Rural Electrification in Africa

Dr. Andreas Wiese
Director Business Development, Energy Division
Lahmeyer International GmbH

West African Power Industry Convention 2007, Abuja, NIGERIA
Agenda

1. Introduction Lahmeyer and Rural Electrification
2. Some Key Features of Rural Electrification
3. Renewable Energy as a Solution for RE in Africa
4. Successful Projects and Programs
   4.1 Example 1. Gambia
   4.2 Example 2. Botswana
   4.3 Example 2. South Africa & Kenya
5. Lessons Learned and Conclusions
## Company Overview

<table>
<thead>
<tr>
<th>Company</th>
<th>Lahmeyer International GmbH (LI) Consulting Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>1966</td>
</tr>
<tr>
<td>Headquarter</td>
<td>Bad Vilbel, Germany</td>
</tr>
<tr>
<td>Services</td>
<td>Technical and economic planning and consulting services</td>
</tr>
<tr>
<td>Fields of Activity</td>
<td>Energy, Hydropower and Water Resources, Transportation</td>
</tr>
<tr>
<td>LI Group</td>
<td>6 Associated Companies</td>
</tr>
<tr>
<td>Employees 2006</td>
<td>LI: 667, LI Group: 863</td>
</tr>
<tr>
<td>Turnover 2006</td>
<td>LI: 94 million Euro, LI Group: 114 million Euro</td>
</tr>
<tr>
<td>Representatives</td>
<td>In 50 Countries</td>
</tr>
<tr>
<td>Projects</td>
<td>In 140 Countries</td>
</tr>
</tbody>
</table>

West African Power Industry Convention 2007, Abuja, NIGERIA
LI’s Business Activities in Africa Region

**Current Project in Africa:**

- **Algeria**
  - Mao Dam
  - Solar Thermal Power plant
- **Burkina Faso**
  - Ouagadougou Water Supply
  - Samendeni Dam
- **Djibouti**
  - Feasibility Study for Wind Park
- **Egypt**
  - Rehabilitation of Thermal PP
  - Wind Farm Zafarana
  - Small Hydropower at Delta Barrages
  - Naga Hammadi Barrage
  - Mubarak Pumping Station
  - Damietta Hydropower Project
- **Ethiopia**
  - Grid-based Rural Electrification Project
  - Genale-Dawa river Basin Development
  - Beles Hydropower and Irrigation Project
  - Chemoga-Yeda Hydro power & Irrigation Project
  - Koraobi Hydropower Project
  - Halele-Werabesa Hydropower Project
- **Gambia**
  - Rural Electrification, scattered Diesel Power Plant and Area Distribution Network
  - Renewable Energy Study
- **Ghana**
  - Accra Sewerage Study
- **Libya**
  - Gulf Steam Power Plant
  - Feasibility Study New CCPP in Sirte
- **Madagascar**
  - Strategic Advisory, Utility Management, Management of JIRMA
  - Lokoho Transmission Project
- **Malawi**
  - Mozambique-Malawi OHL Interconnection
- **Mali**
  - Rural Electrification
- **Mauritania**
  - Water Supply Nouakchott-Aftout Essahi
  - Diesel Power Station
  - New Power Plant Program
- **Mozambique**
  - 110kV Overhead Transmission line

- **Nigeria**
  - Mambilla Hydropower Project
  - Grid Interconnection Nigeria-Benin
  - National Integrated Power Plant
- **Senegal**
  - Electrification Planning in the Provinces of Kaolack-Nioro and Fatick-Gossas
- **Sierra Leone**
  - Rhombe Swamps and Rolako Irrigation
- **Sudan**
  - Garri Sponge Coke Fire Power Plant
  - New Electricity Load Dispatch Center
  - Merowe Dam Project: Hydropower, Irrigation, Orthophoto Mapping
  - Transmission, Environment
- **Tanzania**
  - Dar-es-Salaam Power Generation
- **Uganda**
  - Owen Falls Extension Units 14&15
Scope of Services to Rural Electrification Projects

Consulting and engineering services:
- Grid extension versus off-grid system
- Feasibility study
- Conceptual design
- Detailed design
- Tender documents & evaluation
- Assistance in contract award
- Factory inspection
- Site supervision & Commissioning

Preparation of a rural electrification plan:
- Rural energy demand assessment
- Energy resource assessment
- Options for development
- Development coordination
- Action plan
- Transition from traditional to formal energy supply mechanism
- Sustainable and environmental friendly energy supply
- Need for Environmental & Social Impact Study

Rural energy sector strengthening:
- Services for:
  - Market reforms
  - Tariff design
  - Institutional development
  - Selling and maintenance service
  - Energy efficiency
  - Financing and marketing approaches

West African Power Industry Convention 2007, Abuja, NIGERIA
Current Electrification in Africa

- Approximately one-third of 1.6 billion people **without** access to electricity worldwide live in Africa.
- Only 20% of Africans have access to electricity (excluding South Africa, Maghreb and most Urban areas).
- Access to energy is essential for the reduction of poverty and promotion of economic growth.
- While a great number of projects are currently underway to expand and connect the existing grid networks, many problems exist to make this a realistic option for the majority of people in Africa, especially those who live in rural areas.
- Using renewable energy systems is the very often the only practical solution to meet rural electrification needs.

Key Features of Rural Electrification

Technical Options:
- Grid Extension
- Off-Grid
  - Mini-grids
  - Micro-grids
  - Isolated system

Key Issues:
- Lack of financial resources for grid extension
- High initial costs of off-grid technologies
- Lack of information

Subsidy
- Can pay full cost
- Need financing assistance
- Need subsidies
Expected Benefits of Rural Electrification - Examples

The Price of Lighting with Kerosene & Electricity

Least Cost Option for a Hypothetical 100 HH Village (Lifecycle Costs)

Source: Domestic Energy and Women’s Lives, World Bank, 2004

West African Power Industry Convention 2007, Abuja, NIGERIA
Renewable Energy in Africa

**SOLAR**

**WIND**

**BIOMASS**
## Renewable Energy Resource and Technologies for Electricity Generation

<table>
<thead>
<tr>
<th></th>
<th>Hydro-power</th>
<th>Wind</th>
<th>Geothermal</th>
<th>Photovoltaic</th>
<th>Solar-thermal</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approximate Installed capacity (MW)</strong></td>
<td>20,000</td>
<td>240</td>
<td>134</td>
<td>150 – 200</td>
<td>0</td>
<td>300 – 400</td>
</tr>
<tr>
<td><strong>Country with highest installed capacity</strong></td>
<td>Egypt</td>
<td>Egypt</td>
<td>Kenya</td>
<td>Kenya</td>
<td>-</td>
<td>Mauritius</td>
</tr>
<tr>
<td><strong>Technical potential</strong></td>
<td>Very high</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Average specific investment cost ($10^6$ Euro/MW)</strong></td>
<td>2.0 – 4.0</td>
<td>1.0 -1.2</td>
<td>3.0 – 4.0</td>
<td>5.0 – 8.0</td>
<td>2.2 – 3.0</td>
<td>1.0 – 2.5</td>
</tr>
<tr>
<td><strong>Economic potential</strong></td>
<td>Very high</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Supply of electricity</strong></td>
<td>Partly firm</td>
<td>Fluctuating</td>
<td>Firm</td>
<td>Fluctuating</td>
<td>Partly firm</td>
<td>Firm</td>
</tr>
<tr>
<td><strong>Average full load operation ($10^3$ h)</strong></td>
<td>5.0 – 7.0</td>
<td>2.5 – 3.5</td>
<td>7.0 – 8.0</td>
<td>1.0 - 1.2</td>
<td>2.0 – 2.3</td>
<td>5.0 – 7.5</td>
</tr>
<tr>
<td><strong>Competitive use of resource</strong></td>
<td>yes</td>
<td>no</td>
<td>Partly</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

*Table 1: Renewable energy resource and technologies for electricity generation*
Successful Rural Electrification Projects

- **Decentralized Virtual utilities**
  - Fee for service
  - Rely on dispersed technology (e.g. SHS)
  - Fixed Monthly payments
  - Prepaid cards

- **Energy equipment dealers**
  - Renewable Energy technologies lend themselves to being sold by local dealer network
  - The creation of financing infrastructure

- **Local electricity retailers**
  - Electricity retail business, either off-grid as an isolated system, or connected to the grid and buying a bulk
    - Isolated system: choice of technology best suited to location
    - Grid connection retailers: new local distribution system or lease an existing one

- **Creative Concessions**
  - Invite bidders for concessions to supply electricity in remote provinces
  - Historically, technology driven: access exclusively through grid-extension, exclusively with diesel mini-grids, or exclusively with SHS
  - Current generation of projects more technology neutral

- The main types of emerging service delivery mechanism
LI’s Project: Study for RE Program in Gambia

- LI was contracted by the Government of Gambia
- Plan to install 6,000 SHSs and PV systems for rural clinics, school and community centers
- LI’s scope of services:

  ✓ **1st Phase – Renewable Energy Master Plan:**
    - Energy demand assessment and forecast model development
    - Preparation of a Renewable Energy Master Plan (REMP)
    - Economic and financial analysis
    - Project financing advice including micro credit schemes
    - Development of policies for energy and renewable energy sector development

  ✓ **2nd Phase – Feasibility Study:**
    - Energy demand assessment for selected pilot project
    - Conceptual design and technical layout
    - Cost assessment including investment and O&M costs
    - Environmental and Social Management Plan (ESMP)
    - Institutional Arrangements, Financing Mechanism and Management Structure

West African Power Industry Convention 2007, Abuja, NIGERIA
# LI’s Project: Study for RE Program in Gambia

<table>
<thead>
<tr>
<th>Renewable Energy Source</th>
<th>Product</th>
<th>LGA of Banjul</th>
<th>LGA of Koni-Fing</th>
<th>LGA of Brikama</th>
<th>LGA of Mansokonko</th>
<th>LGA of Kerewan</th>
<th>LGA of Kairiur</th>
<th>LGA of Janjanbureh</th>
<th>LGA of Basse</th>
<th>Total Gambia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Radiation</td>
<td>Large PV Plant</td>
<td>1.000.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,006.0</td>
</tr>
<tr>
<td></td>
<td>Solar Lantern</td>
<td>0.05</td>
<td>0.03</td>
<td>0.05</td>
<td>0.06</td>
<td>0.06</td>
<td>0.01</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pico SHS</td>
<td>0.12</td>
<td>0.05</td>
<td>0.12</td>
<td>0.15</td>
<td>0.12</td>
<td>0.03</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mini SHS</td>
<td>0.30</td>
<td>0.10</td>
<td>0.36</td>
<td>0.42</td>
<td>0.36</td>
<td>0.06</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small SHS</td>
<td>0.96</td>
<td>0.48</td>
<td>0.96</td>
<td>1.08</td>
<td>1.08</td>
<td>0.24</td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large SHS</td>
<td>1.50</td>
<td>0.80</td>
<td>1.60</td>
<td>1.80</td>
<td>1.80</td>
<td>0.40</td>
<td>8.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solar-Diesel 10% RE</td>
<td>406.0</td>
<td>37.0</td>
<td>130.0</td>
<td>310.0</td>
<td>882.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solar-Diesel 15% RE</td>
<td>605.0</td>
<td>55.0</td>
<td>190.0</td>
<td>470.0</td>
<td>1,320.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solar-Diesel 20% RE</td>
<td>825.0</td>
<td>75.0</td>
<td>250.0</td>
<td>650.0</td>
<td>1,810.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Power</td>
<td>SWP_1a</td>
<td>3,960.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,960.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWP_1b</td>
<td>3,960.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,960.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWP_2a</td>
<td>1,500.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,500.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWP_2b</td>
<td>1,500.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,500.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWP_3a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.0</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWP_3b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.0</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WSAS_1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>105.0</td>
<td>105.0</td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>BM_1</td>
<td>600.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>600.0</td>
<td></td>
</tr>
</tbody>
</table>

West African Power Industry Convention 2007, Abuja, NIGERIA
<table>
<thead>
<tr>
<th>Item</th>
<th>Cap in kW</th>
<th>Net Energy Generation per Year</th>
<th>Fuel Saving in Liter per Year</th>
<th>Investment in USD</th>
<th>Lifetime in a</th>
<th>Maintenance Cost in USD per Year</th>
<th>Maintenance Cost in USD per Year (1/14a)</th>
<th>Maintenance Cost in USD per Year (1/25a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV_1</td>
<td>1,060</td>
<td>1,306,450</td>
<td>512,150</td>
<td>6,009,471</td>
<td>20</td>
<td>120,103</td>
<td>160,254</td>
<td></td>
</tr>
<tr>
<td>PV_2_9L</td>
<td>4</td>
<td>63.57</td>
<td>2.19</td>
<td>04</td>
<td>7</td>
<td>2</td>
<td>Reinvest of 50 USD (new later) after 14 years</td>
<td></td>
</tr>
<tr>
<td>PV_2_SH3p</td>
<td>12</td>
<td>13.71</td>
<td>6.37</td>
<td>476</td>
<td>20</td>
<td>6</td>
<td>Reinvest of 132 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>PV_2_SH3m</td>
<td>40</td>
<td>63.70</td>
<td>21.30</td>
<td>794</td>
<td>20</td>
<td>12</td>
<td>Reinvest of 156 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>PV_2_SH3s</td>
<td>75</td>
<td>123.19</td>
<td>41.66</td>
<td>1,103</td>
<td>20</td>
<td>18</td>
<td>Reinvest of 340 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>PV_2_SH3l</td>
<td>120</td>
<td>197.10</td>
<td>65.70</td>
<td>1,408</td>
<td>20</td>
<td>24</td>
<td>Reinvest of 398 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>PV_3_16%</td>
<td>270</td>
<td>521,350</td>
<td>173,363</td>
<td>1,209,000</td>
<td>20</td>
<td>12,036</td>
<td>Reinvest of 398 USD (Battery) after 15 years Reinvest of 135,000 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>PV_3_15%</td>
<td>410</td>
<td>792,420</td>
<td>234,140</td>
<td>1,502,000</td>
<td>20</td>
<td>13,028</td>
<td>Reinvest of 398 USD (Battery) after 15 years Reinvest of 203,000 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>PV_3_10%</td>
<td>500</td>
<td>1,062,880</td>
<td>334,253</td>
<td>2,544,000</td>
<td>20</td>
<td>25,440</td>
<td>Reinvest of 398 USD (Battery) after 15 years Reinvest of 257,500 USD (Battery)</td>
<td></td>
</tr>
<tr>
<td>SWP_1a</td>
<td>3,946</td>
<td>1,872,960</td>
<td>526,000</td>
<td>5,712,000</td>
<td>20</td>
<td>105,739</td>
<td>189,182</td>
<td>253,773</td>
</tr>
<tr>
<td>SWP_1b</td>
<td>3,946</td>
<td>1,872,960</td>
<td>526,000</td>
<td>2,454,144</td>
<td>20</td>
<td>253,737</td>
<td>253,733</td>
<td>358,934</td>
</tr>
<tr>
<td>SWP_2a</td>
<td>1,500</td>
<td>608,762</td>
<td>220,564</td>
<td>2,609,991</td>
<td>20</td>
<td>53,871</td>
<td>66,169</td>
<td>129,299</td>
</tr>
<tr>
<td>SWP_2b</td>
<td>1,500</td>
<td>608,762</td>
<td>220,564</td>
<td>1,272,701</td>
<td>20</td>
<td>129,299</td>
<td>129,299</td>
<td>129,299</td>
</tr>
<tr>
<td>SWP_3a</td>
<td>60</td>
<td>55,920</td>
<td>16,642</td>
<td>250,010</td>
<td>20</td>
<td>5,073</td>
<td>8,117</td>
<td>12,175</td>
</tr>
<tr>
<td>SWP_3b</td>
<td>60</td>
<td>55,920</td>
<td>16,642</td>
<td>137,444</td>
<td>20</td>
<td>12,176</td>
<td>16,233</td>
<td>16,233</td>
</tr>
<tr>
<td>WSAS_1</td>
<td>180</td>
<td>59,734</td>
<td>19,918</td>
<td>282,096</td>
<td>20</td>
<td>8,389</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>BM_1</td>
<td>590</td>
<td>4,206,560</td>
<td>1,530,460</td>
<td>20</td>
<td>4,178</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

West African Power Industry Convention 2007, Abuja, NIGERIA
# LI’s Project: Study for RE Program in Gambia

## Investment Plan - Period I: 2006 - 2010

<table>
<thead>
<tr>
<th>Project/Programme Description</th>
<th>Total kUSD</th>
<th>LGA</th>
<th>Local components %</th>
<th>Imported components %</th>
<th>Total %</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Total %</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Total kUSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut shell heat and power plant 600 kW for Banju Breweries</td>
<td>2,378</td>
<td>Kanfing</td>
<td>10%</td>
<td>90%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>36%</td>
<td>56%</td>
<td>100%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>032</td>
<td>1,644</td>
<td>2,378</td>
</tr>
<tr>
<td>Small wind park 3,900 kW with used equipment</td>
<td>2,404</td>
<td>Brikama</td>
<td>5%</td>
<td>95%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>30%</td>
<td>70%</td>
<td>0%</td>
<td>100%</td>
<td>-</td>
<td>-</td>
<td>726</td>
<td>1,718</td>
<td>-</td>
<td>2,404</td>
</tr>
<tr>
<td>Small wind park 60 kW with used equipment</td>
<td>58</td>
<td>Kerewan</td>
<td>5%</td>
<td>95%</td>
<td>100%</td>
<td>0%</td>
<td>30%</td>
<td>70%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>-</td>
<td>17</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>58</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,880</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>4,880</strong></td>
</tr>
</tbody>
</table>

### Annual investment (% of total investment and in kUSD)

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period I</td>
<td>17</td>
<td>770</td>
<td>2,549</td>
<td>1,544</td>
<td>4,880</td>
</tr>
</tbody>
</table>

---

West African Power Industry Convention 2007, Abuja, NIGERIA
LI’s Project: Study for RE Program in Gambia

<table>
<thead>
<tr>
<th>Component</th>
<th>Small solar home system</th>
<th>Medium solar home system</th>
<th>Large solar home system</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV array</td>
<td>40 W</td>
<td>70 W</td>
<td>150 W</td>
</tr>
<tr>
<td>Battery</td>
<td>35 Ah</td>
<td>60 Ah</td>
<td>120 Ah</td>
</tr>
<tr>
<td>Lights</td>
<td>3 bulbs 9 W LC</td>
<td>4 bulbs 9 W LC</td>
<td>5 bulbs 9 W LC</td>
</tr>
<tr>
<td>Other appliances</td>
<td>10 W DC Radio set</td>
<td>20 W DC Black &amp; White TV set</td>
<td>60 W AC Colour TV Set, 60 W AC/DC Inverter</td>
</tr>
<tr>
<td>Energy Generated per year</td>
<td>33 kWh</td>
<td>59 kWh</td>
<td>121 kWh</td>
</tr>
</tbody>
</table>

---

**Health Centres**

<table>
<thead>
<tr>
<th>Application</th>
<th>Item Description</th>
<th>Hours of use</th>
<th>Daily Consumption in Wh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>5 LC bulbs (15 W each), DC 12V</td>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>1 solar fridge (about 120 W), DC 24V</td>
<td>12</td>
<td>1,440</td>
</tr>
<tr>
<td>Radio</td>
<td>1 radio for information (10 W), DC 12V</td>
<td>12</td>
<td>120</td>
</tr>
<tr>
<td>Ceiling fans</td>
<td>2 ceiling fans (15 W each)</td>
<td>12</td>
<td>360</td>
</tr>
<tr>
<td><strong>Total Daily Consumption in Wh</strong></td>
<td></td>
<td></td>
<td>2,220</td>
</tr>
</tbody>
</table>

---

**ICT's**

<table>
<thead>
<tr>
<th>Components</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Array</td>
<td>2.8 kW</td>
</tr>
<tr>
<td>Battery Bank</td>
<td>1200 Ah</td>
</tr>
<tr>
<td>Distribution System</td>
<td>24 V</td>
</tr>
<tr>
<td>Inverter</td>
<td>800 W</td>
</tr>
</tbody>
</table>

---

West African Power Industry Convention 2007, Abuja, NIGERIA
LI’s Project: Study for RE Program in Gambia

Main Results of the Preparatory Phase:

- Grid-based power is the least-cost option only for large concentrations of households or productive loads.
- Grid-Solutions requires a minimum threshold level of electricity demand and certain load densities to achieve economic scale.
- The costs of grid-based rural electrification extensions have ranged from $230 ~ $1,800 and more per connection, with a median cost of about $600 per connection.
- The PV niche within a national rural electrification strategy would comprise those areas where small amounts of electricity are required and load densities will remain modest.
- Rural Electrification Service Agency models generally allow for the most affordable payment schemes, and can thus reach a larger customer base than other credit delivery schemes.

To ensure sustainability, RE program should:

- Set price to allow full cost recovery:
- Select only consumers with a willingness and ability to pay:
- Ensure that consumer expectations are in line with energy service to be provided:
- Maintain high product quality and responsive services:
- Establish effective fee collection methods and enforce regulations to “shut off” service for non-payment, and:
- Adopt simplified administrative procedure.

- The financing for the implementation of the rural electrification projects is secured by AFDB and implementation is expected to start next year.

Figure 1: Possible PV system delivery scheme
Successful Projects in Africa

- **Pilot Project: Manyana, Botswana**
  - Photovoltaic and Solar thermal Pilot Project
    - PV: 42 Lighting systems,
    - 6 PV Powered streetlights
    - PV Lighting & refrigeration systems for village clinic
    - 6 Solar water heating systems
  - Advantages of PV street lighting
    - Enhances security & general quality of life at night
    - Allows small-scale economic activities
    - Allows more people to participate in social and political activities
    - Shows government’s commitment to places out of reach of centralized electricity supply

- **Result:**
  - Very positive experiences with PV street lighting made in Manyana
  - Community strongly requests for extension and subsequent maintenance
  - Self organisation by the community
  - New systems being installed
  - "Low cost – large social impact"
Successful Projects in Africa

Case Study: South Africa

- 1-2 million people live in areas too remote to ever to access the grid
- In 1999, a tendering process was started for off-grid electrification concession area
- Collaboration of Shell Renewable & the South African utility ESKOM
- 50,000 homes with SHSs of 50Wp
- Subsidies cover usually 80% of the capital investment cost only (NOT operational costs)
- Operational costs including depreciation are covered by the customer fees, to be collected by the concessionaire, on his own commercial risk
- Customers pay a connection fee; $30 and a pre-paid monthly service fee; $8

Case Study: Kenya

- Fewer than 2% of Kenya’s rural households have access to electricity from the grid.
- Solar Home system (SHS) Market without Government support or subsidy
- 150,000 have been installed over the past 2 decades with 20,000 more going in each year
- Shop owners may not be trained technicians
- Most of the solar system purchased in Kenya over the last decade have been in the 10 – 14Wp range

3 stages of market development:
- Innovators and NGOs
- Mass-market, battery-based systems
- Financing mechanisms
Lesson Learned

- **From South African Project**
  - **Challenges in SHS project:**
    - Training staff and the impact of large distance
    - Corruption and Cash Control
    - Complications rooted from the different responsibilities of local authorities, the Department of Mining and Energy, the National electricity Regulator and ESKOM.

- **From Kenya Project**
  - Direct sales of systems will often lead to the purchase of the cheapest components and a too tiny layout for the required needs
  - Seller are often more concerned with selling the system than assessing household energy requirements
  - Direct sales are not always properly installed, leading to dissatisfaction from the start due to low system performance
  - Self-installed systems are frequently not properly maintained because the owner/installer is not educated about correct maintenance procedures-this leads to early battery and system failures
Lesson Learned

(1) **Criteria for selection and priority-setting** for RE should be open and objective.

(2) Grid extension is very often not the most cost-effective solution; **decentralized delivery options** and **alternative energy sources** (e.g. PV, mini-hydro and other renewable energy sources) need to be considered.

(3) The benefits of electrification are directly related to the uses to which it is put and to the costs of alternative sources of power and energy. RE should ideally be introduced in areas where there is already a demand for electricity-using services—usually where there is agricultural growth, rural businesses and rural incomes.

(4) **Pricing policies** play an important role in determining project viability. A rational system of cost recovery (e.g. Government subsidies) is the most important factor determining the long-term sustainability of RE programs.

(5) **Initial connection charges** are a greater barrier to rural families than the monthly electricity bill. Extended financing arrangements are necessary to make connection more affordable.

(6) **Subsidization of operating costs** has widely proved to be counter-productive and to undermine the utilities’ financial position and their ability to extend service.

(7) The **private sector** can be attracted to participate in rural electrification schemes, even in a poor country, if an appropriate legal framework and risk management options are in place, including the assurance of a level playing field in terms of competition and the ability to charge full cost-recovery tariffs.

(8) Evidence from successful rural electrification projects shows that, once electricity becomes available in an area, upper middle class and wealthy households are the first to adopt it. But if the project focuses on promoting electricity for poor households—through low connection fees and lifeline rates, the rate of electricity adoption grows significantly, even among the poorest households.

(9) Key to scaling-up are **conducive macro-economic conditions**, sustained **government commitment** to the project objectives, **competent public institutions**, and **decentralized decision-making**.

West African Power Industry Convention 2007, Abuja, NIGERIA
Lesson Learned II (General)

- **Pricing policies** play an important role in determining project viability. A rational system of *cost recovery* (e.g. Government subsidies) is the most important factor determining the long-term sustainability of RE programs.

- **Initial connection charges** are a greater barrier to rural families than the monthly electricity bill. Extended financing arrangements are necessary to make connection more affordable.

- **Subsidization of operating costs** has widely proved to be counter-productive and to undermine the utilities' financial position and their ability to extend service.

- The **private sector** can be attracted to participate in rural electrification schemes, even in a poor country, if an appropriate legal framework and risk management options are in place, including the assurance of a level playing field in terms of competition and the ability to charge full cost-recovery tariffs.

- Evidence from successful rural electrification projects shows that, once electricity becomes available in an area, upper middle class and wealthy households are the first to adopt it. But if the project focuses on promoting electricity for poor households-through low connection fees and lifeline rates--the rate of electricity adoption grows significantly, even among the poorest households.

- Key to scaling-up are **conducive macro-economic conditions**, sustained **government commitment** to the project objectives, **competent public institutions**, and **decentralized decision-making**.
Thank you for your attention!!

Contact Information:

Dr. Andreas Wiese
Director, Energy Division
Lahmeyer International GmbH

Email: andreas.wiese@lahmeyer.de

Tel: +49 (0) 6101 55 1116   Fax: +49 (0) 6101 55 2100