SM²: SOLAR MONITORING SYSTEM IN MALAWI

Mayamiko Nkoloma mnkoloma@poly.ac.mw
The Scottish Government announced in October 2008 that a EEE Department project will be given the go ahead to undertake a solar powered study focusing on installations in four rural communities in Malawi. Academic and research staff in the Department now have funds to work with partners in Malawi under the Malawi Development Programme of the Scottish Government's International Development Fund. The Community Rural Electrification and Development (CRED) project has received approximately £140,000 of funds from the Scottish Government and will run for two and half years from 1 October 2008.

The project seeks to establish a sustainable model for renewable energy development in Malawi where power supplies in rural areas are very rare - only 7% of the population have an electricity supply. The sustainable model focuses strong community involvement in the electricity supply from scoping and design through to installation and in-life maintenance. Staff from EEE, together with Gary Connor from the Mechanical Engineering Department, will work with the four rural communities and the Government of Malawi’s Energy Department to establish resources, training and support for rural communities to own and benefit from their own solar powered electricity supply.
Problem definition

- Challenges met by solar PV maintenance team at Polytechnic – CRED Prj
  - Long distance between sites
  - Poor road networks

- Consequences
  - Most rural sites are not adequately maintained
Project Goal

- Develop a cost effective wireless based remote monitoring system that continuously presents remote energy yields and performance measures
- Test bed setup at
  - Malawi primary School in Chiradzulo District
    - Solar PV Electrical System
  - Malawi Polytechnic
    - Central Management System
Pictorial View of Malavi Primary School
System Architecture

- SMS
- PV voltages
- PV currents
- Solar radiation

Cellular Network

Internet

- SMS management system
- Database management
- Notifications
- Alarm
- Alerts

Malawi Polytechnic - Monitoring side

Malawi FP School block - Remote site

Sensor board connected to PV system
System Architecture

- WSN based approach
- Waspmote sensor board utilized
  - Arduino based device
  - Modular architecture
    - Communication modules
      - GPRS – Incorporated for SMS transactions, Zigbee
  - 7 input accessible pinouts to capture outside voltages
    - Phidget voltage sensors grafted to read solar PV voltages
System Architecture – Remote Site

- Remote sensing mechanism

Diagram showing the system architecture with components such as GPRS module, Waspmote Sensor Board, battery voltage, charging current, module current, module voltage, discharging current, battery voltage, load current, load voltage, solar panels, batteries, charge controller, lighting outlets, power sockets, and inverter. The diagram also illustrates the cellular network and internet connectivity.
System Architecture – Central Site

- System building blocks
  - SMS Gateway
  - Management System
System Architecture – Central Site

- Linux based SMS Gateway building block
- All in one machine

- Free Software
- Windows and Linux based versions available
- Worked with simplicity
  - With available dongle and laptop
- Can interact with other external programs
  - Shell commands, HTTP requests, Scripting languages, etc
System Key Benefits

- Access to PV system performance from anywhere through the use of internet
- Reports of power output and energy production trends
- Verification of system operation
- Collection of data for service and maintenance planning
- Use of open devices which lower the costs and enable the replicability of the solution
MONITORING & CONTROL OF PHOTOVOLTAIC SYSTEMS:

NEW INNOVATION IN RENEWABLE SYSTEMS: IZIT Master of Technology (M.Tech) research project work

Monitoring and control of photovoltaic (PV) systems is essential for reliable functioning and maximum yield of any solar system. Furthermore, this management and maintenance exercise is critical to the longevity of the system which can extend up to 20 years of operation. However, in Malawi, a typical example of a developing country, high costs of transportation, poor road networks and long distances between sites make it more challenging for technicians to visit all sites and effectively monitor system performance, as such most rural systems are not adequately maintained.

Chikawawa sites
Chiradzulu sites
Blantyre sites

Back and forth movements
• Data collecting
• Routine checks
• Fault finding

NOT EFFICIENT
• More time
• Costly
• Other sites not visited

Engineers
Technicians
Researchers

Malawi Polytechnic
Preliminary Experimental Results

- Voltage obtained from solar panels

- Voltage follows a day and night pattern
  - Solar panels provide voltage during the day and little voltage during the night
Preliminary Experimental Results

- Sensor board temperature

- Monitored to check if the board is not exposed to excessive heat
Preliminary Experimental Results

- Voltage supplied to electrical appliances; lights and sockets
Preliminary Experimental Results

- Voltage supplied to electrical appliances

During the night appliances obtain a constant 12v from batteries.

- Battery voltage not sufficient enough to supply power throughout period of little solar energy
  - At 3am equip is switched OFF by the charge controller due to battery voltage drop. Evidently observed by a complete power outage at the school block.
  - At 10am power comes ON, battery fully charged, energy obtained directly from panels.
Conclusion and Future Work

- Proposed system is currently running and has proved to lower management costs
- Timely information reaches the Polytechnic group right in front of their work stations
- Can assist in alerting technical team of remote circumstance
  - Also ease researchers study time
Conclusion and Future Work

- Results obtained logically agree with what is expected as the trend for solar module voltage during the day and night.
- System functionality and design specifications can be verified.
  - The one presented is under designed.
- There is room for future work.
  - Expand to measure more performance parameters.
  - GSM communication attribute allow easy system replication to other remote rural plants (Installations are being planned for 10 sites).
  - The system can be extended to allow for a smooth switchover between electrical and solar power supply depending on time — of — the — day power needs.
Grazie