Using embedded renewable generation to stabilize rural distribution networks
Status Quo in Tanzania

Rapidly Growing Economy

- Surface: 947,300 square kilometres
- Inhabitants: 55 million (58/km²)
- Access to electricity
  - 1990 - 5.3 million (5.8%)
  - 2014 - 15.5 million (15%)
- Generation mix
  - Hydro 561 MW
  - Gas fuel 544 MW
  - Liquid fuel 210 MW
  - Mini-grids 82 MW

Grid development plan

Source of picture: Official TANESCO national grid system map
REA and TANESCO

Source of picture: www.minigrids.go.tz
Tanzanian distribution grid

The distribution grid

- Extremely large distribution networks supplying thousands of small distribution transformers
## Evaluation of generation options

<table>
<thead>
<tr>
<th>Diesel</th>
<th>Wind</th>
<th>Hydro</th>
<th>PV Solar</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependence on Imports</td>
<td>Regionally restricted</td>
<td>Water is a scarce resource</td>
<td>Great potential in all areas</td>
<td>Support for Wind and Solar</td>
</tr>
<tr>
<td>High fuel &amp; transport costs</td>
<td>Close proximity to GSP stations</td>
<td>High CAPEX</td>
<td>Better adaption on Grid capacity</td>
<td>Can be placed everywhere</td>
</tr>
<tr>
<td>Expensive Maintenance</td>
<td>Maintenance capabilities?</td>
<td>Maintenance costs high</td>
<td>Modular unit repairs</td>
<td>Modularity</td>
</tr>
<tr>
<td>CO₂ Emissions</td>
<td>No CO₂ Emissions</td>
<td>No CO₂ Emissions</td>
<td>No CO₂ Emissions</td>
<td>No long-term experiences</td>
</tr>
</tbody>
</table>
Mbeya – Tunduma distribution network

179 volt at 11am
Embedded energy generation

**Tunduma voltage level characteristic**

- Unsupported grid voltage
- Grid voltage supported by PV
- Tunduma load
- Solar PV and battery
- Resulting net load profile

**Axes:**
- **Voltage in %**
  - 0% to 105%
- **Time in hr**
  - 01:00 to 23:00
- **Power in MW**
  - 0 to 10
Embedded energy generation

Tunduma grid losses characteristic

- Losses current grid
- Tunduma load
- Power Solar PV and battery
- Losses with PV
- Resulting net load profile
Solution with renewable energy - results

Tunduma weekly load losses (1\textsuperscript{st} week of July 2017)

- Loss reduction of approx. 1,200 MWh per year
- Annual savings of approx. 130,000 USD
- Estimated 11,000 new connectable customers without the need of grid extension
Embedded generation concept

**Concept**

- Photovoltaic system with battery storage
- PV system stabilizes the grid during day and charges the battery storage
- Battery stabilizes grid during night times
- Active and reactive power for grid improvement
- Enables the connection of new customers without grid extension
- Widespread use of the system will increase the effect
Thank you for your interest – any questions?

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