

Module Outline

FEASIBILITY REPORT PREPARATION FOR PV PROJECTS





Disclaimer

All rights reserved.

The authors assert their moral rights.

The text in this book is those of the authors and the facts are as reported by them, which have been verified to the extent possible, and the publisher is not in any way liable for the same.

The publisher has used its best endeavors to ensure that URLs for external websites referred to in this book are correct and active at the time of going to press. However, the publisher has no responsibility for the websites and can make no guarantee that a site will remain live or that the content is or will remain appropriate.

No part of this publication may be reproduced, transmitted, or stored in a retrieval system, in any form or by any means, without permission in writing from the International Solar Alliance.

Relevance and Background

Solar photovoltaic (PV) power plants stand out as a transformative solution to meet energy demands while reducing environmental impact. As solar technology advances, the need for effective project planning and execution becomes paramount. The Feasibility Reports in the form of Detailed Project Report (DPR) serves as the blueprint that guides solar PV power plant projects from concept to reality.

A well-prepared DPR combines technical acumen, financial insight, environmental considerations, and regulatory compliance. This training module is designed to impart participants with the skills needed to create comprehensive DPRs. By understanding solar PV technology, financial modelling, risk assessment, and environmental impact, participants will be equipped to craft DPRs that ensure project success, align with industry standards, and drive the transition to sustainable energy sources.

Theme – Financing

Competency – Feasibility Assessment

Code of the Module – To4C10M27

Learning Outcomes

Upon completing this training module, participants will:

- Understand the significance of DPRs
- Comprehend project elements
- Learn the components of DPRs
- Be able to develop DPRs

Method of Delivery

Duration	Resource Code	Resource Delivery
60 min.	M27 L01	Lecture on Feasibility Report Preparation for PV Projects

M27 L01: Lecture Presentation

From technical assessments to stakeholder engagement, the MS PowerPoint presentation will guide participants through the entire DPR process, equipping them with the skills to create well-structured and compelling DPRs that drive successful project implementation.

The presentation has been divided into four sections: Section I – Introduction, Section II – DPR Structure and Content, Section III – Creating and Presenting the DPR, and Section IV on the DPR as



a Tool for Further Decision-Making and Stakeholder Engagement, and Monitoring, Reporting and Adaptation.

Key Topics to be Covered

1. DPR Structure and Content
2. Presenting the DPR
3. DPR as a Tool



Table of Contents

1	Introduction.....	6
1.1	Project Overview	7
1.2	Components of a Typical DPR	7
2	DPR Structure and Content.....	9
3	Presenting the DPR	13
4	DPR as a Tool	14

1 Introduction

Once the decision to establish a solar power plant has been made, careful planning is essential for each subsequent step. The first step involves conducting a local assessment to determine the system's capacity. This is followed by pre-feasibility studies to analyse the system's capacity, structure, climatic parameters, and the modules' ability to tolerate load and shading. Pre-feasibility studies, generic yet well-researched due diligence reports, offer a basic understanding of the technical and economic feasibility of a solar PV captive power system. While detailed project reports (DPRs) are essential for external stakeholders like banks, pre-feasibility reports assist internal stakeholders, such as the board of directors, in corporate decision-making. A DPR is a comprehensive document for investment decision-making, approval, and planning, typically prepared by the system integrator responsible for the turnkey implementation of the power plant.

Through this module, participants will gain a comprehensive understanding of the preparation process for DPRs of solar PV power plants. However, before delving into the preparation of DPRs, participants need to grasp the fundamental aspects of solar PV projects covered in the DPR.



1.1 Project Overview

It is important to first review the following, before DPR preparation:

- **Site Assessment and Preparation:** The chosen site by assessing land requirements, soil conditions, water body type (for floating solar), roof type (for rooftop solar) and potential shading issues to ensure optimal solar panel performance to suit ground-mounted, floating, or rooftop installations. This has been covered in further detail below.
- **Technical Design:** A detailed technical design for the solar power plant layout, solar panel configuration, inverter system, and electrical interconnection.
- **Installation and Commissioning:** Including mounting structures, electrical components, and monitoring systems.
- **Operations and Maintenance (O&M):** An effective O&M plan to ensure the system's reliability and efficiency.
- **Target Capacity:** This should be clear from the inception.
- **Location:** The project's location, chosen for its solar irradiance, accessibility, and compatibility with existing infrastructure.
- **Other Key Details:** Review other noteworthy project specifics, such as partnerships, community engagement initiatives, or unique technological aspects.

The technical, financial and environmental considerations should also be reviewed, which contribute to preparing comprehensive DPRs for solar PV power plants. The above issues are elaborated in the following section.


1.2 Components of a Typical DPR

- **Background of the Promoters:** Information about the promoters, their current businesses and activities, and their interest in the proposed project should be detailed here. Stakeholders often value the project based on the promoters. The promoters' technical capabilities can be substantiated based on prior experience, and their financial strengths should be mentioned to provide assurance that the project can be executed as presented in this DPR.
- **Site Assessment and Feasibility:** Understanding the solar resource potential, site selection criteria, and feasibility studies are essential to lay the foundation for a successful project. Solar Resource Assessment (Solar Insolation and Climate Conditions) involves evaluating data on Global Horizontal Irradiance (GHI), Direct Normal Irradiance (DNI), and Diffuse Horizontal Irradiance (DHI) to anticipate performance under various scenarios. Site Selection Criteria and Considerations encompass solar orientation, available land area, proximity to substations and grid infrastructure, and environmental

factors like wind speed, humidity, and pollution levels that affect system performance. A preliminary site assessment covers shading analysis, topography, and soil/water body/roof conditions, followed by a feasibility study to assess economic, technical, and environmental feasibility.

- **Technical Design:** The selection of appropriate solar PV technology (types of panels, inverters, mounting systems, etc.), system configuration (grid-connected, off-grid or hybrid), electrical design (single-line diagram, array configuration, and interconnection), and implementation of monitoring and control systems are pivotal for the success of the project. By addressing these technical design aspects accurately, solar PV power plant projects can be tailored to maximize energy production, ensure system reliability, and adhere to safety and quality standards. This phase forms the backbone of the DPR.
- **Financial Analysis and Project Economics:** Understanding capital costs (for equipment, installation and civil works), O&M expenses (for inspections, cleaning, repairs, and replacements of components, or for monitoring and control systems), financing options (debt/equity, power purchase agreements, and subsidies), and conducting financial modeling are essential for assessing the economic viability of the project. The financial analysis also covers detailed cash flow models that project income, expenses, and cash flows over the project's lifecycle, calculate Return on Investment (ROI) to assess the





profitability of the project relative to the initial investment, determine Net Present Value (NPV) by discounting future cash flows to present value, and compute Internal Rate of Return (IRR) to evaluate the project's potential for generating returns. Finally, conduct sensitivity analysis to understand how changes in key parameters impact project economics. By conducting a rigorous financial analysis and developing comprehensive financial models, stakeholders can make informed decisions about project investment and financing; this phase enables effective risk management.

- **Environmental Considerations and Regulatory Compliance:** Addressing environmental impact, obtaining regulatory approvals, ensuring compliance, and respecting social and community factors are integral to responsible project development. These will include conducting a comprehensive Environmental Impact Assessment (EIA) to identify potential environmental impacts of the project, identifying the regulatory authorities responsible for granting permits and approvals for solar PV power plant projects, and adhering to local and national regulations related to renewable energy projects, environmental protection, land use, and grid interconnection. It may be noted that in many countries, conducting an EIA for a solar project is not needed. Most importantly, develop a timeline for obtaining permits and approvals, ensuring the integration of these milestones into the project schedule. Engage with local communities and stakeholders to understand their concerns, needs, and expectations, and develop strategies to ensure the project's positive impact on the local community, including job creation, skills development, and infrastructure enhancement.
- **Implementation Planning and Risk Management:** Efficiently executing project plans, ensuring safety, and mitigating potential risks are essential for achieving successful project outcomes. Some important considerations here are:
 - Developing Project Timelines and Milestones
 - Procurement Strategies and Resource Allocation
 - Project Implementation Planning
 - Construction Management
 - Risk Identification and Mitigation
 - Health, Safety, and Environmental Considerations

Once the above project issues are understood, participants can next review the structure and content of DPRs to be able to prepare them.

2 DPR Structure and Content

The typical structure and content of a DPR is as follows.

- **Executive Summary**
- **Introduction** - This section provides the project's background, its national, regional/state context, the state/region's power scenario, and the nation's status of solar energy development. It concludes by elaborating on the solar potential in the state/region and country and the project's objectives.
- **Project Location and Site Description** - This section covers a brief description of the project area/region, type of project land, location descriptions with detailed maps showing state/region, etc. and the project site and its surroundings. Objective parameters like site address, site longitude-latitude, array tilts angle, azimuth, solar radiation, obstacles, shadows, distance of nearest substation/evacuation systems and grid status of substation, approach road to site/connectivity by road, train and air, distance from urban infrastructures, soil strength, brief report on topographical survey, availability of water, drainage system, security, availability of labor, social support for power plant, temperature and temperature variation of the site, rainfall data, highest flood records, highest wind speed at array level, seismic data/record, etc., soil test reports and other tests reports, hourly meteorological data, historical weather data of the project area and technology selection for the proposed project, are covered.



- **Potential Energy Generation and Simulation Studies** - This section talks about solar resource assessment, typical system specifications considered, estimated energy generation potential using software modeling and its justification/basis of calculations.
- **Technical Specifications** - Four major components are covered:

- **Solar PV Generation** - Focusing on technology selection, advantages and disadvantages, comparison of module technologies (such as mono / poly crystalline or thin film or bi-facial or PERC and other newer ones), and the market share of each. Other details include:
 - General project layout, schematic diagram and brief description of each component
 - Criteria for selection of modules
 - Technical features and other special design aspects of the plant
 - Solar PV generation report considering system losses
 - Shadow analysis
- **Power Equipment and Balance of Systems** - This section covers the equipment required to handle the electricity generated by the solar PV plant and includes the following:
 - Module mounting structures.
 - Tracking systems
 - Power conditioning unit (PCU)
 - Monitoring systems
 - Control room
 - Balance of systems
 - SCADA and remote monitoring systems (RMS)
 - Lightning and protections
 - Earthing systems
 - Energy meters
 - Cable and connectors
 - Water for cleaning
- **Power Evacuation Systems** - This section covers details of equipment that will enable evacuation of the generated power to the grid and may include:
 - Erection and installations of power evacuation arrangements
 - Power evacuations diagram
 - Grid synchronization systems with schematic diagrams
 - Transformers

- Isolators and insulators, etc.
- Steel structures, towers, etc.
- Earthing systems, lightning protections
- AC & DC auxiliary power supply arrangements
- Grid interconnection arrangements
- Safety regulations
- **Specifications, Standards, Warranties, and Performance Guarantees** - The above equipment must comply with international and domestic specifications and standards, and suitable information on the same is an integral part of the DPR. These include:
 - Specifications of major items
 - Relevant standards
 - Making mandatory the following during project execution:
 - Photovoltaic module testing reports
 - Photovoltaic products' quality assurance
 - Specifications of cables and connectors
 - Performance warranties of the plants
 - Mode of performance measurement & penalties
- **Supply and Contracts** - Covering bills of materials (BoMs), procedures for EPC/turnkey contracts.
- **Operation and Maintenance (O&M) of Plant** - Ensuring generation at designed levels is crucial as it has a direct bearing on the revenue that the plant generates. This makes O&M important. This section of the DPR gives details on the maintenance plan, spare parts management, training of O&M staff, and availability of tools and machines, servicing kits, checklists, etc.
- **Social and Environmental Issues** - Social impact assessment and management plan, EIA and management plan, and compliances and clearances
- **Implementation Schedule** - This should be phase-wise on various sets of activities leading to the commissioning of the project. The schedule typically comprises the following:
 - Project development
 - Finalization of the equipment and contracts

- Procurement and construction
- Erection and commissioning phase
- **Organization and Staffing Requirements**
- **Project Costing and Financial Analysis**, including cash flow, sensitivity analysis, and financial results/indicators.
- **Annexures** - Reports, data sources, BoMs, energy calculations, program evaluation review technique (PERT) chart, etc.
- **Exhibits** - Pictures of site, single line diagrams, power evacuation diagrams, etc.



3 Presenting the DPR

Once participants have learnt how to synthesize the diverse content into a comprehensive DPR and after the DPR is prepared, convey its findings to stakeholders, and ensure alignment with industry standards and best practices. Various stakeholders have different requirements and the DPR should be so prepared that the requirements of the stakeholders are met. In order to do so, the following aspects should be kept in mind:

- **Synthesizing Knowledge into a Comprehensive DPR**

- Learn to collate technical, financial, and operational insights into a cohesive DPR.
- Understand the importance of structuring the DPR to provide a holistic view of the project.

Example: Incorporating data on solar irradiance, financial projections, and technical specifications to create a robust DPR.

○ **Presenting DPR Findings to Stakeholders**

- Master techniques to convey complex information from the DPR to diverse audiences.

Example: Communicating financial viability to investors and technical specifications to engineers effectively.

○ **Ensuring Alignment with Industry Standards and Best Practices**

- Understand the significance of adhering to established industry standards and best practices.
- Learn how to ensure that the DPR's content and methodologies adhere to recognized benchmarks.

Example: Ensuring the financial modeling in the DPR follows industry-accepted methods for accurate assessments.

This training module will equip participants with the necessary tools to navigate the intricacies of preparing DPRs for solar PV power plant projects. Also, by mastering the skills of creating, presenting, and aligning the DPR, participants will be equipped to encapsulate project complexities, engage stakeholders effectively, and ensure the project's adherence to industry benchmarks.

4 DPR as a Tool

This section equips participants with the skills needed to leverage the DPR for informed decision-making, impactful communication, and stakeholder engagement, thereby enhancing the success of solar PV power plant projects. Participants will also explore the significance of establishing robust mechanisms in the DPR to track progress of the solar projects, gauge performance, and adapt strategies based on monitoring results.

○ **Decision-Making and Stakeholder Engagement**

- Understand the role of the DPR in providing critical data for strategic decision-making.
- Extract relevant data from the DPR, such as financial projections and technical specifications.

- Learn techniques to translate complex technical and financial data into clear and engaging communication.
- Illustrate projected energy generation, financial returns and other benefits such as low growth, renewable energy targets, etc. to resonate with stakeholders and investors.



○ **Monitoring, Reporting, and Adaptation**

- Understand the importance of setting up systematic monitoring and reporting mechanisms.
- Learn how to define key performance indicators (KPIs) for effective evaluation of energy generation, system efficiency, and equipment performance for comprehensive monitoring, among others.
- Explore techniques to track project milestones and assess performance against set targets.
- Learn to interpret monitoring data to assess the project's adherence to established goals.
- Learn how to analyze monitoring data to identify areas for improvement or adjustment.



Reading Material

- *"Large-Scale Solar PV Power Plant Project Report"*
 - *Location: Africa*
 - *Reference: A comprehensive DPR for a large-scale solar PV power plant project in an African country, addressing site assessment, technical design, financial analysis, and regulatory compliance*
 - *Link: <https://www.energy.gov.za/spark/sa%20solar%20park%20indicative%20master%20plan.pdf>*
- *"Renewable Energy Project Feasibility Report"*
 - *Location: Island countries*
 - *Reference: Feasibility report for a solar PV power plant project in a South American nation, focusing on economic viability, environmental impact assessment, and stakeholder engagement.*
 - *Link: https://publicpartnershipdata.azureedge.net/gef/GEFProjectVersions/e78f2bee-6b8c-eb11-a812-000d3a58b431_PIF.pdf*
- *"Solar PV Power Plant Case Study"*
 - *Location: Bangladesh*
 - *Reference: A case study featuring a successful design of a 50 MW solar PV power plant considering Bangladeshi climate*
 - *Link: <https://www.divaportal.org/smash/get/diva2:1607213/FULLTEXT01.pdf>*

