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

Key Requirements for Pre-Feasibility Studies

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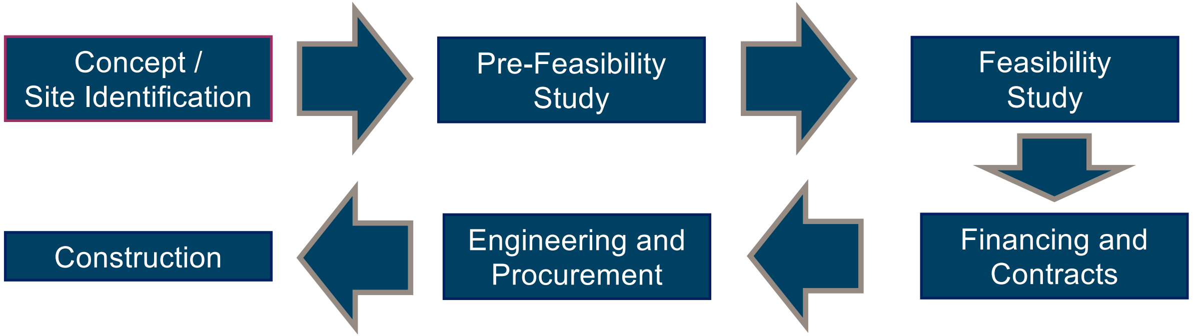
1 Introduction



Power Project Development Phases

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

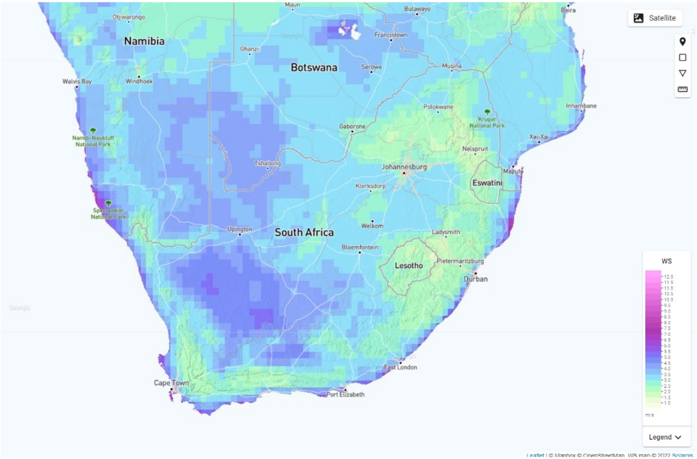
- Establish motivation for power project – renewable, solar PV, wind, battery systems etc.

- 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

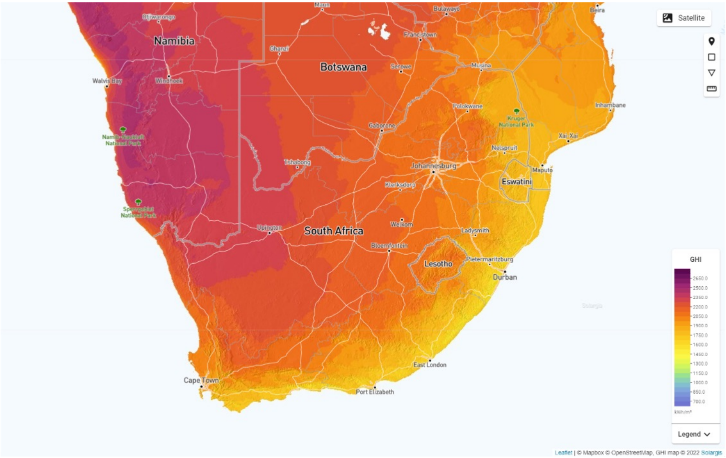
- Existing Eskom invoicing:
  - ❖ Current cost of electricity

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.



Wind Resource Map

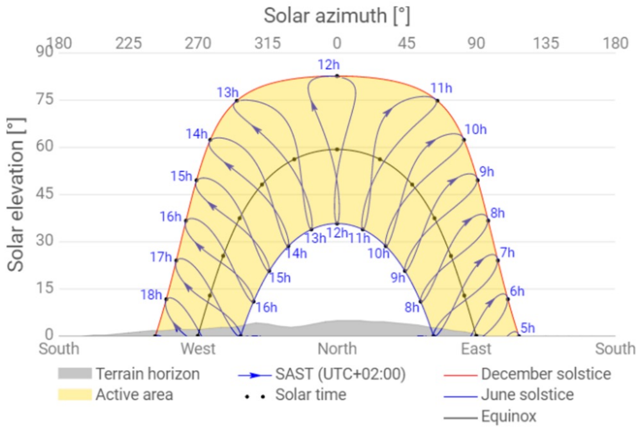


Solar Resource Map

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.

Google Maps photo of area and roads



Site Horizon Profile for Energy Assessment

2 b) Site Assessment

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

Parameter	Value	
Installed DC capacity at STC	43,214.08 kWp	
Installed AC capacity	39,200.00 kW	
Voltage of DC System	1,500 V	
Medium Voltage inside PV Plant	11 kV	
Voltage at Point of Connection	11 kV	
PV Modules	Manufacturer	Jinko Solar
	Model	JKM530M-7TL4-TV
	Unit Power	530 Wp at STC
	No. of units	81,536
Inverter	Manufacturer	Huawei
	Model	SUN2000-185KTL
	Unit Power	175 kW at 40 °C
	No. of units	224
PV Structure	Type	Fixed Tilt
	Tilt angle	20°
	Table configuration	2-V (2 x 26 = 52 PV modules)
	No. of tables	1,568
MV/LV Transformer (inside PV Plant)	Rating: 5,000 kVA, 0.6/11 kV (No. of units = 8)	
Grid Connection	The PV plant shall connect to the existing Marburg SwS via a new 11 kV Marburg Switching Station.	
PV Plant Land usage	46.5 hectares	

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

Parameter	Parameter	Unit
System peak power	43,214.08	kWp
Performance ratio at plant start-up (PR) *	88.0%	kWh/m^2/yr
Plant availability	99.0%	
Yearly degradation factor	-0.5%	kWh/kWp/yr
Specific yield (P50) - year 1 **	1,578	MWh/yr
System yield (P50) - year 1 **	68,188	
System yield (P50) - 20 years	1,300,885	MWh

** 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)*

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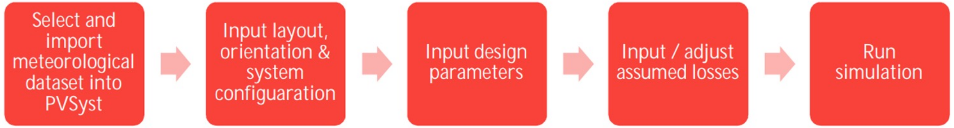

Energy Production Assessment Methodology

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

ID	Parameter	Value [ZAR]
A	**PRE-CONSTRUCTION**	**19,148,159**
1	Project Development, Financing etc.	12,765,439
2	Transaction Fees (Engineering, Legal, Advisory etc)	6,382,720
B	**CAPEX**	**817,531,408**
1	Civil material and works	28,083,966
2	Mechanical equipment/material and works	149,993,911
3	Electrical equipment/material and works *	577,636,125
4	Others	61,817,405
a)	*Spares - 2% of CAPEX*	*15,114,280*
b)	*EPC Costs including margin - 6% of CAPEX*	*45,342,840*
c)	*General Contingency - 3% of EPC cost*	*1,360,285*
D	**TOTAL PROJECT COST (A + B)**	**836,679,567**
		(R 19.36 / Wp)

* *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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