Demonstration PV rural microgrids project in Chad (Central Africa)

Xavier Vallvé, Matteo Briganti and Alexandre Pineau
- Trama TecnoAmbiental (TTA), Barcelona, Spain –
ERDET: Electrification Rural pour le Développement Economique du Tchad

- Project objectives: to demonstrate and develop enabling conditions for deployment of rural RE microgrids in Chad
- Timeframe 2012-2015
- 5 Villages in different regions
- First phase: 3 villages
- 1 village already commissioned and operating (Mombou) since June 2014

Developer:
- UNIDO
- MEP

Contractors:
- Trama TecnoAmbiental (TTA), Spain
- Solairechad, Chad
- IDEB, Chad
### General Characteristics 3 sites

<table>
<thead>
<tr>
<th></th>
<th>DOUGUIA</th>
<th>MOMBOU</th>
<th>GUELENDENG</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Capacity STC (Wp)</td>
<td>&gt; 40 040</td>
<td>&gt; 39 600</td>
<td>&gt; 32 400</td>
</tr>
<tr>
<td>Inverter Power (VA)</td>
<td>36 000</td>
<td>36 000</td>
<td>36 000</td>
</tr>
<tr>
<td>Battery Capacity (kWh)</td>
<td>440</td>
<td>440</td>
<td>220</td>
</tr>
<tr>
<td>LV Distribution line (km)</td>
<td>2.7</td>
<td>9.7</td>
<td>5.9</td>
</tr>
<tr>
<td>Street Lights</td>
<td>19</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>Back up Diesel Genset (kVA)</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Consumer Connections Target</td>
<td>54</td>
<td>138</td>
<td>27</td>
</tr>
<tr>
<td>Total potential buildings estimate</td>
<td>800</td>
<td>200</td>
<td>2500</td>
</tr>
</tbody>
</table>

First phase 3 villages:

Mombou operating since June 2014, Guelendeng and Douguia planned for January 2015
Issues considered

- **Technical issues:**
  - Scope and boundary of the service scheme
  - Demand characterisation and technical solution
  - Metering concept
  - Local Capacity Building

- **Financial issues:**
  - Public / private investment
  - Business model
  - Tariffs

- **Regulatory issues:**
  - Community/local vs national framework
  - Cost based tariffs
Mombou: the village

- Remote in semiarid climate
- 800 people and an additional 200 from hamlets nearby, main income generating activity is cattle
- 135 buildings (129 connected), school, medical centre, mosque, small shops
- several small shops, water pumps for vegetable gardening
- Deferrable load: water pumping for irrigation
- PV electricity since June 2014
Needs Assessment and development of operation scheme

1. Load estimates
2. Ability and willingness to pay
3. Socio economics of the community
4. Reference community resource management: water
Needs Assessment and development of operation scheme
Needs Assessment and development of operation scheme

Year 1: TTA has temporary concession to develop and test private/community model
After year 2: to be decided
Needs Assessment

Estimated Load profile - Dry season (October - June)
Design Criteria

1. High Penetration PV:
   - Diesel Genset as back up
   - Assume 30% demand growth in 10 years
   - Big battery capacity (1 to 2 days autonomy)

2. Robust solution adapted to load profile and environment:
   - DC coupling at ELV
   - to manage each user’s energy in an independent way
   - to guide users’ energy consuming habits to optimize energy management
   - Flat tariffs based on EDA (Energy Daily Allowance)
   - Standard AC distribution grid

3. Community involvement:
   - During the design and construction
   - As part of the operational scheme
   - Potential for future user owned distributed PV generation
Electrical diagram

- Main PV generator
- Backup Genset
- AC Distribution Grid
- Battery
- Dual mode inverter
- DC-DC and DC-AC Conversion
- MPPT PV charge controller
- DC / DC converter
- Electricity dispenser-meter with net metering option
- Grid dependent Inverter
- consumer PV generator
Distribution grid layout

Mombou, Chad
<table>
<thead>
<tr>
<th>Technical Specifications Mombou</th>
</tr>
</thead>
</table>

**MAIN CHARACTERISTICS**

- **Owner**: UNIDO / MEP
- **Contractor and Operator**: TTA and Local Association
- **Electrical service**: 24 h/day, 230 V/400V three-phase
- **Number of user connections**: 129 (135 potential)
- **Public street lighting**: yes
- **Type of tariff**: Energy Daily Allowance (EDA)
- **Demand growth factor**: 30%
- **Rated Average Solar Daily Yield**: 140,4 kWh/day – 5,91 HPS

**PV GENERATOR**

- **Total PV capacity (STC)**: 39.600 kWp
- **Type of PV module / capacity STC**: polycrystalline / 240 Wp
- **Brand and Model**: REC240PE
- **Number of PV module**: 165
- **Inclination / orientation**: 10º / +25º S

**EMERGENCY GENSET**

- **Brand and Model**: FG Wilson P50-1
- **Nominal power**: 50 kVA

**BATTERY**

- **Technology**: Lead acid deep cycle OPzS
- **Brand and Model**: Hoppecke 24 OPzS 3000 rated at 4 464 Ah (C100)
- **Rated Voltage**: 48 V
- **Total / Practical capacity (-70%) (C100)**: 434 kWh / 304 kWh

**DUAL-MODE INVERTER**

- **Brand and Model**: Studer-Innotec XTH 6000-48
- **Number of inverter**: 6
- **Total rated power (5" – 30")**: 90 000 VA – 36 000 VA

**DATA LOGGER and CONTROL**

- **Price signal broadcast**: Frequency
- **Type of data**: Energy, voltage, temperature, radiation , etc.
- **Remote access**: GPRS

**ELECTRICITY DISPENSER – ENERGY METER**

- **Power supply**: 230 Vca, 50 Hz
- **Model**: CIRCUTOR Electricity Dispenser BII
- **Algorithm**: Energy Daily Allowance (EDA) configurable

**PUBLIC STREET LIGHTING**

- **Type of lamp**: 36 W LEDs and 23 W CFL
- **Number of lamp**: 17 (11 poles and 6 wall)

**DISTRIBUTION LINE**

- **Type of cable**: Aluminium XPLE
- **Length of line**: 10200 m
- **Type of distribution**: Underground
EDA (Energy Daily Allowance) service tariffs applied

Flat monthly tariff according to EDA, power limit and virtual energy storage

<table>
<thead>
<tr>
<th>code</th>
<th>Monthly fee (CFA)</th>
<th>EDA (Wh/day)</th>
<th>Maximum power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T11</td>
<td>4.100</td>
<td>550</td>
<td>0.5</td>
</tr>
<tr>
<td>T21</td>
<td>11.200</td>
<td>1.100</td>
<td>0.5</td>
</tr>
<tr>
<td>T41</td>
<td>22.000</td>
<td>2.200</td>
<td>0.5</td>
</tr>
<tr>
<td>T72</td>
<td>38.600</td>
<td>3.850</td>
<td>1.0</td>
</tr>
<tr>
<td>T82</td>
<td>43.900</td>
<td>4.400</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Implementation
Advantages:
- Better use of plot of land
- To create a shaded area for possible association/public activities
- High PV modules - reducing risk of vandalism
Added value solution: PV pergola
Added value solution: local capacity building
Technical solution: mechanical room
Technical solution – three phase LV distribution
Added value solution: Engage the users
Added value solution: deferrable consumptions income generation activities
User interface: Electricity dispenser essential for load control

Energy Cap (EDA); price signal (green/red LED); auxiliary smart switch
Real time price signal through frequency
Start up: Let there be light!
Thank you for your attention!