Load profile & HOMER simulations

Project: Engineering, Procurement and Construction of Hybrid PV-Diesel-Battery Energy Storage System

Location: Pulau Tiga, Maluku, Indonesia

1. Background

A preliminary feasibility study was undertaken to reassess the electrical loads of the community, the solar resource available, and the proposed system configuration that would match the energy needs for households, communal uses and productive activities.

Bidders should follow the assumptions and values below to provide their own modelling according to the specific components and configuration(s) that are being offered.

The hybrid power plant in Pulau Tiga must be shown to achieve at least a 95% generation from renewable energy on average throughout a 20 years lifetime of operation.

All Bidders must produce their own simulations and modelling in HOMER and PVSyst.

A detailed Section of the proposal is required to describe the modelling assumptions, results, and method.

Guidance on modelling and modelling rules are provided in this document.

Bidders are encouraged to contact NZMATES Team should there be any doubts with modelling.

2. Model Configuration

2.1 HOMER

A HOMER License is required to perform the analysis. We recommend that a “Base License” is needed with the following additional modules:

- Multi-Year

HOMER is available from https://www.homerenergy.com/

2.2 Load profile assumptions

- The future power supply should service a 24-hour load of ~64 customers at Pulau Tiga plus the load growth derived through local economic objectives highlighted in the socio-economic characterisation in Section XYZ.
- The load profile used in HOMER shall be made using
    - The underlying demand of the community; plus
    - The additional load from the HVAC system in the BESS room; plus
    - The parasitic load of the new microgrid.
- The underlying community is to be included as per TABLE 1
- The HVAC load is required to maintain BESS temperature and humidity.
- For AC-coupled kiosk style BESS, The HVAC load may be included in the BESS efficiency as described by the BESS OEM. **If this is the case then NO additional BESS HVAC load need be considered.**
- If bidders cannot perform thermal load calculations, HVAC load should be included as outlined in TABLE 1.
- The parasitic load shall be 500W.
- Bidders are required to complete TABLE 1 and include this in their bid documents. Where the calculation above is not used, Bidders must provide calculations of the HVAC load.
- Additional to using the provided hourly load profile, the following assumptions should be used in the HOMER modelling:
    - Load growth: 1.5%/year
    - Random Variability:
        - Day to day 5%
        - Time-step: 5%
    - Scaled Annual Average kWh/day: 124.2 kWh/day **PLUS** the HVAC load
    - Load Type: AC
- The Bidder is required to demonstrate in their Bid Submission, that the peak grid load and peak HVAC load will not overload the system when operating in BESS only mode. The peak grid load is 12kW.

Table 1: Load profile calculation method. Bidders to complete and include in tender documents

Hour	A - Community Load (kW) – Year 1	B – HVAC Load (kW) (if thermal load calculations not completed)	Load applied in HOMER [A + B + P]
0	6.7	0.75	Bidder to provide
1	6.7	0.75	Bidder to provide
2	6.5	0.75	Bidder to provide
3	6.4	0.75	Bidder to provide
4	6.4	0.75	Bidder to provide
5	6.4	0.75	Bidder to provide
6	3.2	0.75	Bidder to provide
7	3.2	1	Bidder to provide
8	3.4	1.5	Bidder to provide
9	3.6	1.5	Bidder to provide
10	3.3	1.5	Bidder to provide
11	3.3	1.5	Bidder to provide
12	3.4	1.5	Bidder to provide
13	3.6	1.5	Bidder to provide
14	3.2	1.5	Bidder to provide
15	3.1	1.5	Bidder to provide
16	3.1	1.5	Bidder to provide
17	3.5	1	Bidder to provide
18	7.3	1	Bidder to provide
19	7.6	0.75	Bidder to provide
20	7.9	0.75	Bidder to provide

Hour	A - Community Load (kW) – Year 1	B – HVAC Load (kW) (if thermal load calculations not completed)	Load applied in HOMER [A + B + P]
21	7.7	0.75	Bidder to provide
22	7.5	0.75	Bidder to provide
23	7.2	0.75	Bidder to provide

- To simulate solar PV generation, Bidders may:
    - Use PVSyst to simulate the PV array and import this hourly generation profile into HOMER.
- The GPS coordinates to be used for P.Tiga are
    - Decimal format: S 3.652895, E 127.906356.
    - Degrees, Minutes, Seconds: 3° 39' 10.42"S,127° 54' 22.88"E
    - This location should be used for all modelling
- PVSyst modelling should include the following assumptions:
    - Annex XY contains the weather file for P. Tiga to be used in PVSyst.
    - The output generation PV production model results from PVsyst should be exported into the HOMER model.
    - The PV derating factor can be 100%
    - The actual PV module and inverter specifications are to be used with the relevant PAN file for modules and OND file for inverters.
    - PVSyst simulations must include all reasonable losses including:
        - LID losses: 3%
        - Soiling Losses: 2%
    - All other losses must be in accordance to equipment specifications or calculations/justification from bidders
        - All DC and AC cabling to the connection point
        - Inverter losses
        - Near shading Losses
- In the HOMER model, the PV module degradation must be accordance with the actual warranted PV module specifications in the Multi-Year option.

2.3 BESS

For the battery, the following assumptions must be used:

- The following BESS parameters must be specified as per the manufacturer recommendations:
    - Round Trip Efficiency at STC
    - Maximum charge and discharge current (or power)
    - Nominal capacity
    - Calendar life (lifetime years)
    - Energy throughput for warranty (in kWh)

2.4 Converter

For the converter, the following assumptions must be used:

- The converter parameters must be specified as per the manufacturer recommendations.
- The converter power may be set to an infinite or very high value only when the battery/PV peak power is defined elsewhere. Bidders take responsibility for being able to meet the peak load of the grid and HVAC.
- If an AC-coupled BESS with separate inverter/battery suppliers is used then:
    - The converter efficiency may be set at 100% with the storage round trip efficiency used to represent the AC to AC efficiency and the charge and discharge current of the BESS should accurately reflect the limitations of the converter.
    - The converter capital cost is to be specified in the converter model.
    - The converter replacement cost is to be specified in the converter model at 50% of the capital cost.
- If an AC-coupled kiosk style BESS is provided from a single supplier:
    - The converter efficiency may be set at 100% with the storage round trip efficiency used to represent the AC to AC efficiency and the charge and discharge current of the BESS should accurately reflect the limitations of the converter.
    - All capital costs associated with the BESS must be included in the battery parameters. I.e.,
        - The converter replacement cost is to be set at 0 USD.
        - The converter capital cost is to be set at 0 USD.
- If a hybrid converter is used:
    - The converter efficiency at STC is to be specified in the converter model.

    - The converter capital costs are to be specified in the converter model.
    - The converter replacement cost is to be specified in the converter model at 50% of the capital cost.
- The lifetime of the converter is to be 10 years or the provided converter warranty.

2.5 Diesel generator

For the diesel generator the following assumptions must be used:

- Diesel Fuel Price: 0,703 USD/Litre
- Diesel generator fuel efficiency:
    - Intercept coefficient (L/hr/kW rated): 0,0644
    - Slope (L/hr/kW output): 0,2756
- Minimum load ratio for diesel generator (%): 30
- Lifetime hours: 24.000 hours
- Minimum runtime: 0 mins
- Fixed capacity genset model to be used
- Generator to be connected to the AC bus
- No runtime schedule is to be defined
- Generator to be included in all simulations

2.6 Controller

In all models:

- The Load Following control model is to be used.

2.7 Economic and financial assumptions

The main economic and financial assumptions to be used are:

- Model currency: USD
- Inflation rate: 3%
- Discount rate: 8%
- Project lifetime: 20 years
- System fixed capital cost: USD 0
- Capacity shortage penalty: USD 0/kWh
- Operation and maintenance costs assumption
    - Fixed O&M: 25,000 USD/year
    - Diesel genset O&M cost: 0.56 USD/hour
    - PV: 0 USD/year
    - BESS: 0 USD/year
    - Converter: 0 USD/year
    - All other components: 0 USD/year
- Replacement cost assumption
    - PV: 50% of present cost

    - BESS: 50% of present cost
    - Diesel genset: 100% of present cost

- Bidders must input their full capital cost in-line with the Bid Offer in the tender into their HOMER model.
- Each Bidder must clearly describe the costs considered for each component in the model.
    - Bidders must split their full capital cost into PV, Battery, Converter and Diesel genset.
    - It is up to each bidder on how to split costs between different components and what is included. A clear explanation of the split must be provided in the bid submission.
    - The total capital cost in the HOMER model must be the same as the bid price.

2.8 Other assumptions

Other assumptions to consider are:

- The Multiyear option is to be enabled with:
    - Project lifetime of 20 years
    - PV module degradation as per the Solar PV assumptions
    - Load growth as per the load growth assumption
- Fixed O&M cost inflation of 3% per year
- PV Lifetime: in accordance to offered brand, specifications, and warranty
- BESS lifetime: in accordance to the offered brand, specifications, and warranty
- If a component is not available in PVSyst or HOMER Pro database, Bidders must generate specific component files with their actual specifications and submit together with modelling files.

3. Modelling Requirements

- A reference HOMER model is supplied in this tender.
- An NZMATES's preliminary feasibility study used several HOMER simulations to assess the required size of major components. This option provides a renewable energy fraction of >95% over the project's lifetime with the lowest lifetime running cost. This recommended the following
    - A 75 kWp PV array
    - 30kW/200kWh lithium-ion BESS
    - 25 kW backup diesel generator[1] provides the lowest lifetime running cost.
- Bidders may offer a sizing which varies from these values, but should not deviate from it significantly.
    - This sizing must obtain the same >95% renewable energy fraction throughout the project's lifetime within the HOMER model
- The contractor will have to perform their own HOMER simulation(s) as part of their tender submission and present and justify their detailed system design based on the optimal simulation outcome.
    - This HOMER model must be submitted alongside the tender.
    - Bidders may modify the reference HOMER model or develop their own.
    - The HOMER file must be clearly labelled:
        - The filename must include the name of the Bidder
        - The project author must include the name of the Bidder
        - Any assumptions should be included in the Notes section of the HOMER model

[1] A 20kW diesel genset is recommended since it is the smallest generation unit PLN can utilize.