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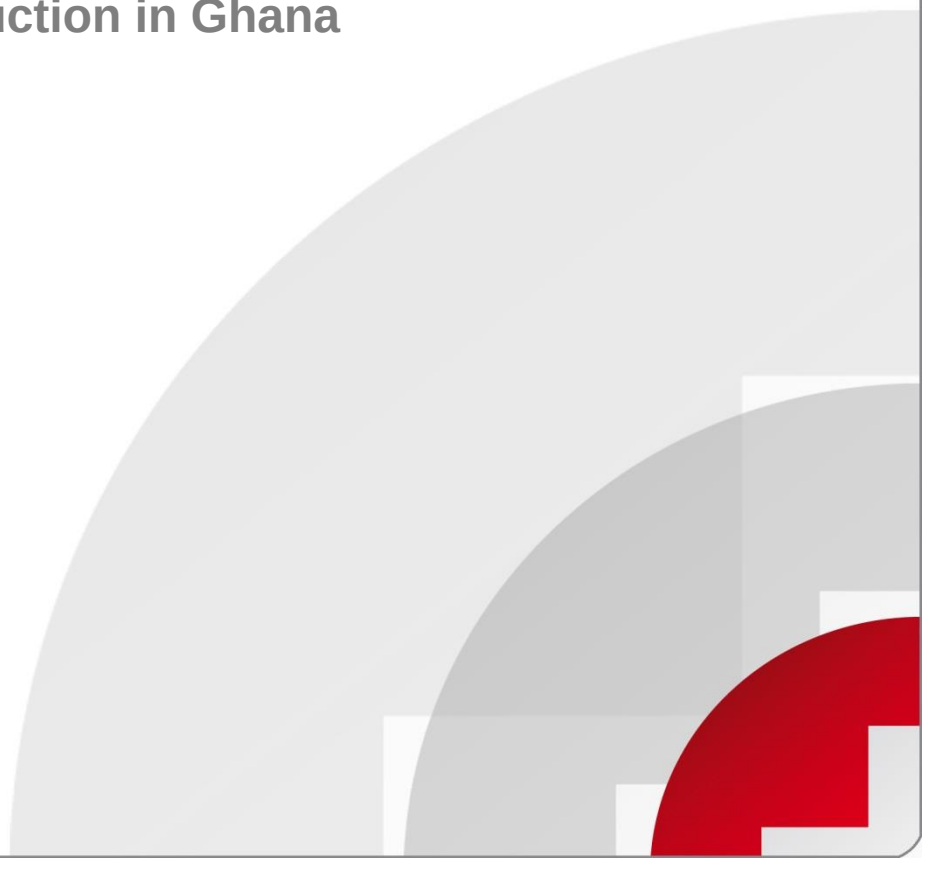
Financial Assessment of the Investment Potential of Renewable Energy Electricity Production in Ghana



Abstract

The economics and financial viability of renewable energy resources (RER) are site specific and to address the global challenges of stabilizing the energy supply while reducing the emission of carbon dioxide (CO2) requires each country to determine the potential of its RER. Ghana being a developing country is affected negatively by constant rise in prices of fossil fuel; a major energy component of the world. The country has experienced outages in its electricity supply in an era it seeks to extend electricity to all places in the country to boost economic activities and realize its goal of being a middle income country. This has necessitated the expansion of its currently installed electric power capacity which must be done taking the energy challenges into consideration. RER are thus thought as being viable alternative to supplying electricity from conventional sources that use fossil fuel as energy source. However, due to the site specificity of RER which determines their economic and financial viability, this dissertation has the overriding objective of assessing the economic and financing potential of Ghana's RER in producing electricity. The RER that are assessed as having potential to be economically deployed in electricity generation are wind, solar and hydro energy resources. The wind regime of Ghana is low throughout the country but high at coastal areas. Ten coastal areas are identified in this study to be viable sites for wind electric conversion systems (WECS). Estimation of capacity factors and possible wind turbine (WT) rated speeds as well as ranges of kilowatt (kW) ratings are determined for these areas. Generally, the solar resources are excellent throughout the country but the three northern regions have the best economic potential as solar insolation and hours of sunshine are highest in these regions. The country is also naturally endowed with hydro power potential with many sites identified as having the potential of being tapped as either mini hydro power (less then 10MW) or medium hydro power (within the range of 10MW to 100MW). Using total life cycle costing (TLCC) and levelized cost of energy (LCOE) produced, it is found that conventional means of generating electricity vis-à-vis diesel generator (DG) has the least TLCC and LCOE when the cost of CO2 is assumed not levied against the DG and carbon credit not given to renewable energy technologies (RETs). On the other hand if the cost of carbon is taken into consideration, the WECS is ranked first in least TLCC and LCOE while the DG and the hydro power are competitive. The solar PV electric system under either condition gives very high TLCC and LCOE due to high initial capital cost (ICC) requirement. In carrying out these assessments, three ownership structures are considered – no-tax case applicable to public utilities, after-tax cost deduction case applicable to an organization that seeks to generate its own power for running its primary business and before-tax revenue requirement case for private independent power producers (IPP) who are profit oriented. The latter case always produces the highest TLCC and LCOE in the ownership structure. Since the dissertation is aimed at serving IPP, further analyses were carried out to determine the financial or investment potential of the RER considering only the before-tax revenue requirement case. Using the cash flow model, the financial/investment viabilities of the RER were assessed in terms of Net Present Values (NPV), Internal Rate of Returned (IRR) and Modified Internal Rate of Return (MIRR). The no carbon case was used as it pertains in most countries especially in Ghana. However, renewable tax credits in the form of production tax credit (PTC) were assumed applicable to the RETs. The same capital structure was assumed for each supply scenario and with the exception of the solar PV system all the others had positive NPVs. The DG was still ranked first with highest NPV, IRR and MIRR as carbon charge

was not levied against it. The second investment choice was the WECS while the hydro power was ranked the third. A hybrid system was considered to be composed of DG and WECS and this system provided NPV higher than the WECS standalone. Sensitivity analyses to vary all the assumptions used indicated that the results were more sensitive to the ICC, capital structure, cost of equity, interest rate and most importantly on the capacity factor (CF) of the RER of the site. The major conclusions drawn from this study are that; the WECS and hydro power have the potential of being used to generate electricity in Ghana but will need government's support in the form of renewable energy policies that will provide loans of low interest to RETs, give PTC and provide knowledge transfer for prospective investors.