Renewable Energy Readiness. A Case Study of Ghana

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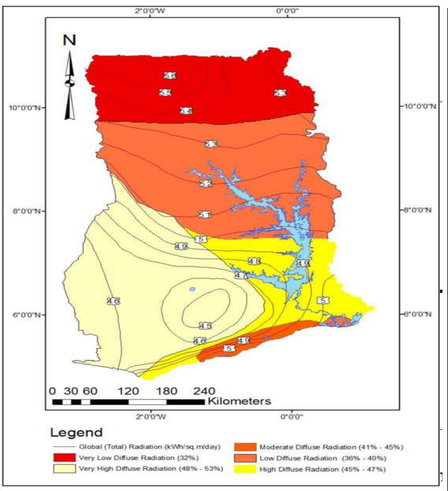
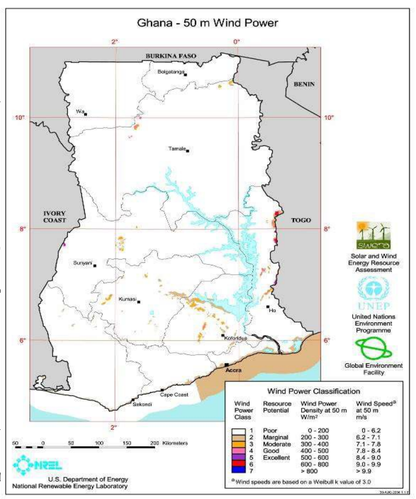
Introduction

- Clean and affordable energy remains a challenge in many African countries despite the important role they play in the economic development of a nation. Recent statistics have shown that over half a billion people on the African continent are without electricity. While the utility and benefits of electricity remain vital to socio-economic development of virtually all nations in the modern day, the exploration of natural resources towards that end has not been without its attendant challenges; chief amongst them is the growing concern of climate change. Towards this end, renewable energy technologies (RETs) such as solar, wind and geothermal have emerged as viable means of meeting both the demands for energy while ensuring environmental sustainability.
- This study adopted an economic and cost related approach to investigate the readiness of Ghana in adopting renewables as its dominant source of electricity.
- The Solar photovoltaic (PV) and wind energy technology systems was selected as the basis for our cost estimations and analysis. These technologies were found to be suitable for the geographic characteristics of Ghana.



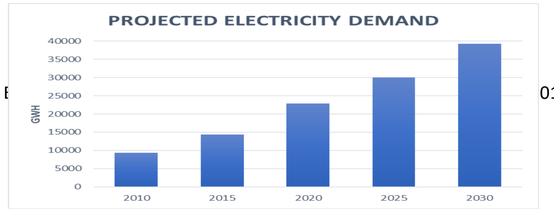


renewable energy?

2. How cost effective is it to adopt renewable energy technologies when compared with the current mode of power generation?

Methodology

- Adopt the Levelized Cost and Cost analysis to investigate the renewable energy readiness of Ghana.
- The use of numeric data and mathematical approach to the analysis of the data.
- Economic and meteorological data of Ghana was used to compute the estimates in order to calculate levelized cost.
- Renewable Energy data on the selected technologies was collected from The Solar and Wind Energy Resource Assessment (SWERA), Ghana Energy Commission, Ministry of Energy and Ministry of Finance
- Financial modelling was applied to this study. This study adopted a comparative analysis of the levelized costs of renewable energy generation and Ghana's conventional energy supply technology using discounting methods.
- The Cost-Benefit analysis technique was applied in answering the second research question. After the levelized costs of the RETs have been estimated in question (1), the costs and benefits from adopting this approach to power production will be evaluated under the existing economic conditions to ascertain in real time what the transition will cost the Ghanaian economy as compared to what non-renewable energy technology costs.



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Preliminary Estimates and Assumptions

Ahead of estimating the levelized costs, the following preliminary estimates are made.

1. The average Ghanaian household size is 4.2 people per household (ArcGIS Online, 2022).
2. The study also assumed that the total electricity consumption per capita remained constant (351.3 kWh per capita) from year 2014 to 2021 based on data from World Bank Development Indicators.
3. From points 1 and 2 above, the total electricity consumption per Ghanaian household for the year 2021 is estimated at approximately 1475.5 kWh
4. From point 3, daily electricity consumption per Ghanaian household in 2021 is estimated at 4.0 kWh
5. Based on this, the total electricity consumption across Ghana in 2021 (11147543394 kWh) was estimated by finding the product the electricity consumption per capita and the total population (31,732,128).
6. The study assumes the absence of intermittent power interruptions. That is to say that there is reliable supply for electricity demands in every household.
7. The study also assumes that each household consumes exactly the amount of electricity it needs.

Results

System features	Solar PV	Wind Turbine
System Capacity (W)	100	150
System total capital cost ($)	561	280.6
Annual O&M cost($/Year)	4.0	3.1
System lifetime (Years)	20	10
Battery capacity (Ah)	100	100
Battery investment cost ($)	40.87	40.87
Battery lifetime (Years)	3	3
Charge controller cost ($)	32.9	32.9
Charge controller lifetime (Years)	10	10

System Type and Features. Source: (Deutsche Ltd, 2022; Energy Source Guides, 2022)

Energy Output Estimation.	Solar PV	Wind Turbine
System efficiency	0.2	0.33
System capacity	100	150
Ghana Annual Average Solar Radiation, Q(W/m2/day)	55	N/A
Output, kWh	401.5	433.62

Sources: (Deutsche Ltd, 2022; Energy Source Guides, 2022; NASA, 2018).

Component	Solar PV	Wind Turbine
C_{pw}	634.4	354.4
M_{pw}	58.85	45.61
R_{pw}	594.37	1063.11
E_{pw}	6128.71	3143.74
Levelized cost ($/kWh)	0.2100	0.4654

	Conventional Tech	Solar PV Modules
Unit cost (US$/kWh)	0.047	0.0525
Daily Cost per Household (US$/kWh)	0.188	0.2100
Yearly Cost per Household (US$/kWh)	68.62	76.65
Yearly Cost per Total Households (US$/kWh)	518,442,558.78	579,111,368.85

on, 2019)

Levelized Cost Estimates for Adopting Solar PV RETs.

The result shows that the cost of providing electricity to meet the demands of Ghanaian household by the conventional approach is more cost effective than the use of the solar PV technology. It will cost Ghana approximately US$ 518.4 million annually to supply the household electricity demands by the conventional approach and US$ 579.1million to supply the same amount by the solar PV module.

➢ Production Costs (Solar PV) – Production Costs (Conventional Technology)

579,111,368.85 − 518,442,558.78 = 60,668,810.07

➢ Difference in Costs as A Percentage of the Conventional Technology

$$\frac{60{,}668{,}810.07}{518{,}442{,}558.78} \times 100\% = \mathbf{11.7\%}$$

However, the test for Ghana's readiness to adopt renewables (60,668,810.07 of electricity as explained is a measure of the relative difference between the cost of continuing conventional technologies and adopting the RETs. If the variation in the cost of the RETs and that of the current system exceeds 5% of the current system's value, then this will be an indication of lack of readiness.

The cost of adopting the Solar PV module for supplying electricity for Ghanaian households for a year is 11.7% higher than using the conventional approach. Based on this estimate and the 5% threshold, it concluded that Ghana is not ready to engage in a full-scale nationwide adoption of RETs as its mains source of electricity.

Policy Recommendation

On the 31st of December 2011, the Parliament of Ghana passed the Renewable Energy Act (ACT 832). The act was to govern the development and utility of renewable energy resources for the provision of electricity to meet the needs of the Ghanaian public. More specifically, the act was designed to direct, promote and regulate the use of renewable forms of energy; such as solar, wind, hydro, biomass, landfill gas and sewage gas among others (The Parliament of Ghana, 2011).

Special consideration should be given to the renewable energy sector when budgetary allocations in the energy sector are considered. It is also recommended that a piecemeal approach be taken on account of this transition. A lack of economic readiness at the present time does not imply that this objective to transition into green energy technologies is no longer a pressing concern.

Drawing on both the letter and the spirit of this legislation as well as the 2015 Paris Agreement, the study proposes the following legal activities towards the full-scale adoption of renewable energy technologies in Ghana.

In addition to the renewable energy ACT, the Government of Ghana should institute a new legal regime that will champion and expedite the implementation of the renewable energy transition. Another central element of this legal regime should be a focus on minimizing the scale of non-renewable forms of energy in favour of RETs. The following provisions are being recommended for inclusion in this legal regime.

Moratorium on burning of fossils/ Carbon pricing: As a means of discouraging the proliferation of non-renewable forms of energy at the expense of environmental sustainability, this legal regime should entail a provision to surcharge corporations, industries and individuals based on the amount of carbon pollution their activities result in.

Renewable Energy quotas: The government should institute a year-on-year quota system for the implementation of the RETs. Considering the fact that the yearly cost of implementing the RETs has been estimated at U.S.$ 579.1 million, over the 30-year period, the RET quota should comprise the investment of 25% of Ghana's GNI into procuring and installing renewable energy technologies. This is expected to be done as a measure towards practicalizing Ghana's commitments towards cleaner forms of energy and the reduction of greenhouse gas emission.

In a nutshell, these regulatory actions are not so much aimed at an immediate overthrow of the present energy producing technology as much as they are a commitment towards gradually phasing out this present approach and ushering in the cleaner approach to electricity production.

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