



Potential Solar Energy Applications in Sierra Leone

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PRESENTATION

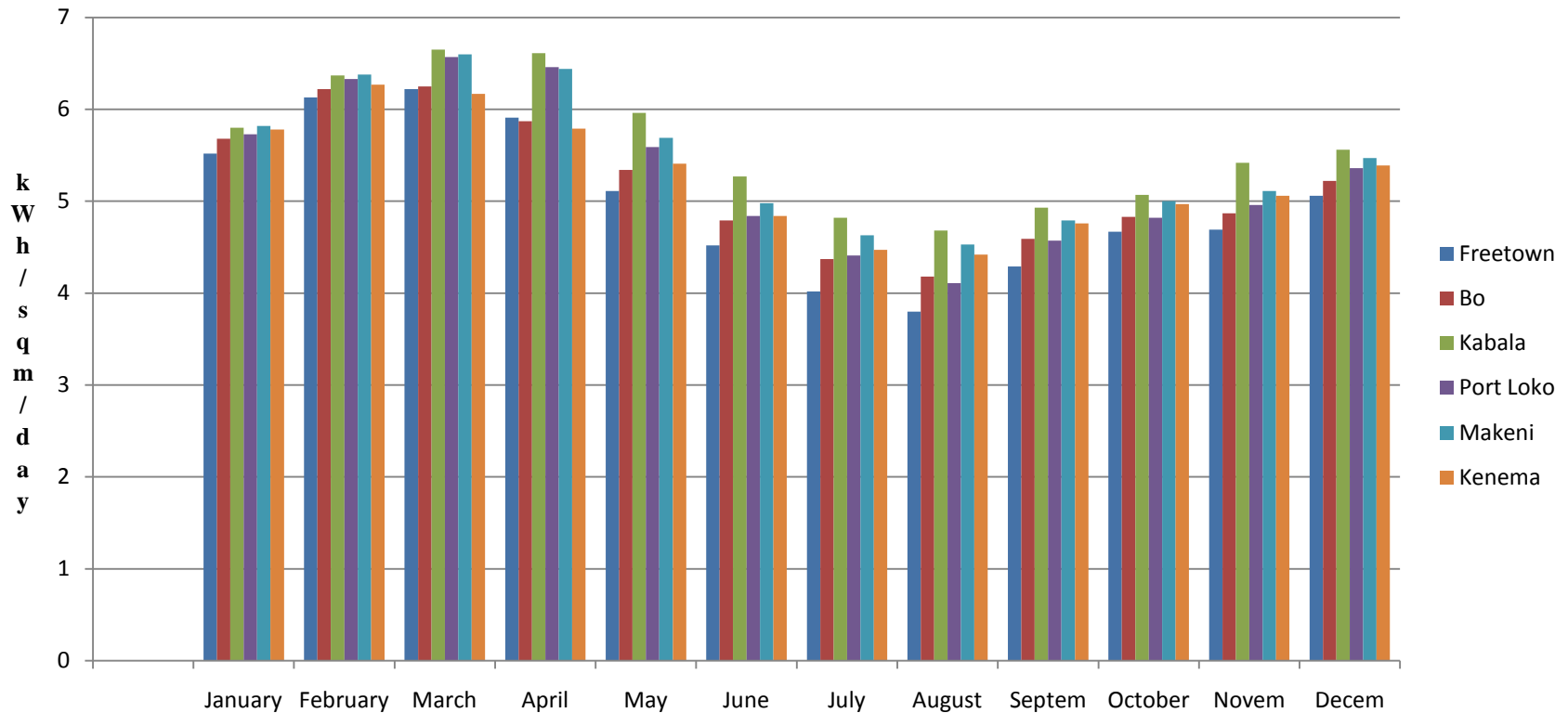
- **SOLAR RADIATION DATA FOR SIERRA LEONE**
- **CURRENT SITUATION**
- **POTENTIAL APPLICATIONS**
 - **SOLAR THERMAL APPLICATIONS**
 - **WATER HEATERS**
 - **CROP DRYERS**
 - **STAND-ALONE SOLAR PHOTOVOLTAIC APPLICATIONS**
 - **LIGHTING**

PRESENTATION (CTD)

- WATER PUMPING
- SOLAR REFRIGERATION
- DECENTRALIZED SYSTEMS
 - HOME SYSTEMS
 - RURAL ELECTRIFICATION SYSTEMS
- GRID-CONNECTED SOLAR PHOTOVOLTAIC POWER GENERATION
- CONCLUSIONS

SOLAR RADIATION DATA IN SIERRA LEONE (2002)

Source: NASA Langley Research Center Atmospheric Science Data
Center: New et al.2002



CURRENT SITUATION

- **SOLAR: SOLAR RADIATION (1,400 – 1,800) KWH/SQ M PER YEAR, VIRTUALLY UNTAPPED**
- **NEED FOR SOLAR PV SYSTEMS IS GREAT DUE TO THE SOLAR RADIATION AND VERY LOW ACCESS TO ELECTRICITY IN THE COUNTRY**
- **PILOT SOLAR LIGHTING AND TELEPHONE CHARGING HAVE BEEN DEMONSTRATED IN VILLAGES OVER THE COUNTRY (KONTA LINE, TOMBO, ETC.)**

CURRENT SITUATION (CTD)

- **A FEW PRIVATE FIRMS PROVIDE SOLAR HOME SYSTEMS**
- **BEFORE THE CIVIL CONFLICT IN THE COUNTRY, SOLAR PV WAS USED EXTENSIVELY IN THE TELECOMMUNICATIONS INDUSTRY AT REPEATER STATIONS. CURRENTLY, REPEATER STATIONS AND CELL SITES ARE USING DIESEL GENERATORS!!!**
- **APPARENTLY, ONLY ONE INSTITUTION IS USING SPV FOR WATER PUMPING**

CURRENT SITUATION (CTD)

- **A NUMBER OF SAMPLE SOLAR PV STREET-LIGHTING UNITS ARE INSTALLED ALL OVER THE COUNTRY**
- **TOTAL SOLAR GENERATED ELECTRICITY IN THE COUNTRY IS ESTIMATED AT ONLY 25kW**
- **USE OF SOLAR THERMAL SYSTEMS (FOR WATER HEATING, CROP DRYING ETC.) LIMITED, EVEN IF RESEARCH ON THE SUBJECT HAS BEEN UNDERTAKEN FOR YEARS**

SOLAR THERMAL ENERGY

Water Heating

COMPONENTS

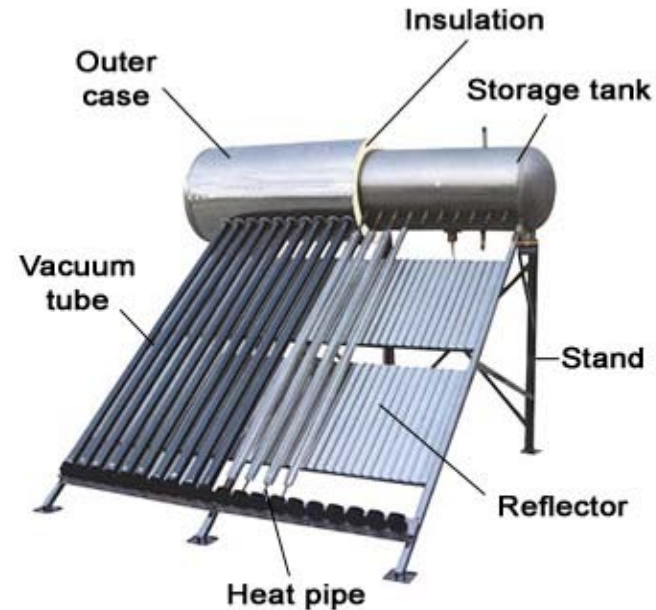
A solar collector

A storage vessel

A heat exchange fluid in the case of indirect systems

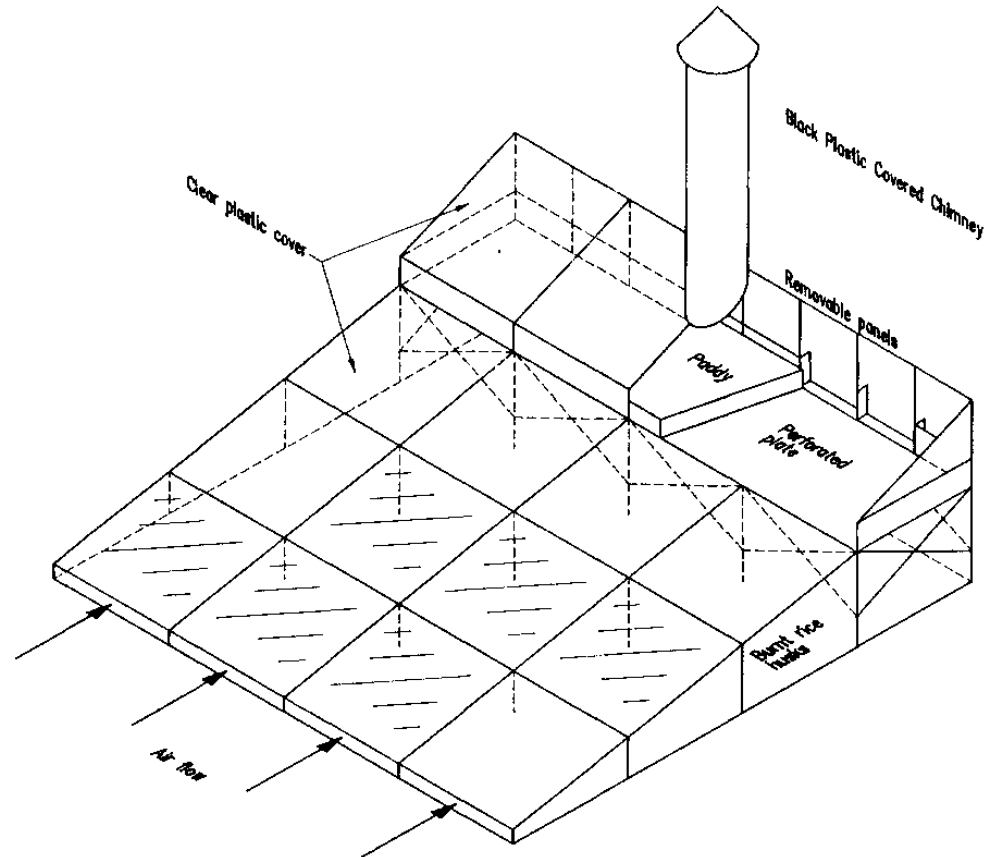
A pump in the case of an active system

Traditionally, flat-plate solar collectors have consisted of a simple glass-topped, insulated box with a flat absorber made of metal and attached to copper pipes.



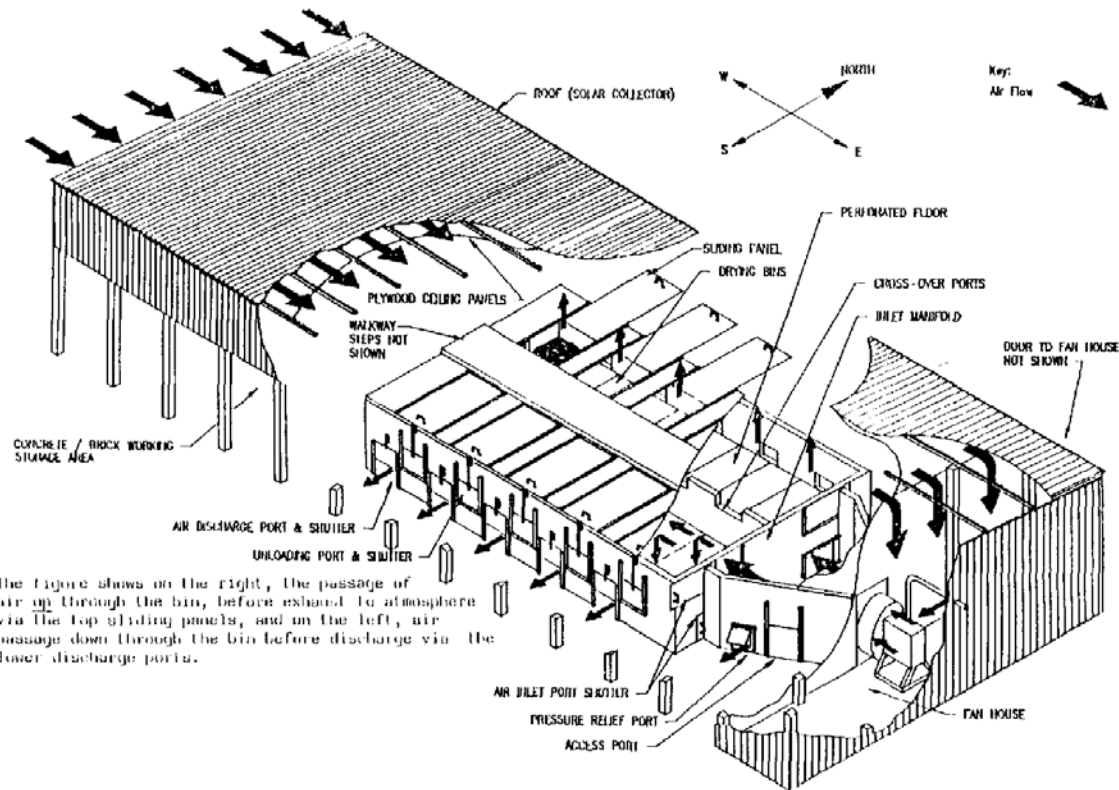
Components of an Evacuated Tube
Solar Water Heating System

Solar Crop Drying: Flat Plate Collectors.



Source: Exell (1980)

Solar drying: Forced Convection Solar Paddy Dryer.



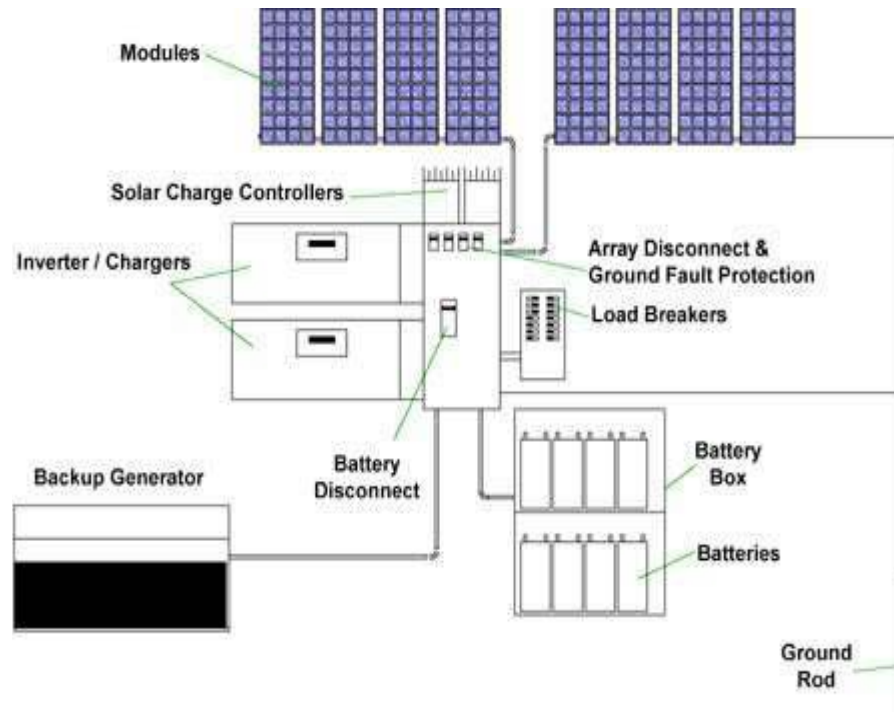
Source: Damardjati, Trim and Haryano (1991).

SOLAR CROP DRYING

- **The dryer consists of three components, a solar collector, the drying bin and a solar chimney.**
- **For a one tonne capacity dryer the collector is 4.5 m long and 7.0 m wide with the solar absorber base of burnt rice husks or black plastic sheet covered with clear plastic sheet.**

STAND-ALONE SPV

Typical Stand Alone System



SOLAR LIGHTING



SOLAR STREET LIGHTING



SOLAR WATER PUMPING SYSTEMS



SOLAR WATER PUMPING SYSTEMS

Solar Irrigation Controllers



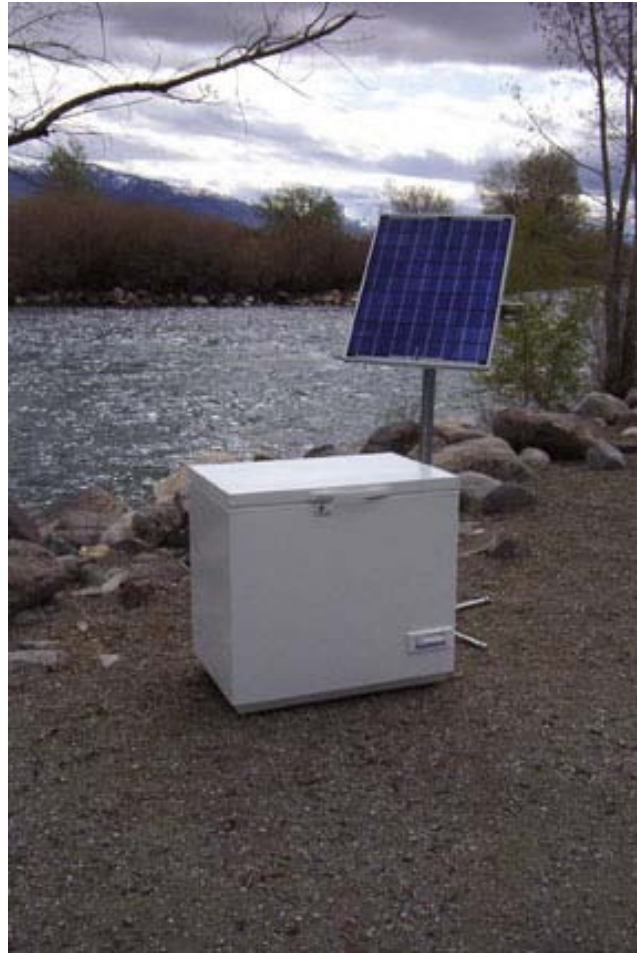
SOLAR WATER PUMPING

- Used to pump water for livestock, plants or humans.
- Need for water is greatest on hot sunny days the technology is an obvious choice for this application.
- Similar to any other pumping system, only the power source is solar energy
- Comprises: a PV array, a motor, and a bore pump. Can be AC or DC

DC POWERED EVAPORATIVE COOLERS



SOLAR REFRIGERATION



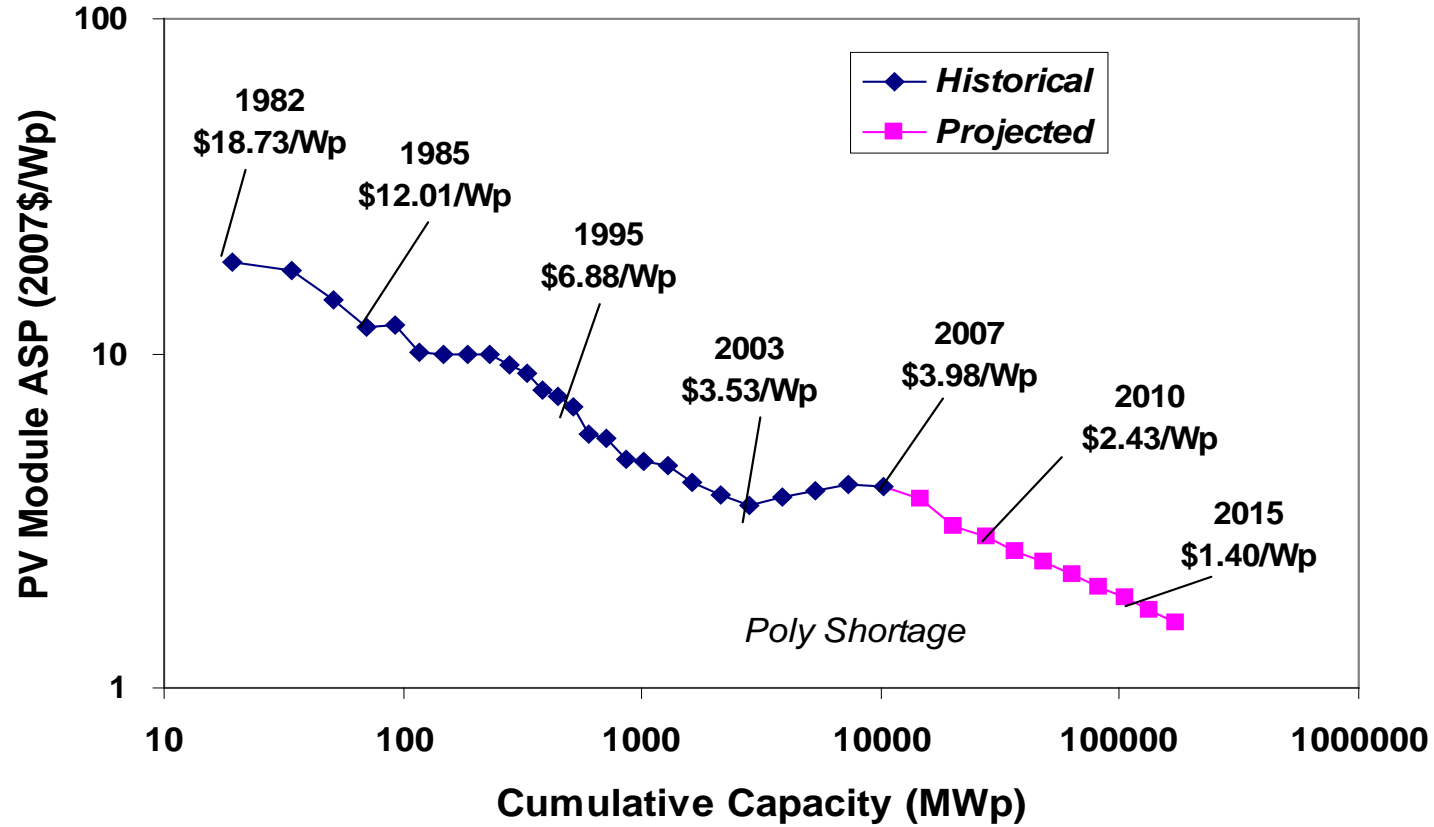
DECENTRALIZED SPV

- **HOME SYSTEMS: DC or AC (Ideal to provide electricity as alternative to grid)**
- **RURAL ELECTRIFICATION – mini grids connected to a number of user and applications**
 - Ideal solution for off-grid locations;
 - Used to power communal facilities such as clinics, schools, court barres, outdoor lighting, etc (either as connected or stand-alone systems.

GRID-CONNECTED SOLAR PHOTOVOLTAIC POWER GENERATION

- **Grid-connected market remains the major prize for the solar industry in view of the huge scale of the electricity supply market.**
- **Growth has been strongest recently.**
- **Best PV electricity prices (in the sunniest locations) approaching US\$0.30/kWh as compared to the highest tariffs now being levied for energy generation from fossil fuels exceeding US\$0.20/kWh, the gap is now close.**
- **SPV electricity prices falling fast and are expected to be competitive to electricity from fossil fuels by 2015**
- **20 GW installed worldwide by the end of 2009**

ECONOMICS OF SPV APPLICATIONS



ECONOMICS OF SPV (CTD)

SPV vs Diesel Water Pumping

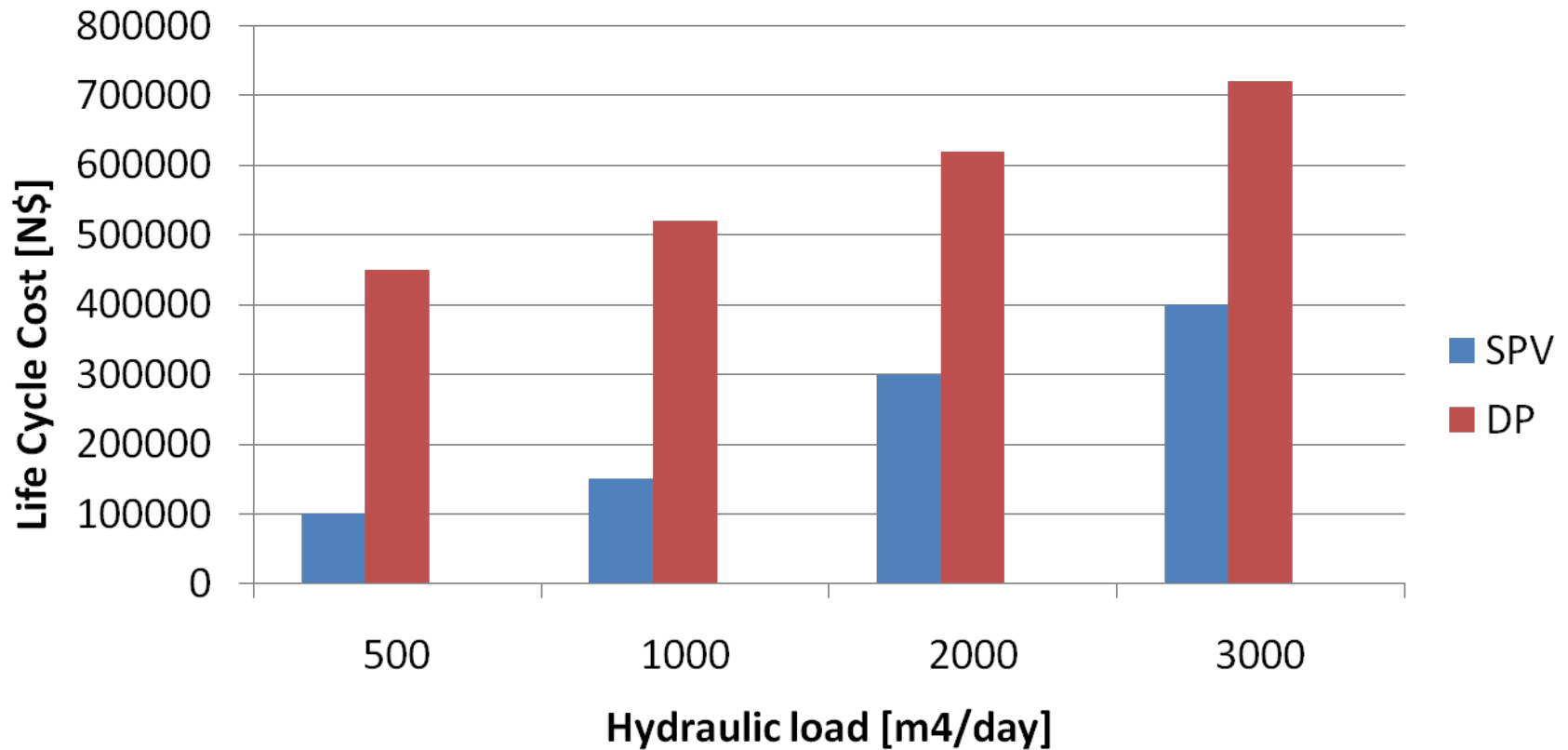
- A cost comparison for solar and diesel water pumps was conducted over a range of pumping in Namibia
- Heads (10m to 200m) and a range of daily flow rates (3m³/day to 50m³/day).

ECONOMICS OF SPV (CTD)

- The life cycle costs (LCC) were calculated over a 20 year period taking into account:
 - the initial upfront cost;
 - the operating costs (diesel fuel for the operation, inspections of pumping systems);
 - maintenance costs; and
 - replacement costs.

ECONOMICS OF SPV (CTD)

Cost Comparison SPV vs Diesel Water Pumping



ECONOMICS OF SOLAR LIGHTING

- It is estimated that using 8 watt fluorescent lights generating 400 lumens, a \$500 SHS can provide high quality lighting at an average cost of \$7.15 per million lumen-hours. For a diesel generator lighting 60W incandescent bulbs, this figure is \$28.77 per million lumen-hours. A kerosene lamp can provide lighting at \$400 per million lumen-hours

CONCLUSIONS

- **PROSPECTS FOR SOLAR ENERGY APPLICATIONS IN SIERRA LEONE GOOD**
- **FOR SMALL-SCALE WATER PUMPING, SPV SHOULD BE THE TECHNOLOGY OF CHOICE**
- **SOLAR LIGHTING AND REFRIGERATION WILL PROVIDE MUCH NEEDED ALTERNATIVE SUPPLY**
- **STAND-ALONE AND DECENTRALIZED SYSTEMS HOLD GREAT PROMISE TO PROVIDE POWER IN REMOTE AREAS**

CONCLUSIONS (CTD)

- **GRID-CONNECTED SOLAR POWER GENERATING PLANTS, WHILE HOLDING GREAT PROSPECTS FOR POWER GENERATION IN THE FUTURE ARE NOT YET READY FOR APPLICATION IN SIERRA LEONE, IN THE LIGHT OF POSSIBILITIES FOR GENERATION BY HYDROPOWER, ALTHOUGH THIS COULD CHANGE IN THE NEAR FUTURE IF COSTS OF SOLAR GENERATION CONTINUE TO DECREASE**

THANK YOU