Detailed feasibility study report • Template

Detailed feasibility study   
of [Site name]   
Solar mini-grid

Project title: [Title]

Project code: [Code]

Date: December 18, 2023

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| --- | --- |
| **Prepared by** | **Submitted to** |
| [Company name]  [Company address] | [Company name]  [Company address] |

List of separate attachments submitted along with this report:

1. Meeting minutes/permission letters
2. Load list
3. Software simulation report
4. Powerhouse layout drawings
5. Structure analysis calculations and report
6. Equipment datasheets
7. Single-line diagram
8. Site map layout (Google Earth .kml file)

Glossary

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# EXECUTIVE SUMMARY

*Describe briefly in* ***one page*** *the design and outcomes of the detailed feasibility study. The executive summary should include the key information of the study.*

*Paragraph #1*

1. *Site location*
2. *Number of households, private and public institutions, and enterprises*
3. *Date when the on-site survey was carried out*

*Paragraph #2*

1. *Current sources of electricity access*
2. *Load and energy demand scenario (short-term and long-term)*

*Paragraph #3*

1. *Land availability for the solar array, powerhouse, and transmission and distribution system*
2. *System description (solar array capacity, on-grid, battery inverter capacity, and battery bank capacity)*
3. *Annual energy production*

*Paragraph #4*

1. *Total system cost*
2. *Cost of electromechanical system, transmission and distribution system, powerhouse*

*Paragraph #5*

1. *Major project risks and mitigations*
2. *Conclusion*

# SITE DETAILS

## Location

*Describe the location of the site and provide information about,*

1. *Site address (ward number, rural municipality, district, and province)*
2. *Site coordinates*
3. *User committee information (If available)*

*Figure suggestions*

1. *Bird’s eye view of the site with boundary marking*

## Site access

*Describe the accessibility of the site. Provide information about,*

1. *Access route description (vehicle access, type of road/**path for e.g., earthen, gravel, black topped (mention accessibility month-wise, etc.)*
2. *Observations of population density in the site area (for example, dense households, sparsely populated, etc.)*
3. *Name and distance from the nearest city and airport*

*Photo suggestions*

1. *Bird’s eye view of the site location within a few hundred meters of ground elevation*
2. *Bird’s eye view of the site location showing pinned site location and the nearest city*

*Access road/path*

## Demography

*Describe the demography of the site area. Provide information about,*

1. *Population*
2. *Number of households, private and public institutions*
3. *Household and institutions distribution by ‘toles’ or wards*
4. *Types of population (ethnicity wise)*
5. *Income sources of community and average monthly expenditure for lighting purpose*

*Photo suggestions*

1. *Focus group discussion*
2. *Institutions/existing milling, grinding industry, etc. power-intensive appliances*
3. *Google Earth photo locating the proposed settlements for electrification*

## Security

*Describe the security aspects of the site area from the perspective of solar mini-grid system that is to be built. Provide information about,*

1. *Security of solar array location*
2. *Security of powerhouse location*
3. *Security for household energy metering*

*Photo suggestions*

1. *North, South, East and West view of solar array location*
2. *North, South, East and West view of powerhouse location*

## Telecommunications and internet access

*Describe coverage of mobile network and internet access. Provide information about,*

1. *Best mobile carrier name and internet service provider*
2. *Type of mobile data connection (for example: calls only, 2G only, 3G only, 4G, etc.)*
3. *Reliability of mobile network*
4. *Nearest facility with internet access (for example, ward office, rural municipality office) and its distance from the powerhouse*

## Climate

*Describe the climate of the region based on data trends obtained from reliable sources (such as, nearest weather stations, Meteonorm software, etc.). Provide information about,*

1. *Graph on annual temperature trends*
2. *Graph on annual precipitation trends*
3. *Notes from DFS regarding extremities in climate and weather- conditions like flooding, landslide, lightning, etc. that concern SMG*

## Current status of electricity

*Describe the current status of household electricity sources on the site. Provide information about,*

1. *Future plans, data, and information on grid electricity access collected via NEA, or LG/PG*
2. *Current household electricity sources (for example, solar home systems, diesel generators, kerosene, jharo, etc.)*
3. *Nearest location with grid electricity access and its distance from the site*
4. *Nearest location with other mini-grid plants (SMG/MHP) to look for the possibility of interconnection in the future*
5. *Remarks on electricity infrastructure at the site (for example, distribution poles already erected, micro/mini-hydro project planned for the same site, etc.)*

## Community perspective

*Describe the observations and findings from the survey and focused group discussions with the community. Provide information about,*

1. *Awareness of the users about solar mini-grid systems (for example, seeing no difference between grid electricity and solar mini-grid electricity from the user’s perspective, understanding that the solar arrays and power conditioning units will be centralized, etc.)*
2. *Willingness to pay, understanding tariff mechanism*
3. *Willingness for kind and cash contribution, if needed*
4. *Details of any tariff collection practice in the community for other applications. For example, water distribution, etc.*
5. *Social cohesion or divisions within the community, social and political conditions etc.*
6. *Possibility of new PEUs after installation of SMG*
7. *Any social concerns regarding solar mini-grid project*

*Local/Provincial government perspective*

1. *Ownership of the project for sustainable and smooth operation*
2. *Willingness to pay cash contribution if needed*

# SITE ASSESSMENT

## Solar array location

1. *Must include the available land area, ownership details and commitment letter, GPS coordinates, topography, orientation and azimuth, near and far shading, current land use description, local land use regulation and policy, slope and soil type, wind loading, etc.*
2. *Should have a general assessment of usability with respect to natural calamities such as floods, landslides, lightning etc.*
3. *Should have assessment related to safety from humans, fencing needs*

*Photo suggestions*

1. *Bird’s eye view of obtained data and site with boundary markings*

## Powerhouse location

1. *Must include the available land area, ownership, details and commitment letter, GPS coordinates, topography, orientation, current land use description, local land use regulation and policy, slope and soil type, structure analysis, etc.*
2. *Should have a general assessment of usability with respect to natural calamities such as floods, landslides, etc.*
3. *Should have assessment related to safety from humans, fencing needs*

*Photo suggestions*

*Bird’s eye view of obtained data and site with boundary markings.*

## Existing infrastructure

*Describe any existing infrastructure that the SMG can utilize. For example, existing power poles, powerhouse buildings, etc.*

## Environmental and social assessment

1. *Information about environmental impacts, potential biodiversity impacts and socio-economic impacts resulting from the installation of SMG in the community must be mentioned with a degree of adversity*
2. *The total boundary covered by the project and its impact on natural habitats, vegetation, culture, settlement, social coercion etc.*
3. *The project's impact on indigenous people, their lifestyle, use of resources livelihood, livestock, water source, etc. along with information about the loss of forest/trees to avoid shading in the solar array must be included*

*Photo suggestions*

*Bird’s eye view of obtained data and site assessment along with any adversaries that were observed during the DFS stage must be attached here.*

# LOAD AND ENERGY DEMAND ANALYSIS

## Daily household load and energy demand analysis

*Describe, draw, calculate, and show in tables and graphs the daily HH load demand analysis for 24 hours to establish a relationship between the obtained data and the design parameters*

## Daily PEU and public load and energy demand analysis

*Describe, draw, calculate and show in tables and graphs the daily PEU and public load demand analysis for 24 hours to establish a relationship between the obtained data and the design parameters.*

## Total estimated load and energy demand analysis

*Produce analysis, a graphical and tabular representation of estimated demands from HH, PEU and public places (e.g. schools, health posts, temples, government offices, etc.) located within the community. Describe briefly about load distribution over 24 hours and its relevancy on the calculations related to component sizing particularly solar array, inverters and battery bank sizing.*

# TECHNICAL DETAILS OF SOLAR MINI-GRID

## Design summary

*Describe and summarize the selection, sizing, ratings, system architecture, standards, formulas and calculations, assumptions and derivations used to come up with the perceived design in a short paragraph as well as in tabular form.*

## System architecture

*Present a block diagram and explain the significance of the system architecture chosen for the particular project. Explain its advantages with respect to the design and the project parameters.*

## Energy generation

*Present the energy generation scenario using manual calculations, forecast energy generation based on the report produced by using software such as PVsyst, Homer, etc. and online databases of irradiance for the specific site location. Use graphical representation to present sun path diagrams, GHI, losses, monthly energy generation profiles, etc.*

## Single line diagram

1. *Will include labelling of the project name, system size, cable sizes, and all the component sizes including MCBs, SPDs, etc. along with the legend*
2. *Must represent the possible array, inverter, battery bank, switchgear configuration, etc.*
3. *Each component used in the SLD must be recognized well despite its size, the quality and printing layout must be maintained for A3-size paper*

## Site layout

1. *Overall project map layout using CAD inclusive of PV array, powerhouse, HHs, PEUs, T&D extension, etc.*
2. *Measurements of data related to the size, topography, terrain, soil condition, etc. and plotting them using CAD or similar software*
3. *The presented data and drawings must fulfil the need to serve the purpose for tendering proceedings*
4. *Separate drawings and descriptions for powerhouse, civil structures, land labelling requirements, standards, etc.*

## Shading analysis

### Near and far shading

1. *Mention the criteria, formula, tools, etc. used in determining the shading analysis.*
2. *Shading analysis for the proposed array over 12 months with December 22nd data in focus, simulations (if needed)*
3. *Each row of the proposed array should have its shading analysis done and projected*

## Solar PV array

1. *Specification of the module used for calculations, drawings, and analysis*
2. *The sizing, design, distribution, and positioning of solar PV array within the community*
3. *Sizing, design, and placement of combiner boxes, relevant accessories, power evacuation channels, earth points, etc.*

## Module mounting structure

1. *Must include a sample drawing for the envisaged module mounting structure*
2. *Calculations related to wind loading requirements, civil foundation requirements, size of vertical legs, purlins, braces and struts, rafters, base plates, joints, mid-clamps, end clams etc. must be presented*
3. *For rooftop installations (if applicable), proper sealing of surfaces using grouts, etc. must be mentioned*
4. *Type of material proposed, its strength, advantage, selection procedure and other technical parameters and specifications must be clearly mentioned*

## On-grid inverter(s)

1. *Must include the selection criteria, design basis, and calculations including losses related to the inverter sizing and selection*
2. *Must include specifications relevant to design and selection*
3. *Must choose inverter citing compatibility to the other selected components*

## Battery inverter(s)

1. *Must include the selection criteria, design basis, and calculations including losses related to the inverter sizing and selection*
2. *Must include specifications relevant to design and selection*
3. *Must choose inverter citing compatibility to the other selected components primarily battery bank and DC components*

## Battery bank

1. *Must include the selection criteria, design basis, and calculations related to the battery sizing and selection including losses, days of autonomy, parallel paths, etc.*
2. *Must include specifications relevant to design and selection*
3. *Must present the total surface area the proposed battery bank would occupy inside a battery room and if it’s a vertical stacking, total height to aid in powerhouse sizing*

## Power house and fencing

1. *Must include the drawings, specification, and civil components description including fencing*
2. *Must include plan and side views showing tentative placement of installed equipment*
3. *Must include details regarding construction materials, structure analysis, PCC, roofing, doors and windows with proper ventilation, foundation etc. meeting statutory regulations, standards and requirements for civil construction, design, and drawings*

## Transmission and distribution

1. *Must include a table with a summary of design, lengths, conductors used, accessories used, poles, insulators, lightning arrestors, transformer sizing and specification wherever necessary, etc.*
2. *T&D must be designed to maintain the voltage drop as agreed upon and the loss calculation sheet must be annexed*
3. *Basis of selection of cable types- ACSR, ABC or other types must be mentioned*
4. *T&D will be accompanied by Drawings and layout fit for A3 size paper indicating load centres, Powerhouse, PEUs, public buildings etc., pole erection guidelines, specification of components used, etc.*

## Metering

1. *Selection of meters for the SMG must be done according to the requirements set and obtained during the DFS stage. Example: Type 1: for HH, Type 2: for PEU, Type 3: Others. 1 meter at the output of the AC distribution box must be included*
2. *Meter must be chosen in such a way that with the change in tariff structure and need for step tariff, the meter should be able to adhere to the changes and comply*
3. *Detailed specifications and meter type (Pre/Post-paid) must be produced as per the agreed standards*

## Cables

1. *Cable sizing for DC and AC cables must be done and presented. Formulae used for calculation must be included*
2. *Different cable types and sizes must be proposed for different sections. E.g., UV cable of suitable diameter for outdoors, flexible multistrand cables for DC side, XLPE for AC output, etc.*
3. *Type of cables e.g., single core, three core, etc. must be mentioned and a chart of cables used in the SMG must be presented*
4. *AC, DC, and communication cables must be distinguished and labelled well in the SLD*

## Others (MCBs, SPDs, AC/DC combiner boxes, etc.)

1. *MCBs sizing and calculation must be shown. Different MCBs for each string (String breakers), DC MCBs for DC side, AC MCBs for AC side and MCCB on the output must be designed as per the site conditions and detailed specifications including the class, type etc. must be mentioned. All the accessories must comply with the agreed standards and guidelines*
2. *SPDs are major components of any SMGs thus, SPDs as per the agreed SLD and requirements in each PV, DC and AC termination points must be designed including the class, type and standards*
3. *AC/DC combiner boxes must be sized in such a way that a multiple number of cables, isolators, SPDs, fuses, etc. could easily accommodate and if necessary, more than 1 combiner box must be proposed. They must comply with the agreed specifications and standards*

### Cable routing plan

1. *Cable route must be shown in the overall electrical layout diagram to and from the array and the powerhouse. This cable routing plan is different from the T&D line*
2. *The shortest possible route without compromising the laying of cables overhead, underground, etc. as per the site condition must be proposed*
3. *Use of cable trays, cable baskets, ducts, and conduits of appropriate size chosen in a way to avoid stress and strain in the cables must be proposed, specific to the indoor and outdoor conditions*

## Protection equipment

### Lightning arrestors

1. *Lightning arrestors (LA) must be proposed in such a way that they cover the total area occupied by the solar PV array as well as the powerhouse. If one LA is not enough, 2 LAs or more must be proposed*
2. *The grounding of LA must be mentioned along with its termination points and specifications. The type and ratings of LA must adhere to the agreed specifications and standards*
3. *All the accessories used in LA including down conductor, pole etc. must be mentioned*

### Earthing and SPDs

1. *Total numbers of earthing as per the design and site conditions must be mentioned. Clear instructions about its connection and termination points must be mentioned*
2. *Type of earthing proposed, its specification, installation standard and details about the accessories used in earthing must be mentioned clearly*
3. *Must mention the sought-after earth resistance and ways to attain the value complying with the agreed specification*
4. *Along with the earthing, earthing test pits must also be considered and size and specifications related to earthing pit must be provided in detail*

# SAFETY CONSIDERATIONS

1. *Measures that must be taken for the safety of SMG including PV array, powerhouse, transmission, and distribution centres etc. must be mentioned*
2. *Precautions and measures such as fencing, operation and management authority, safe handling of SMG components and safe use of appliances must be mentioned*
3. *Other safety measures that were recorded from the DFS stage must be mentioned in this section including but not limited to operational safety adhering to relevant points from Occupational Health and Safety Management System (OHSMS) manual*

# SITE CLEARANCE

1. *Need for site clearance and its impact must be mentioned in the report*
2. *Basics of site clearance covering the total project area that could be breached during the installation phase must be clearly instructed*
3. *The ways to protect, amend or preserve the original condition of the site must be explained in points so that they can be referred to during the bidding and execution phase*

# BILL OF QUANTITY AND COST

## Electromechanical system

1. *Detailed BoQ for the proposed system with a breakdown of each component must be done*
2. *Detailing in the BoQ should be such that, if possible, every component used such as the breakdown of distribution boards and its components, MCBs, MCCBs, busbars, etc. must be proposed in specifics instead of a lump sum*
3. *BoQ for services and goods must be separated*
4. *Vatable and non-vatable items must be distinguished*
5. *Currency used must be in NPR with commas as a separator*
6. *Basis of rate for each component*

## Transmission and distribution

1. *Separate BoQ for transmission and distribution must be prepared, however, all the BoQ will be compiled to form a single BoQ*
2. *Breakdown of components such as numbers of insulators, connectors, LA, Poles etc. must be done instead of treating them as lump sum*
3. *Other points mentioned above apply to this section as well*

# FINANCIAL ANALYSIS

## Source of funds

1. *Source of funds may vary in %, cash or kind from different sources. All the sources of funds must be mentioned and stated in tabular form accompanied by a narrative*

## Tariff setting

1. *Tariff setting mechanism, its purpose and the approach used in setting the tariff must be mentioned*
2. *Proposed tariff must be done scientifically and calculations used must be presented*
3. *The data from the socio-economic section must be used, analysed and discussed with the field enumerator regarding paying capacity, willingness etc. to determine and present the tariff for the proposed system*
4. *Describe the tariff collection mechanism to ensure reliable and transparent revenue collection*

## Financial indicators

1. *Financial indicators such as IRR, payback period, LCOE, cash flow diagram, ADSCR, lifecycle costing, etc. must be calculated and presented*
2. *If the financial indicators don’t produce desired results, possible business cases and enterprise-based solutions must be devised and presented*
3. *For clarity and better understanding, graphs, charts and flow diagrams must be used along with tables and figures to showcase financial indicators*

# CONCLUSION

*Provide a summary of the SMG architecture, agriculture potential, project cost and outcomes of the economic analysis.*

# ANNEXES

## Meeting minutes from the community

1. *Land permit minutes/contracts for the construction of the solar array, powerhouse and transmission and distribution power paths*
2. *User committee registration at the LG (if applicable)*
3. *Letter of commitment from local government for the partnership with the PG/FG and other development partners.*
4. *If the site is located outside of the last-mile electrification area of GoN, attach a letter from the local level or district/provincial NEA office mentioning national grid will not reach the proposed site for at least three years.*

## Load list

## Software simulation report

## Rate analysis for each component used

## Powerhouse layout

## Detailed drawings of components

## Transmission and distribution layout

## Site photos

## Product datasheets