

*Photovoltaic applications in remote villages of
the West and North West Regions of Cameroon*

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PLAN

- Rural electrification method in Cameroon
- Alternative methods
- Photovoltaic (PV) Application in West Region
- PV Application in North West Region
- Results on PV hybrid systems (PVHS) research (Mbaka *et al*, 2010)
- Conclusions

Rural electrification in Cameroon (1/2)

- In Cameroon only peri-urban villages at distances less than 2km often benefit from single wire earth return (SWER) grid extension.
- Thus rural areas have low electrification rates of 4-6%.
- This is due to high costs of grid extension about 5000€/km.
- The cost for SWER grid extension for a village located at 1.5km from the nearest grid point in 2004 was 13.5 m FCFA.
- Thus the costs of grid extension is often financed by the government and in some cases by individuals or villages.
- High connection rates do not also allow low income rural households to opt for electricity connections and meters.
- Thus it common to find water related diseases in remote villages that lack electric water pumping systems.
- Medical care is thus limited, rural industry is absent and education does not benefit from advances in ICT.

Rural electrification in Cameroon (2/3)



- Fig. 1 SWER grid extension in Bandjoun showing low household density

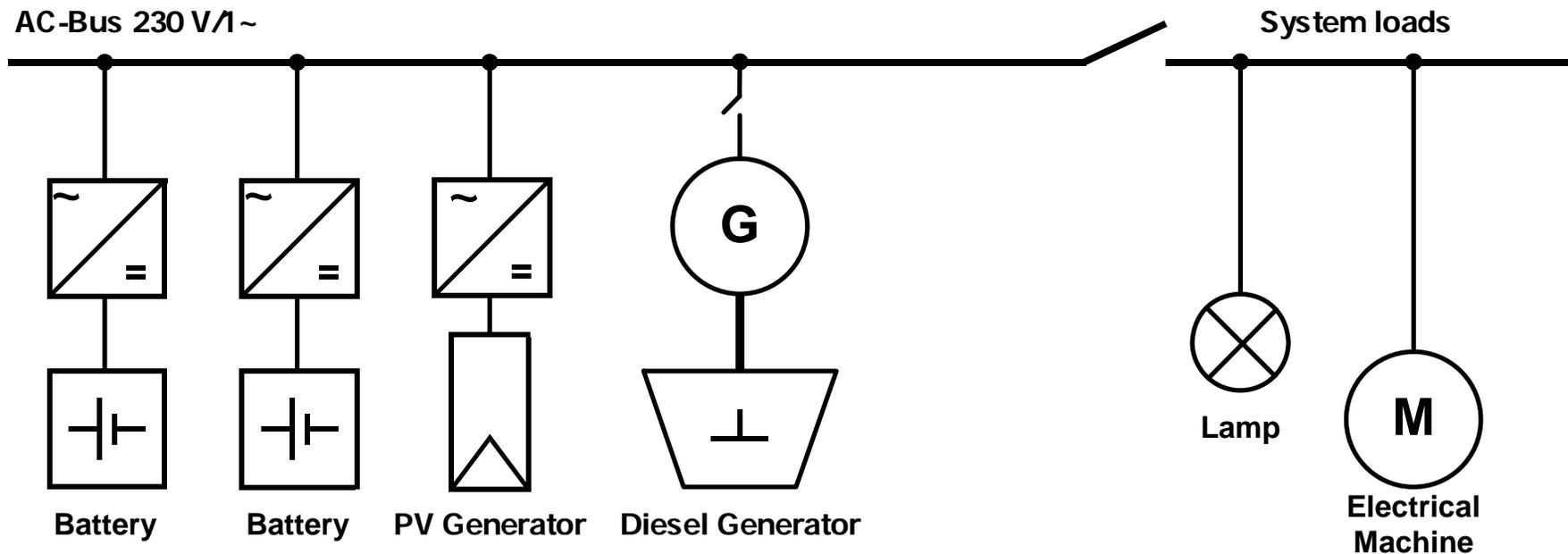
Rural electrification in Cameroon (3/3)

- Households in non-electrified villages continue to rely on kerosene for lighting, batteries for entertainment and firewood for cooking.
- Smoke from kerosene and firewood contribute to eye and respiratory diseases and sometimes fire disasters.
- Poor sources of water result in water related diseases causing many deaths every year.
- The use of kerosene and batteries reduces the savings of rural households that could be used for education and health care.
- Renewable energy resources (solar, pico hydro and wind) and renewable energy technology can be economically used by households and community facilities (health centres, electric water pumping systems and business centres).

Alternative solutions (1/3)

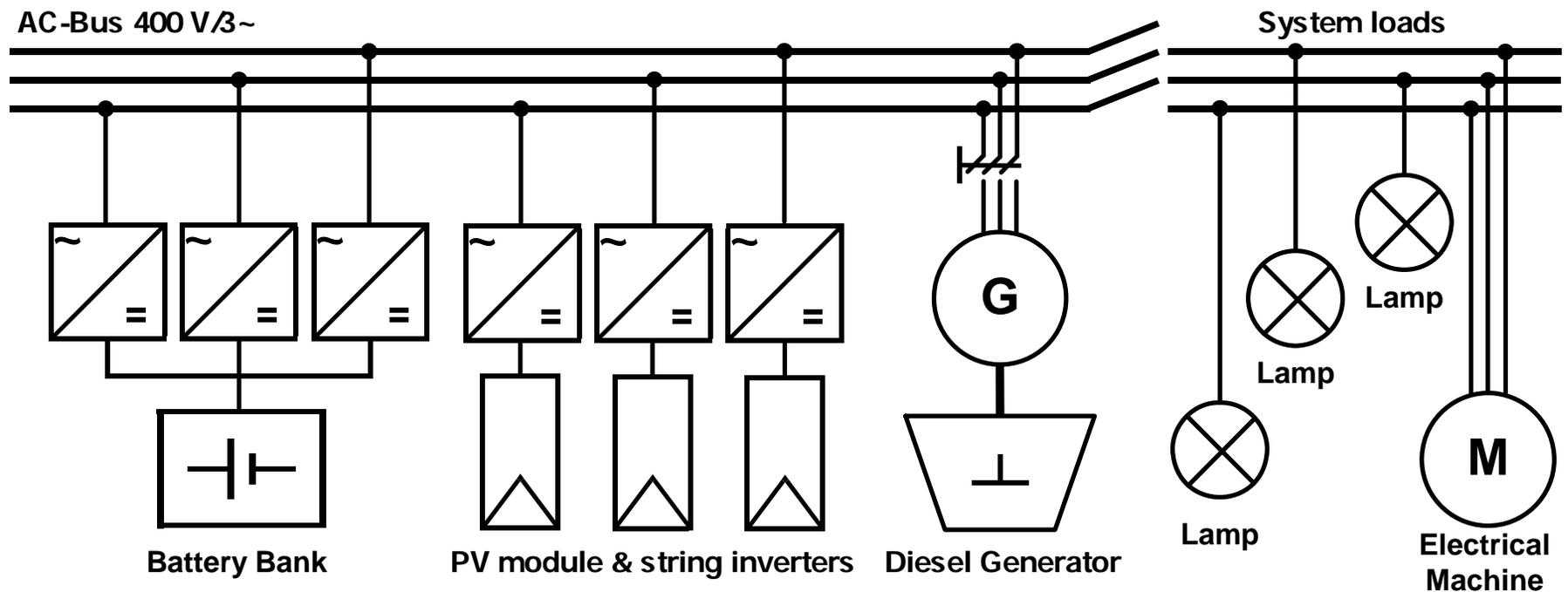
- Solar lanterns with possibilities for battery charging with a lifetime of 25 years, can economically replace kerosene lamps and batteries for rural households in Cameroon.
- CAT Bamenda has conceived a project with partners TOTAL Cameroon importer of solar lanterns and CAMCCUL the farmers bank to provide small-loans to farmers for the purchase of solar lanterns.
- CAT Bamenda is responsible for the maintenance of solar lanterns and replacement of defective lanterns within the period of warranty.
- Solar Home Systems can also be designed and installed on request as is the case of the Babungo integrated health centre.
- Solar powered pumps can also be designed and installed as is the case of the Nzong Foto water pumping facility, in Dschang.
- Photovoltaic/diesel systems can also be designed and implemented for the electrification of remote villages.

Alternative solutions (2/3)



- Fig. 2 Single phase AC-coupled hybrid power system

Alternative solutions (3/3)



- Fig. 3 Three phase AC-coupled hybrid power system

Photovoltaic Application in West Region (1/6)

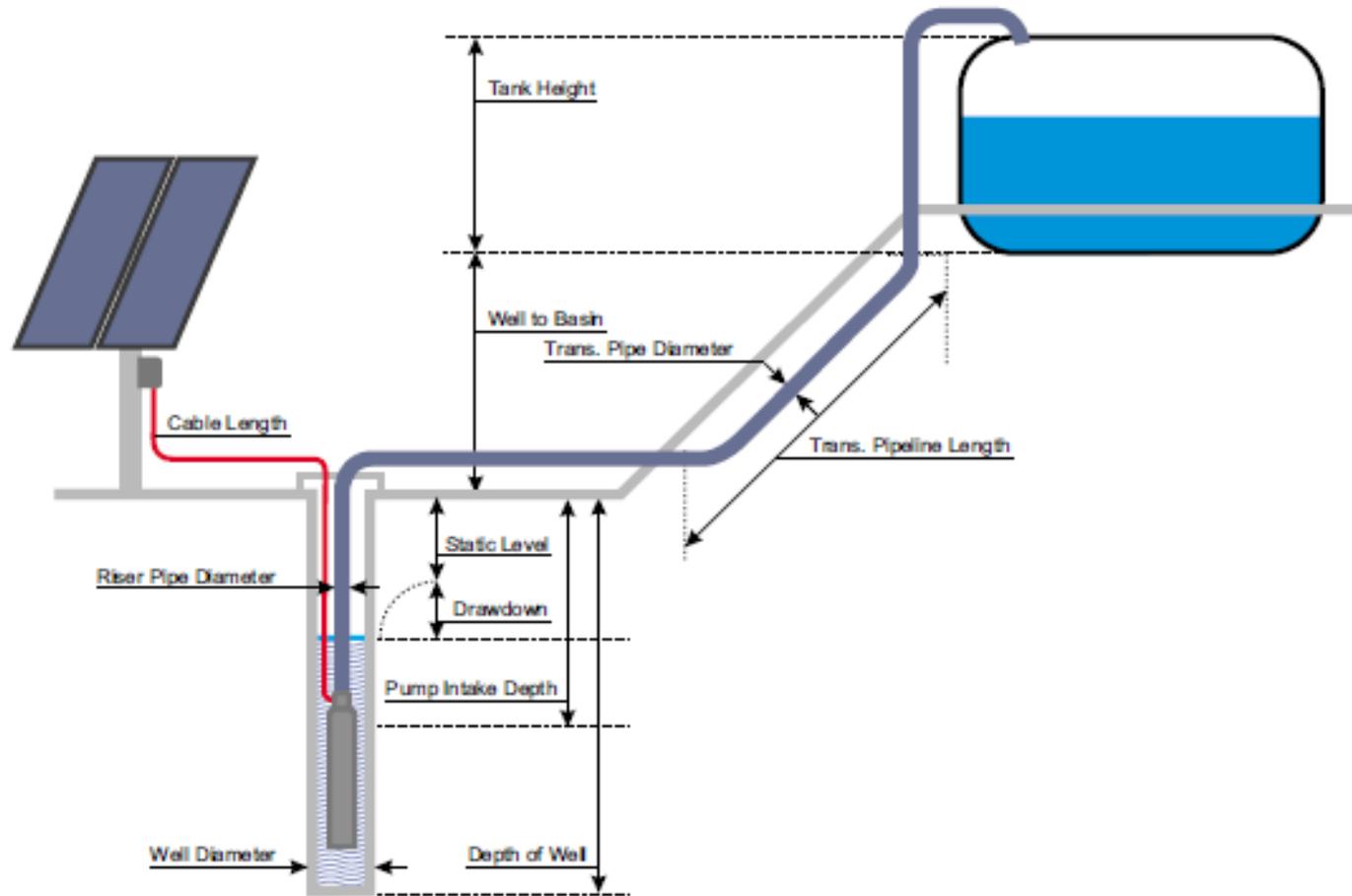
- Nzong-Foto, Dschang (5°30' N, 9°54' E) in the West Region of Cameroon has an average daily radiation of 4.68kWh/m²/d.
- The solar water pumping system in Nzong Foto at 20km from Dschang serves a population of about 3000 inhabitants.
- The overhead water tank has a capacity of 5m³ and the vertical lift is 120m and the maximum water flow rate is 1.2 m³/h.
- The components of the system include a 320 Wp solar array, Lorentz PS 1200 submersible water pump.
- The total cost of the installation was 10 million FCFA and was financed by the Chief of Nzong-Foto who leaves in Italy.
- The system has been operating since February 2011 and the pump fills the tank twice per day.
- Water related diseases have reduced resulting in increased productivity in the area.
- Solar based options for rural homes and clusters of households are currently being studied by Geni Electric company.

Photovoltaic Application in West Region (2/6)



- Fig.4 Location of solar application near Dschang

Photovoltaic Application in West Region (3/6)



● Fig. 5 Photovoltaic water pumping system

Photovoltaic Application in West Region (4/6)



- Fig. 6 PV array comprising 4x80Wp Lorentz solar modules

Photovoltaic Application in West Region (5/6)



- Fig. 7 Completed photovoltaic installation

Photovoltaic Application in West Region (6/6)



- Fig. 8 Water collection by pupils, students, villagers

Photovoltaic Application in North West Region (1/3)

- Babungo, Ndop (6°03' N, 10°25' E) in the North West Region of Cameroon has an average daily radiation of 4.98kWh/m²/d.
- The solar application at Babungo integrated health centre 4km from Babungo town, serves a population of 16000 inhabitants.
- There are three separate solar systems with a total installed capacity of 3600W for a health centre, volunteers/staff quarters, a community building, a piggery and a poultry .
- The health centre has 40 single rooms, a laboratory with a microscope and two solar fridges.
- The volunteer/staff quarters consists of 6 apartments (2 rooms, kitchen, toilet and living).
- The community building has a hall with a seating capacity for 100 persons and two bed rooms.
- The solar system financed by a foundation in the Netherlands was realised from 2009-2010 at a total cost of 32 million FCFA.
- The system has been operating successfully since completion.

Photovoltaic Application in North West Region (3/3)

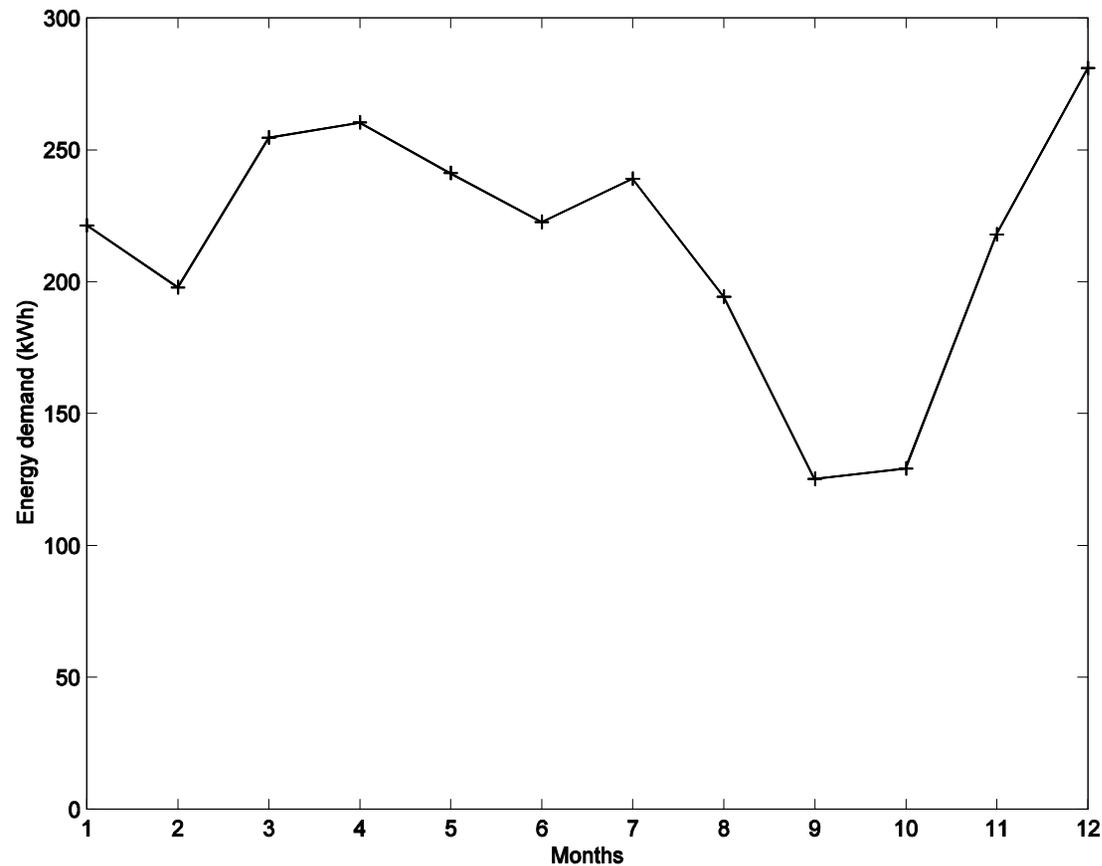


- Fig. 10 PV installation of Babungo Health Centre

Results of PVHS Research (1/4)

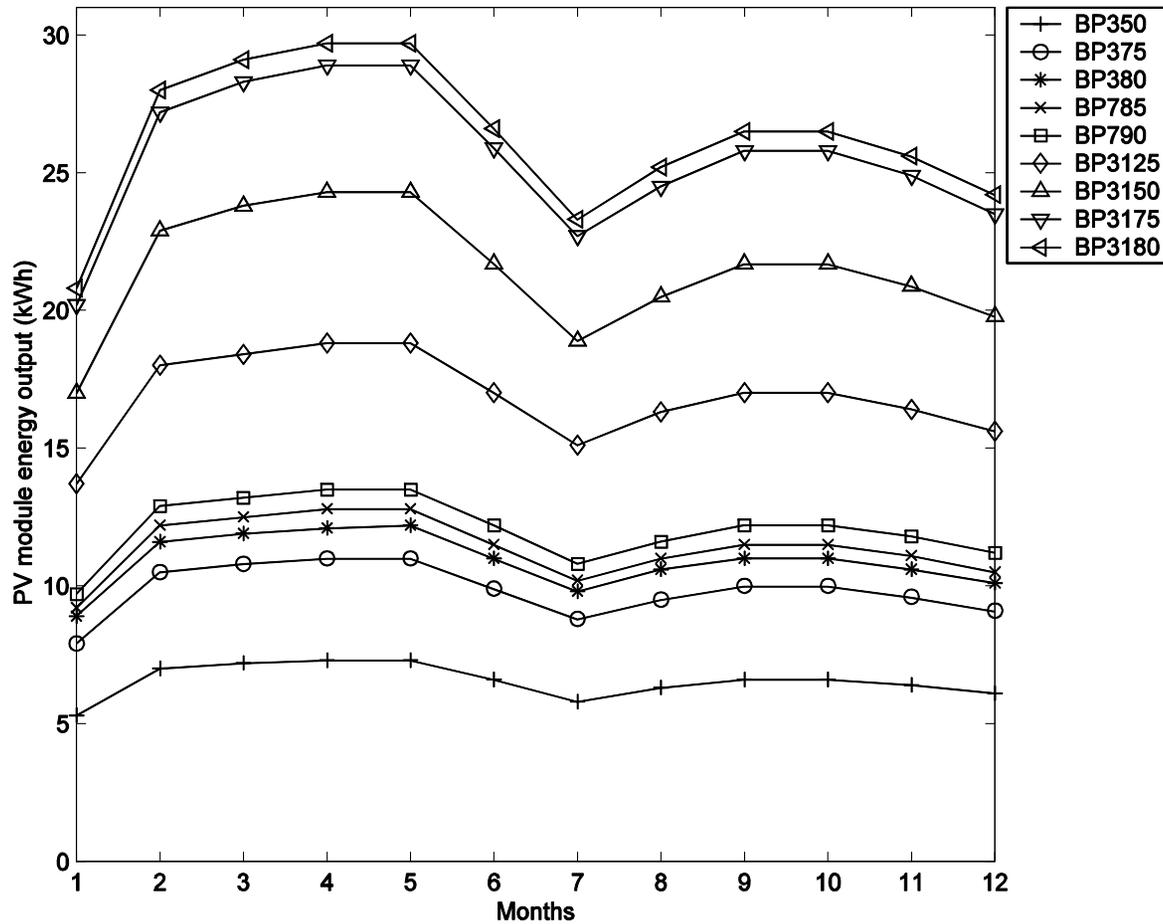
- Mini-grids for isolated Senegalese villages have been evaluated using an estimated load profile for a village with 750 inhabitants and the well known software HOMER (Alzola *et al*, 2009; <https://homerenergy.com>).
- HOMER requires daily load profiles which are often influenced by human behaviour in the different seasons of the year.
- A PVHS sizing model using monthly energy demands and outputs of PV modules has been developed (Nfah *et al*, 2007).
- Economic analysis using the Net Present Value (NPV) technique has also been proposed and tested on an energy demand of a secondary school estimated at 7.08 kWh/d.
- Sensitivity analysis using fuel prices and PV module costs showed that the PVHS had renewable fractions of 83-95.6%
- Several PVHS configurations were determined for the same energy demand by varying the renewable fraction (Mbaka *et al*, 2010).

Results of PVHS Research (2/4)



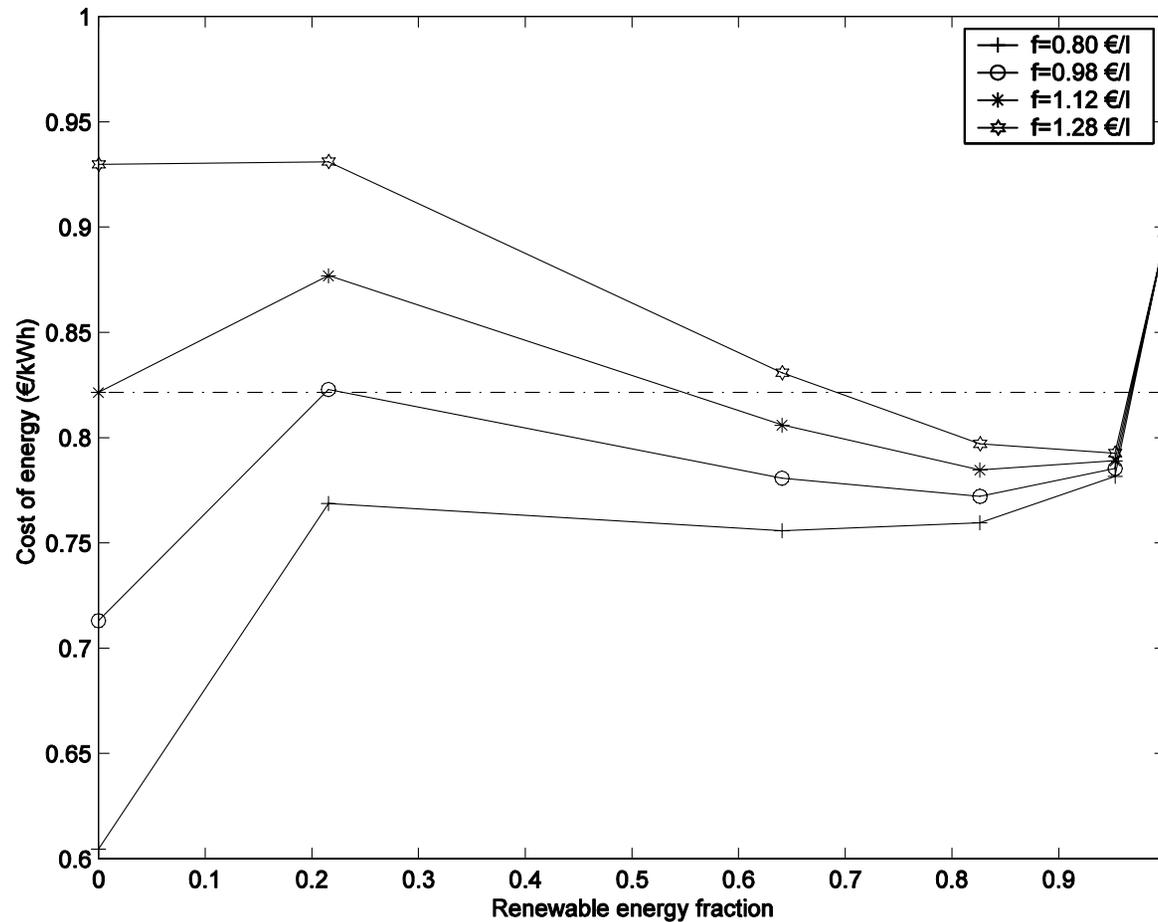
- Fig. 11 Monthly energy load profile selected in PVHS design (Nfah *et al*, 2007)

Results of PVHS Research (3/4)



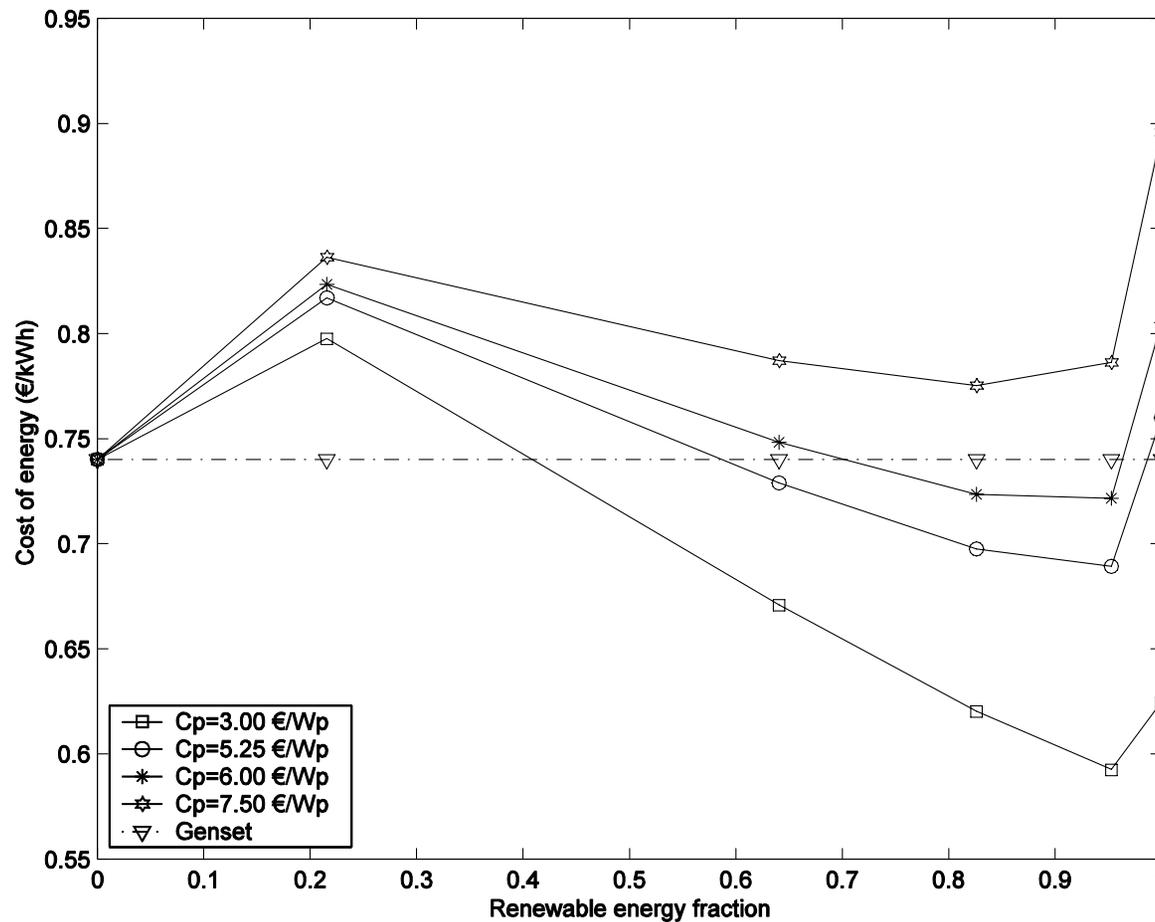
● Fig. 12 Variation of monthly output of selected solar modules (Nfah *et al*, 2007)

Results of PVHS Research (4/4)



● Fig. 13 Energy cost sensitivity to fuel costs and renewable fraction (Mbaka *et al* , 2010)

Results of PVHS Research (4/4)



● Fig. 14 Energy cost sensitivity to PV costs and renewable fraction (Mbaka *et al* , 2010)

Conclusions

- Solar energy options can contribute significantly to the quality of life in remote villages in Cameroon. However, the absence of community involvement may lead to the failure of the systems.
- Given that these systems were financed by the Chief of Nzong Foto and a foundation in the Netherlands, socio-economic studies for the evaluation of the capacity of villages to pay for solar energy options need to be conducted.
- In order to cover operation and maintenance of photovoltaic systems, it will be worthwhile to create local management committees and minimal fee-for-service tariffs.
- The impact of existing solar powered systems in remote villages in Cameroon merit investigation.
- It is also important that these systems should be economically designed so as to increase the number of these applications.
- The system design approach can be based on monthly demand data that is often used for energy billing.