

Module Outline

PROJECT DEVELOPMENT - DRE





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Relevance and Background

Renewable energy systems that generate and distribute energy from renewable sources at or near the point of consumption are called decentralized and distributed renewable energy (DRE) systems. These systems differ from centralized renewable energy systems that generate energy at large power plants and transmit it over long distances to consumers. DRE systems have several advantages over centralized systems, such as increased resilience, reduced transmission losses, improved grid efficiency, local economic benefits due to job creation, reduced pollution and greenhouse gas emissions by using renewable energy sources like solar to generate energy, and are becoming increasingly popular as a way to meet the world's growing energy needs and will play a key role in transitioning to a clean energy future.

Theme – Project Management

Competency – Project Development (DRE)

Code of the Module – To3Co6M18

Learning Outcomes

At the end of the presentation, the participants will be conversant with the:

- Importance of DRE systems, and their project planning and development
- Basic understanding of new solar technological applications like floating solar and how such projects can be developed
- Planning and development of solar mini-grids

Method of Delivery

Duration	Resource Code	Resource Delivery
60 min.	M18 L01	Project Development - DRE

M18 L01: Lecture Presentation

The MS PowerPoint presentation starts with the definition of a DRE system and discusses the key benefits of such systems, making them an important component in the power portfolio of any region/country. Thereafter, the presentation provides a recap of the various stages of project development focusing on DRE projects, specifically covering three applications – grid-connected PV, floating solar, and solar mini-grids.

Key Topics to be Covered

- 1 DRE Systems
- 2 Solar DRE Project Development
- 3 Importance of project planning


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- 4 Grid-Connected Solar DRE Projects
 - 5 Grid-Connected Floating Solar: Project Design
 - 6 Solar Mini-Grids: Design and Development



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1 DRE Systems

While decentralized and distributed energy systems are often used interchangeably, they have distinct meanings. A decentralized energy system involves spreading the generation, transmission, and distribution of energy across a wide area, rather than concentrating them in a single location. This can be achieved using various renewable energy sources, such as solar, wind, and biomass, which are positioned near the point of use. Decentralized energy systems offer greater resilience to disruptions compared to centralized systems, as they are less dependent on a single point of failure. A distributed energy system connects small-scale energy generation units to a larger grid. These units can be renewable or non-renewable, but they are typically situated near the point of use. In the context of renewable energy, "decentralized" and "distributed" are often combined to describe systems that utilize small-scale renewable energy sources for local electricity generation. These systems can function independently or be linked to the larger grid. Distributed Renewable Energy (DRE) systems offer several advantages over centralized systems, including resilience, efficiency, economic benefits, and environmental advantages. As a sustainable solution, DRE systems are becoming increasingly popular, with the potential to enhance the efficiency, reliability, and resilience of our energy system. DRE systems offer a number of advantages over centralized systems, such as:

- **Resilience** – as compared to centralized systems, DRE systems are more resilient.
- **Efficiency** – being close to the point of consumption, there are minimal transmission and distribution losses.
- **Economic Benefits** – create jobs and promote investments at the community level.
- **Environmental Benefits** – as the source of energy is renewable energy, they are environmentally beneficial.

DRE systems are becoming increasingly popular as a way to meet the growing energy needs sustainably. They have the potential to make our energy system more efficient, reliable, and resilient.

2 Solar DRE Project Development

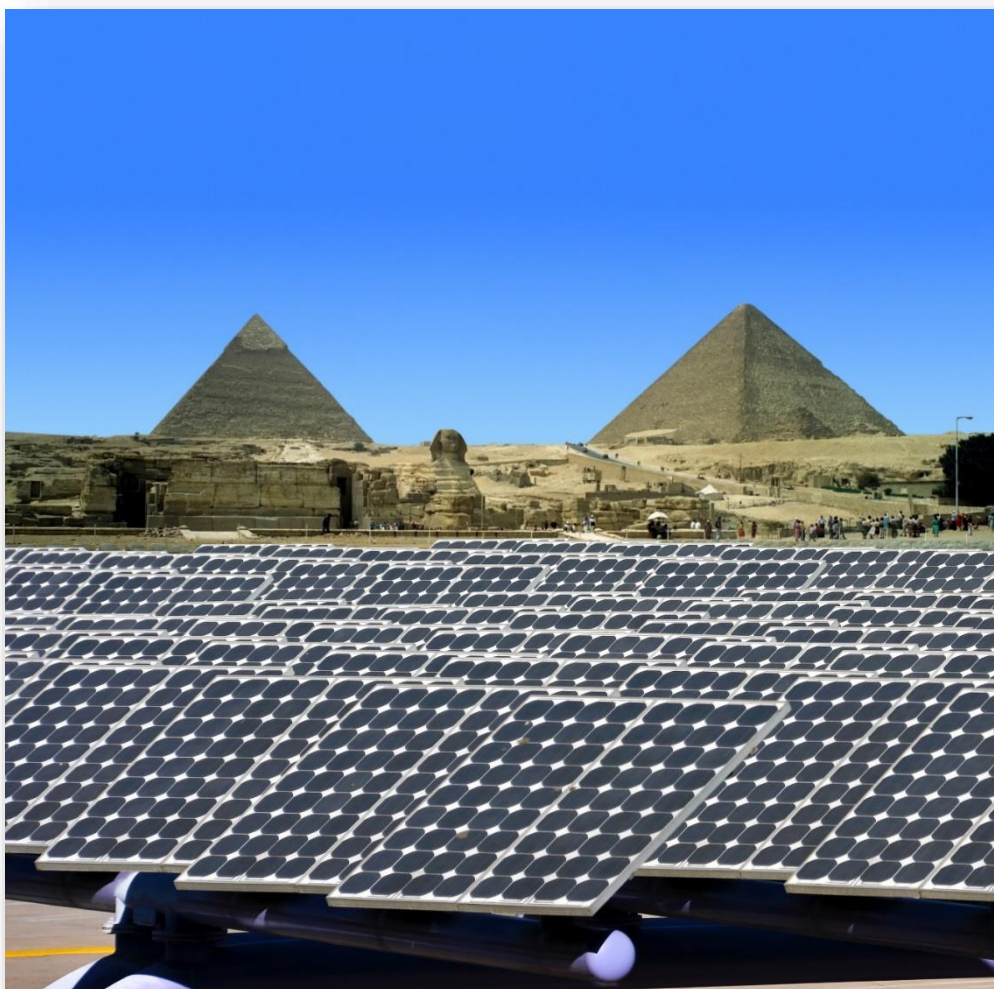
The various stages of development of a solar DRE project are:

- **Pre-Development:** This stage involves:
 - Identifying the site considering factors such as the amount of sunlight available, the availability of land, and the proximity to transmission lines.
 - Conducting feasibility studies, including both technical and financial aspects of the project.
 - Obtaining the necessary permits and approvals from local, state and federal agencies.
- **Development:** This design stage involves:
 - Determining the size and layout of the project, as well as the type of solar panels and other equipment to be used.
 - Finding investors or lenders to finance the project.
 - Hiring contractors to install the solar panels, inverters, and other equipment to build the project.
- **Construction:** This stage involves:
 - Mounting the solar panels on the roof or ground, and connecting them to the inverters.
 - Converting the direct current (DC) output of the solar panels into alternating current (AC) electricity by installing inverters.
 - Installing other equipment such as batteries, transformers, and monitoring systems.
- **Commissioning:** This stage involves:
 - Testing the solar panels, inverters, and other equipment to ensure that they are operating as designed.
 - Officially putting the project into operation.
- **Operation and Maintenance:** This stage involves:
 - Monitoring the project by regularly checking the performance of the project and identifying any problems.
 - Performing regular maintenance, including cleaning solar panels, inspecting equipment, and replacing any worn or damaged components, for reliable operation.

3 Importance of Project Planning

The installation phase of a plant is usually well-planned and straightforward. However, other aspects are often overlooked during planning, potentially impacting the project's budget or timeline. To ensure successful project development, it is crucial to establish clear objectives, consider all factors that may affect the project, create accurate budgets and timelines, and plan for contingencies. This is especially vital for complex projects involving multiple stakeholders, like a solar mini-grid project. A well-planned solar DRE project is more likely to succeed when it is technically feasible, financially viable, and environmentally sustainable. Additional key benefits of project planning for solar DRE projects include:

- **Reduced Risks:** Planning helps to identify risks like delays, cost overruns, and technical problems and adopt appropriate mitigating measures.
- **Improved Communication:** A well-planned project helps to improve communication between the project team and multiple stakeholders.
- **Increased Efficiency:** Of the project team and ensuring that resources are used effectively.



4 Grid-Connected Solar DRE Projects

4.1 Stakeholders Involved

Unlike off-grid solar projects, which primarily interact with customers, grid-connected DRE projects involve interactions with various stakeholders. These include the electricity regulatory commission, utility or DISCOM, the electricity purchaser, financing institutions, investors, EPC (Engineering, Procurement, and Construction) companies, and government departments or agencies responsible for project approvals. Ensuring that the system does not negatively impact the grid's functioning is of utmost importance. The roles and responsibilities of stakeholders may vary across regions and countries, necessitating verification by project developers before the design stage.

4.2 Project Management of a Solar DRE Project

In this context, project management is the process of planning, organizing, and managing the resources and activities required to deliver a solar DRE project on time, within budget, and to the required specifications. The project manager is responsible for overseeing all aspects of the project, from the initial planning stages to the final commissioning and handover, and will need to work with a variety of stakeholders, including the client, project team, contractors, and regulatory authorities. For the successful project management of solar DRE projects, the project manager should:

- Use a project management tool like MS Project to help track the progress of the project, manage the budget, and communicate with stakeholders.
- Be flexible.
- Build a strong team with the right skills and experience.
- Communicate effectively and regularly with all stakeholders.
- Identify and manage the risks associated with the project to avoid problems down the road.
- Document all aspects of the project, from the initial planning stages to the final handover. This will help to avoid confusion and disputes later.

5 Grid-Connected Floating Solar: Project Design

A floating solar project is a solar power plant that is installed on a water body, such as a lake, reservoir, or pond. They can be installed on these water bodies that are sometimes not suitable for other uses or which are lying idle. Once the solar panels are installed, they help reduce evaporation from the water bodies, which can help to conserve water resources. They can help cool the water body, which can be beneficial for fish and other aquatic life. As they are installed on water, the microclimate around the panels is cooler as compared to that of land installations. This results in higher electricity generation.



Thus, though floating solar development is similar to ground-based PV plants, it has a number of the above advantages over traditional solar projects. Although these projects are at a nascent stage of development, there are also some challenges that developers need to keep in mind. The cost of installation can be higher than for traditional solar projects, the floating structures need to be designed to withstand the forces of wind and waves, and maintenance of the panels is also more difficult.

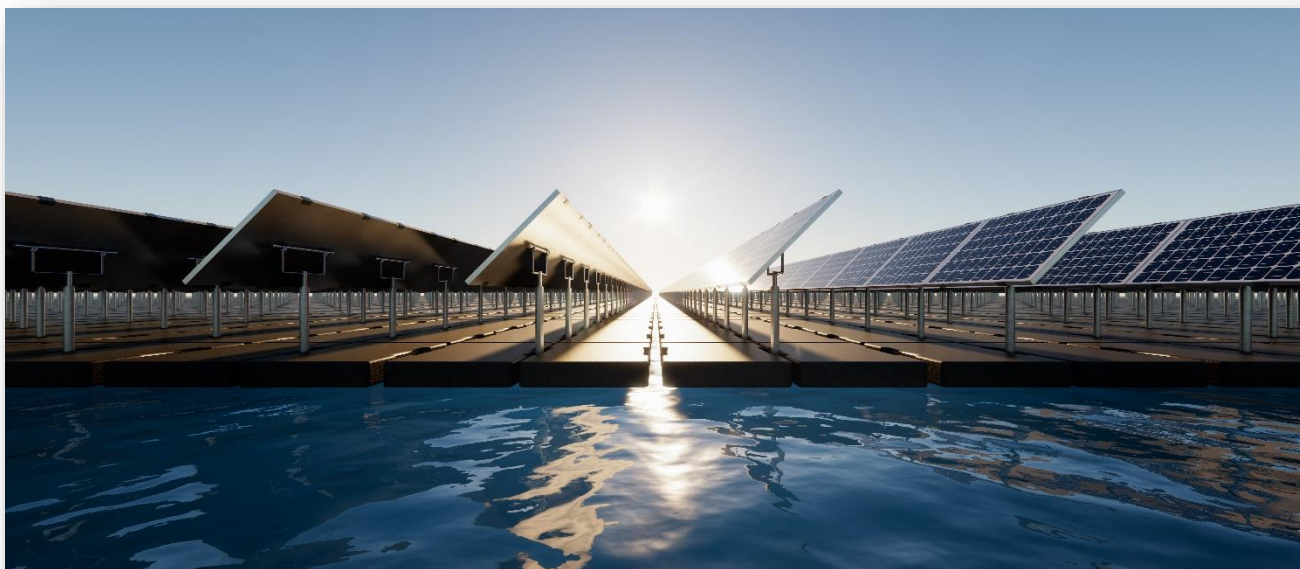
Floating solar panels are mounted on a floating structure, which can be made of a variety of materials, such as steel, concrete, polyethylene, polyvinyl chloride (PVC), or plastic. The solar arrays, and maybe inverters and transformers too, are not ground-based but float on the water surface. This difference demands special attention to the design aspects of these components in addition to the other normal ground-based plant designs.

Besides the solar panels, inverters, and floating structure, the other major components of a floating solar project are anchors to keep the floating structure in place, and are made of steel, concrete, or plastic, electrical cables, and the monitoring system. The specific components of a floating solar project will vary depending on the size, location, and design of the project.

5.1 Design Considerations of a Floating Solar Project

Some of the factors that should be taken into consideration in floating solar projects are:

- The water depth at the proposed site should be shallow enough so that the floating structure can be anchored securely, but not so shallow that the solar panels are exposed to the water or so high that it will be affected by wind/waves.
- Floating solar panels can release pollutants into the water, so it is important to ensure that the water quality is not compromised.
- The floating structure should be designed to withstand the maximum wind and wave conditions that are expected at the site.
- The anchoring system should be designed as per the water depth, wind and wave conditions, and size of the floating solar project.
- The type of solar panel that is used will depend on the climate and the amount of sunlight that is available at the proposed site. Solar panels that are designed for use in harsh environments, such as those with high winds and waves, should be used.
- The solar panels need to be cleaned regularly to remove dirt and debris. The floating structure also needs to be inspected regularly to make sure that it is still in good condition.
- The cost of floating solar projects is typically higher than the cost of traditional solar projects. This is because of the cost of the floating structure and the anchoring system. However, the cost of such projects is expected to decrease as the technology matures.



6 Solar Mini-Grids: Design and Development

A mini-grid is a set of small-scale electricity generators and possibly energy storage systems interconnected to a distribution network that supplies electricity to a small, localized group of customers and operates independently of the national transmission grid (The World Bank, 2022). Being one of the cheapest sources of energy generation, solar is the most preferred renewable energy source for mini-grids.

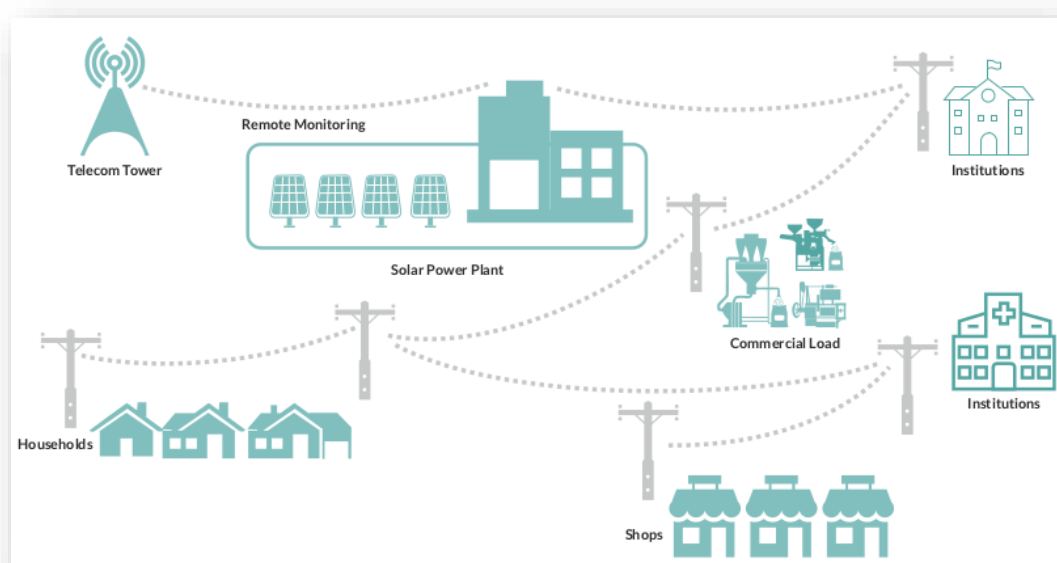


Figure 1: Schematic of a solar mini-grid (Source: Smart Power India – Rockefeller Foundation)

Mini-grids are especially relevant for developing and under-developed countries due to the following:

- **Addressing Energy Access Challenges:** Despite significant progress in recent years, a significant proportion of the Indian population still lacks access to reliable electricity. Mini grids can help to address this challenge by providing clean and affordable electricity to remote and underserved communities.
- **Decentralized Power Generation:** Mini grids offer a decentralized approach to power generation, with all the advantages this offers as mentioned earlier.
- **Supporting Renewable Energy Deployment:** Mini grids are ideally suited for the deployment of renewable energy sources, such as solar, wind, and biomass, which can help to reduce greenhouse gas emissions and mitigate climate change impacts.
- **Promoting Local Economic Development:** Mini-grids can support local economic development by creating job opportunities, promoting entrepreneurship, and facilitating the growth of small and medium-sized enterprises.

- **Enhancing Resilience:** Mini grids can help to enhance resilience to natural disasters and other shocks, by providing a reliable and local source of electricity even in the face of disruptions to the national power grid.

6.1 Project Development Process

The project development phase of a mini-grid covers all activities that help in selecting feasible sites for setting up a solar mini-grid plant. This phase includes desk research for potential site identification, site profiling, site assessment, detailed energy surveys, economic analysis, site selection, land selection, and grid mapping. Sometimes, the sites are given by the sanctioning or awarding agency/ authority. The organization developing, owning, and running the mini-grid is generally called an ESCO (energy service company).

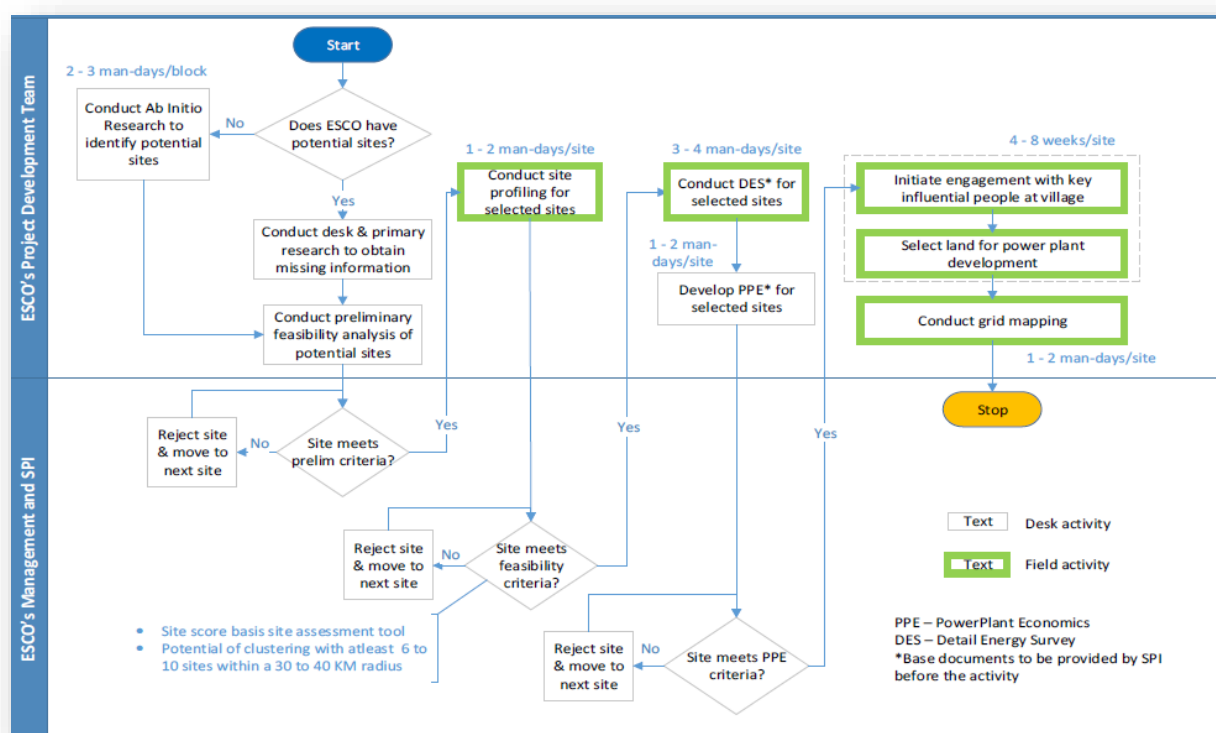


Figure 2: Project development of a mini grid (Source: Smart Power India/ Rockefeller Foundation)

6.2 Design Considerations of a Solar Mini-Grid Project

The design considerations of a solar mini-grid are:

- **Load:** The first step is to determine the load that the mini-grid will need to serve. This includes the number of households or businesses that will be connected to the mini-grid and their consumption pattern.

- **Available Solar Resource:** This determines the capacity of the solar generation to meet the assessed load.
- **Battery Storage:** The size of the battery depends on the size of the load, the duration of the load (energy consumption), the amount of solar irradiance available, the daily hours of backup supply needed, and autonomy (number of days that the battery can supply electricity in the absence of any solar generation).
- **Inverters:** The type and size of inverters required will depend on the load, solar array, and the battery.
- **Wiring and Protection:** As per the requirements of the plant and the local electrical code.
- **Monitoring and Control:** Mini grids these days are equipped with remote monitoring and operating systems, which ensure their efficient and reliable operation.
- **Maintenance:** Solar mini-grids require regular maintenance to ensure that they continue to operate reliably. The type and frequency of maintenance required will depend on the components used and the local climate.
- **Local Regulations:** The local regulations for solar mini grids will need to be considered, as well as the availability of subsidies or other incentives.



Reading Material

Designing Sustainable Energy for All: Sustainable Product-Service System Design Applied to Distributed Renewable Energy

<http://library.oapen.org/bitstream/handle/20.500.12657/27829/1002176.pdf?sequence=1>

Mini-Grids for the Base of the Pyramid Market: A Critical Review

<https://www.mdpi.com/1996-1073/11/4/813>

The user-value of rural electrification: An analysis and adoption of existing models and theories

<http://www.sciencedirect.com/science/article/pii/S1364032114001622>

Distributed Generation Regulation Library

<https://www.21stcenturypower.org/resources/dglibrary>