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RESEARCH ARTICLE RENEWABLE ENERGY

The Environmental Impact and Societal Conditions of PV Power Plants: A Case Study of Jericho Gate-Palestine Stat Of

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ABSTRACT

To address the issue of decline in the energy sector of Palestine, the energy consumption breakdown is as follows: Israel 87%, Jordan 2%, renewable energy 3%, and Gaza generates 8% of the energy demand, according to the Palestinian Central Bureau of Statistics. For this reason, investments in renewable energy sources in Palestine, particularly in Jericho, have risen notably, as all power plants influence the environment, including photovoltaic (PV) power plants. Given their intended large capacities, evaluating their environmental impact is essential. Enhancing the production technology of PV system components , boosting solar cell efficiency, and utilizing materials that are more environmentally friendly will help mitigate these effects. The aim of this paper is to examine the current state of the environmental effects of PV power plants amidst these evolving conditions regarding CO2 emissions, land use, pollutant and noise emissions, and water usage, and to develop an environmental management plan to reduce the adverse impact of PV.

التأثير البيئي والظروف المجتمعية لمحطات الطاقة الشمسية الفوتوضوئية: دراسة حالة بو ابة أريحا- دولة فلسطين

ماهر المغالسة[1]

الكلمات المفتاحية
محطات الطاقة الشمسية الفوتوضوئية
التأثير البيئي
استعمالات الاراضي
انبعاث CO2

الملخص

تعتمد فلسطين بشكل رئيس على مصادر خارجية لتلبية احتياجاتها من الطاقة، حيث تُستورد حوالي 87% من إسرائيل، و2% من الأردن، بينما تسهم الطاقة المتجددة بنسبة 3%، وتغطي محطة توليد الكهرباء في غزة نحو 8% من الطلب الكلي على الطاقة. ونتيجة لهذا الاعتماد الكبير على مصادر خارجية، شهدت الاستثمارات في مشاريع الطاقة المتجددة، خاصة في منطقة أريحا، نمواً ملحوظاً في السنوات الأخيرة. ومع أن محطات توليد الطاقة المتجددة، بما في ذلك المحطات الكهروضوئية، تُعد أقل ضرراً بالبيئة مقارنة بالمصادر التقليدية، إلا أنها لا تخلو من تأثيرات بيئية. وبالنظر إلى الإمكانيات الكبيرة للطاقة الشمسية في فلسطين، فإن تقييم الأثر البيئي لهذه المحطات يُعد أمراً ضرورياً. إن تحسين تكنولوجيا تصنيع مكونات الأنظمة الكهروضوئية، ورفع كفاءة الخلايا الشمسية، والاعتماد على مواد صديقة للبيئة، عوامل أساسية في الحد من الآثار السلبية لهذه المحطات. تهدف هذه الورقة البحثية إلى دراسة الوضع الحالي للتأثيرات البيئية لمحطات الطاقة الكهروضوئية في السياق المحلي، من حيث انبعاثات ثاني أكسيد الكربون، واستخدام الأراضي، والتلوث الهوائي والضوضاء، واستهلاك المياه، بالإضافة إلى وضع خطة إدارة بيئية تهدف إلى تقليل تلك الآثار قدر الإمكان.

Introduction

Driven by concerns about climate change and global warming, at the end of 2024; the global renewable energy capacity reaches 4.448 TW, from them 2.085 TW for Photovoltaic (PV) solar energy systems, 1.136 TW for wind energy. This growth in the RE market reflects a global shift towards renewable and sustainable energy technologies [1]. Moreover, the importance of PV solar energy fields is paramount, especially given its role as an optimal complement to both renewable and conventional energy sources within hybrid energy systems. These systems are widely deployed globally due to their robustness and reliability in energy production from various sources, including PV/grid, PV/wind, PV/diesel, PV/concentrated solar power (CSP), PV/wind/diesel, and PV/wind/battery configurations [2-10].

PV power plants are a potential way to turn solar energy into clean, sustainable electricity. PV In addition to environmental sustainability, PV plants may have negative environmental effects that need to be carefully considered and mitigated. Photovoltaic technology is a key part of the switch to renewable energy sources, and as more nations install photovoltaic systems, the potential decrease in greenhouse gas emissions is probably going to continue [11-17].

The main environmental impacts of PV plants include occupied land, greenhouse gas emissions (GHG), water consumption, hazardous materials, visual effects, and noise. Nonetheless, the overall quantity and category of land used by a PV power station is called land use. Therefore, land utilization might influence local biodiversity and natural habitats. Due to the wide range of effects on land use, the location, size, and construction method of a PV plant greatly

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affect its impact on land use. For instance, some PV power plants can be integrated into existing buildings or structures, while others necessitate the grading or clearing of significant land areas. Some PV power installations may share land with other uses, including agriculture or grazing, while others may displace or eliminate wildlife habitat. This variation highlights how crucial it is to select and design locations to minimize ecological disturbance. Animal corridors and the restoration of native plants are two additional strategies that could reduce negative impacts on nearby ecosystems.

GHG denotes the release of carbon dioxide and additional gases produced by the functioning of photovoltaic (PV) power stations. Climate change and global warming are exacerbated by these emissions. Throughout the life span of a PV power plant, the effect of GHG is mainly influenced by the manufacturing, transportation, installation, operation, and decommissioning stages [18-21]. For instance, producing specific varieties of photovoltaic cells needs large quantities of energy and raw materials, potentially raising their carbon footprint. This decrease in operational emissions represents a beneficial move towards enhancing PV technology's role in a sustainable energy future. By implementing more sophisticated manufacturing techniques and materials in the creation of PV systems, the lifecycle emissions of these systems will keep declining. Solar energy is increasingly recognized as a powerful option for addressing climate change [22-24].

Water use mean the volume and quality of water used or released by a PV power facility and can significantly affect the availability and sustainability of water resources in an area. Nonetheless, the kind of photovoltaic technology and the site of the plant greatly affect water consumption. For instance, photovoltaic solar panels do not need water to produce electricity, but they might require it for maintenance and cleaning. Moreover, it is crucial to grasp and regulate water consumption and to reduce the ecological effects of photovoltaic energy production while taking into account the sustainability of regional water supplies.

Farrell et al. [25] explored and suggested the most effective methods for recycling PV modules that have completed their life cycle.

They focused on enhancing the collection of elements from the PV while taking into account current design constraints. Furthermore, They provided updates on several of the newest recycling techniques at both the industrial and research levels. Zhang et al. [26] examined the advantages of executing solar photovoltaic initiatives and their possible environmental effects, offering suggestions to enhance their sustainability. While solar photovoltaic technology greatly decreases greenhouse gas and pollutant emissions, it may also result in adverse environmental impacts. Loss of biodiversity, habitat degradation, climate effects, resource use, and solar panel disposal are all part of these implications.

Dias et al. [27] introduced a new method for recycling silicon solar panels that includes the removal of panels, followed by shredding and electrostatic separation, yielding a valuable combination of metals and silicon, as well as a less valuable assortment of glass, silicon, and polymers. The article analyzes the technical, environmental, and economic aspects of the suggested method in relation to full recycling and landfill disposal systems. It shows that the suggested approach is better than landfilling and that in certain cases, recycling semiconductor materials could be more advantageous than total recycling. As the demand for solar photovoltaic modules continues to rise, it is essential to get ready for the complete recycling of utilized photovoltaic modules. Semiconductor materials can be obtained separately through manual, mechanical, chemical, or a mix of these techniques.

Subramaniyan et al. [28] proposed a technique for numerically predicting the deterioration rate of solar panels. It analyzed how dynamic environmental factors, such as temperature, UV radiation, and relative humidity, affect the degradation of PV modules. The researchers employed a cumulative exposure model to associate environmental factors with the modules ' degradation pathway in their investigation. We anticipate that their study will improve our understanding of PV module deterioration, possibly leading to enhanced performance in future designs. Allouhi et al. [29] provided a summary of the latest developments in photovoltaic technology, markets, and materials. Methods for reducing pollution are analyzed to enhance the efficiency of power output and manage thermal aspects of PV systems. The authors also outline opportunities and challenges in the solar energy sector .

Haas et al. [30] suggested that the increasing popularity of floating photovoltaic power plants is fueled by their potential advantages, such as decreased evaporation losses and enhanced efficiency. This research investigates the impact of floating solar panels on hydropower generation and the quality of reservoir water. A three-dimensional numerical hydrodynamic water quality model was used to evaluate scenarios with and without solar panels. A mathematical method for optimal hydropower scheduling was employed to account for variations in water and energy prices. The findings indicate that using floating photovoltaic modules significantly improved both total energy production and water quality metrics. The article also explored the potential economic benefits of incorporating renewable energy sources into hydroelectric systems.

The purpose of this research is to utilize existing data to demonstrate the current condition of the environmental impacts of PV solar energy installations. Thus, we carry out a targeted analysis and assessment of Jerico's ecological circumstances. Figure 1 provides a clear illustration of the environmental management procedure.

The environmental and social condition in the project area

Jericho is situated in the West Bank, Palestine at coordinates 31° 51′ 22″ N 35° 27′ 36″ E with 58.701 km^2 (Figure 2), and serves as the administrative center for the Jericho Governorate. it had a population of 20,907 [31]. The key information on the PV solar field is illustrated in Figure 3.

Climate and nature of the weather

The Jericho Gate area experiences a dry subtropical climate characterized by hot, arid summers and mild, humid winters. In winter, daytime temperatures range from 10°C to 18°C, while night-time temperatures fall between 5°C and 10°C. The precipitation totals around 200 mm annually, and the prevailing wind during this season is from the northwest. In summer, daytime temperatures range from 28°C to 35°C, with night-time temperatures varying from 18°C to 25°C. Summer sees little rainfall, with the northeast wind prevailing during this time; nevertheless, temperatures can vary significantly based on your specific location. The location may also face droughts, high winds, and sandstorms.

The air quality

The air quality in the Jericho Gate region fluctuates

significantly throughout the year; during summer, the location experiences dust storms from the desert, causing a notable decline in air quality, while vehicle emissions increase due to heightened traffic. In winter, air quality sees marked improvements with reduced dust and increased rainfall. Weather phenomena, such as strong winds, can result in air pollution with dust and sand. Precipitation assists in purifying the air from pollutants; nonetheless, human actions, especially traffic, continue to be a significant contributor to air pollution, notably on Mahmoud Darwish Street, which frequently suffers from severe congestion. Factories and workshops can also contribute to air contamination. Overall, the air quality in the Jericho Gate area along Mahmoud Darwish Street is generally acceptable, but it can worsen at certain times, particularly in the summer. Figure 4 illustrates the air quality index.

Noise levels

Noise levels in the Jericho Gate area at Mahmoud Darwish Street vary greatly based on the time of day. For instance, throughout the day, noise levels rise because of traffic and business activities, whereas at night, they drop considerably, particularly after midnight. However, noise levels are particularly high on Mahmoud Darwish Street because of traffic congestion, although they are lower in the interior of

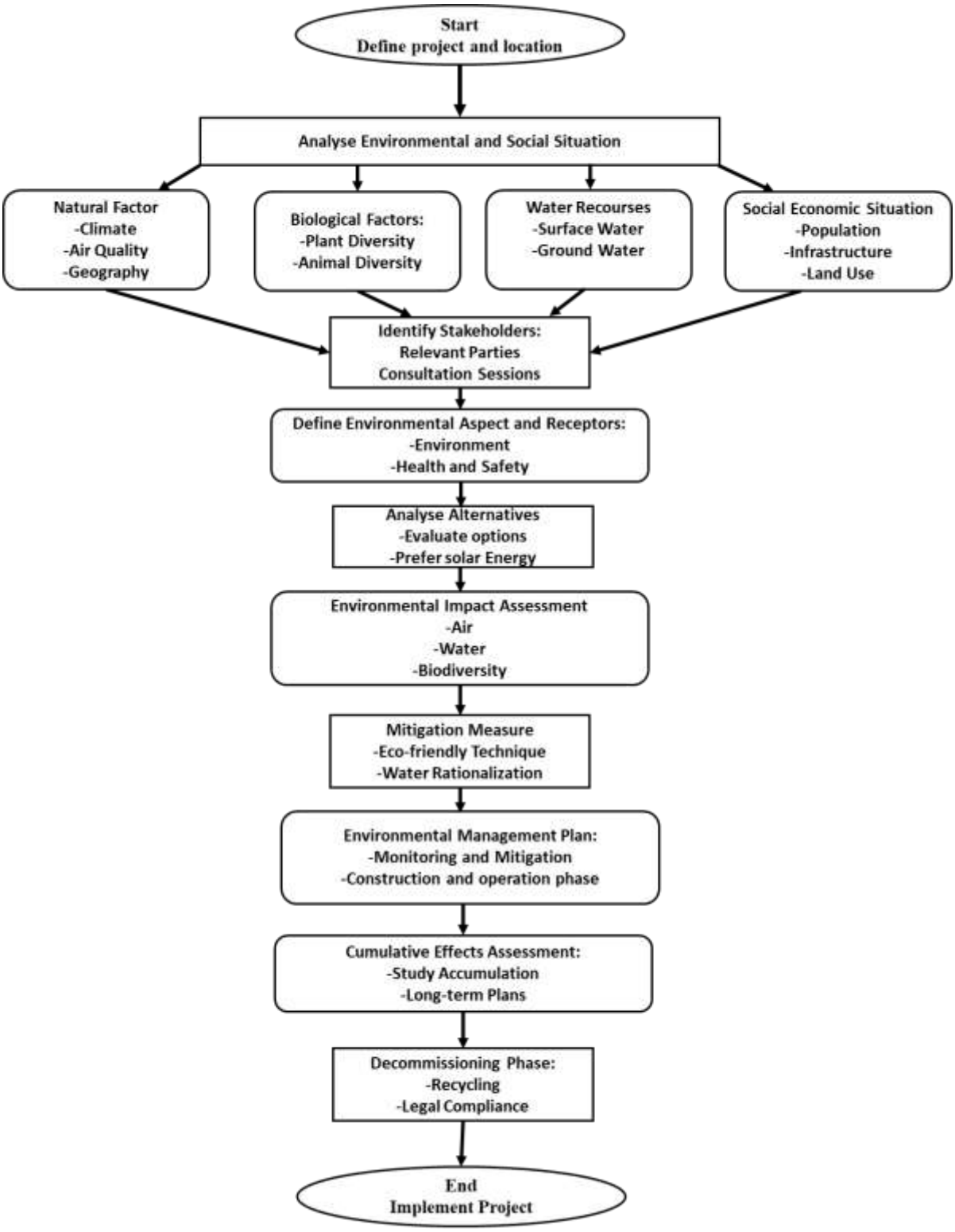

Fig.1: Environmental Management process

Fig.2: Location of Jericho District
[Source: https://www.mapsofindia.com/world-map/palestine/jericho/location-map.html]

the location. Ambient conditions, such as construction work, result in a significant increase in noise levels. Events and celebrations may also cause a temporary rise in noise levels. Overall, noise levels in the Jericho Gate area and Mahmoud Darwish are relatively high, especially throughout the day, and can be accurately measured using a noise recording device. However, levels above 85 decibels are harmful to health. Figure 5 illustrates the noise levels.

Physio-geography and Soil

The Jericho Gate area has an ideal location for establishing a PV plant, as it enjoys ample sunlight throughout the year. This area features large expanses of flat land, which facilitate the setup of solar panels. The concentration of trees and structures nearby diminishes, lowering the level of shade that could influence the plant's efficiency. The sandy soil in the location is suitable for installing PV systems, as it promotes water drainage and prevents corrosion. The absence of rocks simplifies the task of digging foundations for the installation of PV systems, and the local infrastructure provides a strong power grid, which eases the connection of the station to the electric grid. The Jericho Gate area is indeed an ideal location for constructing a PV plant, as it offers all the physiographic factors and soil necessary for the project's success.

Geomorphology and Geology

The Jericho gate area is located in a low plain known as the Jordan Valley, where the location is surrounded by mountain slopes from the West, many valleys spread in the location, the significant of which is Wadi Al-Qalat and the soil in the location consists of recent sedimentary deposits, such as sand and gravel and sedimentary rocks from the Cretaceous Period spread in the location and there are some geological cracks in the location, especially in the mountainous areas.

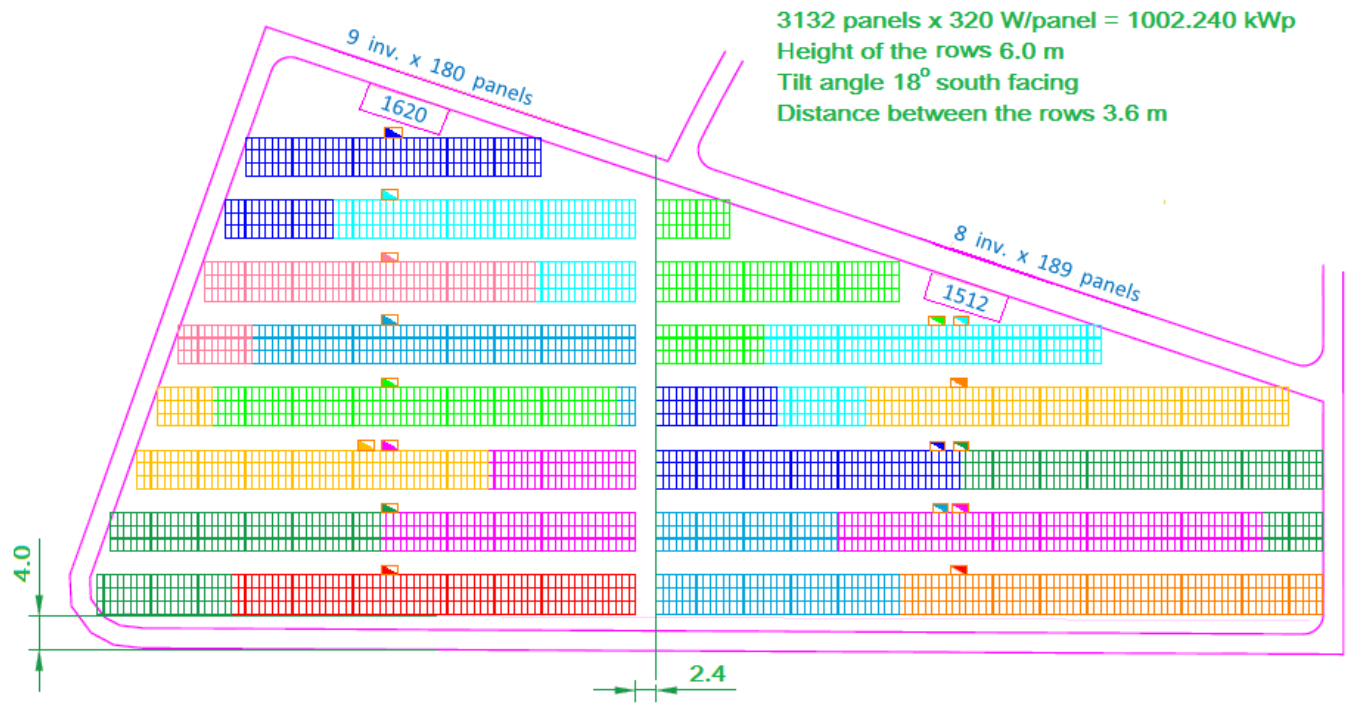

Fig.3: Layout of the 7.5 MW Aricho PV solar field

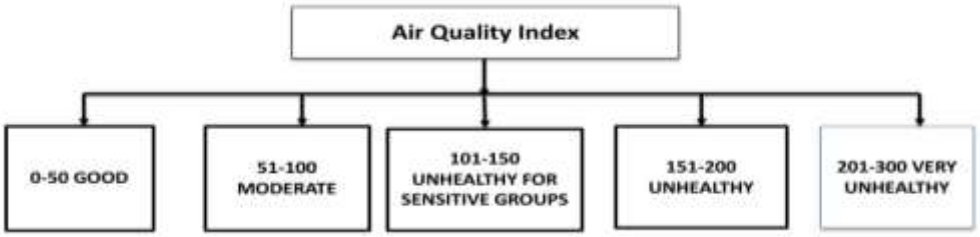

Fig.4: Air Quality Index

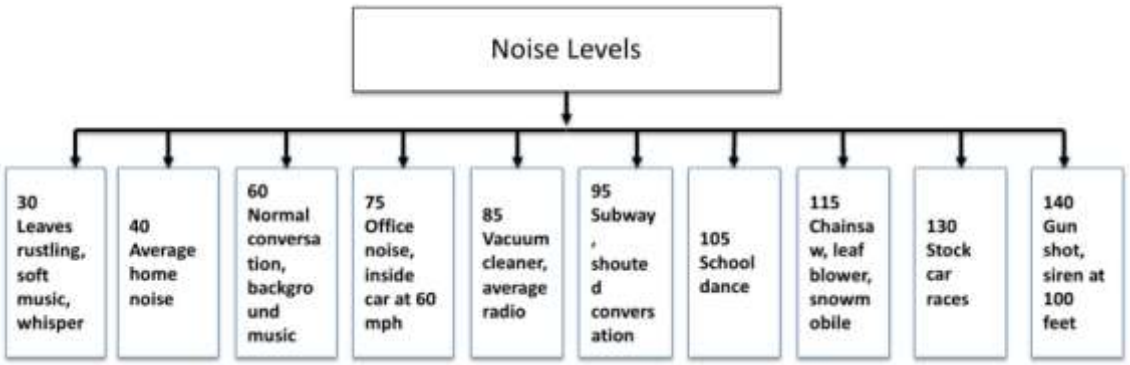

Fig.5: Noise Level

Seismic situation

The occurrence of earthquakes cannot be completely ruled out, especially in the presence of some geological cracks in the location, it is necessary to choose a location away from areas at risk of landslides and design solar panels to withstand earthquakes through the use of strong materials and appropriate installation techniques and insure all buildings in the station against earthquakes. Mitigating measures and environmental monitoring for the physical environment are clearly explained in Table 1.

Physio-geography and Soil

The Jericho Gate area has an ideal location for establishing a PV power plant, as it enjoys ample sunlight throughout the year. This area features large expanses of flat land, which facilitate the installation of PV power plant. The density of trees and buildings in the vicinity decreases, reducing The quantity of shade that may affect the plant performance. The sandy soil in the location is suitable for installing solar panels, as it promotes water drainage and prevents corrosion. The absence of rocks simplifies the process of digging foundations in order to install solar panels, and the local infrastructure provides a strong power grid, which eases the connection of the station to the electric grid. The Jericho Gate area is indeed an ideal location for constructing a PV plant, as it provides all the soil and physiographic elements required for the project's success.

Geomorphology and Geology

The Jericho Gate area is located in the Jordan Valley, where the site is surrounded by mountain slopes to the west. Many valleys spread throughout the location, such as Wadi Al-Qalat. The soil consists of recent sedimentary deposits, including sand and gravel, while sedimentary rocks from the Cretaceous Period are also present. In the region, especially in the mountainous zones, there exist various geological fissures.

Seismic situation

The possibility of earthquakes cannot be entirely dismissed, particularly with geological fractures in the location. It is obvious to choose a location away from areas at risk of landslides and to design PV panels to withstand earthquakes by using strong materials and appropriate installation techniques , and to insure all buildings at the station against earthquakes. Mitigating measures and environmental monitoring for the physio -geography and soil are clearly explained in Table 2.

Water Resources

Surface water

The Jordan River flows a few kilometers from the location, and many valleys feed into it, along with some underground wells in the vicinity . However, the region faces challenges regarding surface water, the most significant of which is water scarcity, particularly during the summer. Additionally, several surface water sources are affected by pollution. Water-saving techniques must be implemented at all stages of the plant's operation. This includes treating wastewater for reuse in the irrigation of green spaces surrounding the plant, utilizing solar energy for water purification, and cooperating with the relevant authorities to ensure the plant meets its water needs.

Groundwater

There are some groundwater resources around Jericho Gate, consisting of modern sedimentary layers that allow water to leak easily. However, the location faces challenges regarding groundwater, the most significant of which is that the water surface level is continuously decreasing due to unfair usage . Comprehensive studies of groundwater must be conducted before starting the construction of the station. Mitigating measures and environmental monitoring for water resources are clearly explained in Table 3.

Bioecology

Plant diversity

Biogeographic system

The significant characteristics of the biogeographic system in the region include a hot and dry climate, with an average annual temperature of 25 degrees Celsius, as well as numerous drought-resistant plant species and a diverse range of animal species spread throughout the location.

Natural system

The Jericho Gate area is characterized by a unique natural system that includes a diversity of terrains , including mountains, valleys, and plains.

Types of vegetation

The project area is characterized by its plant diversity, where many types of plants that have adapted to the hot and dry climate are spread throughout the region. The significant types of vegetation in the region are palm trees, which are the most famous tree species there , and they are widely spread in low-lying areas, and sidro trees, which are perennial trees known for their ability to resist drought, and potem trees that grow in mountainous areas.

Animal diversity

Mammals

The project area is described by its animal diversity, featuring many species of mammals that have adapted to the hot and dry climate of the location. The notable species of mammals include deer and hares that live in burrows, while rats occupy urban areas. Additionally, there are foxes, hyenas, wildcats, rock hyenas, and donkeys.

Fowls

The project area is characterized by its biological diversity, as it is dotted with many species of birds that have adapted to the hot and dry climate in the location, such as birds of prey (hawks, owls, eagles), songbirds (sparrows, pigeons, babblers) and waterfowl (swans, ducks, geese) in addition, some rare bird species are widespread in the location, for instant, the white stork and the Egyptian eagle. Mitigating measures and environmental monitoring for Bioecology are clearly explained in table 4.

Socio-economic situation

Population

Jericho Gate area at Mahmoud Darwish Street is characterized by its population diversity, as it includes a mixture of Palestinian families of various origins and backgrounds. Refugee families make up a large percentage of the location's population, as many Palestinians were displaced to Jericho after the 1948 war. Local families from Jericho also live in the location, some of them of ancient Arab origins and some of Bedouin origins. Recently, the location has attracted new arrivals from various parts of Palestine in search of job opportunities and housing. The region's population is predominantly young due to a high birth rate.

Land use

Jericho Gate area is located on the outskirts of the city of Jericho, on Mahmoud Darwish Street. The area features vast expanses of vacant land, which makes it ideal for setting up a PV plant. Certain areas of the land in the region are utilized for farming, primarily for palm cultivation, while other sections function as grazing grounds for animals. Furthermore, there are extensive areas of unoccupied land available for development.

Infrastructure, utilities and transportation.

There is a good road network in the Jericho Gate area, which facilitates the transportation of equipment and materials needed to set up a PV plant. Additionally, there is a good electricity network in the location, which eases the connection of the PV plant to the Jerusalem electricity grid. Furthermore, there is a reliable water network in the location, which supports the provision of water needed to clean solar panels. However, there are no large facilities in the location; there are some houses and shops. Nevertheless , there is good public transport, which aids the transportation of workers to the site, and there are sufficient parking lots available. The impact on infrastructure, utilities , and transportation is expected to be minimal. The power grid may need to expand to connect the PV power station to the Jerusalem power grid, and the road network may require expansion to facilitate the transportation of equipment and materials for constructing the PV plant. Mitigating measures and environmental monitoring for socio-economic situation are clearly explained in Table 5.

Archaeological sites and cultural heritage

Archaeological surveys of the project area were conducted by the Department of Public Antiquities. Two sites have been found: the first is Tell Al-Sultan, which is located about 2 km from the Jericho Gate area. Tell Al-Sultan is among of the significant archaeological sites in Palestine, as it includes the oldest city in the world. The second site is Hisham Palace, located about 3 km from the project area; it is an Umayyad palace from the eighth century AD. The city of Jericho is among the oldest cities in the world, and it possesses a rich cultural history. Researchers are conducting numerous excavations in the Jericho Gate area in search of antiques and gold. They have achieved some successes in recent years; in 2019, a team of archaeologists found a set of gold jewelry dating back to the Bronze Age at Tell Al-Sultan, which is among the significant findings. Based on this, an official letter will be requested from the Department of Antiquities containing the Department's approval for the project. It is stated in the letter that "the Department of Antiquities has no objection to completing the procedures for the project, provided that work will be halted if any monuments or archaeological finds are discovered during the project implementation phase, and the Department of Antiquities must be informed." This letter will be included in the Environmental Impact Assessment (EIA) Study Report as part of the Archaeological Survey. Mitigating measures and environmental monitoring for archaeological sites and cultural heritage are clearly explained in Table 6.

Identify stakeholders and stakeholders

The identification and involvement of stakeholders are important factors during the project phase. Depending on the local environmental regulations and the EIA, the most important activities related to stakeholder involvement during this study are as follows:

1. Identification of stakeholders related to the project.
2. Conduct a consultation session and document the results and reactions during the session through the report of the consultation as part of the terms of reference document.
3. Conduct field visits to meet with representatives of the local community.

Definition of environmental aspects and receptors

A systems specification of the Environmental Management definition of the environmental, economic, and social aspects

Table 1: Mitigating measures and environmental monitoring for the physical environment.

#	Item	Summary of potential impacts	Mitigating measures	Monitoring requirements	Frequency of monitoring	Necessary reports	Performance Indicators
1	**Air quality**	Dust emissions from construction works	1. Avoid unnecessary handling of material dust, such as reducing the height of bucket bins when unloading dust and transporting trucks out of the project. 2. Train workers to handle construction materials and debris during the construction phase to reduce emissions. 3. Cover trucks when transporting dusty materials off the project site . 4. During the construction period, dust will be generated from unpaved roads and work areas and must be controlled through water spraying as needed. 5. Set appropriate speed limits to reduce dust generation due to vehicle movement over unpaved surfaces.	Daily monitoring of dust levels during construction activities .	Daily	Corrective actions for all dust emission issues and preparation of a report if there are any.	Not seeing clouds of dust at execution sites.
		Emissions from exhaust throughout the construction phase	1. Do not use motors for longer than necessary. 2. Ensure the implementation of appropriate and periodic maintenance and monitoring of vehicles to reduce exhaust emissions	Daily monitoring of exhaust emissions.	Daily	-	Periodic maintenance of vehicles.
2	**Noise**	High noise levels at the project site during construction work.	1. Use effective site management applications, ensure that all equipment is properly maintained and operated, and confirm that equipment is used as instructed by the manufacturers. 2. Limit the use of motors when not needed to reduce noise levels .	Adopting a program to measure the noise levels generated by project activities using mobile noise monitors and adhering to the instructions for the reduction and prevention of local noise.	Measure the noise level one month after the start of work, and then after receiving any complaints from the site workers or a third party.	The contractor prepares a corrective action report for the project in case of any abuses .	Commitment to local controls specified by the Ministry of the Environment.

Table 2: Mitigating measures and environmental monitoring for the Physio-geography and Soil.

#	Item	Summary of potential impacts	Mitigating measures	Monitoring requirements	Frequency of monitoring	Necessary reports	Performance Indicators
1.	**Soil**	Impact on the soil due to the potential for contamination.	1. Prepare a spill prevention and response plan to control any leakage or unintentional spillage. Spill response measures should be implemented (where necessary) to contain and clean contaminated soil, in addition to providing personal protective equipment for on-site workers. 2. A range of measures must be taken to prevent spillage (as needed) to contain and clean any contaminated site. 3. Proper storage of hazardous materials in isolated areas on-site is essential. Appropriate safety procedures must be applied when handling this material to avoid leakage and leaching into the soil. 4. Spill reduction measures must be implemented (as needed) to contain and clean contaminated soil. In the event of chemical spills, they should be collected immediately and disposed of according to the Leak Prevention and Response Plan, as well as the MSDS (Material Safety Data Sheet) . The contractor must provide chemical removal supplies.	Monitor storage space visually and machines by conducting regular reviews. Perform on-site activities and submit reporting forms in case of accidents. Train workers at the location in the event of any spillage.	Weekly	Accident and corrective action recording	The number of leakage incidents recorded during the audit phase of the site Staff Training Documents on Preventive Procedures Leakage
		Soil erosion	Control soil surface erosion caused by runoff (rainwater) by collecting runoff from paved work areas into trenches and pits to aggregate /hold and restrict flow quantities.	Monitoring the Application of Sowell Conservation and Control Methods for Runoff	Weekly	Preparation of a report includes corrective actions.	Issuance of inspection reports
	The soil	Impact on the soil due to Possibility of leakage For chemicals and oils Stored.	1. Manage property in a good way in All times 2. Storage of fuel and oil in places Custom where the surfaces are Impervious to prevent fuel spillage and oils. 3. Spills reduction measures should be implemented (as needed) To contain and clean contaminated soil.	Monitor the project site to ensure that there is no soil damage inside and outside the project area	After the rain	-	Training Records Workers on Procedures Response from Spills
2.	**Wastes**	Improper management of hazardous and non-hazardous waste during the construction phase.	1. Provide garbage containers at the sites to prevent the dumping of waste in the project area and surrounding areas. 2. Waste should be collected at regular intervals and properly disposed of. Regular and periodic sanitation should focus on the collection and disposal of organic waste and water. 3. Waste management procedures are established on the site, including the separation and storage of different types of waste such as hazardous, non-hazardous, recyclable materials, building materials, plastics, paper, etc., to facilitate proper disposal of generated waste . 4. Provide storage space for dangerous materials . 5. A special label for hazardous materials should also be used to indicate what these substances are and their hazardous properties.	Verify site cleanliness and proper storage of hazardous waste and wastewater	Daily	Prepare a monthly waste report	Adhere to special waste management procedures
	management wastes	Wastewater flow from Wastewater	1. Building Small water treatment plant Sanitation and waste Liquid resulting from site activities toilets and drainage facilities Health during the operation phase 2. Follow Safe disposal process of units Damaged or broken by following	Wastewater quality monitoring and compliance	Permanently	-	-

	Plant Health and measures to deal with Photovoltaic Modules Damaged or broken	the best practices of those materials And coordination with the Ministry of Environment.	to Palestinian standards and repeated sampling of Incoming water and water outgoing and flowing from Treatment plant and continuous inspection of units Photovoltaic	

Table 3: Mitigating measures and environmental monitoring for Water Resources.

#	Item	Summary of potential impacts	Mitigating measures	Monitoring requirements	Frequency of monitoring	Necessary reports	Performance Indicators
1.	**Water sources**	Effects of torrential rains and floods	1. Installing padded cement sheets is a necessary first step in redirecting certain torrents. 2. It is advisable to establish distinct borders for the valley banks by lowering the ground level in the flood zone until the flood flows in a specific direction for maintenance purposes and to ensure that work can continue in all weather conditions . 3. Installing channels beneath the project's access road, in addition to the internal roadways, allows the water from the valleys to flow down them safely. 4. PVC pipes must be used at each matrix intersection with a road or channel to protect PV during the design and coordination of unit arrays.	Monitoring drainage characteristics during the rainy season	Daily (during precipitation)	Preparing accident reports in case of floods as a result of heavy rainfall.	No flooding occurs in Site
	Aesthetic effects	Construction-related aesthetic impacts include backfilling and excavations where building materials are deposited .	1. Ensure order, cleanliness, and management are usually present and consistent. 2. All inert and superfluous materials should be managed within the project boundaries , and solid waste disposal in neighboring areas should be avoided during the construction process.		Daily	Through the preparation of inspection reports	Cleanliness and arrangement of the site

Table 4: Mitigating measures and environmental monitoring for Bioecology.

#	Item	Summary of potential impacts	Mitigating measures	Monitoring requirements	Frequency of monitoring	Necessary reports	Performance Indicators
	Bioecology	Impact on existing birds In the region	1. Reduce the possible impact of movement Site workers and vehicles with Animals/birds, including On burrows / and nests. 2. Transportation of nests located on the site. 3. Storage of waste in location inside closed containers, Especially leftovers to avoid attracting Birds to the site 1. Removal of plantings by manual method	For visual control in a form Daily and direct within Project Area	weekly	-	No occurrence of any Harm to birds

1.	**Plant Environment**	Impact on existing vegetation in the region	2. Avoid removing existing plants unless it is absolutely essential. 3. Prevent the two-year-olds from chopping down nearby plants. 4. Stop others from using the nearby spaces for parking or maintenance.	Visual monitoring within the project area	During the entire construction phase	Prepare periodic reports on environmental performance, health and safety.	-
2.	**Wildlife**	Impact on existing fauna in the region	1. Prohibit employees from killing or hunting animals and from demolishing terrestrial bird nests in the project area and its surroundings . 2. Remove ground nests discovered on the property in collaboration with the Ministry of Environment. 3. Notify the Ministry of Environment of any instances in which an animal has been killed. 4. To avoid creating disruption, minimize construction during the night.	Coordination with the Ministry of Environment for the Protection of Nature when needed.	During the entire construction phase	Prepare periodic reports on environmental performance, health and safety.	-

Table 5: Mitigating measures and environmental monitoring for socio-economic situation.

#	Item	Summary of potential impacts	Mitigating measures	Monitoring requirements	Frequency of monitoring	Necessary reports	Performance Indicators
1.	**Traffic**	Increase or disability in Traffic to Project Location Due to Transportation of materials and equipment Through roads Surrounding	1. Follow traffic management procedures and ensure that all Trucks and vehicles used in the project area are Operated by experienced and licensed personnel. 2. Pedestrian safety: All vehicles must be compliant with Permissible speed limits. 3. Maintenance of vehicles and trucks periodically 4. All workers on site must adhere to the signs and the necessary procedures before performing any event. 5. Prevents the passage of vehicles in work areas and mobility areas Limited. 6. It is forbidden to carry out maintenance procedures for vehicles within an area Work. A specific area should be allocated for maintenance operations. 7. The number of signals used and the distances between them must comply with the approved laws and an environmental, health and safety performance assessment must be carried out prior to commencing any construction work.	Maintain continuous communication with the PV plant and monitor the movement of buses and trucks Heavy duty to and from the project site.	Significantl y Continued	Check all Accidents	Lack Complaints from Users Road in Area during Construction work Failure to happen Accidents
2.	**society Local**	Possible effects on Community in Region, Health & Safety and safety for the community Local	1. Develop a grievance mechanism and a plan to involve owners Relationship and stakeholders of the project before the construction phase 2. Conduct an appropriate assessment (preferably during the spring) to study The extent to which the land is used in the tilling season for the production of Feed the herds and identify the parties who carry out these Activities. It is also advisable to conduct this study before starting By the process of creation 3. Appointing a community communication officer responsible for everything related to Local community affairs. 4. Implement an effective security and protection system on site.	1) Preparation of control procedures for the identification of activities Consultation with stakeholders, concerned authorities and complaint records. 2) Ensure that the site	During phases Project	-	Comply with the guidance and requirements of the finance institution Implementation of the grievance mechanism and preparation of a plan to involve stakeholders and stakeholders the number of complaints and the time it took to resolve the

				Appropriately protected And that access to Website Monitor and organized through all Project phases.			complaint.
3.	**Working Environment**	Workers and conditions Work	1. Take the necessary steps to ensure that and the application of both local laws related to the work environment Workers' and Employees' Rights and Public Health and Safety. 2. Follow up on employee complaints. 3. Providing a safe and healthy work environment For employees that are in line with relevant international applications With regard to occupational health and safety and to be in line with the same Time with contractor policies followed on site during Construction Phase. 4. Under no circumstances may any person be employed who has not Completes the minimum age for employment specified by the laws Local. Children under 18 years of age may not Employing them in hazardous work. 5. Ensure that all employees apply to work with all their will without any coercion.	Make sure all Systems until Ensure that standards are followed Work, health and Safety.	regularly during phases Project	-	Follow the standards Finance Corporation International & Application Management System Complaints.
	Effects Aesthetic And optical	Possible effects following Bright lighting due to PV Panels	1. Technology used on panels PV reduces Reflection to a large extent and therefore Reduce the likelihood of lighting Bright and due to the coating Special anti-reflective coating	-	-	-	-
4.	**Archaeological sites and cultural heritage**	Possible concerns of influence on sites Archaeological remaining non Visible and invisible and unknown (Possibility of finding on it)	2. Commitment to the space allocated for the project and not to exceed it. 3. Compliance with the protocol followed by the Department of Antiquities : a. All construction must be halted if Any archaeological sites during the construction phase b. The Department of Antiquities evaluates the resources that have been found It may carry out an emergency clearance operation (archaeological excavation During the construction phase, which is followed only when finding Archaeological Resources) c. The additional time resulting from the archaeological excavation process is not considered a permit to destroy the site or the materials found. Each site must be given sufficient time and care before any Intervention. d. Resumption of work after consultation with experts in science Antiquities from the Department of Antiquities and with official authorities and the application of mitigating measures Occasion according to the law e. In case of discovering cultural heritage sites or archaeological resources During the construction of the project with a possibility of damage, it The location where the resource is found must be fenced off Immediately and inform the Department of Antiquities and invite them to submit Consultation and an agreement with the department to reduce the	Site Inspection Time One minimum dimension Discover any locations Archaeological Remains Inform the employees of the Location with procedures Sudden finding On the effects in case of Discovery of traces or Cultural Resources in Project Distances	Site Inspection One time After finding On any website Archaeological or site Cultural heritage	Prepare a report to Department of Antiquities Public in case Find any Resources /Locations Archaeological	-

damage to The maximum.

Table 6: Mitigating measures and environmental monitoring for Archaeological sites and cultural heritage.

#	Item	Summary of potential impacts	Mitigating measures	Monitoring requirements	Frequency of monitoring	Necessary reports	Performance Indicators
1	**Dangers On health and safety Due to construction work**	Exposure to potential risks to public safety during the construction phase such as: slippage tripping, work at heights, fire resulting from works Hot or smoking or Electrical seam, hazard output from machinery, heavy vehicles, shocks Electrical	1. Comply with environmental, health and safety policies and procedures at the site. 2. Appointment of personnel responsible for health and safety procedures at the site. 3. Training the workers on site as necessary before starting their work. 4. An assessment of the expected risks must be prepared before commencing the business And communicate with all relevant people for all Types of works on site. 5. Provide dedicated corridors in the business area and put Specific signals and ensure adequate lighting in these areas. 6. Reduce the use of extended cables at work sites, ensure that cables are located within specific paths 7. Ensure that all electrical equipment is usable and in good condition, it is not permissible to carry out work on electrical systems and the electricity is connected.	1) Visual inspection before starting any activity. 2) Ensure that proper measures are practiced at the project site 3) Periodic inspection and inspection of facilities Project. 4) Routine periodic inspection of used equipment and tools 5) Response Trainings In the event of Fire 6) Monitor work areas To identify risks Expected fire	1) Before starting any activity 2)Continuously 3) monthly 4) Before working in elevated locations 5) Every six months 6) form Continued Based on Evaluation Process Risks from conflagration	Prepare a monthly health and safety report	1) Documenting the reports of accidents or injuries of workers on-site and verified including Complies with safety measures 2) Calculation of Frequency Rate of Lost Time Fatal Accident Rate
2	**Health and safety**	Exposure to health risks during the construction phase, such as: musculoskeletal disorders, Vibrations, temporary or permanent hearing loss, heat stress, dermatitis	1. Training staff on environmental, health and safety policies and procedures on site 2. Reduce work requiring handling and manual load as much as possible, and provide mechanical levers to reduce it 3. Ensure that all equipment used in construction work Suitable in terms of size, weight, plus costs Vibrations resulting from it. 4. Ensure that all equipment is inspected and maintained as per requirements Manufacturer. 5. Conduct noise assessment periodically in work areas that make noise and take appropriate preventive measures depending on Therefore. 6. All possible preventive and mitigating measures must be taken To reduce noise from equipment such as concealed covers For noise, noise reducers.... Etcetera. 7. Provide appropriate noise protection equipment for workers in Areas with high noise. 8. Holding awareness and training courses for workers about diseases and the expected effects of work in conditions and degrees High heat during the construction phase. 9. Ensure that sufficient quantities of drinking water are	1) Monitoring the health of workers 2) Monitor work areas To identify risks Expected noise 3) Periodic examination Hearing protection Preventive 4) Fitness tests 5) Maintenance of protective equipment Hearing	1) Continuously 2) monthly 3) Before use 4) Before Employment 5) monthly	Preparation of a report Shahry Health & Safety	1) Injuries to workers؛On-site and verified including Corresponds Procedures Safety 2) Calculate the frequency of the wasted time rate Fatal accident rate and treatment cases Medical and the number of absences from work 3)Recording Hours Training in Health Safety & Environment Number of events Non-conforming Procedures Health & Safety

			available at the site Work during the construction phase 10. Giving training to all at-risk workers in Binah Work out how to protect themselves and make sure there is oversight Effective to ensure the use of the correct methods of prevention. 11. Provide appropriate PPE and ensure adequate laundry and changing facilities. 12. Organizing work during the period of high temperatures, taking into account taking breaks during the implementation of the works and providing umbrellas in different locations at the work site				
3	**Health and safety**	Exposure to potential risks on public safety during Operation phase as: Slipping, tripping and working At altitudes, fire	1. Follow health and safety procedures public during the project work phase. 2. Provide dedicated corridors in an area Business and specific signaling And make sure there is adequate lighting in these Areas. 3. Ensure that all business areas And the storage areas are neat and there is no Obstacles, regulation of the arrival of shipments Materials for the site to reduce the material Accumulated 4. Ensure that areas are marked Slippery and provide suitable shoes For slippery areas. 5. Reduce work that requires work at heights as much as possible 6. Avoid having high distances in Elevated work areas from During the placement of protection nets, And the presence of appropriate scaffolding 7. Conduct a fire risk assessment in Construction areas, sourcing Fuel, ignition and making sure to save Prevention and fire fighting precautions In addition to defining paths Escape 8. Setting an on-site alarm system to alert On-site workers 9. Placing fire extinguishers in areas Specified to be extinguishers Suitable for the nature of the expected fire in Each region 10. Develop a response plan in advance Expected emergencies in Work area, with identification of people Authorized to deal in cases Emergencies, and the procedures that must be Follow it and the method of evacuation 11. Provide a number of qualified persons To do first aid 12. Providing equipment and supplies First aid at the workplace, As bandages, antiseptics, And anti-inflammatories... Etcetera 13. Develop a response plan in cases of On-site emergencies and training	1) For routine periodic inspection For equipment and tools used to work on Altitude. 2) Make sure housekeeping and the ranking in the site Project. 3) Periodic inspection and inspection for project facilities. 4) Monitoring work areas To determine fire hazards Expected. 5) Response drills in In the event of a fire. 6) Periodic inspection and maintenance For fire extinguishers, testing Detection System fires, and other Fire fighting equipment.	1) Before starting work 2)Continuously 3) Monthly 4) Based on fire risk assessment 5) Every six months 6) Monthly	Cooking Report Periodic	Documentation of Maalat accidents or Injuries to workers On-site and verified including Corresponds Safety measures and occupational health and repeat calculation Average time Lost Training Records Workers on matters related to Health & Safety Professional Number of events Non-conforming Health procedures and safety

of this project and the project activities that may have an impact on the future served as the basis for the definition of the environmental, economic, and social aspects adopted for the EIA study.

1. Project documentation and related studies.
2. Consultation with the project owner (company).
3. Consultation with the Ministry of Environment during the consultation session and the stage of preparing the reference bases, in addition to the relevant stakeholders during the preparation phase of the EIA Study.

The physical environment, biological environment, economic and social environment, and public and occupational health and safety are among the environmental and social receptors that have been recognised as being relevant to this project. Furthermore, the relationship between environmental factors and receptors that the project may impact during its creation, commissioning, removal, and decommissioning phases has been established.

Results and analysis

The PV plant initiative in the Jericho gate region is a long-term investment developed in compliance with international standards. This project aims to provide a sustainable and clean source of electrical energy while complying with local laws and regulations, and international best practices. The design was established through an agreement among all stakeholders, considering the possible social and environmental effects. It is anticipated that the project will run for about 20 years, with the possibility for renewal. Studies indicate no significant impacts anticipated during the project's removal and completion phases, since every part will be decommissioned and recycled in an eco-friendly way. The evaluation of alternatives suggests that establishing a PV power facility in the Jericho gate area is the best option compared to not implementing any project at all. The PV plant offers a renewable, environmentally beneficial energy source and diminishes harmful emissions compared to traditional power stations. After evaluating several technologies, it was determined that a solar panel tracking system is the most efficient and appropriate for the project's location and features. The site was selected based on several criteria, primarily its closeness to the electricity grid, land ownership and usage, and proximity to residential areas.

Carrying out a cumulative impact assessment study is considered good practice within the procedure of recognizing risks and possible impacts. Cumulative effects denote the outcomes that can result from the build-up of comparable projects in a specific region over time, such as influences on biodiversity, which may result in the separation of natural habitats and potentially harm local plants and animals. Moreover, the region's air quality may deteriorate as a result of the dust and noise emissions from accumulating solar projects.. The effect on water resources, due to higher water usage, may result in a lack of water in the location. The effect on land use, due to alterations in land utilization, could influence agriculture, tourism, and other pursuits, thereby affecting the local community and heightening the strain on local infrastructure and resources. Developers are required to:

1. Gather information on all solar energy initiatives in the location, encompassing their location, scale, and environmental and social effects.
2. Utilize predictive models to examine the possible cumulative impacts of projects over an extended period.
3. Formulate strategies to reduce these cumulative impacts, including utilizing sustainable solar energy solutions and optimizing water usage.
4. Engage the local community in evaluating cumulative effects and creating mitigation strategies. By thoroughly evaluating these cumulative impacts, developers can create an environmentally responsible and sustainable PV power initiative in the Jericho Gate region.

Large-scale solar plant development and associated infrastructure usually require flattening vast areas and removing vegetation. This may result in habitat destruction, deterioration, and fragmentation, displacing animal populations and decreasing species diversity and abundance. Due to changes in the microclimates of the soil and air, the shadow impacts of solar panels can alter the variety and composition of species in the habitats below. The impacts on biodiversity can be advantageous in some circumstances and vary depending on geographic location. Regarding bird diversity and abundance, solar farms noticeably perform better than other types of power plants. Nevertheless, the increased bird population around PV power plants results to issues with panel contamination due to bird feces. Additionally, large numbers of brown hares have been observed in solar farms at various sites. Throughout the operation of PV power plants, vegetation on the project site is significantly diminished or transformed.

Solar farms typically need some type of vegetation control under, as well as in the gaps between solar panels and behind roads and power lines. Undesired vegetation is occasionally controlled with herbicides, or the ground is coated with gravel. In certain instances, a particular kind of plant cover is grown, yet it is frequently trimmed to keep it at a low height. In summary, solar farms can lead to a rise in the variety and populations of broadleaf plants, grasses, butterflies, bumblebees, and birds. The extent of biodiversity advantages significantly relies on how the area is managed. Areas crucial for wildlife can be sown with various seed blends after construction to reduce the use of herbicides. Creating high-quality marginal wildlife habitat and utilizing a conservation grazing or mowing approach will produce positive outcomes.

During constructing a PV power station, noise pollution is one environmental issue that must be taken into account. A solar facility must be designed and managed in compliance with local and national noise regulations, similar to any other industrial or energy-generating establishment. Nevertheless, a PV system can produce noise while it is being constructed, operated, and maintained. The main sources of noise are transformers, inverters, cooling fans, and trackers. The nature, dimensions, and position of the PV system all affect the occurrence and severity of noise. A possible concern with the electronics in solar systems is electrical interference. All digital electronics, such as those used in photovoltaic systems, generate a certain amount of noise. Charge controllers and various inverters, particularly modified sine wave inverters, are the primary sources of issues. Techniques such as shielding, noise cancellation, filtering, and suppression can be used to reduce the noise produced by inverters. Metal casings are used for inverters and various electronic devices. A widely recognized and efficient wiring

technique is shielded twisted pairs. Filtering is a typical characteristic of almost all electronic devices.

Transformers are employed by the solar system to increase the voltage for more efficient transmission to the nearby power grid. The transformer has three sources of noise: the fan, coil, and core. The electromagnetic forces that arise twice in every AC cycle produce the noise from the coil and core. As a result, 100 Hz is established as the main source of noise. While silent transformers and inverters are on the market, builders of solar systems typically overlook this feature because of their expensive price. Consequently, noise barriers might serve as a potential solution for reducing noise. In many instances, a forced ventilation system (fan) is required due to the heat generated by transformers and inverters. A benefit of solar panels is that they primarily function during daylight hours, when noise levels are generally more tolerable.

PV systems, similar to numerous other long-lasting products, can last for many years, particularly with proper maintenance. PV modules can sometimes be revitalized or repurposed to serve as energy generators, gaining a "second life" after approximately 30 years of operation. All PV systems, nonetheless, will ultimately arrive at the conclusion of their effective lifespan. Although installation mistakes and weather damage are the primary reasons for end-of-life problems, certain customers and system operators want to upgrade their panels prior to the warranty expiring or to leverage advancements in technology. Disposing of PV modules in landfills can take up significant space and limit its availability for alternative uses. Disposing of materials in landfills can lead to soil pollution and the leaching of harmful substances from photovoltaic materials, such as lead, selenium, and cadmium. Recycling aids in minimizing land use impact by reclaiming valuable resources and decreasing the necessity to extract raw materials. Washing, rinsing, and sorting of materials could demand considerable water usage for recycling photovoltaic modules. Especially in regions with scarce water resources, water consumption can influence both the amount and the quality of accessible water supplies. Employing effective water technologies, closed-loop systems, and alternative solvents can all contribute to minimizing water usage.

Given that solar energy is viewed as a sustainable and eco-friendly energy source, the examination of available alternatives indicated that constructing a PV plant in the Jericho Gate area is the most favourable option compared to foregoing all development projects. In comparison to conventional power plants, the PV plant produces reduced harmful emissions. After reviewing the different technologies of the project, it was concluded that the solar panel tracking system was the most efficient. The site for the project was chosen according to various criteria, with the most important being its closeness to residential neighbourhoods, ownership of the land, the electrical infrastructure, and the present use of the site. Overall, building a PV facility in this area is a sustainable, eco-friendly, and economical choice that aligns with global environmental standards.

Conclusion

An extensive analysis was carried out to evaluate the ecological effects of the solar power plant initiative at the location. The research recognized the possible effects of the project on both the environment and the local community and formulated strategies to reduce these effects. The major effects encompassed those on biodiversity, recognizing various endangered species of plants and animals in the area; effects on air quality, since the project results in heightened dust and noise emissions; and effects on water resources, as a volume of water will be consumed throughout the construction and operational phases. Many measures were proposed, such as:

1. Conducting comprehensive surveys to identify all living organisms in the location.
2. Toxic materials (heavy metals) are also utilized in manufacturing components for PV systems. They only present a major environmental issue if the modules are not recycled after the PV plant's lifespan but disposed of in landfills, which can consequently result in a significant soil and drinking water pollution.
3. Water usage throughout the life cycle of a PV power plant is minimal and does not pose a major issue; the same is true for noise emissions
4. The use of environmentally friendly construction technologies.
5. Installation of air quality control systems.
6. Rationalization of water consumption.

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