A Product of

SRMI Sustainable Renewables Risk Mitigation Initiative

A Sure Path to Sustainable Solar, Wind and Geothermal

Renewable Energy Deployment Guidelines

October 2022

This report was researched and prepared by the World Bank with the contributions of its consultants Nodalis, Norton Rose Fulbright, Capsim, and Mannvit in partnership with the Agence Française de Développement (AFD), the International Renewable Energy Agency (IRENA), Sustainable Energy for All (SEforAll), 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, Nadia Taobane, Claire Nicolas and Elin Hallgrimsdottir), Nodalis (Thomas Barbat, Martin Buchsenschutz, Théo Cladière and Laetitia Labaute), Norton Rose Fulbright (Benoit Denis, Amandine Delsaux and Anne Lapierre), Capsim (Cécile Lafforgue and Ronan Besrest), and Mannvit (Claus Ballzus and Kristín Steinunnardóttir) 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, Rebeca de Bakker Doctors, Fernando de Sisternes, Zuzana Dobrotkova, Rida E Zahra Rizvi, Chandrasekar Govindarajalu, Besnik Hyseni, Tarek Keskes, Soeren Krohn, James Knuckles, Jason Lee, Annabelle Libeau, Alexis Madelain, Charles Miller, Suchada Nevis, Dayae Oudghiri, Yi Xu, Yabei Zhang, Joeri de Wit).

Editor: Steven Kennedy
Design: Visual Capitalist (first publication) and Sergio Andres Moreno (second publication)

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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), a multiplication by nine of the wind power generation and a doubling of the geothermal power generation in the developing world by 2025. It represents around 650, 270 and 8 gigawatt (GW) additional solar, onshore wind and geothermal energy production, respectively, for an investment of more than US$450 billion in new solar PV generation, US$320 billion for wind power and US$ 27 billion for geothermal.

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 renewable energy (RE) projects for consideration by the private sector. To develop such bankable pipelines, countries must take a series of key steps to tackle critical risks perceived by the private sector while minimizing risks for the public sector.

In 2018, the World Bank–Energy Sector Management Assistance Program (WB-ESMAP), in partnership with Agence Française de Développement (AFD) and International Solar Alliance (ISA) together with International Renewable Energy Agency (IRENA) and Sustainable Energy for All (SEforAll), developed the Sustainable Renewables Risk Mitigation Initiative (SRMI)[1] to address these challenges. SRMI aims to support countries in implementing sustainable renewable energy (RE) programs that will attract private investments and reduce reliance on public finances.

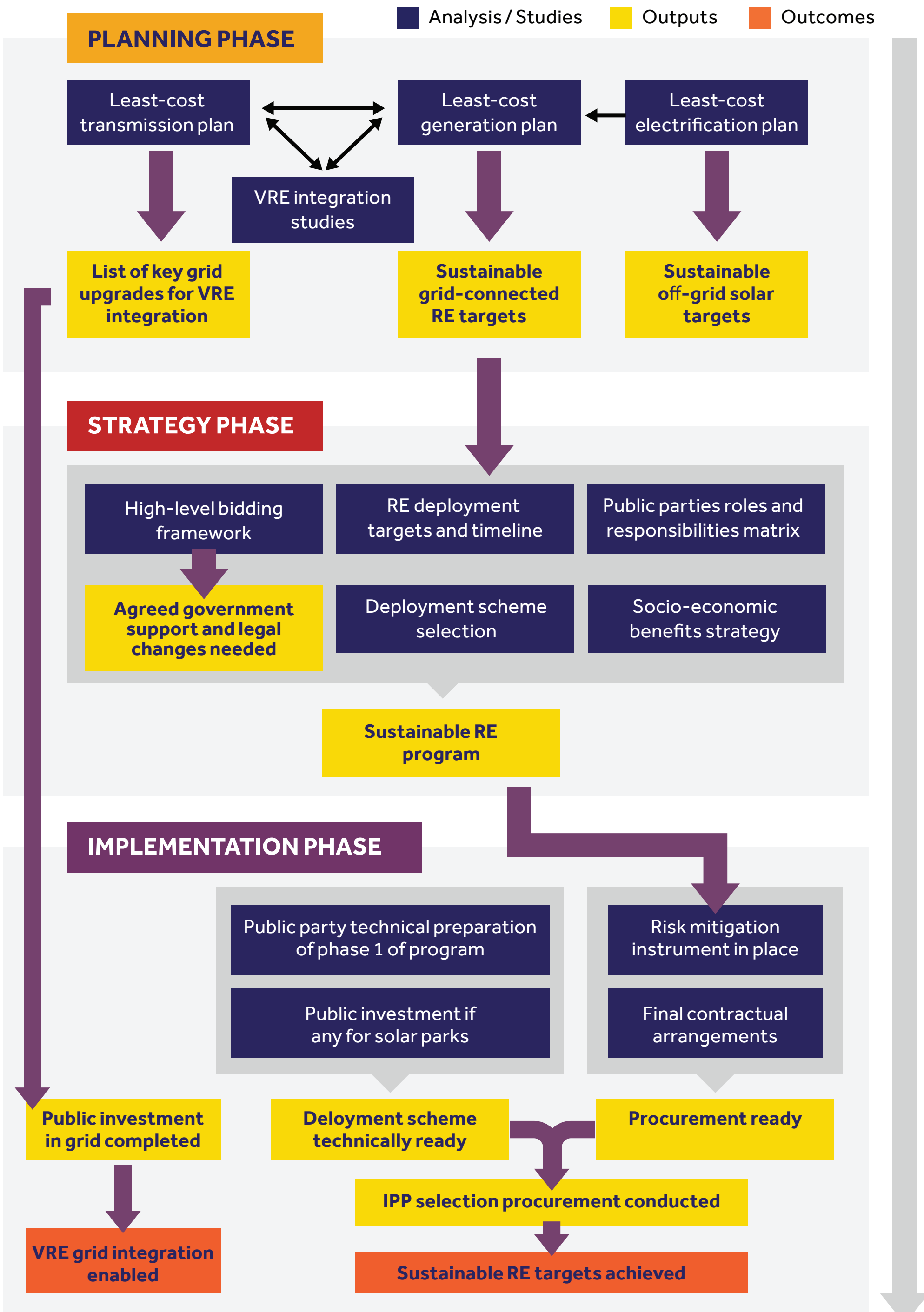
SRMI's unique approach offers development and climate financing for:

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

The present guidelines lay out a three-phase approach for privately financed sustainable RE projects. In the Planning phase, technical plans are made to enable the country to develop informed RE targets. A sustainable RE program is developed during the Strategy phase. In the Implementation phase, action is taken to execute the sustainable national RE program. This integrated approach enables countries to capitalize on the deployment of RE generation to fight climate change and support energy access but also to promote energy security, keep pace with rapidly growing electricity demand, and foster socioeconomic development.

1 *Previously called the Solar Risk Mitigation Initiative*

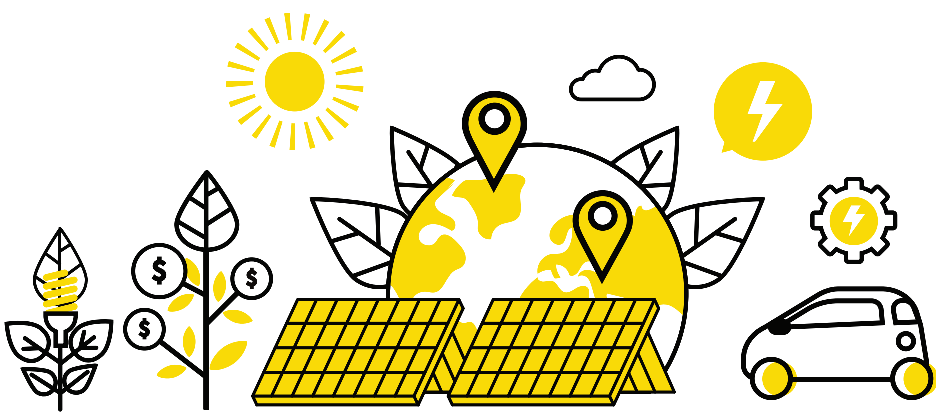
Figure 1. SRMI a three-phase approach



The report details the steps to be taken to develop an effective RE 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 RE program.

To support the first publication and development of SRMI's methodology, a private sector market sounding was conducted for solar PV, along with consultations with governments and development finance institutions (DFIs). In parallel, a pipeline assessment gauged country needs for technical assistance, public investments, and risk mitigation.

The main conclusion of the pipeline assessment is that few countries had completed the preliminary work necessary to mount a sustainable RE program. In Sub-Saharan Africa, for example, where most countries express strong willingness to develop such programs, 85 percent of the countries assessed for the report[2] do not meet the conditions for a sustainable RE program. They lack the fundamental first step: a comprehensive generation plan. In addition, to ensure that RE deployment will not become an issue for the utilities, countries will have to build the infrastructure needed to integrate VRE into their power grids. In Sub-Saharan Africa, three out of four countries in the region have weak grids unable to accommodate a VRE penetration of more than 5–10 percent.



2 A high-level pipeline assessment of the Sub-Saharan Africa region was conducted in 2018 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.

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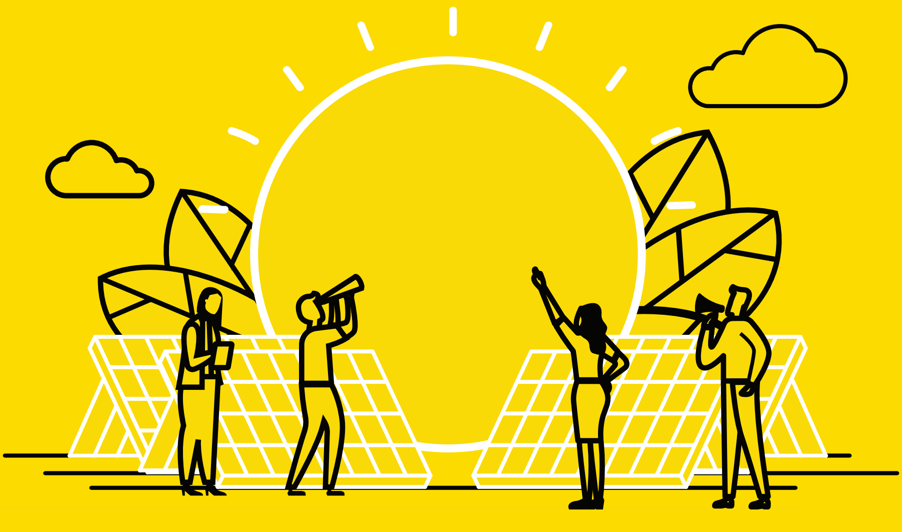
INTRODUCTION



1.1 BACKGROUND AND CONTEXT

To meet the Paris Agreement targets, substantial deployments of solar and wind generation are needed to mitigate climate change, support countries in reaching their energy security objectives, and ensure energy access for all. Based on the International Energy Agency's (IEA) Sustainable Development Scenario, the World Bank estimates that developing countries need to install 1,060 GW of solar and 650 GW of wind, respectively, by 2025. Those targets represent increases of 650 GW and 270 GW of solar PV and wind, respectively, from 2020 installed capacity—to be built within five years with investments of over US$450 billion in solar PV and US$320 billion in wind.

Despite plunging prices in power purchase agreements (PPAs) for solar PV and wind, project implementation has not reached the scale needed to meet the Sustainable Development Goals (SDGs) [3]and the Paris Agreement. Private investments in solar and wind power generation will have to be leveraged in order to support faster deployment and reduce the burden on public fiscal resources.

Yet why are there so few privately owned solar and wind projects in developing countries? How can countries manage significant deployments of private investments in RE—deployments that would both align with national needs and be affordable?

To answer those questions and provide concrete solutions, several institutions are collaborating on the Sustainable Renewables Risk Mitigation Initiative. Initially focused on solar PV deployments (and then called Solar Risk Mitigation Initiative), SRMI is now scaled up to supply RE in general with wind and geothermal while supporting green mini-grids and deploying battery storage. These changes acknowledged the need to adapt to the reality on the ground while meeting the objectives of net zero and universal access.

The present document is the second publication of a set of Sustainable RE Guidelines developed under SRMI, the first one focused only on solar deployment, the second one on solar, wind and geothermal. A third part of the SRMI guidelines is forthcoming on socioeconomic development under the SRMI methodology which takes the perspective of governments and state utilities. It presents key steps to be taken to design and implement a sustainable RE roadmap in which private investment is leveraged through bankable, cost-optimized projects, that allow countries to maximize the socioeconomic benefits triggered by the RE 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).

SUSTAINABLE RENEWABLES RISK MITIGATION INITIATIVE

SRMI is an initiative of the WB-ESMAP, developed first with AFD and ISA and later joined by IRENA and SEforAll. It is supported by a stakeholders group that includes the African Development Bank (AfDB), the European Investment Bank (EIB), the Kreditanstalt für Wiederaufbau (KfW) and the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ). Key financiers are making SRMI's implementation possible with financial support via ESMAP of, in particular, the United Kingdom Foreign, Commonwealth and Development Office (FCDO) and the Norwegian and Canadian governments, and through co-financing investments, in particular the Green Climate Fund (GCF), the Clean Technology Fund (CTF) and the Canada Facility.

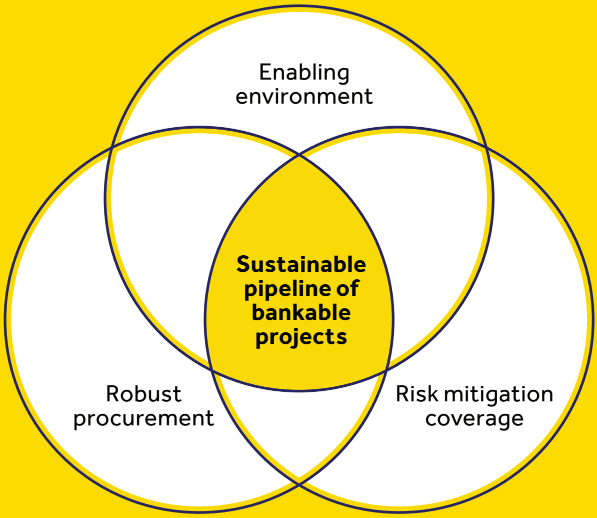
SRMI helps countries develop and implement their grid-connected and off-grid RE targets by mitigating risks inherent to RE deployment and attracting private capital. This approach allows the government to focus on the key aspects of renewable electricity generation, VRE integration and energy access.

SRMI's unique approach offers development and climate financing for:

- technical assistance to help countries develop evidence-based RE targets, implement a sustainable RE program, and maintain robust procurement processes with the support of transaction advisors
- critical public investment to enable integration of VRE, finance 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 RE in developing countries, SRMI emphasizes three components to tackle risks that prevent or limit RE 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.



For more information: https://www.esmap.org/sustainable_renewables_risk_mitigation_initiative

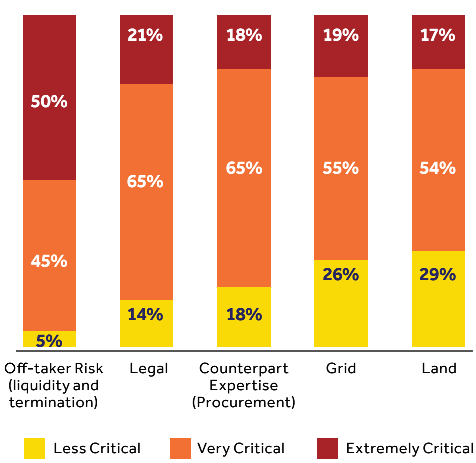
1.2 DEVELOPING A PIPELINE OF BANKABLE AND SUSTAINABLE SOLAR, WIND AND GEOTHERMAL PROJECTS

At the core of SRMI is the limited pipeline of sustainable IPP-owned RE projects. The aim of the document is to inform governments in the development of an attractive yet sustainable program taking into account public and private sectors' 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. Even if this particular survey applied to solar, risks faced by IPP's are the same or similar for wind and geothermal projects.

Although risks are particular to each country and its context, most developing countries present commonalities that can be grouped into two broad categories: (i) risks at the development phase, that is, prior to construction and operation; and (ii) risks arising once the project begins to operate. Both

Figure 2. Key risks identified by private investors



Source: World Bank Market Sounding 2018.

types of risk are integrated into the IPPs and the 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. In addition to these risks, wind and geothermal in particular face resource risks:
  - Uncertainty of the wind resource estimates usually owing to insufficient measurements relative to the complexity of a wind farm site.
  - Geothermal resource risk owing to insufficient resource information (ESMAP 2012 and IGA 2014), needed to evaluate if the geothermal resource has enough potential to recover the development costs.
- **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, currency inconvertibility, and war and civil disturbance. It is essential for geothermal projects to monitor and manage the geothermal resource throughout the lifetime of the project. Best practices in resource management, should be enforced to ensure sustainability.

Countries seeking the benefits of leveraging private investment can begin by conceiving sustainable RE programs at the national level, targeting critical development and operational risks. An efficient 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 reach a more affordable tariff containing the lowest possible risk premium.

1.3 THREE-PHASE APPROACH

The SRMI's Sustainable Renewables guidelines present a methodology to develop a sustainable pipeline of solar, wind and geothermal 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, the methodology lays out steps designed, first, to ensure sustainability for the country through energy security and affordable electricity, and second to reduce the risks perceived by IPPs and lenders.

This document focuses on grid-connected solar PV projects, onshore wind farms and geothermal projects. It assumes the point of view of the government/public sector. As the roles 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 assigned to 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 consider the specific circumstances of the country to devise solutions tailored to the methodology described in this document.

The methodology has three phases.

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

In the **Strategy** phase, the national RE programs are 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 questions, central to the development of a sustainable RE program:

What are the domestic RE resources – and in the case of solar, wind and geothermal: to what extent have the resources been validated through measurements, long term data gathering and surface studies in specific locations?

How much VRE can be integrated into the national grid?

How much new electricity production, particularly solar wind, and geothermal capacity, is needed to meet forecast demand and over what time horizon?

Where is new solar, wind and geothermal electricity generation needed, and where should it be injected into the grid?

What are the critical public investments required for sustainable solar, wind and geothermal deployment?

Who should invest in solar/wind/geothermal 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 socioeconomic benefits of projects be maximized?

What risk mitigation instruments do private investors need to cover residual risks?

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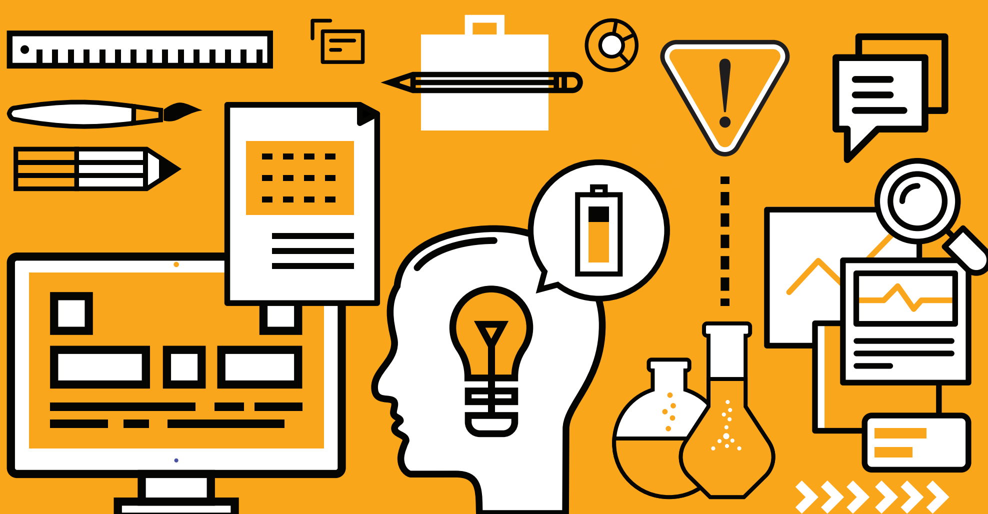
DIAGNOSTIC TOOL



The diagnostic tool presents the key actions a country should consider to deploy solar, and wind and geothermal energy 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 an asterisk in the table below are moderately critical, those marked with a dagger are highly critical. They should be viewed as a whole, with an appreciation of how they interact, as the results of one step can affect the input of another. These interactions are noted in detail in the body of this report as well as presented in the figure below. 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, wind and geothermal 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**	**
Output		**SUSTAINABLE OFF-GRID RE 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)	**
Output		**KEY GRID UPGRADES, including battery storage**	
Input	Domestic VRE resource assessment	The global solar and wind atlases (online tools) may be used to assess country-specific sites.	*
Input	Domestic geothermal resource assessment	Identify geothermal resources by literature review, perform relevant surface studies (e.g. geophysical, geological and geochemical studies) and for selected sites if deemed necessary drill and test exploration wells (ESMAP 2012).	**
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** (economic analysis iterated with transmission and VRE integration analysis)	**
Output		**SUSTAINABLE GRID-CONNECTED RE TARGETS**	

TYPE	ELEMENTS	APPROACH	RANKING
PHASE 2: STRATEGY			
Input from Ph1	Sustainable grid-connected RE targets from Ph 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 Ph1 can be based on a high-level grid analysis.	**
Strategy	**RE deployment targets and timeline**		**
Input	Local development assessment	Assess socioeconomic impact of the program.	*
Input	Industrial development assessment	Assess local industrial and labor capacities.	*
Strategy	**Socioeconomic development strategy**		*
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 RE projects in the given country.	*
Input	Private sector high-level risk analysis	Conduct an 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 RE PROGRAMS, reflecting strategic considerations and key inputs/outputs from Phase 2**		

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 Pha 1.	**
Output		**PUBLIC INVESTMENT IN GRID COMPLETED AND GRID OPERATORS TRAINED**	
Outcome		**VRE INTEGRATION ENABLED**	
Input from Ph2	Selection of deployment scheme	Select deployment scheme and include RE programs deve-loped in Ph 2.	**
Input	Substation availability assessment	Required if substation-based competitive bidding approach is implemented. The assessment integrates load flow analysis and high-level land assessment.	*
Input	Feasibility study, land selec-tion and acquisition, key public investments	Required if a competitive bidding approach is implemented. Study identifies solar, wind and geothermal 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 prequalification 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 arrange-ments and risk mitigation instruments	Investment-ready contractual arrangements and risk mitiga-tion instruments, backed as needed by state or development finance institutions.	**
Output		**IPP selection (tender 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**	

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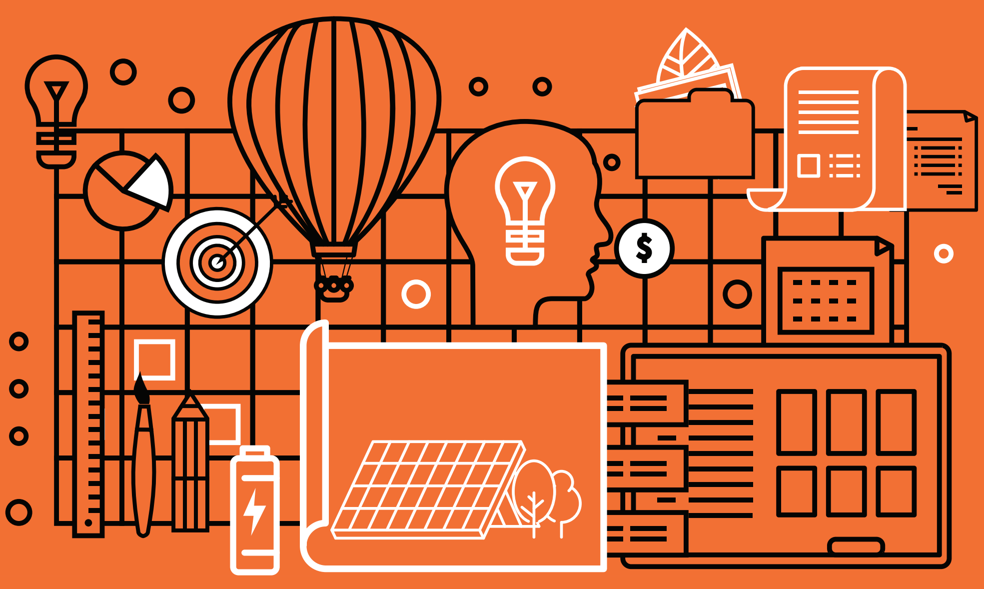
PHASE 1: PLANNING



3.1 OBJECTIVES

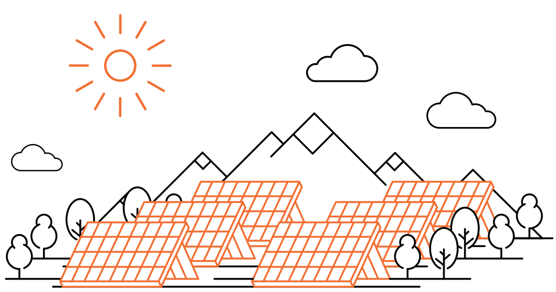
The planning phase is critical. Governments looking to set RE targets for their energy sector must plan carefully to ensure that electricity is affordable, and consumers receive a reliable service. To ensure the sustainable development of solar, wind and geothermal, technical studies must answer a number of questions.

- What is the off-grid and grid-connected demand?
- What generation capacity is needed to meet demand and over what time horizon?
- What are the results of a cost-benefit analysis of these investments?
- What grid and dispatch reinforcements are needed, and when

Special attention must be paid to the upfront geothermal risk profile and it is essential to base the assessment on technical studies to evaluate the resource potential (ESMAP 2012 and IGA 2014). For solar and wind targets, evidence-based technical plans and VRE integration studies need to answer several additional key questions:

- 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?
- 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 more ownership over the process of policy implementation, 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, first, of projects being cancelled, and , second, of grid integration issues leading to power curtailment (since the effects of VRE integration would have been carefully studied and prepared for).

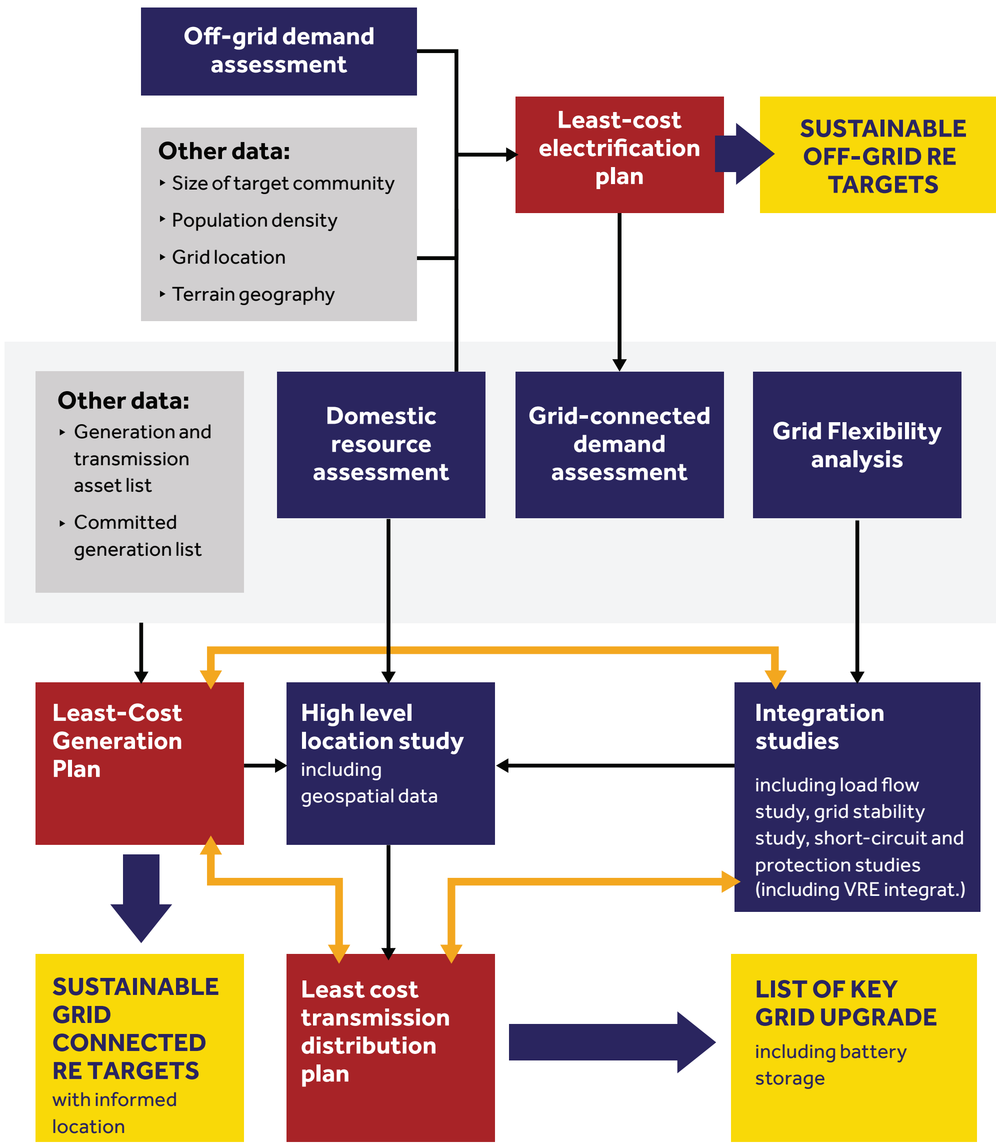


The main outcomes of the planning phase include

- **medium-term off-grid and grid-connected sustainable RE 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, and wind and geothermal 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?** An answer would come from a national-level assessment of grid-connected and off-grid demand.*

3.2.1 OFF-GRID DEMAND

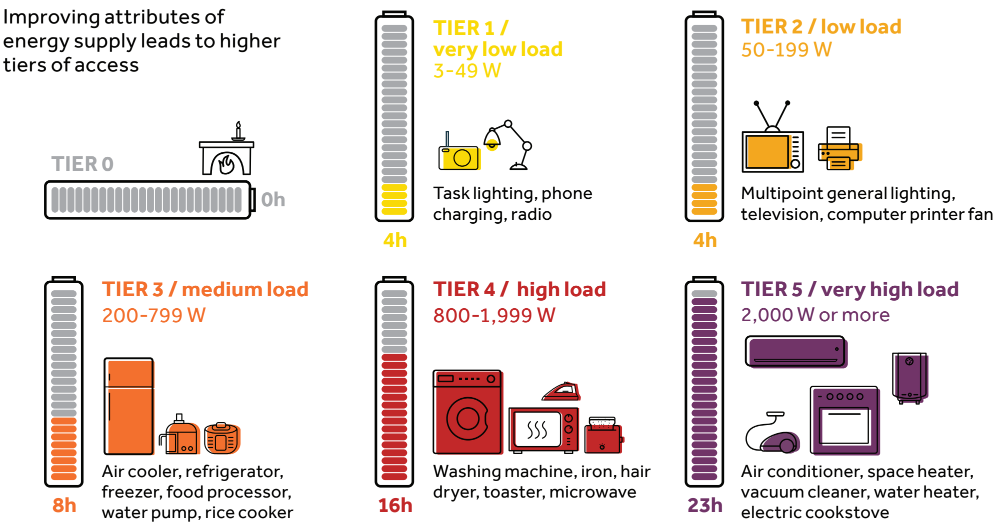
In 2020, around 733 million people had no access to electricity. Of these, 77 percent were in Sub-Saharan Africa. The COVID-19 pandemic has set back efforts to improve access to electricity and clean cooking fuels, increasing the number of people without access to electricity by 2 percent. In the same year, 2.4 billion people worldwide lacked access to clean cooking facilities, and relied on biomass, coal, or kerosene as their primary cooking fuel (TRACKING SDG 7: The Energy Progress Report 2022).

Another basic need is heating and cooling where wood, coal and gas is the primary fuel and might be changed to clean RE sources. Cooling is important as about 1 billion people are at high risk due to lack of access to cooling and a further 2.34 billion lack access to clean and efficient cooling according to SEforALL analysis.

It is important to assess in as much detail as possible the energy 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. 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 energy. 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 the figure below), 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, heating/cooling 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. 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.

PATHWAYS TO ACCELERATE PROGRESS TOWARDS THE ACHIEVEMENT OF SDG 7

SEforALL (Sustainable Energy for All) is an independent international organization. It had previously established itself as a strong advocate for a clean energy transition that leaves no one behind and a powerful convener of stakeholders interested in pursuing Sustainable Development Goal 7 (SDG7). The emphasis now is on driving real, urgent actions outlined under SDG7 to focus on affordable, reliable, sustainable and modern energy development in harmony with the Paris Agreement on Climate Change. For this to happen, the role of SEforALL has expanded beyond advocacy to achieve universal access to electricity and modern cooking energy systems by 2030.

SEforALL collaborates with countries to assist them embrace and deploy renewable energy technologies that will serve people, communities and economies. Enabled by its special relationship with the United Nations, SEforALL engages directly with high-impact countries based on specific country needs and goals. It assists governments in developing plans, policies and regulations conducive to sustainable energy development. It also works with businesses, finance and development partners to identify their requirements for investing in a country's energy sector. It then works with these partners and governments to develop solutions that unlock finance for energy projects.

Source: www.SEforALL.org

3.2.2 GRID-CONNECTED DEMAND

The main parameters of a demand assessment are:

- Socioeconomic 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

In addition, compiling load profiles for different consumer categories, and ascertaining demand patterns across geographical regions and seasons, create more accurate grid-connected demand forecasts, including future daily and seasonal demand in their forecasts. 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 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.

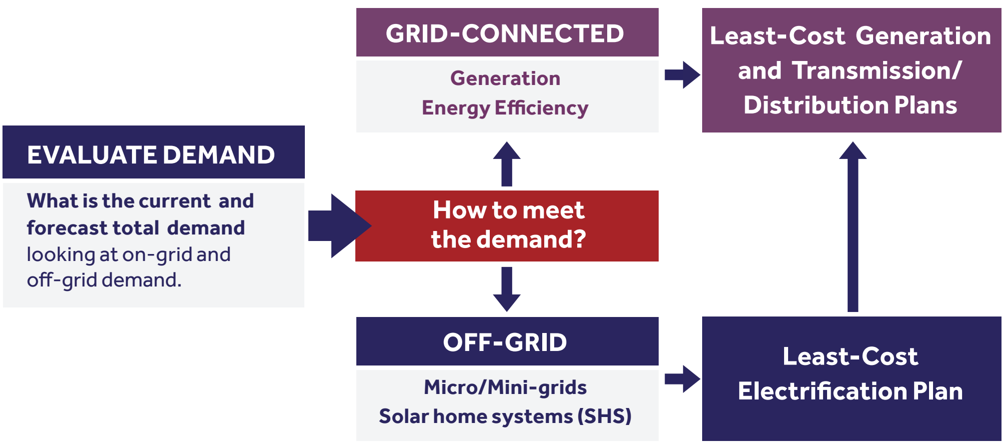
Electric mobility represents a unique opportunity to reap both environmental and economic benefits. The extent to which higher shares of EVs and their demand for charging might affect power grids will depend both on the technologies and charging modes, and on charging patterns. EVs can affect the requirement 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 greater flexibility and to support the integration of higher shares of VRE. 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.

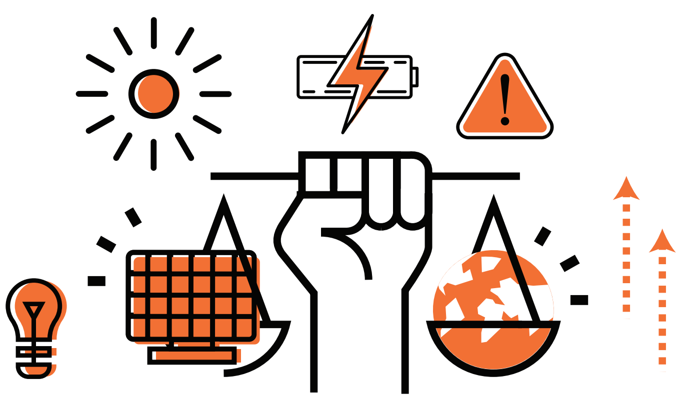
For more information, see http://documents.worldbank.org/curated/en/193791543856434540/pdf/132636-EMADv4-web.pdf

3.3 LINKING DEMAND TO TECHNICAL SOLUTIONS

Once demand has been forecast, 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 expansion plans for off-grid and grid-connected areas.

Figure 5. From demand to plans





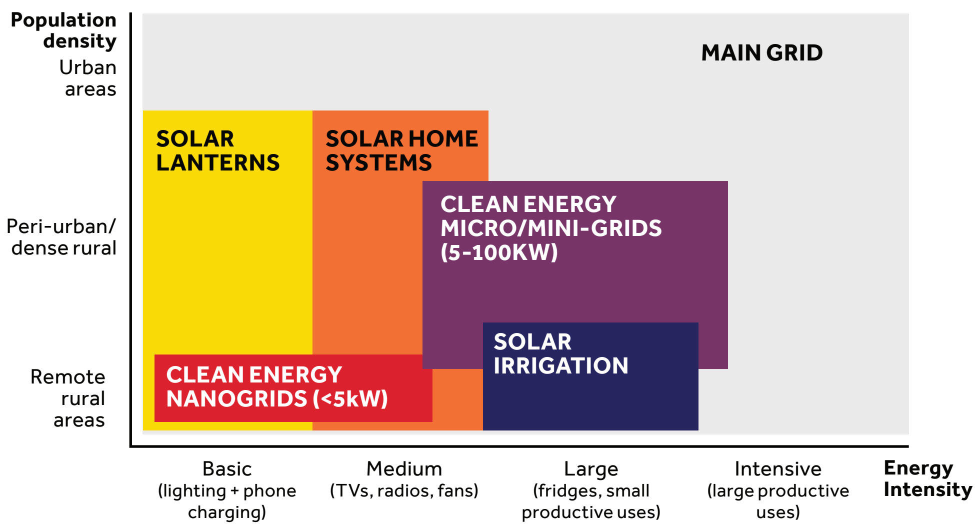
3.3.1 ELECTRIFICATION PLAN FOR OFF-GRID AREAS

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, or (iii) SHSs.

The most appropriate technical solution is selected mainly in keeping with the size of the target community, its population density, distance to the national grid, complexity of terrain, and demand forecasts. Additional considerations include the targeted MTF tier of access, and the expected levels of public and private investment.

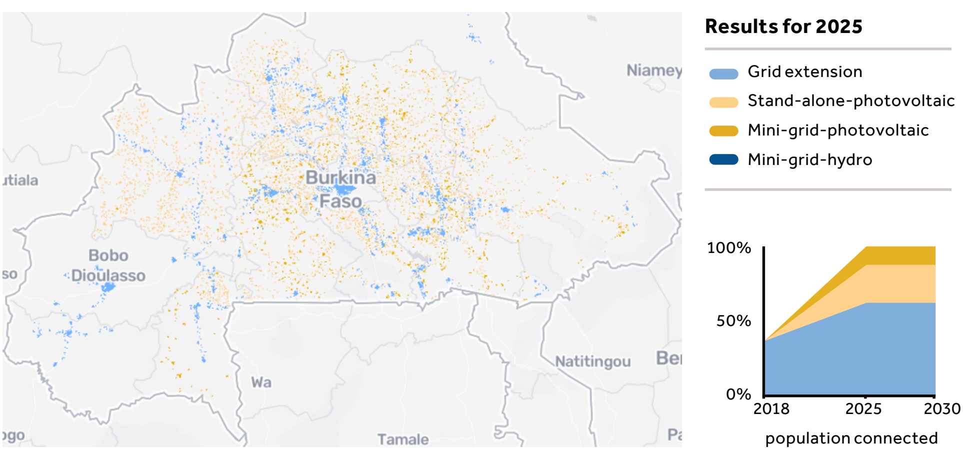
To develop integrated electrification plans, geospatial mapping and least-cost planning tools are key. These can clarify the fastest and most cost-effective way to achieve universal access in a country.

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



Source: Hystra 2017

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

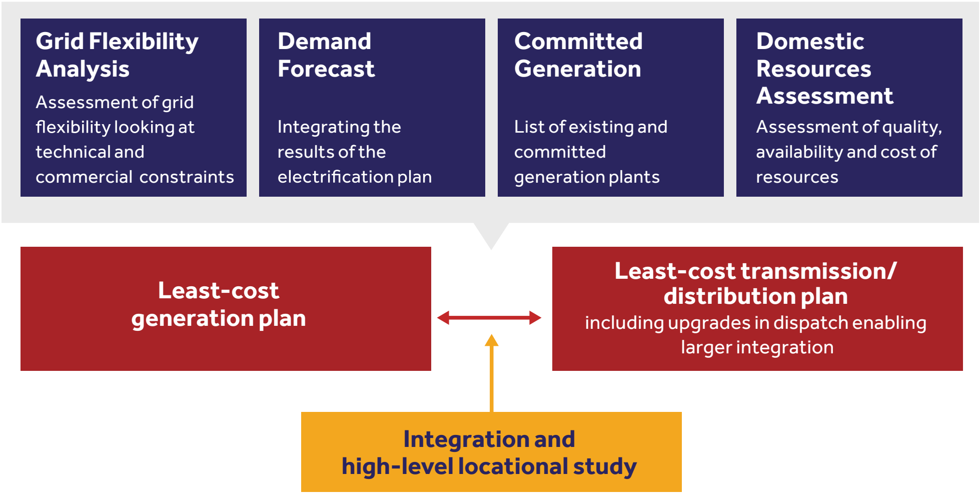
To match grid-connected demand and power supply, two plans need to be prepared by the government and/or the state utility: **a least-cost generation plan** that determines a cost-optimized electricity mix that can meet demand at any time, and **a least-cost transmission plan**. These capacity expansion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

The variation in hourly and monthly VRE resource availability can be analysed to optimise the value of electricity injection to the grid, given the hourly load (i.e., electricity demand) in the electrical grid net of VRE generation and the type of other power plants. It should be noted that geothermal energy differs from the VRE resources as it produces stable electricity all year round and is suitable as base-load power. It has therefore less impact on the infrastructure cost related to grid upgrades than for VRE.

Both plans rely on simulations generated by dedicated software. The least-cost generation plan requires specific planning tools, such as PLEXOS, Balmorel and Opt-GEN to cite a few commercial examples. Note that other non-commercial models also exist, such as WASP, and may 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 RE, sectoral planners must use the right planning tools to ensure sufficient capacity in the relevant utility or ministry.

Some of the core inputs of these two plans are (i) a grid flexibility analysis that will answer the questions a) **where can we connect RE to the grid?** and b) **how much VRE can be integrated into the grid given its current setup?**, (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, wind and geothermal resource capacity. The 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 grid reinforcement and VRE integration. The least-cost generation plan, the least-cost transmission plan, and integration studies are conducted in parallel and affect each other's results in an iterative process.

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

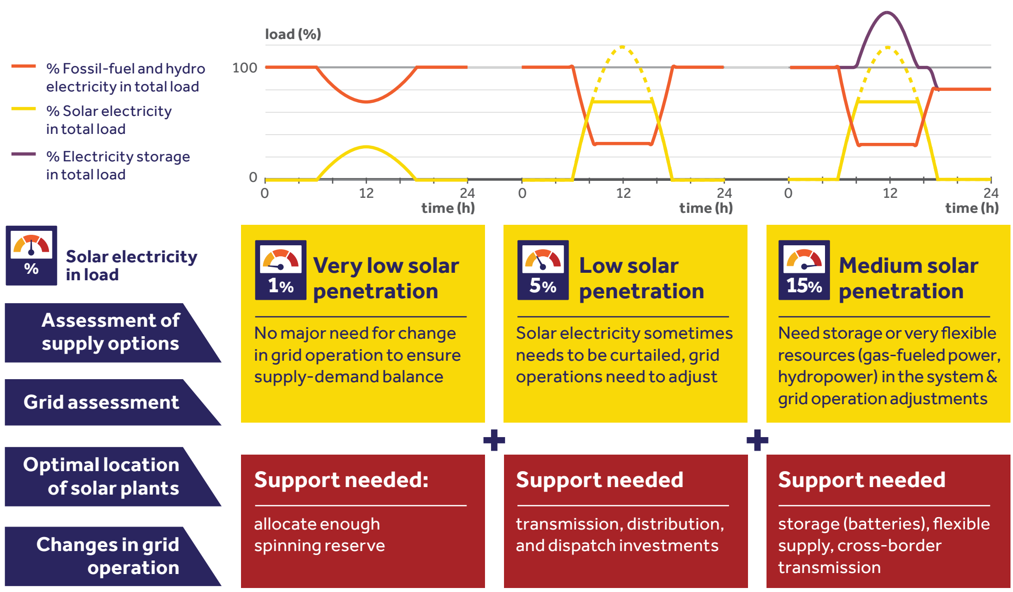


A. GRID FLEXIBILITY ANALYSIS

The main challenges related to the integration of VRE into the grid are: (i) their intermittent nature, which implies variable production, (ii) uncertain availability which is more prominent for wind, although this can be estimated in the short-term based on meteorological forecasting, (iii) that solar can only produce power during the day, and (iv) that solar is not a rotating generator. On the latter, it is important to note that wind to some extent and geothermal can provide electrical inertia to the grid and support fault ride through. Three issues must be considered when considering VRE penetration into a grid: (i) the capacity for the generation mix to meet demand at any hour of the year, considering VRE variability; (ii) the economic optimum in terms of power system operating costs, after considering both cost reductions thanks to VRE and the investment costs required to deploy and integrate VRE; and (iii) the limitations of solar PV and wind capacity to maintain grid stability, due to their variability and their limited capacity to contribute to the balancing of demand and generation (World Bank 2019). Geothermal energy will provide a steady production of electricity and can help stabilize the grid by providing some control over turbine output but does not provide energy storage unless connected with hydrogen production or similar technology able to store power.

The figure below shows an example of 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



Evaluations of dispatch capabilities and the limits of grid integration provide up-to-date views of the grid and are key to determining RE targets.

These analyses estimate the level of RE penetration possible based on technical and commercial constraints, and constitute a first input into the least-cost generation plan. As the least-cost generation and transmission plans are being developed, these VRE integration studies will be repeated in an iterative process.

SIMULATING DISPATCH CAPABILITIES

To evaluate the flexibility of a grid, its technical constraints must be assessed. Does it lack, for example, a Supervisory Control and Data Acquisition (SCADA) system. How about automatic generation control (AGC) or a type of generation that by its nature is 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 must provide 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 software like PSS/E, DigSilent and Matlab. Their results are assessed further as part of the economic analysis conducted for the least-cost expansion plans that look at five specific requirements: (i) new transmission/distribution requirements, particularly if the existing transmission system is not dimensioned to accommodate VRE in a given area (ii) the solar PV and wind capacity that can be accommodated while guaranteeing grid stability and reliability of power, taking into account of storage capacity, reserve needs, and ramping reserve requirements), (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(s) - 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 view of climate change impacts, such as hardening (pole reinforcements, under-grounding) and redundancy (installations of secondary lines) to prevent storm outages.

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 support the transition of power systems into "VRE-friendly" grids that will decrease integration costs over 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 used to better integrate VRE and grid management. Regional integration and cross-border electricity trade could also be effective ways to (i) increase national grid capacity to absorb VRE; (ii) reduce kWh cost by expanding PV or wind projects where solar irradiation or wind resources are the most favorable; and (iii) optimize the mix at the regional level, thus reducing the need for national investments in grid reinforcement.

As costs fall, battery storage is becoming basic to VRE integration. More important, it can support the grid through frequency and voltage control. When associated with VRE plants, it can also mitigate variability and lack of dispatchability—some of the issues seen with VRE power. Battery storage provides power reserves during transient events (like a generator going offline) and smooths production, for example, when there is cloud cover, and displaces production to the evening/night.

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

B. COMMITTED GENERATION

A list of committed generator is a core input to the generation plan, differentiating between power plants that are under construction or nearing financial close and those that are only committed but have not reached financial close. The least-cost generation plan allows the government to assess if committed plants are indeed least cost and necessary; this will support them in reviewing their commitments before reaching the point of no return, that is, when canceling a plant becomes impossible.

FOSSIL FUEL SUBSIDIES IN LEAST-COST GENERATION PLANS

In recent years, governments have been subsidizing fossil fuel production and consumption at a yearly cost to taxpayers of up to US$1 trillion. 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 reach their goals but also unlock major domestic financing to facilitate and accelerate sustainable development. When developing a plan to ensure that least-cost generation is not skewed by subsidies of fossil fuels (should they exist), it is critical for planners 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

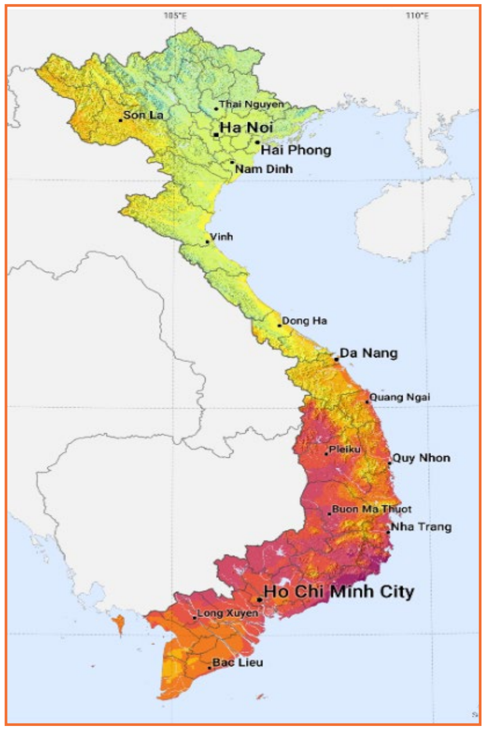
D. DOMESTIC RESOURCE CAPACITY

RE resource levels are location specific. If the resource is highly specific to certain regions or zones, which is always the case for wind and geothermal energy, 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 ESMAP website. Data for all RE resources are available from IRENA.[4]

Geospatial data can be combined with on-site meteorological data to obtain greater accuracy, which in turn will help solar projects be considered bankable by lenders. For wind projects to be considered bankable, on-site measurements taken over at least 12 months are essential. For geothermal, a demonstration of the resource is essential through studies and drilling to reach a bankable geothermal project. IRENA offers an online platform providing tools and guidance to assist in the development of bankable renewable energy projects[5] and ESMAP has published guidelines on preparing a bankable feasibility report for geothermal (ESMAP, 2021).

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

Figure 10. Example: a solar resource map of Vietnam



CONCENTRATED SOLAR POWER: DISPATCHABLE RENEWABLE ENERGY

CSP generates solar power by using mirrors or lenses to concentrate sunlight, which is then converted into heat used to produce electricity through a steam turbine. Thermal storage, means that 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 plummeted, making it competitive with other dispatchable plants in regions with good direct normal irradiation, including with coal-based plants.

CSP prices could be further optimized by combining CSP with storage to PV, reducing costs while maintaining dispatchability during hours after sunset. 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 (metal 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/), data on solar energy are available in the Global Solar Atlas (https://globalsolaratlas.info/) and data on all RE sources are available from https://www.irena.org/.*

5 *https://www.irena.org/navigator*

3.4 PLANNING FOR THE BETTER INTEGRATION OF FUTURE RE PROJECTS

Once preliminary RE targets have been decided in accordance with the least-cost generation plan's results, it is important to ***identify the optimal injection points in the grid and to determine what power plants can to do to support the grid***.

3.4.1 HIGH-LEVEL LOCATIONAL STUDY

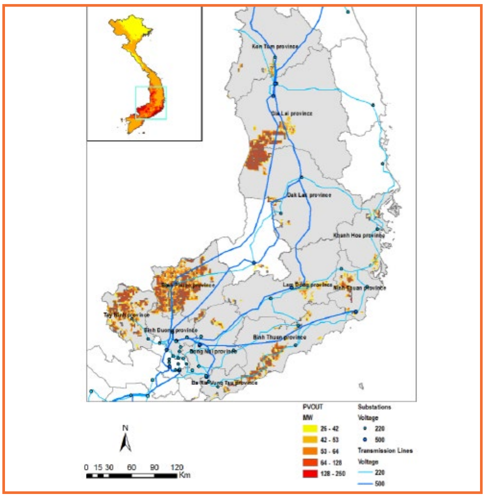
The domestic resource assessment combined with the results of the grid study and a land availability study, if needed, will clarify the optimal points of RE injection into the grid to minimize grid reinforcement costs. The resulting high-level locational study allows multicriteria analysis of renewable energy resources (e.g., solar irradiation for solar generation, wind speed distributions for wind power, resource estimates for geothermal fields), 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/) for solar and wind enables countries to perform this analysis using available geospatial data. IRENA has developed a data base for all RE, https://globalatlas.irena.org. For geothermal, several databases exists mostly on a coutnry or regional level.

Co-location of two or more RE sources (hybrid operation) can be considered as part of the high-level locational study. This combination has many advantages, such as maximizing the plants' infrastructure and grid connection, minimizing the effects of seasonal variations in power production, supporting daytime peak load, and reserving more hydro, geothermal or wind power for the evening peak.

The hourly and occasionally seasonal variability of wind power often varies by location within the country, for example, between coastal and inland areas. In some countries, it may be possible to find sites that are load-following (i.e., correlated with electricity demand) or complementary to solar power when the wind is primarily a night resource. This means that the value of electricity to the grid may be higher when sourced from such areas, even

Figure 11. Example of a high-level locational study



Source: MapRE for Vietnam, World Bank.

in cases where the kWh generating cost may be higher. The Global Wind Atlas shows the hourly, monthly and annual variability of wind speeds for any location. Additional detail can be obtained by purchasing commercially available time series for historical wind speeds for potential wind farm sites.

The geothermal electrical generation is continuous and stable throughout the year, which can provide the country with baseload capacity and grid support.

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.

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 frequency variations 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.

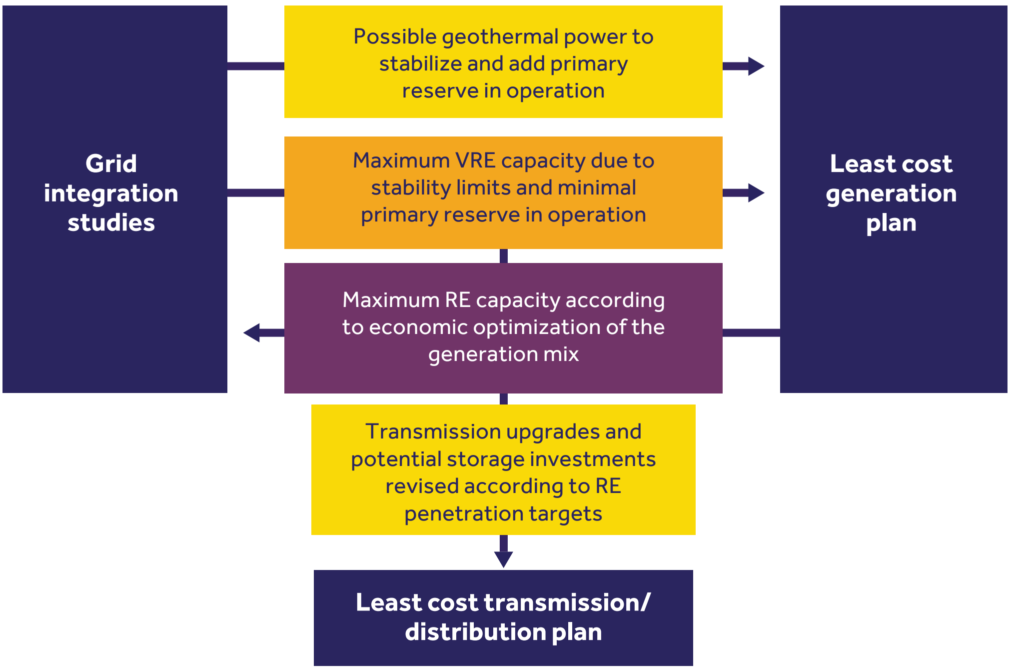
It is important to update the national grid code with international best practice for interconnecting solar, wind and geothermal sources, to ensure that the grid management will be as easy and cheap as possible.

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

3.5 SUSTAINABLE RE: ARRIVING AT EVIDENCE-BASED TARGETS

In conclusion, optimized RE capacity is determined through an iterative process involving a least-cost generation plan, 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 integration and high-level locational studies mitigates much of the risk of curtailment.

At the end of the planning stage, governments will have informed RE targets showing where best to locate projects and a list of key investments needed to improve their grid integration capacity.

4

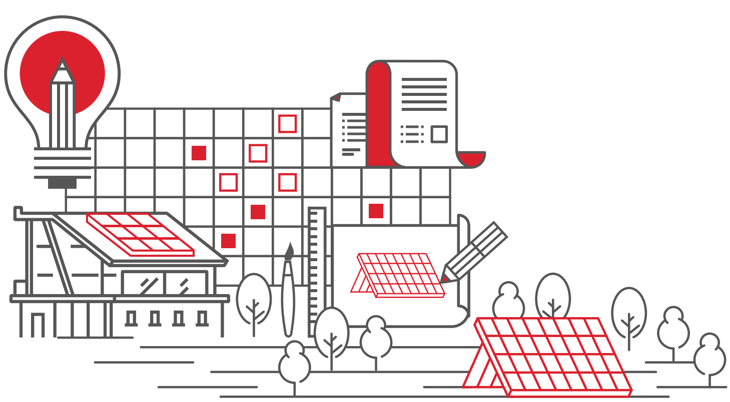
PHASE 2: SETTING A STRATEGY

4.1 OBJECTIVES

Once the government knows what quantity of RE can be injected into the grid, has set solar, wind and geothermal targets and developed the generation and transmission/distribution plans accordingly, the next set of questions is:

- How are solar, wind and geothermal targets to be implemented?
- If the government aims to mobilize private investments in generation, how will IPPs be selected and under what high-level risk allocation?
- What are the roles and responsibilities of public stakeholders?
- Does the current legal and regulatory framework enable an efficient selection of IPPs?
- How can the socioeconomic benefits of solar, wind and geothermal deployment be maximized?

To answer these questions, the government can develop a RE deployment strategy outlining how high-level risks are to be allocated across stakeholders, detailing their roles and responsibilities, and setting a timeline for deployment.

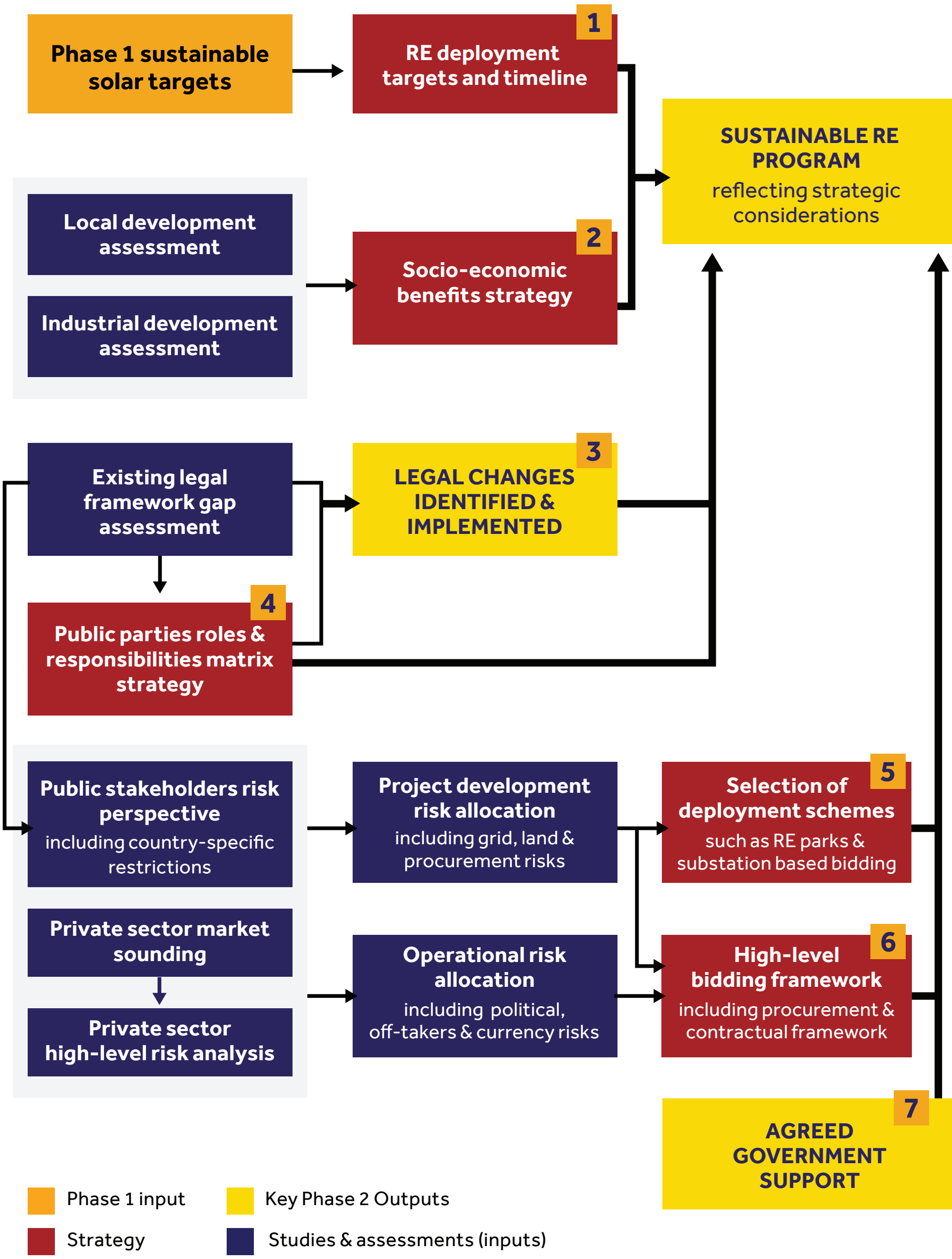


It could also include plans for mitigating risk. The government may choose to support IPPs through sovereign guarantees, foreign exchange authorizations, tax exemptions. Specifically for geothermal, the government can consider a support mechanism to mitigate early stage resource risk and encourage step wise approach to the utliziation of the resource. 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 to IPPs. Clarifying these points before an IPP is selected and a PPA signed can speed up the IPP selection process, reduce chances of procurement failure, and provide a long-term vision for deploying RE 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, wind and geothermal projects.

Figure 13. Designing a solar, wind and geothermal deployment strategy



4.2 AN ENABLING LEGAL FRAMEWORK

If a government decides to leverage private capital to finance its RE targets, two key questions need to be considered: ***(i) who will be responsible for what elements of the implementation process, and (ii) does the legal framework enable private generation in the energy market through a competitive selection process?*** In countries that lack a legal framework for IPPs and competitive bidding, this step must be prioritized. Even in countries with such a framework, it is important to assess potential legal restrictions.

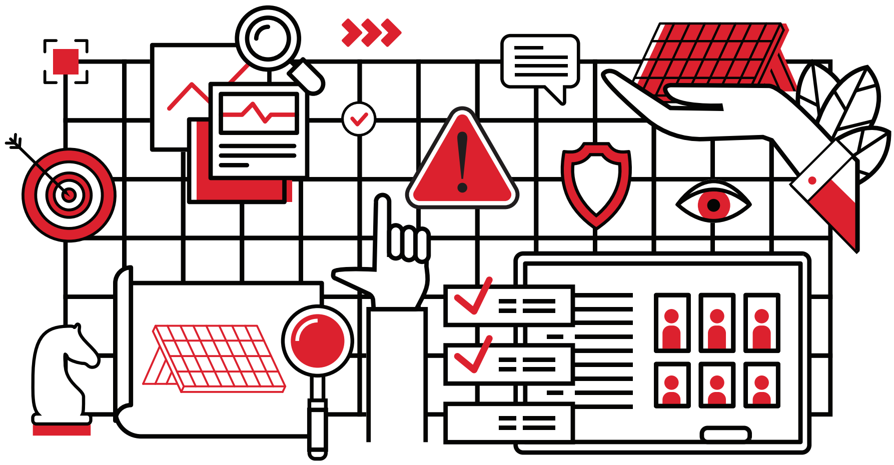
4.2.1 ROLES AND RESPONSIBILITIES

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

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

- Developing the solar, wind and geothermal deployment programs
- 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 RE programs' objectives and their 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, key stakeholders involved at the operational level will ensure that the programs are aligned with relevant strategies deployed by the various ministries, enhancing potential synergies. Strong inter-ministerial cooperation mechanisms are necessary to coordinate efforts among the projects' stakeholders, such as state and local administrative levels, IPPs, grid operators, off-takers, etc., and to 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 with the Moroccan Agency for Sustainable Energy (MASEN), could lead to a more flexible procurement scheme and allow for hires of more specialized and qualified workers. Providing one focal point for bidders, and streamlining the overall bidding process, can also reduce the timeline and associated costs for the IPPs. The creation of a new entity can, however, also slow the implementation process and reduce the already limited capacity of relevant agencies/ministries.

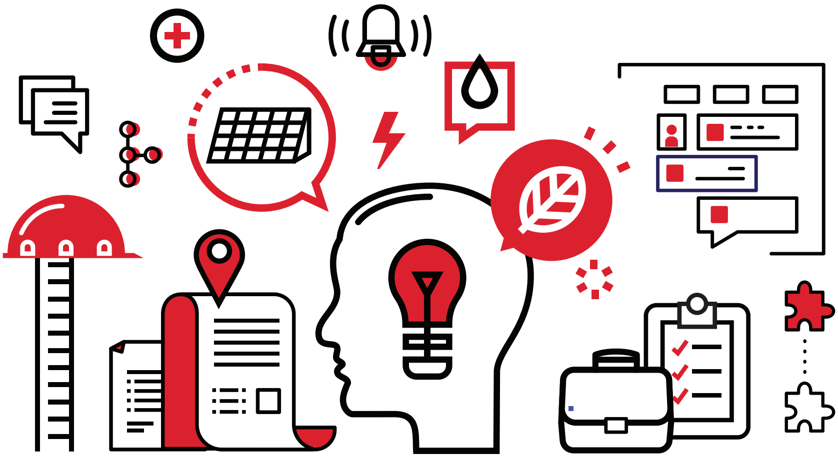
4.2.2 SUPPORTING PRIVATE SECTOR PARTICIPATION

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 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) and beyond the tender. 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 with a clear mapping of titles for land (such as easements and usufructs and other personal titles such as leasing or rental agreements) and clear dispute resolution mechanisms
- 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, wind and geothermal IPP-owned projects.
- Clear incorporation of corporate governance requirements (including related parties and vertical/horizontal integration requirements)
- Clear antitrust regulation (and specifically merger/acquisition controls)
- Clear bankruptcy/insolvency regulation

The Regulatory Indicators for Sustainable Energy (RISE) were developed by the World Bank Group, ESMAP, and SEforAll, with support from the Climate Investment Funds (CIF). RISE allows countries to benchmark their progress 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

Power sector reforms have long included a standard set of policy prescriptions: the unbundling of power utilities, independent regulators, cost-recovery pricing, and competition in power generation. 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.

It found, first, that private sector participation in generation has largely succeeded despite enduring challenges in planning, procurement, and risk sharing. In countries where these challenges were adequately addressed, governments leveraged private investments for the greater benefit of society, procuring them through a transparent and competitive process. Second, the current technology disruptions will likely 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—usually at the level of national laws. In addition, specific bidding mechanisms may also require a ministerial or presidential decree or decision. A high-level risk analysis will inform the selection of the optimal deployment scheme and 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 nascent solar, wind and geothermal industries. However, now that the VRE markets are in the hundreds of gigawatts range, competitive bidding for VRE is the optimal way to cut prices and boost competition. Indeed, the main risk with FIT schemes is that too many IPPs may be interested, and the government faces a situation of over-capacity. It should be noted that some countries have an abundance of geothermal resources and are hence able to foster competition between multiple developers ensuring low power prices.

If competition usually leads to lower PPA tariffs, tenders can become costly and time consuming for governments. Governments can reduce the cost of bids by developing a set of legal contractual documents and procurement processes early on that can be used again in subsequent phases. In addition, to ensure a successful tender, the government may need to provide upfront the right mitigation instruments covering the main identified risks by IPPs.

4.3 HIGH-LEVEL RISK ANALYSIS

Once the framework under which the IPP will be selected is assessed, the next question is: ***what are the critical risks perceived by IPPs—that is, the risks that will affect their willingness to invest or their cost of capital? And what are the public stakeholders' views on risks (including country-specific restrictions)?***

The identification, allocation, and mitigation of risk are critical inputs to a comprehensive RE strategy. The private sector high-level risk assessment outlines:

- each risk from the IPP's perspective with a pass or fail grade, i.e., 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 financing costs for different parties with and without the identified risks. This assessment enables countries to select the most suitable deployment scheme 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 reduce the risk premium for IPPs. In turn, these factors reduces the expectations of equity returns and improve 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 RE deployment program and clearly allocating them among parties—and setting up associated risk mitigation instruments—are core to the success of the program.

Understanding the risk-related views of public sector stakeholders, as well as any restrictions 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 affect the selection of the deployment scheme
- **operational risks** that inform the bidding framework.

GEOTHERMAL RISK MITITAGION MECHANISM

Many countries view geothermal as an opportunity to diversify their power generation with clean energy that can provide baseload power. Despite a global potential of 70-80 GW and more than a century of development, only about 20% of known resources are currently utilized. It is widely acknowledged that the slow pace of development is primarily due to the high resource risk encountered during the early stages of the multi-stage geothermal development process. The real or perceived risk of geothermal energy makes it difficult for the private sector to mobilize capital for exploration drilling.

According to an ESMAP analysis (ESMAP, 2016), successful scaling up of geothermal development has benefited from government support. This assistance can take many forms, and several of the mechanism listed below have already been put in place:

- **Government support mechanism.** Under this mechanism, the government or government-backed entities lead the development of privately owned geothermal projects. In some cases, government or government-backed entities continues their support throughout the project's life cycle. As a result, the government bears all of the risks that emerge in the early stage of the project, and in some case, all of the risk that appears later in the project.

- **Cost-sharing mechanism.** During the early stages of the project, particularly the exploration drilling phase, the associated costs are shared between the government and the private sector. This mechanism makes use of public resources to mobilize private funds. This could be accomplished in two ways: i) the government conducts exploration and resource confirmation before transferring development rights to the private sector to complete and operate the now lower-risk project, and (ii) the private sector develops all stages of a geothermal project, but the government shares the cost of the exploration stage to shift some of the risks away from the developer. In each case, governments bear some or all of the exploration risks in order to encourage private investment for most of the development.

- **Geothermal resource risk insurance mechanism.** The developer combines exploration risks across a portfolio of development projects and then shifts a portion or all of the risk to a third party (insurance company). This will ensure some or all losses are covered if certain pre-specified targets are not met.

- **Early stage fiscal incentives mechanism.** This includes tax credits and duties exemptions, which reduce the initial cost of geothermal exploration. This mechanism has the effect of transferring some of the early-stage risks from the developers/investors because it reduces the amount of risk capital that must be mobilized, as well as lowers a developer's exposure to potential losses if a project does not move forward.

4.4 SELECTING A DEPLOYMENT SCHEME

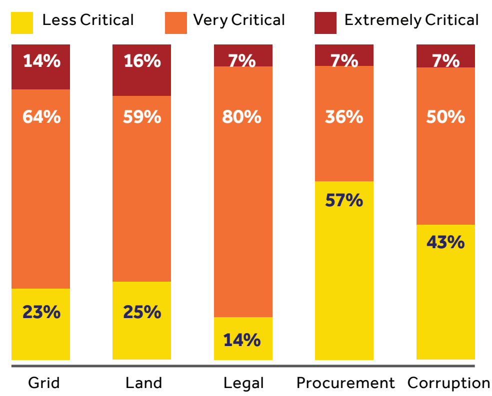
Once the main risks are identified in the high-level risk analysis, the next question is: ***Which is the best deployment scheme to cover the key development risks?***

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).

The market sounding mentioned above (for solar projects), in the introduction, identified legal, grid, and land risks as the main perils of project development, 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	GEOTHERMAL DEVELOPMENT RISK	GRID CONDITION KNOWLEDGE AND CURTAILMENT RISK
Secured land rights are critical for long-term investment and financing. The main asset considered a security for the lender is the solar, wind or geothermal 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.	The largest risk for geothermal projects is the resource risk: the energy producing potential of the resource is not known until significant upfront costs have been made. To mitigate this risk for lenders and investors it is important to ensure that the site has been adequately explored before development plans are made. Various form of support have been tried and tested (see Box "Geothermal Risk Mitigation Mechanism") and the risk can be mitigated by providing additional revenue streams: e.g. a feed-in -tariff higher in the first 10 years of operation to allow for rapid recovery of capital costs or the possibility to enable plants to sell geothermal steam and water to third parties, see section 4.4.	**Limited knowledge of grid availability/ conditions** leads to (i) the IPP spending excessive time trying to get information from the government/utility to conduct a grid integration study for the specific project; and (ii) an incomplete grid integration study that may not represent the reality of the grid. If the project is based on 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

Competitive bidding schemes fall into three broad categories: (i) location agnostic competitive bidding, (ii) substation based competitive bidding, (iii) solar and wind park competitive bidding and (iv) geothermal site competitive bidding. Each deployment scheme tackles different risks perceived by IPPs, see the table below for details.

Table 3. Types of deployment schemes

LOCATION-AGNOSTIC COMPETITIVE BIDDING	
The procurer tenders a predetermined capacity/energy amount, with no constraints on location, allowing the developer to select the project location freely.	
✓ 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. This procurement strategy is not suitable for geothermal as it is highly location specific.
The first solar and wind 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 (e.g. Vietnam).	

SUBSTATION-BASED COMPETITIVE BIDDING

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

It helps optimize the use of existing transmission capacity in the deployment of RE 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, competition for land around the substation would drive the PPA price up. For wind, it may lead to major constraints, as the wind resource is location specific, leading to instense competition for given sites around the substations. Therefore, to be successful, the substation-based tender for wind would require many substations, with good wind resources across the country in the vicinity of the substations.

This procurement strategy is not considered suitable for geothermal as it is highly location specific.

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

SOLAR AND WIND PARK COMPETITIVE BIDDING

The government identifies the site(s), conducts land clearance, and constructs infrastructure for the 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, or wind project. For a wind park, it is necessary to have a fully bankable wind resource assessment for the site.

The RE 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 upfront budget to develop the RE park facility before conducting a tender – particularly for wind parks where the resource assessment on site may take up to 2 years. There is a risk that the infrastructure expected from the government is not built in the agreed timeline with the winning IPP, increasing cost to the government. It is important to integrate these potential delays assessments 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. Egypt was very successful in obtaining extremely low wind power prices when tendering its very first pre-developed IPP wind power project at the Gulf of Suez.

GEOTHERMAL SITE COMPETITIVE BIDDING

The government identifies the site(s), conducts land clearance and constructs infrastructure for the geothermal site that can range from the evacuation line to basic elements such as the roads. The government additionally will need to setup de-risking strategies which can consist of: i) The government conducts all pre-surveys and test drilling for multiple sites, ii) the government sets up schemes to jointly share the early stage resource risk, iii) the government does no de-risking and tenders out sites directly. The strategy can be a combination of all proposed schemes and in some regions there are regional risk sharing mechanisms already available.

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 geothermal project.

The geothermal site significantly lowers resource risks, as well as those associated with acquiring land and consents, 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 upfront budget to develop the geothermal site before conducting a tender: developing a geothermal site for which the resource assessment is needed may take up to 5 years. There is a risk that the infrastructure expected (evacuation line) from the government is not built by 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, substation).

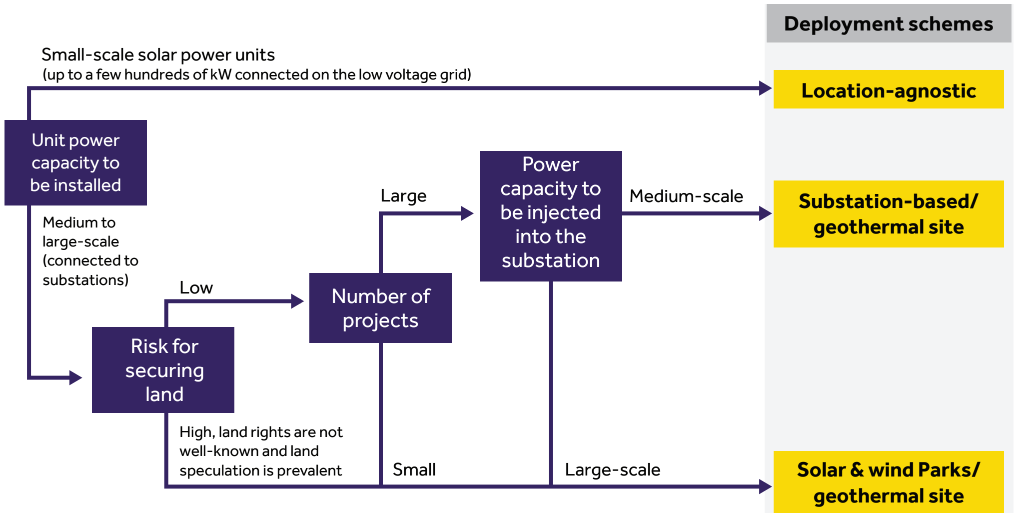
This procurement strategy is not recommended for solar and wind.

4.4.3 SELECTING THE DEPLOYMENT SCHEME

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 (i) grid information availability, and (ii) RE parks/sites, in particular, in small countries, for example, islands, or where land titling is not bankable and the grid has few connecting points offering available space.

Figure 15. Land and grid risks: Key to the selection of the deployment scheme for solar and wind projects



Note: Regardless of the size of the geothermal project, the geothermal site competitive bidding scheme is proposed.

If the high-level risk analysis identifies the **grid** as a key issue for IPPs, the government can (i) make grid information available to anyone online so IPPs have a better sense of where curtailment risks are minimal under location-agnostic schemes; (ii) explicitly add interconnection costs to kWh bid prices to reflect the higher costs of grid reinforcement required in each grid segment, preferably publishing such costs transparently in advance of the tendering process; (iii) develop a substation-based competitive bid; or (iv) develop a solar/wind park scheme, or (v) develop a geothermal site scheme. 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 low-kilowatt PV projects, it is recommended that planners have some sort of control over the connection to ensure that the project will not adversely impact the grid or that too many projects will get built in one location leading to power evacuation constraints.

If **land** constraints are identified in the high-level risk analysis, such as land scarcity or insecure tenure, solar/wind park and geothermal site schemes should be favored by governments as a mitigation measure. Critical points in this case are that the land transferred to the winning IPP should be free of people while the soil and other environmental characteristics be aligned with the RE plant's requirements. Also, the right of way for the evacuation line should be made available to the IPP. For onshore wind and geothermal, even more land constraints occur due to the localization of the resource. It is important to verify the number of potential sites with good wind and geothermal resource that exist close to the grid and if these have been allocated to developers already. If most sites have been allocated and the resource is very limited, it might be better to conduct a closed competition among developers. However, in the event where wind and geothermal IPPs are uncommon, it may be easier to secure the best sites before launching the tendering process.

In the event of severe land constraints, viable options include floating PV, rooftop PV or near-shore/offshore wind. Although their construction and equipment costs are currently higher than for land-based plants, these additional costs are partially offset by increased energy production thanks to the surrounding water's cooling effects. There is also a general lack of dust in the case of floating solar and higher wind speeds in the case of offshore wind (for countries with offshore wind potential).

The selection of a deployment scheme needs to be explicit in a country's solar, wind and geothermal deployment programs 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 upfront for electrification purposes as well as to 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 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 or local industries like e.g. a fish processing plant, 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 faces different challenges and the main constraint is usually the regulations prevalent in a country. The state utility has often a monopoly over distribution and transmission and will relinquish an area, or several, 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?*** The government needs to think through mini-grid deployment and to ensure, before procurement, that the program is sustainable and that the regulations in place enable the implementation of the selected model. Another core constraint can be the demand for electricity of the connected customers. As the sizing of the mini-grid is being done based on a 10- to 15-year projection for electricity demand (as it cannot easily be resized), the mini-grid may be oversized the first few years, leading to major financial challenges for the private investors. SRMI has developed a new mini-grid demand mitigation instrument with the GCF to pilot this instrument in Democratic Republic of Congo (DRC).

SHSs are a good electrification solution for low-consumption customers (mostly focusing on tiers 1 and 2), and in areas with 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 ownership remains with the SHS provider, and (iii) via a lease-to-own model where ownership is 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 https://openknowledge.worldbank.org/handle/10986/31926

4.5 BIDDING FRAMEWORK

The results of the high-level risk analysis, together with choosing the appropriate deployment scheme, lead to the main question: ***What are the main parameters of the bidding program under a fair risk allocation?***

The bidding framework is meant to provide structure around the procurement of entire RE programs. It encompasses issues that are specific to procurement and contractual matters. Such parameters are integrated into country regulations, usually under a ministerial decree. The government needs to develop a high-level plan to allocate **procurement and contractual risks** in partnership with the private sector to decide on the key elements of the framework.

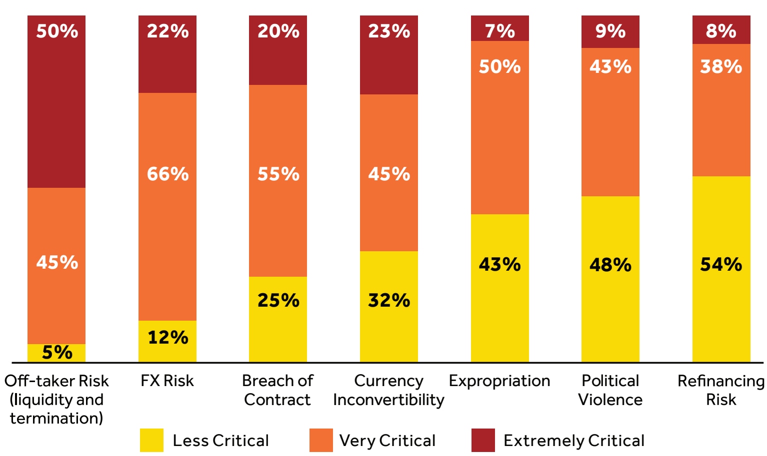
This bidding framework should be refined for a specific phase of the program or project when the related procurement starts. It would include details of the bidding mechanisms, procurement framework, and contractual arrangements underlying the specific contractual arrangements. Depending on the country, however, these parameters may sometimes 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. This is notably the case for wind power, where there is usually a critical minimum mass for a local market of at least 50-100 MW to make it worthwhile for wind turbine manufacturers to supply turbines and associated operation and maintenance services for a period of 20-25 years of operation.

4.5.1 OPERATIONAL RISKS IDENTIFIED

Each country will have different operational risks as perceived by IPPs. Accordingly, they will need to adapt their procurement and contractual frameworks to those results combined with the public stakeholders' restrictions. The market sounding presented in the introduction found the main risks perceived during operations 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, wind or geothermal 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 (arbitral award default, denial-of-recourse risk with arbitration that is not international)
- expropriation
- transfer restriction and currency inconvertibility
- war and civil disturbance.

CURRENCY RISK

Currency risks can impact solar, wind or geothermal markets and IPPs' balance sheets through currency devaluation/ foreign exchange, 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. But, during the operational phase of the plant (usually between 20 to 25 years for VRE and 30+ years for geothermal), the foreign exchange risk is substantial in case of a **mismatch of currency flows**.

Where the IPP revenues are in a local currency and a mismatch occurs between the debt and equity currency, the risk of devaluation and of convertibility is high and could lead to high costs for the IPP. Operation expenditures (OPEX) are minor for solar projects and therefore a mismatch of currency will have a minimal impact. OPEX are more important in the case of wind and geothermal, and tariffs in PPAs are consequently usually indexed for the part of the tariff that relate to O&M. The share of the O&M intended for spare parts is then normally defined in or linked to the foreign currency used in the contract, (usually US dollars or euros).

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 RE in the energy mix and ensuring energy security for the country. The procurer must be clearly identified upfront, alongside two key elements:

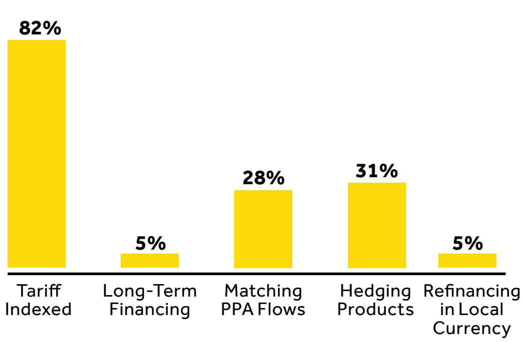
A. PAYMENT MECHANISM

The payment mechanism is decided in the payment structure to the IPP in the PPA. Considering the variability of solar and wind production, their payments are usually in the form of energy-based payments per megawatt-hour (MWh) and not in terms of MW (capacity), however for geothermal the PPA can be based both on installed MW as well as MWh or solely on MWh.

B. 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, partially indexed to domestic and foreign inflation corresponding to the share of local and foreign O&M costs for the project, or increasing every year at a given rate. The choice of who takes the inflation risk and currency risk could greatly affect the PPA tariff and therefore needs to be decided in an informed manner. According to the market sounding results, most IPPs would request that the tariff be indexed to a hard currency such as US dollars or euros, as long-term affordable hedging products are still scarce. This entails the government taking the foreign exchange risk. Alternatively, the main mitigant would be the 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 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 the procurer is willing to pay and the risks the procurer is willing to take to improve bankability. The key risks that need to be tackled at the program stage are (i) off-taker risk (payment and contract termination), and (ii) legal change risk as both can have long-term impacts on the country and require the involvement of public parties.

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, is usually between 20 and 25 years. The PPA tenure is key for IPPs to be able to access long-term nonrecourse financing. As solar and wind projects have relatively small OPEX needs, the cost of their investment is upfront, and therefore the tenor of the loan has a strong impact on the PPA price. The same applies for geothermal although OPEX is greater than for solar and wind but never the less considered low, as the geothermal field needs to be maintained to keep the level of production.

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. 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

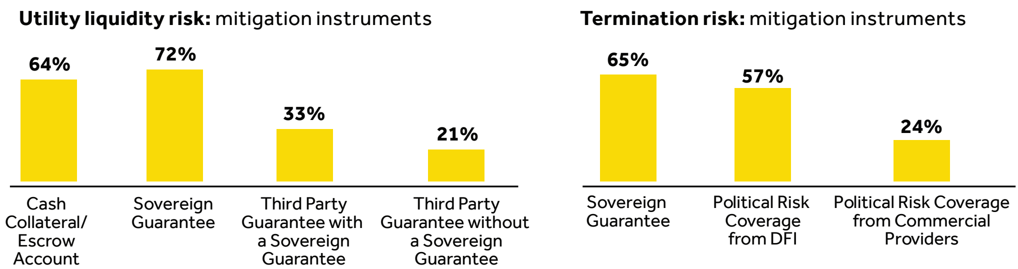
Political risk can be mitigated by inserting, in the contractual documentation, a termination clause benefiting the IPP in the case of *force majeure*, which also provides for specific indemnities covering (notably) the IPP's outstanding debt repayment obligations. Specific risk mitigation coverage can 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, according to the market sounding, by an adequate payment security mechanism to secure payments and/or a guarantee (sovereign or 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 the off-taker's default on PPA payments.

Government backing of the obligations of the off-taker under the PPA with a bankable letter of support is often a key element for a successful contractual scheme that relies 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

It is potentially problematic to introduce private participation in generation without first or at least simultaneously undertaking deeper sectoral reforms. In many countries, off-takers may not have a strong balance sheet or credit history. Their weak financial performance can often be linked to high investments in electrification, high losses, implementation of nonindexed 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 also need to 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.

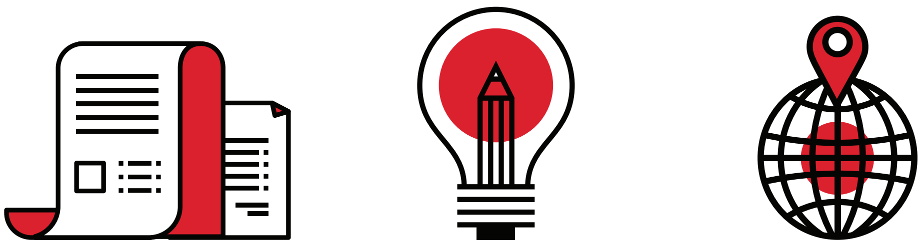
In the medium term, governments need to support utilities to improve their services and collect payments, improve grid quality to reduce technical losses, better target their fuel and electricity subsidies to the poorest segments of the population, and continuously reduce their cost of generation. It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

4.6 MAXIMIZING SOCIOECONOMIC BENEFITS

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

Policy makers 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 add-ons to model jobs creation taking into account employment rates as a socioeconomic metric (Dhakouani A., 2017).

Figure 19. Maximizing the socioeconomic benefits of private participation



PLANNING

Provide visibility to the market locally & internationally, including

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

STRATEGY

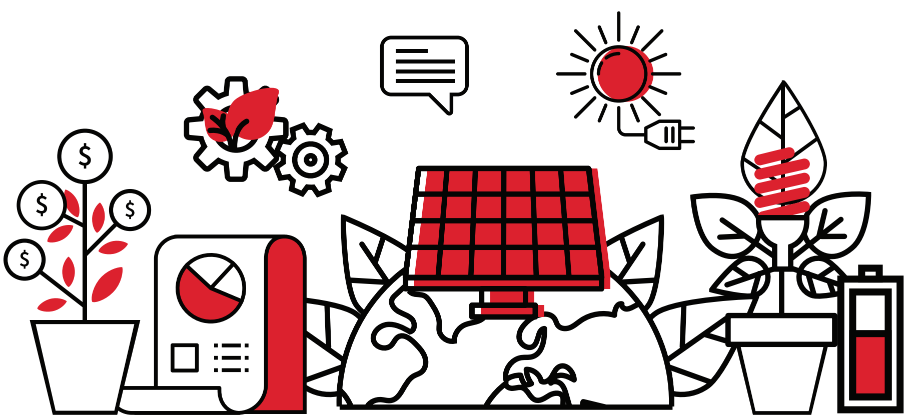
Build capacity and competitiveness of local players

- 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



SOCIOECONOMIC BENEFITS CAN BE SUPPORTED 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
- take local suppliers through the solar/wind/geothermal 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/wind/geothermal program, disseminate adequate knowledge on the solar/wind/geothermal 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/wind/geothermal value chain and share these studies with prequalified bidders to facilitate bidders' investigation of local opportunities to partner or subcontract. Meetings could be organized among prequalified bidders (and their main subcontractors for engineering, procurement, and construction as well as operation and maintenance) and local players.

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

Since 2013, as part of the Noor Ouarzazate solar PV project, the government-selected IPP 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 training on remunerative work related to livestock, agriculture, and handicrafts. Six years after its implementation, it already reports significant benefits for women who 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/

C. DIRECT USE OF GEOTHERMAL ENERGY AND THERMAL CASCADING

A possible by-product of geothermal electricity production can be utilizing the resource directly for heat (direct use) e.g. balneology, greenhouses, fish farming, drying and district heating or mineral extraction. This can create local job opportunities (both short and long term), promote gender equality, food security and support economic activities.

D. MAXIMIZE BENEFITS FOR LOCAL COMMUNITIES

Working with public stakeholders, planners should arrange for a socioeconomic study of local communities and use the results to tailor suitable programs. While the government often understands community needs, and knows how to meet those needs, it often lacks the means to finance needed measures. One way to fund local programs is through the bidding process, which could include provisions for the IPP to finance, say, 1 percent of the capital expenditure, which governments could then spend 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 socioeconomic development to benefit local communities. This is the case with the Redstone 100 MW CSP solar project, which commits to a 2.5 percent community trust. Set up as a not-for-profit organization, the trust benefits local communities near 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.

E. MANAGE EXPECTATIONS TO ENSURE BETTER RESULTS

A carefully designed community 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 higher wages for workers at all skill levels. Janitors in the coal industry could, for instance, increase their salaries as 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 or wind-related positions; many coal miners have skill sets, such as mechanical and electrical expertise, skills that are transferable to RE industry jobs. They could benefit from new jobs created in renewables as coal phases out, with government support 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 former coal miners (e.g., as solar panel assemblers) and providing better salaries and a healthier work environment.

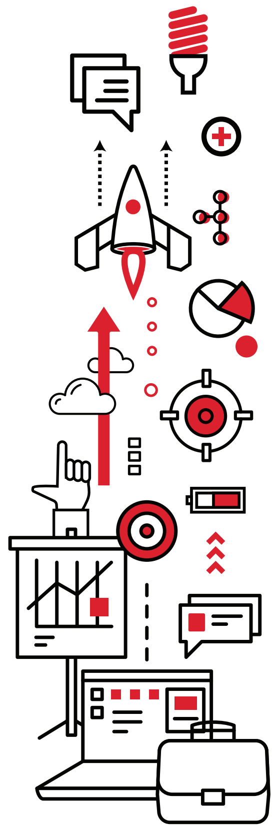
F. ENHANCE THE POSITION OF LOCAL PLAYERS AND LOCAL JOBS ON THE VALUE CHAIN

The government might map local players and their skills, then identify how they might fill gaps on the solar/wind/geothermal value chain. Any theoretical assessment might be improved by benchmarking local players against preselected subcontractors by asking, for example, pre-qualified bidders to explain why they do not intend to preselect local subcontractors. This information will help the public stakeholders tailor programs to boost 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 RE 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. Construction workers and technicians make up the majority of laborers. The acquisition of 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 workers 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 because costs are paid by the IPP and budgeted up front. There is in addition no increased risk because they have been seconded, or cross-assigned, so they fall 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

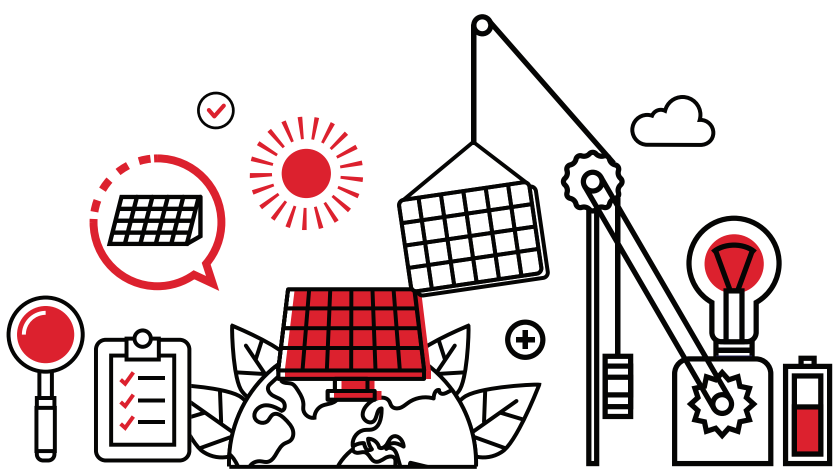


4.7 RE DEPLOYMENT PROGRAM: KEY RESULTS

*Based on the government's strategy and a high-level risk assessment, a **RE deployment program** can be developed in ways that outline:*

- clear roles and responsibilities for stakeholders;
- high-level risk allocation of development and operational risks highlighting 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 contract-specific issues as identified in the risk assessment.

Under the program, the government may also identify and plan specific actions to support socioeconomic development, and spell out key changes to the legal framework to encourage and facilitate sustainable RE deployment.



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PHASE 3: IMPLEMENTATION

5.1 OBJECTIVES

Once project implementation begins, the government's RE targets have been set. Furthermore, all public parties have agreed on, and enacted, a strategy to reach those targets.

If that strategy involves private participation in RE energy production, then planners must address the following questions 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 RE 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 RE 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 reduces 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 RE targets will have been achieved by leveraging private investments in a fair and sustainable manner, while all risks from the public and private perspectives will have been optimized.

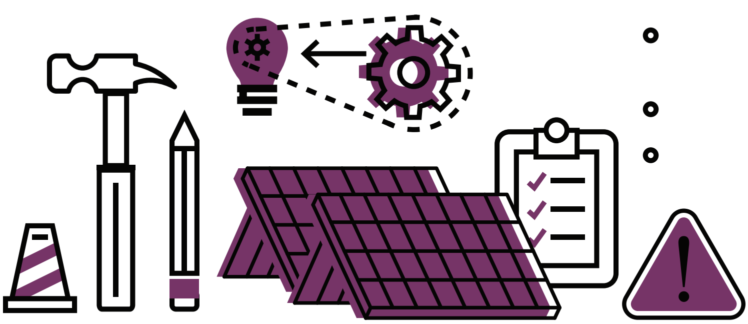
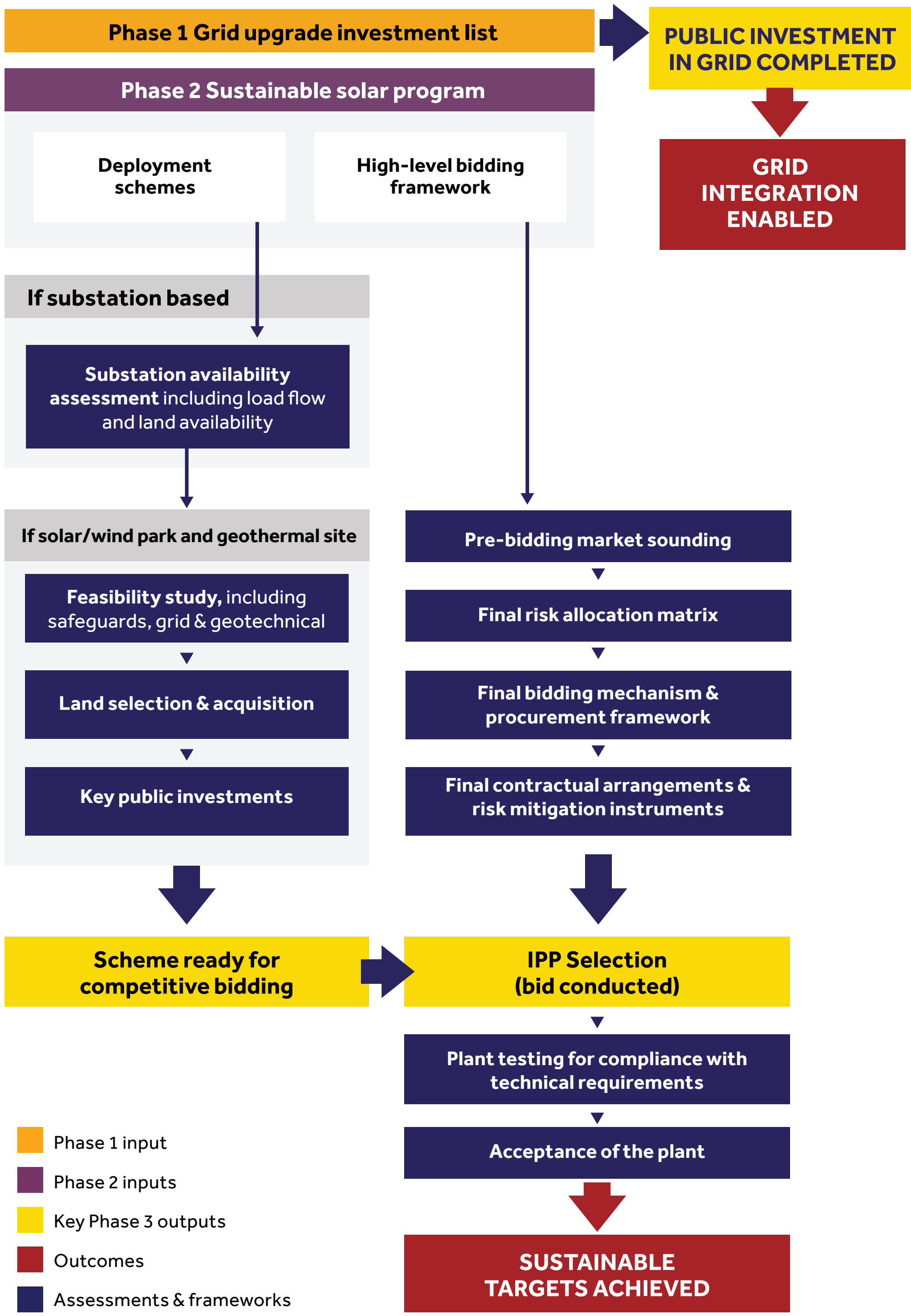


Figure 20. Key steps in the implementation phase



5.2 PREPARING THE TECHNICAL ASPECTS OF A SOLAR/WIND/ GEOTHERMAL 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, a solar/wind park model or geothermal site model, it is necessary to prepare the grid and make the land and other infrastructure available, as the case may be.

Figure 21. Roles of the public and private sectors, by type of deployment scheme for solar and wind

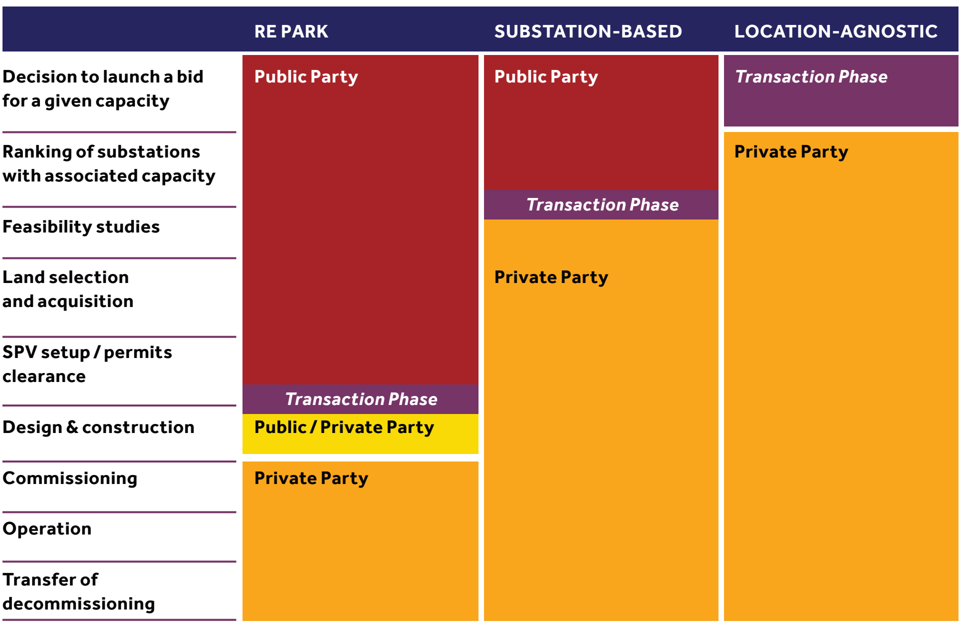
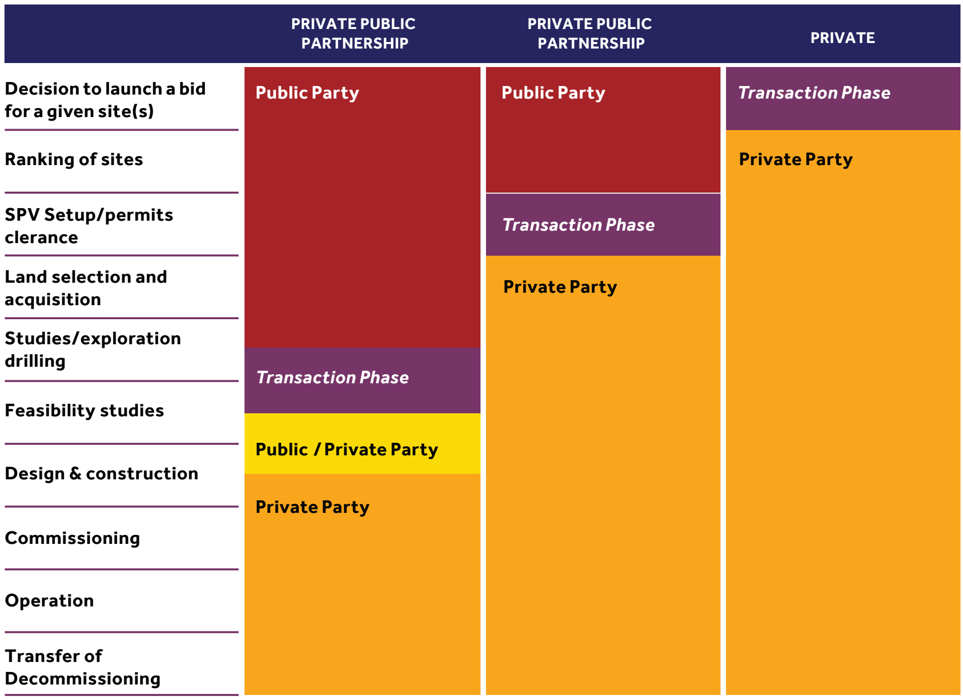


Figure 22. Roles of the public and private sector for geothermal site scheme



Note: Please refer to the ESMAP publication on geothermal for additiona information (ESMAP 2012, ESMAP 2016).

5.2.1. SUBSTATION-BASED SCHEME: DETERMINING LOCATIONS AND CAPACITY

A substation-based scheme requires assessing the most appropriate locations for RE deployment with integration foremost in mind. These assessments would combine the results of a load-flow analysis with land assessment. They also consider the timeline set for transmission upgrades. In addition, for substation selection (for wind and geothermal but to a lesser extent solar), the availability of resources needs to be assessed and folded into the multicriteria list for the tender. The substation-based scheme would not be recommended when the wind resource is limited to specific areas, restricting the number of substations that could be tendered.

This assessment makes it possible to prepare a list of optimal substations and associated capacity. The auctioneer 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 tender. It is recommended that the total capacity tendered 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 , WIND, OR GEOTHERMAL PARK/SITE: FEASIBILITY STUDY

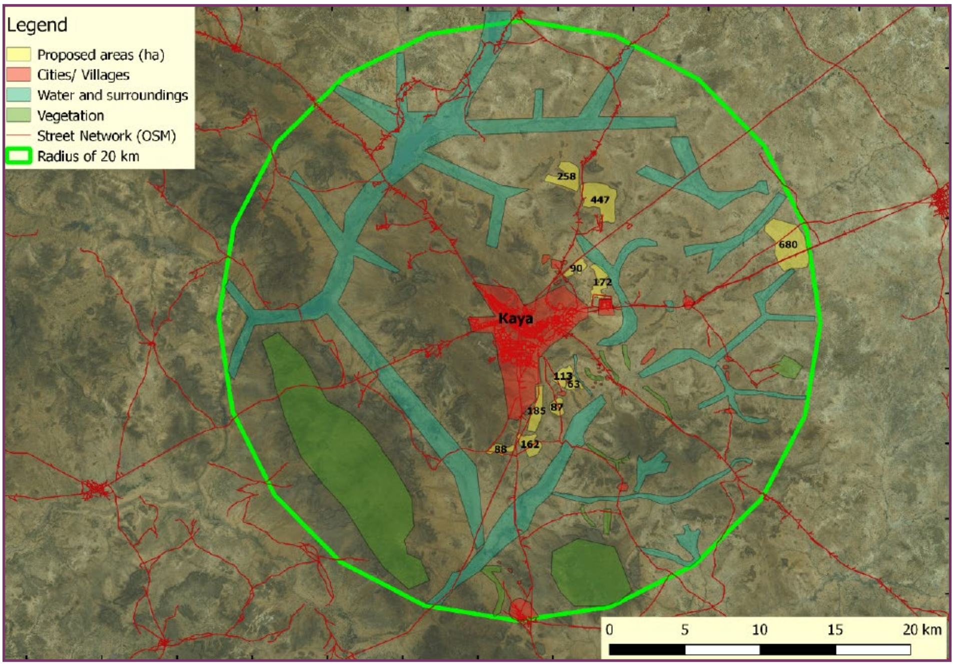
If the government decides to develop a solar, wind or geothermal park/site, it must select suitable pieces of land, for the power plant and the right of way, after considering social and environmental impacts. The solar, wind, or geothermal park/site should be sufficiently large for the total capacity envisioned for the medium-term (if implemented in phases, which is recommended for geothermal). In the case of wind and geothermal, local topography and land cover are essential elements that determine the resource and hence the precise location of the future projects. It may be economic to build transmission lines of 30 km or more from a substation to reach the best RE resources near the grid.

If a solar, wind or geothermal park/site is to be located on private land, it is important that the government acquires the land needed for the project at an early stage, e.g. by signing options with landowners potentially affected by the project.

The project may be auctioned in phases (e.g., for a 300 MW park, only 150 MW might be auctioned during the first phase, and the rest a few months or years later, in a second phase) to follow the electricity demand. A geospatial analysis of the land around the substation can be conducted to support the identification of different pieces of land.

A key factor for wind emerges when multiple wind farms are built near one another, causing something called "wind shade." It is essential that future wind farms avoid casting shade on existing farms because each additional farm diminishes the wind resource downstream from prevailing wind directions. This issue can be handled with proper planning that honors the geometry of wind farm perimeters and observes adequate distances between farms. Advantages are usually seen in scattering wind farms over a larger territory because weather patterns take time moving across the country. This means that the variability of wind power can be more or less cancelled out by distancing the wind farms.

Figure 23. An example of geospatial analysis for solar park land identification



The hourly and monthly patterns of power generation from wind may vary greatly across the different country locations. For geothermal, it is however important to note that it is not recommended to have multiple IPP's utilizing the same resource (site). Instead development in stages is recommended, and also essential for greenfield projects. If however, a decision is made to have multiple developers utilizing the same resource it is essential that the resource is controlled by one independent party that ensures an optimal utilization of the resource and proper resource management.

Several different analyses need to be conducted as part of the feasibility study for a solar farm, once the land has been identified:

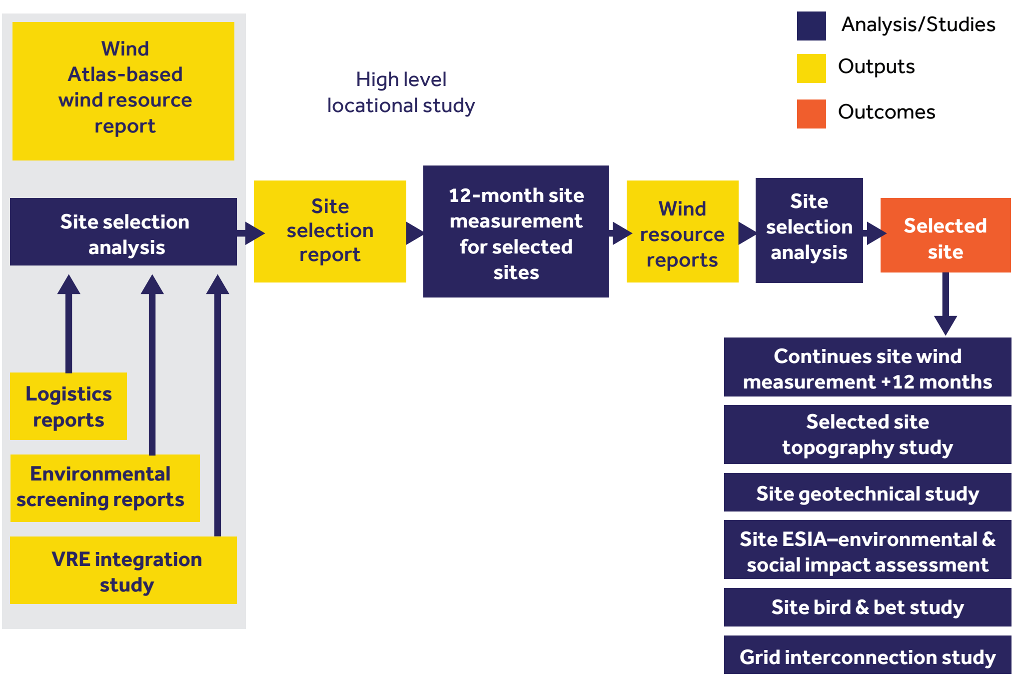
- A topography and geotechnical analysis to verify that the soil and terrain are suitable for a solar plant.
- An environmental and social impact assessment (ESIA), combined, if needed, with a land acquisition and resettlement plan following international standards such as the Equator Principles and 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 in particular for CSP projects.

Studies on other environmental factors like 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 provide useful data and thus help reduce the costs of the tender and lower the risk premium embedded in the proposed tariff.

Pre-feasibility studies for suitable wind farm sites identify high-resource, windy areas with a wind atlas, such as the Global Wind Atlas. A GIS mapping exercise is then undertaken overlaying this mapping with topographical maps to avoid steep slopes, and to determine proximity to transmission grids, road networks, population centres and protected areas – this can be done under the high-level locational study in Phase 1.

Figure 24. Wind Farm Location Assessment

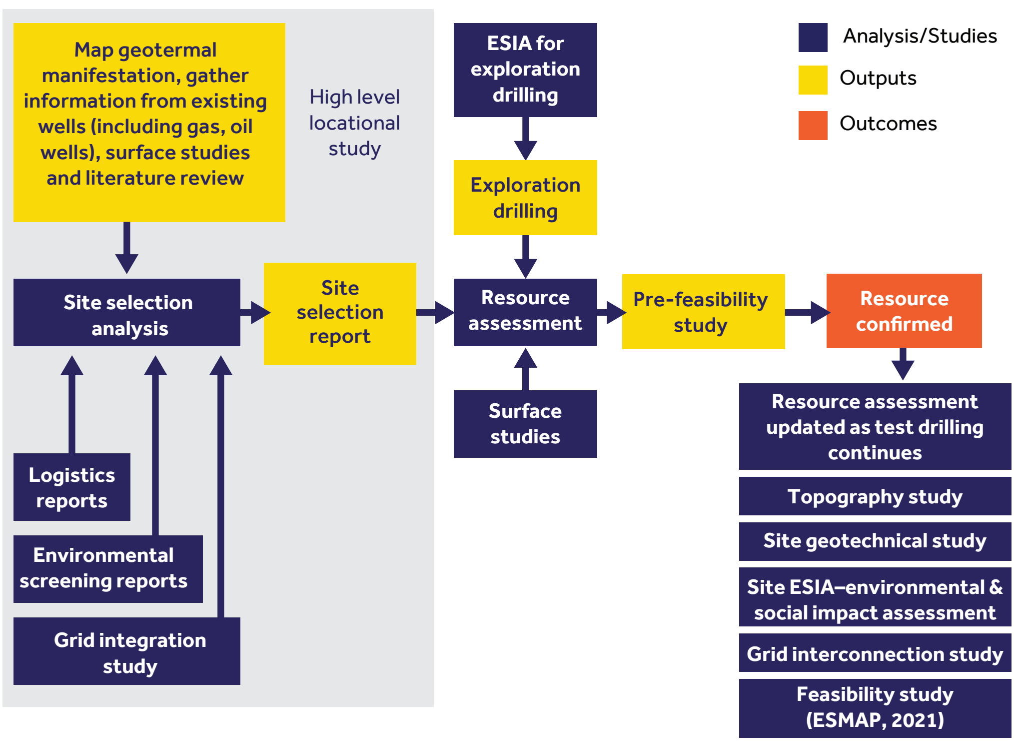


For the most promising sites, several different analyses need to be conducted:

- A logistical study to ensure that large and heavy equipment can be transported to the proposed sites.
- A bankable wind measurement program for each site that is compliant with the latest international IEC/ISO-61400-12 and MEASNET wind measurement standards for the sites being tendered. This requires an upfront investment in a site wind measurement program with a duration of at least 12 consecutive months, and preferably 24 months to further reduce resource uncertainty. Such a program will include installation of remote-sensing LIDAR equipment and/or tall meteorology masts on the site (measurements are recommended at two-thirds of the hub height or higher). The program should be documented with a bankable report for an example wind farm so as to demonstrate the technical and economic viability of the project. This report would also be used later to provide comfort to lenders during their due diligence process.
- A topography and geotechnical analysis including geotechnical drilling to verify that soil and terrain at the site are suitable for a wind plant. This serves to estimate foundation costs for turbines and mitigates a potentially costly risk for developers.
- An 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.

Prior to drilling, geothermal sites are identified using existing resource information data, surface manifestations, as well as through the conducting of additional surface studies where deemed necessary. These studies along with logistic report, environmental screening and grid integration study result in high level location study.

Figure 25. Geothermal resource confirmation



In order to determine if an economically viable geothermal resource exists, surface studies and exploration drilling are required. As exploration drilling requires construction on site for water supply, access roads and drill pads, an environmental and (depending on context) social impact assessment is required. After finalization of exploration drilling resource models, engineering basic design (including process design, maps showing main pipe routes and preliminary location of wells and power plant, time schedule, cost estimate), grid studies (location of substation and demonstration that the electricity can be distributed) and the ESIA already performed will feed into a pre-feasibility study. From there, the extent of drilling required to reach bankable feasibility depends on the requirements of the financing entities and the size of the project.

In order to prepare a feasibility study, several inputs are needed (ESMAP, 2021):

- Resource assessment based on drilling test results and surface studies. The extent to which the energy production potential of the resource is confirmed depends on the size of the project and the specific requirements of the financing entity to reach a level of confidence about the financial viability of the project
- Environmental and Social Impact assessment
- Geothechnical studies for the power plant location
- Topograpy study to determine pipe routes for the gathering system
- Grid study to demonstrate that power can be dispatched

5.2.3 PERMITS

To reduce the perceived risk associated with acquiring permits in a given country, under a solar, wind, or geothermal project, 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 best technical option, 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, privately-owned battery storage would need to be combined with a solar project to be able to price the usage of the battery for load shifting.

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 standard. To price the service provided by the battery, different tariff for day and night may be proposed to IPPs.

5.3 PUBLIC INVESTMENTS

Beyond the RE plants to be financed by private investors, the government must determine what additional investments are required for the efficient development of a solar, wind or geothermal program.

5.3.1. POSSIBLE PUBLIC INVESTMENTS

Done in a timely manner and in accordance with best practices, public investment in RE parks or sites provide visibility to potential IPPs (mitigating development risks) and creates synergies, leading to lower costs. Based on the government decision to have one or many IPPs in a given park, the public party may optimize its investments differently.

Public sector commitments to set up strategic infrastructure, such as transmission lines, 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 power 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.

In the case of any combination of a solar, wind and geothermal park/sites, 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 use the RE plant erected on the land during the period of the PPA. A yearly park/site 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 RE power).

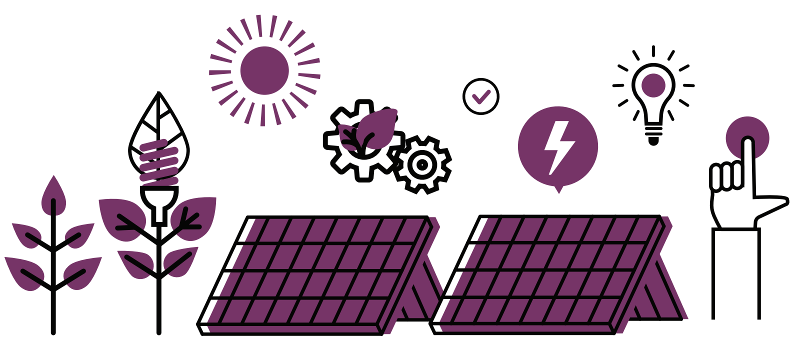


Table 5. Elements of solar, wind parks or geothermal site for public investment consideration

ELEMENTS	OPTIMUM PARTY IN CHARGE
Solar/wind/geothermal park/site land, including identification of rights of way and ownership	Public party procuring the solar/wind/geothermal 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. Wind farms are normally not fenced, and agriculture can still be performed on 95 percent of the area covered by the wind farm. However, site securing still needs to be realized. Geothermal steam fields are usually not fenced. Only hazardous parts in the geothermal field need to be protected with a fence. The same applies for the powerhouse area. This is usually done by the developer.
Land technical preparation	If the site is complex and if there is more than one IPP in the same park/site, it is best if the public party prepares the land, especially with regard to the earthworks. For geothermal the land preparation is done by the entity responsible for exploration drilling. This depends on the de-risking scheme selected by each country.
Connection line from plant to substation	If there is more than one IPP in the same park/site, 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 a park. For geothermal sites water supply for drilling and drains is usually done by the entity responsible for exploration drilling. Water supply and drain for other power plants are usually done by the developer.
Weather station	May be handled by the public party to optimize costs for parks. In any case, a wind farm owner will build and maintain its own meteorological mast on the site.
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. This is usually not done for geothermal other than the main road leading to the site.
Internal access roads	May be handled by the public party to optimize costs in the case of solar farms. For wind parks and geothermal sites, internal roads are built by the developer so as to correspond with the specific layout of wind turbine locations and geothermal wells, power plant, cooling towers, etc.

Source: Adapted from Bridge to India (2017).

5.3.2 GRID STRENGTHENING

In parallel with the implementation of the RE 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 RE and ensure a better quality of electricity service. These upgrades might include battery storage or other means to stabilize the grid if the level of VRE penetration is already reaching the limits imposed by existing infrastructure.

INNOVATIVE FINANCING

The government (if it finances RE 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 20+- years, well-organized procurement and selection processes are needed. The main areas of expertise required during the selection process are as follows:

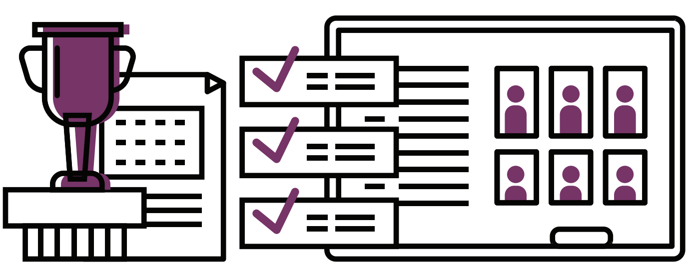
- legal and regulatory
- technical and safeguards
- financial considerations
- procurement

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 and Wind Programs.

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.

Under the Open Solar Contracts Initiative, standardized contracts for solar projects have been launched by IRENA and the Terrawatt Initiative to streamline project development and finance processes for small and medium-sized, grid-connected solar PV projects.[6]



6 For more information: https://opensolarcontracts.org.

5.4.1 PRE-BIDDING: MARKET SOUNDING

The program bidding framework (and the high-level market sounding) is used in designing the program's key features. Using this as a starting point, the government could conduct a call for expressions of interest to consider bidding mechanisms, procurement frameworks, and contractual arrangements. A market sounding allows the government to gauge the market's appetite, to probe its risk-allocation mechanisms, and to collect insights to considered later, when setting the pre-qualification criteria.

Figure 24. 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 sized to ensure broad competition while attracting top players
Preparation of the request for proposals phase	▶ Preparation of procurement rules and contractual arrangements

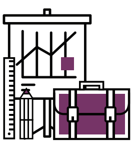
5.4.2 BIDDING MECHANISMS

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

A. BIDDING PROCESS

PREQUALIFICATION

A prequalification phase limits the number of bidders and facilitates 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.

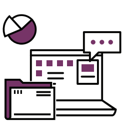


TECHNICAL AND FINANCIAL PROPOSALS AND REVERSE AUCTION

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. In the case where the technical aspects of the project are complex (such as for solar with battery projects and geothermal projects), a two phased approach for the proposal can be promoted so to give IPPs the possibility to provide comments on the technical specifications and for the government to adjust them if need be.

BONDS

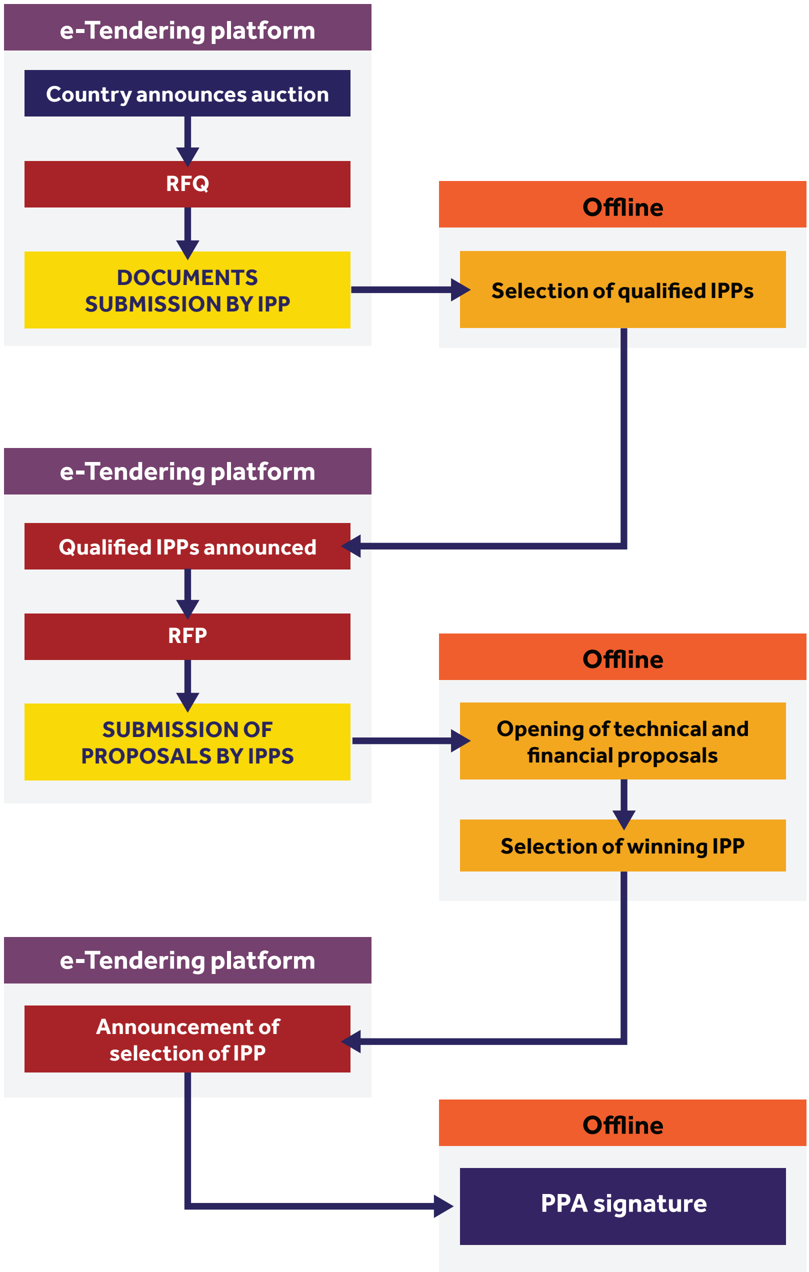
Bid bonds enable procuring authorities to eliminate frivolous or low-quality offers and bidders from the selection process and ensure that the project will be completed. All bidders may be requested to provide an adequately sized bid bond upon submitting their proposal. Release of the bid bond may occur 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, reducing the risks of complications during submission and increasing security while sharing documents.

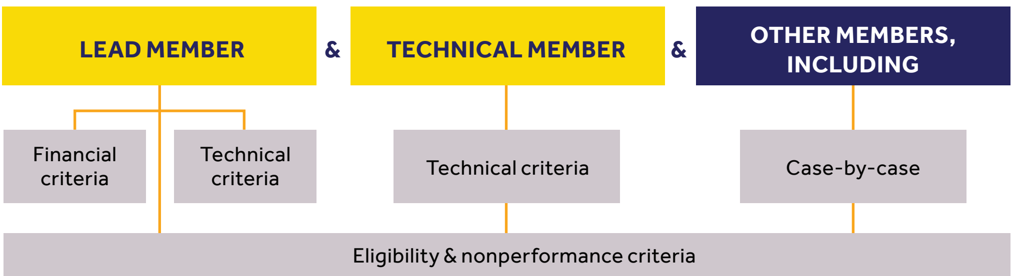
Figure 25. Key elements of the bidding process using an e-tendering platform



B. QUALIFICATION CRITERIA

Qualification criteria call for bidders' technical and financial capabilities that mesasure their experience, readiness, financial closure experience, net worth, and so forth. Criteria may vary based on the bidding model (namely, substation-based or solar/wind/geothermal park/site) and, notably, 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/wind/geothermal plant during the lifetime of the PPA.

Figure 25. Qualification criteria applicable to consortium members



During the prequalification stage, the technical and financial criteria need to be clearly stated in to avoid uncertainties that might lead to complaints. Similarly, technical and financial qualifications need to be clearly stated in the RFP to ensure transparency and reduce the likelihood of complaints from those not selected.

The composition of consortia has to be clearly specified as well, with the role of each party explicitly defined. The participation of local players might be strongly encouraged under a broader strategy, or even required, to increase community participation in the solar /wind/geothermal program.

C. SELECTING THE WINNING BID

The winning bid could be selected in either of the following ways:

- based solely on the criterion of price, with the project awarded to the bidder with the lowest tariff, or the lowest tariff plus grid reinforcement costs;
- through a weighted average criterion, where 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/wind/geothermal park/site 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/wind/geothermal park/site (feasibility study, land ownership documents, etc.) and for the substation-based bidding the 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*), and 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, wind or geothermal park/site is to be combined with prepackaged guarantees/financing, bidders can 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 but that are not as competitive as they might 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, wind or geothermal park/site 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, or partial (O&M) 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

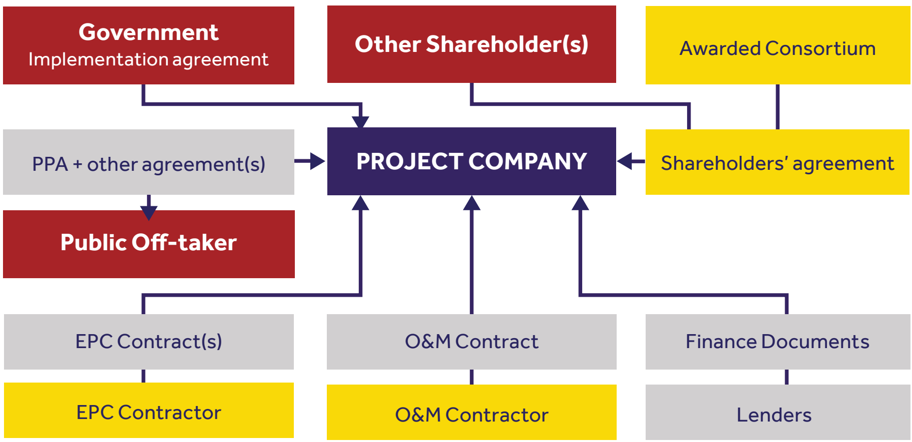
The contractual arrangements set forth in the RFP need to address all key risks, with clear risk-allocation mechanisms presented in the contract documents. Before drafting these documents, a detailed risk-allocation matrix outlining these mechanisms should be finalized, taking into account key takeaways 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 grid maintenance downtime. Stringent insurance requirements should be included in the bidding documents to enable adequate insurance 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 RE projects is represented in the figure below.

Figure 26. The typical contractual structure of an IPP-owned RE 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/wind/geothermalpark/site agreement covering various elements of the park's infrastructure/services.
- An implementation agreement, reflecting government-granted support for the project, will be signed by the project company. The strength of this critical agreement varies. Is it a simple letter of comfort? Or does it guarantee that the government will pay the amount due to the project company by the public off-taker in case the off-taker defaults. The nature and scope of the required support have to be assessed in light of the overall risk-allocation framework, the creditworthiness of the off-taker, the market practices in the country and its track record, etc.

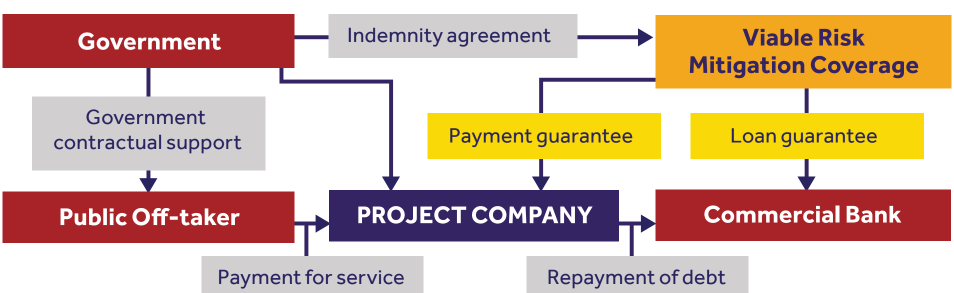
C. ASSOCIATED BONDS, LETTERS OF CREDIT, AND GUARANTEES

- 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. The figure below 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 obligation of the public off-taker for a rolling six-month period is usually required when the off-taker has a perceived liquidity risk. Where the public off-taker has weak creditworthiness, the IPP will need a support mechanism to back the off-taker's payment obligation 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 28. Illustration of guarantee structure



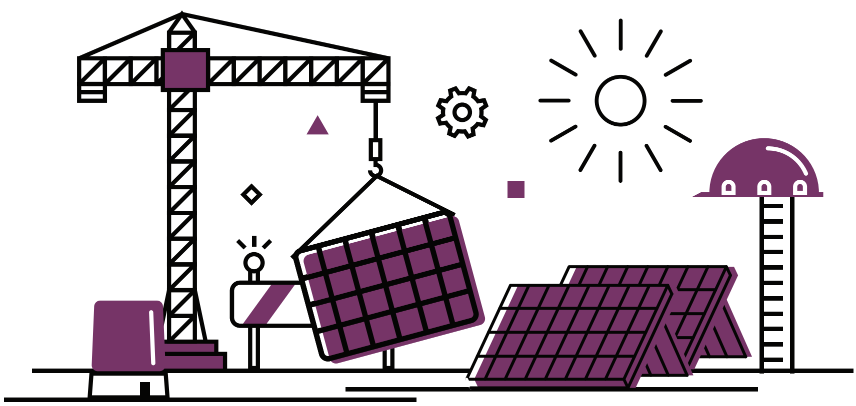
5.5 CONSTRUCTION AND PRODUCTION

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 is given technical requirements for construction and O&M. The government needs to follow these to ensure that the design aligns with the grid and country requirements. The utility will usually check, prior to connection, that technical requirements are being followed.

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

At the end of the PPA tenure, if the PPA was a build, operate, and transfer 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 predefined performance criteria. A transfer made under the build, operate, and transfer schemes tend, however, to be quite complex because of taxes and decommissioning.



6

CONCLUSION

CONCLUSION

At the end of the implementation phase, a country will have a sustainable, affordable pipeline of RE projects financed by the private sector and supported by fair risk allocation. The government can capitalize on its RE programs to fight climate change, fulfill its nationally determined contributions, support its energy access agenda, and improve energy security while maximizing its socioeconomic 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. The table below presents an example of a risk allocation matrix with associated mitigation instruments.

Table 6. Solar, wind and geothermal deployment risk allocation matrix with associated mitigation instruments

TOPIC OF CONCERN	RESPONSIBILITY	MITIGATION
		PROCESS RISKS
Project relevance to country objectives	Government	Least-cost plans defined at the planning phase. Clear technical specifications shared in the bidding process.
Procurement	Government	Clearly defined stakeholder roles and responsibilities during deployment, supported by the 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)
Insufficient 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.

CONSTRUCTION		
Environmental and social issues	IPP	Mobilization of land under solar/wind/geothermal park/site scheme by the government. Additionally, for geothermal sites analyses of seismic events and pollution.
Permitting	IPP	Appropriate legal framework and streamlined process set by the government, further mitigated under the solar/wind/geothermal park/site scheme.
Construction delays	IPP	Liquidated damages applicable under the PPA to incentivize the IPP to comply with the contractual timeline. Solar/wind/geothermal park/site deployment scheme (this reduces this risk for the IPP, by mitigating the land access risk, but increases the risk for the government if solar/wind/geothermal park/site 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 RE integration (furthered by deployment under a substation or solar/wind/geothermal park/site 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 predefined 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 mechanisms and appropriate escrow arrangements to incentivize the IPP to comply with its maintenance obligations.
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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SRMI Sustainable Renewables Risk Mitigation Initiative