International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Using Renewable Energy Resources as Alternatives to Protect Environment against Gaseous Emissions

Zubayda Riyad Abdallah Al-Madadha

Independent Engineering Researcher, College of Engineering, Mutah University, AL-Karak, Jordan
Corresponding author Email: *zubeida_madadha[at]yahoo.com*

Abstract: ***The environment, with all its components, suffers from many dangers as a result of the excessive consumption of traditional energy sources, which is considered the primary cause of global environmental problems that threaten the planet, such as global warming and climate changes, which have negatively affected human daily life in various fields. Therefore, it is necessary to pay attention and search for a new and renewable alternative that compensates for conventional energy, namely, renewable energies, which are one of the main sources of global energy because they are clean, pure, and environmentally friendly energy, which made them of great importance in achieving sustainable development and protecting the environment.***

Keywords: environment, climate change, emissions, conventional sources, renewable energy

1. Introduction

After World War II, The world witnessed technological and industrial developments in all social and economic activities, due to the extraction of natural resources; the exploitation of forests due to the establishment of factories and facilities, the exploitation of agricultural lands, expansion in housing, and building, expansion in transportation and communication lines, etc. Hence, the problem of the global and local environment appeared after the increase in economic growth (Armeanu et al., 2018; Rao and Yan, 2020).

In general, conventional energy sources are scarce; limited, non-permanent, and exposed to two problems; depletion and pollution as a result of irrational use. Accordingly, alternative sources of energy described as inexhaustible and environmentally friendly should be found as alternative sources (Abu-Rumman et al., 2020). Such substitutive sources should prevent environmental pollution and reduce dependence on oil and gas derivatives.

During the past decades, humans and living organisms have been exposed to environmental pollution problems caused by gaseous emissions and the depletion of conventional sources. Therefore, such resources are to be preserved by reducing their use or replacing them with other safe sources. Legalizing the use of conventional resources or not using them by dependence on other environment-friendly sources provides a clean and human health environment (Baniyounes, 2017; Panwar et al., 2011). By doing so, we are advancing a step towards sustainable and economic development without harming the environment.

Renewable energy is considered an effective source to achieve the continuity of energy supply and replacement of fossil fuel energy to acknowledge the benefit of future generations and reduce the pollution effects resulting from the conventional energy sources (Boyle, 2004). There are different sources of renewable energy that help reduce the use of fossils, reduce threats to the environment, and protect it from pollution.

In response to the environmental pollution danger worldwide and the importance of keeping the climate clean and healthy, Jordanian government awareness has increased, and thus enacted a set of laws and regulations for purpose of monitoring and controlling the gases emission emitted from power plants, vehicles, and industrial activities (Al-Hamamre, et al., 2017; Al-Sayed, 2013; Baniyounes, 2017; Pastor, et al., 2020). Recently, and in consideration of the laws of environment protection, Jordanian authorities related to environment protection encouraged projects of using renewable energy sources as alternatives to conventional energy sources. Therefore, the current study attempts to introduce the importance of using renewable energy for reducing environmental pollution and saving costs taking Jordan as a case of enacting and implementing environment protection laws and regulations to reduce pollutant emissions during the past decades until the current situation in 2021.

1.1 Problem statement

Today, attention must be paid to the environment and its preservation, because any pollution or danger to which may directly affect the human health and safety of the planet as a whole (Al Zou'bi, 2010; Azzuni et al., 2020; Baniyounes, 2017). That is why renewable energy is considered the best alternative for saving the environment from pollution emitted by conventional energy sources.

Renewable energy has become an alternative way to traditional energy (Anagreh et al., 2010; Harjanneand Korhonen, 2019; Kiwan and Al-Gharibeh, 2020; Twidell and Weir, 2015). Therefore, its usage has to be extended to future generations to reduce the effects of the environmental pollution generated by conventional energy sources. This study attempts to show the role of renewable energy in protecting the environment and preventing pollution, by answering the following questions:

1) What is the role of renewable energy in protecting the environment and preventing pollution?
2) What are laws and regulations enacted by Jordanian governments to protect the environment against gaseous emissions

1.2 Research Significance

The importance of this study comes in addressing one of the current topics, which is of great importance in all countries and at all levels, namely, renewable energy, trying to explain the relationship between renewable energy, which is an alternative energy source to fossil (traditional) energy, and their inexhaustible role in protecting the environment.

1.3 Research aim and objectives

The current study aims to:

1) Highlight the concept of the environment and the various problems it faces and how to protect it.
2) Clarify the reality of renewable energy as an alternative to (conventional) fossil energy.
3) Show the role of renewable energy in protecting and preserving the environment for sustainable development.

2. Theoretical Background

2.1 The concept of environment

The environment is a fabric of different interactions between living organic organisms (plant, human, and animal) and non-living organisms (air, heat, light) (Goodstein and Polasky, 2017). This interaction takes place according to a balanced, integrated, and accurate system, which is the ecosystem.

Human is considered part of the ecosystem where he plays an active role by practicing their daily life activities. By his abilities, human has become a dominant element in the surrounding environment. The successive development in human's life in terms of a rapid increase in scientific and technological development, increase in agricultural and industrial production, and the establishment of cities and roads...etc., has had clear negative effects on many environmental systems (Sherbinin et al., 2007; Falchi et al., 2011).

2.2 The Environmental pollution

Pollution is scientifically defined as physical, chemical, or biological change that leads to damage of water, air, or land, and is harmful to human health and all other living organisms (Kampa and Castanas, 2008; Hoang, 2018). Pollution is defined as any change in the physical, chemical, and biological characteristics of the natural environment, created by humans, which includes air, water, and soil pollution (Halfwerk and Slabbekoorn, 2015). Environment pollution is the physical, thermal, or biological change or any radioactive activity, directly or indirectly, which results in several risks that affect the environment (Mabahwi et al., 2014). It is also the imbalance in the natural balance between the elements of the environment resulting from human activity.

Here we will address the pollution effects through the elements of the environment (air, soil, and water):
Environmental scientists have explained the significant increase in harmful environmental influences, which may lead to the destruction of the entire environment, the extinction of some living species, the pollution of oceans, seas, surface and groundwater, and climate change. Pollution constitutes a major threat to the environment, and its negative effects extend to humans, animals, plants, water, air, and soil.

2.2.1 Air pollution

Air is described as polluted if it contains a strange substance or if there is a significant imbalance in the proportion of its components in a way that leads to dangerous effects (Mabahwi, et al., 2014). This pollution results from multiple and different sources. the most important of which is the depletion of energy sources such as coal and nuclear energy, increase in industrial and population concentration, and what war causes through its fires and smoke in the air. According to Kampa and Castanas (2008), air pollution refers to the release of pollutants such as toxic gases and biological particles and particles in the atmosphere.

Some of the air pollution negative effects include (Mabahwi, et al., 2014; Raaschou-Nielsen et al., 2013):

1) Acid rain: It is an increase in the concentration of hydrogen ions in the rain than the normal concentration in the water. Among acid rain, effects are the fragmentation of granite rocks, the elimination of fish, crops, and trees due to the high acidity of the water, in addition to the erosion of water channels, metal equipment buildings, monuments, car paint.. .etc.
2) Effect on the ozone layer: Among its effects, it causes most respiratory diseases, reduces lung efficiency, and leads to difficulty seeing and breathing.
3) Causing harm to living organisms.
4) Noise pollution, physical pollution, audio, and visual pollution

2.2.2 Water pollution

The aquatic environment refers to the water pools. It includes oceans, seas, rivers, lakes, and others. Water pollution is the presence of any kind of pollutants in a certain percentage that can affect the quality and validity of water and make it unusable (Goel, 2006). Physical, chemical, biological, or radioactive pollution may occur to water and inhibits its usability.

Water pollution includes pollution emanating from land, pollution emanating from dumping, seabed activities, ships' activities, and pollution emanating from the air (Freeman, 2010). This sources' multiplicity of aquatic environment pollution makes it difficult to identify and account for the effects resulting from it.

Several pollutants and waste from factories, power plants, a means of transportation, and sewage channels in urban settlements, where a large part of them seeps into the underground water through the cavities and pollutes it (Heath, 2018). Also, water pollution is the pollution of water pools, such as lakes, rivers, ponds, etc., which is considered the most harmful type of pollution (Pandey, 2006).

2.2.3 Soil pollution

Soil pollution can be defined as the existence of pollutant substances or compounds in the soil, which alter its physical,

chemical, and biological properties of it (Mirsal, 2008). Among these changes is the increase of salts, which eliminate the living organisms in the soil (Rodríguez-Eugenio et al., 2018).This pollution results from human waste and acid rain,

2.3 Relationship between renewable energy and environmental protection for sustainable development

2.3.1 Environment protection

Environmental protection is the regulation and control of human activities and behaviors about the environment he or she lives in, and knowledge of activities that lead to an imbalance in the ecological balance (Portney, 2016).

One of the most important environmental impacts associated with traditional energy uses is what is known as the global warming phenomenon. Global warming occurs as a result of an increase in the concentration of some gases in the atmosphere, the most important of which is carbon dioxide (Paramati et al., 2017). On the contrary, the use of renewable provides a positive effect in protecting the environment through reducing the emission of pollutant gases and their related environmental pollution.

Renewable energy has a significant role in protecting the environment, maintaining its balance, and not disturbing the order of the universe. Particularly, thermal energy and photovoltaic technologies do not generate any kind of solid, liquid, or gaseous product when producing electricity (Al-Sayed, 2013; Al Zou'bi, 2010).

2.3.2 Sources of renewable energy

a) Solar energy

Solar energy is renewable, clean, and inexhaustible. Solar energy, unlike fossil fuels, does not release carbon dioxide (CO2) into the atmosphere, does not emit greenhouse gases, and does not contribute to global warming (Anagreh et al., 2010; Harjanne and Korhonen, 2019). It is described as clean energy with minimal impact on the environment. Additionally, Photovoltaic is mainly made from recyclable materials.

b) Geothermal energy

Bioenergy systems have a major role in protecting the environment as they contribute to mitigating the effects of climate change, if they replace the traditional use of fossil fuels, and if the levels of emissions resulting from bioenergy production are kept low.

The environmental impacts associated with geothermal energy projects require consideration of the effects of using air, land, and water locally during both the construction and operation phases, which are common to most energy projects, but more related to geothermal energy (Dickson and Fanelli, 2013). Geothermal systems usually emit gases mixed with steam from surface faults, and minerals dissolved in water emitting from hot springs (Glassley, 2014). Some gases may be dangerous, but they are usually treated or monitored during production.

c) Hydropower energy

Hydropower may have a large environmental footprint at the local and regional levels, as it provides advantages at the macro-ecological system (Kaygusuz, 2004). In terms of environmental impacts, hydropower projects may entail resettling communities living within or near a collection tank or construction sites, compensating communities whose lands are inundated, and addressing public health issues (Yüksel, 2010). However, a properly designed hydropower project can be a driving force for socio-economic development

d) Wind energy

Wind energy has major environmental benefits resulting from replacing electricity generated by power plants that depend on fossil fuels. Wind energy has significant potential in reducing greenhouse gas emissions (Herbert et al., 2007; Burton et al., 2011).. In addition, attempts to measure the relative effects of various electricity supply technologies show that wind energy generally has a small footprint on the environment.

e) Organic Energy (BioEnergy)

Biomass is one of the renewable sources as it constitutes 50% of the total renewable energy (Berndes, Bird, & Cowle, 2010) The energy extracted from biomass varies according to the source from which it is generated. Since the need for fuel is increasing in most countries of the world, especially the poor countries, it is necessary to use bio-energy to produce biogas from animal waste, plant residues, and sewage waste, especially most of the developing countries depend on agricultural products and simple technological capabilities are needed for bioenergy production (Faaij, 2006; Chum et al., 2011).

Bio-methane is a 100% renewable gas produced from the waste of food industries, restaurants, agricultural waste, and household waste. Therefore, biomass is a source of renewable energy. Biogas can be used in different ways just like natural gas; it can be used as fuel to produce electricity in power plants, and it can also be converted into bio-methane (after purification and odor) to be later injected into the gas distribution network (Scarlat et al., 2018).

2.3.3 The need for renewable energy to mitigate climate change

About 0.66 of gas emissions are traced back to fossil fuels. Approximately, carbon emission of energy grows at the rate of 2.0%. Hence, Protecting the environment and climate change requires a search for renewable energy. in addition to the protection of the environment, renewable energy could offer cost-effective projects (Wang et al., 2018).

Protecting climate change and the environment entail using renewable energy as an alternative energy source. In addition to keeping the environment clean and free of gas emissions and reducing climate change, the use of renewable energy provides another competitive advantage through cost-saving, especially for the remote regions that are difficult to be served using conventional energy sources (Jabber et al., 2003; Sovacool and Florini, 2012; Wang et al., 2018).

Energy governance is another concept that promoted renewable energy to grow rapidly. It is the process of national and international interactions, communications, coordination, and political agreements between private-public organizations to provide safe and economic energy (Bazilian et al., 2014; Zaman&Brudermann, 2018). Also, it is defined as a system of regulating communications and interactions among energy-related institutions for purpose of protecting the environment and economy (Fontaine, 2011)

Climate change and widespread air pollution caused by fossil fuels have promoted investors, companies, and governments to recognize the need for decarbonizing the world economy (Arroyo and Miguel, 2020). Climate change poses a great challenge to humanity and ecosystems. Hence, urgent steps have to be taken to decarbonize energy (Global Commission on the Geopolitics of Energy Transformation, 2015).

Renewable energy is considered an effective way to decarbonize the ecosystem and save the climate against air pollution. International Renewable Energy Agency (2018) has revealed that renewable energy combined with energy efficiency could perform a 90% reduction in energy emissions.

2.4 Environmental pollution and use of renewable energy in Jordan

2.4.1 Emissions of pollutant gases in Jordan

The increasing use of diesel fuel and heavy fuel oil (HFO) caused air pollution in urban areas, such as Amman and Zarqa cities. Gas emissions were calculated using the Revised Intergovernmental Panel on Climate Change (IPCC) Guidelines, which were confirmed by the UNFCCC (IPCC 2000). The table below (1) shows the percentage of emissions from (2014 to 2020). Thus, the Jordan government should invest in carbon emissions reduction through improving energy efficiency and promoting the use of renewable energy as an alternative solution.

Today, around 10% of the energy demand is supplied by renewable energy sources (Energy & Minerals Regulatory Commission: EMRC). During the last two decades, SOx has increased rapidly. The power stations, transports, and large industries are considered the main sources of SOx. About, 67 % of the national emissions of SO2 emissions are generated by electric power generation plants. The second SOx emitter is the manufacturing industry due to its dependence on diesel fuels and HFO. SO2 generated from the incineration processes of hydrogen sulfide (H2S) in petroleum refinery approximately amounts to 40 tones as a daily rate. Also, SO2 is generated by boilers and heaters as a result of refinery fuels gas and HFO burning. However, the incineration of H2S is the main contributor to SO2 in refineries (Pearson 1992).

Table 1: Estimates of air emissions in Jordan (Gg year $^{-1}$)

pollutant	2014	2015	2016	2017	2018	2019	2020
CO_2	17320.1	17737.1	18093.6	18487.1	18860.4	20716.9	22422.0
NO_x	3574.5	3660.6	3734.1	3815.4	3892.4	4275.5	4627.4
CO	37.6	38.5	39.3	40.1	40.9	45.0	48.7
PM	11.5	11.8	12.0	12.3	12.5	13.8	14.9
VOC	11.0	11.3	11.5	11.8	12.0	13.2	14.3
SO_x	10.9	11.1	11.4	11.6	11.8	13.0	14.1

Nitrogen dioxide (NOx) is also increasing due to the increase in traffic and industrial activities. According to Kiwan and Al-Gharibeh (2020), approximately, half of the NOx emissions are created by the transport sector. Reducing NOx emissions can be achieved by using advanced technological improvement. For instance, in power stations, NOx can be reduced through using low NOx- burners or through replacing HFO with natural gas.

NOx emissions emitted from traffic can be reduced using new technological engines giving a low percent of NOx. Before twenty years from now (i.e. 2000), a high percentage of imported vehicles were described as obsolete consuming a high percent of NOx. However, for five years (2015), most of the imported vehicles have been supplied with hybrid-engine, which depend on both fossil oil and electricity reducing NOx emissions. Recently, (Since 2019), Jordan has intended to import full-electrical engine vehicles, which have entered the Jordanian market and become accepted by Jordanian citizens.

Despite the Jordanian government's attempts to improve mass passenger transport during the previous years, it still needs more improvements in terms of the use of modern vehicles and transport organization. The lack of mass passenger development and organization prompted people to use their private vehicles (Jabber, 2003), which increased NOx emissions.

Subsequently, emissions from poorly maintained vehicles and small and medium trucks are excessive; their rate is (5 to 10) per vehicle more than its rate in developed countries (jabber, 2000). It is known that vehicles of more than 20 years old have out-of-date engines that lead to a high level of fuel consumption. As a resolution, in 1995, the government issued a law related to releasing some taxes on the saloon cars, in addition to encouraging the replacement of the obsolete cars based on scrapping the old cars and licensing the new ones. The result of taxes reduction manifested in late 1999 when a high percentage of people changed their intention to purchase new vehicles or replaced the old with new ones.

Actions taken as a response to the emissions control accompanied with the improved traffic management programs and production of high-quality fuels have

significantly contributed to NOx reduction and thus cost reduction of health services (Holzinger et al., 2001).

Another factor of the environment's pollution is Volatile organic compounds (VOC) created by refining processes from petroleum stations. In the current status, VOC is estimated to be (30 to 40 per day). However, VOC can be dramatically reduced by double seals that inhibit VOC evaporation. Also, some other methods could be used for reducing VOC emissions, such as absorption, scrubbers, and incinerator systems.

2.4.2 Jordanian laws and regulations for environment protection

The three past decades have witnessed crucial changes in Jordan in terms of industrial, housing, commercial, and agricultural sectors. However, the continuous development in different Jordanian sectors has been followed by negative effects on the environment.

In general, one of the development plan's objectives is to increase the quantity and quality of exports. Rather, the development plan focusing on economic growth has paid insufficient attention to environmental protection. Rao and Yan (2020) mentioned that more attention to increasing economic growth has created more environmental problems. Therefore, a set of laws and regulations were enacted to protect the environment against pollution, such as laws and regulations concerning clean air and water standards, laws of mobile sources and stationary emissions, regulations of wastewater treatment, etc.

The increasing environmental pollution has altered the Jordanian government to issue regulations relating to protecting the environment and its natural resources. In 1993, the government issued the Environmental Protection Law. In 1996, the General Corporation for Environmental Protection (GCEP) was established as a financially and administratively independent institution, and it was the official body responsible for protecting the environment in Jordan. In 2003, the ministry of environment was established to replace (GCEP).

Heavy oil including a high content of sulfur is considered as the main source of power supply of Jordanian industrial activities. According to Jabber et al. (2003), around 40% of the final national demand was heavy oil consumption, and around 88% of the total electricity was generated by heavy oil fuel. As shown in figure 1. Below, around 1% of diesel with sulfur is used for generating energy in 2020.

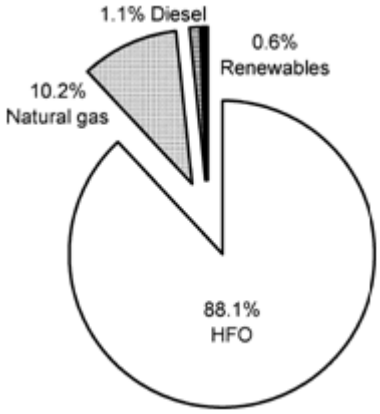

Figure 1: Electricity generation during 2020 according to a type of primary energy source

High costs incurred from the use of flue gas sulfurization systems are considered a challenge for power plants to sustain a clean industrial environment. Nevertheless, recently, authorities concerned with the environmental issues have become aware of the environmental consequences resulting from fossil fuels consumption accompanied with little consideration to limited environmental protection standards. Accordingly, the Jordanian government has decided to import natural gas from Egypt for power supply plants' operations. Yet, despite the successive efforts devoted by the concerned authorities, there is a persistent need for more attempts to reduce environmental pollution.

3. Conclusion

The development that the world witnessed in the 20th century in all life fields, especially in industrial activities, has led to astonishing economic growth in most countries. However, this astounding leap in terms of growth and development has led authorities to ignore the opposite side of different industries' development, which is the environmental pollution caused by gases emissions as a result of the excessive use of conventional energy sources (i.e. fossil fuel).

Subsequently, different agencies and organizations have paid attention to the danger of gas emissions and their negative consequence on the environment in all its components; human, plants, animals, air, water, soil, etc. Hence, most of the countries established environment-related organizations, and several conferences have been conducted concerning environment protection.

The environment-related scientific and practical efforts have been devoted to providing alternative solutions for emissions reduction and replacement of natural gases. Using renewable energy has helped countries to reduce gas emissions and save costs. Despite its high costs in the short term (construction and operation), it is feasible in the long term. Therefore, it is highly recommended to be the energy alternative solution for future generations.

Jordan is one of the preceding countries that devoted huge efforts to reduce gas emissions despite its limited capabilities. In this context, the Jordan government issued several laws for environmental protection and established

the ministry of environment for environment protection. The ministry, by integrated agreement with other authorities especially Energy Regulatory Authority (ERA), supported the use of renewable energy by providing many energy-related facilities.

Although, the Jordanian government has paced a long way in improving energy efficiency and gas emissions reduction, using renewable energy is still at its limited scope and thus needs more expansion. Accordingly, there is a persistent need today for more facilities provided by the government to the citizens and organizations to use renewable energy as an alternative to conventional energy.

References

[1] Abu-Rumman, G., Khdair, A. I., &Khdair, S. I. (2020). Current status and future investment potential in renewable energy in Jordan: An overview. *Heliyon*, *6*(2), e03346.
[2] Al-Hamamre, Z., Saidan, M., Hararah, M., Rawajfeh, K., Alkhasawneh, H. E., & Al-Shannag, M. (2017).Wastes and biomass materials as sustainable-renewable energy resources for Jordan. *Renewable and Sustainable Energy Reviews*, *67*, 295-314.
[3] Al-Sayed, R. (2013, May). Status of renewable energy in Jordan. In 2013 1st International Conference & Exhibition on the Applications of Information Technology to Renewable Energy Processes and Systems (pp. 66-72). IEEE.
[4] Al Zou'bi, M. (2010).Renewable energy potential and characteristics in Jordan. *JJMIE*, *4*(1), 45-48.
[5] Anagreh, Y., Bataineh, A., & Al-Odat, M. (2010).Assessment of renewable energy potential, at Aqaba in Jordan. *Renewable and Sustainable Energy Reviews*, *14*(4), 1347-1351.
[6] Armeanu, D., Vintilă, G., Andrei, J. V., Gherghina, Ş. C., Drăgoi, M. C., &Teodor, C. (2018). Exploring the link between environmental pollution and economic growth in EU-28 countries: Is there an environmental Kuznets curve?. *PloS one*, *13*(5), e0195708.
[7] Arroyo M, F. R., & Miguel, L. J. (2020). The Role of Renewable Energies for the Sustainable Energy Governance and Environmental Policies for the Mitigation of Climate Change in Ecuador. *Energies*, *13*(15), 3883.
[8] Azzuni, A., Aghahosseini, A., Ram, M., Bogdanov, D., Caldera, U., &Breyer, C. (2020). Energy security analysis for a 100% renewable energy transition in Jordan by 2050. *Sustainability*, *12*(12), 4921.
[9] Baniyounes, A. M. (2017). Renewable energy potential in Jordan. *International Journal of Applied Engineering Research*, *12*(19), 8323-8331.
[10] Bazilian, M, Nakhooda, S., & Van de Graaf, T. (2014). Energy governance and poverty. *Energy Research & Social Science.*, *1*, 217–225.
[11] Berndes, G., Bird, N., & Cowle, A. (2010). Bioenergy, Land Use Change and Climate Change Mitigation. Report for Policy Advisors and Policy Makers.
[12] Boyle, G. (2004). Renewable energy.Oxford University Press.
[13] Burton, T., Jenkins, N., Sharpe, D., &Bossanyi, E. (2011). Wind energy handbook. John Wiley & Sons.
[14] Chum, H., Faaij, A., Moreira, J., Berndes, G., Dhamija, P., Dong, H., ...&Pingoud, K. (2011). Bioenergy. In Renewable energy sources and climate change mitigation: Special report of the Intergovernmental Panel on Climate Change (pp. 209-332). Cambridge University Press.
[15] Dickson, M. H., &Fanelli, M. (2013). Geothermal energy: utilization and technology. Routledge.
[16] Faaij, A. P. (2006). Bio-energy in Europe: changing technology choices. *Energy policy*, *34*(3), 322-342.
[17] Falchi, F., Cinzano, P., Elvidge, C. D., Keith, D. M., &Haim, A. (2011).Limiting the impact of light pollution on human health, environment and stellar visibility. *Journal of environmental management*, *92*(10), 2714-2722.
[18] Fontaine, G. (2011). The effects of governance modes on the energy matrix of Andean countries. *Energy Policy*, *39*, 2888–2898.
[19] Freeman, A. M. (2010). Water pollution policy.In Public policies for environmental protection (pp. 179-224).Routledge.
[20] Glassley, W. E. (2014). Geothermal energy: renewable energy and the environment. CRC press.
[21] Global Commission on the Geopolitics of Energy Transformation.A New World. The Geopolitics of the Energy Transformation; International Renewable Energy Agency: Masdar, Arab, 2019.
[22] Goel, P. K. (2006). Water pollution: causes, effects and control. New Age International.
[23] Goodstein, E. S., &Polasky, S. (2017). Economics and the Environment. John Wiley & Sons.
[24] Halfwerk, W., &Slabbekoorn, H. (2015). Pollution going multimodal: the complex impact of the human-altered sensory environment on animal perception and performance. *Biology letters*, *11*(4), 20141051.
[25] Harjanne, A., &Korhonen, J. M. (2019).Abandoning the concept of renewable energy. *Energy policy*, *127*, 330-340.
[26] Heath, A. G. (2018). Water pollution and fish physiology. CRC press.
[27] Herbert, G. J., Iniyan, S., Sreevalsan, E., &Rajapandian, S. (2007). A review of wind energy technologies. *Renewable and sustainable energy Reviews*, *11*(6), 1117-1145.
[28] Hoang, A. T. (2018). A reportofthe oil spill recovery and treatment technologiesto reduce the marine environment pollution. *International Journal of e-Navigation and Maritime Economy*, *9*, 35-49.
[29] Holzinger, R., Jordan, A., Hansel, A., &Lindinger, W. (2001). Automobile emissions of acetonitrile: Assessment of its contribution to the global source. *Journal of atmospheric chemistry*, *38*(2), 187-193.
[30] Jaber JO (2002). Future energy consumption and greenhouse gas emissions in Jordanian industries. *Applied Energy*, *71*,15–30
[31] Jaber JO, Mohsen MS, Al-Sarkhi A, Akash A (2003) Energy analysis of Jordan's commercial sector. *Energy Policy*, *31*, 887–894.
[32] Kampa, M., &Castanas, E. (2008). Human health effects of air pollution. *Environmental pollution*,*151*(2), 362-367.
[33] Kaygusuz, K. (2004). Hydropower and the world's energy future. *Energy Sources*, *26*(3), 215-224.

[34] Kiwan, S., & Al-Gharibeh, E. (2020). Jordan toward a 100% renewable electricity system. *Renewable Energy*, *147*, 423-436.
[35] Mabahwi, N. A. B., Leh, O. L. H., & Omar, D. (2014). Human health and wellbeing: Human health effect of air pollution. *Procedia-Social and Behavioral Sciences*, *153*, 221-229.
[36] Mirsal, I. A. (2008). Soil pollution. New York, NY: Springer.
[37] Pandey, S. (2006).Water pollution and health. *Kathmandu University medical journal (KUMJ)*, *4*(1), 128-134.
[38] Panwar, N. L., Kaushik, S. C., & Kothari, S. (2011). Role of renewable energy sources in environmental protection: A review. *Renewable And Sustainable Energy Reviews*, *15*(3), 1513-1524.
[39] Paramati, S. R., Sinha, A., &Dogan, E. (2017). The significance of renewable energy use for economic output and environmental protection: evidence from the Next 11 developing economies. *Environmental Science and Pollution Research*, *24*(15), 13546-13560.
[40] Pastor, R., Tobarra, L., Robles-Gómez, A., Cano, J., Hammad, B., Al-Zoubi, A., ...& Castro, M. (2020). Renewable energy remote online laboratories in Jordan universities: Tools for training students in Jordan. *Renewable Energy*, *149*, 749-759.
[41] Pearson, C. R. (1992). Environmental protection assessment for Jordan Petroleum Refinery Company, Final Report, Zarqa, Jordan.
[42] Portney, P. R. (2016). Public policies for environmental protection. Routledge.
[43] Raaschou-Nielsen, O., Andersen, Z. J., Beelen, R., Samoli, E., Stafoggia, M., Weinmayr, G., ...&Hoek, G. (2013). Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects (ESCAPE). *The lancet oncology*, *14*(9), 813-822.
[44] Rao, C., & Yan, B. (2020). Study on the interactive influence between economic growth and environmental pollution. *Environmental Science and Pollution Research*, *27*(31), 39442-39465.
[45] Rodríguez-Eugenio, N., McLaughlin, M., &Pennock, D. (2018). Soil pollution: a hidden reality. FAO.
[46] Sovacool, B. K., & Florini, A. (2012). Examining the complications of global energy governance. *Journal of Energy & Natural Resources Law*, *30*(3), 235-263.
[47] Scarlat, N., Dallemand, J. F., &Fahl, F. (2018). Biogas: Developments and perspectives in Europe. *Renewable energy*, *129*, 457-472.
[48] Sherbinin, A. D., Carr, D., Cassels, S., & Jiang, L. (2007).Population and environment. *Annu. Rev. Environ. Resour.*, *32*, 345-373.
[49] Twidell, J., & Weir, T. (2015). Renewable energy resources. Routledge..
[50] Wang, B., Wang, Q., Wei, Y. M., & Li, Z. P. (2018). Role of renewable energy in China's energy security and climate change mitigation: An index decomposition analysis. *Renewable and sustainable energy reviews*, *90*, 187-194.
[51] Yüksel, I. (2010). Hydropower for sustainable water and energy development. *Renewable and Sustainable Energy Reviews*, *14*(1), 462-469.
[52] Zaman, R., Brudermann, T. (2018). Energy governance in the context of energy service security: A qualitative assessment of the electricity system in Bangladesh. *Applied Energy*, *223*, 443–456.