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Review Article

A Review: Renewable Energy from an Environmental Perspective

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Abstract: The interconnection between RE deployment and environmental sustainability is becoming a focal point for achieving sustainable development in Iraq, Iran, and Turkey. Iraq has a lot of solar energy potential and favorable wind corridors; nonetheless, the role of renewable energy in the total generation of electricity remains around 2%, due to insufficient policy support, lack of funds, and technological issues. In turn, both Iran and Turkey have developed certain policies aimed at promoting the adoption of sustainable energy and have included such tools as feed-in tariffs and the active engagement of the private sector, leading to a higher share of REs in energy production. Moreover, renewable energy can have significant positive impacts on the environment in terms of greenhouse gas reduction, enhanced air and water quality, and the formation of the circular economy with the help of biomass and waste to energy. For that matter, renewable energy deployment needs an appropriate policy, financial incentives, training, and raising public awareness. From the viewpoint of power supply stability, hybrid renewable energy systems, smart grids, and geospatial information system-assisted location choice eliminate the disadvantages of intermittency inherent to renewable energy. The conceptual transition assumes that carbon dioxide can be treated as a convertible residue, and therefore the national energy supply system may become low-carbon, decentralized, and sustainable with the aid of expanding renewable energy resources in Iraq.

Keywords: Renewable energy, sustainability, solar energy.

INTRODUCTION

Development and energy security are now more than ever closely linked with environmental sustainability. Fossil fuel dependency goes hand-in-hand with increases in greenhouse gases, air pollution, and an unstable climate system. Such dependencies lead to carbon dioxide pollution, poor air quality, and water scarcity. Desertification, in turn, results from global warming and increased energy problems. Countries around the world have responded to both climate change and sustainable development by transforming their energy architecture towards renewable energy. Given its high solar and wind energy resources, Iraq has a strategic window of opportunity for transitioning to low-carbon4, decentralized and resilient energy systems. It is aligned with the environmental agenda, decreases reliance on oil, and provides socioeconomic advantages by creating job opportunities and increasing access to energy. Renewable energy technologies such as solar photovoltaic, wind, biomass and other hybrid systems provide an avenue for achieving environmental sustainability and energy security [1-2]. Furthermore, [4-3] Iraq has a paradoxical position being one of the world largest oil producers, suffering from chronic electricity shortages, acute environmental pollution and energy infrastructure lockdown [2-1].

Natural gas and oil-fired power plants account for 95+% of total electricity generation in Iraq. It has created a legacy of chronic greenhouse gas emissions, air pollution, and an unstable energy supply. Even though Iraq has the potential to harness lots of solar and wind power since most of the country is located in high solar irradiance (SH) zone and there are large areas with very good wind corridors in the northern and western regions, renewable energies only constitute less than 2% of the entire electricity generating capacity [5]. This difference stems from many challenges, such as policy weaknesses, financial limitations, and technology gaps [6-7]. As a regional approach focuses on nearby states, the current research is concerned about Iran and Turkey, as they will serve as examples illustrating available avenues for investing in

renewable energy resources. Over the years, Iran has slowly rolled out policies under the aegis of renewable energy development with small to modest sized solar, wind and hydropower projects coming up in light of challenging geopolitical (sanctions) and economic conditions [9-10]. In contrast, Turkey has been able to make good progress in increasing its renewable energy capacity, particularly solar and wind energy due to government incentives (investments) and feed-in tariffs that put it into regional pioneer of renewable energy [11].

Renewable Energy

Renewable energy is taken from the natter, which is not only resourceful but virtually inexhaustible in the time frame of a human lifetime. For example, sunlight, wind, moving water, geothermal energy and biomass [12]. In contrast, renewable energy systems exert comparatively small environmental impacts during operation and provide a means of minimizing carbon emissions [1], as they typically emit only low levels of life-cycle greenhouse gases.

Photovoltaic Solar energy in Iraq has great potential, with an average solar irradiance of 5.3–6.5 kWh/m²/day in the majority of sites across more than 3000 hours per year [13-14]. Wind energy potential is found in the northern and western governorates, where measured wind speeds at a height of 50 meters are between 5 and 7 m/s, appropriate for large-scale wind turbines [15]. Biomass energy, which comes mainly from agricultural residue and animal manure (as well as municipal solid waste), is still low since the current collection and conversion systems of these resources are not yet fully developed [16].

Environmental Sustainability:

Environmental sustainability refers to the practice of utilizing natural resources in such a way that is not depleting them for future generations [17]. Green energy sustainability in the domain of this field usually involves reducing carbon emissions, controlling air and water pollution, maintaining biodiverse ecosystems, and promoting social and economic equity [18]. Access to affordable, reliable and modern energy (Sustainable Development Goal 7 or SDG7) is one of the United Nations Goals which further affirms the need for deployment of renewable energy [19].

The advantages of renewable energy on the environment are:

Cutting down greenhouse gas emissions: The generating systems of renewable energy do not emit or very few carbon dioxide contributing on the mitigation of climate change.

Cleaner air: When we replace electricity from fossil fuels, it reduces emissions of PM, SO_2 and NO_x that are the leading causes of respiratory and cardiovascular diseases.

Water Conservation: Solar photovoltaic and wind power systems use vastly less water to operate than from thermal power plants which using huge amounts of facility analyzing.

Application of Biomass and Waste to Energy Conversion: The application of biomass from identified sources helps improve resource efficiency and waste management [20].

Policies and Governance of Renewable Energy

The future relationship between renewable energy and sustainability is anchored by three key aspects. These include:

- Policies with regulatory incentives such as feed-in tariffs, net metering, tax incentives, and renewable energy portfolio standards
- Policies based on financial mechanisms such as green bonds, subsidies, and concessional loans for renewable energy projects
- Capacity-building activities including training of the workforce, creation of research centers, and manufacture of goods

In addition, political interventions in relation to renewable energy in Iraq have been quite sparse since there is no existing national policy framework that supports wide-scale development of solar energy in residential buildings, which is considered as a critical enabling policy framework at both national and municipal levels. However, with regards to political measures in Iraq, there have been some initiatives that form the basis of a framework including the five-year UNDP project to provide affordable renewable energy with the Ministry of Housing, and international partnerships including collaborations with the International Renewable Energy Agency [22]. On the other hand, policies related to feed-in tariff (FIT) and procurement of energy through purchases have been more developed in the case of Iran and Turkey where new market mechanisms have been developed. These include auctions for energy generation in renewable energy zones like YEKA backed by both private and institutional investors [23-25].

Table 1: Comparison of Iraq, Iran, and Turkey with regard to their renewable energy sources

Country	Solar Irradiation (kWh/m²/day)	Wind Speed (m/s)	Current RE Share (%)	Major RE Source	Policy Support
Iraq	5.3–6.5	5–7	<2	Solar, Wind	Pilot programs, IRENA support
Iran	5.0–5.8	6–8	5–7	Solar, Wind, Hydro	Feed-in tariffs, purchase obligations
Turkey	4.5–6.0	6–8	13–15	Solar, Wind, Hydro, Geothermal	YEKA zones, incentives, public-private partnerships

Case studies: Three Case Studies in Iraq, Iran, and Turkey [26]

1. Iraq – Karbala Solar Power Plant (300 MW):
- Energy output per annum: 550 GWh;
- Reduction of carbon emissions per annum: 200,000 tons;
- Additional advantages: energy security improvements in Karbala and reduced dependency from fossils fuels.

2. Iran – Manjil and Rudbar Wind Power Plants:
- Capacity: 200 MW;
- Environmental effects: emission of CO2 reduced to 150,000 tons per year, local air pollutants reduced.

3. Turkey – Soma and Balıkesir Wind Power Plants:
- Total Capacity: 1,200 MW;
- Environmental effects: CO2 emissions reduced to 1.5 million tons annually, significant decrease in SO2 and NOx emissions.

All the presented examples clearly demonstrate that implementation of renewable energy goes beyond mere technologic issues and is the crucial approach to sustainable environment. Measuring the environmental impact in terms of reduction of emission, air pollutants, and other natural resource utilization could be an effective tool for prioritization by policy-makers [27].

CONCLUSION

Some researchers argue that both Iraq, Iran, and Turkey have considerable reserves of renewable energy sources. Iraq is rich in solar and wind energy while Iran has diverse sources of renewables, such as solar and wind energy together with hydropower facilities (table 1). Turkey also has the diversity of sources of renewable energy. However, despite great reserves, the policy barriers, lack of funds and technology, and the problem of grid connection prevent the development of renewable energy and make its share in energy production insignificant (less than 2%). As far as Iran and Turkey are concerned, there are proper frameworks and incentives for the fast deployment and sufficient private participation in the project.

Renewable energy implementation helps to achieve environmental sustainability because of reduction of greenhouse gas emissions, air pollution, and water utilization. Realization of the above-mentioned aspects would require not only advanced technology but regulatory measures, financial means and, most importantly, capacity building among local people in order to involve them in the process of energy production. Moreover, hybrid system, smart grid and GIS for the site selection can increase the effectiveness and reliability. Deployment of renewable energy in Iraq provides socio-economic effects in addition to environmental ones.

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