Rural electrification in Sub Saharan Africa in a context of fluctuating oil-prices

Nygaard, Ivan; Bindner, Henrik W.; Katic, Ivan

Published in:
Energy solutions for CO2 emission peak and subsequent decline

Publication date:
2009
Rural electrification in SSA in a context of fluctuating oil prices

Is the time ready to move from SHS to hybrid PV-diesel systems?

Ivan Nygaard, UNEP Risø Centre, RISØ DTU, Denmark
Henrik Bindner, Wind Energy Division, RISØ DTU, Denmark
Ivan Katic, Energy & Climate Division, Technological Institute, Denmark
Outline of Presentation

• Rural electrification – the context
• Solar PV and development aid
• Changing economic conditions
• Hybrid PV-diesel for small isolated grids
• Simulation results
• Conclusion
Rural electrification in SSA

- Electricity is one among other preconditions for development
- Per capita CO₂ emissions are low, so priorities are
  - Increased access
  - Clean development path
- Increase still slow:
  - Liberalization
  - New structures

Historically low electrification in Africa,
27 % in SSA
Rural electrification technologies

Price per kWh

- **Dry Cell Batteries**

Individual use:
- **Car batteries**
- **PV – gen. set**

Collective use:
- **Mini-grids**
- **Diesel - hybrid**
- **Grid connection**
- **Fossil - renewable**

Modernity

- Lighting
- Communication
- Productive use
Solar PV (SHS) historically

• High expectations in the 1970’s
  — high and increasing oil prices
  — rapid development of technology
  — aspirations of economic development in rural areas

• Converging interests between donors and industry
  • green movement, decentralisation, SHS as a liberal approach, climate change concerns
  • PRS contract (10 % of annual EU production of PV panels in 1989)

• Seemingly good arguments
  — leap-frog technology, high solar irradiation, long lifetime, low maintenance, difficult access to fossil fuel
SHS - status in the new millennium

Bad reputation
- Donor driven agenda
- Second best solution
  - SHS mainly for communicative and not for productive use
  - Not an alternative to grid connection
- Donated systems to schools, health centres, community centres have a high failure rate
- Theft a great problem

Matured technology
- Increasing markets
  - 2.5 million SHS worldwide
  - > 0.5 million SHS in Africa

- Especially in a few countries
  - Kenya 200,000
  - South Africa 150,000
  - Morocco 100,000
  - Mali 70,000
  - Zimbabwe 15,000
Solar PV in hybrid systems

• PV hybrid is more flexible compared to SHS
  — Supply to mini-grids
    • productive use, standard appliances
    • future grid connection, useful for building up load

• PV hybrid (wind) is mainly used for specific purpose
  — isolated nature camps (Thailand)
  — small islands communities
  — test plants (ex. 500 kW in Thailand)
  — Gobabeb research centre, Namibia
  — SYS-LAB test system at Risø DTU

• Increasing no. of reports that hybrid systems are competitive to diesel systems
Hybrid PV-diesel system in Mali

• Technical Specifications:
  – Diesel 100 kVA
  – PV, 72 kWp
  – Battery, 24720 Ah
  – Present max load, 25 kW
  – Consumers, 217

• Economy
  – Investment 512,000 EUR
  – Subsidy  60 %
  – Import tax exemption, 100 %
  – Consumer price: 0,27 EUR/kWh

Sources: Presentation by Amadou Isaac Diallo, Director General of Yeelen Kura,
Presentation by Djibril SEMEGA, Technical responsible at SSD-EN SA at meeting in Club Agences en charge d’ER-Bamako 2008
Changing conditions: oil prices

Inflation Adjusted Monthly CRUDE OIL PRICES
(1946-Present) In November 2008 Dollars
©www.InflationData.com
Updated 1/8/2009

Source of Data:
Oil Prices - www.iogs.com/Special/crudeoil_Hist.htm
CPI-U Inflation index - www.bls.gov
Oil prices forecast, DOE

Crude Oil Prices

- West Texas Intermediate (WTI)
- Average Refiner Acquisition Cost (RAC)

Dollars per barrel


Short-Term Energy Outlook, August 2009
Price reduction of PV modules

Doubling of cumulated production reduces prices by 20 %

Accumulated capacity, 1995-2008

Solar module retail prices
Simulation preconditions
Production costs for diesel, PV-hybrid and PV alone

Small system (37 kW)

Large system (150 kW)
Production costs for diesel, PV-hybrid and PV alone

Oil price 25 USD/barrel

Oil price 75 USD/barrel
Simulation conclusion

- SHS will increasingly be interesting for
  - dispersed villages and outskirts of nucleated villages,
  - not competitive to mini-grid systems
- PV – hybrid systems for mini-grids are feasible compared to diesel systems, but depending on context
- Calculations are sensitive to:
  - system size, system configuration
  - existing and future load patterns
  - battery lifetime
Policy recommendations

• Ensure a level playing field for PV and diesel solutions
  – fuel subsidies, (fuel tax)
  – Equal tax on material (also replacements)

• Increase project volume to reduce costs
  – Move from single projects to programmes
  – Economy of scale and reducing technology risk

• Institutional framework
  – Rural electrification agencies (planning)
  – Utilities
  – Concession: Mali (EDF), Senegal (ONE), SA (several)

• Given continuing high oil prices
  – It is likely that PV-hybrid systems will prevail in rural electrification schemes in SSA within the next 10 years
Thanks for your attention !