses the impact of sustainable energy on quality of life. The authors tackle different applications in life like using electric cars, drying clothes and using public means of transport instead of driving private cars. However, the present study aims

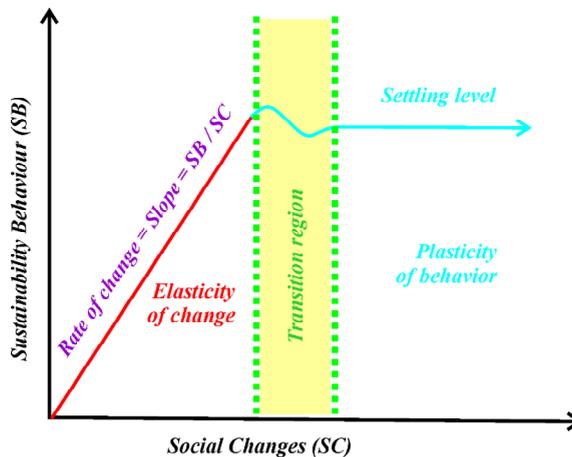
to provide a more in-depth understanding of the elasticity and plasticity concepts, promoting them as a model of social change.

Social changes of human communities are deeply influenced by their behaviour in response to sustainable resources. This fact is depicted in Figure 3, which shows that social changes, influenced by sustainable energy behaviour can be divided into two regions. The first region is the elasticity of changes where the differentiation in sustainability behaviour is reflected on flexible social changes. The rate of change of sustainability behaviour as a function of social changes is represented by the slope of the curve which is measured by:

$$\text{Rate of change} = \text{Slope} = \frac{\text{Sustainability behavior (SB)}}{\text{Social changes (SC)}}$$

The foregoing relation means that the development of human behaviour in response to sustainable energy will develop new social changes (development). The slope here represents the ratio between the two variables. The rate of inclination of this curve indicates the rapidity of the society response to sustainability changes. The risk in the elasticity region is that whenever sustainability behaviour activities stop, social development will stop and it may even return back to the first corner. This forces communities to continue till they reach the settling level (Plasticity) of behaviour where no more elasticity which ensures the non-return to zero point. It is normal for the curve to fluctuate about the settling point before levelling because of the different dynamic effects propagating from the surrounding ambience, this case is called the transition region where the situation is still not completely stable. The second region is the plasticity of behaviour region where the social sustainability behaviour reaches a static level not influenced by any external factors enabling social changes to get developed freely.

Figure 3 Elasticity and plasticity of sustainability behaviour versus social changes (see online version for colours)



An example of this social behaviour is the trend to use solar photovoltaic panels to produce domestic energy. Spreading awareness amongst people to use this sustainable source of energy and leave traditional electricity produced by fossil fuels is necessary to increase the number of users. On one hand, if the percentage of users is low, there will be

a risk that they return back to traditional energy because of discourage (Elasticity region). On the other hand, if the percentage of users increases and technology is well spread, its prices will decrease and others will be encouraged to get involved, reaching a specific percentage of users that will change the whole energy trend towards the new technology.

6 Discussion and results: sustainability social behaviour

Despite the vitality of the conventional energy resource based on oil and gas for any country, their negative impact on environment and people's lives is of concern. This negative impact can be mitigated and overcome with introducing RE sources that are sustainable and environmental-friendly. But how can we encourage sustainability social behaviour towards a more dependency on them amongst ordinary people for their own social, health and economic benefit?! In order to achieve public engagement in the sustainability behaviour, the Palestinian authorities should disseminate laws, concerned with adoption of RE technologies, such as Decision of the Council of Ministers No. (6) of 2017 on the regulation of incentive package contract for the purpose of encouragement of investment in the employment of RE technologies.

The government and relevant institutions should encourage and finance installation of PV solar panels. They should also encourage adoption of sustainable electric vehicles. The official institutions should also encourage and set rules for energy efficiency in buildings (insulation, led lights, HVAC). People need to be encouraged to use public transportation and housewives need to be more aware of the importance of outdoor clothes drying.

However, perhaps some people do not have enough patience to continue with their sustainability behaviour and get back to the conventional energy resources as they are more available and easier to reach and use in light of the busy contemporary life. This means that there is still more work that needs to be done to influence individual and community and make sustainability behaviour as an internally motivated action. There is an urgent need to raise awareness of the importance of sustainability behaviour, spread knowledge about RE technology, and promote civic values of being moderate in consuming resources and also promote environment friendly self-identity of people. When people return to these values and self-identity they will have the internal motivation to act likewise voluntarily and their desire to adopt sustainability behaviour will increase to prove themselves as environment-friendly [Steg et al., (2018), p.24].

There is a need for more research to emphasise economic and cultural facts about the adoption of RE technology to influence the community in general, including the impact on job creation, education, and access to technology, products and services in the field. If this is achieved, the society will witness a positive structural social change and development, bringing socioeconomic benefits to the entire community and a better quality of life for Palestinians.

6.1 Social strategies of sustainable energy behaviour

In order to reach the saturation limit and get into the plastic region shown in Figure 3, the community should put forward specific strategies that lead finally to improving their quality of life. These strategies take the shape of two types of social changes; changing context and changing knowledge as shown in Figure 4. Changing context means

developing new values and rules of the whole society that can be summarised in the following steps:

- 1 Encouraging developing countries to involve RE as their main resources.
- 2 Enhancing energy conservation and reducing consumption.
- 3 Establishing energy efficiency educational and training programs.
- 4 Encouraging in-grid electricity generation and improving the feed-in tariffs.
- 5 Integrating energy efficiency and RE in social, engineering and economic teaching and learning courses.

Meanwhile, changing knowledge is depicted by improving the individual behaviour taking the following steps:

- 1 Spreading individual awareness of using RE techniques like solar heating and solar electricity generation.
- 2 Transparency of information given to individuals about energy prices and environmental effects.
- 3 Encouraging families to use in-garden waste digesters to produce cooking gas instead of using traditional gas sources.
- 4 Putting more efforts to research on energy storage techniques.
- 5 Encouraging using energy efficient appliances and energy conserving lights.

Knowing that 'one size does not fit all' necessitates the thinking of different sources and techniques for sustainable energy, some of which are:

- Solar collectors for water heating.
- Solar PV panels for electricity generation.
- Bio-gas digesters to produce cooking gas.
- Wind mills to produce electricity.
- Many other ideas are used worldwide like marine waves, street bumps, hydro power, solar concentrators, ... etc.

The diversity of these resources copes with nature of humankind that has on one direction the desire to have his own self-identity in determination and on the other direction he has the desire to be consistent with his surrounding in implementation.

6.2 Sustainable energy indicators

Sustainable energy can be measured using several indicators. These indicators are related to different aspects of life and influenced by the work of other researchers who designed similar indicators for green areas and green campus (Amrina and Imansuri, 2015). The indicators have been subdivided into three pillars that represent the main pillars of sustainability.

All sustainability aspects are based on three pillars: environmental, social and economic factors. Similarly, the human being behaviour in sustainable energy has

indicators that can be divided into the same three pillars. These indicators can be individual or institutional and are as follows (see Figure 5):

Figure 4 Social strategies towards sustainable energy and improving quality of life (see online version for colours)

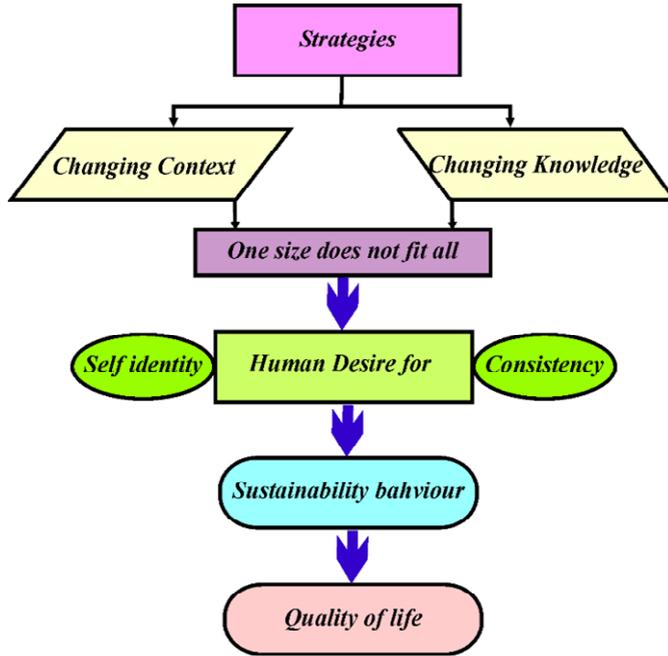
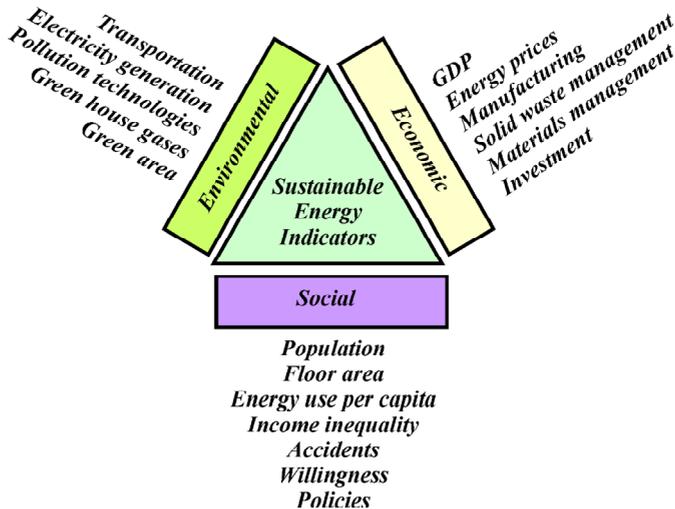


Figure 5 Sustainable energy indicators divided into three pillars (see online version for colours)

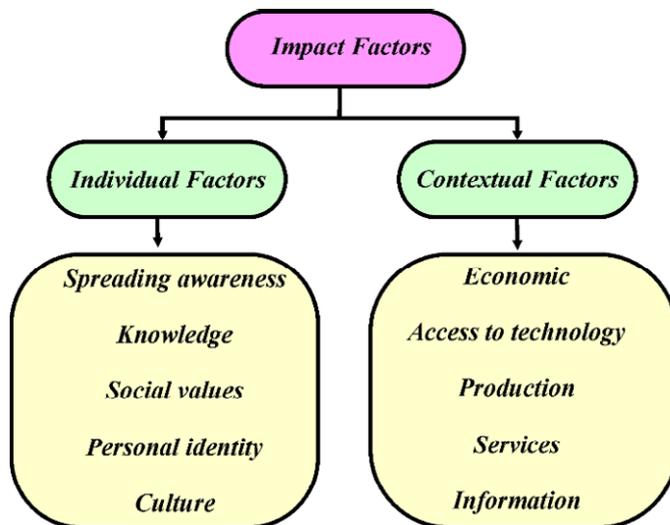


- 1 Economic indicators:
 - Gross domestic product (GDP)
 - Energy prices
 - Manufacturing techniques
 - Solid waste management
 - Material management
 - Investment.

- 2 Environmental indicators:
 - Transportation means
 - Electricity generation techniques
 - Pollution reduction technologies
 - Green house gases (GHG)
 - Planted green areas.

- 3 Social indicators:
 - Population
 - Floor area per capita
 - Energy consumption per capita
 - Income inequality
 - Accidents and health risks
 - Willingness to implement sustainable energy
 - Policies of sustainable energy.

Figure 6 Social impact of sustainable energy, both individual and contextual factors (see online version for colours)



6.3 *Impact factors of sustainable energy on social behaviour*

Sustainable energy and energy efficiency have a great influence on the social behaviour in any society. The impact of using RE can be measured at the level of community (contextual) or at personal level (individual) as shown in Figure 6. Individual persons are influenced by changing their way of life to implement sustainable energy in their daily utilities. It is not required from people to understand the scientific concept of each application in sustainable energy but it is mandatory for them to understand the best way of implementation to be able to evaluate the advantages and disadvantages of each technique depending on the specific needs.

Individual impact factors are the main blocks in building a total overview of the social behaviour, accumulation of these individual factors leads to a complete society compendium. Individual impact factors are summarised as:

- 1 Spreading awareness about the importance of using RE resources.
- 2 Expressing knowledge about the consequences of the ways of application.
- 3 Changing social values related to energy uses and consumption.
- 4 Consistency with the local society in keeping self-identity.
- 5 Developing new cultural events that confirm the local and global trends in sustainable energy.

Contextual impact factors can result either from accumulation of individual factors or as general factors influenced by global changes. These contextual factors are summarised as:

- 1 Economic factor, where using free RE resources save a lot of money spent on traditional energies.
- 2 Using modern RE techniques needs access to new technologies that require up to date knowledge.
- 3 Production and productivity in factories is much influenced by using sustainable energy because it reduces the costs and increases the added value of each product.
- 4 Using RE in service departments increases the opportunities to provide low price services to people.
- 5 It is required from the government and higher education institution to provide community with necessary information about the best practices and appropriate ways to implement sustainable energy.

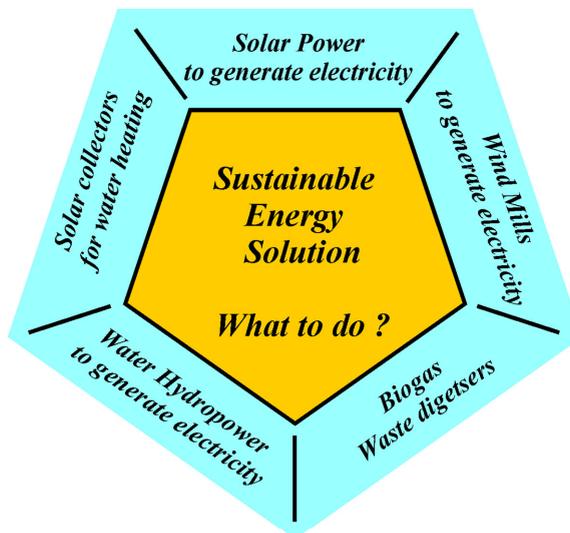
6.4 *Sustainable energy solutions*

It is worth paying attention to the existing sustainable energy techniques and solutions shown in Figure 7 and discussing their problems and obstacles:

- 1 Solar power to generate electricity: This source exists in two techniques:

- a Solar photovoltaic panels: can be installed on roof or in open areas to produce clean electricity. One of the main problems of this technique is that it needs energy storage techniques like batteries or compressing air in storages tanks and releasing it to function a generator at night. Another storage technique is pumping water to a higher place storing potential energy and at night releasing the water to function a turbine used to generate electricity.
 - b Solar concentrator: is a set of mirrors spread around a central water tank to concentrate the solar radiation on the tank heating and evaporating the water inside, the produced vapour is then used and function a turbine to generate electricity. This technique also faces the problem of storing energy at night, which is normally solved by functioning a gas turbine to generate electricity. This technique is used on national level.
- 2 Solar collectors to heat water: Solar collectors are used to heat water for domestic use. Heated water is stored in an insulated tank and used for daily household applications, the storage tanks can keep hot water for hours after sunset which makes it a feasible and efficient renewable technique.
 - 3 Wind mills to generate electricity: Wind blades rotate on a shaft which in turn rotates a generator to generate electricity. They are widely used in countries where the wind has enough speed, otherwise they are unusual in warm countries.
 - 4 Water hydropower to generate electricity: Water power from dams and rivers is used on national levels only to produce electricity. This technique functions continuously and not influenced by day and night.
 - 5 Biogas waste digesters: These digesters are used to make fermentation for the household waste and produce ethanol gas that can be used for cooking instead of the traditional gas taken from petroleum.

Figure 7 Existing sustainable energy techniques and solutions (see online version for colours)



Besides using the foregoing renewable techniques or some of them according to the region and needs, people are encouraged to follow the following behaviours that help them to reduce energy consumption and thus reduce their costs, and this leads to a better quality of life:

- Using public transportation instead of private cars.
- Drying clothes outdoor instead of using electric dryers.
- Installing energy efficient lights instead of old ones.
- Designing solar glazed walls to heat buildings naturally.
- Designing wide windows in buildings for natural lighting.
- Using building management system (BMS) that controls opening and closing doors, shutters and lights to conserve energy consumption.
- Insulating walls to avoid thermal effects and to reduce energy required for heating and cooling.
- Using energy efficient cars or electric cars.

6.5 How Palestine will be affected

Palestine is limited as with regard to the diversity of energy resources and economic resources. Introducing RE technologies will help enrich RE-associated economic diversification, positively impacting Palestine's GDP.

The outcomes of the energy sector directly and indirectly impacts people's lives, so what is the social impact of RE technologies in Palestine and how can it improve people's quality of life? A cleaner and greener life, no doubt, will have positive economic and social impacts on people. Transition to a more sustainable and environmental-friendly energy will positively impact the health and wellbeing of people with reduced air pollution. Transition from fossil oil energy to a cleaner energy will also result in structural changes in the society, moving it towards a more desired socio-economic development on the long run.

At the economic level, this transition to a new technology will no doubt create new types of jobs in the sectors of services and technology. According to the International Renewable Energy Agency (IRENA), 122 million jobs will be created globally by 2050 as a result of a transformed energy sector, more than a third of which will be RE jobs (IRENA, 2021).

A considerable amount of energy can be produced by renewable resources in Palestine, especially solar energy. According to the PCBS, the RE share in the total final energy consumption in Palestine reached 11.7% in the year 2019 (see Table 3 for further energy performance indicators in Palestine during the period 2014–2019). This percentage can be increased by encouraging further usage of solar heaters and promoting investment in the installation of PV technology to generate electricity.

Table 3 Selected energy performance indicators in Palestine, 2014–2019

<i>Indicators</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>	<i>2017</i>	<i>2018</i>	<i>2019</i>
Renewable energy share in the total final energy consumption (%)	13.8	13.8	13.6	10.3	10.7	11.7
Energy dependence rate (%)	80.3	84.8	84.7	87.3	86.9	86.4
The energy consumption of the transport sector to the total energy consumption (%)	48.7	43.6	45.6	46.6	45.4	43.2
The energy consumption of the household sector to the total energy consumption (%)	38.4	41.4	39.7	38.4	38.0	38.8
The energy consumption of the service sector to the total energy consumption (%)	7.6	8.5	8.8	8.8	9.8	11.3
The energy consumption of the industry sector to the total energy consumption (%)	4.2	5.2	4.8	5.4	6.1	5.6
Annual electricity consumption per capita (KWh/Capita)	1,048.0	1,151.4	1,141.9	1,138.7	1,148.7	1,280.0

Source: Source of data: PCBS (2019)

7 Conclusions

This study employed a combination of engineering and social sciences approaches in order to have a better understanding of how social transition to sustainability can best be achieved. Achievement of a better quality of life for Palestinians requires promoting engagement of ordinary people in sustainability transition. The study placed this engagement within a conceptual framework, based on concepts of elasticity and plasticity of sustainability behaviour to achieve social change and a better quality of life. The change within these concepts depends on the extent of promotion towards the adoption of sustainability behaviour and keeping it in a stable level (plasticity) not reversing back (elasticity). Social change and transition to sustainability behaviour and adoption of RE technologies can be accelerated, depending on the extent of engagement of the public in the sustainability transition process. This acceleration, however, can not be left to the matter of coincidence. The public authorities need to implement an awareness program towards the benefits of the adoption of sustainability behaviour through daily life routine. The public's engagement can be promoted by spreading awareness of the importance not only of taking part in the sustainability transition process, but also on how to participate [Moneer, (2021), 64] in the process and achieve the best results of the adoption of RE technology on the quality of life of the community in general and individual in particular. Sustainability behaviour needs to become an internally motivated action by the individual in order to reach the level of environment friendly self-identity community.

The paper suggests several solutions and activities related to RE to convert society to sustainability friendly one. These actions can be measured using specific indicators to

make sure that society has reached the required level of awareness and has become willing to achieve full transition to sustainability behaviour.

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