

**The Role Of Renewable Energy In Enhancing The Dimension Of Sustainable Development :A Case Study in the Northern State Cement Company / Badoush Expansion Cement Factory in Nineveh Governorate**

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**Abstract**

The research aims to study the extent of the impact of renewable energy as a criterion for achieving and enhancing the dimensions of sustainable development through a case study in the state Cement Company, north of the Badoush Cement Plant. In achieving its objectives, the research relied on the quantitative descriptive approach, and the research problem was represented in the main question that expresses the extent of the administrative leadership's ability to recognize the extent to which renewable energy contributes to promoting sustainable development, represented by dimensions related to the environment and climate, reducing pollution and waste that accompany the cement manufacturing process, and the extent of the impact of the absence of Investing in renewable energy on the dimensions of the environment and climate. The relationship was tested and analyzed based on the data obtained from the state Cement Company through the given data related to demand and the percentage of waste. Accordingly, a set of conclusions was presented, the most prominent of which is that there is a great need to give renewable energy a strategic content that meets and enhances the dimensions related to sustainable development. The research concluded by presenting a set of proposals that serve the directions of the company under study, the most important of which is working to develop everything that meets the establishment of renewable energy facilities in a way that enhances the dimensions of sustainable development. Relevant to the studied company's mission and vision.

**Keywords: renewable energy, sustainable development**

## 1. Literature review

### 1-1:renewable energy

Sustainable development is one of the most important issues in today's world and renewable energy (also known as clean energy) is a key part of this realm. Unlike finite fossil fuels that harm the environment, renewable energy comes from sources that nature renews constantly. This makes it not only sustainable but also much more environmentally friendly. The essay discusses the importance of renewable energy while briefly mentioning major types such as solar, wind, and hydropower (among others) which will be discussed later in detail; it also addresses climate change and underscores the need to reduce our dependence on finite resources these play such an important role in sustaining human life because their availability is continuous all over the world. The benefits of renewable energy wind, solar, geothermal, hydroelectric, and biomass go beyond environmental considerations. They also have implications for health as well as the economy. The transition to renewable energy can have a significant impact worldwide through reducing greenhouse gas emissions which are identified in numerous studies with climate change (**Romero-Lankao et al., 2023**). Each different type of renewables source offers their own unique solution in energy production: Solar power. Wind power. Hydropower... these stand out among the myriad available today (**Yao, L et al., 2016**).The abundance and versatility of these resources are best illustrated by examples like wind power or solar power. With eco-friendly hydroelectric or bioenergy also in the mix to easily meet our energy demands while minimizing negative environmental impact: indeed these resources have plenty of potential and are easily applicable. (**Gür, T. M. (2018)**). Alternative energy sources such as solar, wind, geothermal, hydropower and bioenergy are good options for traditional fossil fuels. Consideration of ocean energy can also complement these common sources (**Moriarty, P., & Honnery, D. (2012)**) Solar power is among the most available and generally used renewable sources of energy: it works by converting the sun's energy into workable power. This power can be used for many applications, e.g., solar water heating for buildings plus solar distillation, pumping, and drying; while solar has several advantages that include diverse applications and low maintenance costs— not forgetting reduced electric bills challenges such as weather dependency and cost of energy storage need to be addressed (**Panwar, N. L., Kaushik, S. C., & Kothari, S. (2011)**). Though these hurdles exist, solar power still stands as a promising alternative and an option gaining more ground in the production of

clean energy. Wind energy is yet another major source of renewable power; it takes the kinetic force developed by moving air to produce electricity. Consider how wind turbines capture such natural power: they take in wind's force through their rotation with blades that transmit it into mechanical systems. Despite few or many variables involved in the process, countries like China emerge leaders demonstrating high levels of turbine assembly capacity within their shores. **(Twidell, J. (2021))** Although wind power has its advantages (clean, renewable, job-creating), it can lead to bird deaths and is not always in harmony with the local ecosystem. Hydropower, on the other hand, is derived from flowing water's kinetic energy a consistent source of renewable electricity. Through the conversion of hydraulic energy into electric power, hydropower stations play a role in reducing greenhouse gas emissions and curbing fossil fuel use. **(Yi, J., Dai, S., Li, L., & Cheng, J. (2024))**. Hydropower is one of the clean energy sources because it does not produce harmful gases which pollute the environment instead generates electricity by using force of water However, while hydropower does not directly emit greenhouse gases, the construction of dams and reservoirs can have negative environmental impacts Geothermal energy is an important renewable energy source that involves harnessing heat from within earth's surface Geothermal power refers to electrical power generated through geothermal energy technologies such as dry steam power stations or flash steam power stations The use of geothermal energy for electricity production is increasing, with 30 countries currently using this resource. They represent a significant share of global installed geothermal power capacity **(Hassan, Q.et (2024))** The majority of closed-loop geothermal heat pumps work by moving water or a water-glycol solution through an enclosed system constructed typically from high-density plastic materials. This novel approach to power generation underscores the promise of geothermal energy as a sustainable and dependable source of power. Biomass energy comes from organic matter like agricultural crop residue forestry residues, wood processing residues and special energy crops: this pool of biomass resources can be converted into energy using several techniques combustion, gasification, anaerobic digestion, pyrolysis. Although burning biomass emits carbon dioxide back into the atmosphere the carbon that is released is part of a natural carbon cycle since plants absorb carbon dioxide during growth, therefore it is considered carbon-neutral. **(Raihan, A., & Bari, A. M. (2024))** The point at the tip of the pyramid in terms of which it addresses and trumps climate change, energy security, and sustainable development. The plentiful sources that make up renewable energy such as solar, wind, hydrothermal geothermal, and biomass paint a picture for us. They tell us

how we can significantly bring down our greenhouse gas emissions— an act that will see us transition into a cleaner world filled with clean energy for our future generations. When considering renewable energy we need to take both hands: one carrying economic benefits while the other carries social plus environmental considerations ensuring justice and equity in the transition of energy. The future thus holds much promise but be warned there are impediments like policy frameworks as well as grid integration and notably storage which has to be surmounted to realize its full potential.

## **1-2:dimensions of sustainable development**

Sustainable development is an idea that has gained considerable attention in the last few years. It entails meeting current needs without compromising future generations' ability to meet their own needs a concept with two time dimensions. Sustainable development tackles economic, social, environmental, technological, and policy issues from multiple angles, striving to establish a world that is more sustainable on all counts and fair for everyone involved. In this piece of writing, we would like to present you with different aspects of sustainable development each playing its role towards this common goal sustainability itself. One such aspect is The Economic Dimension of Sustainable Development which significantly influences the policies adopted by nations towards achieving sustainability Integration of evaluation with economic tools provides decision makers with practical ways through which different developmental programs can be effectively implemented (**Redclift, M. (1991)**). According to the 2030 Agenda for Sustainable Development international trade is identified as key drivers for inclusive growth levels within economies as well poverty reduction efforts which must be promoted across all developing countries and LDCs in particular. The green economy is another concept in the macro of the economy. It has been increasingly identified as a major strategy of sustainable development by both developed and developing countries (**Pawlowski, A. (2008)**) The Social Dimension of Sustainable Development that focuses on ensuring that development initiatives are inclusive and reach all sectors of society led the UK to adopt sustainable development principles in planning, housing, and urban policies. This principle is based on the belief that every individual has the ability to meet his or her basic needs and thus stresses importance for minimum requirements for dignified human life (**Strezov, V., Evans, A., & Evans, T. J. (2017)**) Poverty-alleviation programs need therefore to be assessed from poverty dimensions. But also policies to enhance local priorities through recognizing environmental dimensions as

highlighted by different indicators within them this includes those related to future generations, such as preservation of natural resources and ecosystems' critical value for Sustainable Development Goals (SDGs) attainment at local levels The role of renewable energy sources in many nations toward attaining sustainable development has been discussed in other works Solid waste management not only reduces environmental pollution effects but also improves public health and urban areas' quality of life (**Sen, A. (2013)**) Innovation is an integral part of driving progress towards sustainability. Technological innovation can impact all aspects of sustainable development: economy, society, environment through digital technologies which facilitate sectoral sustainability Coherent policies that address the three dimensions of sustainable development have to be put in place by all countries. In order to achieve the Sustainable Development Goals, policy makers must recognize technology's transformative potential as well as its limitations (such as inability to replace political will or address trade-offs) A balanced and integrated approach to policy formulation is needed if sustainable development goals are to be achieved holistically Inclusion of policies with the economic, social, and environmental dimensions fosters the values of sustainability within the government for future healthy institutions It is in this light that we acknowledge how different cultures influence their developmental strategies through societal norms; thus, gender equality should be considered as a core element which leads to more progressive outcomes. Development programs should consider integration of gender perspectives as an essential component (**Escap, U. N., & Scientific, C. (2015)**) given that addressing disparities will lead us towards parity between men and women: an end goal shared by all members making up any society [23]. An outcome-based approach can never be successfully attained without taking cognizance of this critical relationship that forms part and parcel of each other health contributing back onto sustainability because both depend on each other for support. An effective quality health system framework is the nexus of health system performance and end user satisfaction, ensuring sustainable health outcomes The inclusion of health indicators that pertain to environmental sustainability in the 2030 Sustainable Development Goals illustrates how intertwined these two aspects are When societies prioritize healthy environments and ensure all individuals have equitable access to healthcare, they work towards sustainable health outcomes for all: healthy people living in a healthy environment The role that education plays in achieving sustainability is highlighted by The Education Dimension of Sustainable Development (**Benaim, A., Collins, A., & Raftis, L. (2008)**). it emphasizes equipping learners with knowledge and skills

related to sustainability. Environmental education forms the basis of Education for Sustainable Development (ESD) across all levels from primary to tertiary and adult learning systems with the aim of instilling a sense of responsibility within individuals. This is achieved through the cultivation of value systems and attitudes that promote sustainability. The integration of lifelong learning, together with principles of sustainability, into educational curricula serves to strengthen the Education Dimension, which in turn plays a significant role in ensuring that future generations are well informed and committed towards sustainable development.

On the other hand, The Governance Dimension assumes a critical role in implementation and oversight of actions leading towards sustainability: governance frameworks such as good governance are identified as major facilitators for achieving the SDGs. According to the World Bank, elements of governance including accountability, transparency, rule of law and government efficiency act as supportive mechanisms to efforts geared at sustainable development. Sustainability is a multifaceted issue that calls for coherence between various dimensions. These include participation and reflexivity as well as adaptation without which policies and practices aimed at achieving sustainable goals cannot be successful (Sharma, K., & Sarkar, P. (2024)). In summary, while different dimensions work together towards ensuring sustainability in all sectors (which would result into a more equitable world), each dimension has unique impacts that steer policies, practices and behaviors towards sustainability. This points to viewing challenges in an interrelated way on a global scale for integrated solutions; we can only achieve this by taking a holistic approach to sustainable development that recognizes the diverse dimensions and their contributions.

## **2- methodology**

### **2-1:Description of the Model Used in Analysis and Estimation**

To estimate and interpret the impact of renewable energy on environmental and climatic changes, which are among the most important dimensions of sustainable environmental development in the researched company, a model consisting of several fields was adopted over a period of five non-consecutive productive years for the production of cement that meets international standards (ISO) for the period from 2014-2021. This period is considered as variable X, representing the production years in the absence of renewable energy exploitation and the resulting consequences due to changes in various dimensions related to globalization, which affected the

delay in transitioning to renewable energy. This is based on evidence and facts about international political events during that period and the region's experiences of political, economic, cultural, technological, and health changes and conflicts, which had many impacts on the demand for cement (variable Y), and consequently on the climate. This is calculated through a special equation used by the plant management to account for the waste produced per ton of cement as follows

**I. The period from 2014 to June 2014 (“interruption period”)**

According to Table (1), there was a supply and demand for cement, with an average supply of 257,770 tons and expenses amounting to 252,752, utilizing the available raw materials in the warehouses (clinker produced in the kiln). This was due to the stability witnessed in the first half of the year with the use of modern technology in production and reliance on international standards (reliability) specific to cement previously obtained by the company. The impact on climate change can be calculated through the waste released into the climate as follows:

Reduction rate = 0.574% of kiln production (raw material used in cement production “clinker”)

Waste for the year 2014 = 0.574% × 252,752 = 1.460% per ton

These waste percentages reflect (lost renewable energy opportunities), which contain different concentrations of heavy elements such as zinc, iron, and lead, representing lost investment opportunities for renewable energy. Consequently, their absence leads to high waste in the surrounding environment and high pollution.

**Table (1): Movement of Produced Materials, Inputs in Production, and Demand for Production for the Period from 2014 to June 2014**

Year	Century Production	Raw Material Expenses	Total Cement Production	Cement (Demand for Cement)	Supply for
2014 - June 2014 (“interruption	254,437	252,752	255,340	257,770	

period")				
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(1)The specific equation that condenses the raw materials used in the manufacturing process and releases the remainder as waste into the atmosphere.

## II. Period from (March 17, 2018 - 2019)

It is noted from Table (2) that there is a supply and demand for cement, but at a lower rate than production, amounting to 440,621 tons compared to the produced quantity of 588,643 tons, with expenses totaling 1,098,422. This demand is lower than the previous year before the disruption in 2014 due to the return after a period of political conflicts (post-political globalization) and its accompanying impact on the demand for the product, while maintaining international standard specifications in production. As for the impact on climate change, it can be calculated through the waste released into the climate as follows: Reduction percentage = 0.574% of furnace production (a raw material used in cement manufacturing "clinker") Waste for 2014 = 0.574% × 588,643 = 3,378.81 tons It is noted that the waste percentage has increased compared to 2014 due to the increase in the production of the raw material because there was no previous stock, thus lacking greater investment opportunities with high pollution emissions, distancing from achieving sustainable development dimensions.

**Table (2): Movement of Produced Materials and the Demand for Production for the Period from March 17, 2018 – 2019**

Year	Furnace Production	Raw Materials Expenses	Total Cement Production	Cement Demand
March 17, 2018-2019	588,643	1,098,422	444,796	440,621

Source: Prepared by researchers based on annual company reports

## III. Period from (2019 - 2020)

It is noted from Table (3) that there is a supply and demand for cement, reaching 683,479 tons, a higher rate than the total produced quantity of 673,379 tons, indicating the use of existing stock with expenses totaling 1,208,842. This demand is higher than the previous year due to the return to production after the disruption and rapid development, keeping pace with technology in production and



manufacturing according to the reliability and ISO specific to cement production. As for the impact on climate change and the environment, it can be calculated through the waste released into the climate as follows: Reduction percentage = 0.574% of furnace production (a raw material used in cement manufacturing "clinker") Waste for 2014 = 0.574% × 663,167 = 3,806.57 tons It is noted that the waste percentage has increased compared to the previous year due to the increase in the production of the raw material and due to the increase in production with the absence of energy, which inversely affects it.

**Table (3): Movement of Produced Materials and the Demand for Production for the Period from 2019 – 2020**

Year	Furnace Production	Raw Materials Expenses	Total Cement Production	Cement Demand
2019-2020	663,167	1,208,842	673,379	683,479

Source: Prepared by researchers based on annual company reports

#### **IV. Period from (2020 - 2021)**

It is noted from Table (4) that the demand for cement has decreased compared to the previous year, reaching 603,989 tons, which is slightly more than the total production of 596,229 tons (also utilizing existing stock to cover the demand), with raw material production expenses amounting to 1,005,669. This decrease in demand is due to the impact of health globalization, which means the transfer of disease and healthcare from one country to another (Hour, 2017, 2), and the COVID-19 pandemic represented globalization of the disease through its spread, which restricted cement production and construction activities. As for the impact on sustainable development in the dimensions related to the environment, it can be calculated through the waste released into the climate as follows: Reduction percentage = 0.574% of furnace production (a raw material used in cement manufacturing "clinker") Waste for 2014 = 0.574% × 577,976 = 3,317.58 tons It is noted that the waste percentage has decreased compared to the previous year due to the reduced production of the raw material and the decreased annual demand.

**Table (4): Movement of Produced Materials and the Demand for Production for the Period from 2020 – 2021**

Year	Furnace Production	Raw Materials Expenses	Total Cement Production	Cement Demand
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2020-2021	577,976	1,005,669	596,229	603,989
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Source: Prepared by researchers based on annual company reports

## V. Period from (2021 - 2022)

It is noted from Table (5) that there is a supply and demand for cement with a continued decrease, as the demand reached 585,280 tons, which is less than the total produced quantity of 592,448 tons, indicating a surplus stored in the warehouses, with raw material production expenses amounting to 1,138,126. This decrease is due to the ongoing effects of health globalization and the COVID-19 pandemic. As for the impact on climate change (the environmental dimension), it can be calculated through the waste released into the climate as follows: Reduction percentage = 0.574% of furnace production (a raw material used in cement manufacturing "clinker") Waste for 2014 = 0.574% × 612,500 = 3,515.75 tons It is noted that the waste percentage has increased compared to the previous year due to the increased production of the raw material and decreased demand for production.

**Table (5): Movement of Produced Materials and the Demand for Production for the Period from 2021 – 2022**

Year	Furnace Production	Raw Materials Expenses	Total Cement Production	Cement Demand
2021-2022	612,500	1,138,126	592,448	585,280

Source: Prepared by researchers based on annual company reports

## 3-Conclusions and Recommendations

### 3-1:Conclusions

1. **Impact of Renewable Energy Absence:** The analysis of quantitative data indicates a significant impact due to the absence of renewable energy.
2. **Company's Focus on Product Development:** The researched company is focused on developing its products and keeping pace with technological and global advancements concerning ISO international production specifications, demonstrating high resilience in challenging circumstances.

3. **Management's View on Renewable Energy:** The company's management considers renewable energy to have both positive and negative impacts on production and the rate of defects in its absence.
4. **Impact on Climate Change:** Renewable energy has a clear impact on climate change, particularly in the environmental dimension, as seen through the waste produced during the company's cement production process.
5. **Health Impact of Cement Manufacturing Waste:** There is a clear impact of waste from the cement manufacturing process (both gaseous and solid, such as dust and small particles) on public health, especially on pregnant women in the workplace or nearby areas.

### **3-2: Recommendations**

1. **Increased Focus on Environmental Specifications:** The company's management should increase its focus on environmental specifications and allocate a budget to support the safe and healthy disposal of waste.
2. **Annual Cultural Program on Environment and Renewable Energy:** It is essential to prepare a comprehensive annual cultural program about environmental activities, renewable energy sources, and climate change, emphasizing the need for preservation. This program should include inviting specialists in general quality and environmental conservation from Iraqi universities and institutes.
3. **Exposure to Global Environmental Practices:** Managers and employees should be exposed to global practices of companies implementing environmental conservation activities and mitigating the impact of the absence of renewable energy on work performance. This will help achieve better results in product quality and continuous excellence through investment in these areas.
4. **Measures and Equipment for Handling Cement Waste:** Necessary measures and equipment should be found to handle cement waste, both gaseous and solid. This includes monitoring the combustion process and injecting additional air if toxic gases like CO appear, reducing fuel consumption for energy generation in cement production by finding an effective mechanism for maximizing energy utilization, and reusing waste while partially relying on renewable and clean energies.

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