Alternative Financing for Municipal Embedded Generation (AFMEG) in South Africa

Key Requirements for Pre-Feasibility Studies
1 Introduction

Power Project Development Phases

- Concept / Site Identification
- Pre-Feasibility Study
- Feasibility Study
- Financing and Contracts
- Engineering and Procurement
- Construction
2 Pre-Feasibility Approach

- A Pre-Feasibility study follows the following approach
  - Define the need
  - Site Assessment
  - Technology Assessment and Preliminary Design
  - Energy Production Assessment
  - Electricity Evacuation Analysis
  - CAPEX and OPEX Estimation
2 a) Define the need

- Establish motivation for power project – renewable, solar PV, wind, battery systems etc.

- Municipality Electrical Infrastructure Master Plans:
  - Existing electricity grid / network configuration, status-quo and constraints
  - Outlook on additional capacity recommendations
  - Load demand analysis
  - Planned network upgrades

- Existing Eskom invoicing:
  - Current cost of electricity
2 b) Site Assessment

- Potential sites identified for projects based on wind and solar resource
- Site closest to the preferred grid connection point – reduced grid connection costs and permitting
- Bankable resource data tools – SolarGIS, Meteonorm, PVGIS etc.
2 b) Site Assessment

- Site Visit is desirable, but can be completed in the next phase – Topography, Geology, Flora and fauna, Human occupation etc.

- Factors to assess in a desktop study – terrain, weather, shading/obstacles etc.
GROUP QUESTION:

- How do the following aspects affect / influence site selection?
  - Climate / weather
  - Topography
  - Land Use
  - Local Regulations
  - Site Access
  - Grid Connection
2 c) Technology Assessment and Design

- Solar PV vs. Wind – dependent on resource and land availability

- Assessment of major equipment – PV modules, Inverters, PV Structures
  - Technology types / categories
  - Suitability to meet the needs
  - Pricing trends (CAPEX and OPEX)

- Design
  - Limited to land available:
    - Fixed Tilt = 1.4 ha per MW
    - Tracker = 2.2 ha per MW
  - MV voltage aligned to grid network
2 d) Energy Production Assessment

- Energy Production Assessment Tools – PVSyst

- The energy production assessment provides the following:
  - Design optimisation (compare different scenarios)
  - Loss estimation (electrical, shading, optical etc.)
  - Energy values (MWh) for first year of operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>System peak power</td>
<td></td>
<td>43,214.08 kWp</td>
</tr>
<tr>
<td>Performance ratio at plant start-up (PR) *</td>
<td></td>
<td>88.0% kWh/m²/yr</td>
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<tr>
<td>Plant availability</td>
<td></td>
<td>99.0%</td>
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<tr>
<td>Yearly degradation factor</td>
<td></td>
<td>-0.5% kWh/kWp/yr</td>
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<tr>
<td>Specific yield (P50) - year 1 **</td>
<td></td>
<td>1,578 MWh/yr</td>
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<tr>
<td>System yield (P50) - year 1 **</td>
<td></td>
<td>68,188 MWh</td>
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<tr>
<td>System yield (P50) - 20 years</td>
<td></td>
<td>1,300,885 MWh</td>
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</tbody>
</table>

* PR without plant availability and module degradation (see section 3.3.1)
** Including availability and average degradation during year 1 (see section 3.3.2)
2 e) Electricity Evacuation Analysis

• Define the preferred grid connection solution

• Preliminary analysis of the grid connection solution:
  ❖ Evacuation Line Loading
  ❖ Evacuation Line Voltage Variation / Drop

• A detailed grid study is performed during the next phase to confirm that the operation of the plant is in line with the grid operator requirements.
2 f) CAPEX and OPEX Estimation

- Estimate approximate costs for land, equipment, development, construction and operation of the project (CAPEX)
- Estimate approximate costs of operation
- These estimates provide inputs to the financial model

<table>
<thead>
<tr>
<th>ID</th>
<th>Parameter</th>
<th>Value [ZAR]</th>
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<tbody>
<tr>
<td>A</td>
<td>PRE-CONSTRUCTION</td>
<td>19,148,159</td>
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<tr>
<td>1</td>
<td>Project Development, Financing etc.</td>
<td>12,765,439</td>
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<tr>
<td>2</td>
<td>Transaction Fees (Engineering, Legal, Advisory etc)</td>
<td>6,382,720</td>
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<td>B</td>
<td>CAPEX</td>
<td>817,531,408</td>
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<tr>
<td>1</td>
<td>Civil material and works</td>
<td>28,083,966</td>
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<tr>
<td>2</td>
<td>Mechanical equipment/material and works</td>
<td>149,993,911</td>
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<td>3</td>
<td>Electrical equipment/material and works</td>
<td>577,636,125</td>
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<td>4</td>
<td>Others</td>
<td>61,817,405</td>
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<tr>
<td>a)</td>
<td>Spares - 2% of CAPEX</td>
<td>15,114,280</td>
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<tr>
<td>b)</td>
<td>EPC Costs including margin - 6% of CAPEX</td>
<td>45,342,840</td>
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<tr>
<td>c)</td>
<td>General Contingency - 3% of EPC cost</td>
<td>1,360,285</td>
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<tr>
<td>D</td>
<td>TOTAL PROJECT COST (A + B)</td>
<td>836,679,567</td>
</tr>
</tbody>
</table>

* Electrical CAPEX portion represents 65-75% of the total CAPEX for solar PV Plants with breakdown below:
  - PV modules – 27%
  - Inverters, combiner boxes, transformers, MV Switchgear – 22%
  - Electrical balance of plant (Cables, earthing etc.) – 13%
  - Grid Connection – 22%
  - Electrical works and installation – 9%
  - SCADA, Communications and Security – 6%.
Thank You

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