**Solar Electric Technician Training**

**Handouts: Module 4: Site selection for solar PV systems**

# Site assessment in solar PV system installation

A thorough site assessment is a critical first step in any solar electric PV or water pumping system installation. By evaluating site accessibility, installation conditions, shading issues, and other factors, solar technicians can ensure that the solar system operates efficiently and safely for years to come.

## Site accessibility

When assessing the accessibility of a potential site for solar installation, several key factors must be evaluated to ensure ease of transport and communication.

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| **SN** | **Factors** | **Description** |
| 1. | Road condition | Check if the road leading to the site is black-topped (paved) or off-road (dirt, rocky). Off-road locations may present challenges for transporting materials and equipment's. |
| 2. | Nearest landmark | Identify major landmarks near the installation site. This helps in guiding the installation team and transportation of materials. |
| 3. | Telecommunication and internet Access | Assess the availability of mobile networks or internet access at the site. These are critical for communication and monitoring, especially for remote systems. |

## Actual installation site condition

Different installation site conditions, such as roof-mount or ground-mount, will impact the installation process and structural requirements.

1. **Roof mount**

If the system is being installed on the roof, the following factors should be checked:

| **SN** | **Factors** | **Description** |
| --- | --- | --- |
| 1. | Number of roofs | Determine how many roofs will be used for panel installation. |
| 2. | Type of roof | Identify the roof type: Reinforced Cement Concrete (RCC), tiles, Galvanized Iron (GI) sheets, etc. This helps determine the mounting method and any structural reinforcements needed. |
| 3. | Roof accessibility | Evaluate how easily the roof can be accessed for installation and future maintenance. |
| 4. | Load-bearing Condition | Confirm if the roof can support the weight of solar panels and all the cables layouting. Weak structures may need reinforcement. |
| 5. | Roof orientation | Determine the direction the roof faces (north, south, east, or west). Solar panels should ideally be installed on a south-facing roof for maximum sunlight exposure in Nepal. |
| 6. | Roof tilt angle | Check the tilt angle of the roof. For Nepal, an optimal tilt angle for solar panels is between 20° to 30° depending on the location. |
| 7. | Roof age | Consider the age of the roof to assess whether it needs repairs or replacement before installation. |

1. **Ground mount**

For ground-mounted systems, technicians should assess the following:

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| **SN** | **Factors** | **Description** |
| 1. | Ground material | Identify the ground foundation (e.g., RCC, soil) to identify how the solar panels can be mounted in the respective area. |
| 2. | Ground orientation | Check the orientation of the ground. As with roof installations, panels should be oriented to face south for optimal sun exposure. |
| 3. | Vegetation | Ensure that there is no vegetation (trees, bushes, etc.) that could obstruct sunlight or pose a risk of shading and timely trimming should be scheduled. |

## Shading/Shadow

Shading can significantly reduce the efficiency of a solar system. The following shading factors must be evaluated:

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| **SN** | **Factors** | **Description** |
| 1. | Potential sources of shading | Identify any potential sources of shading both near and far from the installation site. Even objects that are far away but tall (like buildings or trees) can cast shadows that reduce system performance. |
| 2. | Ground orientation | Check the orientation of the ground. As with roof installations, panels should be oriented to face south for optimal sun exposure. |
| 3. | Vegetation | Ensure that there is no vegetation (trees, bushes, etc.) that could obstruct sunlight or pose a risk of shading and timely trimming should be scheduled. |
| 4. | Shadow from natural landscape | In hilly areas, natural landscapes such as mountains or hills could cast significant shadows. This is especially important in rural and mountainous regions of Nepal. |

## Other factors

Additional site-specific and environmental factors must be considered for a safe and efficient installation.

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| **SN** | **Factors** | **Description** |
| 1. | Flammable materials | Check for the presence of flammable materials such as presence of gasoline, lighters, dry husk, etc. nearby the solar system installation site. This could present a fire hazard. |
| 2. | Wind velocity | Measure the average wind velocity at the site, as strong winds may necessitate stronger mounting structures to avoid damage. |
| 3. | Space availability | Ensure there is enough space for installing inverters, batteries, and a pump controller either inside or outside the building. These components require safe, secure, and accessible areas. |
| 4. | Wire layout and existing conduit | Assess the wiring layout scenario. Determine if wires will be placed overhead or underground. Underground wires offer more protection but are harder to install and maintain. In case of installation in existing building or institution, verify if there's existing conduit do have spare space for additional wiring of solar PV system. |

# Use forms to assess site condition to select suitable location for all the components for different types of system.

**Example: Solar water pump site survey form – Irrigation (Solar Irrigation Pumps, SIP)**

Read the survey form to get an insight of the necessary task to be performed. The highlights of the survey form for solar water pump – irrigation purpose are as follows.

* List of tools required during the survey such as GPS, measuring tape, camera, calculator, stopwatch, sun-path mobile appl, pen and notebook.
* List of documents to be collected includes land permit for installation and community consent for the installation and use of the system.
* General information of the site – location details, type of SIP ownership, agriculture value chain, land and water information, existing water-pumping mechanism, grid information.
* Identification of locations for the solar PV components – solar array, pump intake, controller, water transmission and distribution layout.
* Sketch the locations for better visualization for later system design.
* During each of the information collection, click the pictures (if necessary).

# Prepare and plan the installation at site for mounting structures, inverters, battery banks, water pumps, pump controllers and Balance of System, BoS

Solar electric technicians need to follow critical steps before installation and during the preparation of the mounting structure. Verifying the location, reading the structure drawings, checking orientation and tilt angles, recalculating spacing, verifying the components’ location and preparing the necessary tools are all essential to ensure that the installation is successful and that the system operates efficiently. Proper planning and communication prevent delays and errors during installation. These roles include:

* **Verifying the survey report:** Cross-check the site details in the survey report, such as the location, shading issues, and area measurements.
* **Consulting with the concerned or authorized person:** Ensure clear communication with the client, engineers, or supervisors to confirm expectations and requirements.
* **Verifying the Bill of Materials (BoM):** Cross-check the materials as per listed in the bill of quantity and ensure that the materials and equipment are as per the mentioned.
* **Listing the installation tools:** Prepare a complete list of all necessary tools and equipment for the installation, such as wrenches, drills, levelers, and protective gear.

**Read specifications and manual for the inverter (one sample for specification and manual)**

Understanding the specifications of an inverter is crucial for its proper installation and operation in a solar PV system. The specifications give detailed information about the inverter's capacity, power input/output, efficiency, and environmental conditions. Understanding the inverter’s specification ensures that the design engineer had selected the right inverter for the solar PV system, maximizing system efficiency and longevity.

The inverter manual provides all the necessary information to safely and correctly install and operate the inverter. The following parameters are considered.

1. **Safety parameters:** it helps prevent accidents, system failure, and ensures compliance with safety standards.

* Grounding/Earthing instructions
* Overvoltage protection
* Anti-Islanding protection
* Shutdown procedures

1. **Mounting parameters:** Proper mounting ensures the inverter’s longevity and safe operation.

* Mounting type – wall mount with minimum gaps
* IP65 (protection under UV, wind and moisture)

1. **Operating conditions:** Adhering to operating conditions prevents damage and maintains system efficiency.

* Voltage and current range
* Temperature range
* Humidity levels

1. **Installation process**: Proper installation minimizes the risk of malfunction and ensures optimal performance.

* Step-by-step guide
* Positioning and securing the inverter

1. **Wire connection:** Incorrect wire connections can lead to electrical hazards or system failure.

* DC input connection
* AC output connection

1. **Ventilation requirement**: Adequate ventilation prevents overheating and extends the lifespan of the inverter.

* Clearance space
* Cooling mechanism

**Cable route layout**

The layout of the cable route is a critical aspect of any solar installation, as it ensures the safe and efficient transmission of electricity between the solar panels, inverters, and other system components. The following points need to consider:

* **Plan the route:** Before installation, review the system design and site plan to determine the best route for the cables. Consider factors like distance, safety, and accessibility.
* **Avoid obstacles**: Ensure the cable route avoids physical obstructions such as rocks, trees, or buildings. This will prevent damage to the cables and reduce installation complexity.
* **Minimize cable length:** Keeping the cable route as short as possible minimizes electrical losses, ensuring efficient energy transmission.

## Underground cable routing Vs. Overhead cable routing

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|  | **Underground cable routing** | **Overhead cable routing** |
| **Benefits** | **Protection from weather:** less vulnerable to weather-related damage, such as wind, rain, or snow.  **Aesthetic:** Hiding the cables underground provides a cleaner look, especially in residential or public installations. | **Lower cost:** Overhead cables are generally less expensive to install, as they don't require trenching or heavy earthworks.  **Easy access**: Maintenance is easier, as overhead cables are more accessible for repairs or inspections. |
| **Considerations** | **Trenching:** You’ll need to dig trenches to bury the cables. The depth of the trench should comply with local electrical codes, typically around 600 mm to 1 meter, to prevent accidental damage.  **Cable protection**: Use conduits to protect the cables from moisture, soil pressure, or accidental digs. Poly Vinyl Chloride, PVC or metal conduits are commonly used for underground cable protection.  **Marking:** It's important to mark the cable route on the surface to prevent accidental damage during future site work | **Safety:** Ensure that overhead cables are installed at a safe height to prevent accidental contact. Follow local electrical codes for minimum clearance heights (usually around 5 to 6 meters above the ground).  **Pole spacing**: When installing overhead cables, make sure to use poles at proper intervals to maintain cable tension and prevent sagging.  **Weather exposure**: Overhead cables are more exposed to weather conditions like wind and rain, which can lead to wear and tear over time. Use weather-resistant materials and supports to extend their lifespan. |

## Conduits

Purpose: Conduits are essential for protecting electrical wiring, especially in harsh environments. Whether installed underground or overhead, conduits provide mechanical protection and prevent exposure to the elements.

**Types of conduits:**

* **PVC conduits:** Lightweight, cost-effective, and resistant to corrosion. Suitable for underground use.
* **Metal conduits**: Strong and durable, ideal for areas with heavy physical impacts, such as industrial sites.

**Installation tips:**

* **Conduit size:** Ensure the conduit is large enough to accommodate all the cables without overcrowding. This helps with heat dissipation and makes future maintenance easier.
* **Waterproofing:** For underground installations, ensure the conduits are properly sealed to prevent water ingress, which could damage the cables over time.

# Site assessment forms

For confirmed installations, we will utilize standard forms and formats to conduct detailed site surveys for different solar PV technologies. These forms are designed to ensure a thorough and consistent evaluation process.

We will cover three types of solar PV systems: Solar Mini Grid (SMG), Solar Water Pumps (SWP), and Solar Grid-Connected Systems (SGCs). The specific forms for each technology are provided in the annexes for your reference. Make sure to familiarize yourself with each form and understand the specific requirements for the technology you are assessingFor all three solar PV technologies, the survey forms are available in annexes.

By following these standard forms and procedures, you will ensure a thorough and effective site assessment, leading to successful installation and operation of the solar PV systems.After familiarizing with the standard Forms for site survey, do carry out following activities for best result.

1. **Complete the forms during the site visit**

* Use the provided forms to systematically record all observations and measurements.
* Ensure that all relevant fields are filled out accurately.
* Take photos for future refrence.

1. **Review and analyze data**

* After the site visit, review the completed forms to assess site suitability.
* Identify any issues or considerations that need to be addressed before installation.

1. **Document findings**

* Compile the information into a comprehensive site assessment report.
* Include recommendations and any additional notes based on the survey data.

## Final preparation for solar PV system installation

Based on the survey results, engineers and designers will develop customized solar PV systems tailored to meet the specific requirements of clients. Before the actual installation begins, it’s crucial to conduct a thorough final verification. Here’s a detailed breakdown of the steps:

1. **Site verification**

* **Site visit by technicians and engineers:** The engineering team and technicians will visit the site to confirm that the survey data is accurate. This step is essential to ensure that the site conditions align with the design specifications.
* **Assessment:** During the visit, they will inspect the physical space, verify that it matches the survey findings, and identify any site-specific issues, such as shading, structural stability, or accessibility challenges.

1. **Preparation and planning**

* **Installation preparation:** After verifying the site, the team will create a detailed plan for the installation process. This plan will align with the project timeline and cover all necessary steps to ensure a smooth installation.
* **Coordination:** The engineering team will work closely with the installation crew to ensure everyone understands their roles and responsibilities.

1. **Briefing the technicians**

* **Detailed briefing:** Before installation begins, the engineering team will hold a briefing session with the technicians. This session will cover:
* **Bill of Quantities (BOQ):** The finalized BOQ will be provided, outlining all the materials and components required for the installation.
* **Drawings:** Technicians will receive detailed drawings, including mounting structure drawings, engineering drawings, and single-line diagrams. These documents will guide them in setting up the system according to the design.
* **Technical specifications:** Manuals and specifications for inverters, battery banks, water pumps, and other components will be reviewed to ensure correct installation procedures.

## Key areas of focus

* **Mounting structure drawings and specifications:** The team will review how to correctly install mounting structures based on detailed drawings and specifications.
* **Technical specifications and manuals:** Manuals for each component will be consulted to ensure proper installation, wiring, and configuration.
* **Cable route planning guide**: Best practices for routing electrical cables will be discussed to maintain safety and efficiency during installation.
* **Engineering drawings and single line drawings:** These documents will be reviewed to understand the system layout and integration points.
* **Regulatory and code requirements:** The team will review all relevant regulations and codes to ensure compliance throughout **the** installation process.

By following these steps, the team will ensure that the solar PV system installation is well-organized and executed smoothly, resulting in a high-quality and reliable system that meets client expectations.

* **Annex A: Standard Site Assessment Form for Solar Mini Grid (SMG)**
* **Annex B: Standard Site Assessment Form for Solar Water Pumps (SWP)**
* **Annex C: Standard Site Assessment Form for Solar Grid-Connected Systems (SGCs)**