FEASIBILITY OF A SOLAR PHOTO-VOLTAIC SYSTEM AS AN ENERGY SOURCE FOR LIGHTING IN GRID-CONNECTED RESIDENTIAL BUILDINGS IN CAMEROON: CASE STUDY OF BUEA

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Abstract

Cameroon has the second largest hydropower potential in Africa after the Democratic Republic of Congo. However, even with this potential, electricity supply in the country is insufficient and unreliable especially in the midst of the dry season, thus the many residents affected are inconvenienced due to lack of energy for lighting. This and coupled with climate change constraints, necessitates the investigation of measures geared towards effective utilization of the available energy from the grid and the feasibility of an alternative energy source to be employed in the onsite generation of electricity in residential buildings for lighting. In this research, a total of 100 residential dwellings of different classes (T1 to T7) were surveyed in the town of Buea, Cameroon. The survey employed the use of a questionnaire designed to collect data on current lighting technologies used in dwellings and the electricity load for lighting and basic communication appliances (radios and mobile phone chargers) of the dwellings. An economic and environmental analysis for transition towards efficient lighting in the surveyed dwellings was conducted. The load profiles of the dwellings classified from the k-means algorithm in R Statistics were used in the HOMER Pro software for a techno-economic modelling of residential PV systems (stand-alone and grid back-up) to meet the load of the dwellings. The survey had a questionnaire return rate of 92%. Results of the survey revealed that artificial lighting in the dwellings is achieved through the use of the following technologies: incandescent lamps, compact fluorescent lamps (CFL) and fluorescent tubes. The economic assessment of efficient lighting transition in the dwellings for an artificial daily lighting duration of six hours revealed a net present value (NPV) that ranges from $47 (T1 building) to $282.02 (T5 building), a benefit cost ratio (BCR) of 1.84 and a simple payback period (PBP) of 0.17 year (2 months) for the substitution of current incandescent lamps in dwellings with CFL. The substitution of incandescent lamps with light emitting diodes (LED) revealed an NPV of the range $89.14 (T1 building) to $370 (T5 building), a BCR of 3.18 and a PBP of 1.92 years (23 months). The substitution of incandescent lamps with CFL and LED results to a reduction in lighting related greenhouse gas (GHG) emissions from dwellings by 66.6% and 83.3% respectively. Results from the HOMER modelling revealed a levelized cost of electricity (LCOE) of the PV system under the following parameters: 0% annual capacity shortage, 40% minimum battery state if charge (SOC), 25 years PV lifetime, 5% discount rate and 2% inflation rate to be 10 to 13 times more expensive

(stand-alone system) and four to eight times more expensive (back-up system) compared to the grid electricity. The PV systems have potentials to save an annual emission of 89.17 to 527.37 kg$CO_{2\text{-}e}$ for the stand-alone system. Favourable government policies are necessary to spur the deployment of these low carbon technologies in the residential sector of Cameroon.

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Acronyms

AC	Alternating Current
BCR	Benefit Cost Ratio
CD	Compact Disc
CFL	Compact Fluorescent Lamp
DC	Direct Current
DVD	Digital Video Disc
ESDP	Electricity Sector Development Programme
GHG	Greenhouse Gas
GWh	gigawatt-hour
HOMER	Hybrid Optimization Model for Renewable Energy
IRR	Internal Rate of Return
kW	kilowatt
kWh	kilowatt-hour
LED	Light Emitting Diode
MPPT	Maximum Power Point Tracker
MW	Mega-Watt
NPC	Net Present Cost
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
PBP	Simple Payback Period
PV	Photo Voltaic
SOC	State of Charge
SONARA	National Oil Refinery of Cameroon
STC	Standard Test Conditions