A Product of
SRMI Solar Risk Mitigation Initiative

A Sure Path to Sustainable Solar

Solar Deployment Guidelines

September 2019

This report was researched and prepared by the World Bank with the contributions of its consultants Nodalis, Norton Rose Fulbright, and Capsim in partnership with the Agence Française de Développement (AFD), the International Renewable Energy Agency (IRENA) and the International Solar Alliance (ISA). The work was funded by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust funded program administered by the World Bank, and the Clean Technology Fund (CTF), one of two multi-donor trust funds among the Climate Investment Funds (CIF).

Authors: World Bank (Sabine Cornieti and Nadia Taobane), Nodalis (Thomas Barbat, Martin Buchsenschutz, Théo Cladière and Laetitia Labaute), Norton Rose Fulbright (Benoit Denis, Amandine Delsaux and Anne Lapierre) and Capsim (Cécile Lafforgue and Ronan Besrest) with the contributions from AFD (Mathilde Bord-Laurans, Jérôme Gastaud and Arthur Honoré), ISA (Cécile Martin-Phipps), IRENA (Jeff Vincent), the Kreditanstalt für Wiederaufbau (KfW) (Daniel Etschmann and Wooslène Vanginé), European Investment Bank (EIB) (Bettina Abel, Bastiaan Verink and Svetla Stoeva), Clinton Foundation (Kyle Coulam, Sania Detweiler, Siana Teelucksingh, Alexis Tubb and Fiona Wilson) and World Bank Group staff and consultants (Juliette Besnard, Fernando de Sisternes, Zuzana Dobrotkova, Rida E Zahra Rizvi, Chandrasekar Govindarajalu, Besnik Hyseni, Tarek Keskes, James Knuckles, Jason Lee, Annabelle Libeau, Alexis Madelain, Charles Miller, Claire Nicolas, Dayae Oudghiri, Yi Xu and Yabei Zhang)

Editor: Steven Kennedy
Design: Visual Capitalist

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EXECUTIVE SUMMARY

Achieving global goals for access to energy and mitigation of climate change will require a quadrupling of present levels of solar photovoltaic (PV) generation in the developing world by 2025 to reach around 950 gigawatt (GW)[1].

This represents an investment of more than US$500 billion in new solar PV generation alone. To reach this objective, large amounts of private funding will have to be unlocked to complement the limited public financing available. Yet most developing countries still lack a pipeline of bankable solar projects for consideration by the private sector. To develop one, countries must take a series of key steps to tackle critical risks perceived by the private sector while also minimizing risks for the public sector.

The World Bank–Energy Sector Management Assistance Program (WB-ESMAP), in partnership with, Agence Française de Développement (AFD), International Renewable Energy Agency (IRENA) and International Solar Alliance (ISA) developed the Solar Risk Mitigation Initiative (SRMI or "the Initiative") to address these challenges.

SRMI aims to support countries in developing sustainable solar programs that will attract private investments and so reduce reliance on public finances.

Its unique approach offers development and climate financing for

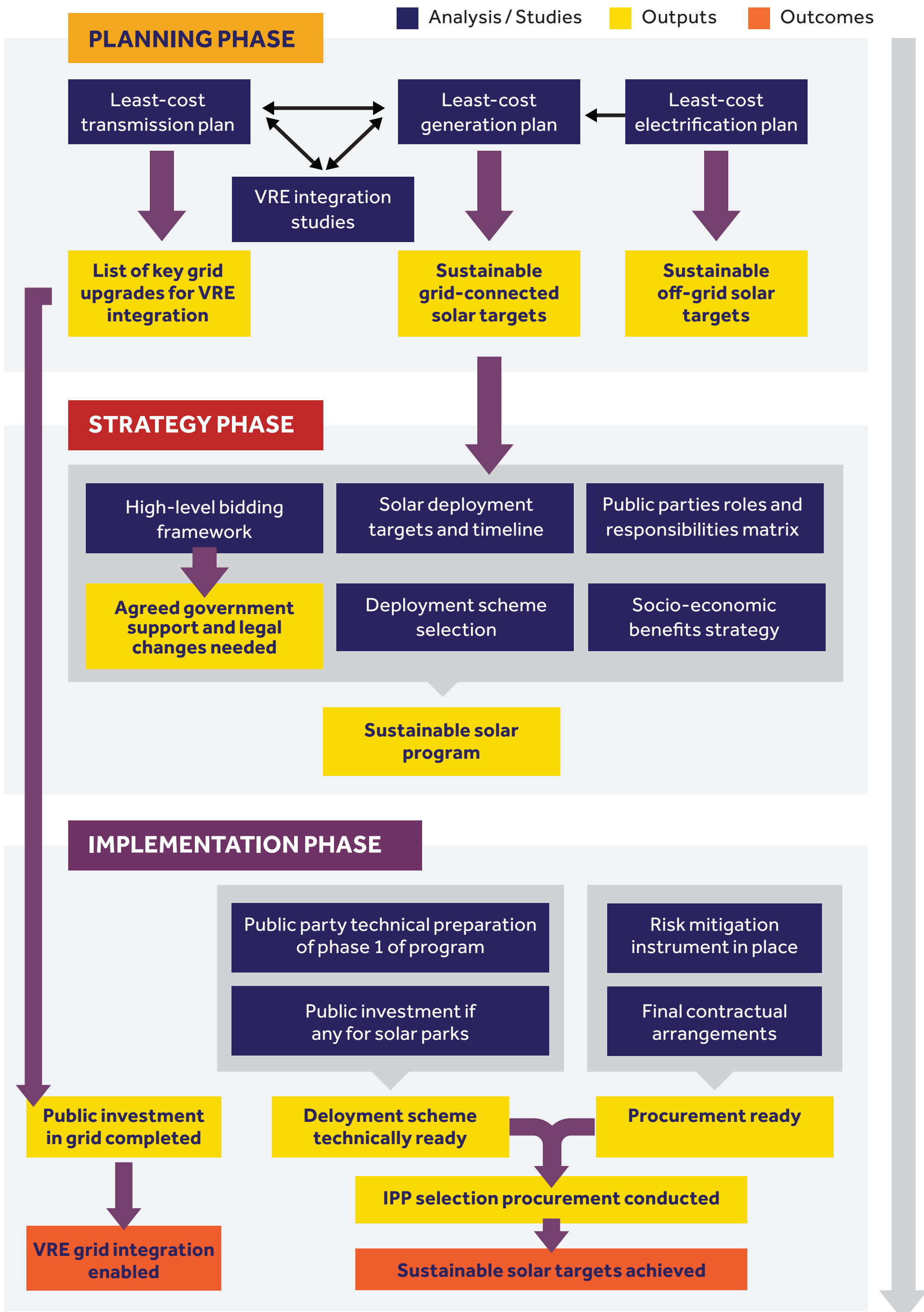
- technical assistance to help countries develop evidence-based solar targets, implement a sustainable solar program, and maintain robust procurement processes with transaction advisors
- critical public investments to enable integration of variable renewable energy (VRE), finance solar park infrastructure, and increase access to electricity
- risk mitigation instruments to cover residual risks perceived by private investors

To complement the Initiative, the present guide was developed to lay out a path to privately financed sustainable solar projects. SRMI developed a three-phase approach to solar PV deployment. In the Planning phase, technical plans are made to enable the country to develop informed solar targets. In the Strategy phase, a sustainable national solar program is developed. In the Implementation phase, action is taken to execute the sustainable national solar program.

This integrated approach enables, countries to capitalize on the deployment of solar generation to fight climate change and support energy access but also promote energy security, keep pace with rapidly growing electricity demand, and foster socio-economic development.

[1] *According to the World Bank's estimates, based on the International Energy Agency's Sustainable Development Scenario.*

Figure 1. SRMI a three-phase approach



The report details each step to be taken to develop an effective program, highlighting links between each step and other critical matters that should be considered along the way to ensure an integrated approach.

The guidelines also include **a diagnostic tool** that countries can use to benchmark their progress in fulfilling the conditions for a sustainable solar program.

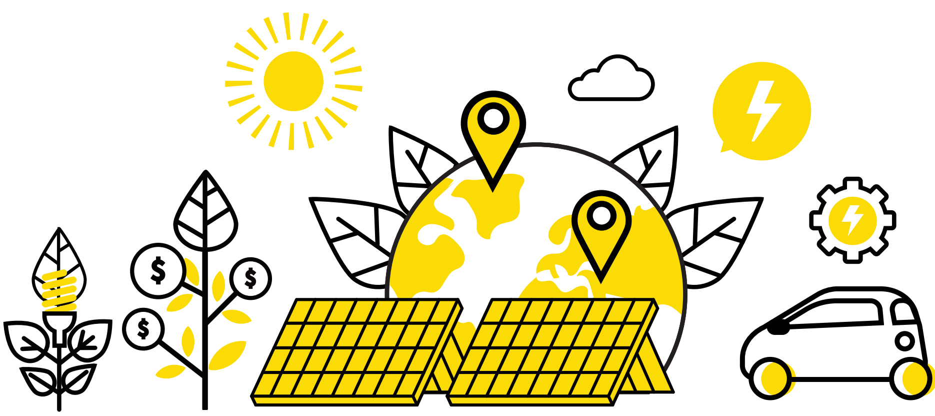
To support the development of the Initiative, a market sounding was conducted, along with consultations with governments and private investors. In parallel, a pipeline assessment was done to gauge the needs of countries for technical assistance, public investments, and risk mitigation.

The main conclusion of the pipeline assessment is that few countries have completed the preliminary work necessary to mount a sustainable solar program. In Sub-Saharan Africa, for example, 90 percent of the countries assessed for this report[2] do not meet all the conditions for a sustainable solar program, even if in most countries strong willingness to develop such programs is present.

The pipeline assessment estimates that more than US$120 million in technical assistance—for the completion of least-cost generation, transmission and electrification plans; VRE integration studies; and development of the solar program, with support for procurement from transaction advisors—would be required to enable all countries in this region to reach the implementation phase of such a program.

For solar deployment to not become an issue for the utilities, countries will have to build the infrastructure needed to integrate VRE into their existing power grid. Based on the pipeline assessment for Sub-Saharan Africa, three out of four countries in the region have a grid considered weak that cannot accommodate a solar PV penetration of more than 5–10 percent.

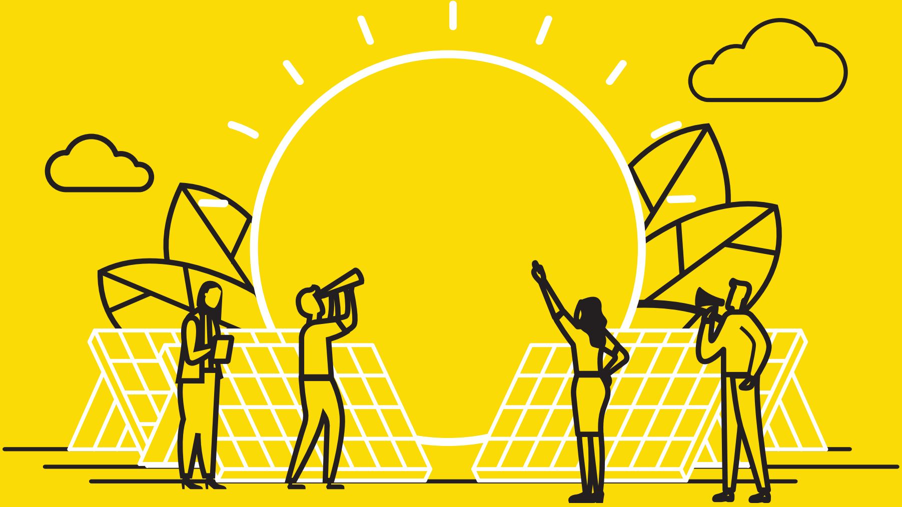
Enabling these grids to absorb the current solar PV targets (more than 22 GW) will require public investment of more than US$1billion in grid upgrades, dispatch upgrades, and storage—but those steps would unlock over US$17 billion of private investments.



[2] *A high-level pipeline assessment of the Sub-Saharan Africa region was conducted using data from various sources, including SEforAll, IEA, the World Bank, and the countries themselves. Sufficient data was available for 46 countries of the region.*

1

INTRODUCTION



1.1 BACKGROUND AND CONTEXT

A substantial deployment of solar and wind generation is needed to meet the Paris Agreement's targets to mitigate climate change, to support countries in reaching their energy security objectives, and to ensure energy access for all.

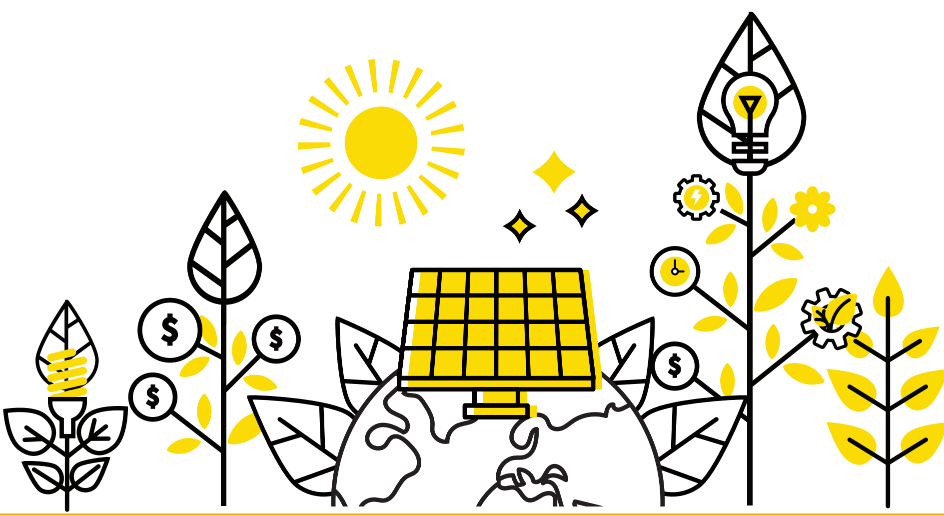
According to the World Bank's estimates, based on the International Energy Agency's (IEA) Sustainable Development Scenario, 950 gigawatts (GW) of solar photovoltaic (PV) and 580 GW of wind need to be installed in developing countries by 2025.[3] Those targets represent increases of 690 GW of solar PV and 330 GW of wind from today's current installed capacity—to be built within six years and an investment of over US$500 billion in solar PV and US$400 billion in wind.

Despite the steep reduction in power purchase agreement (PPA) prices for solar PV and wind, together variable renewable energy (VRE), deployments are lagging behind the rate and scale needed to reach the Sustainable Development Goals (SDGs) and the Paris Agreement.

To support faster deployment and reduce the burden on public fiscal resources, private investments in solar and wind power generation will have to be leveraged.

Yet, why are there so few privately owned solar and wind projects in developing countries? What do countries need to do to see a significant deployment of private investments in VRE, deployments that would be aligned with national needs while also being affordable?

To answer those questions and provide concrete solutions, several institutions have joined forces to develop the Solar Risk Mitigation Initiative (SRMI, or the Initiative). Focused on solar PV deployments and to be scaled up to wind, SRMI supports countries in designing sustainable programs that could leverage private investments. The present document is the first part of a set of Sustainable Solar Guidelines developed under the Initiative. From the perspective of governments and state utilities, it presents key steps to be taken to design and implement a sustainable solar roadmap in which private investments are leveraged through bankable, cost-optimized projects, and that will allow countries to maximize the socio-economic benefits triggered by the solar projects implemented.



[3] Universal energy access (SDG 7), reduction of the severe health impacts of air pollution (part of SDG 3), and fighting climate change (SDG 13).

SOLAR RISK MITIGATION INITIATIVE

SRMI is an initiative of the WB-ESMAP in partnership with, AFD, ISA and IRENA. It is supported by a Stakeholders Group that includes the African Development Bank (AfDB), the European Investment Bank (EIB), and the Kreditanstalt für Wiederaufbau (KfW). SRMI helps countries develop and implement their grid-connected and off-grid solar targets by mitigating risks inherent (i) to solar deployment and (ii) to attracting private capital.

This approach limits public investments to critical aspects of VRE deployment and energy access. SRMI's core approach will be applied to wind energy in the second phase of the Guidelines.

SRMI's unique approach offers development and climate financing for

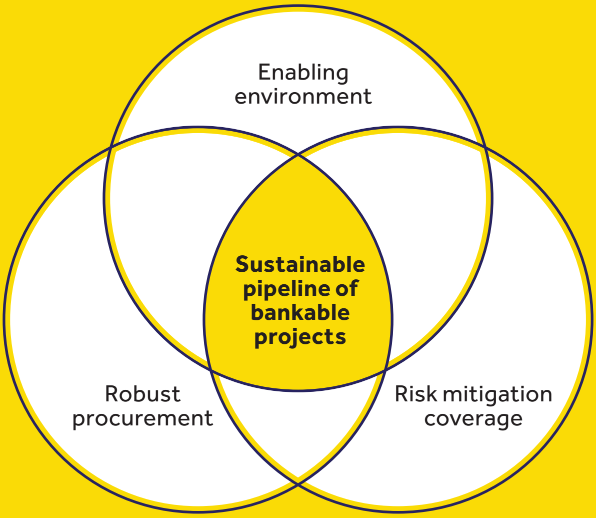
- technical assistance to help countries develop evidence-based solar targets, implement a sustainable solar program, and maintain robust procurement processes (with transaction advisors)
- critical public investments to enable integration of variable renewable energy (VRE), finance solar park infrastructure (if applicable), and increase access to electricity
- risk mitigation instruments to cover residual risks perceived by private investors.

To overcome the challenges of scaling up solar PV in developing countries, SRMI emphasizes three components to tackle risks that prevent or limit solar scale up and to support the development of a sustainable pipeline of bankable projects:

- the enabling environment
- the procurement process
- risk-mitigation coverage to cover residual risks

SRMI's first products are (i) the Sustainable Solar Guidelines, of which this document is the first part (the second part will be in the format of a user-friendly ,interactive document focusing on utility-scale solar PV, as well as wind and off-grid solar), and (ii) a Global e-Tendering Platform that will enable countries to launch a competitive process to select independent power producers (IPPs) in a robust manner.

This secure and customizable platform is expected to increase the visibility of countries' solar programs at an international level, enhancing their attractiveness, increasing competition, and driving PPA prices down. Also, under development are a risk assessment and mitigation platform, led by IRENA, to provide guidance on risk-mitigation instruments; and an integrated capacity building program, led by ISA, that will cover the solar value chain from the design and procurement of bankable projects to their operation and maintenance (O&M).



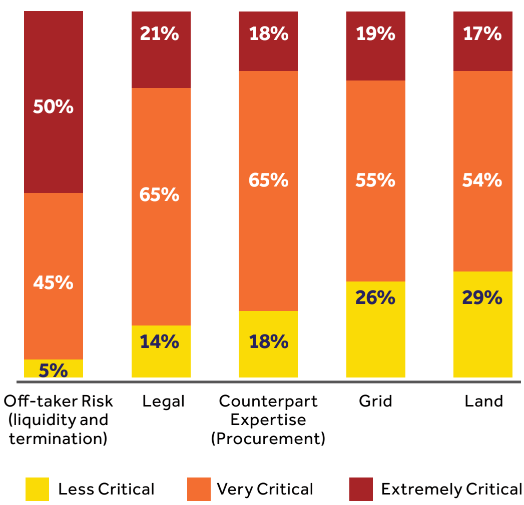
For more information: https://www.worldbank.org/en/topic/energy/brief/srmi

1.2 DEVELOPING A PIPELINE OF BANKABLE AND SUSTAINABLE SOLAR PROJECTS

***At the core of SRMI is the limited pipeline of sustainable IPP-owned solar PV projects.** The aim of the document is to inform governments in the development of an attractive yet sustainable program taking in account public and private sector's perspectives.*

In 2018, under SRMI, the World Bank commissioned a market sounding of the risk mitigation coverage of solar PV projects. Focused on IPPs, developers, investment funds, and private lenders, the market sounding confirmed that the critical issue faced by IPPs is not the lack of robust risk-mitigation instruments per se, but rather a combination of (i) insufficient off-taker creditworthiness, (ii) inadequate legal and regulatory frameworks, (iii) weak procurement processes and capacity, (iv) risk of curtailment due to grid integration constraints, and (v) land ownership issues (see *Figure 2*).

Figure 2. Key Risks Identified by Private Investors



Source: World Bank Market Sounding 2018.

Although risks are inherent to each country and its context, most developing countries present common risks that can be grouped into two broad categories: (i) risks occurring during the development phase, that is, prior to construction and operation; and (ii) those that arise once the project begins to operate. Both types of risk are integrated into the IPPs and lenders' cost of capital.

- Development risks encompass (i) grid risk, including connection risks; (ii) land risk, including availability, permitting, and environmental and social aspects; (iii) legal risk, including the applicable regulatory, arbitration, and judicial frameworks; (iv) procurement risk; and (v) integrity risk.
- Operational risks encompass (i) off-taker credit risk (including the off-taker's record of performance and timely payment) and risk of contract termination; (ii) the country's power sector risk (including sector financial sustainability risk, reform risk, regulatory risk, and delay in the government's construction work; (iii) market risk (including currency risk and interest rate risk; (iv) country and macroeconomic risks; and (v) political risk (including risks of breach of contract; expropriation; transfer restriction and currency inconvertibility; and war and civil disturbance).

In light of the results of the market sounding, countries seeking the benefits of leveraging private investments can begin by conceiving a sustainable solar program at the national level, targeting critical development and operational risks. A fair risk allocation between the private and public stakeholders translated into clear contractual arrangements will allow governments to address those risks in a viable manner and arrive at a more affordable tariff containing the lowest possible risk premium.

1.3 THREE-PHASE APPROACH

*The SRMI's Sustainable Solar Guidelines present a methodology to **develop a sustainable pipeline of solar projects that can be privately financed.***

Drawing on lessons learned from the successes and failures of national electricity policies and IPP selection processes in developing countries, each step in the methodology is designed to ensure sustainability for the country through energy security and affordable electricity, and to reduce the risks perceived by IPPs and lenders.

This document focuses on ground-mounted solar PV projects, while the second part of the Guidelines will be extended to include wind and off-grid. The report assumes the point of view of the government/public sector. As the specific role of ministries, utilities, and regulators are country specific, the public party is referred to as "the government" throughout the document, except when a given role is clearly set for the utility or other specific actor. In addition, because the document assumes the perspective of the public sector, it does not look at schemes in which the government is not involved, such as when the off-taker is a private entity. Application of such approaches should take into account the specific circumstances of the country to devise tailor-made solutions building on the methodology described in this document.

The methodology can be divided into three phases.

The Planning phase focuses on technical plans that enable the country to develop informed solar targets.

In **the Strategy phase**, the national solar program is developed around key steps to a sustainable implementation; those steps reflect the country's specific needs for the careful selection of investors and an allocation of risk optimized for the country's circumstances.

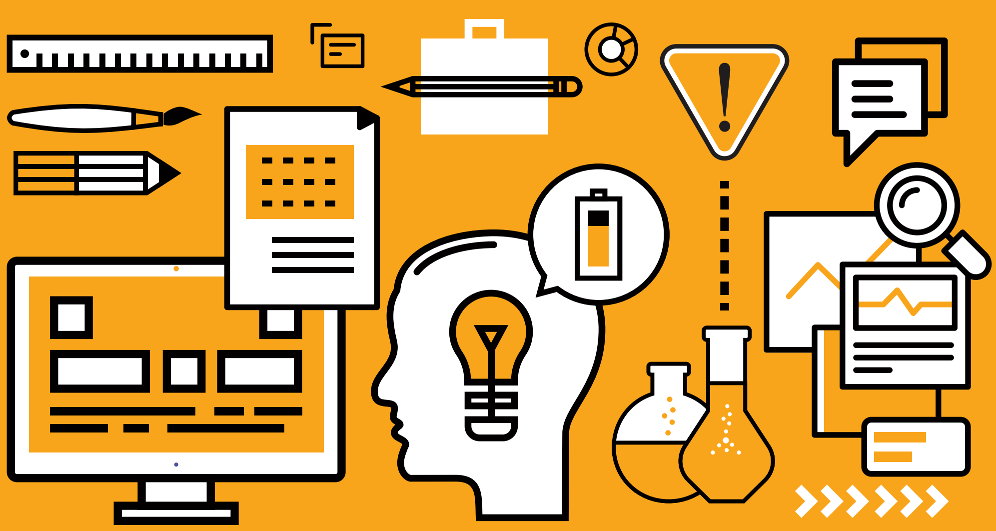
The strategy is put into action during the **Implementation phase**.

Across the three phases, it is critical to consider the following key questions, central to the development of a sustainable solar program:

- How much VRE can be integrated into the national grid?
- How much new generation, particularly solar capacity, is needed to meet estimated demand and over what time horizon?
- Where is new VRE generation needed, and where should it be injected into the grid?
- What are the critical public investments required for sustainable VRE deployment?
- Who should invest in solar projects?
- How should private investors be selected?
- What is the best way to allocate and mitigate risks to ensure that projects are both bankable and affordable?
- How can the socio-economic benefits of projects be maximized?
- What risk-mitigation instruments do private investors need to cover residual risks?

2

DIAGNOSTIC TOOL



2 DIAGNOSTIC TOOL

The diagnostic tool presents the key actions a country should consider to deploy solar power sustainably. The approach centers on developing a pipeline of projects capable of attracting private investment. The steps are developed from the perspective of public stakeholders, especially the Ministry of Energy and the state utility. Depending on the country, roles are assumed by different actors; therefore, the stakeholder assigned to each activity will need to be identified when the framework is implemented.

These steps have various levels of criticality. Those marked with one star in the table below are moderately critical; those with two stars are highly critical. They should be viewed as a whole, with an appreciation of how they interact, as the results of one step can constitute or affect the input of another. (These interactions are examined in detail in the body of this report as well as presented in *table 1*.) Steps need not be developed in a strict sequence, as some can be conducted in parallel. It is imperative, however, to understand how a given step might fundamentally alter the entire program and its successful implementation. The main analytical inputs are presented in the tool; critical data inputs are not represented below but in the core of the document.

Table 1. Diagnostic tool: An approach to solar deployment

TYPE	ELEMENTS	APPROACH	RANKING
		PHASE 1: PLANNING	
Input	Off-grid demand assessment	Critical when access is low. The Multi-Tier Framework may be used to support the assessment.	*
Plan		**Least-cost electrification plan**	**
OUTPUT		**SUSTAINABLE OFF-GRID SOLAR TARGETS**	
Input	Studies of integration of variable renewable energy	Perform load-flow analysis, grid-stability study, and short-circuit and protection studies.	**
Input	High-level locational studies	Perform load-flow analysis and gather geospatial land/geography data.	*
Plan		**Least-cost transmission/distribution** (economic analysis iterated together with generation plan)	**
OUTPUT		**LIST OF KEY GRID UPGRADES, including battery storage**	
Input	Domestic resource assessment	The global solar and wind atlas (online tool) may be used to assess country-specific sites.	*
Input	Grid-connected demand assessment	Integrate results of least-cost electrification plan.	*
Input	Grid flexibility assessment	Clarify technical and commercial flexibility constraints such as the lack of a dispatch automatic control or take-or-pay agreements.	**
Plan		**Least-cost generation plan** (economic analysis iterated together with transmission plan and VRE integration analysis)	**
OUTPUT		**SUSTAINABLE GRID-CONNECTED SOLAR TARGETS**	

* moderately critical   ** highly critical

TYPE	ELEMENTS	APPROACH	RANKING
		PHASE 2: STRATEGY	
Input from Ph1	Sustainable grid-connected solar targets from Phase 1	Set targets for the total competitive bidding program as well as its phases based on results of least-cost generation plan. If the plan is not yet ready, the targets for the first phase can be based on a high-level grid analysis.	**
Strategy		**Solar deployment targets and timeline**	**
Input	Local development assessment	Assess socio-economic impact of the program.	*
Input	Industrial development assessment	Assess local industrial and labor capacities.	*
Strategy		**Socio-economic development**	*
Input	Assessment of gaps in legal framework	Ensure legal framework enables private generation and competitive selection. If legal gaps identified are not critical, the Program can be launched prior to the enactment of the legal changes.	**
Strategy		**Public parties' roles and responsibilities**	**
OUTPUT		**LEGAL CHANGES IDENTIFIED AND IMPLEMENTED reflecting legal gap assessment and responsibility matrix**	
Input	Public stakeholders' risk perspective	From analysis of gaps in existing legal framework, identify legal, financial, and political restrictions.	**
Input	Private sector consultations	Conduct consultations with the private sector to identify their perceived critical risks during development and operation of future solar PV projects in the given country.	*
Input	Private sector high-level risk analysis	Conduct analysis integrating the results of the consultations.	**
Input	Project development risk allocation	Allocate development risks, integrating perspectives of public stakeholders and private sector.	**
Strategy		**Selection of deployment schemes**	**
Input	Operational risk allocation	Allocate operational risks, integrating perspectives of public stakeholders and private sector.	**
Strategy		**High-level bidding framework**	**
OUTPUT		**AGREED GOVERNMENT SUPPORT AND RISKS TAKEN BY THE PUBLIC PARTY**	
OUTPUT		**SUSTAINABLE SOLAR PROGRAM reflecting strategic considerations and key inputs /outputs from Phase 2**	

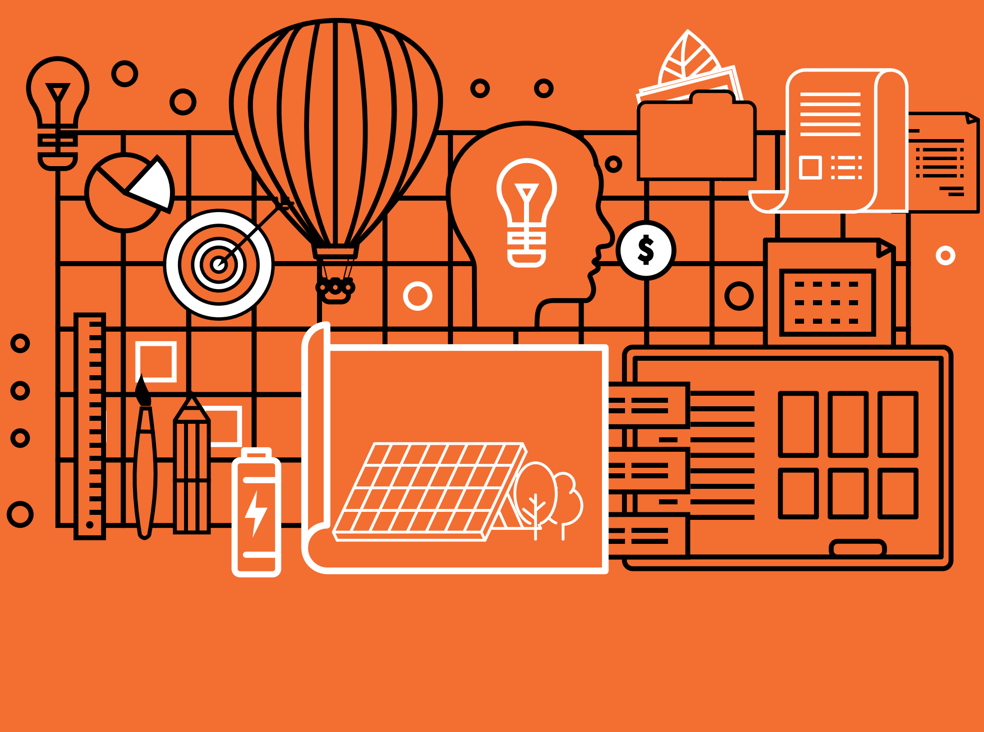
* moderately critical   ** highly critical

TYPE	ELEMENTS	APPROACH	RANKING
PHASE 3: IMPLEMENTATION			
Input from Ph1	List of grid-upgrade investments	Compile list of grid and dispatch upgrades, and potential storage investments from Phase 1.	**
OUTPUT	**PUBLIC INVESTMENT IN GRID COMPLETED AND GRID OPERATORS TRAINED**		
OUTCOME	**VRE INTEGRATED WITH GRID**		
Input from Ph2	Selection of deployment scheme	Select deployment scheme and include it in solar program developed in Phase 2.	**
Input	Substation availability assessment	Required if substation-based competitive bidding approach is implemented. Assessment integrates load flow analysis and high-level land assessment.	*
Input	Feasibility study, land selection and acquisition, key public investments in solar parks	Required if solar park competitive bidding approach is implemented. Study identifies solar park investments to be financed by the public party.	*
OUTPUT	**SCHEME READY FOR COMPETITIVE BIDDING**		
Input	Pre-bidding market sounding	Integrate the results of the consultations conducted for the program-level. Informs the bidding process (including on the design of the pre-qualification criteria).	**
Input	Final risk allocation matrix	Allocate risks, integrating the public stakeholder restrictions and private sector risk perspective as per market sounding conducted prior to bidding.	**
Input	Final bidding mechanism and procurement framework	Allocate risks, integrating perspectives of public stakeholders and private sector as per the final risk allocation matrix.	**
Input	Final contractual arrangements and risk-mitigation instruments	Investment-ready contractual arrangements and risk-mitigation instruments, backed as needed by state or development finance institutions.	**
OUTPUT	**INDEPENDENT POWER PRODUCER (IPP) SELECTION (bidding conducted)**		
Input	Testing of plant(s) for compliance with technical requirements, followed by acceptance	Power plant built by IPP upon conclusion of power purchase agreement, in compliance with technical standards and contractual requirements.	**
OUTCOME	**SUSTAINABLE TARGETS ACHIEVED**		

* moderately critical ** highly critical

3

PHASE 1: PLANNING



3.1 OBJECTIVES

The planning phase is critical.

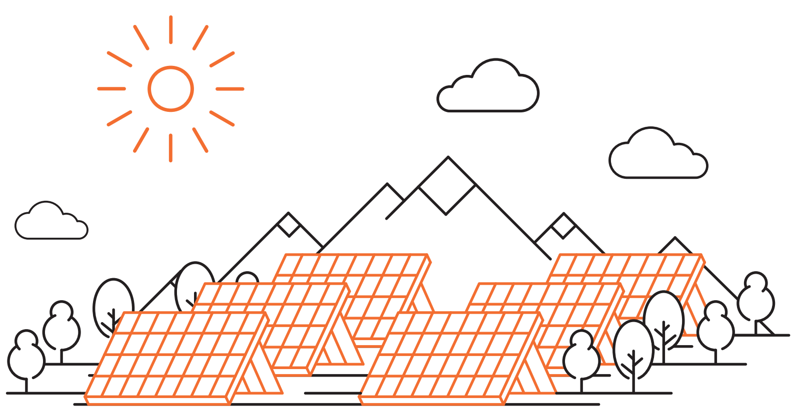
Governments looking to set solar targets for their energy sector must plan carefully to ensure that electricity is affordable, and consumers receive the highest-quality service possible. To develop sustainable solar targets, evidence-based technical plans and VRE integration studies need to answer several key questions:

- What is the off-grid and grid-connected demand?
- What generation capacity is needed to meet demand and over what time horizon?
- What is the optimal capacity of VREs given the shape of the load curve?
- How much VRE can be integrated into the grid, considering technical and economic parameters?
- To what extent can VRE integration limits be enhanced with storage support or grid upgrading?
- What are the results of a cost-benefit analysis of these investments?
- Where are the optimal injection points for VRE?
- What grid and dispatch reinforcements are needed, and when, for successful VRE integration?

A comprehensive set of medium-term plans should cover the topics of electrification, generation, and transmission/distribution, integrating the results of technical analyses of VRE integration and the deployment of energy efficiency. Streamlined power development planning allows governments increased ownership over the process of implementing policy, while limiting the risks of numerous bilateral negotiations with private developers. It also helps policy makers select the best strategies and projects.

From the perspective of IPPs, knowing that a country has set long-term plans lowers perceived risks of

- projects being cancelled
- grid integration issues leading to power curtailment (since the effects of VRE integration would have been carefully studied and prepared for)

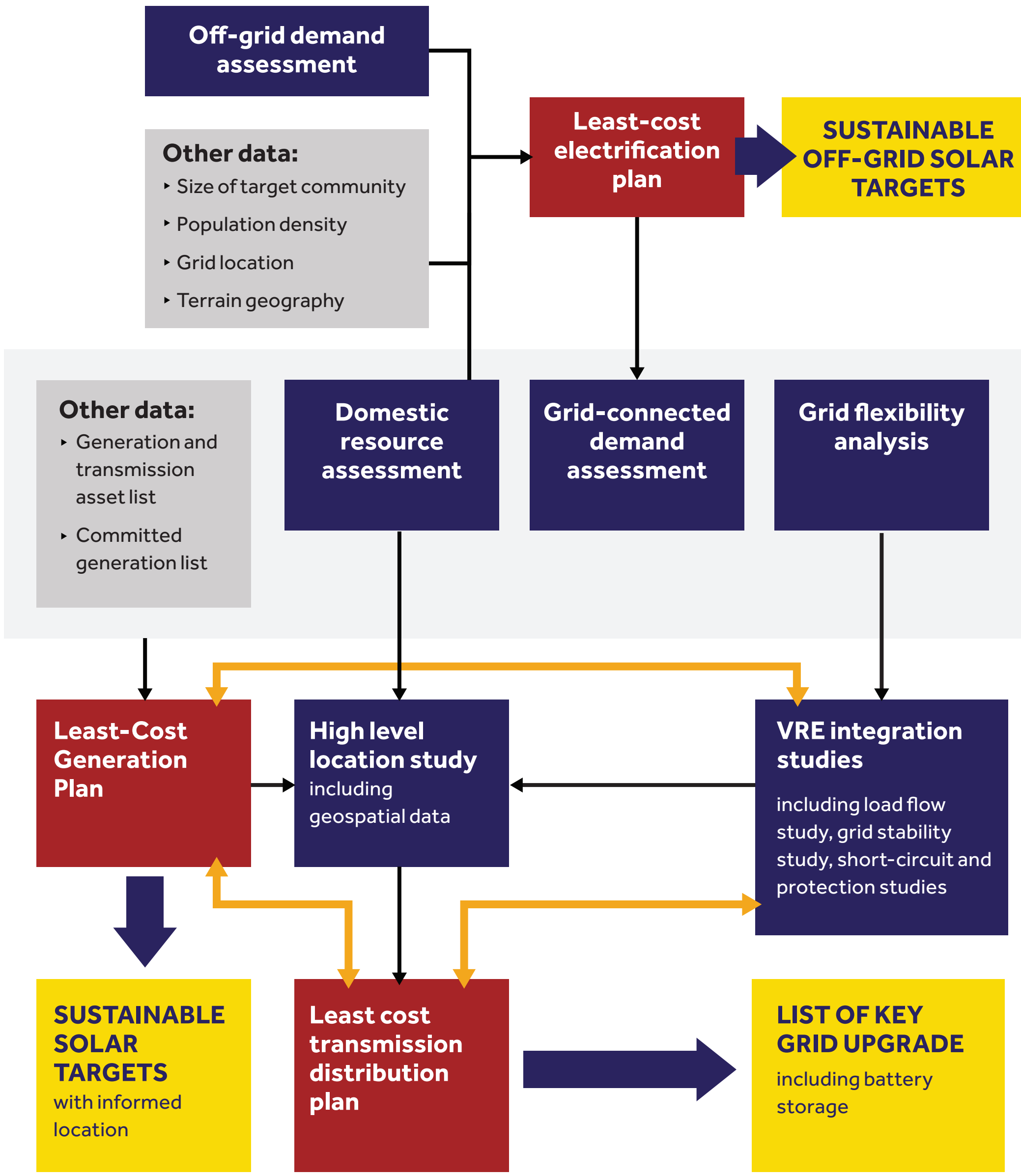


The main outcomes of the planning phase include

- **medium-term off-grid and grid-connected sustainable solar targets**
- **a list of grid and dispatch upgrades requiring public investment.**

Key Phase 1 outputs
Plans
Studies & Assessments
Other data
Iterative process

Figure 3. Key steps in the process of planning solar energy deployment



3.2 MEETING EXISTING AND FUTURE DEMAND AT THE CORE OF THE PLANNING PHASE

Power development plans have one unifying objective: to meet existing and future demand. Therefore, the first critical question is, ***how much demand is there?*** *Answering this, calls for a national-level assessment of grid-connected and off-grid demand.*

3.2.1 OFF-GRID DEMAND

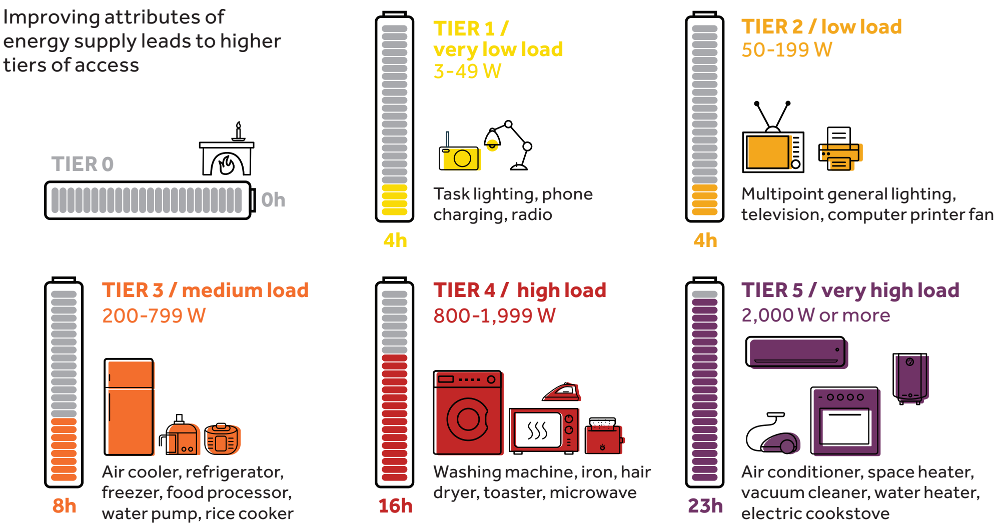
In 2018, around 1 billion people were without access to electricity. Of these, 600 million people were in Sub-Saharan Africa and 15 countries in that region had access rates below 25 percent. About 350 million people in Asia also lacked access. In the same year, 2.7 billion people worldwide lacked access to clean cooking facilities worldwide, and relied on biomass, coal, or kerosene as their primary cooking fuel (IEA 2018).

It is important to assess in as much detail as possible the electricity demand of those people not connected to a grid. This information will help decide how to answer their demand in an optimal manner, with the most affordable technical solutions.

Granular surveys, such as those of the Multi-Tier Framework (MTF), are critical in this regard (ESMAP 2018). Assessments need to cover a representative sample of households, small and medium enterprises, agricultural, commercial, and industrial usages, and public facilities (such as schools and clinics) to generate a detailed picture of off-grid energy usage and demand at all levels. Gender-disaggregated data are crucial in devising programs to improve women's livelihoods through access to electricity. Bottom-up consultations with consumers, local government agencies, civil society organizations, entrepreneurs, and investors can also play an important role in identifying electricity access priorities among households, community services, and businesses.

Under the MTF, energy access is measured based on technology-neutral tiers (as per *Figure 4*), and thresholds are defined based on whether energy supply meets requirements across a range of attributes (SEforALL and World Bank 2015). Surveys provide data on energy-related spending, energy use, user preferences, consumers' willingness/ability to pay for electricity and cooking solutions, and consumers' satisfaction with their primary energy source. The results can be used to analyze what is preventing people from gaining access to higher tiers of energy access. This gap analysis can be a powerful tool for governments as they make decisions regarding policy, regulation, and investment.

Figure 4. Measuring energy access: Five tiers



Source: Adapted from the MTF, World Bank 2019.

ASSESSING OFF-GRID ENERGY DEMAND FOR CLEAN COOKING AND OTHER PRODUCTIVE USES

The Sustainable Energy for All (SEforALL) initiative, as aligned with the United Nations' Sustainable Development Goals, aims to achieve universal access to electricity and modern cooking energy systems by 2030.

Cooking is the neglected productive application that also offers a rare opportunity to capture an existing expenditure. Cooking with electricity offers a transformative value proposition for households, allowing for more efficient and faster cooking times, adjustable heat levels, safer cooking, no dangerous indoor emissions (which are responsible for millions of deaths), as well as a cleaner cooking space. The use of clean electric cookstoves and electric rice cookers can significantly increase a household's energy demand. This is a critical factor for energy sector planners to take into account; a change in cooking equipment that impacts overall household demand may also inform the optimal technical solution for energy provision.

The development of productive uses and household appliances (such as phone charging, radios, TVs, fans, and refrigerators) needs to be integrated into off-grid demand assessments as they are core to the decision to provide electricity through a grid connection or mini-grids or solar home systems (SHS). Indeed, demand for electricity from small industries and businesses is a key success factor for mini-grids. Because of the typically low energy usage of household customers, mini-grids are likely to struggle to generate the critical revenue needed for financial viability in the absence of electricity-consuming household appliances. The revenues generated by households are often small because of low levels of electricity consumption. By fostering productive uses such as agriculture, fisheries, tourism, baking, sewing, hair dressing, and mining, operators can increase their average electricity consumption and revenue from mini-grids, improving their chances of long-term viability (NREL 2018).

For more information, see https://www.esmap.org/node/71163

3.2.2 GRID-CONNECTED DEMAND

The main parameters of a demand assessment are:

- socio-economic trends, such as population and economic activity forecasts (growth rates, sectoral dynamics, etc.)
- the locations of grid-connected and off-grid areas
- electricity needs for domestic and productive uses
- time horizons
- geographical distribution

Plus, compiling load profiles for different consumer categories, and demand patterns across geographical regions and seasons, enable grid-connected demand forecasts to be more accurate, including in their forecasts of future daily and seasonal demand.

This is important when strategizing demand-supply synchronization. Assessments also need to address the demand expected from new connections to the grid. Ideally, this should be based on an electrification plan that provides a clear timeline for new connections as well as their associated demand.

DEMAND ASSESSMENT IN A WORLD OF DISRUPTIVE TECHNOLOGY

It is critical to consider how grid-connected demand might be affected by efforts to increase energy efficiency and individual rooftop photovoltaic (PV) installation and by efforts to accelerate the deployment of electric vehicles (EVs). Expansion of energy efficiency can impact the volume of electricity requested by single customers and also alter demand. Similarly, efforts to deploy rooftop PV production—if scaled up to significant levels—can lead to peak production occurring during the day, and no production during the evening when the sun is down (the so-called duck curve phenomenon).

Electric mobility represents a unique opportunity to reap both environmental and economic benefits. The extent to which higher shares of EVs and their demand for charging will affect power grids will depend greatly on the technologies and charging modes used, and on charging patterns. EVs can affect the requirement for capacity at certain times and locations. For instance, uncontrolled charging can increase power systems' peak-load and cause congestion in the distribution grid. On the other hand, electric mobility represents an opportunity for power system development, with the potential to contribute to increased flexibility and to support the integration of higher shares of variable renewable energy. In order to allow a full participation in grid services and enable smart charging, an underlying infrastructure of communication, control, power electronics, and storage technologies is required.

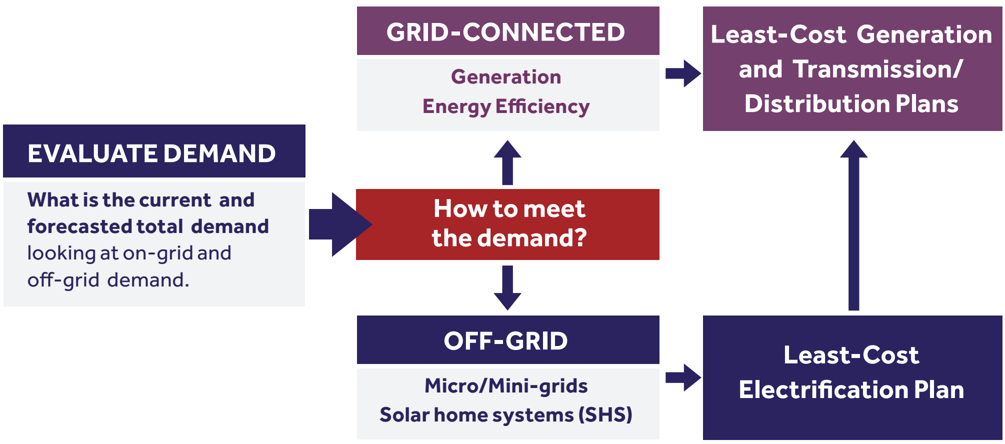
For more information, see http://documents.worldbank.org/curated/en/193791543856434540/pdf/132636-EMADv4-web.pdf

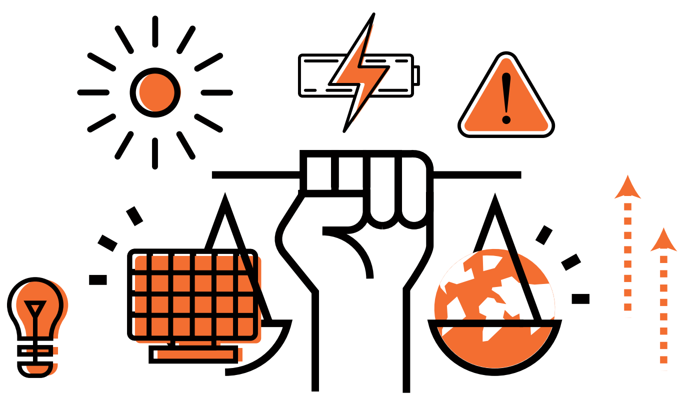
3.3 LINKING DEMAND TO TECHNICAL SOLUTIONS

Once demand has been forecasted, the next step is to ***determine how best to meet it. What is the optimal generation solution for meeting this demand?***

That determination will take the form of separate least-cost plans for off-grid and grid-connected areas (*Figure 5*).

Figure 5. From demand to plans



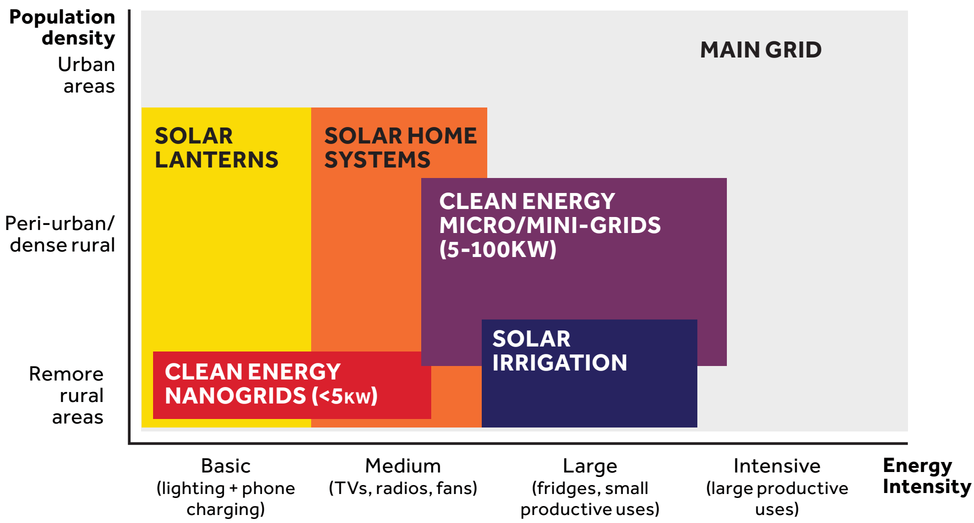


3.3.1 ELECTRIFICATION PLAN FOR OFF-GRID AREAS

For off-grid areas, it is necessary to make an electrification plan that defines which areas are most suitable for connection to (i) the grid, (ii) micro/mini-grids (iii) SHSs.

The most appropriate technical solution is mainly selected based on the size of the target community, its population density, distance to the national grid, complexity of terrain, and demand forecasts (*Figure 6*). Additional considerations include the targeted MTF Tier of access, and the expected levels of public and private investment.

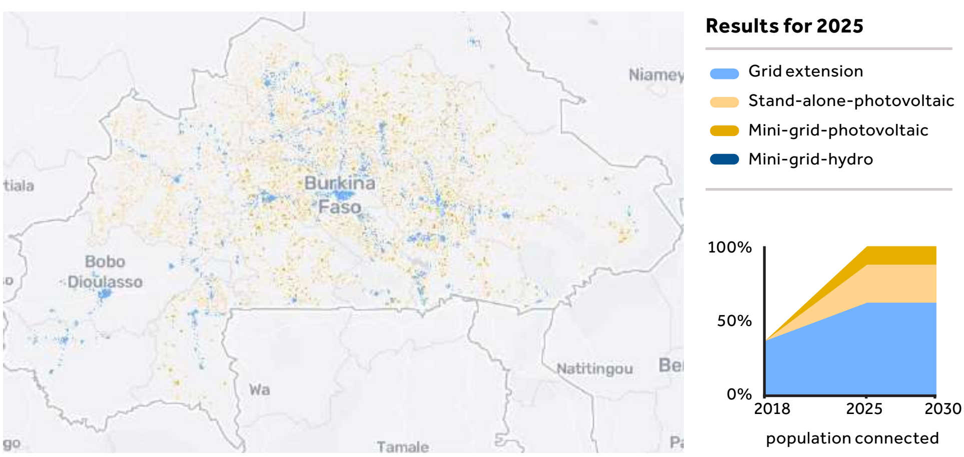
Figure 6. Electrification options, by population density and energy intensity



Source: Hystra 2017

To develop integrated electrification plans, geospatial mapping and least-cost planning tools are key *(see Figure 7 for an example)*. These can clarify the fastest and most cost-effective way to achieve universal access in a country.

Figure 7. Example of a geospatial representation of an off-grid deployment plan in Burkina Faso



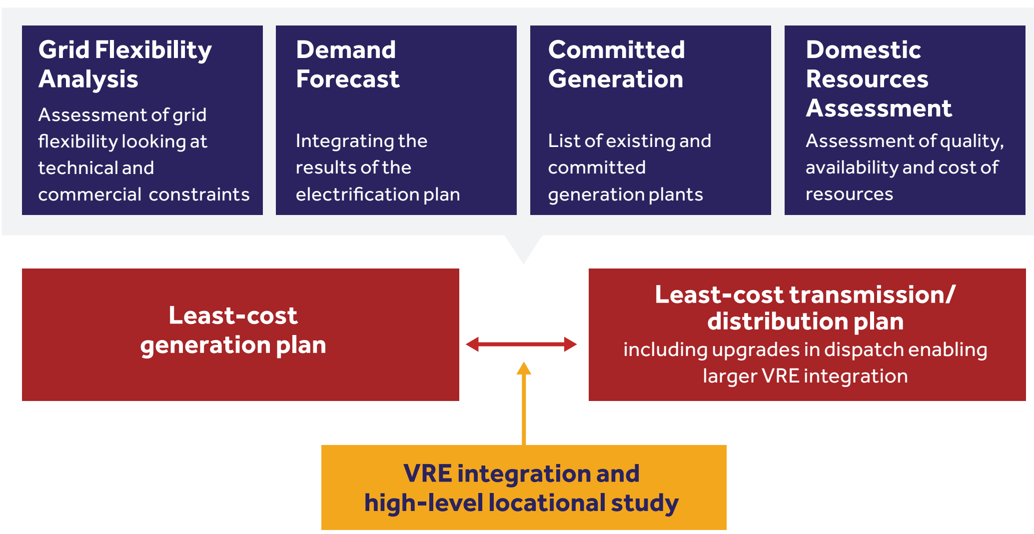
Source: World Bank Global Electrification Plan (GEP) 2019.

3.3.2 GRID-CONNECTED GENERATION AND TRANSMISSION/DISTRIBUTION PLANS

To match grid-connected demand to an electricity solution, two plans need to be prepared by the government and/or the state utility: **a least-cost generation plan** that determines a cost-optimized electricity mix that can meet demand at any time), and **a least-cost transmission/distribution plan** (*Figure 8*). These capacity expansion models simulate generation and transmission capacity investment, given assumptions about future electricity demand, fuel prices, technology cost and performance, and policy and regulations.

Both plans rely on simulations generated by dedicated software. The least-cost generation plan requires specific planning tools, such as PLEXOS, Balmorel, Opt-GEN, and WASP to cite a few commercial examples. Note that other non-commercial models may also be developed using optimization tools such as those provided by GAMS, Python, and other programming languages. Depending on which planning tool is used, solar, wind, and hydropower variability can be represented in a more or less accurate manner. When deploying large amounts of VRE, it is critical for sectoral planners to use the right planning tools and ensure that there is enough capacity in the relevant utility or ministry to use them. The most advanced tools allow policymakers to integrate external environmental costs (such as GHG emissions) into a given scenario.

Figure 8. Key inputs into generation and transmission / distribution plans



Some of the core inputs of these two plans are (i) a grid flexibility analysis that will answer the question of how much VRE and ***how much solar PV capacity can be integrated into the grid***, (ii) a demand forecast that reflects the objectives set in the electrification plan, (iii) a list of committed and existing generation, and (iv) an assessment of national solar resource capacity.

A demand forecast was discussed earlier, and the other three inputs are outlined below. Also, it should be noted that technical data on grid infrastructure (lines, substations, reactive power compensators, etc.) and information about operating rules are critical to consider when planning VRE integration. The least-cost generation plan, the least-cost transmission plan, and VRE integration studies are conducted in parallel and affect each other's results in an iterative process.

A. GRID FLEXIBILITY ANALYSIS

The main challenges related to the integration of solar PV into the grid are

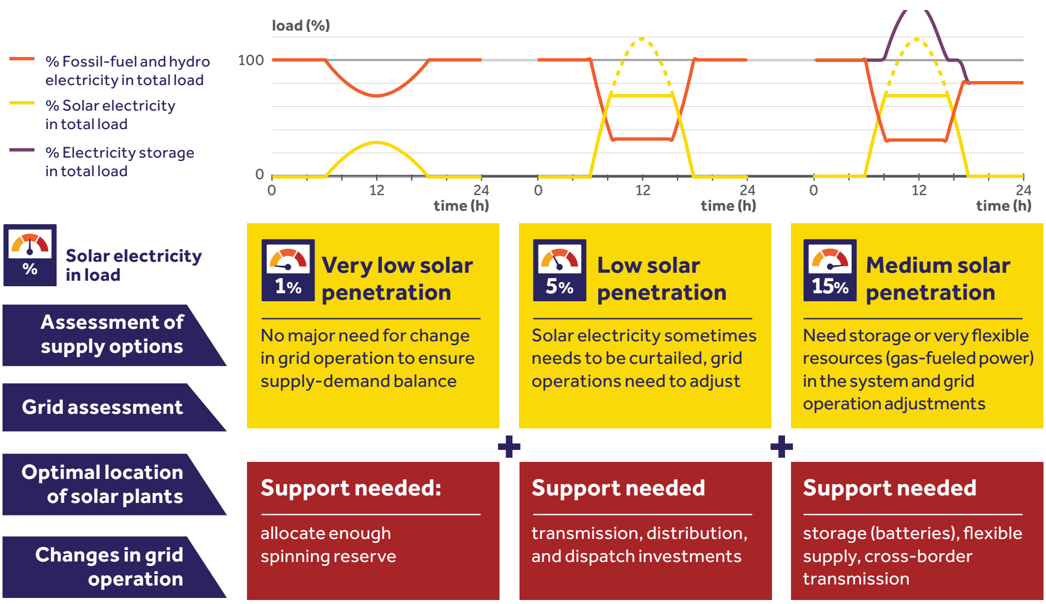
- its intermittent nature (which implies variable production)
- uncertain availability (although this can be estimated in the short term based on meteorological forecasting)
- that it can only produce power during the day
- that it is not a rotating generator

Three issues must be considered when considering VRE penetration into a grid:

- the capacity for the generation mix to meet demand at any hour of the year, considering VRE variability
- the economic optimum in terms of power system operating costs, after considering both cost reductions thanks to VRE and the investment costs required for deploying and integrating VRE
- the limitations of solar PV capacity to maintain grid stability, due to its variability and its limited capacity to contribute to the balancing of demand and generation (World Bank 2019).

Figure 9 shows how the degree of grid support required depends on the amount of solar electricity in the load, with percentages used for purposes of illustration. Plans are best customized to the specific location and country.

Figure 9. Assessing the grid support required for various shares of solar energy



Evaluating dispatch capabilities and the limits of grid integration provides a picture of the grid as it is today and is key to determining VRE targets.

These analyses estimate the level of VRE penetration possible based on technical and commercial constraints, as a first input into the least-cost generation plan. It is important to note that VRE integration studies will be repeated in an iterative process as the least-cost generation plan is being revised.

SIMULATING DISPATCH CAPABILITIES

To evaluate the flexibility of a grid, it is critical to assess its technical constraints, such as the lack of a Supervisory Control and Data Acquisition (SCADA) system or of automatic generation control (AGC), or the availability of a type of generation that is by nature not highly reactive. It is also important to integrate commercial constraints, such as take-or-pay PPAs, grid code requirements for how much support a generator has to provide to the grid, and key performance indicators for utility-owned generators. These commercial constraints may inhibit the smooth integration of VRE.

VRE INTEGRATION STUDIES

Power flow studies and stability assessments are generated using power system analysis software such as PSS/E, DigSilent and Matlab and their results are assessed further as part of the economic analysis conducted for the least-cost expansion plans. Specifically, these determine (i) the solar PV capacity needed to guarantee grid stability (taking account of storage capacity, reserve needs, and ramping reserve requirements), (ii) new transmission/distribution requirements (if the existing transmission system is not dimensioned to accommodate VRE in a given area), (iii) reactive power compensation requirements to maintain voltage levels, (iv) operating characteristics of the planned system (such as the mix of generators, losses in the system, active and reactive power flows, transformer tap setting, and protective relay settings), and (v) system performance under emergency conditions (for example, the loss of a transmission line or a generator), given reserve needs and ramping reserve requirements (World Bank 2019).

*These analyses will also list the technical upgrades needed to improve the dispatch system and overall VRE integration, and potential improvements on the commercial side and to the grid code. The required **least-cost grid reinforcements** are also outlined in the **transmission plan**.*

These may also include additional infrastructure to accommodate resiliency measures, particularly in the context of climate change impacts, such as hardening (reinforcement of poles or under-grounding) and redundancy (construction of a secondary line) to prevent outages during a storm.

TRADITIONAL VRE INTEGRATION STRATEGY DISRUPTED BY ACCELERATED REDUCTION IN BATTERY STORAGE PRICES

Taking advantage of variable renewable generation requires significant expansion and modernization of electrical grids. Specific technologies and processes may be used to support the gradual transition of power systems into "VRE-friendly" grids that will significantly reduce integration costs in the long term. The penetration of VRE requires power system planning and grid management to adapt to the particular characteristics of VRE. It also requires better forecasting methods and stringent grid code requirements. Basic grid support services are now becoming relevant to all generators, including VREs, which are connected to medium and lower voltage levels (World Bank 2019).

Grid reinforcements that will support VRE integration (as per the least-cost transmission plan) include:

- Addition or replacement of lines and transformers for grid extension and capacity enhancements (both for answering growing demand and for integrating VRE power).
- Equipment for smoothing the voltage plan, such as capacitor banks and other reactive power compensators, together with the flexible alternating current transmission system (FACT).
- Equipment for faster and more efficient grid operation, such as monitoring systems, demand and production forecasting systems, and automats for controlling generation units and grid operations through automatic generation control with a strong SCADA system.

Demand response programs—that is, when the utility signals to identified customers demand change requests to better match demand with their offer—can also be put in place to enable better integration of VRE and grid management.

Also, regional integration and cross-border electricity trade could be very effective to

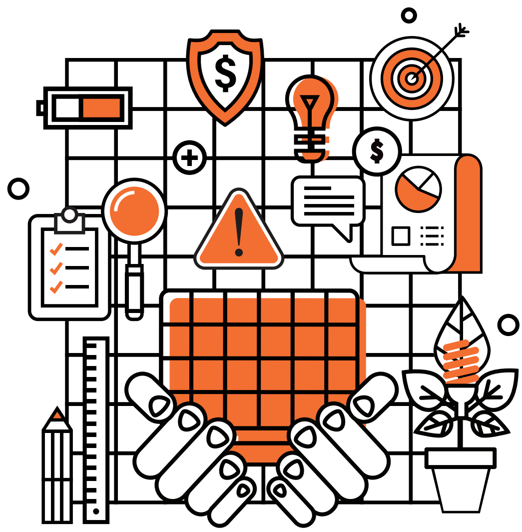
- increase national grid capacity to absorb VRE
- reduce kWh cost by increasing the size of PV projects where solar irradiation is the most favorable
- optimize the mix at the regional level, thus reducing the need for national investments in grid reinforcements

As its costs continue to fall, battery storage is also becoming core to VRE integration. Importantly, it can provide support to the grid through frequency and voltage control. When associated with VRE plants, it can also mitigate some of the issues raised by the variability and lack of dispatchability of VRE power. It can provide power reserves during transient events such as the lack of a generator, smooth production for example, when there is a cloud, and displace production to the evening/night.

For more information: see https://www.esmap.org/batterystorage

B. COMMITTED GENERATION

A core input to the generation plan is a list of committed generation. It is important to be able to differentiate between power plants that are already under construction or have reached financial close and those that are only committed but have not reached financial close. The least-cost generation plan will enable the government to assess if committed plants are indeed least cost and necessary; this will support them in reviewing their commitments before the point at which canceling a plant becomes impossible.



FOSSIL FUEL SUBSIDIES IN LEAST-COST GENERATION PLANS

In recent years, governments around the world have been subsidizing fossil fuel production and consumption at a cost to taxpayers of up to US$1 trillion each year. While these subsidies try to make the fossil fuel industry more competitive and fossil energy more affordable, they also entail enormous societal costs due to economic inefficiency, inequality, air pollution, and climate change. Fossil fuel subsidy reforms not only remove distorted incentives that undermine countries' ability to make progress toward their goals but can also unlock significant domestic financing to facilitate and accelerate sustainable development efforts. When developing a plan to ensure that least-cost generation plans are not biased by subsidies of fossil fuels (should they exist), it is critical to use the real cost of fuels so as not to favor fuel-based generation in the plan.

For more information, see https://openknowledge.worldbank.org/bitstream/handle/10986/28863/121266-WP-PUBLIC-10-11-2017-16-35-36-ESRAFReportOverviewNoteFINALdigital.pdf?sequence=4

C. DOMESTIC RESOURCE CAPACITY

VRE resource levels are location specific, as illustrated in *Figure 10*. If the resource is highly specific to one region/zone, it is important to consider this in any plan, and in particular in the transmission upgrade plan. Open source geospatial data for solar and wind are available online on the Energy Sector Management Assistance Program (ESMAP) website[4].

Geospatial data be combined with on-site meteorological data for more accuracy, which in turn will help solar projects be considered bankable by lenders.

In locations where direct normal irradiation is high enough, concentrated solar power (CSP) is a good option to consider in the least-cost generation plan as it can produce dispatchable generation while still being renewable. The main steps presented in the document are the same for solar PV and CSP.

Figure 10. A solar resources map of Vietnam

Source: Global Solar Atlas Vietnam.

CONCENTRATED SOLAR POWER: DISPATCHABLE RENEWABLE ENERGY

CSP generate solar power by using mirrors or lenses to concentrate sunlight that is then converted into heat that can produce electricity through a steam turbine. Thanks to thermal storage, CSP can provide electricity during peak hours after sunset, matching critical needs for most of the utilities. For the past two years, CSP prices have gone down drastically and have become competitive with other dispatchable plants in regions that have good direct normal irradiation, including with coal-based plants.

CSP prices could be further optimized by combining CSP with storage to PV, maintaining a crucial dispatchability during several hours after sunset while reducing costs. CSP also has greater potential to contribute to industrial development than PV. The main components of CSP plants (solar field, thermal storage and power block) can often rely on local industries (metallic and metallurgic, piping, glass and electric as well as electronic industries).

[4] Open source geospatial data on wind are available online in the ESMAP Global Wind Atlas (https://globalwindatlas.info/), and data on solar energy are available in the Global Solar Atlas (https://globalsolaratlas.info/).

3.4 PLANNING FOR THE BETTER INTEGRATION OF FUTURE VRE PROJECTS

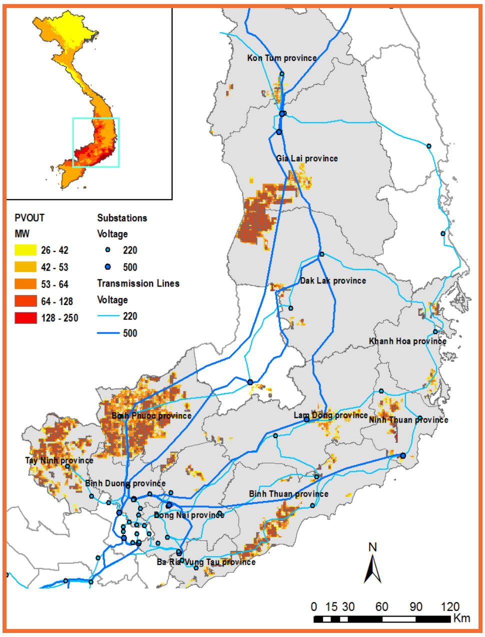
Once preliminary solar targets have been decided, it is important to ***identify the optimal injection points in the grid and to determine what power plants need to do to support the grid.***

3.4.1 HIGH-LEVEL LOCATIONAL STUDY

The domestic resource assessment combined with the results of the grid study and a land availability study, if needed, will clarify the optimal points of VRE injection into the grid, minimizing grid reinforcement costs. The resulting high-level locational study (*see Figure 11 for an example*) allows multicriteria analysis of renewable energy resources (e.g., solar irradiation for solar generation), land availability, capacities of existing grid infrastructure (lines, substations) for power evacuation, the proximity of demand centers to supply, and social acceptability. A tool developed by the Berkeley Lab MapRE (*https://mapre.lbl.gov/*) enables countries to perform this analysis using available geospatial data.

As part of the high-level locational study, co-location of solar PV with hydro generation could be considered. This combination has many advantages, such as maximizing the hydro plant's infrastructure and grid connection, minimizing the effects of seasonal variations in power production, supporting day time peak load, and reserving more hydropower for the evening peak.

Figure 11. Example of a high-level locational study



Source: MapRE for Vietnam, World Bank.

The results of this high-level locational study inform transmission and distribution plans, and specifically help to identify points where the grid infrastructure needs to be upgraded to integrate solar projects.

The identified injection points are optimal at a given time but since investments will be staged, this approach is a short-term one and needs to be revised regularly based on the construction of the new infrastructure.

3.4.2 GRID CODE

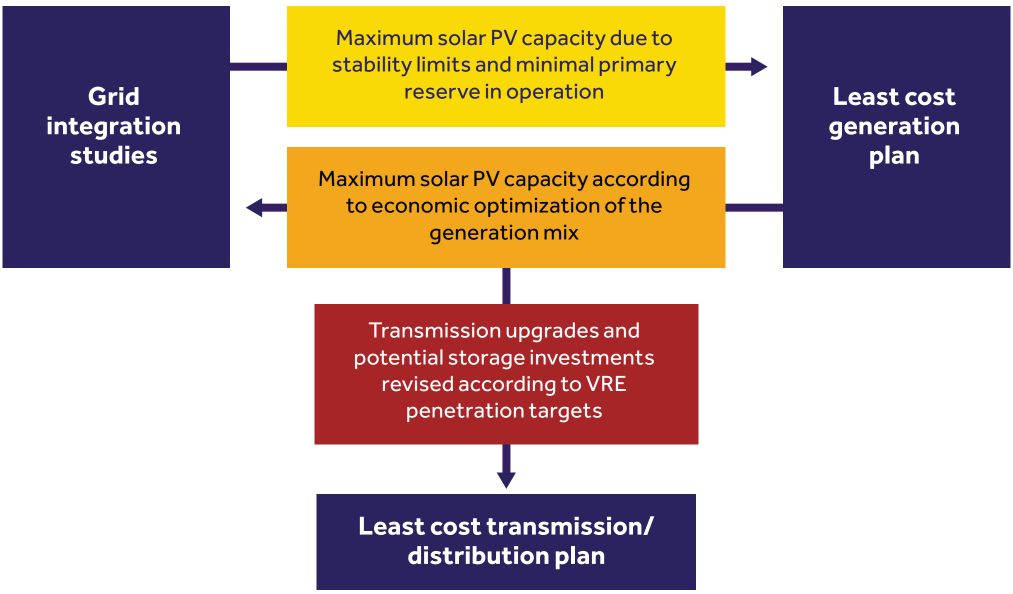
The electrical grid needs to be considered in its entirety, but the services provided by each generation unit are crucial to ensure frequency and voltage stability. Defining clear grid service rules helps to cover several risks, both for grid operators and IPPs. Distributed grid services enhance operation flexibility and grid stability by (i) minimizing the frequency and voltage drops on normal and fault transients due to power plants' support, (ii) reducing the risk of oscillations and the need for reactive power compensators or storage, and (iii) guaranteeing the quality of electricity.

As part of the grid code, standard procedures for the connection phase of solar projects can be added to minimize technical and planning risks both for independent power producers and grid operators.

3.5 ARRIVING AT EVIDENCE-BASED SUSTAINABLE SOLAR TARGETS

In conclusion, optimized solar PV capacity is determined through an iterative process that involves a least-cost generation plan, VRE grid integration studies, and a high-level locational study. *Analyses and simulations are repeated until the most critical constraint, technical or economic, is determined.*

Figure 12. Planning through an iterative process



From the government's perspective, a robust generation plan informed by a VRE integration study and a high-level locational study can substantially mitigate the risk of curtailment.

At the end of the planning stage, governments will have informed solar targets with an indication of where best to locate future projects as well as a list of key investments needed to improve their grid VRE integration capacity.

4

PHASE 2: SETTING A STRATEGY

4.1 OBJECTIVES

Once the government knows what quantity of VRE can be injected into the grid, and has set solar targets and generation and transmission/distribution plans accordingly, the next questions are:

- How are solar targets to be implemented?
- If there is an aim to mobilize private investments in generation, as assumed here, how will IPPs be selected and high-level risks allocated?
- What are the roles and responsibilities of public stakeholders?
- Does the current legal and regulatory framework enable the efficient selection of IPPs?
- How can the socio-economic benefits of solar deployment be maximized?

To answer these questions, the government needs to develop a solar deployment strategy.

This will outline how high-level risk is to be allocated across various stakeholders, detail their roles and responsibilities, and set a timeline for deployment. It will also include plans for mitigating risk. For example, the government may choose to support IPPs through sovereign guarantees, foreign exchange authorizations, or tax exemptions. These actions need to be outlined at the strategy phase to avoid unnecessary delays down the road.

The mobilization of private capital for new generation enables countries to free some of their limited fiscal space. A carefully designed strategy will go far toward maximizing the benefits of private involvement. At this stage, the government needs to decide (i) the roles and responsibilities of the various parties, (ii) whether changes need to be made to the law, (iii) what studies and activities need to be undertaken to support the selection of efficient deployment schemes, and (iv) what risks the government will internalize and what risk mitigation instruments it might offer IPPs.

To clarify these points before the selection of an IPP and the signing of a PPA can help speed up the IPP selection process, reduce chances of procurement failure, and provide a long-term vision for deploying solar projects. From the IPPs' perspective, a clear government strategy reduces perceived risks due to a weak or inadequate legal framework and an unclear selection process. Deployment strategies that reduce the risk of curtailment and land issues are also critical to sustainable development of solar PV.

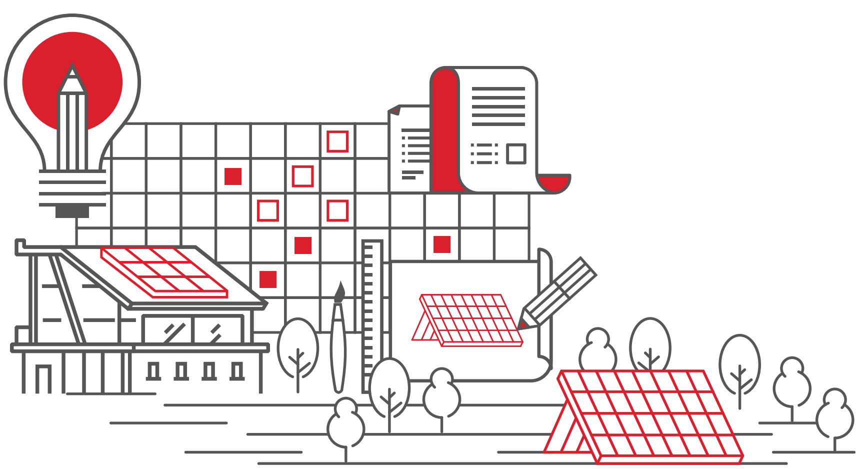
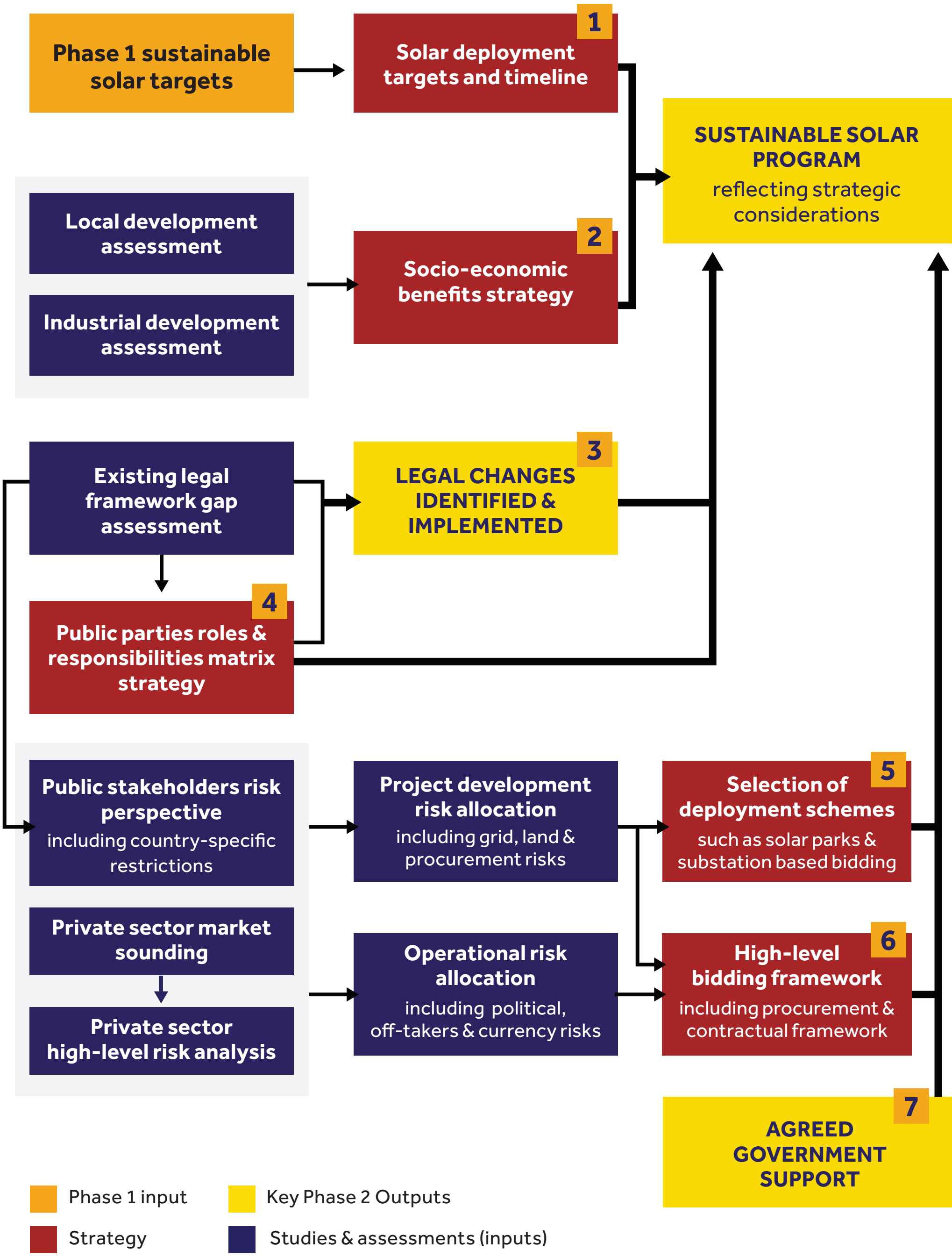


Figure 13. Designing a solar deployment strategy



4.2 AN ENABLING LEGAL FRAMEWORK

If a government decides to leverage private capital to finance its solar targets, there are two key questions to consider: ***Who will be responsible for what elements of the implementation process? and does the legal framework enable private generation in the energy market, and do so through a competitive selection process?***

In countries that lack a legal framework for IPPs and competitive bidding, this step must be prioritized. Even in those that have such a framework, it is an important assessment to better understand potential public restrictions.

4.2.1 ROLES AND RESPONSIBILITIES

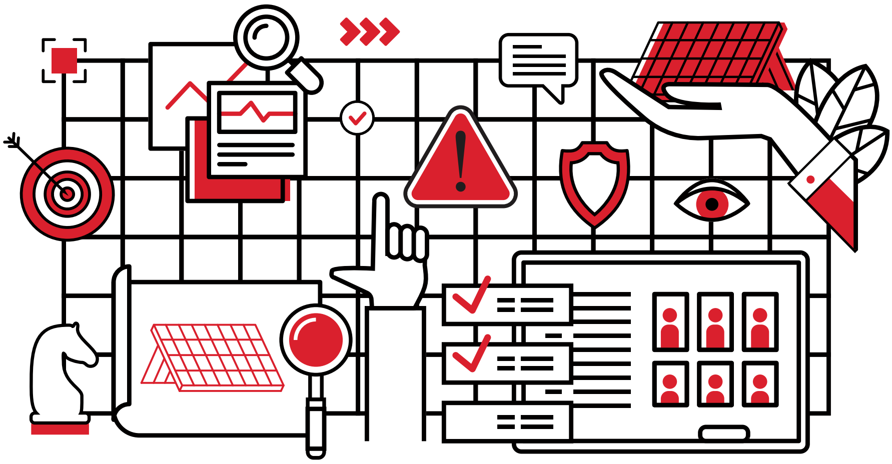
The roles and responsibilities of the public institutions involved in the energy market and sector, such as the ministry of energy, the state utility, the ministry of finance, the ministry of industry, the renewable energy agency, and the regulator, as the case may be, must be specified and formalized at the regulatory level to ensure that there is a clear path to deployment, with buy-in from all stakeholders.

Responsible entities for the following key functions need to be identified:

- Developing the solar deployment program
- Leading and supporting the procurement and selection of an IPP
- Signing the PPA
- Setting and approving tariffs
- Providing required support mechanisms
- Conducting technical studies
- Spearheading investments associated with deployment plans
- Implementing regulatory changes

Involving all key public stakeholders at the strategic level will ensure alignment with the solar program's objectives and its endorsement while ensuring that resources (such as state support) are made available to implement the program as designed. It will also help prioritize cost-effective projects supporting local and industrial development. Down the road, involving key stakeholders at the operational level will ensure that the program is aligned with relevant strategies deployed by various ministries in the country, enhancing potential synergies. Strong interministerial cooperation mechanisms are necessary to efficiently coordinate efforts between the projects' stakeholders (state and local administrative levels, IPPs, grid operators, off-takers, etc.) and ensure timely delivery of project outcomes (see the box below for a discussion of one such mechanism).

In addition, ensuring strong ties between the utility and the procurement entity, if different, will help ensure that procured projects comply with utility needs and plans in terms of technological, capacity, timing, and technical specifications.



AD HOC ORGANIZATIONAL SCHEMES

Governments may adopt ad hoc organizational measures with a view to improving administrative efficiency. For example, they may create a dedicated body to coordinate efforts among ministries, administrations, and jurisdictions, or a specific public authority to lead the bidding process. A newly created entity, publicly owned but governed by private law such as in the case of Morocco's Moroccan Agency for Sustainable Energy (MASEN), can potentially be able to apply a more flexible procurement scheme and hire more qualified human resources. Providing one focal point for bidders, and streamlining the overall bidding process, will also reduce the timeline and associated costs.

However, the creation of a new entity can also slow the implementation process and reduce the already limited capacity of relevant agencies/ministries.

4.2.2 SUPPORTING PRIVATE SECTOR PARTICIPATION

Before 1990, private participation in the electricity sector of developing countries was limited to Chile, where comprehensive reforms in the 1980s created a competitive private market. Today most countries have opened the generation segment of their energy markets to private participation.

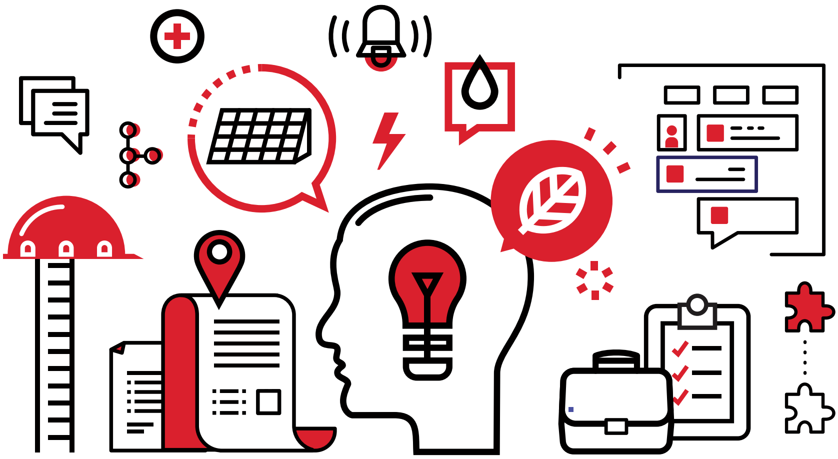
To open power generation to private participation, specific regulations need to be enacted in such a way as to ensure full top-down normative coherence, from the constitutional level to that of local regulations, especially where state involvement in the electricity value chain is significant (as in the case of state-owned monopolies). Passing corresponding reforms through laws and regulations issued at a ministerial level would ensure the long-term stability of the regulatory framework, and thus lower IPPs' perceptions of risk.

In addition to enabling private generation in the energy market through consistent legal provisions, the overall legal framework should cover the following points, as further detailed in these guidelines:

- The establishment of effective dispute-resolution mechanisms at all stages of the tender (i.e., from the initial stages of procurement to project commissioning). Key aspects of the bidding process (e.g., bid bonds) should be covered by contractual arrangements with clear dispute-resolution mechanisms acceptable to all stakeholders.
- Land access and plant ownership over a long period.
- Efficient mechanisms to enforce the security package offered to the lender under the plant financing arrangements.
- Streamlined permitting processes.
- Adapted insurance regulations.
- Suitable foreign exchange regulations.
- Clear tax provisions applicable to solar IPP-projects.

The Regulatory Indicators for Sustainable Energy (RISE) were developed by the World Bank Group, ESMAP, and SEforAll, with support from the Climate Investment Funds.

RISE allows countries to benchmark themselves through a score reflecting a snapshot of the country's energy-sector policies and regulations. A set of indicators makes it possible to compare national policy and regulatory frameworks for sustainable energy, organized by the three pillars of sustainable energy: energy access, energy efficiency, and renewable energy.



RETHINKING POWER SECTOR REFORM

The unbundling of power utilities, creation of independent regulators, achievement of cost-recovery pricing, and introduction of competition in power generation have been part of a standard set of policy prescriptions for power sector reforms. The World Bank's flagship report Rethinking Power Sector Reform assesses the actual experience of power sector reform and how it diverges from the theoretical paradigm.

Two of its findings are:

- Private sector participation in generation has been relatively successful despite enduring challenges in terms of planning, procurement, and risk sharing. In countries where the three areas were adequately addressed, governments successfully leveraged private investments for the greater benefit of society, procuring them through a transparent and competitive process.
- The technology disruptions currently underway are expected to have wide-ranging implications for the design of power sector reforms. The current wave of innovations, such as decentralized renewable energy, battery storage, and digitalization, contribute to the empowerment of consumers, who may become prosumers and thus hold utilities accountable for poor performance through grid defection.

For more information, see https://www.esmap.org rethinking_power_sector_reform

4.2.3 COMPETITIVE BIDDING

Transparent and competitive bidding reduces a variety of risks and thus contributes to lower tariffs. *Competitive processes should be rooted in sound legal grounds.*

However, the specifics of bidding mechanisms may require a ministerial decree. A high-level risk analysis will inform the selection of the optimal deployment scheme and overall bidding framework.

SELECTION SCHEMES: COMPETITIVE SELECTION, FEED-IN-TARIFFS, OR BILATERAL NEGOTIATIONS

Bilateral negotiations between a single private developer and the government are not recommended as they usually lead to higher prices and lengthy negotiations.

To encourage competitive, privately owned generation and to leverage private capital, governments have two choices.

- They can set the price of the power purchase agreement up front by means of a feed-in-tariff (FIT), in which case the quantity of power produced depends solely on each investor's appetite.
- Conversely, they could set the quantity up front and invite investors to compete on the price (expressed per kWh) through a competitive bidding scheme.

Internationally, FIT schemes have supported a nascent solar industry. However, now that the market is in the hundreds of gigawatts range, competitive bidding is the most optimal way to increase competition and decrease prices. At the same time, if competition reduces tariffs, bids can become costly and time consuming for governments. Governments can reduce their cost of bids by developing a set of legal contractual documents and procurement processes early on that can be used again in subsequent phases.

Through SRMI, a global e-tendering platform will be made available to governments that do not already have an online platform dedicated to the selection of IPP in the renewable energy sector. This global platform will increase the visibility of each of these competitive bidding processes while reducing the cost, as it will be made available to governments as a public good. The role of e-tendering platforms is presented in *Phase 3: Implementation*.

4.3 HIGH-LEVEL RISK ANALYSIS

*Once the overall legal framework under which the IPP will be selected is assessed, it is necessary to ask **what are the critical risks perceived by IPPs—that is, those risks that will affect their willingness to invest or their cost of capital? And what are the public stakeholder's views on risks (including country-specific restrictions)?***

The identification, allocation, and mitigation of risk are critical inputs to a comprehensive solar strategy.

The private sector high-level risk assessment outlines:

- each risk from the IPP's perspective with a pass or fail grade (if the risk is not fixed, the IPP will not invest in the project)
- its overall impact on the cost of capital from the equity and debt perspective, to be able to mobilize commercial financing in competitive conditions

Offering conditions enabling a project financing scheme, under which the lenders would have limited or no recourse, is critical to attract IPPs.

The private sector high-level risk assessment combines investor surveys/consultations as well as market observations of finance costs for different parties with and without risks. This assessment enables countries to select which deployment schemes are the most suitable and informs their bidding framework so as to balance risks between the private sector and the government, keeping in mind the trade-off between the PPA price and the risks governments will take.

Building a favorable environment for foreign investors, guaranteeing safe and attractive investment conditions, as well as allocating risk in a fair manner reduces the risk premium for IPPs, thus reducing the expectations of equity returns and improving lending terms. Indeed, these perceived risks are internalized in the lending terms and the equity return expectations. Integrating these risks in the bidding framework of a country's solar deployment program and clearly allocating them between parties—and setting up associated risk mitigation instruments—is core to the success of the program.

Understanding the risk-related views of public sector stakeholders, as well as any restrictions that they may impose or by which they may be bound, is important in gauging the willingness or ability of a given country to assume a specific risk.

A high-level risk analysis considers

- **development risks** (before construction and operation) that impact the selection of the deployment scheme
- **operational risks** that inform the bidding framework

4.4 SELECTING A DEPLOYMENT SCHEME

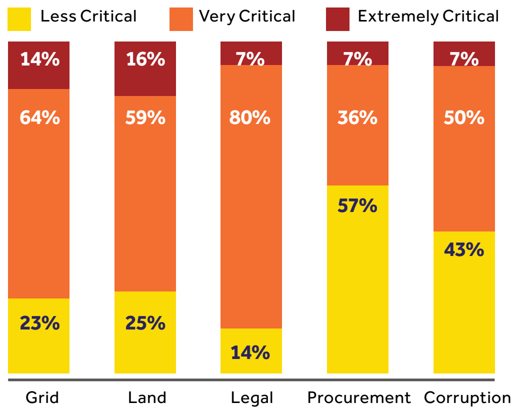
Once the main risks are identified in the high-level risk analysis, the next question is: ***Which deployment scheme is the most optimal to cover the key development risks?***

4.4.1 DEVELOPMENT RISKS IDENTIFIED

Planners will need to adapt their deployment strategy based on (i) the assessment of the risks perceived by the private sector, (ii) the country's willingness to contribute to the development activities (such as mobilizing the land for the project), and (iii) the country's specific restrictions (legal, financial and political constraints).

Based on the results of the market sounding presented in the introduction (outlined in *Figure 14*), the main risks specific to the project development phase are legal, grid, and land risks, and, to a lesser extent, integrity and lack of transparency in procurement.

Figure 14. Project development risks



Source: World Bank Market Sounding 2018.

Table 2. Key risks to be addressed by deployment schemes

LAND OWNERSHIP RISK

Secured land rights are critical for long-term investment and financing. The main asset considered a security for the lender is the solar plant, whose ownership relies on legal rights over the land, enabling the project company the special purpose vehicle (SPV) to hold the plant during the project agreements (PPA and finance agreements).

Depending on the land's legal structure, access to land can be through formal, informal, or customary systems. IPPs will assess the country's land tenure system to evaluate the land security the system provides to its project. If land cannot be secured in a bankable manner, IPPs will usually not invest in the country or will have expectations of very high equity returns.

GRID CONDITION KNOWLEDGE AND CURTAILMENT RISK

Limited knowledge of grid availability/ conditions leads to

- the IPP spending excessive time trying to get information from the government/utility to conduct a grid integration study for the specific project
- an incomplete grid integration study that may not represent the reality of the grid

If the project is based on this incomplete grid study, there is potentially a **risk of curtailment** as the project would not have been based on sound technical and commercial constraints. It is a risk that will arise during operation but is linked to the development phase as it depends where the project connects into the grid.

4.4.2 DEPLOYMENT SCHEME TYPES

Solar competitive bidding schemes are broadly grouped into two categories, "standard competitive bidding" and "solar park competitive bidding," with the key difference being that the land is provided to the IPP as part of solar park schemes. Two types of standard competitive bidding are common for solar deployment: location-agnostic and substation-linked bidding, presented in *Table 3*. Each deployment scheme tackles different risks perceived by IPPs.

Table 3. Types of deployment schemes

LOCATION-AGNOSTIC COMPETITIVE BIDDING

The procurer tenders a pre-determined capacity/energy amount, with no constraints on location, allowing the developer to select the project location freely.

Advantage	Disadvantage
Developers can select sites according to their own criteria, enabling them to target sites that are cheaper and easier to develop or offer better resources.	Developers may gravitate to the same region, causing grid congestion as well as land scarcity and speculation. Connecting such independently selected sites may result in an increase in cost for the grid network that could have been avoided if better planned.

The first solar competitive bidding schemes (e.g., in South Africa) were all location-agnostic. Most countries are now moving away from such competitive bidding schemes as they are experiencing major grid constraints. Feed-in tariffs are usually also location-agnostic and face the same grid constraints.

SUBSTATION-LINKED COMPETITIVE BIDDING

The government identifies substations with available megawatt capacity, and a certain megawatt capacity at each substation is opened for bidding.

Advantage	Disadvantage
It helps optimize the use of existing transmission capacity in the deployment of solar projects, reducing the potential cost to integrate them. It can proactively drive grid investments needed for new variable renewable energy generation.	If the number of selected substations is too small, there may be major competition for land around the substation that would drive the PPA price up.

Mexico developed such a scheme that has been very successful in supporting a more controlled deployment of solar photovoltaic in the country. Germany's premium and penalty scheme is a variation of this scheme.

SOLAR PARK COMPETITIVE BIDDING

The government identifies the site(s), conducts land clearance, and constructs infrastructure for the solar park that can range from the evacuation line to basic elements (such as the fence, roads, street lighting, etc.). Once the project is ready for competitive bidding, the bidding procedure begins and the winning IPP is responsible for the financing, construction, and operation of the solar project.

✓ The solar park significantly lowers development risks (particularly those associated with acquiring land and consents) and shortens the development timeline for the private sector, which results in cost savings and thus lower PPA tariffs.

✗ The implementing agency will need time and an up-front budget to develop the solar park facility before conducting an auction. There is a risk that the infrastructure expected from the government is not built in the agreed timeline with the winning IPP, leading to an extra cost to the government. It is important to integrate such potential delays in the assessment of what the government will build and what it will leave to the IPP (e.g., interconnection line).

India and Morocco championed the public solar park scheme, leading to competitive PPA prices. The World Bank Group developed a scaling solar concept that has reduced up-front development risks. It was very successful in Zambia and Senegal.

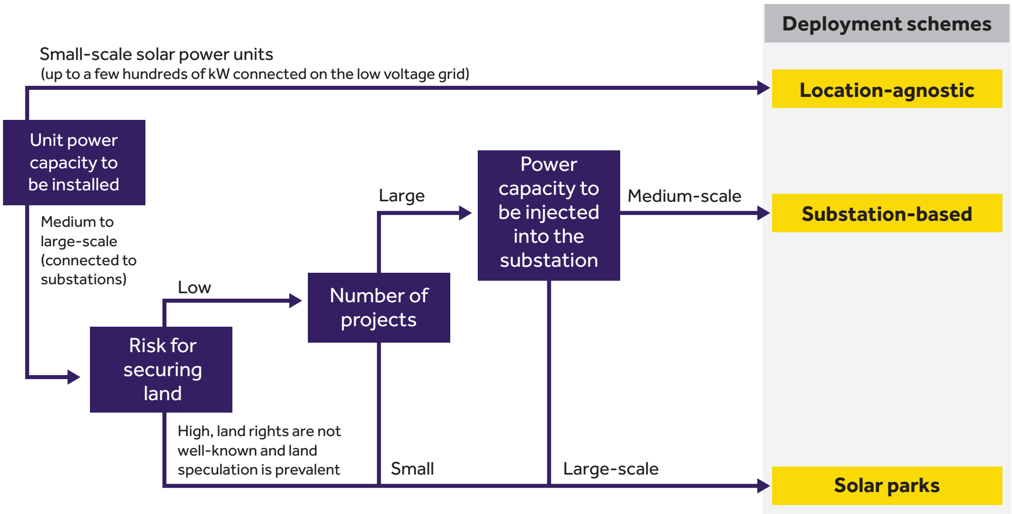
4.4.3 SELECTING THE DEPLOYMENT SCHEME(S)

Choosing the right deployment scheme for the country depends on the results of a high-level risk analysis, which is based on market soundings and discussions with private investors, to better assess their perceived risks with regards to project development.

As per the results of the market sounding, IPPs prefer to mitigate the deployment risks with

- solar parks
- grid information availability

Figure 15. Land and grid risks: Key to the selection of the deployment scheme



If the **grid** is identified in the high-level risk analysis as a key issue for IPPs, the government can

- make grid information available to anyone online so IPPs have a better sense of where there will be the least curtailment risk under location-agnostic schemes
- develop a substation-based competitive bid
- develop a solar park scheme

However, from a grid integration perspective and to optimize the existing infrastructure, location-agnostic schemes are not recommended for projects that are more than a few megawatts. Even for rooftop PV projects that are a few kilowatts (kW) it is recommended to have some sort of control over the connection to ensure that the project will not damage the grid.

If **land constraints**, such as constraints in land availability or the security of tenure, are identified in the high-level risk analysis, solar park schemes should be favored by governments as a mitigation measure. Critical points in this case are that the land made available to the winning IPP should be free of people and the soil and other environmental characteristics be aligned with the solar plant's requirements. Also, the right of way for the evacuation line should be made available to the IPP. In the event of severe land constraints, floating PV can be a viable option, and an increasingly popular one.

Although the construction and equipment costs are currently higher than for ground-mounted plants, these additional costs are partially offset by increased energy production thanks to the surrounding water's cooling effects and also a general lack of dust.

The selection of a deployment scheme or schemes needs to be explicit in a country's solar deployment program and decided up front as it entails work from the government's perspective with regard to technical analysis or even investments, as discussed in *Phase 3: Implementation*. The assessment of the perceived development risk will be translated into a **development risk allocation matrix** supporting the selection of the optimal scheme to be implemented in the country.

OFF-GRID BUSINESS MODELS

To reduce the size of the investment needed up front for electrification purposes as well as increase efficiency, private investments can be part of the off-grid solution for mini-grids and SHSs. There is no standard business model for integrating private investment in electrification plans. Instead, the process depends on the strength of the state utility, the public financing available for electrification, the electrification timeline and rate, and the willingness/ability to pay of off-grid populations.

Mini-grid business models are numerous and can involve a lot of different partners. More precisely, they can be financed fully by the public sector, under a public-private partnership, or fully by the private sector. They can be managed by the utility, by communities, by the private sector, or by the private sector jointly with the public sector. Anchor customers, such as mining companies, can also be leveraged for their creditworthiness and demand as part of a business model that would integrate the public off-taker and an IPP.

Each of these models has different challenges and the main constraint is usually the regulations prevalent in a country. The state utility usually has a monopoly over distribution and transmission and will relinquish an area only to a fully private mini-grid or provide a concession to a private mini-grid manager.

Three core questions arise with mini-grids: What happens when the grid arrives? How are retail tariffs regulated? And what are the quality of service and technical standards?

Mini-grid deployment needs to be well thought through by the government, and before procurement, to ensure that the program is sustainable and that the regulations in place enable the implementation of the selected model.

SHS are a good electrification solution for low-consumption customers and in areas where there is low population density. SHS deployment can be promoted in various ways. For example, households may (i) buy their own SHS directly without any operation and maintenance, (ii) via a fee-for-service model where the ownership stays with the SHS provider, and (iii) via a lease-to-own model where the ownership gets transferred to the household.

The state utility can be part of the deployment under the fee-for-service model (as in Peru). The private sector can be leveraged and promoted by the government through various schemes, such as results-based financing (under which the government pays the private party based on results and competition between private stakeholders pushes down prices) and minimum subsidy tenders.

For more information, see http://hdl.handle.net/10986/31926

4.5 BIDDING FRAMEWORK

Based on the results of the high-level risk analysis and simultaneous with deciding the appropriate deployment scheme, the main question to ask is: ***What are the main parameters of the bidding program under a fair risk allocation?***

The bidding framework is meant to provide the framework for procurement of the whole solar program. It encompasses

- procurement-specific issues
- contractual-specific issues

Such parameters are integrated into country regulations, usually under a ministerial decree. A high-level plan for the **allocation of procurement and contractual risks** needs to be developed by the government in partnership with the private sector to decide on the key elements of the framework.

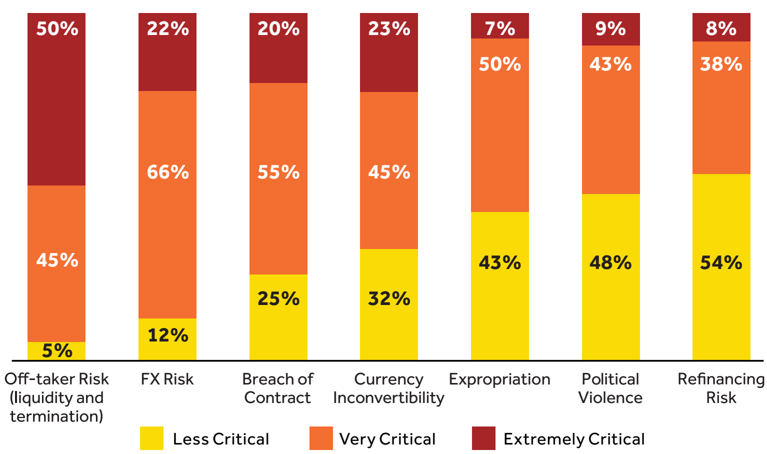
This bidding framework should be further detailed and refined for a specific phase of a program/project when the related procurement starts. It includes details of the bidding mechanisms, procurement framework, and contractual arrangements that would be the basis for the specific contractual arrangements. However, depending on the country, sometimes these parameters need to be included up front in the regulations. These points are further presented in *Phase 3: Implementation*.

The more visible the upcoming bidding processes are to the market, the better. Whenever possible, governments should provide stakeholders with a transparent and predictable schedule of upcoming tenders, including information on successive rounds, if applicable.

4.5.1 OPERATIONAL RISKS IDENTIFIED

Each country will have different operation risks perceived by IPPs and will need to adapt its procurement and contractual framework to those results combined with the public stakeholders' restrictions. Based on the results of the market sounding presented in the introduction and *Figure 14*, the main risks perceived during operation are off-taker (liquidity and termination), foreign exchange, breach of contract, currency inconvertibility, and, to a lesser extent, expropriation, political violence, and refinancing risks.

Figure 16. Project operation risks



Source: World Bank Market Sounding 2018.

Table 4. Key risks to be addressed by the bidding framework

OFF-TAKER RISK

Under a project finance scheme with limited recourse or non-recourse to shareholders, the bankability of a solar project is based on the capacity of the SPV to reimburse the loan, and hence on the capacity of the public off-taker to make the electricity payments on time to the SPV. The risk of payment delays and contract default (breach of contract and contract termination) by the utility, also called **liquidity risk and termination risk**, has a large impact on the cost of capital where a utility is financially weak (as is the case in most developing countries).

POLITICAL RISK

Core political risks perceived by IPPs are

- breach of contract risk (arbitral award default, denial-of-recourse risk with arbitration that is not international)
- expropriation risk
- transfer restriction and currency inconvertibility risk
- war and civil disturbance risk

CURRENCY RISK

Currency risks can impact solar markets and IPPs' balance sheets through currency devaluation/foreign exchange risk, risk of convertibility, and transfer restrictions.

Foreign exchange risks can be easily managed during the construction phase of the plant, as they apply only for a limited time.

If there is a **difference between the debt/equity currency and the currency of the construction contract**, this risk is likely to be hedged and the associated costs regarded as a one-off cost by the IPP. However, during the operational phase of the plant (usually between 20 to 25 years), the foreign exchange risk is substantial in case of a **mismatch of currency flows**.

Where the IPP revenues are in a local currency and there is a mismatch between the debt and equity currency, the risk of devaluation and of convertibility is high and could potentially lead to high costs for the IPP. Operation expenditures (OPEX) are minor for solar PV projects and therefore a mismatch of currency will have a minimal impact.

4.5.2 PROCUREMENT FRAMEWORK

The procurement framework defines the bidding process requirements for a procurer based on the country's appetite for risk, and its commitment to integrating VRE in the energy mix and ensuring energy security for the country. ***The procurer has to be clearly identified up front, alongside two key elements:***

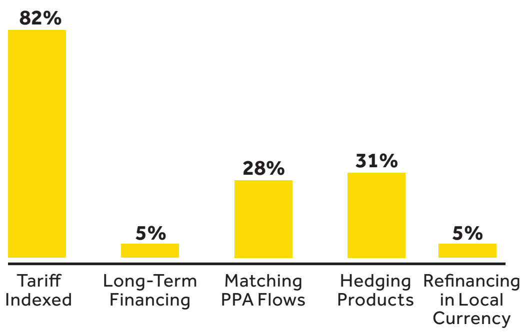
A. THE PAYMENT MECHANISM

The payment mechanism is decided in the payment structure to the IPP in the PPA. Considering the variability of solar production, the payments are usually in the form of energy-based payments per megawatt-hour (MWh) and not in terms of MW (capacity).

B. THE TARIFF STRUCTURE

The tariff structure is a core decision from the government's perspective in the risk allocation. It needs to be decided considering the results of the high-level risk analysis and availability of adequate financing in the local currency. The tariff can be in a foreign currency, indexed to a foreign currency, indexed to inflation, or increasing every year at a given rate. The choice of who takes the inflation risk and currency risk will potentially impact the PPA tariff greatly and therefore needs to be decided in an informed manner. As per the results of the market sounding presented in *Figure 17*, most IPPs would request that the tariff be indexed to a hard currency such as U.S. dollars or euros, as long-term affordable hedging products are still rarely available. This entails that the government would take the foreign exchange risk. Alternatively, the main mitigant would be IPPs' access to adequate local financing, matching loan flows and revenues. This would entail the development of a strong lending market that would propose appropriate terms and conditions under project financing with the right maturity. The selection of the tariff structure is important at the program level. The approval of the foreign exchange office or the ministry of finance may be required, depending on the applicable legal framework, in the event the tariff is indexed to another currency.

Figure 17. Foreign exchange risk: mitigation instruments



Source: World Bank Market Sounding 2018.

4.5.3 CONTRACTUAL FRAMEWORK: RISK ALLOCATION UNDER THE PROGRAM BIDDING FRAMEWORK

Risk allocation between the procurer and the IPP in the PPA contract is a result of the trade-off between the price (that the procurer is willing to pay) and the risks (that the procurer is willing to take to improve bankability).

The key risks that need to be tackled at the program stage are:

- off-taker risk (payment and contract termination)
- legal change risk as both can have long-term impacts on the country and require the involvement of different public partiess

The **allocation of the high-level contractual risk informs which mitigation instruments** or provisions the government will provide to the IPP and what can be expected from the IPP. Key terms of the contractual framework to be decided by the government at the program level and to support key risks perceived by IPPs are as follows.

A. PPA TENURE

PPA tenure, best matched to the asset life, which is usually between 20 and 25 years. The PPA tenure is key for IPPs to be able to access long-term non-recourse financing. As solar projects have very small OPEX needs, the cost of the investment is up front, and therefore the tenor of the loan has a strong impact on the PPA price.

B. GOVERNMENT SUPPORT

Government support for changes in the law is key to mitigate risks of legal and tax changes that IPPs cannot control. Governments can attach a letter of support to the PPA, committing that any change in law that would negatively impact the project's operation and profitability would not be applicable to it. Similarly, governments can agree to **international arbitration** to provide further assurance to lenders and IPPs in the event of termination or breach of contract. This is critical especially in countries where the justice system is not up to international standards.

C. POLITICAL RISK

Political risk can be mitigated by inserting, in the contractual documentation, a termination clause benefiting the IPP in the case of political force majeure events, which also provides for specific indemnities covering (notably) the IPP's outstanding debt repayment obligations. Specific risk mitigation coverage can also be proposed for the IPP in particularly unstable host countries.

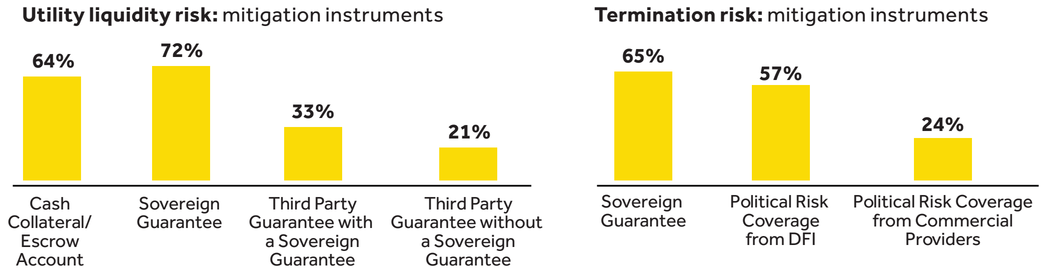
D. OFF-TAKER PAYMENT RISK

Off-taker payment risk, as presented before, is critical to IPPs when the utility is not considered creditworthy. It can be mitigated, as per the result of the market sounding presented in *Figure 18*, by an adequate payment security mechanism to secure payments and/or a guarantee (sovereign guarantee or development finance institution [DFI] guarantee). Similarly, **termination and breach of contract risks** due to the utility default can be reduced through provisions for termination payment (compensation for debt due, and equity return and premium) and/or by an appropriate guarantee (sovereign guarantee or DFI guarantee).

The ***payment guarantee*** covers the PPA payment obligations from the off-taker to the SPV whereas the loan guarantee covers default by the SPV on loan repayment caused by default by the off-taker on PPA payments.

Government backing of the obligations of the off-taker under the PPA with a bankable letter of support is very often a key element of a successful contractual scheme relying on a balanced and fair risk allocation. These supports need to be agreed upon by the government and in particular the ministry of finance prior to procurement.

Figure 18. Liquidity and termination risks: mitigation instruments



Source: World Bank Market Sounding 2018.

IMPROVING OFF-TAKERS' CREDITWORTHINESS

Introducing private participation in generation without first or at least simultaneously undertaking deeper sectoral reforms is potentially problematic. In many countries, off-takers may not have a strong balance sheet or credit history. Off-takers' weak financial performance can often be linked with high investments in electrification, high losses, implementation of non-indexed and non-cost-reflective retail electricity tariffs that do not meet the utility's revenue requirements, and the high cost of electricity generation. Postponing tariff adjustments, subsidy reforms, and policies to reduce the cost of generation, losses, and inefficiencies affects the creditworthiness of the off-taker and usually leads to demands for government guarantees for PPA, exposing taxpayers to substantial contingent liabilities.

In the short term, countries that have financially vulnerable utilities have no choice other than to provide some sort of mitigation support for this risk, which is intrinsically a government matter. However, they need to also ensure that the PPA price of any new generation is as low as possible, so it does not further burden the utility's financial status.

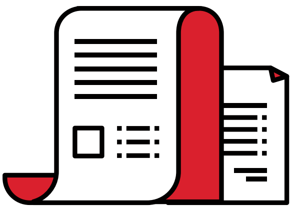
In the medium term, governments need to support utilities to improve their services and collect payments, improve grid quality to reduce technical losses, better target their fuel and electricity subsidies to the poorest segments of the population, and continuously reduce their cost of generation. It is critical for countries to build a strong program to support their utilities to reach sustainability.

4.6 MAXIMIZING SOCIO-ECONOMIC BENEFITS

The next question is **how to maximize the program's socio-economic benefits?** *Sound planning with medium-term targets will allow countries to maximize the socio-economic benefits triggered by the solar projects implemented as part of a sustainable and integrated roadmap.*

Policymakers can also decide to integrate the impact on jobs when modeling their least-cost generation selection. For example, the bottom-up model Open Source Energy MOdelling SYStem (OseMOSYS) has been used in Tunisia with an adds-on to model jobs creation taking into account employment rates as a socio-economic metric (Dhakouani A. 2017).

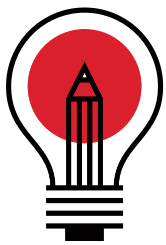
Figure 19. Maximizing the socio-economic benefits of private participation



PLANNING

Provide visibility to the market locally & internationally, including

- VRE targets and implementation timeline
- Assessment of local players
- Mapping of existing and new skills
- Assessment of socio-economics impact



STRATEGY

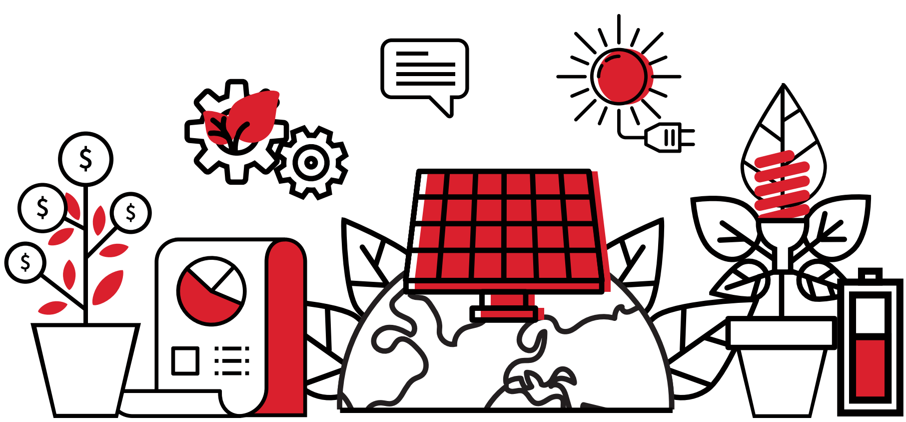
Build capacity and competitiveness of local players

- Gap analysis on skills and industries
- Action plans to boost competitiveness of local players and to train on skills needed

IMPLEMENTATION

Support employment of local workers, communities, women, and youth

- Public policies such as preferential treatments and financial incentives for maximizing positive local development



SOCIO-ECONOMIC BENEFITS CAN BE SUPPORTED IN THE FOLLOWING WAYS.

A. PROVIDE VISIBILITY LOCALLY AND INTERNATIONALLY.

To support the development of local industry, the government can

- inform the market of the programs' features, including local and industrial development targets, and
- take local suppliers through the solar value chain to allow them to identify relevant opportunities so they can position themselves as needed

The creation of a business cluster could also help local players benefit from the deployed solar program, disseminate adequate knowledge on the solar value chain, provide relevant training in coordination with professional training institutions, help local companies gain visibility, and link them to international players involved in the bidding processes, as the case may be.

B. FACILITATE THE ASSESSMENT OF LOCAL OPPORTUNITIES.

The government could conduct external studies in accordance with best practices to assess the potential of the local market in the solar value chain and share these studies with prequalified bidders to facilitate bidders' investigation of local opportunities to partner/subcontract. Meetings between the prequalified bidders (and their main subcontractors for engineering, procurement, and construction as well as operation and maintenance) with local players could be organized.

C. MAXIMIZE BENEFITS FOR LOCAL COMMUNITIES.

Carrying out a socio-economic study to assess the needs of local communities would help in the design of tailor-made programs to meet these needs to the extent possible, in coordination with all the public stakeholders involved. While the government often understands community needs and how to meet them, it often lacks the means to finance the measures needed to address them. The bidding process could include provisions for the IPP to finance a small percentage of the capital expenditure (e.g., 1 percent) that could be spent by governments on local development.

For example, in South Africa, projects mandated under the Renewable Energy Independent Power Producer Procurement Programme are required to set aside a percentage of total project revenues for socio-economic development to benefit local communities. This is the case of the Redstone 100MW CSP solar project, which commits to a 2.5 percent community trust. Set up as a not-for-profit organization, the trust will benefit local communities living around the project site, particularly women (who are involved as trustees). Distributions received by the trust must be applied to specific community development programs, including health care, education, training, and development

SOLAR PLANTS AND WOMEN'S EMPOWERMENT: AN EXAMPLE FROM MOROCCO

As part of the Noor Ouarzazate solar PV project, since 2013, the IPP selected by the government has implemented a full corporate social responsibility (CSR) plan in collaboration with governmental entities. The objective of the CSR plan is to improve livelihoods and economic opportunities of the local communities, with a particular focus on women. In order to reach this objective, the IPP facilitated the creation of mixed agricultural cooperatives and women-only handicraft cooperatives, and provided trainings related to livestock, agriculture, and handicrafts.

Six years after its implementation, it already reports significant benefits for women that are part of the program. Among the results are substantial increases in income and assets, knowledge of livestock management, and knowledge of handicraft production.

W+ certificates were used to monetize the benefits of actions supporting women. Under this certification, the project is monitored for the categories "Income and Assets" and "'Knowledge and Education." The W+ certificates associated with these actions can be sold, generating incremental revenues for the women to reinvest in their projects.

For more information, see https://www.wplus.org/project/livelihoods-project-in-ouarzazate-morocco-2/

D. MANAGE EXPECTATIONS TO ENSURE BETTER RESULTS.

A carefully designed communication and engagement plan would improve communication with local stakeholders and allow the government to better manage the expectations of key stakeholders.

SYNERGIES BETWEEN MINING AND RENEWABLES FOR A SUCCESSFUL ENERGY TRANSITION

The solar industry can present an opportunity for workers from the coal industry by offering improved payrolls for workers at all skill levels. Janitors in the coal industry could, for instance, increase their salaries by becoming low-skilled mechanical assemblers in the solar industry (Harvard Business Review 2017).

A relatively minor investment in training would allow the vast majority of coal workers to switch to solar-related positions; many coal miners have skill sets, such as mechanical and electrical expertise, that are transferable to solar industry jobs. They could benefit from new jobs created in renewables in the context of a coal phase-out, with the support of the government to manage social impacts on workers and communities. An integrated framework for such a transition would address temporal, spatial, and educational aspects of the job matching process, as well as job losses within the energy sector and in other sectors of the economy.

The Guqiao Solar Farm in China provides an example of such transition: it has been built on top of an abandoned coal mine in Anhui Province. This 150 MW solar farm retrains and employs some of the former coal miners (e.g., as solar panel assemblers) and provides them with a better salary while offering them a healthier work environment.

E. ENHANCE THE POSITION OF LOCAL PLAYERS AND LOCAL JOBS ON THE VALUE CHAIN.

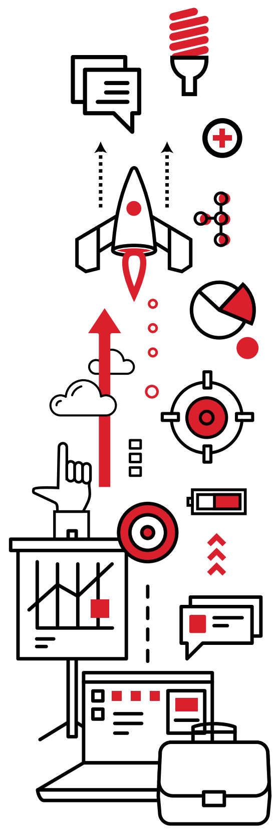
The government might map local players and their skills, then identify how they might fill gaps on the solar value chain. Any theoretical assessment might be improved by benchmarking local players against preselected subcontractors by asking, for example, prequalified bidders to explain why they do not intend to preselect local subcontractors. This information will help the public stakeholders design a tailor-made program to enhance the position of local players on the value chain. From a sustainability perspective, operation and maintenance jobs require specific attention as they constitute more than half of the jobs associated with a solar PV plant (IRENA 2017).

SKILLS DIVERSIFICATION: OPPORTUNITIES IN OPERATION AND MAINTENANCE

In the solar PV value chain, 56 percent of the human resources required are in O&M while manufacturing and procurement compose 22 percent of the total. The majority of laborers are construction workers and technicians. Developing new O&M skills requires, in addition to theoretical knowledge, "learning by doing."

To create a local champion, the government could designate a team of skilled people and include provisions in the bidding documents to second them to the O&M contractor. They would be able to get hands-on experience, scalable and replicable, at no cost to the government (as costs will be paid by the IPP and budgeted up front) and at no increased risk (they will be seconded and hence under the responsibility of the O&M contractor). Holding a minority stake in the O&M vehicle may allow the government to improve its knowledge of the O&M business with only a limited amount of money at stake.

For more information, see https://www.irena.org/publications/2017/Jun/Renewable-Energy-Benefits-Leveraging-Local-Capacity-for-Solar-PV

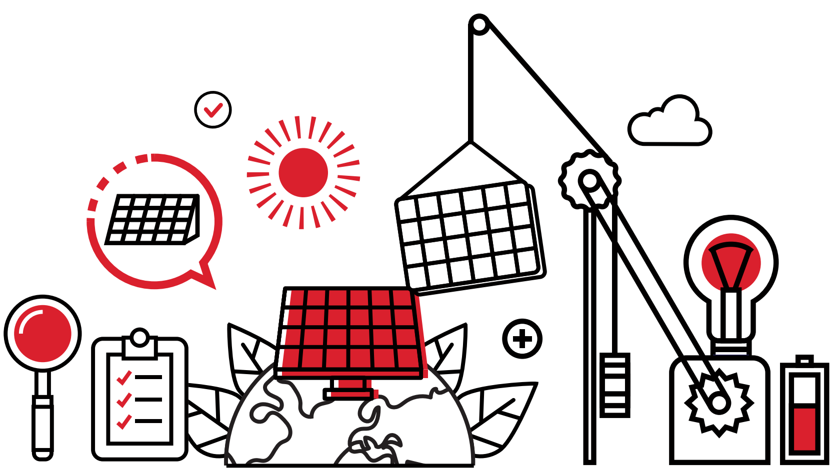


4.7 SOLAR DEPLOYMENT PROGRAM: KEY RESULTS

Based on the government's strategy and a high-level risk assessment, a solar deployment program can be developed that outlines:

- clear roles and responsibilities of stakeholder
- high-level risk allocation of development and operational risks with associated mitigation instruments and key actions
- selected deployment scheme(s)
- the targets of the program divided in yearly or 18-month phases
- the overall bidding framework including procurement and contractual specific issues as identified in the risk assessment.

Under the program, the government may also identify and plan specific action points to support socio-economic development, and key changes to be made to the legal framework to encourage and facilitate sustainable solar deployment.



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PHASE 3: IMPLEMENTATION

5.1 OBJECTIVES

By the time a project's implementation begins, a government's solar targets have been set and a strategy to reach those targets has been agreed upon by all public parties and enacted.

If that strategy involves private participation in solar energy production, then several questions must be addressed at the start of the implementation phase:

- What technical analyses and investments must the public sector undertake before selecting an IPP?
- How can the process of IPP selection be optimized?
- What will the government's role be in the operational phase of an IPP-owned solar project?

At this point, the public sector will operationalize the decisions made in the previous two phases.

By preparing a robust procurement process, combined with appropriate technical analysis and financial support, the public sector will foster affordable and sustainable solar projects that address the energy needs of the country while supporting its socioeconomic development. By planning and anticipating in a coordinated manner the key actions of the various public entities involved, the government can prevent delays in the procurement process that otherwise would affect the procuring authority's credibility as well as bidders' costs.

From the IPPs' perspective, the implementation of a robust, formal procurement scheme relying on bankable contracts and supported by adequate risk mitigation coverage, will reduce several key risks, namely (i) lack of procurement transparency and long negotiation timelines, (ii) financing and contractual risks, and (iii) off-taker and political risks.

By the end of this phase, the nation's solar targets will have been achieved by leveraging private investments in a fair and sustainable manner, while all risks from the public and private perspective will have been optimized.

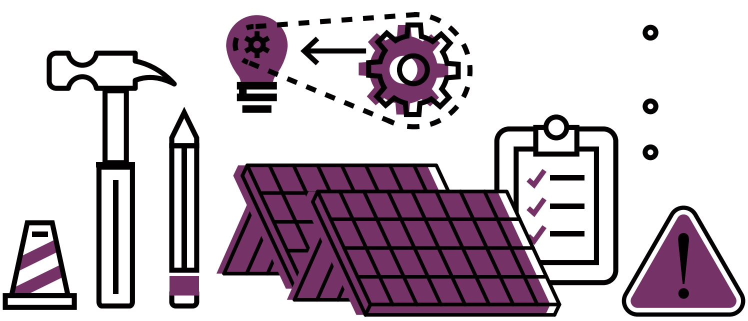
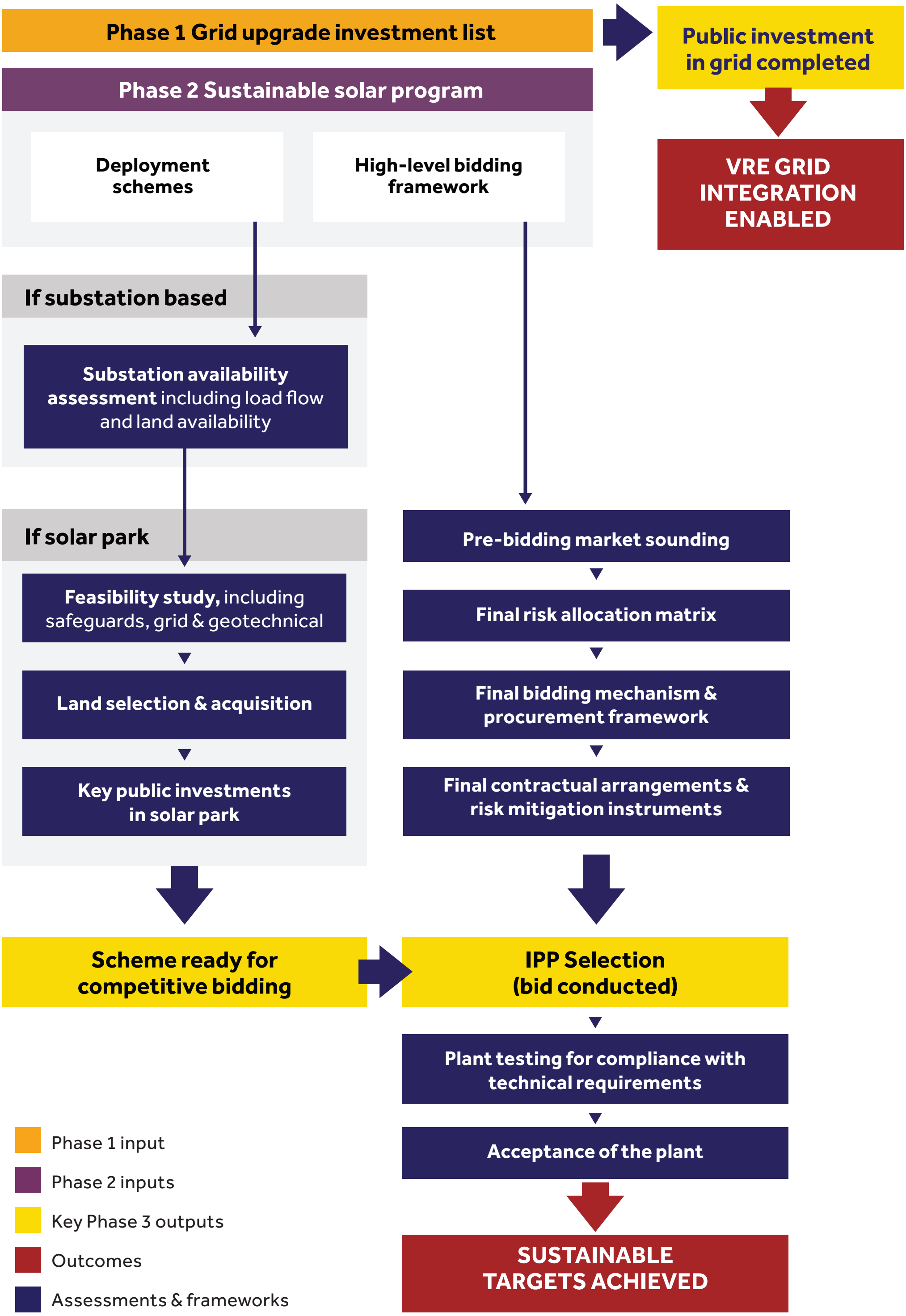


Figure 20. Key steps in the implementation phase

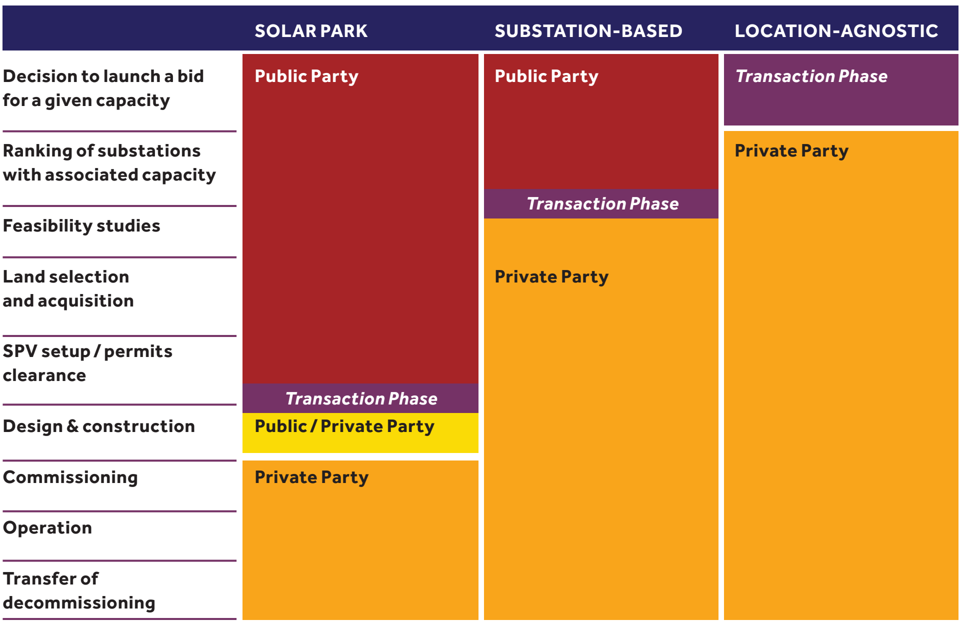


5.2 PREPARING THE TECHNICAL ASPECTS OF A SOLAR PROGRAM

Before starting the procurement process, the public authorities must identify ***what needs to be done, from a technical standpoint, to implement the chosen deployment scheme.***

If the government decides on a location-agnostic model, no technical steps need to be taken prior to procurement, whereas for a substation-based model or solar park, it is necessary to prepare the grid and make the land available as well as other infrastructure, as the case may be.

Figure 21. Roles of the public and private sector, by type of deployment scheme



5.2.1 SUBSTATION-BASED MODEL: DETERMINING LOCATIONS AND CAPACITY

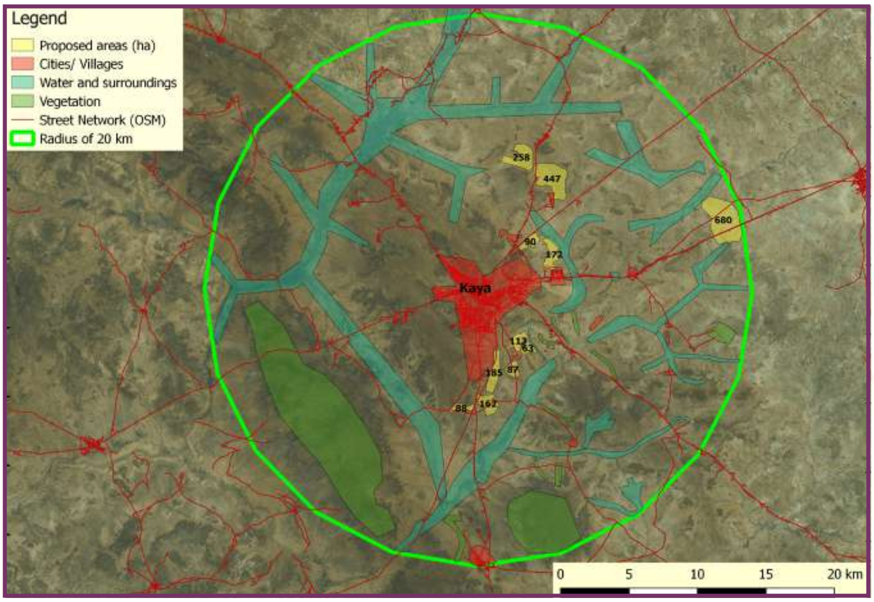
A substation-based scheme requires an assessment of which substations are the most appropriate for solar deployment from an integration point of view. The assessment integrates the results of a loadflow analysis combined with land assessment. It also considers the timeline set for transmission upgrades.

Based on this assessment, it is possible to prepare a list of optimal substations and their associated capacity that can be integrated without risk. The procurer should include this list in its request for proposals (RFPs), indicating the maximum capacity per substation in MW and the maximum capacity for the total auction. It is recommended that the total capacity auctioned be smaller than the cumulative maximum capacity per substation. This will ensure that the offer meets the demand while maximizing competition, reducing the risk of collusion between private investors. If land around one substation is very expensive, this substation will naturally be eliminated due to higher bids.

5.2.2 SOLAR PARK: FEASIBILITY STUDY

If the government decides to develop a solar park, it must select a suitable piece of land around the identified substation, for the power plant and the right of way, after considering social and environmental impacts. The solar park should be located as close as possible to the substation and should be sufficient for the total park size envisioned. The project may be auctioned in phases (e.g., for a 300 MW solar park, only 150 MW might be auctioned during the first phase, and the rest 12 months later, in a second phase). A geospatial analysis of the land around the substation can be conducted to support the identification of different pieces of land to assess which is optimal.

Figure 22. An example of geospatial analysis for solar park land identification



As part of the feasibility study, and once the land has been identified, several different analyses need to be conducted:

- A topography and geotechnical analysis to verify that the soil and terrain are suitable for a solar plant.
- An environmental and social impact assessment (ESIA), combined, if needed, with a land acquisition and resettlement plan following international standards such as the Equator Principles and the World Bank Social and Environmental Framework, as well as country-specific environmental and social regulations.
- A site-specific grid interconnection study.
- A solar irradiation analysis using time series data, possibly correlated with ground-based measurements for a refined assessment of the local solar resources.

Other studies (of dust, flood risk, seismic activity, climate change impacts, and water availability) may be needed depending on the location of the site.

Done in accordance with international standards and shared with prequalified bidders during the bidding process, these studies will provide useful data to them and thus help reduce the costs of the tender and lower the risk premium embedded in the proposed tariff.

5.2.3 PERMITS

To reduce the perceived risk associated with acquiring permits in a given country, under a solar park scheme, the government can get key permits for the project even before an IPP is selected.

Depending on how permits are acquired, the government may choose to create a new SPV—that is, a company dedicated to the project and that may be transferred to the auction winner—or transfer permits without such a vehicle. Permits are country specific, and their criticality needs to be assessed based on the risk analysis conducted for the program. Two key permits that should be acquired by the government, if possible, before procurement are the grid interconnection license and the environmental and social permits. Sometimes the project also needs to be officially registered on a list of public-private partnerships.

A list of the permits needed before the operational phase (such as a building permit) and their associated steps, as well as related authorizations and regulations, can be developed and provided to bidders as part of an RFP. A fast track within relevant ministries/agencies could be set up to assist IPPs in obtaining these identified permits.

BIDDING SCHEME: SOLAR + BATTERY STORAGE

In countries where grid flexibility has already been maximized and new solar projects cannot be integrated without affecting the grid, or where the duck curve is prominent, battery storage may be a solution. If utility-owned battery storage is the most advantageous, and where fiscal space is limited, the private sector could finance the battery storage provided to the grid. As very few countries have ancillary service markets, most privately-owned battery storage is combined with a solar project.

In California and Hawaii, in the United States, projects combining solar power and battery storage are becoming the norm. In these cases, local governments prepare detailed technical specifications (maximum ramped up and down, percentage of generation to be dispatched during the evening peak demand, quality of outputs, etc.) and provide these to all bidders so they are able to compare their offers. As battery storage prices continue to fall, combined solar and battery projects may soon become the standar.

5.3 PUBLIC INVESTMENTS

Beyond the solar plant to be financed by private investors, the government must determine ***what additional investments are required for the efficient development of a solar PV program.***

5.3.1 POSSIBLE PUBLIC INVESTMENTS IN SOLAR PARKS

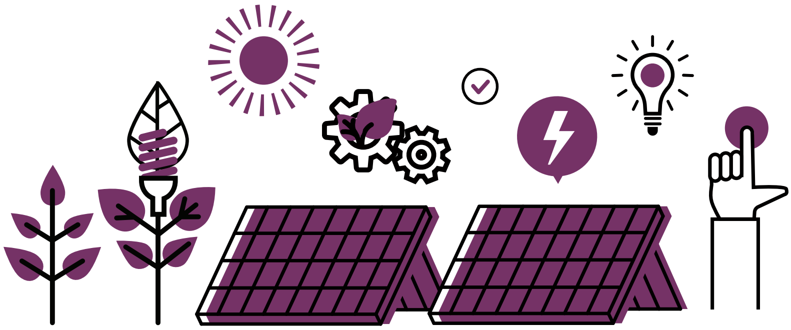
Done in a timely manner and in accordance with best practices, public investments in solar parks provide visibility to the IPP (mitigating development risks) and optimize costs (as costs can be pooled, building on synergies). Based on the government decision whether to have one or many IPPs in a given solar park, the public party may optimize its investments differently.

Public sector commitments to set up strategic infrastructure, such as the transmission line, reduce the IPP's risks but increase the risks to the government if these commitments are not fulfilled. If the government decides, for instance, to build the transmission line, it needs to be sure that the line will be ready before the solar plant reaches its testing phase. Otherwise, the public off-taker will have to pay tariffs to the IPP for electricity that cannot be delivered until the situation is remedied.

Table 5. Elements of solar parks for public investment consideration

ELEMENTS	OPTIMUM PART IN CHARGE
Solar park land, including identification of rights of way and ownership	Public party procuring the solar project—usually the state utility.
Fencing	Best if done by the public party to ensure that new settlements are not built after purchase and during procurement.
Land technical preparation	If the site is complex and if there is more than one IPP in the same park, it is best if the public party prepares the land, especially with regard to the earthworks.
Connection line from plant to substation	If there is more than one IPP in the same park, this would be best done by the public party. Otherwise, a secured right of way would be enough.
Water supply and drains	To be done by the public party if water supply and flooding pose risks and if several IPPs share the park.
Weather station	May be handled by the public party to optimize costs.
Fire station	May be handled by the public party to optimize costs.
Main road	May be handled by the public party to optimize costs.
Street lighting	May be handled by the public party to optimize costs.
Internal access roads	May be handled by the public party to optimize costs

Source: Adapted from Bridge to India (2017).



In the case of solar parks, the government usually retains ownership of the land, leasing it to the IPP through a bankable lease contract. Such an agreement should allow the IPP to own the solar plant erected on the land during the period of the PPA. A yearly solar park fee can be paid by the IPP to the government for leasing the land and other costs incurred, such as the transmission line and fencing. A community fund may also be integrated into this fee to support local development (e.g., in particular to foster the involvement of women and youth in local businesses benefiting from the new solar power).

5.3.2 GRID STRENGTHENING

In parallel with the implementation of the solar deployment scheme, the public authorities should invest in the upgrades of the grid infrastructure that was planned under its least-cost transmission plan to support the integration of VRE and ensure a better quality of electricity service. These upgrades might include battery storage if the level of VRE penetration is already reaching the limits imposed by existing infrastructure.

INNOVATIVE FINANCING

The government (if it finances solar park infrastructure) or the private IPP financing the plant may choose to seek types of funding such as green financing (e.g., certified green bonds), concessional/climate financing, "responsible financing" (from socially responsible investors), and top-up financing, such as the sale of certificates associated with the project or related activities.

The certificates might assign a value to the gas emissions avoided (as with carbon certificates) or attest to other attributes of renewable electricity production from the point of generation to the point of consumption (as with International Renewable Energy Certificates).

5.4 PROCUREMENT / SELECTION OF IPPs

Once the government has completed its analysis and decided what investments to make in a given scheme, the next question is ***how to select private investors****.*

To select private investors to finance, build, and operate a power plant for 25 years, well-organized procurement and selection processes are needed.

The main areas of expertise required during the selection process are as follows:

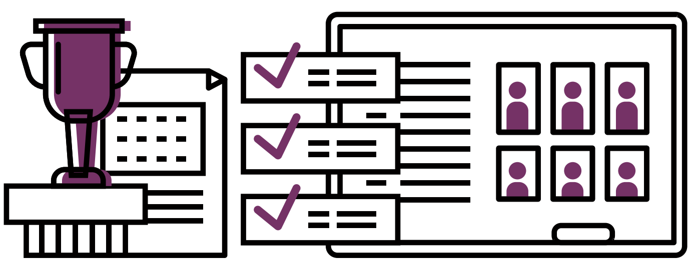
- legal and regulatory
- technical and safeguards
- financial considerations
- procurement.

Usually the government will require support from transaction advisors for assistance in this respect. There are consulting firms that can support the government, or development finance institutions, such as the International Finance Corporation under its Scaling Solar Program.

The main parameters to consider when developing a robust procurement are

- **pre-bidding market sounding**
- **clear bidding mechanisms** (encompassing a strong bidding process, clear qualification and winner selection criteria), and comprehensive and bankable tender documentation
- **an agreed-upon procurement framework** (that would integrate, as the case may be, a ceiling tariff, competitive bidding capacity limits, and tariff indexation)
- **contractual arrangements and supporting mechanisms** (encompassing the final risk allocation matrix, the different contracts reflecting the final risk allocation and the associated bonds, letters of credit and guarantees, as the case may be).

Standardized contracts for solar projects have been launched by IRENA and the Terrawatt Initiative under the Open Solar Contracts Initiative to streamline project development and finance processes for small and medium-sized, grid-connected solar PV projects. The contracts are currently available for review.[5]



[5] *For more information: https://opensolarcontracts.org.*

5.4.1 PRE-BIDDING: MARKET SOUNDING

Using the overall program bidding framework and the high-level market sounding conducted when designing the program's key features as a starting point, the government can consider conducting a call for expressions of interest or a detailed market sounding to consider the details of the bidding mechanisms, procurement framework, and contractual arrangements. A thorough sounding allows the government to gauge the market's appetite, to probe its risk-allocation mechanisms, and to collect useful insights that may be considered when setting the pre-qualification criteria.

Figure 23. Key steps in a market sounding

MAIN OBJECTIVES	ACTIONS TAKEN
Inform the market about the program	▶ Communication about the program to the principal market players and sounding of their interest
Better definition of the program features	▶ Gathering the views of the market on the preliminary structuring and the high level allocation of risks ▶ Better understanding of market practices ▶ Evaluation of the players expectations and constraints
Preparation of the prequalification phase	▶ Assessment of the financial strength and technical capabilities of the players=> RfQ criteria sizesd to ensure broad competition while attracting top players
Preparation of the request for proposals phase	▶ Preparation of procurement rules and contractual arrangements

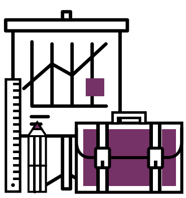
5.4.2 BIDDING MECHANISMS

The bidding mechanisms provide the structure of the bidding process, qualification criteria, winner selection procedure, and tender documentation.

A. BIDDING PROCESS

PREQUALIFICATION

A prequalification phase is usually recommended to limit the number of bidders and to facilitate the management of the tendering process. In general, preselecting 8 to 12 bidders ensures both a good level of competition and easy management. Prequalification criteria have to be carefully chosen, so as to preselect bidders with sufficient experience and financial capabilities. A request for qualifications is made available to all parties without restrictions.



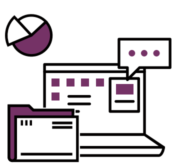
TECHNICAL AND FINANCIAL PROPOSALS AND REVERSE AUCTION

Typically, the government requests from qualified IPPs, at the RFP stage, two proposals: one technical, the other financial. The technical evaluation uses a pass/fail approach to ascertain technical compliance. The lowest bids from technically compliant IPPs are then considered. The lowest bid can be determined by using the lowest price proposed, or it can be set under a reverse auction. Iterative price discovery is usually not recommended in countries where competitive bidding is new, so as to avoid unrealistic expectations of competition and to ensure that the auction does not fail because of financially uninformed bidders.

During the process, governments can share the draft contractual documents for comment and approval before IPPs submit their proposals. Advance sharing avoids long negotiations after IPP selection.

BONDS

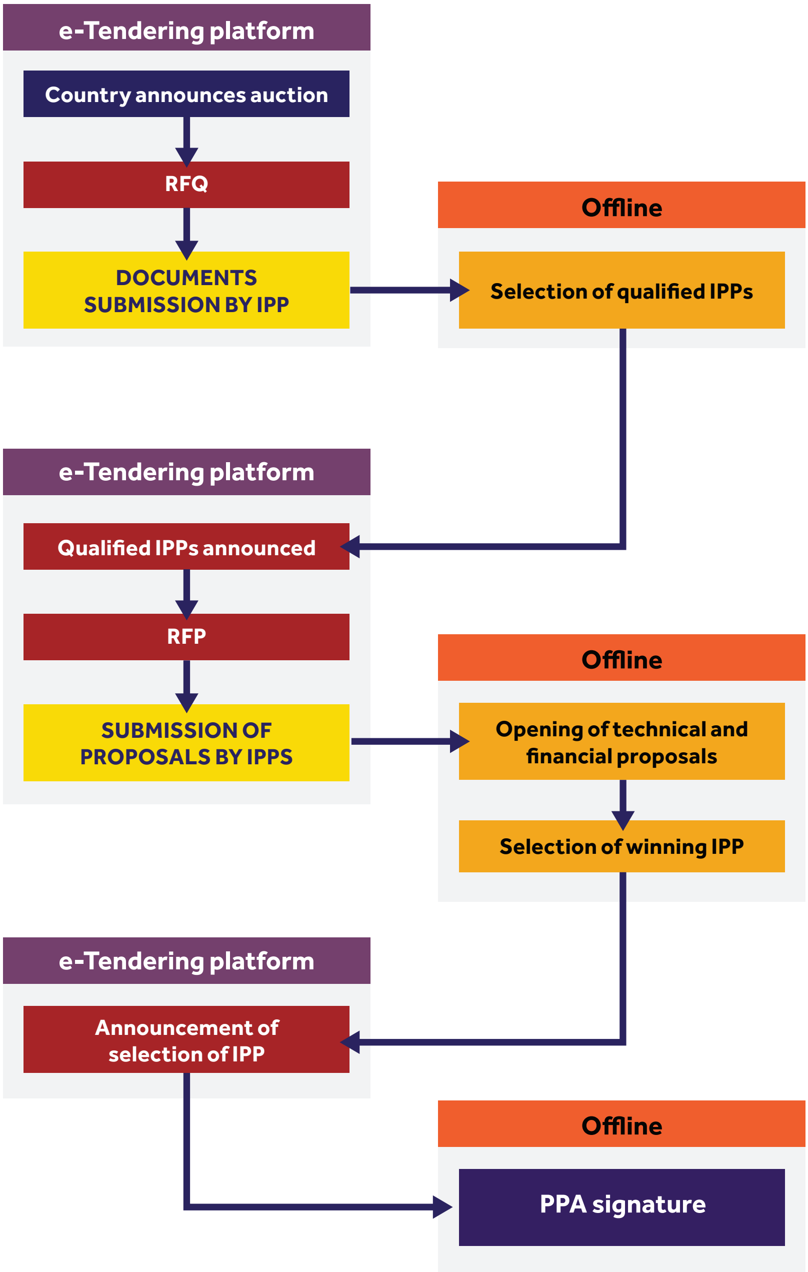
Bid bonds enable procuring authorities to eliminate frivolous or low-quality offers and bidders from the selection process and ensure that the project will be completed. All bidders may be requested to provide an adequately sized bid bond upon submitting their proposal. Release of the bid bond may occur upon signing the project documents, upon submission of the project development guarantee, or upon rejection of the proposal.



E-TENDERING PLATFORM

The use of an e-tendering platform is recommended to ensure transparency and efficiency. Communication, document sharing, and submissions would be conducted on the platform (*Figure 24*), reducing the risks of complications during submission and increasing security while sharing documents.

Figure 24. Key elements of the bidding process using an e-tendering platform

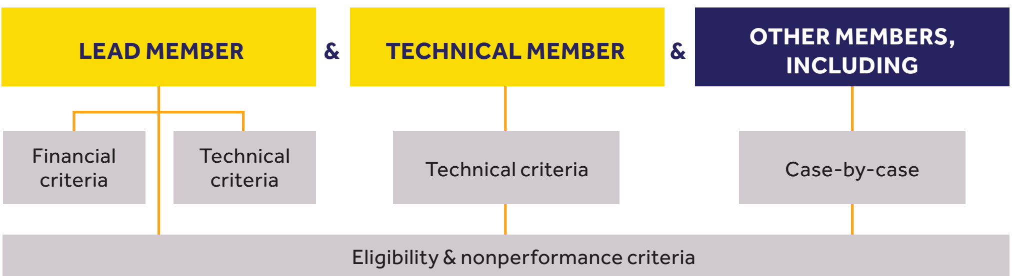


B. QUALIFICATION CRITERIA

Qualification criteria involve a combination of bidders' technical and financial capabilities measuring their experience, readiness, financial closure experience, net worth, etc. Criteria may vary based on the type of bidding model (namely, substation-based or solar park) and, importantly, on the level of competition in the market and its maturity. Preselecting the right stakeholders is key, as the overall process is based on this critical stage. The government will have to deal with the winning consortium over the long term, relying on the selected IPP for designing, financing, building, operating, and maintaining the solar plant during the lifetime of the PPA.

During the pre-qualification stage, the technical and financial qualification criteria need to be clearly stated in the request for qualifications to avoid uncertainties that may lead to potential complaints. Similarly, technical and financial qualifications need to be clearly stated in the RFP to ensure transparency and reduce potential complaints over non-selection. The composition of consortia has to be clearly specified as well, with the role of each party being explicitly defined. The participation of a local member may be strongly encouraged or required under a broader strategy to increase the participation of local players in the solar program.

Figure 25. Qualification criteria applicable to consortium members



C. WINNER SELECTION

The winner of the bid may be selected based:

- solely on the criteria of price, with the project awarded to the bidder with the lowest tariff
- through a weighted average criteria of the tariff discovered from bidding and other objectives such as economic development or local content requirements, that is, when they serve more than one policy objective

Selection of bidders through multiple criteria may lead to a higher tariff discovery in bids, affecting the financials of the procuring authority in case of incentives favoring non-competitive measures (e.g., if local content is not based on a competitive value chain).

D. TENDER DOCUMENTS

RFP documents typically include:

- **instructions to bidders and forms**
- a **complete set of contractual agreements**, which mainly consist of the implementation agreement, PPA, connection agreement and solar park infrastructure contract (if any)
- all **technical specifications** for the construction and operation of the plant that the IPP shall apply.

This will ensure that the risk allocation is clearly reflected in the documents as per the government's decisions and will save bidders time and money. It will also limit the negotiation timeline on contracts post award, as bidders would have had to accept the contracts when submitting their bids.

Additionally, the government can add the following documents to the RFP:

- **all technical documents** such as those needed for the solar park (feasibility study, land ownership documents, etc.) and for the substation-based bidding (substation list)
- a **list of permits**
- a **fiscal appendix** detailing the fiscal and custom framework and applicable regime for IPPs
- a **local market assessment** *(see Phase 2: Strategy)* as the case may be
- a **term sheet of guarantees and staple financing** proposed by development finance institutions in coordination with the government

Such a package will facilitate financing, raise bidders' awareness of the risk mitigation options available, and reduce the risk premium up front (which will be reflected in the proposed tariff). Where a solar park is to be combined with prepackaged guarantees/ financing, bidders can mainly focus on the technical aspects of their bids, offering the best value for money. This in turn will benefit the government as it supports the efficiency of transactions.

Any parameter affecting the tariff should be clearly stated in the RFP to avoid negotiations after the submission of bids. A **list of assumptions** (including tax treatment) may be shared with bidders to be taken into consideration in their financial modelling and avoid any misinterpretation. The **financial model** used for the financial selection could also be shared with all bidders.

5.4.3 PROCUREMENT FRAMEWORK

Three key aspects of the procurement framework need to be agreed upon before launching the bid:

A. A CEILING TARIFF

Some countries share this information to ensure that the PPA price of the project is affordable for the country, but it may be interpreted as a price signal to the market, encouraging bidders to propose tariffs in the ceiling range and not be as competitive as it could have been. On the other side, if the ceiling tariff is too low the auction may be under-subscribed.

B. COMPETITIVE BIDDING CAPACITY LIMITS

This is the maximum capacity per IPP and is critical in developing a solar park framework to diversify the exposure to one player. When setting the maximum capacity per IPP, there is a trade-off between (i) achieving the economies of scale needed to build a bigger plant, which would allow a lower-cost PPA versus (ii) mitigating the public sector's risk of the project not being built by the selected IPP.

C. TARIFF INDEXATION

Tariff indexation, as per the program-level bidding framework presented in Phase 2: Strategy.

5.4.4 CONTRACTUAL ARRANGEMENTS AND SUPPORTING MECHANISMS

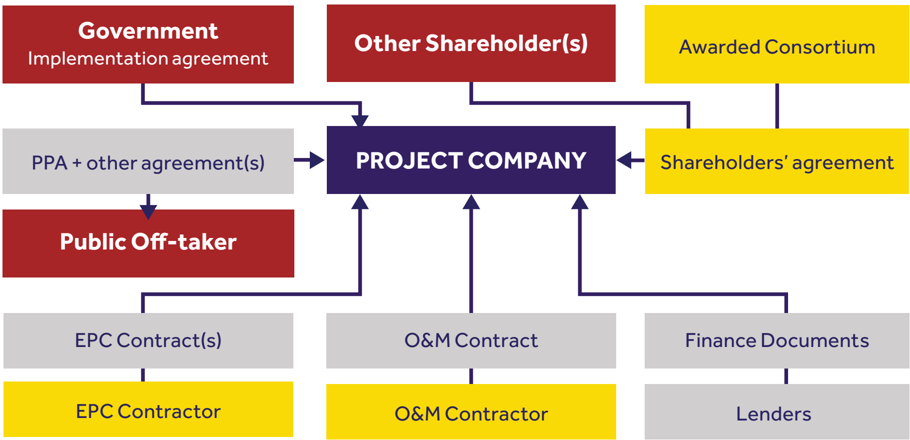
A. FINAL RISK ALLOCATION MATRIX

- The contractual arrangements set forth in the RFP need to address all key risks, with clear risk-allocation mechanisms presented in the contract documents. Before drafting these documents, a detailed risk-allocation matrix outlining these mechanisms should be finalized, taking into account key takeaways from the completed studies and from the high-level risk allocation set during the program design phase. It should cover all the key risks identified, defining appropriate mitigation approaches and pricing residual risks whenever possible.
- The key inputs to the contractual arrangements are the PPA tenure, payment security mechanisms, provision for changes in law, and termination clauses. Off-taker arrangements may involve a take-or-pay agreement with a stated number of hours per year for downtime for grid maintenance. Stringent insurance requirements should be included in the bidding documents to enable adequate coverage of force majeure events under insurance and to ensure that insurance premiums are factored into the bid.

B. CONTRACTUAL ARRANGEMENTS

- Defining the contractual arrangements up front, and in line with chosen risk-allocation mechanisms, is critical for the success of the bidding process. A typical contractual structure for IPP solar projects is represented in *Figure 26*.

Figure 26. The typical contractual structure of an IPP-owned solar project



- Once selected, the awarded consortium (representing one or more IPPs) under one SPV will sign the PPA with the off-taker, setting the terms and conditions for the provision of electricity over the PPA tenure. It will also sign a connection agreement (if not covered under the permits already granted to the project and secured by the government) regarding the conditions required to connect the plant to the applicable substation and to inject the electricity produced in the grid. Other agreements may also be needed such as (i) a land lease agreement that allows the plant's construction on bankable conditions aligned with project finance requirements, and (ii) a solar park agreement regarding various elements of the park's infrastructure/services.

- An implementation agreement reflecting the support granted by the government to the project will be signed by the project company with the government. The strength of this critical agreement varies depending on whether it is a simple letter of comfort or a guarantee from the government to pay the amount due to the project company by the public off-taker in case of the off-taker's default. The nature and scope of the support needed has to be assessed in light of various parameters, including the overall risk-allocation framework, the creditworthiness of the off-taker, the market practices in the country and its track record, etc.

C. ASSOCIATED BONDS, LETTERS OF CREDIT, AND GUARANTEES

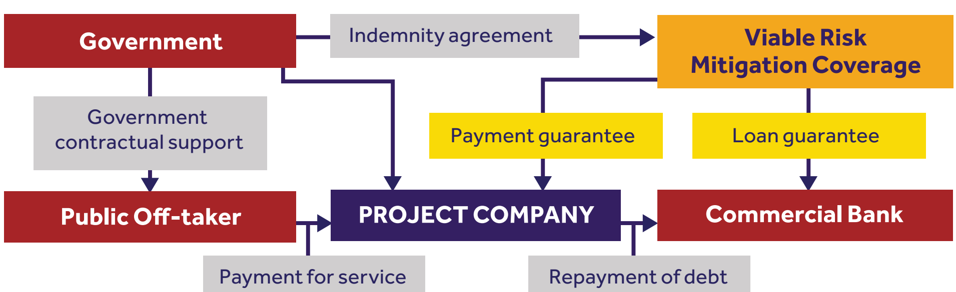
- Bonds and letters of credit (LCs) backing the obligations of the IPP to the off-taker and the off-taker to the IPP throughout the process are critical risk mitigation instruments that incentivize the parties to comply with their obligations. *Figure 27* illustrates the standard bonds and LCs required by the public off-taker to back the SPV's contractual obligations throughout the process (amounts are indicative). These are in addition to the bid bond, which is replaced by the development bond upon the signing of the PPA.

Figure 27. Power purchase agreement bonds

- The **construction bond** will back the obligation of the SPV to build on time and may be drawn to cover liquidated damages owed to the off-taker in the case of a delay (or costs in case of the project's dismantlement, post rejection, as applicable). The **performance bond** will back the obligations of the SPV to perform as per the contractual arrangements and may be drawn on by the off-taker to cover liquidated damages applicable in the event of underperformance.

- From the off-taker to the IPP, an **electricity payment LC** backing the payment obligation of the public off-taker for a rolling six-month period is usually required when there is a perceived liquidity risk of the off-taker. In a context where the public off-taker has weak creditworthiness, the IPP will also need a support mechanism to back the payment obligation of the off-taker in case of the PPA's termination. In such a case, the IPP will have to reimburse the outstanding debt to the lenders for which it will rely on the payment of the termination amount by the off-taker, enhanced by a guarantee as the case may be (*figure 38*).

Figure 28. Illustration of guarantee structure



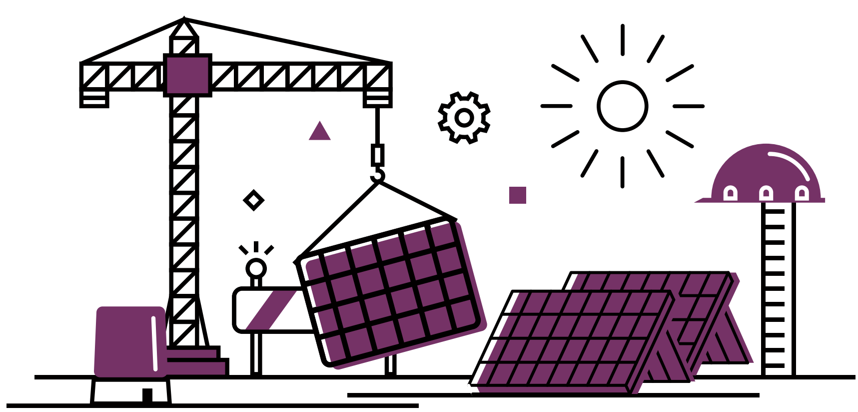
5.5 CONSTRUCTION AND PRODUCTION

After the IPPs are selected, the government needs to answer the following questions: ***Are the IPPs following the agreed timeline and technical requirements? How will assets be transferred at the end of the PPA?***

As part of the PPA, the IPP has been given technical requirements for construction and O&M that the government needs to follow to ensure that the design is aligned with the grid and country requirements. The utility involved will usually check, prior to connection, that technical requirements are being followed.

During production it is key to provide informed production forecasts of 24 hours, 12 hours, and usually 1 hour and a few minutes to support the planning and dispatch teams. The forecasting tools used can be at the site or centralized. Usually countries have both site-specific forecasting provided by the IPP and centralized forecasting for all the variable renewable energy projects on their grids.

At the end of the PPA tenure and if the PPA was under a build, operate, and transfer mode scheme, the project has to be transferred to the government. Concession and/or PPA agreements usually provide for the transfer of the power plant to either the contracting authority or the off-taker. Some specific provisions and mechanisms need to be included in the PPA to ensure that the plant to be transferred meets pre-defined performance criteria. However, a transfer made under the build, operate, and transfer schemes is usually quite complex due to taxes and decommissioning.



6

CONCLUSION

CONCLUSION

At the end of the implementation phase, a country will have a sustainable, affordable pipeline of solar projects financed by the private sector and supported by fair risk allocation. The government can capitalize on its solar program to fight climate change, fulfill its nationally determined contributions, support its energy access agenda, and improve energy security while maximizing its socio-economic impacts.

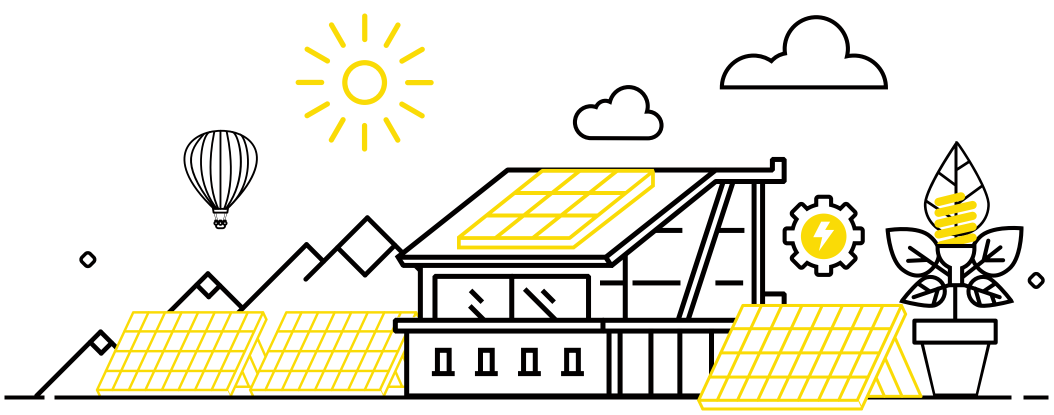
This document presents key steps the government needs to take to attract private investments while ensuring that its own conditions and restrictions are met. *Table 6* presents an example of a risk allocation matrix with associated mitigation instruments.

Table 6. Solar deployment risk allocation matrix with associated mitigation instruments

TOPIC OF CONCERN	RESPONSIBILITY	MITIGATION
		PROCESS RISKS
The project's relevance to country objectives	Government	Least-cost plans defined during the planning phase. Clear technical specifications of the project shared in the bidding process.
Procurement	Government	Clear roles and responsibilities of stakeholders defined during the deployment strategy and supported by appropriate legal and regulatory framework. Secured electronic platform for competitive bidding.
Selecting the right private sector players	Government	Market sounding for useful insights and the design of strong pre-qualification criteria to pre-select players capable of delivering the project on time and as per requirements.
		PROJECT RISKS
		Investment (equity) and financing (debt)
Availability of financing in competitive conditions	IPP	Bankable project with balanced and fair risk-allocation enhanced as the case may be with appropriate support mechanisms (e.g., a loan guarantee, a liquidity facility).
Debt service default	IPP	Roll-in letter of credit to the benefit of the IPP/the bank to mitigate liquidity risk in case the public off-taker delays payment to the IPP. Termination amount set in the PPA to cover at least the outstanding debt amount due by the IPP to the financing bank. Appropriate support mechanisms to back the payment of the termination amount (covered in the implementation agreement with the government and enhanced as the case may be by a guarantee).
Repatriation of distributions	IPP	Adequate legal and regulatory framework in place, backed by the government in the implementation agreement and enhanced as the case may be by an appropriate guarantee.

TOPIC OF CONCERN	RESPONSIBILITY	MITIGATION
Construction		
Environmental and social issues	IPP	Mobilization of land under solar park scheme by the government.
Permitting	IPP	Appropriate legal framework and streamlined process set by the government, further mitigated under the solar park scheme.
Delay in the construction of the plant	IPP	Liquidated damages applicable under the PPA to incentivize the IPP to comply with the contractual timeline. Solar park deployment scheme (this reduces this risk for the IPP, by mitigating the land access risk, but increases the risk for the government if solar park infrastructure is not ready on time).
Rejection of the plant	IPP	Clear testing mechanism for the public off-taker to be able to reject a defaulting plant with appropriate bonding in place to incentivize the IPP to comply with its dismantlement obligations and as the case may be, to indemnify the public party for part of the costs incurred.
Operation and maintenance		
Curtailment	Government	Take or pay provisions mitigating the revenue risk for the IPP triggered by a curtailment (not planned under maintenance). Technical preparation done up front by the government during the planning phase and public investments made for VRE integration (furthered by deployment under a substation or solar park scheme).
Underperformance of the plant	IPP	Liquidated damages applicable under the PPA to incentivize the IPP to comply with the contractual performance. Termination of the PPA for the IPP default in case of underperformance above pre-defined thresholds.
Termination	Government	In case of termination without dismantlement (with the government taking over the operation of the plant): Provisions included in the PPA to require adequate maintenance being done with testing mechanism and appropriate escrow arrangements to incentivize the IPP to comply with its maintenance obligations.

TOPIC OF CONCERN	RESPONSIBILITY	MITIGATION
Cross-cutting risks		
Foreign exchange risk	IPP/ Government	Revenue flows matching financing flows to the extent possible. PPA indexed to USD/EUR (to match the financing currency). Hedging mechanism to mitigate the residual foreign exchange risk.
Change in law	Government	Compensation of the IPP for change in law included in the PPA, backed by the government in the implementation agreement and enhanced as the case may be by an appropriate guarantee.
Force majeure	IPP/Government	Insurance to mitigate natural force majeure. Political force majeure events covered by the public off-taker in the PPA, backed by the government in the implementation agreement, and enhanced as the case may be by an appropriate guarantee.
Early termination of the PPA	IPP	**In case of public off-taker default triggering an early termination of the PPA:** Termination amount to be paid by the public off-taker to the IPP sized to cover at least the outstanding debt amount due by the IPP to the financing bank and the IPP equity. Appropriate support mechanism to back the payment of the termination amount (covered in the implementation agreement with the government and enhanced as the case may be by a guarantee).



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