Detailed feasibility study report • Template

Detailed feasibility study   
of [site name]   
Solar grid-connected system

Project title: [Title]

Project code: [Code]

Date: December 20, 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. NEA electricity bills for the last 3 years
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)
9. Diesel generator log sheet for at least 1 year

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. *Information about the project site, owner’s discretion*
3. *Date when the on-site survey was carried out*

*Paragraph #2*

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

*Paragraph #3*

1. *Land/roof space availability for the solar array, powerhouse and power evacuation approach*
2. *System description (solar array capacity, inverter ratings, system architecture)*
3. *Annual energy production and savings*

*Paragraph #4*

1. *Total system cost*
2. *Cost of electromechanical system, powerhouse and power evacuation*
3. *Financial and economic analysis like NPV, IRR and payback period*

*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. *Registered business and nature of business*

*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 on vicinity coverage and implications on delivery of equipment (if any)*
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 nearest city*

## Ownership and source of fund

*Describe the ownership modality and funding mechanism or the business model. Provide information about,*

1. *Owner/Co-owner and model (CAPEX, OPEX/ESCO)*
2. *Funding mechanism and involved parties’ contribution*
3. *Financial institutions and loan experience of the project owner (if applicable)*

## Security

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

1. *Security of solar array location*
2. *Security of powerhouse location*

*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 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.*

## Current status of electricity

*Describe the current sources of electricity used by the facility. Provide information about,*

1. *Type and technology of the electricity sources, their specification and capacity*
2. *The energy mix scenario when a new source is added*
3. *Location of the main distribution panel and distance from the powerhouse*
4. *Remarks on electricity infrastructure at the site (for example, location for powerhouse, cable trenches/trays available, transformer size needs upgradation, etc.)*

## User perspective

*Describe the observations and findings from the survey and based on the discussions with the user. Provide information about,*

1. *Awareness of the users about solar grid-connected systems (for example, knowing that the system is only meant for use to reduce the electricity bills during sunshine hours and would not have any backup)*
2. *Willingness for long-term agreement, understanding tariff mechanism in comparison with NEA*
3. *Willingness for kind and cash contributions if needed*
4. *Any technical/financial/regulatory concerns regarding the solar grid-connected project*
5. *Knowledge of the solar grid-connected net-metering system*

*Local/Provincial government perspective*

1. *Willingness for financial contribution if needed*
2. *Facilitation of net metering services with NEA*

# SITE ASSESSMENT

## Solar array location

1. *Must include the available land/roof area, safe roof access pathway, ownership details, GPS coordinates, topography, orientation and azimuth, near and far shading, current use of space, permissions for use, slope and land/roof type, roof-wise area calculation for solar PV installation, wind loading, height of the roof from ground, etc.*
2. *Should have a general assessment of usability with respect to natural calamities such as floods, landslides, lightning, etc.*
3. *Structure analysis report for roof mount type installation, safety from exposure to chemicals, industrial waste, etc.*

*Photo suggestions*

1. *Bird’s eye view of obtained data and site with boundary markings*
2. *Photos of each building and its roof or ground area where the solar array will be installed*

## Powerhouse location

1. *Must include the available/allocated area, ownership and permission, GPS coordinates, topography, orientation, current use of the designated area, 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 exposure to chemicals, industrial waste, etc.*
4. *Oversee and present if the allocated location is suitable with respect to distance, cable route, space for air vents or if air conditioning is required.*
5. *Distance between the power generation and the evacuation transmission line which may be 400V, 11KV, or the substation for larger projects.*

*Photo suggestions*

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

## Existing infrastructure

*Describe any existing infrastructure that the system can utilise. For example, existing power poles, cable trenches, cable trays, transformer and its rating, number of earthing present, earth resistance, earthing termination points, presence of lightning arrestors and SPDs, etc.*

*Photo suggestions*

*Bird’s eye view of obtained data and existing infrastructure that could be used in designing and installing a new system*

## Environmental and social assessment

1. *Information about environmental impacts, potential biodiversity impacts and socio-economic impacts resulting from the installation of the system 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 load demand analysis for 24 hours to establish a relationship between the obtained data and the design parameters.*

*The data collected by using power loggers should be presented with information about active, reactive, apparent power, power factor, observations related to voltage, current spike, total energy consumption, maximum load demand, etc.*

# TECHNICAL DETAILS OF SOLAR GRID-CONNECTED SYSTEM

## Design summary

*Describe and summarise 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. Graphical representation of the energy mix scenario showing the energy consumption from the national grid, solar PV systems, diesel generator systems.*

### System architecture

*Present a block diagram and explain the significance of the system architecture chosen for the 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 an online database 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 project name, system size, cable sizes, and all the component sizes including MCBs, SPDs, etc. along with the legend*
2. *Must represent the array, inverter, switchgears 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, evacuation point, termination units, etc.*
2. *Measurements of data related to the size, topography, terrain, soil condition (where applicable), etc. and plotting them using CAD or similar software*
3. *The presented data and drawings must fulfil the need of serving the purpose of tendering proceedings*
4. *Separate drawings and descriptions for powerhouse, civil structures, land levelling requirements and standards, roof structure, wind loading analysis report, 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, calculations and results for inter-row spacing must be shown clearly*

## Solar PV array

1. *Module specifications used for calculations, drawings, and analysis*
2. *The sizing, design, distribution, and positioning of solar PV array within the facility along with coverage area*
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, changes sought after in the rooftop space/civil foundation requirements, information about required penetrations and drill holes, size of vertical legs, purlins, braces and struts, rafters, base plates, joints, mid-clamps, end clams, etc. must be presented*
3. *For rooftop installations, proper sealing, waterproofing of surfaces using grouts, etc. must be mentioned*
4. *The 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*
4. *Must represent the distribution of modules with respect to array size (kW), string sizing calculations, breakers and isolators sizing to be placed before MPPT input terminals etc.*
5. *Describe a proprietary or third-party online monitoring system compatible with the system*

## Powerhouse

1. *Must include the drawings, specification, and civil components description including fencing requirements (if any)*
2. *Must include plan and side views showing tentative placement of envisaged 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*
4. *Mention if existing space adhering to the requirements of the system will be provided*

## Power evacuation plan

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. *Must include main distribution panel capacity and ratings of circuit breakers used, extra slot for connection, metering arrangements, etc. Basis of selection of cable types-underground (armoured), overhead outdoors (UV), etc.*
3. *Must include the requirement for additional units of switchgear, SPDs, transfer switches, etc. for seamless operation of on-grid inverters*
4. *The evacuation plan will be accompanied by drawings and layout fit for A3 size paper indicating all the components used, powerhouse, evacuation plan, route plan, termination guidelines, specification of components used, etc.*
5. *Detailed specifications and meter type used or to be used must be produced as per the agreed standards and regulatory requirements set by NEA*

## 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. *The 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 calculations must be shown. Different MCBs for each string (string breakers), DC MCBs for the DC side, AC MCBs for the AC side and appropriate circuit breakers 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 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. The combiner box must be chosen to meet the IP standards for outdoor and indoor applications accordingly.*

### Cable routing plan

1. *The cable route must be shown in the overall electrical layout diagram to and from the array, the powerhouse and the evacuation location*
2. *The shortest possible route without compromising the laying of cables overhead, underground, etc. as per the site condition must be proposed*
3. *The 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 and applications*

## 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 clearly specified with ratings*

### 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. *The 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, specifications related to earthing pit must be provided in detail*

# SAFETY CONSIDERATIONS

1. *Measures that must be taken for the safety of the system including PV array, powerhouse, power evacuation units, etc. must be mentioned*
2. *Measures that must be taken for safe roof access*
3. *Precautions and measures such as fencing, operation and management authority, safe handling and safe use of appliances must be mentioned*
4. *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. *The 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 originality of the project area must be retained and 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*

# OPERATION AND MAINTENANCE

1. *Describe whether the institution already has technical resources that can be capacitated for O&M of solar grid-connected systems*
2. *Describe water access near the solar PV array for effective system performance*

# BILL OF QUANTITY AND COST

## Electromechanical system

1. *Detailed BoQ for the proposed system with the 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 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. *The basis of rate for each component/ rate analysis of components that are available within district rates published by GoN must be considered*

# FINANCIAL ANALYSIS

## Source of funds

1. *The 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*

## Financial indicators

1. *Financial indicators such as IRR, Payback period, LCOE, Cashflow diagram, ADSCR, lifecycle costing, etc. must be calculated and presented*
2. *If the financial indicators don’t produce the desired results, possible business cases and 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*
4. *In the case of ESCO model, PPA rate within the parties must be taken as a reference for calculation. However, PPA for net metering issued as per the Directives for Net-metering by NEA must be considered depending upon the modalities of operation agreed upon.*

# CONCLUSION

*Provide a summary of the system architecture, per unit cost reduction potential, project cost and outcomes of the economic analysis to showcase the profitability to the users of the system.*

# ANNEXES

## Load list

## Software simulation report

## Rate analysis for each component used

## Powerhouse layout

## Detailed drawings of components

## Power evacuation plan and layout

## Site photos

## Product datasheets