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ARTICLE

Using Renewable Energy to Reduce Production Costs and Achieve Environmental Sustainability: An Applied Study

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Abstract

Purpose

This paper aims to investigate the impacts of solar energy exploitation on reducing production costs and enhancing environmental sustainability, particularly in the context of industrial power generation and energy consumption.

Design/methodology/approach

The study employs a qualitative analytical approach based on a review and synthesis of existing studies and conceptual analysis related to solar energy utilization, production costs, fossil fuel dependency, and environmental performance in industrial activities.

Findings

The analysis reveals that solar energy represents an important modern technology capable of significantly reducing production costs while decreasing reliance on fossil fuels for power generation. The continued expansion of industrial activities has contributed to high levels of pollutant emissions; however, the adoption of solar energy can mitigate these effects by lowering carbon emissions and limiting the use of fuel-driven mechanical propulsion systems. Furthermore, solar energy contributes to resource conservation, cost savings, and improved environmental performance.

Originality/value

This paper highlights the dual economic and environmental benefits of solar energy exploitation by linking cost efficiency with sustainability outcomes. It reinforces the strategic importance of solar energy as a viable solution for industries seeking to achieve long-term cost reductions while addressing environmental challenges associated with fossil fuel dependence.

Keywords: Renewable energy (solar), reducing production costs, environmental sustainability

Introduction

The continually growing environmental challenges that have been facing the global community since the end of the twentieth century have made the need to move towards a high-end manufacturing technology an urgent need. The use of these technologies, however, clean energy production, especially solar power is the most relevant among them and should be implemented in the factory being studied. This effort aims at reducing the costs of electricity production and environmental pollution as a result of using fossil fuels and lead to the overall cost of production is minimized. In turn, the relevance of this question is explained by the need to understand the impact of the deployment of solar energy on achieving environmental sustainability and reducing the expenditures in the facility under study.

Methodology

First: The Research Problem

The Iraqi production units, especially the Iraqi Leather Production Company, still rely on the traditional non-renewable electricity production technologies, despite the rapid industrial development in power generation. This reliance increases electricity and fuel bill payments leading to aquatic and atmospheric pollution, resource loss by emissions and wastewater and finally, the cost of production is increased. Practically, economic activities in the country of Iraq rarely focus on environmental issues or preservation of natural resources. The research problem is therefore formulated based on the main question which is the following: does the implementation of renewable energy and, more specifically, solar power, make the cost of production reduce and, at the same time, promote the sustainability of the environment?

Second: Research Objectives

The main goal of conducting this research is to examine how renewable energy can help in lowering the cost of production and sustaining the environment by ：

1. Determine the knowledge base of renewable energy and estimate the contribution of this to cost reduction and environmental sustainability .
2. Examine the deficiencies of conventional energy production system (fossil fuels) in the General Company of Leather Industries.

Third: The Importance of the Research

The practical implications of this study consist of the fact that implementation of renewable solar energy in the General Company of Leather Industries will lead to the reduction of production cost and pollution of the environment, hence the promotion of environmental sustainability .

Fourth: The Research Hypothesis

The current study has been based on the following broad hypothesis: (The use of renewable energy leads to the decreased costs of production and a decrease in pollution due to emissions; hence the environmental sustainability is attained)

The Theoretical Framework of Renewable Energy and Its Role in Reducing Production Costs and Achieving Environmental Sustainability

Renewable Energy

First: The Concept and Definition of Renewable Energy

The use of renewable energy especially the focused solar energy has received global interest as an imperative strategic solution to meet the future energy needs in both the domestic and the international scale. The relationship between the effectiveness of the development initiatives and the availability of energy is clear, and energy provision is

their major determinant. This dependence has advanced in the view of the growing exhaustion of the conventional energy resources, which is estimated to be depleted within the next three decades.

Moreover, there is a secondary problem that is posed by the contribution of traditional energy sources to the increase of pollution rates in the world, particularly, in highly populated metropolitan regions, which constitute the peak energy expenditure. Renewable energy is most often perceived as energy that can be obtained by the means of naturally replenishing, inexhaustible sources. Its notable features are that it is very sustainable, and its environmental impact is relatively smaller than that of traditional energy sources [1]. It is also defined as energy based on the perpetually renewable inputs that are not connected to the use of fossil fuel [2]. Based on this definition, researchers define renewable energy as the electricity produced by using ever-renewing natural resources, e.g. solar radiation, wind, water, and biomass, and consider it an ecologically neutral substitution to energy based on fossil fuels, which produces harmful pollutants that lead to the ecological degradation.

Renewable Energy Sources

Renewable energy is of numerous types. The most crucial ones will be discussed below [2],[3], [4].

1. Wind Energy: This energy is produced through wind turbines which make the wind kinetic energy of the atmosphere to electrical energy. It is believed to be one of the most effective renewable sources and the cost of the production of it is relatively low.

2. Hydropower: It is a type of energy produced using the kinetic and potential energy of flowing water in a dam or river system and it forms a huge part of the renewable energy mix.

3. Biomass Energy: This is a renewable energy source that is derived as by-products of agricultural products and other organic substances. It plays an important role in the rural redevelopment and it is usually used to heat and cook [5]

4. Solar Energy: Solar energy is one of the widely used renewable energies especially in areas with high levels of solar irradiance whereby the solar radiations are captured through photovoltaic panels and converted into electrical power. It is also typified by a minimal environmental impact since it does not discharge harmful gases or pollutant. Our research sample will use this technology because the Middle East is a region with constant abundance of the sun during the year.

Third: Characteristics of Renewable Energy

Renewable energy has numerous features and benefits, the most prominent ones being [6]:

1. Inexhaustible Source: This is a resource which tends to regenerate every time it is used, unlike fossil fuels like oil, coal or natural gas.

2. 2 -Less Economic Costs: Despite the fact that the initial process of installing renewable-energy sources, e.g.: photovoltaic panel and wind turbines, involve considerable investment cost, operational and maintenance expenses are relatively cheap. In addition, clean energy helps to curb the increasing reliance on pollutant fossil fuels hence reducing energy spending in the long-run.

3. Low Emissions: Greenhouse gasses are not produced in the course of operation and consequently renewable energy does not contribute to global warming.

Environmental Sustainability

First: Definition of Environmental Sustainability

Environmental sustainability is the ability to protect the natural environment and natural resources of the current and future generations through the responsible use of resources and reduction of negative environmental effects .

Second: Environmental Sustainability Objectives .

1. Protect the environment: Ecosystems and biodiversity .
2. Sustainable Resource Use: The sustainable and responsible use of the natural resources .
3. Pollution Reduction: The minimization of the negative emissions and environmental pollutants .
4. Quality of Life Improvement: The process of increasing the quality of life of people and communities by means of providing healthy and safe environment .

Third: The Significance of Environmental Sustainabiliy [7], [8]

1. Protection of Natural Resources: The preservation of the natural resources to be used by the future generations .
2. Protecting Public health: The health of the people by reducing pollution and air and water quality .
3. Economic Development: The promotion of Economic development through the sustainable use of resources .
4. Biodiversity preservation: Biodiversity conservation and ecosystem preservation .
5. Managing the Erosion of the Ozone Layer: The reduction of climate change through limitation of harmful emissions .

Sustainability of the environment is key to providing a greater future to the future generations, as well as the preservation of the natural environment, and the natural resources [9], [10].

Results and Discussion

Section One: The Research Sample

An Overview of the General Company for Textile and Leather Industries

Ministry of Industry and Minerals absorbed a number of public enterprises in 2015, thus, forming the General Company for Textile and Leather Industries. This merger was done in line with Cabinet Resolution No. 360 of 2015, requiring the merging of the following organizations under the auspices of the ministry: the General Company for Cotton Industries, the General Company for Hand-woven Carpets, the General Company for Textile Industries, the General Company for Leather Industries, the General Company for Ready-Made Garments, the General Company for Wool Industries, the Wasit General Company for Textile Industries, and the Dhi Qar Textile Factory [11], [12]. The resultant organization, which is also called the General Company of Textile and Leather Industries, has a registered capital of 13,369,027, 346 Iraqi dinars (thirteen billion, three hundred, and sixty-nine million, twenty-seven thousand, three hundred and forty-six dinars). (Iraqi Gazette, 4447, 2017)

These are several manufacturing plants that constitute the corporation as listed

below:

1. Leather Factory, Baghdad: It is a plant with several active works of production, which are:

Leather Factory

Men's Shoe Factory Sports Shoe Factory in Kufa Tanning Workshop

Men's Shoes Sports Shoes Fully Tanned Leather

Military Shoes Military Products Leather Jackets

Occupational Safety Shoes
School and Travel Bags
Leather Shoe Soles

2. Cotton Factory
3. Wool Factory
4. Handwoven Carpet Factory
5. Hilla Textile Factory
6. Wasit Textile and Knitting Factory
7. Ready-Made Garments Factory – Mosul
8. Dhi Qar Textile Factory

The researcher in the study chose workshop number 8 as the sample in the study of the Leather Factory due to the following reasons[13], [14], [15]

1. The factory is also very large compared to the factories of other companies and it manufactures a large variety of products .
2. The factory has received the Iraqi Quality Certificate hence addressing the ISO 9001 requirements .
3. Most of the product constituents are produced in-house and in this case, the researcher can follow the production process .
4. The products are not cheap and this is mainly because the cost of production is high and much of this cost is expended on electricity costs .
5. The factory cooperated with the researcher in the abilities to deliver the required data, which was suitable and well-organized .

Part Two: Solar Energy as A Cost-reduction and Environmentally-sustainable Process .

The electricity bills of the research sample laboratory will be calculated and the amount of electrical power that will be needed to go (in amperes) will be found in this section. This computation will make it possible to evaluate the expenses of the system of the installation of solar energy to operate the laboratory in comparison with the use of national electricity grid or generators. It will also prove the reduction in the cost of generating electricity using solar energy and how this use has affected the sustainability of the environment .

First: The determination of the electricity cost of Plant No. 8 in 2022 as represented in the table below:

Table 1. Electricity Costs for Plant No. 8 for 2022 (Amounts in Iraqi Dinars)

No.	Type of Cost	Amount
1	National Electricity Cost	49,320,000
2	Fuel Cost for Operating the Plant's Generator	6,500,000
3	Cost of Oils Used for the Plant's Generator	1,350,000

4	Cost of Maintenance of the Plant's Generator	1,870,000
5	Wages of the Plant's Generator Operators (2 workers at a monthly salary of 450,000 for 12 months)	10,800,000
	Total Costs	69,840,000

Source: Company Cost Records

We note that the electricity costs for Plant No. 8 in 2022 amounted to sixty-nine million eight hundred and forty thousand Iraqi dinars. This is a very high amount for a single plant and leads to increased production costs and, consequently, a higher product price.

Secondly: Calculating the amount of electrical energy required to operate Plant No. 8.

We will divide the plant into activities and then calculate the electrical energy required to operate each activity to determine the size of the solar energy system needed to operate the plant and, therefore, the cost of the solar energy system, as shown in the following table:

Table 2. Amount of Electrical Energy Required to Operate Plant No. 8 (in Amps)

No.	**Activity**	**Electrical Energy (in Amps)**
1	Transferring raw materials to the production line (raw material elevator)	30
2	Cutting (machine)	15
3	Sewing (10 machines)	25
4	Traction (machine)	30
5	Dyeing (dye vapor extractors)	10
6	Transferring finished goods to the warehouse (finished goods elevator) 30	
	Total	140

Source: Prepared by the researcher.

We note from the previous table that the amount of electrical energy required to operate Plant 8 is 140 Amps. In light of this, we will be able to calculate the required size of the solar energy system and determine its cost in the following section.

Third: Design and Cost Calculation of the Solar Energy System Required to Operate Plant No. 8

In the analysis of the electrical energy requirement of the plant in the previous section, the solar generation system is suggested as the alternative to the traditional sources of energy. The system consists of a number of components, and each of them is explained below depending on the visits of the researcher to special manufacturers: (Prepared by the researcher after visiting special companies)

1. Solar panels (Solar Modules): These panels convert the incident solar radiation

to electrical energy that is also provided with a 15-year warranty. Each of these modules can provide about 2A at the nominal operating point hence to deliver the desired 140A required by the plant 70 modules are required. A single Longi module costs the market at US 250.

2. Mounting Structure: The mounting system attaches the panels on to the roof. The size of the panel is usually 2m long and 1m wide. The researcher concluded that the 30 20 m area on the roof of the laboratory gives 600 m 2 of usable space, unlike the 150 m 2 required in the project. The mounting system will cost 35 US per square meter.
3. Power Inverter: It is an inverter that converts a direct current (DC) produced by the panels into an alternating current (AC). There are 2 inverters of 16,000 W with the ability to work with 71 A of inputs. Each inverter is priced at US, 4,000 dollars with a five years warranty.
4. Wiring and Circuit Breakers: The interconnection between the panels and inverters to the distribution board of the plant is done by special wiring and circuit breakers. DC conductors are used between the panels to the inverter, the AC conductors are used between the inverter and breakers which serves the plant distribution panel. The entire price of the wiring and circuit protection parts amounts to US $ 2,000. Battery storage will not be provided, since the plant will be likely turned off at 2:00 p.m., long before the sun goes down, and therefore power will not have to be produced at night.

The cost of the solar energy system for the factory can be calculated in the following table:

Table 3. Calculating the Cost of a Solar Energy System for Plant No. 8

No.	Part	Details	Cost
1	Solar Panels	The plant needs 70 panels, price per panel $250	Total $17,500
2	Installation Structure Total	Structure area 150 square meters, price per square meter $35	$5,250
3	Inverters	The plant needs 2 inverters, price per panel $4,000	Total $8,000
4	Wires and Circuit Breakers	The plant needs wires of different gauges and circuit breakers of different sizes, costing $2,000	Total $2,000
5		Total	$32,750

Source: Prepared by the researcher based on visits to companies specializing in solar energy

The tabular data shows that the capital investment that will be needed to install a solar photovoltaic system in the Plant No. 8, adequate to meet its electricity demand, and eliminate reliance on standard generation sources, will be US32750 that is equivalent to 43230,000 Iraqi dinars. The cost of infrastructure per annum is 4,323,000 Iraqi dinars in the first year of operation since it is expected to last ten years. Contrarily, the current facility spends around 69,840,000 Iraqi dinars annually on electrical supply. In turn, the installation of the solar system would save up an annual 65,517,000 Iraqi dinars, which will make a significant difference in the cost of production in Plant No. 8.

The same tabular data confirms that the expenditure of installing a solar powered set of Plant No. 8 that would supply the plant with electricity and save it the burden of depending on traditional energy sources will amount to US 32750 or 43 230000 Iraqi

dinars. Fourth: Solar Energy to achieve Environmental Sustainability in laboratory No. 8.

The use of solar energy in producing electricity within Laboratory No. 8 can go a long way in promoting environmental sustainability due to the following reasons;

1. Cutting of Damaging Gases: The production of solar energy produces no greenhouse gas like carbon dioxide or microscopic dusts, which are the characteristics of fossil-based generators currently used to provide electricity to the lab. This does away with one major contributor to air contamination and enhances quality of air in the atmosphere.
2. Renewable Energy Source: Solar energy is by nature renewable, and with regard to fossil fuels, it does not experience a certain exhaustion. Therefore, its use alleviates the usage of the available natural resources that are currently used to energize the generators of the laboratory.
3. Noise Minimization: Photovoltaic panels have no noises unlike the electrically powered generators and hence lower noise pollution will be generated in the operational environment.
4. Long-term Sustainability Photovoltaic panels are normally serviced with a range of about 25 years and this means that there will be a long duration of time when clean energy will be provided to the plant.

These points indicate that the implementation of solar energy in the production and generation of electricity at the Plant No. 8 does not only help in reducing operating costs, but also helps in the realization of environmental sustainability across the board, which in turn supports the hypothesis of the study.

Conclusions

1. The use of solar panels is one of the modern technologies of electricity production, which the majority of nation-states support as a measure to reduce pollution caused by different industrial activities. They provide clean, sustainable, and in fact free electricity, thus reducing production costs.
2. The application of solar energy in power generation reduces the cost of production in the sample observed in the study as it replaces traditional energy sources based on fossil fuels, thus limiting environmental pollution caused by emissions of energy plants powered by electricity.
3. The use of clean energy such as solar energy cut the amount of electricity produced per year by 69,840,000 to 4,323,000 hence decreasing the total cost of production.

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