

Statement on the Effectiveness of Using Solar Energy to Manage the Electricity Crisis to Achieve Sustainable Development : A Descriptive and Analytical Study of the Opinions of a Sample of Citizens in Baghdad Governorate

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ABSTRACT

The research aims to demonstrate the effectiveness of using alternative energy, represented by solar energy, to control the power outage crisis in Iraq, get rid of environmental pollutants, and reduce the costs spent on subscribing to fossil fuel-powered generators, which contributes to achieving sustainable development goals. The sample of the study was to compare the costs of equipping continuous hours of operation by the MTS company specialized in installing and equipping solar panels, and the cost of equipping private generators for electrical energy with the same number of amps and time, and showing the extent of their effectiveness for citizens. And it has The two researchers concluded that resorting to clean energy sources contributes to getting rid of the negative effects on the environment through the harmful waste of generators that operate on fossil fuels. They also compare the cost spent on subscribing to these generators with the cost of purchasing and installing solar panels and to control crises related to energy provision. Its impact on society and the economy alike. One of the most prominent recommendations reached by the two researchers was the necessity of using solar energy to obtain electrical energy and eliminating the costs spent on electricity supplied by diesel or gasoline generators, as it has a significant impact on maintaining public safety and achieving sustainable development.

INTRODUCTION

Metaverse technology has emerged rapidly with technological advancements in the digital age. Issues such as virtual environments, digital twins, and cybersecurity have become realities in the fields of financial reporting, accounting, and auditing. Through metaverse technology, it has become necessary to reimagine the way data is accessed and managed, thus assisting in better decision-making. Sunder believes that accounting is a product of human imagination, adding that if imagination is the source of discipline in accounting and all human progress, it may be necessary to examine the current and future state of imagination in the accounting profession. It raises a thought-provoking question: "Why don't we imagine alternative scenarios instead of simply waiting for changes to occur or having them imposed upon us?" The virtual world is a catalyst for change for industries and economies that need to rethink their physical presence in the market. It helps maintain the accounting profession's sustainability (Hussainey & Alsartawi, 206: 2024). This requires maintaining the sustainability of the accounting profession in light of industrial revolutions and the risks they pose, seizing opportunities to confront technological challenges and keep pace with dynamic changes by employing metaverse technology in the field of accounting as a mechanism to support continuous accounting in obtaining reliable outputs that can be relied upon for decision-making. This enables it to add value and create a competitive position in the digital economy market. Research Methodology and Previous Studies

LITERATURE REVIEW

Previous Studies: This research reviews some local and international studies relevant to the current study, then explains what distinguishes the current study from previous studies, as follows:

- 1- Study (Yassin, 2023): The study aims to identify the various types of renewable energy sources in Iraq and how to invest them in various sectors to achieve sustainable development. One of the most prominent findings of the research is the availability of various types of energy sources in Iraq, including solar, hydroelectric, and wind, which can be used to mitigate the sources of pollution resulting from the increasing demand for electricity.
- 2- Study (Estebanian, 2020): This study aims to clarify solar energy policy in Iraq and the obstacles preventing the development of a renewable energy system in light of the multiple turmoil facing the country. One of the most prominent findings of the study is that the use of solar energy to generate electricity contributes to reducing the burden on major power stations, achieving decentralization, creating job opportunities, and reducing electricity bills in the long term.
- 3- Study (Abu Ratima, 2020): This study aimed to identify the types of solar energy systems for homes and their most prominent advantages and disadvantages. The most prominent findings of the study were that the use of solar energy contributes to eliminating global warming and climate change, which threaten the planet. Solar panels are safer than power station poles when exposed to collapse during natural disasters.
- 4- Study (Al-

Hawamdeh, 2003): This study aims to analyze the axes of the crisis, its causes, and the effects it leaves behind in the Hashemite Kingdom of Jordan. Among the most prominent findings of the study is that crises mature as a result of existing seeds for their emergence and accumulation from various legislative, financial, and administrative dimensions. Developing solutions is essential to addressing the crisis, and they must be comprehensive and integrated to avoid its recurrence and future exacerbation.

The most important distinction of the current study from previous studies:

This study complements previous studies by demonstrating how to harness solar energy to generate electricity and comparing the cost of obtaining it with the cost of obtaining electricity using traditional systems to achieve clean energy sustainability and reduce the costs of environmental and material damage to citizens.

Theoretical Aspect

Introduction

Solar energy represents an important source of alternative energy, particularly in Asia in general and in Iraq in particular, due to its importance in addressing the political and economic conditions surrounding the entire world, particularly in relation to fossil fuels and global prices, in addition to the increasing pollution of the Earth's environment caused by the proliferation and waste of traditional energy sources. It is necessary to turn to other natural sources that do not cause this pollution and achieve independence in energy production to manage the surrounding crises, whether political, economic, or social, and to protect the environment from pollution and strive to achieve sustainable development in the field of clean energy. To this end, this research has been divided into four axes. The first axis addresses solar energy as an alternative energy source in terms of concept and types. The second axis presents the concept of crisis management and its dimensions. The third section reviews the concepts of cost reduction and sustainable development in terms of concept and dimensions. The fourth axis compares the replacement of traditional energy for electricity production with solar energy in terms of its long-term cost reduction and the achievement of sustainable development in its various dimensions. Solar Energy as an Alternative Source of Electricity (Concept, Types)

1. The Concept of Solar Energy

Addressing the topic of alternative energy represents a vital topic due to the recent rapid market growth. The need for energy sustainability has become urgent and necessary in light of the increasing demand for electricity. Clean energy specialists have found that hydrogen production is crucial for developing an integrated economy with sustainable clean energy. Replacing fossil fuels that produce carbon dioxide (CO₂) with a clean energy source based on hydrogen in fuel cells is essential, as the output of these cells is H₂O and does not emit polluting gases such as CO₂ and nitrogen oxides.

Before delving into the field of solar energy, it is necessary to clarify the types of fossil (non-renewable) and alternative (renewable) energy sources, which are represented by the following: (Naji, 2022: 21)

1. Fossil (non-renewable) energy: These represent energy sources formed by nature and present in specific quantities that are depleted within a specific period of time, such as oil, natural gas, and coal.
2. Alternative (renewable) energy: These represent energy sources that exist naturally and periodically and cannot be depleted, such as sunlight, biomass, wind energy, geothermal energy, and wind power.

This study will focus on the concept of solar energy as one of the alternative energy sources. Taher and Hussein described it as the most powerful renewable energy source, being environmentally friendly, inexhaustible, and an important source of energy in Iraq. This is because Iraq is located on the annual solar belt, which provides year-round availability (Taher and Hussein, 2023: 350). Adewnmi et al. also explained that solar energy is a radiant beacon in the world of sustainable energy, as it is inexhaustible when generating heat and electricity by converting sunlight into electrical energy via the photovoltaic effect of cells that produce steam, which drives turbines to generate electricity (Adewnmi, et al., 2024: 411).

It is clear from the two concepts above that solar energy represents the light and heat produced by the sun in the form of radiation that travels in multiple directions at the speed of light, resulting from reactions that occur within the sun. The sun is composed of two elements, hydrogen and helium, with the former constituting 82%, while the latter represents 18%. Hydrogen atoms are converted into helium atoms through reactions between these two elements, and the excess material from the reaction is converted into tremendous energy, represented by solar energy. (Jamal and Badr, 2023: 355)

2- Factors Affecting Solar Energy Production

There are several factors that affect the intensity of solar radiation and the time available for the sun to reach Earth, thus maximizing the use of this energy, whether thermal or light. These factors include:

First, temporal and geographical variation: There are two types of solar radiation intensity measures: global horizontal irradiance (GHI) and direct normal irradiance (DNI), which is perpendicular to solar cells. Most energy is absorbed when sunlight is perpendicular to them, as it provides the largest surface area. Oblique incidence of sunlight reduces electricity production. This is evident in the varying times of daylight, with the sun being high in the summer and the days being long in some cases. The Earth's regions, resulting in intense, prolonged solar radiation, also affect the intensity of solar radiation at different altitudes. (Bamisile et al., 2025: 3)

Second: Atmospheric clarity factor: Atmospheric particles affect the amount of solar radiation falling on a given area. These effects include dust, clouds, and fog, which limit the amount of solar radiation reaching those areas. (Jamal and Badr, 2023: 362)

It is clear from this that the intensity of solar radiation is one of the most important factors in generating photovoltaic energy. This is most evident at the equator, where regions located along the equator enjoy strong sunlight for long periods of the year, especially in the summer, which calls for attention to investing in solar energy in these regions. 3- Types of solar cells: Converting inexhaustible sunlight into electrical energy via cost-effective photovoltaic technologies is one of the most potential strategies for decarbonizing the global industry in general, thus preserving a carbon-free and environmentally pollutant-free future. Solar cells have been generally classified into three types (Cellurs.M.et.al., 2024:3)

1. Solar cells based on crystalline silicon.
2. Thin-film solar cells.
3. Non-silicon-based solar cells, such as organic solar cells.

Anwer z. et.al. explained concentrated solar power, which relies on harnessing the heat provided by direct solar radiation, as follows: (Anwer z. et.al. 2023:67-68)

1. Parabolic trough collector (PTC): This consists of a group of reflectors curved in one dimension, parallel to the sun's rays, and is connected to the solar field.
2. Solar tower technology (SPT): Also called central receiving systems, it consists of a field of reflectors that track the sun, called heliostats. Their task is to reflect and concentrate the sun's rays onto a decentralized receiver mounted at the top of the tower, which is fixed.
3. Parabolic Dish Technology (PDC) stations: These focus the sun's rays at pivot points supported above the center of the dish (receiver). The dish and receiver move together, eliminating the need for a heat transfer fluid and a cooling tower. This is an advanced technology based on solar photovoltaic technology. What also distinguishes them is their ability to generate electricity even when the sun is out.
3. Linear Reflector (LFR) stations: These stations resemble a parabolic trough, using long rows of slightly curved or flat mirrors.

3- Components of a photovoltaic solar energy system used in homes:

The solar energy system used in homes consists of the following parts: (Abu Ratima, 2020: 422)

- 1) Solar panels: These are one of the essential components of a solar energy system in homes. They consist of a group of cells connected together in series or parallel in a single frame. The cells are made of semiconductor materials such as silicon, which absorbs sunlight. Silicon has a very shiny property and is coated with anti-reflective materials. Types of solar panels include: Polycrystalline silicon, which has square, stacked cells. Its advantages include low cost, a lifespan of 25 years (sometimes more), and an efficiency rate of 16.9%. Monocrystalline silicon, which has a uniform appearance and an efficiency rate of 22.5%. The third type is called thin film,

which is streamlined and thin and takes the shape of the surface to which it is installed and is very rare.

- 2) Mounting frame: This represents the mounting location. The importance of panels lies in determining the location, area, and angle of inclination.
- 3) Charge regulator: This regulates the current and voltage entering the battery to protect it from damage. Its function is similar to that of a mobile phone battery charger.
- 4) Batteries: The purpose of this component is to store electrical energy for use at night due to the lack of sunlight. They are made of lead plates, which explains their high price.
- 5) Current transformer: As is well known, solar panels produce only direct current, while devices operate on alternating current. Therefore, a current transformer, also known as an inverter, is used. It is responsible for converting direct current to alternating current and is the most expensive component in a solar energy system. The following figure illustrates these components.

The concept of crisis management and its dimensions

Research on crises began to emerge in the 1960s and 1970s, particularly in the fields of social and psychological sciences, in response to the economic and social disasters that occurred at that time (Iftikhar, R., ET.AL., 2023: 100). Crisis management refers to a set of measures that Crisis management is carried out by the crisis management authority with the aim of analyzing and assessing security threats and planning and implementing a response to crises when they occur. (Scuek, R. & Szynowski, R., 2024: 75)

Al-Dulaimi defined it from a social perspective as "large, unexpected, and unpredictable events that threaten to harm the organization and its stakeholders" (Al-Dulaimi, 2008: 66). Crisis management refers to how organizations respond to major challenges when they perceive a threat to infrastructure that requires an urgent response under conditions of uncertainty. The basic premise is that the state and its institutions bear the responsibility to initiate and organize a large-scale response to such events. (Boin, A. & Rhinard, M., 2023: 657)

It is clear from the above that crisis management is the ability to overcome a crisis as quickly as possible and with minimal losses, and sometimes to confront a crisis before it occurs through careful planning, developing alternatives for every potential emergency, and investing time and effort to successfully overcome the crisis through several methods, including working as a team. To manage a crisis, or through democratic participation at all organizational levels, or through containing the crisis by narrowing its scope and using the language of dialogue and understanding. Park, S. et al., indicated that the resources available in any society are an important factor in governmental crisis management in general. Researchers stated that there are two dimensions that affect crisis management in general. The first dimension represents the terror dimension based on the time available to crisis managers to make a correct and quick decision without errors due to the lack of time to correct errors. The other dimension of the crisis is the time dimension, which is the time allotted for crisis managers to make a quick and successful decision. (Park, S., et al., 2022:3)

This shows that there are two important matters when managing crises during a crisis: the responsibility of those responsible for managing and containing the crisis to bear the consequences of the pressure that arises during the crisis to make a correct and successful decision to successfully overcome the crisis, and the consideration that the time available for making the decision is limited and cannot be delayed to avoid the escalation of the crisis and failure to confront it. This can only be achieved through working as a team and with participation. everyone .

Cost Reduction and the Concept of Sustainable Development: Concept and Dimensions

1- The concept of cost reduction: It is the reduction of waste and inefficiency in operational processes (Edward, J., Vanderbeck, 2010: 64).

Drury explained that the concept of cost reduction represents the economic unit's ability to maintain its competitive advantage by reducing the prices of products or services while maintaining quality, customer satisfaction, and increasing profits in the long term. (Drury, 2018: 559)

From the above, it is clear that reducing the costs of a product or service represents an ongoing approach and effort to eliminate activities that do not add value at all stages of the value chain, from the design stage to the distribution and after-sales service stages. This is achieved through the use of modern technological means to achieve customer satisfaction and a competitive advantage in the market.

2- The concept and dimensions of sustainable development: The emergence of the concept of sustainable development in the late 1980s came as a result of the environmental problems that emerged at that time, significantly impacting living organisms and the Earth in general. (Bin Al-Tayeb, 2016: 10). The concept of sustainable development has multiplied since the interest in the coal industry, addressing technological, environmental, and economic issues to reduce pollution. This is because the coal industry is a major source of carbon dioxide emissions into the atmosphere. (Salieiev, I., 2024: 54). (Angelaki, M., et al.) defined it as "development that meets the needs of the present without harming the interests of future generations" (Angelaki, M., et al., 2024: 5080). Sustainable development also represents "securing the needs of long-term human growth for multiple generations" (Arman, et al., 2024: 1132).

3- Dimensions of Sustainable Development: There are three dimensions of sustainable development, as follows: (Al-Kaabi and Farhan, 2021: 156)

- The environmental dimension: It addresses the growth of environmental issues such as global warming, drought, and acid rain, and how to address environmental sustainability by reducing pollution. Toxic emissions and energy consumption.
- The social dimension: Focuses on improvements in quality of life and well-being through the provision of job opportunities, the responsibilities of

governments and individuals when undertaking various activities, and strengthening relationships within and outside economic units.

- The economic dimension: The optimal use of resources that achieves economic benefits.

From the above three axes, it is clear that solar energy is used in many areas of our daily lives. Many solar cells of various types have been installed in Iraq, particularly in streets, modern buildings, some homes, and economic units. What has encouraged the increased demand for solar cells is the irregular provision of electricity by government agencies and the reliance on generators to supply all areas of Iraq with electricity. This is in addition to the increase in environmental pollutants resulting from the consumption of fossil fuels and the increase in the incidence of serious diseases and birth defects in the country. One of the most important factors that has contributed to the shift to solar energy is the exposure of most areas of the country to sunlight for long periods, especially during the summer and spring in the central and southern regions.

METHODOLOGY

Research Methodology

- 1- Research Problem: The research problem is represented by the ongoing power outage crisis and the increasing number of private generators providing electricity to citizens, leading to increased energy costs and increased environmental pollutants.
- 2- Research Objectives: The research aims to shed light on sustainable sources of electricity that can replace environmentally polluting sources and ensure continued energy supply at a lower cost, ensuring optimal use of solar energy to manage the crisis of declining electricity supply hours by government stations.
- 3- Research Importance: The importance of the research is highlighted by how to exploit the natural energy sources available in Iraq to mitigate the power outage crisis and protect the environment from pollution and the health and economic impacts on citizens.
- 4- Research Hypothesis: The research is based on the main hypothesis that the use of solar energy to generate electricity contributes to reducing environmental damage caused by smoke emitted by private generators and reduces the cost of obtaining electricity in the long term.
- 5- Research Limits: The researcher relied on Arab and foreign sources, including books, peer-reviewed scientific research, university dissertations, theses, and periodicals, to gather information. She also compared the costs of obtaining energy from MTS for the installation and supply of solar panels in Baghdad Governorate with the costs of supplying them by private generators.

RESEARCH RESULT

Practical Aspect

First: Level of responses to the research variables.

These three variables (Solar energy, Sustainable development) were measured to extract the arithmetic mean and standard deviation, as follows:

Table (1) Level of responses of the research sample to the research variables

standard deviation	mean	variables
1.4	3.6	Solar energy
1.5	3.7	Sustainable development

The results for the above variables indicated that the sample's responses to these variables were above average and tended toward agreement, with a standard deviation indicating a high level of agreement.

Testing the Hypotheses of Impact between Research Variables

First: The Impact of Solar energy on Sustainable development

The following table shows that the calculated (F) value between the Solar energy variable and the Sustainable development variable reached (41). This means that there is an impact of the Solar energy variable on the Sustainable development variable. The company confirms the existence of the effects of Solar energy in achieving Sustainable development. From here, we conclude that the second hypothesis is accepted, according to the statistical results in Table No.(2)

Table No. (2) Impact matrix

		Solar energy
Sustainable development	F	41
	Sig	0.000 ^b
	α	0.77
	β	0.78
	R Square	0.74 ^a

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The results showed that the solar energy variable received a relatively high level of agreement among citizens.
2. The field results showed that solar energy received the highest mean, which confirms citizens' interest in investing in solar energy.
3. The field results showed that citizens are monitoring the competition between solar energy and reliance on private generators.
4. All correlations between the study variables showed a strong and significant correlation between sustainable development and the solar energy variable, indicating the role of solar energy in positively activating sustainable development.
5. The research results showed that the influence hypothesis indicates a positive and significant impact of solar energy on sustainable development.

Recommendations

In light of the aforementioned conclusions, we can point to a number of recommendations, as follows:

1. The research recommends the importance and role of solar energy in sustainable development, as follows:
 - a. Developing training programs to provide professional training for new managers.
 - b. Providing managers in sensitive administrative positions with training on the latest solar energy methods.
 - c. Comprehensively and periodically reviewing the previously prepared training plan and incorporating environmental changes and evolving needs.
2. The study recommends that all managers in solar energy companies improve policies that help bolster citizens' confidence in developing sustainable development capabilities through solar energy development, which helps create an environment conducive to citizens investing in solar energy.
3. Requesting senior management at all levels to submit development proposals that help companies utilize their resources efficiently.
4. Formulating a strategy for building and developing human resources by conducting a broad and comprehensive strategic analysis of all managers and their capabilities in dealing with various resources and situations.
5. Formulating a strategy that directs company operations to focus on citizens, aiming to provide company services according to the aspirations and desires of these citizens, by conducting a survey on the quality of services provided by solar energy companies.
6. The research recommends trying to apply the research model and actually introduce it into practical practice and develop it based on the results that showed correlations and influence between the research variables in the Iraqi environment.

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