The Role of the Public Sector in Mobilizing Commercial Finance for Grid-Connected Solar Projects

Lessons Learned and Case Studies

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THE ROLE OF THE PUBLIC SECTOR IN MOBILIZING COMMERCIAL FINANCE FOR GRID-CONNECTED SOLAR PROJECTS

Lessons Learned and Case Studies

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ACKNOWLEDGMENTS

This report was prepared by Monyl Toga Makang and Zuzana Dobrotkova. The team would like to acknowledge the leadership and the advice provided by Riccardo Puliti, Rohit Khanna, Chandrasekar Govindarajalu, Efstratios Tavoulareas, Pierre Audinet, Razvan Purcaru, Silvia Martinez Romero, Sheoli Pargal, and Vivien Foster.

The following people provided comments on the case studies: Amit Jain, Arnaud Braud, Chris Trimble, Ines Perez Arroyo, Janina Franco, Manaf Touati, Manuel Berlengiero, Manuel Luengo, Nadia Taobane, Reynold Duncan, Roberto La Rocca, Sandeep Kohli, Surbhi Goyal, Xavier Remi Daudey and Yuriy Myroshnychenko. Thao Phuong Nguyen supported the administration and the analysis of the survey results. Contributions were also received from Andrey Shlyakhtenko, Jonathan Walters, Jorge Servert, and Zhengjia Meng.

Primary research and interviews were conducted by CPCS Transcom Limited, in association with Rina Consulting.

Funding support was provided by the Climate Investment Funds (CIF), the Energy Sector Management Assistance Program (ESMAP), and the Public-Private Infrastructure Advisory Facility (PPIAF).

ABOUT THIS REPORT

This report assesses the role of public interventions in mobilizing commercial financing for grid-connected solar projects in seven developing countries—Chile, India, Maldives, Morocco, the Philippines, Senegal, and South Africa. Desktop research is complemented by interviews with development professionals, academics, and public officials, and the results of an online survey developed to gain insights and perspective from private developers and other commercial capital providers.

The report does not analyze the impact of government support on the cost of developing solar power projects, or on the level of tariffs. The focus is on the ability to attract commercial investors and lenders, without analysis of the financing terms. The scope is limited to utility-scale, grid-connected projects because of the risk concentration inherent to large projects and the importance of large-scale investments in clean energy for the transition toward low carbon development pathways. The analysis puts into perspective the linkages between global and country-specific factors, the complexity and multifaceted nature of the choices that decision makers face, and their rationale for pursuing a specific course of action. For this reason, the report does not attempt to offer prescriptive solutions, but merely outlines the public interventions that have been successful and the context in which they were deployed.

The report was inspired by the lack of literature on the role of public sector interventions in mobilizing commercial financing in the global solar market, which is now considered mature. The moment is therefore ripe to bring lessons from the take-off phase of solar deployment and adapt approaches to solar deployment to this new era of a truly global and competitive solar market.

The report is intended for policy makers and development partners, including development banks and other donors providing technical assistance in developing countries. It should also be of interest to investment and commercial banks, developers, investors, and other players active in the solar market. For governments and policy makers, the findings are expected to inform decisions on allocating public financing for leveraging commercial investments and inform their decision-making process. For development partners, the report provides a useful perspective on their efforts to attract non-public sources of financing in support of the development agenda.

ABBREVIATIONS

AC	alternative current
ADB	Asian Development Bank
AfDB	African Development Bank
ANER	National Agency for Renewable Energies
ASPIRE	Accelerating Sustainable Private Investments in Renewable Energy
CERC	Central Electricity Regulatory Commission
CIF	Climate Investment Funds
CNE	Comisión Nacional de Energía
CO_2	carbon dioxide
COE	Certificate of Endorsement
COP	Conference of Parties
CRSE	Electricity Sector Regulatory Commission
CSP	concentrated solar power
CTF	Clean Technology Fund
DC	direct current
DNI	direct normal irradiance
DOE	Department of Energy
EPIRA	Electric Power Industry Reform Act
ERC	Energy Regulatory Commission
EU	European Union
EUR	Euro
FIT	Feed-in tariff
FONSIS	Fonds souverain d'investissement stratégiques
GCF	Green Climate Fund
GDP	Gross Domestic Product
GFSA	Government Framework Support Agreement
GW	gigawatt
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation

IMF	International Monetary Fund
INR	Indian Rupee
IPP	independent power producer
IREDA	Indian Renewable Energy Development Agency
JICA	Japan International Cooperation Agency
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
LPDSE	Lettre de Politique du Développement du Secteur de l'Energie
MASEN	Moroccan Agency for Solar Energy
MEMDD	Ministry of Energy, Mines and Sustainable Development
MNRE	Ministry of New and Renewable Energy
MPE	Ministry for Petroleum and Energy
MW	megawatt
MWac	megawatt alternative current
MWh	megawatt hour
NDC	Nationally Determined Contribution
NERSA	National Electricity Regulator of South Africa
NGCP	National Grid Company of Philippines
NGO	nongovernmental organization
NREB	National Renewable Energy Board
NREP	National Renewable Energy Policy
OECD	Organisation for Economic Co-operation and Development
ONEE	Office Nationale de l'Electricité et de l'Eau Potable
PHP	Philippine peso
POISED	Preparing Outer Islands for Sustainable Energy Development
PPA	power purchase agreement
PPP	public–private partnership
PSE	Plan Senegal Emergent
PV	photovoltaic
PVOUT	photovoltaic electricity output
REIPPPP	Renewable Energy Independent Power Producer Procurement Program
RUMSL	Rewa Ultra Mega Solar Park Ltd.
SECI	Solar Energy Corporation of India
SEGS	Solar Energy Generating Systems
SERC	State Electricity Regulatory Commission
SIC	Central Interconnected System
SING	Northern Interconnected System

SREP	Scaling-Up Renewable Energy Program
STELCO	State Electric Company Ltd.
TWh	terawatt hour
UDAY	Ujwal Distribution Company Assurance Yojana
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollar
USAID	United States Agency for International Development
VRE	variable renewable energy
WESM	wholesale electricity spot market
XOF	West African CFA franc

CHAPTER 1 LESSONS LEARNED FROM SEVEN DEVELOPING COUNTRIES

Background

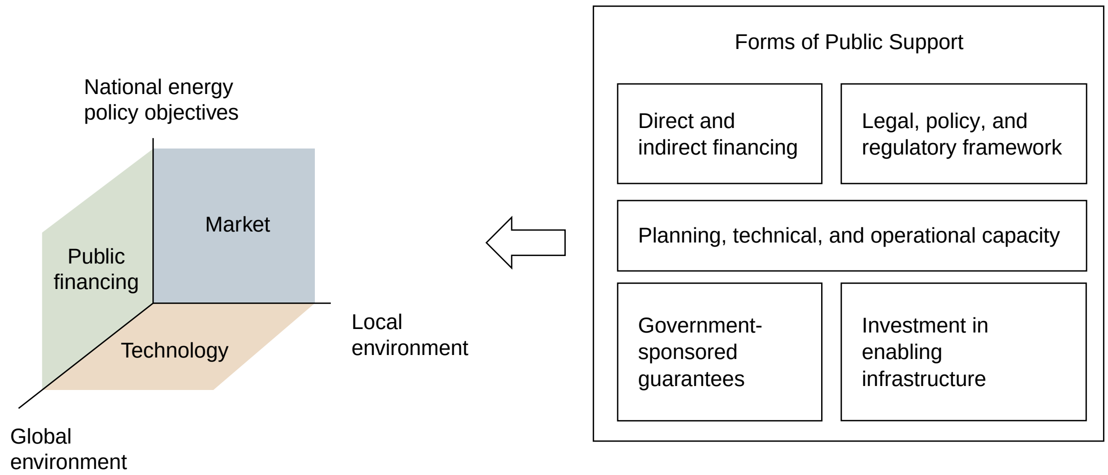
The need to diversify the energy mix, enhance energy security, reduce exposure to fossil fuel price volatility, and decrease global emissions of greenhouse gas is central to the deployment of utility-scale solar projects. The public sector alone cannot provide the trillions of dollars needed to provide universal access to electricity and meet the climate change goals. However, it plays an important role in removing market barriers to catalyze commercial financing to achieve energy policy objectives.

For the purposes of this report, commercial financing refers to financing provided on market terms that imposes the commercial discipline of capital markets, in contrast to financing provided on favorable terms, such as below-market interest rates, long grace periods (during which only interest or service charges are due), and/or longer loan repayment periods. Examples of commercial financing include funding provided by private investors, commercial banks, and other stakeholders, such as pension funds; financing provided by a development finance institution to a private investor on commercial terms; and financing raised by a public utility from commercial banks, through a bond issuance, or a stock exchange listing. In this report, the terms "private" and "commercial" are used interchangeably when referring to investors and financing sources.

The analytical framework used in this report consists of three pillars: the technology, the market, and the financing. First, from a technology perspective, the solar PV market for power generation is growing rapidly, with early signs of consolidation in some markets (including China, Japan, Europe, and the United States). CSP deployment is growing at a slower pace and is being deployed at scale only in some regions (for example, the Middle East and North Africa). These developments promote economies of scale and the convergence toward the cost of fossil fuel generation. Second, the size of the local market and its attractiveness to domestic and foreign companies and investors are important factors to be considered. Finally, all countries do not have equal access to an abundant supply of public funds to support the deployment of the solar market. The opportunity cost of public investment in solar also varies from one country to another. Thus, when deciding on the scope of public support to solar development, policy makers consider the availability of adequate and suitable sources of financing to pursue a range of policy objectives (for example, reduce cost, increase supply, or promote local economy).

In this analysis, the forms of support deployed by the public sector to create a market for solar power generation, mitigate investment risks, or achieve specific national energy policy objectives are grouped into five categories: (i) direct and indirect financing; (ii) legal, policy, and regulatory framework; (iii) planning, technical, and operational capacity; (iv) government-sponsored guarantees; and (v) investment in enabling infrastructure. Figure 1.1 represents the three pillars and the five forms of public support of the analytical framework.

Figure 1.1 Drivers and typology of public interventions



Direct financing encompasses concessional loans and grants from governments for solar power generation plants. It also includes equity investments for which the return is below the level required by commercial investors. Indirect financing refers to fiscal and financial incentives (for example, subsidies) provided by a government to solar market investors. The legal, policy, and regulatory framework comprises laws, policies, regulations, and guidelines governing private investment in renewable energy in general, and solar in particular. Planning, technical, and operational capacity affects the extent to which national actors account for the introduction and subsequent expansion of solar deployment in the power sector, and can effectively maintain the integrity and the stability of the electricity grid. Government-sponsored guarantees refer to commitments made by sovereign entities to compensate commercial investors for payment defaults due to the failure by state-controlled entities to honor their contractual obligations. Finally, investment in enabling infrastructure refers to major capital expenditures, excluding investments in solar plants, undertaken by the public sector to facilitate the development of solar projects. Table 1.1 presents specific examples under each of these categories and lists the case studies where these interventions have been relevant.

Table 1.1 Examples of public sector action for solar energy deployment

Form of public support	Direct and indirect financing	Legal, policy, and regulatory framework	Planning, technical, and operational capacity	Government-sponsored guarantees	Investment in enabling infrastructure
Examples of specific tools used	• Concessional and non-concessional loans • Equity investment in project development companies • Tariff subsidies • Price-based incentives (FITs, premium over spot price) • Tax incentives and fiscal exemptions • Grants (for project preparation or capital investment, for example)	• Laws governing private sector investment in RE • Clear market rules and well-defined procurement mechanisms (competitive tenders, negotiated deals, net metering, and so forth) • Transparent price-setting and adjustment mechanisms • Technical regulations and standards (for example, grid access and connection) • Licensing and permitting regime	• Data on solar resource • Generation and transmission plans that account for solar expansion • Grid integration studies • Zoning for solar development • Grid operational management and dispatch that account for the variability of the solar resource	• Credit guarantees • Payment and liquidity guarantees • Indemnity agreements • Other payment security mechanisms	• Investment in transmission lines • Investment in grid infrastructure • Development of solar parks
Relevant country case studies	Direct financing: Morocco Indirect financing: All the countries except Chile	All the countries	India, Chile, South Africa	Chile, India, Morocco, South Africa	Chile, India, Morocco, South Africa

The following section presents the most relevant forms of public support that enabled the development of grid-connected solar projects based on the experience of the case study countries. It is structured according to the three pillars of the analytical framework: technology, market, and public financing. The first subsection examines how the technology deployment influenced public support. The second subsection discusses the impact of the size and the attractiveness of the local market on the role of the public sector. The last subsection presents how the selected countries used public financing to support solar deployment. The final section outlines the main takeaways from the analysis.

Factors That Influenced the Scope of Public Support

The Impact of the Technology

Solar energy technology received public financing during its early development stage. This financing was deployed initially in the form of grants and loans for research and development and pilot plants. Policy instruments later supplemented public financing to foster the development of first-of-a-kind plants. This support was critical to build capacity in the pioneer countries, creating a crucial number of scientists, engineers, and industry players. Solar PV and CSP are now seen as mature technologies, except for specific applications such as floating solar. The experience of the case study countries shows that the most relevant forms of public support are: (i) legal, policy, and regulatory framework; (ii) planning, technical, and operational capacity of state actors; and (iii) investment in enabling infrastructure. The use of government-sponsored guarantees and public financing has been found to be related to the financial viability of the power sector and the pursuit of specific policy objectives respectively, rather than the technology risk or the level of solar penetration in the country.

Solar PV generation is a variable renewable energy (VRE), unlike conventional sources of power. In conventional systems, generation tracks the load. The system operator forecasts demand and manages the generation mix in real time to provide the needed energy, considering the generation, transmission, and distribution constraints and ensuring the stability of the system. But the specific characteristics of solar PV generation include: (i) electricity output which varies throughout the day with weather conditions and is not available at night; and (ii) lack of mechanical inertia making frequency deviations more common. If frequency deviations exceed specified values, solar PV plants need to be disconnected from the grid, even if there is adequate transmission capacity. CSP, on the other hand, behaves as a conventional power plant, providing inertia to the system due to its rotating generation units, and so faces less technical challenges.

As deployment of variable renewable energy increases from 'inception' through 'ramp-up' to 'saturation', the need for complementary system changes arises. During the inception phase, the proportion of solar is negligible compared to the installed capacity of conventional power, and its variability has a limited impact on the grid. Plants can be connected without adjustments to the operational management of the system. As solar penetration increases, integrated generation and transmission planning that take account of solar power development, and the elaboration of technical standards for grid connection become critical to ensure a smooth integration of the variable source of supply. Defining geographic areas for development that accounts for grid integration, grid stability, and power evacuation issues, becomes critical with rapid additions of VRE to the power system. Key stakeholders (for example, regulators, system operators) need to adjust to the changing nature of the power system and strengthen their regulatory, technical, planning, and operation capacity. Grid operators and dispatchers need appropriate forecasting tools and control systems and flexible sources of generation to manage the net load. The transmission system needs to be reinforced to avoid congestion and facilitate power evacuation. As variable renewable energy increases further, the deployment comes up against the maximum practicable level with existing assets. In the absence of additional investments, power generation needs to be curtailed to maintain the stability of the power system. The need for new transmission lines, integration into larger power systems (through regional power interconnectors), and energy storage systems become critical. The threshold levels at which a system moves from inception through ramp-up to saturation depend on the characteristics and robustness of the power system. Table 1.2 presents the evolution of public support for solar PV as the penetration of VRE increases in the national electricity grid based on the experience of the case study countries.

Legal, Policy, and Regulatory Framework

From a technology perspective, the legal, policy, and regulatory interventions relate to the establishment of technical requirements and mechanisms to facilitate the integration of solar PV plants and maintain the stability of the grid. Doing so requires instruments such as grid codes, incentives, or market remuneration mechanisms for frequency or reserve capacity. Power curtailments in countries such as Senegal and South Africa have been partly attributed to the absence of such technical requirements. In the long run, as the penetration of solar PV increases, the absence of adequate technical standards could deter commercial investment. When asked to rate the importance of a grid code defining technical and operational specifications for the connection of solar plants in their decision to pursue an investment in a given country, approximately 45 percent and 53 percent of the survey respondents respectively indicated that it was either a critical or a moderate factor. In contrast, only 2 percent stated that it was a negligible consideration.

Planning, Technical, and Operational Capacity

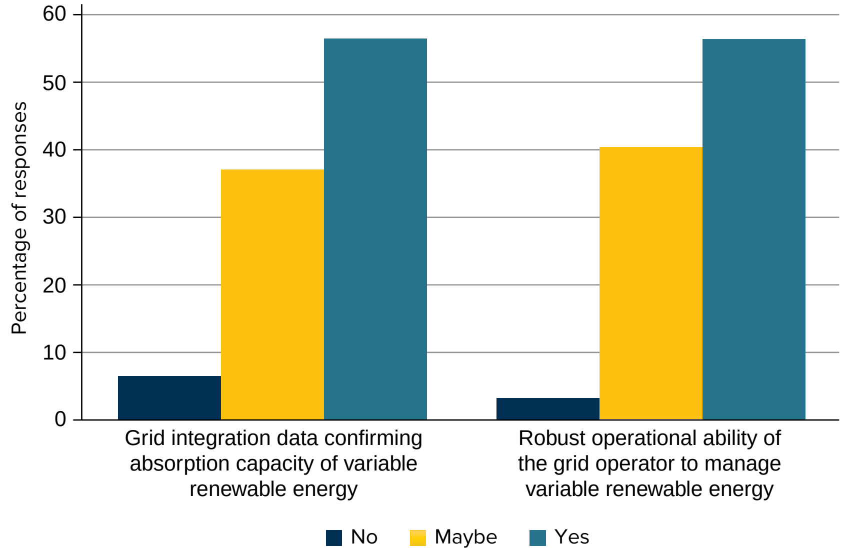
The integration of VRE into the grid and the adequate operational capacity of the grid operator are important considerations for private investors regardless of the market size. Over half of the survey responses recorded highlight that public support in these areas is needed to attract commercial investment, as shown in Figure 1.2.

Table 1.2 Evolving scope of public interventions with the penetration of variable renewable energy

	Penetration of variable renewable energy (VRE) in local power market		
	Inception First set of plants have insignificant impact at overall system level; effect is barely noticeable.	**Ramp-up** Additional plants result in large swings in the net load requiring changes in the way the system is operated; availability of flexible sources of generation becomes a concern.	**Saturation** Deployment moves toward the maximum practicable level with existing assets. Power needs to be curtailed to maintain the stability of the power system.
Legal, policy, and regulatory framework			
Incentives for firm power and grid ancillary services[a]			
Grid codes and technical standards			
Planning, technical, and operational capacity			
Integrated generation, transmission, and grid integration planning[b]			
Solar development zoning			
Training of dispatch personnel			
Demand-side management			
Investment in enabling infrastructure			
Upgrade of dispatch equipment[c]			
Deployment of energy storage systems			
Investment in transmission lines and regional interconnections			
Development of solar parks			

a. Examples include pricing the value provided by dispatchability, stability, frequency regulation, and developing remuneration mechanism
b. Examples include automated control center for variable renewable energy forecasting
c. Special care is needed to consider a rapid transition from inception to ramp-up, especially in small markets, which may lead to system bottlenecks before the necessary investments are implemented

Figure 1.2 Relevance of public support for VRE grid integration and operational capacity of the grid operator according to private investors



Smaller power systems are often weaker than larger systems, because they have fewer lines in the grid, substations, and generation units; operating these grids does not traditionally require a high level of sophistication. Many countries in Sub-Saharan Africa, some countries in Asia and Central America, and some small islands have small grids (less than 1 gigawatt or just a few gigawatts of total capacity). The simplicity of system operations, the geographic concentration of solar PV plants, the absence of interconnections to larger systems, the limited access to flexible capacity (such as hydropower resources), and the absence of reserves impede the smooth integration of VRE and threaten the stability of these power systems. The experiences of Senegal and South Africa illustrate the challenges of integrating VRE into small- and medium-size power markets.

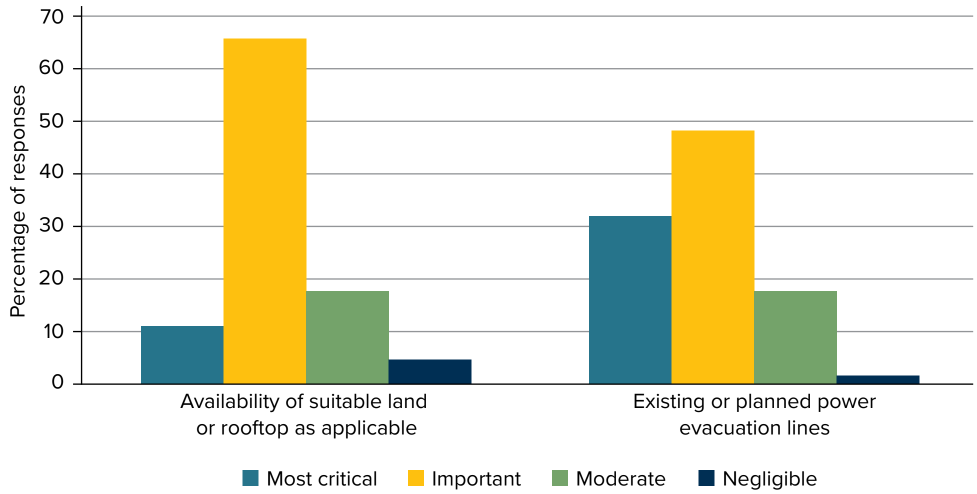
Senegal has a total installed capacity of 1,025 MW, with a predominance of thermal-based power generation. Grid-connected solar power represented about 10 percent (or 102 MW) of total installed capacity in 2018. In the preceding three years, many outages in Senegal resulted from the inability to regulate system frequency within tight bands due to the variability of grid-connected PV generation. These issues were compounded by the fact that there is no automatic control of the voltage and the frequency of the network stability by the grid operator at the dispatch center. At times, the utility must curtail power generated to maintain the stability of the grid, though it is contractually obliged to pay for the power it was not able to dispatch. With nearly 200 MW of solar PV and 150 MW of wind power purchase agreements (PPAs) already signed, and expected to be operational during the 2019–22 period, the risk of further grid instability and power curtailment will increase. The capacity of the grid to absorb variable power is the key factor limiting significant development of the solar market. Beyond 2022, Senegal's deeper integration into the regional West Africa Power Pool's power exchange system should expand the potential market size and increase the flexibility of the system.

Investment in Enabling Infrastructure

The availability of suitable land and power evacuation facilities are key investment drivers for over 70 percent of the investors surveyed (Figure 1.3).

Public financing has been crucial to the development of solar parks in India and Morocco. The use of solar parks across India has significantly de-risked the process of acquiring land and accessing the transmission grid. The solar park program targets total capacity of 40 GW. In 2017, the government of India and the World Bank announced the signing of a US$100 million financing package to provide sub-loans to

Figure 1.3 Importance of adequate land and power evacuation infrastructure according to private investors



enable selected states to invest in various solar parks, mostly under the leadership of the Ministry of New and Renewable Energy. The Shared Infrastructure for Solar Parks Project is financed through a US$75 million loan from the International Bank for Reconstruction and Development; and a US$23 million concessional loan and US$2 million grant from the CTF. The first solar parks supported under the project are in the Rewa district of Madhya Pradesh, with 750 MW targeted installed capacity (World Bank 2017). As of June 2018, the government had approved 45 solar parks across 22 states, totaling 26 GW of planned capacity (MNRE 2018).

Morocco developed the three phases of the 580 MW Noor-Ouarzazate solar complex through the solar park concept. The public sector, through the Moroccan Agency for Solar Energy (MASEN), acquired approximately 2,500 hectares of land for solar development, developed infrastructure facilities such as roads, power evacuation lines and water supply, and secured all the permits and authorizations needed to develop the project. This public support reduced investment risk for the private sector, and helped to position Morocco as a world leader in CSP technology.

Grid infrastructure such as power interconnectors becomes critical as the share of variable renewable energy continues to increase. In Chile, transferring power from solar plants concentrated in the northern part of the country to the major load centers far in the south created grid congestion in some areas, triggering power curtailment and imposing significant losses to IPPs. Its congested transmission system has been widely regarded as a hindrance to the scale-up of renewable energy. As a result, some solar project developments were put on hold because of uncertainty regarding their ability to effectively deliver the power produced. In 2016 the government of Chile formalized its commitment to address these transmission issues by passing a major electricity transmission law. Several transmission projects are now under construction or have been commissioned, creating new market opportunities and increasing the stability of the power system and the security of supply.

India's Green Energy Corridor, which seeks to remove bottlenecks by connecting renewable energy–rich regions to the western and southern power grids helps improve transmission capacity and interstate connectivity. The government is also considering investment in storage, both jointly with variable renewable assets in hybrid power plants and as stand-alone grid assets.

In South Africa, the rapid scale-up of solar PV power has sparked the need to alleviate transmission constraints and enhance the stability of the power system. In 2018, South Africa launched a battery storage program to enable a higher penetration of variable renewable energy (including solar PV power). When completed, the program is expected to deliver at least 1,440 MWh of storage per day. Co-financing of US$655 million is being provided by the World Bank, the African Development Bank (AfDB) and the CTF. In parallel, the South African electricity utility Eskom is strengthening its renewable energy forecasting abilities and increasing the availability of flexible, dispatchable generation units to respond to variations in renewable energy output (World Bank 2018a).

Table 1.3 Forms of public support relative to the size of the local market

Power market size	Small islands	Small power market[a]	Medium-to-large power market	Very large power market
Total installed capacity (GW)	0–1	0–5	6–99	100 and above
Case study countries	Maldives	Senegal	Chile, Morocco, Philippines, South Africa	India
Legal, policy, and regulatory instruments				
Feed-in tariffs/feed-in premiums	No	No	FIT in the Philippines	No
Target and quota obligations	No	Yes	Yes	Yes
Competitive auctions	Yes	Yes	Yes (except in the Philippines)	Yes
Wholesale electricity spot market	No	No	Yes in Chile and the Philippines only	No
Open grid access	No	No	Yes (Chile)	Yes
Regulatory capacity building, advisory support, and technical assistance	Yes	Yes	Yes (no evidence in Chile)	Yes
Government-sponsored guarantees				
Fully-fledged sovereign guarantees	Yes	Yes	Yes in Morocco only (for lenders, private developers received letters of comfort)	No
Other credit enhancement mechanism	Yes (liquidity fund backed by a letter of credit)	No	Yes in South Africa only (commitment included in the Implementation Agreements signed with IPPs)	Partial (security fund to cover payment defaults from distribution utilities)

a. Other than small islands with a total installed capacity varying between 0 and 1 GW
FIT: feed-in tariff
IPP: independent power producer

Market Size and Attractiveness

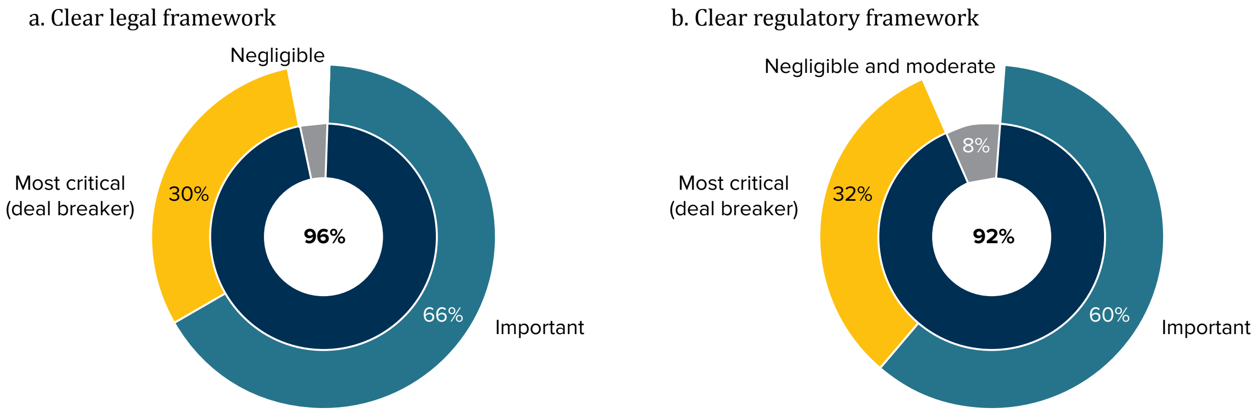
The types of public support that are directly linked to the nature and the characteristics of the local market are related to the legal, policy and regulatory framework, and to government-backed guarantees. The latter have been mostly used in countries that have a limited record of commercial investment in the power sector, where the power market is dominated by a single-buyer utility, and private investors are concerned about the ability of the state-owned utility to honor its payment obligations. The experience of the case study countries is summarized in Table 1.3.

Legal, Policy, and Regulatory Framework

The presence of a conducive legal and regulatory framework was among the top-rated investment drivers identified by the investors surveyed for this study (Figure 1.4).

Countries that have supplemented the publication of renewable energy target capacities with supportive and coherent sector laws, regulations, policies, and action plans; adopted tested mechanisms for private sector participation; and clearly communicated their medium- to long-term power procurement strategy, have been able to attract a high level of interest from private investors and commercial financiers. Among

Figure 1.4 Importance of legal and regulatory frameworks for private investment in renewable energy according to private investors



the countries selected for the case studies, Chile has been the most successful in this regard.

Chile's experience underlines that an established regulatory framework that supports private investment in the electricity sector and the presence of strong off-takers are key to the rapid scale-up of solar investment. As markets mature, the importance of concessional and development finance loses its significance. Chile's electricity grid has integrated solar PV generation capacity at one of the fastest rates in the world. The share of solar energy in installed generation capacity rose from barely 2 percent in 2015 (or 0.6 GW) to about 13 percent (or 2.3 GW) in December 2018, catalyzed by over US$5 billion in commercial capital.

Chilean banks play an important role in financing solar PV and merchant plants in Chile. CSP has taken more time to establish itself with only 40 MW of capacity commissioned, primarily to provide steam to mining projects rather than to generate power. In 2012, the CTF approved a concessional loan of US$67 million, along with other donor funding, out of a total financing envelope of approximately US$400 million to support the construction of the first CSP plant in Latin America (CIF 2012, IDB 2012). The Chilean government also offered incentives, through the Support for Non-Conventional Renewable Energy Development Program, including a US$20 million grant and a concession for land in the Atacama region. The tender was awarded to the 210 MW Cerro Dominador project (110 MW of CSP and 100 MW of PV). The project was subsequently delayed as the developer faced financial difficulties. In May 2018, Chile announced that the CSP part of the Cerro Dominador project, a 210 MW plant (110 MW of CSP and 100 MW of PV) with 17.5 hours of thermal storage, had been able to attract financing of US$758 million. Chile's success in solar power deployment has been achieved without public or concessional financing.

Country-specific factors partially explain Chile's successful solar deployment journey. First, the country is endowed with some of the world's highest solar irradiation, which provides exceptional resources for both solar PV and CSP deployment. Second, Chile has a long history of private sector participation in the electricity sector, which started in the 1970s. To date, the private sector controls the totality of electricity production. Next, the country has one of Latin America's strongest sovereign credit ratings for long-term debt in both foreign-denominated and local currency and thus is a very attractive destination for private investment. Finally, Chile's strong institutional capacity, and the restructuring of the auction process for the procurement of power by distribution companies, have been the most instrumental success factors. Thanks to increased competition and the declining costs of solar technology, bids to supply solar power have come in at some of the lowest prices in the world in recent years.

The case of the Philippines shows that even in markets with a track record established through successful rounds of solar power procurement, market interest can be eroded if public stakeholders are perceived to abruptly change existing policies and regulations. The Philippines procured a substantial portion of its solar capacity through a feed-in tariff (FIT) program which was introduced through the 2008 Renewable Energy Act and implemented in 2012. At the time the Act was developed, FIT programs were common around the world, as the price of solar was higher than that of other generation sources. The FIT was awarded on a first-come, first-served basis for projects that had achieved at least an 80 percent construction completion rate. The "race to FIT" meant that developers had to shoulder significant risk at the development and construction stage of their projects. For this reason, and due to limits on foreign asset ownership imposed by the Constitution, most projects were financed on a corporate finance basis (that is, without recourse to the project assets) by the project sponsors, sometimes with the support of engineering, procurement, and construction companies that were willing to take on project risk. Both private and government-owned banks in the Philippines were eager to lend to companies involved in the FIT program. By the end of March 2016, following two rounds of FIT awards, approximately 818 MW worth of solar projects had been completed and commissioned, only 526 MW of which were granted feed-in tariff status, in compliance with the prevailing allocation policy. About five months later, outstanding unallocated capacity had risen to almost 400 MW. After some period of uncertainty, the Philippines' Department of Energy announced that there would be no further rounds of feed-in tariff. The announcement dealt a blow to investors, who had hoped for continuing tariff support through a similar mechanism (Riveira 2016, Velasco 2017). Projects that had not managed to enter the FIT scheme thereafter resorted to alternative off-take arrangements (that is, spot market or negotiated contracts), which offer less price protection. The FIT program demonstrated that the private sector in the Philippines has the technical and financial capacity to develop solar power, especially given the generous tariff (averaging US$0.198 per kWh).

The feed-in tariff was successful in scaling up investment in solar PV, but subsequent progress was limited. However, on December 30, 2017, the Department of Energy promulgated the rules and guidelines for the implementation of renewable portfolio standards for on-grid areas. These rules require distribution utilities, electricity suppliers, generation companies supplying directly connected customers, and other mandated energy sector participants to source or produce a minimum share of electricity from their energy mix from eligible renewable energy resources, including solar. The minimum requirement will be enforced in 2020; 2018 and 2019 being transition years. This development will potentially offer new perspectives for private investment in the grid-connected solar market.

Calls for procurement of solar power launched as part of well-designed programs have generated commercial interest, even in countries with a relatively weak regulatory environment. The most successful procurement programs involved strong political commitment and comprehensive transaction advisory support to define risk allocation and the scope of measures required to address the country's unique risk factors (from the technical, legal, regulatory, and financial perspectives); elaborate fit-for-purpose transaction documents that balance the objectives of the government and the expectations of commercial investors; and engagement with prospective investors in a transparent and open manner. These features lead to bankable project agreements, one of the most important drivers of commercial investment, as the experience of South Africa illustrates.

South Africa's Renewable Energy Independent Power Producer Procurement Program (REIPPPP) has been the cornerstone for commercial investment in solar projects in the country. Since its inception in 2010, the program procured 45 solar PV and CSP projects and facilitated the mobilization of over US$8 billion in capital.[1] By the end of 2017, South Africa had installed solar PV capacity of 2.2 GW and CSP capacity of 300 MW. The resounding success of the REIPPPP was in part attributed to pre-existing factors. South Africa's business environment is generally conducive to private investment, with an enabling legal framework that allows private investment (including foreign ownership) in power generation assets. The country has a sophisticated, well-regulated, and established financial sector with experience financing infrastructure projects. The country is endowed with exceptional resources for both solar PV and CSP development. The size of the solar market— estimated at 30 GW for CSP and 40 GW for PV—is large, and South Africa's power interconnections with other countries in the southern Africa region increases its attractiveness to private developers. In this favorable context, a well-designed competitive procurement process, combined with government support to back the off-take obligations of the national power utility Eskom, unlocked the commercial grid-connected solar market and opened the door for participation by international developers with considerable experience and capacity. An IPP Office was created to manage the REIPPPP, with experienced staff seconded from the National Treasury and the Department of Energy and extensive

1 This number is based on projects that have achieved financial close by June 30, 2018.

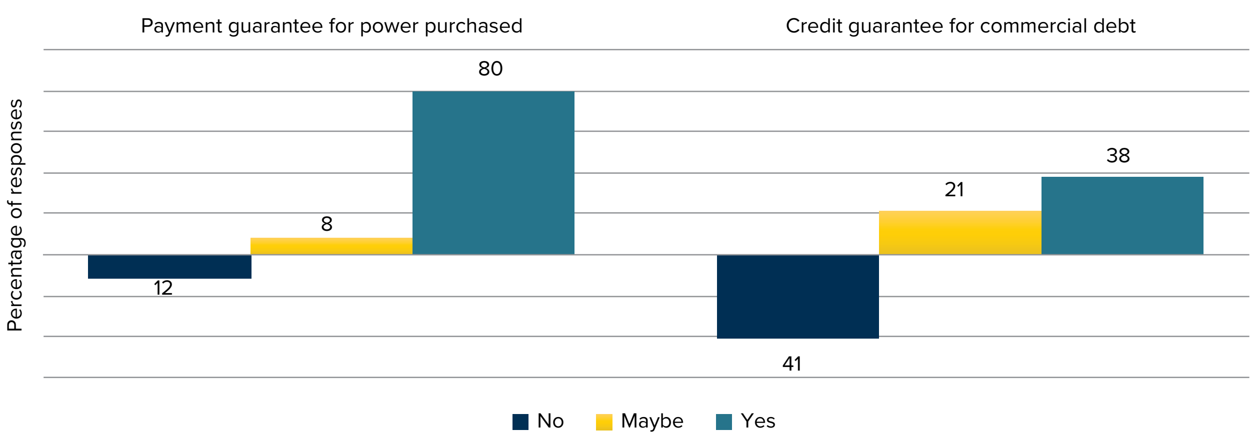
support from domestic and international advisers. The efficient design of the bidding process as well as the high quality of the contractual documents, which reflected a deep understanding of the private sector's perspective, helped ensure a high response rate to the tenders. Advisers helped design and manage the program, reviewed bids, and incorporated lessons learned as implementation progressed. Various bilateral donor agencies, including agencies in Denmark, Germany, Spain, the United Kingdom, and the Global Environment Facility, funded technical assistance (Eberhard et al. 2017).

Recent auction results, such as those from the Senegal Scaling Solar[2] auction, demonstrate that even countries with smaller power markets and weaker institutional capacity can procure renewable energy in a competitive, transparent manner at large scale, and obtain low prices if the risk allocation is well-designed and the commercial agreements are bankable. In October 2017, Senegal launched a request for proposals for the procurement of up to 100 MWac of solar capacity. Thirteen prequalified bidders participated in the tender. The results were published in April 2018. Two projects totaling 60 MWac were awarded to a consortium of international developers. The resulting tariff for the first year is EUR 0.038 (US$0.047) per kWh for the first plant and EUR 0.03987 (US$0.049) per kWh for the second, a record low for Sub-Saharan Africa (IFC 2018).

Government-Sponsored Guarantees

Governments have addressed payment concerns by offering sovereign guarantees, indemnity, and in some cases, comfort letters. Investors indicate that they prefer guarantees issued by creditworthy third parties (such as multilateral development banks) when there are concerns about the financial capacity of the government to meet its commitment or the legal underpinning of such commitment. Approximately 90 percent of the private investors surveyed for this report ranked the absence of a track record of honoring power payments by state-owned entities as the most critical barrier to the deployment of solar projects (Figure 1.5). Among the credit risk mitigation measures, the availability of payment guarantees for the power purchased was the most important public intervention supporting the mobilization of commercial financing.

Figure 1.5 Relevance of public support for guarantees and credit risk mitigation instruments for utility-scale solar deployment according to private investors



Maldives, Morocco, Senegal, and South Africa have all backstopped the financial obligations of state-owned off-takers to enable private developers to mobilize commercial financing for solar projects. Chile did not provide guarantees to investors, since distribution companies are privately owned and end-user tariffs are cost reflective.

2 Scaling Solar is an approach developed by the World Bank Group that aims to accelerate private development of large-scale grid-connected solar PV projects in emerging markets using a one-stop shop package that includes fully developed and bankable project agreements; pre-approved indicative terms for financing, guarantees, and insurance; and legal, technical, and financial advisory services to support governments from project preparation to contract award.

The experience of Maldives reveals that during the early market development stage and in the presence of financially weak state-owned single-buyer off-takers, governments need to support guarantees and credit-enhancement mechanisms (for example, escrow accounts) to mitigate the risk of nonpayment. Maldives is one of the world's most geographically dispersed countries, with 1,192 islands spread over an area of 115,300 square kilometers. Electricity production from solar resources increased from less than 1 MW in 2011 to approximately 9 MW in 2017. Private sector–led solar investments outside the resort islands are very limited. Barriers to commercial solar projects include inadequate or missing regulatory frameworks, grid integration issues, lack of land, absence of planning, limited rooftop space on densely populated islands, off-taker payment risk, and lack of domestic financing for renewable energy projects. In 2016, the government of Maldives launched the Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) program, which aims to encourage private sector investment in the renewable energy sector. The first subproject procured through the ASPIRE program was awarded to a Chinese-Swiss consortium and commissioned in March 2018. The 1.5 MW solar rooftop facility, on the island of Hulhumalé, is only the second independent power project in Maldives. In the first IPP, a local company, Renewable Energy Maldives, installed 652 kW grid-connected solar PV modules across six islands in 2012. The combination of a government-backed guarantee from the World Bank and a payment facility pre-funded through a grant from the Scaling-Up Renewable Energy Program (SREP), has been critical to the successful procurement of the subproject (Kohli and Braud 2016). The government is committed to applying the lessons learned from this subproject to design the next procurement phases. Future projects could include guarantees as an option, to be applied at the discretion of bidders. There is also interest in exploring how public financing could be used to bring down interest rates for local financing programs.

The extent to which commercial solar deployment can rely on government guarantees and similar arrangements is limited by the size of national budgets. Long-term solutions involve sector reforms to achieve financial equilibrium in the power sector and turnaround of financially weak utilities (so that they can tap capital markets, borrow, or sign power purchase agreements without a counter guarantee from the state).

Availability and Use of Public Financing

Public funding has helped governments pursue specific policy objectives based on their national development priorities (for example, reduce the tariff by reducing project development and financing costs, to facilitate access to finance by local investors). Among the public sources of funds, concessional funding for climate action has been a central element of international climate change agreements to encourage countries to transition toward low-carbon emissions and climate-resilient economies.

The analysis of the case study countries shows that there is no convergence in how they used direct and indirect public financing for solar deployment, as presented in Table 1.4. Overall, countries with the most developed financial markets (such as Chile and South Africa) have attracted robust commercial capital inflows using market-based mechanisms, without targeted financial incentives. In 2010–11, countries such as Morocco successfully mobilized substantial low-cost concessional funding to support the implementation of their solar strategies.

Direct Financing

Only 8 percent of the survey responses indicated that direct financing by the public sector in solar generation assets (for example, equipment and civil works) was an important investment consideration, compared to 66 percent which characterized this form of public intervention as nonessential. However, blending public concessional sources of funds with commercial finance has helped develop projects that were not viable on fully commercial terms.

The government of Morocco used a combination of grants, concessional debt, and non-concessional debt to co-invest in a project development company alongside a private developer. The use of public concessional funds allowed Moroccan Agency for Solar Energy (MASEN) to lower the cost of debt financing, improve the viability of CSP development, and ultimately reduce the tariff subsidies needed. Since 2010, approximately US$4.3 billion (including US$3 billion in public, multilateral, and bilateral funding) has been invested

Table 1.4 Use of public financing for the development of solar plants

Availability of commercial financing	Low	Moderate	High
Source of commercial funds	Mostly international	Local and international	Mostly local
Case study countries	Maldives Senegal	Morocco Philippines	India Chile South Africa
Direct and indirect public financing			
Direct financing	No	Morocco only	No
Indirect financing	Yes (fiscal incentives)	Yes (fiscal incentives and feed-in tariff in the Philippines, tariff subsidies in Morocco)	Yes (fiscal incentives in India and South Africa, viability gap funding in India, financing of selected local investor groups through public financial institutions in South Africa) None in Chile

in the Moroccan solar market (World Bank 2018b). For the international donor community, supporting CSP in Morocco was an opportunity to introduce renewable energy in the Middle East and North Africa, accelerate the global CSP learning curve, and develop a global public good that would contribute to the deployment of CSP worldwide. With the successful mobilization of substantial low-cost concessional funding in support of Morocco's solar ambitions, 2010–11 saw concerted efforts from all key public stakeholders to kick-start the implementation of the country's solar strategy.

In 2014, Morocco also mobilized approximately US$24 million from the CTF to finance the development of three 25 MW solar PV plants by the national power utility, ONEE; the capacity was later upgraded to 40 MW for each plant. The CTF has provided US$435 million of highly concessional finance for the three CSP plants, with additional financing provided by the World Bank, the AfDB, and other international financial institutions (CIF n.d.). The involvement of the CTF and international finance institutions significantly reduced the cost of capital for developers, thereby lowering the cost of electricity generated. The country will host one of the world's largest solar complexes, with approximately 580 MW installed capacity when completed. In 2017, solar represented 181 MW (or 2 percent) of the country's 8.8 GW electricity installed capacity.

Indirect Financing

Approximately 82 percent of the survey responses indicated that fiscal incentives were moderately important or desirable to support commercial investment for solar deployment. Countries offer fiscal incentives to attract private investments in the solar industry to reduce the tariff. In India fiscal incentives are embedded in both central- and state-level legislation. The central government provides direct tax benefits, such as sales tax exemptions or reductions, excise duty exemptions, and custom duty exceptions. Project developers are also exempted from income tax on earnings from selling the power produced by solar energy projects during the first 10 years of operation. In the Philippines, the fiscal incentives provided for in the Renewable Energy Act, passed in 2008, include an income tax holiday for the first seven years followed by a 10 percent income tax rate (compared with 30 percent otherwise) when the tax holiday expires and tax exemptions for the carbon credits generated from renewable energy sources (Rohankar et al. 2016).

Grants have also been used to provide up-front capital subsidies to private developers, in return for a lower tariff. This support helps improve the affordability of the power generated and encourages investors to develop projects in areas where there is limited private sector interest (for example, small projects in remote locations with low electricity demand). The tariff buy-down mechanism is embedded in the structure of Maldives' ASPIRE project. The project envisages the provision of up-front capital subsidies to the winning bidders to offset a portion of the up-front capital cost (World Bank 2014).

India implemented a viability gap funding mechanism, among other fiscal and regulatory incentives. Under this scheme IPPs were invited to bid at a fixed tariff and to indicate their subsidy requirement per MW of installed capacity. The capacity on offer is awarded to the bidder with the lowest viability gap funding requirement. The scheme was designed to address affordability issues for distribution companies. Thanks to the capital subsidy, solar power is sold to distribution companies at a below-market rate. Viability gap funding was well received by private developers, because the subsidy was granted early on in the project life cycle, thus limiting their risk.

Conclusion

Five main findings emerge from the analysis:

- **Public financing for solar PV plants is not critical, given the commercial maturity of the market.** Public support for grid-connected solar projects has evolved as the technology risk decreased, the deployment accelerated, and the costs fell. Solar PV plants can now be developed on commercial terms, worldwide. The CSP market is nearing maturity. Once markets fully monetize the full value CSP brings to the electricity system (including its contribution to grid stability), its penetration will increase, making it more competitive and obviating the need for public investment there, too.
- **Governments' plans and policies should be predictable and offer long-term visibility.** Commercial investors closely follow potential project pipelines and upcoming procurement processes. Sudden policy reversals or protracted periods of uncertainty can erode market confidence.
- **Governments should undertake reforms for financially sustainable power utilities, to reduce the reliance on government guarantees.** While solar deployment can be supported by credit enhancement mechanisms such as guarantees in the short-to-medium term, the extent to which such mechanisms can be sustained over time is limited by fiscal constraints and budgetary restrictions. Over the long term, reforms are needed to avoid the recurrent need for state guarantees and similar instruments that impact on national budgets.
- **The capacity of key institutional stakeholders should be strengthened.** Most developing countries need to build institutional capacity and strengthen the technical and operational management of key institutional stakeholders, grid operators, regulators, and state-owned utilities to face the challenges associated with the scale-up of solar power. Regulators and policy makers need to keep abreast of the development of solar technologies, their applications, and benefits, to design fit-for-purpose responses that would maximize the value added and attract commercial interest. Operational and technical capacity-building is needed to enhance the ability of grid operators and power sector planners to face the challenges linked to the management of the solar power.
- **The public sector should invest in grid infrastructure, especially for solar PV deployment.** Grid integration and VRE dispatch capability are important considerations for commercial investors regardless of the market size. The importance of these factors increases with higher levels of solar penetration. The scale-up of grid-connected solar power projects requires public investment in automated control centers, transmission infrastructure, regional power interconnectors, and energy storage systems. Optimal solutions will vary across countries.

References

CIF (Climate Investment Funds). n.d. Projects in Middle East and North Africa Region https://www.climateinvestmentfunds.org/country/middle-east-and-north-africa-region

———. 2012. CTF funding for Chile: Concentrated Solar Power Project. September 12. http://pubdocs.worldbank.org/en/482041531492777534/1762-PCTFCL201A-Chile-Approved-decision.pdf

Eberhard, Anton, and Raine Naude. 2017. *The South African Renewable Energy IPP Procurement Programme: Review, Lessons Learned and Proposals to Reduce Transaction Costs.* Cape Town: University of Cape Town Graduate School of Business.

IDB (Inter-American Development Bank). 2012. Chile CTF-IDB Concentrated Solar Power Project IDB Private Sector CTF Proposal for Submission to the CTF Trust-Fund Committee. August. http://pubdocs.worldbank.org/en/832871531492769374/1762-PCTFCL201A-Chile-Project-Document.pdf

IFC (International Finance Corporation). 2018. "Senegal Scaling Solar Tender Produces One of the Lowest Electricity Costs in Africa." Press Release. April 10. https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/4CB4EFF92BB608CE8525826B004CAECD?OpenDocument

Kohli, Sandeep, and Arnaud Braud. 2016. "Rooftop Solar in Maldives: A World Bank Guarantee and SREP Facilitate Private Investment in Clean and Affordable Energy." Live Wire 2016/61. Washington, DC. https://openknowledge.worldbank.org/handle/10986/23948

MNRE (Ministry of New and Renewable Energy). 2018. "List of Solar Parks Approved under the Solar Park Scheme of MNRE as on 30-06-2018." New Delhi. https://mnre.gov.in/file-manager/UserFiles/List-of-approved-Solar-Parks.pdf

Riveira, D. 2016. "DOE nixes expansion of feed-in tariff scheme." *The Philipphines Star,* November 4. http://www.philstar.com/business/2016/11/04/1640159/doe-nixes-expansion-feed-tariff-scheme

Rohankar, N., Jain, A., Nangia, O., and Dwivedi, P. 2016. "A Study of Existing Solar Power Policy Framework in India for Viability of the Solar Projects Perspective." *Renewable and Sustainable Energy Reviews* 50 (April): 510–518.

Velasco, Myrna M. 2017. "Cusi scraps next round of FIT for solar, rules no subsidy for stranded capacity." *Manila Bulletin,* May 29. https://business.mb.com.ph/2017/05/29/cusi-scraps-next-round-of-fit-for-solar-rules-no-subsidy-for-stranded-capacity/

World Bank. 2014. *Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) Project.* Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/402251468300650153/Maldives-Accelerating-Sustainable-Private-Investments-in-Renewable-Energy-ASPIRE-Project

———. 2015. *Morocco—Clean and Efficient Energy Project (English).* Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/344261468052477656/Morocco-Clean-and-Efficient-Energy-Project

———. 2017. *India—Shared Infrastructure for Solar Parks Project (English).* Washington, DC: World Bank. http://documents.worldbank.org/curated/en/916221491098471122/India-Shared-Infrastructure-for-Solar-Parks-Project

———. 2018a. *Disclosable Restructuring Paper—South Africa—Eskom Renewables Support Project—P122329 (English).* Washington, DC: World Bank. http://documents.worldbank.org/curated/en/390371543618515176/Disclosable-Restructuring-Paper-South-Africa-Eskom-Renewables-Support-Project-P122329

———. 2018b. Private Participation in Infrastructure (database). Washington, DC: World Bank. https://ppi.worldbank.org/data

CHAPTER 2 CHILE CASE STUDY

Chile is an upper-middle income country and a member of the Organisation for Economic Co-operation and Development (OECD). It is also one of the fastest-growing economies in Latin America in recent decades. The country's economy is export driven, with a focus on commodities and mining. Copper mining is the second highest contributor to the Chilean economy after the manufacturing sector. It represented approximately 8.9 percent of the GDP in 2018, compared to 10.6 percent for manufacturing industries in the same year (Banco Central de Chile 2019).

Chile has a highly developed, market-driven electricity sector and the best solar resources in the world. But the sector has been challenged by a lack of affordable sources of domestic energy supply and the desire to keep energy prices low to support the country's mining industry. Chile depends on imports for two-thirds of its primary energy supply (IEA 2018a). The decrease in solar costs has been a welcome change in the country's search for domestic sources of affordable energy production. Table 2.1. presents Chile's selected socioeconomic indicators.

Table 2.1 Chile's selected socioeconomic indicators

Indicators	Values
Population (2017)	18 million
Land area	743,532 km^2
Annual GDP growth (2017)	1.5 percent
Human Development Index	0.843 (very high)
Ease of doing business rank	55th of 190
Access to electricity	100 percent

Sources: World Bank 2018a, 2018b; UNDP 2018.

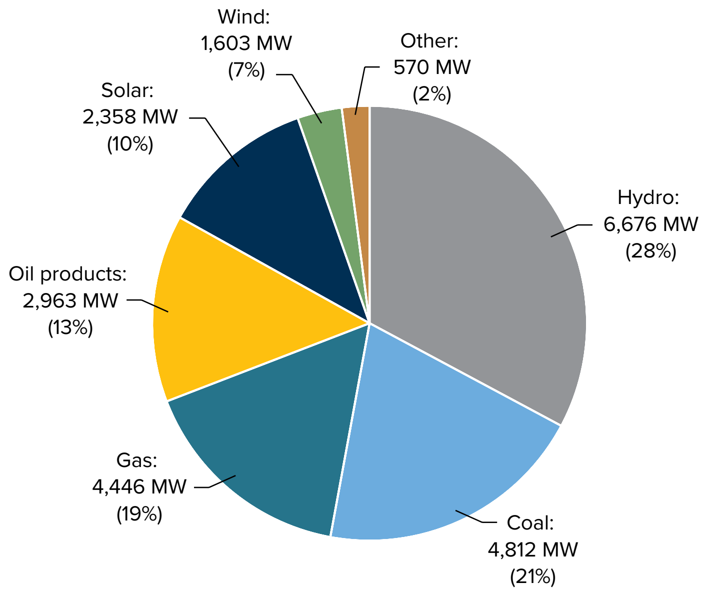
Overview of Chile's Power Sector

Electricity Installed Capacity and Consumption

Chile had been heavily reliant on its hydropower resources and import gas supply, predominantly from Argentina, to meet its energy needs until the need to diversify the power supply was put into sharp focus in 2007 and 2008, when severe droughts coincided with reduced gas imports from Argentina. The cuts resulted in load shedding and an increase in the price of electricity, as utilities were forced to resort to expensive diesel-powered generation to meet demand. The marginal price of electricity rose from about US$60 per MWh in early 2006 to as high as US$340 per MWh in 2008. The increase hurt both consumers and the competitiveness of the mining sector.

To address the situation, the government took steps to diversify the country's energy supply mix. Coal increased from 21 percent of total generation in 2000 to 41 percent in 2012, and liquefied natural gas terminals were built. However, plans to construct a 2,750 MW hydro scheme in the Patagonia region (HidroAysén) were cancelled because of public criticism. Consequently, Chile started looking seriously at the role renewable energy could play to achieve its policy objectives of security of supply, increased competition, and lower prices. Chile has total installed generation capacity of 23,428 MW. Renewable energy represents about 20 percent of capacity, of which almost half (about 2.3 GW) is solar (Figure 2.1).

Figure 2.1 Power generation mix in Chile, December 2018

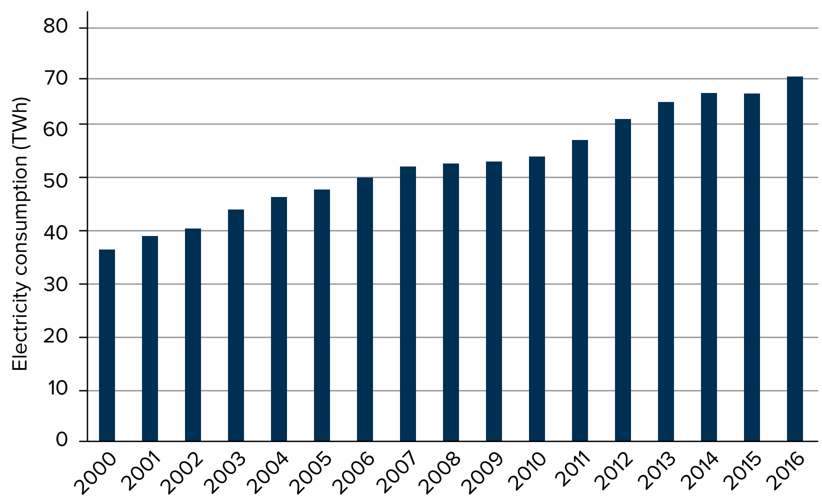


Source: CNE 2019.

Electricity demand in Chile has grown considerably since 2000, in line with economic growth. Consumption of electricity grew at a compounded average annual rate of 4.1 percent between 2000 and 2016 (Figure 2.2). Total generation in 2017 was 74.2 TWh, with fossil fuels providing almost 60 percent of generation, hydro 30 percent, and renewables the remainder (CNE 2019).

Because of its very long and narrow shape, until recently Chile had two separate energy grids, which together had more than 99 percent of the country's generating capacity.[3] The Central Interconnected Grid (Sistema Interconectado Central [SIC]) supplied energy to the major metropolitan areas of Chile; it had about 80 percent of the country's generation capacity (CNE 2019). The Northern Interconnected Grid (Sistema Interconectado del Norte Grande [SING]) supplied mostly industrial and mining-related customers in the north. The two grids are connected by two 500 kV high voltage transmission lines commissioned in November 2017.

Figure 2.2 Electricity consumption 2000–16



Source: IEA 2018b.

3 Two smaller systems, Aysen and Magallanes, are located in the south of the country, each with installed capacity of less than 200 MW.

Institutional Arrangements and Key Stakeholders

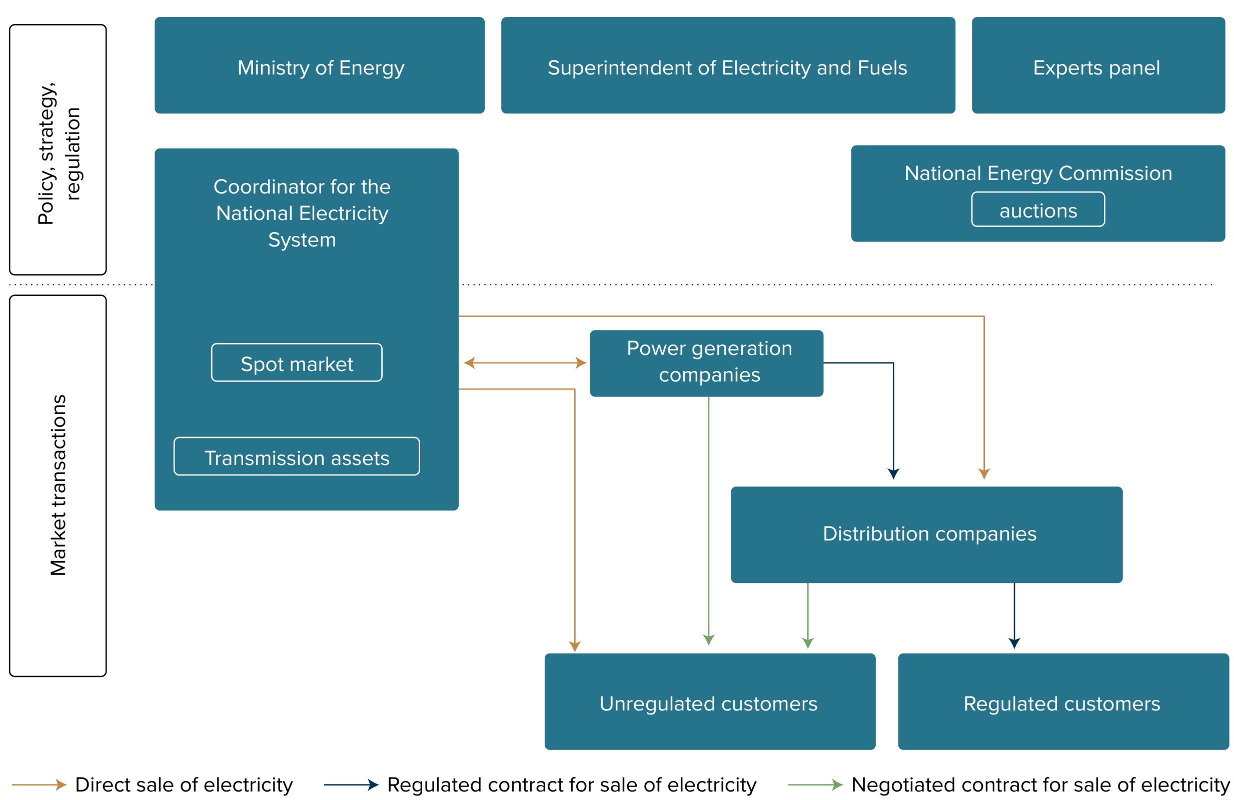
Chile was a regional pioneer in privatizing and deregulating the electricity sector. It undertook a set of comprehensive reforms in the 1970s and 1980s that restructured the two integrated public utilities, Endesa and Chilectra, into independent generation and distribution companies and privatized them. The result of the reforms, which were completed in the early 1990s, is an electricity sector that is 100 percent owned and operated by private sector players.

The independent National Energy Commission (Comisión Nacional de Energía [CNE]), a subsidiary of the Ministry of Energy, is responsible for regulation and oversight. The Superintendent of Electricity and Fuels sets technical standards and oversees compliance. A panel of experts, composed of accredited technical and legal professionals with specific expertise, resolves disputes within the sector. The grid is managed by the Coordinator for the National Electric System, which replaced the economic dispatch centers that existed for each grid before the interconnection in late 2017. It is responsible primarily for programming the dispatch of generation companies to ensure that demand is satisfied at minimum cost.

Chile's electricity system is designed to recover the full cost of providing electricity (transmission, generation, and distribution). Transmission and distribution companies are regulated as natural monopolies. Transmission companies are remunerated through tolls paid by generators in proportion to their use of facilities.

Distribution companies serve both regulated and unregulated customers within a given concession area. Regulated customers (customers whose installed power capacity is less than 500 kW) are charged a fixed connection charge plus a variable charge for energy consumed. Unregulated customers (customers with 2 MW or higher installed power capacity) are in general larger industrial customers and mining companies and constitute about 45 percent of demand. They are able to buy energy on the spot market or directly from generation or distribution companies through private power purchase agreements (PPAs). Customers with installed capacity between 500 kW and 2 MW can choose to be either regulated or not regulated (Figure 2.3).

Figure 2.3 Institutional arrangements in Chile's power sector



Key Energy Policy Objectives

The energy crisis of 2008 inspired the government to play a larger role in developing policy to support these objectives, culminating in the Energy Agenda 2014–18, the precursor to Chile's current electricity policy. This document called for the embrace of renewable energy and set a target of reducing the marginal cost of electricity in the SIC by 30 percent to below US$105.96 per MWh in 2017 (Chile 2014).

Chile's current energy policy, Energy 2050, sets ambitious goals for the share of electricity generated from renewable energy of 60 percent by 2035 and 70 percent by 2050. It also seeks to have the second-lowest price of energy in the OECD by 2050 (Chile 2016).

To define the path forward, in May 2018 the government of Chile launched an Energy Roadmap, *Ruta Energética 2018–2022.* It was developed through a participatory process with 2,200 representatives from the country's 15 regional capitals, including representatives from the public sector, academia, nongovernmental organizations (NGOs), environmentalist groups, unions, companies, and indigenous communities, among many others. The Energy Roadmap includes seven strategic areas: energy modernization, energy with a social element, energy development, low-emission energy, sustainable transportation, energy efficiency, and energy education and training.

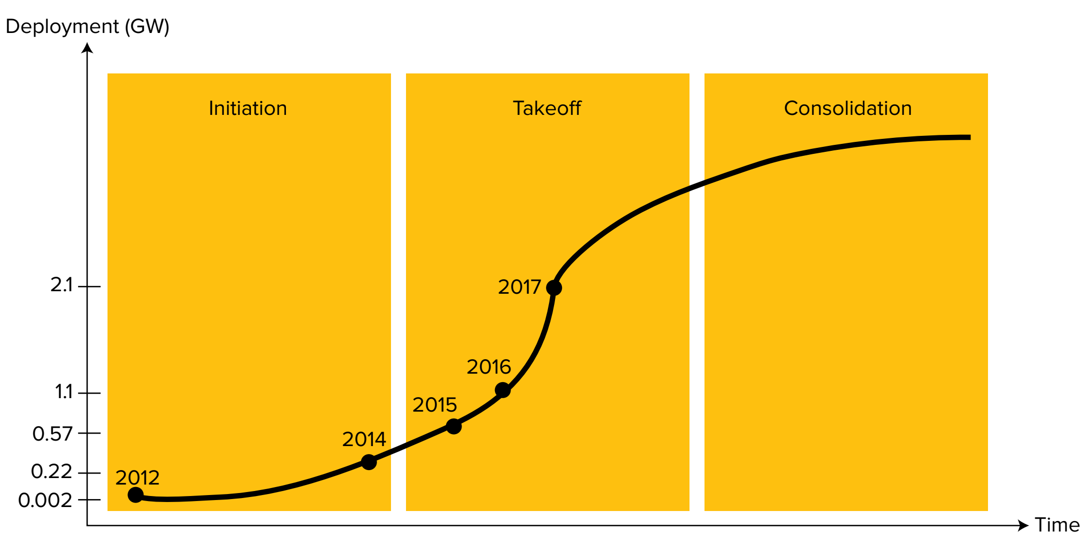
Chile has also made commitments under the UN Framework Convention on Climate Change (UNFCC). Chile's commitment in its Nationally Determined Contribution (NDC) is to unconditionally reduce its CO_2 emissions per GDP unit by 30 percent below 2007 levels by 2030. Conditional on international financial contributions in the form of grants, the country is ready to reduce its greenhouse gas emissions intensity of GDP by 35–45 percent relative to 2007 levels, by 2030. There are no specific commitments on solar in Chile's commitments.

Chile's Solar Market

Chile's Position in the Global Development of Solar

Chile's policy makers passed the Non-Conventional Renewable Energy Law in 2008. Globally, PV prices began to fall rapidly in 2011, encouraging developers to look at Chile, given its relatively high spot prices. By 2012, the equivalent of over 4,000 MW-worth of permits for solar PV development had been issued or were being processed, signaling significant developer interest and the beginning of the market inception phase for solar PV (Figure 2.4). The first large-scale PV projects in Chile predominantly served mining companies or traded on the spot market, to take advantage of the relatively high prices for energy after 2007 (more than US$300 per MWh).

Figure 2.4 Phases of deployment of solar photovoltaic power in Chile



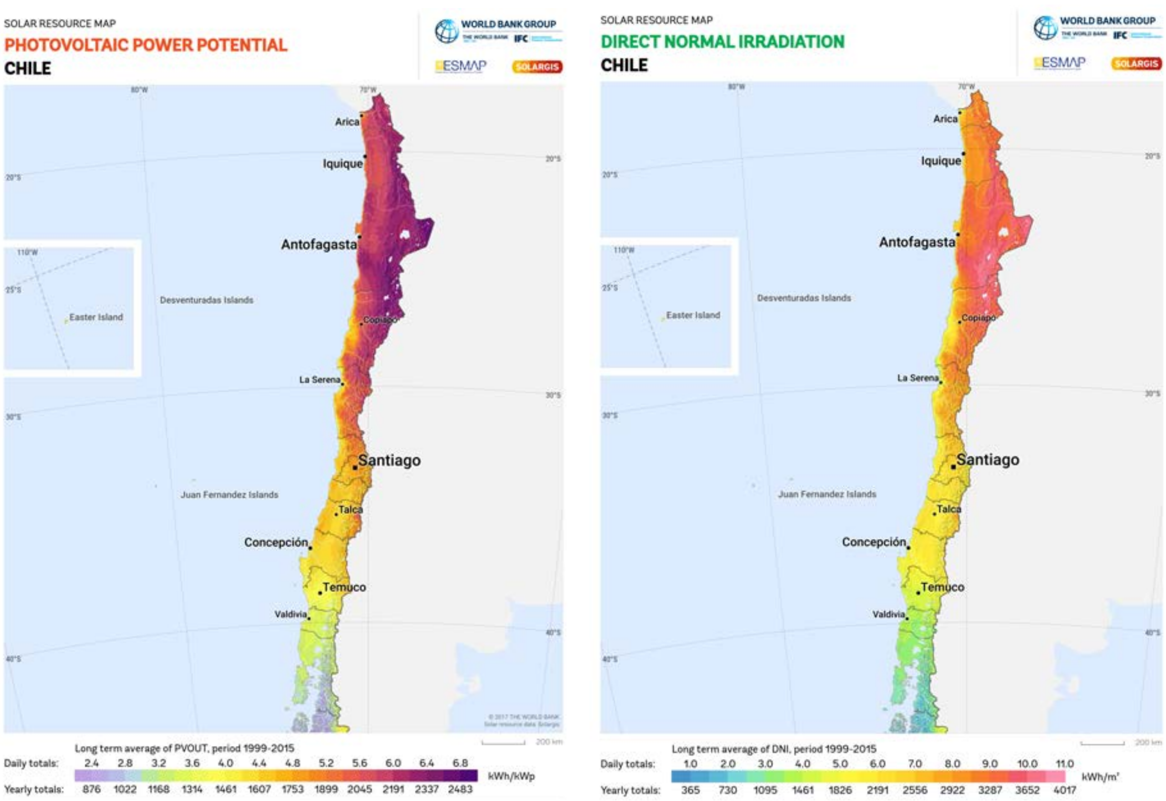
Subsequent solar PV plants were procured through competitive processes, managed first by private distribution companies and after 2015, by the National Energy Commission.

Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

Chile can be characterized as a significant market for renewable energy, particularly given its goal of increasing the share of electricity generated from renewable resources from 20 percent in 2017 to 70 percent by 2050. The country has some of the highest irradiation in the world (Figure 2.5). In the Atacama Desert, in the north of the country, direct normal irradiation reaches more than 3,300 kWh per m^2 per year, providing excellent resource for CSP. For PV, the best locations in Chile can generate more than 2,500 kWh per kWp a year.

Figure 2.5 Photovoltaic power potential and direct normal irradiation in Chile



Source: World Bank 2018c.

Market Structure and Competition

Chile has a fully unbundled and liberalized electricity sector, which over the past decade has fostered a vibrant renewables sector.

Independent power producers (IPPs) are able to participate in tenders run on a periodic basis by the National Energy Commission. The tenders are used to procure energy for regulated customers, for which distribution companies are required to have long-term contracts that match supply and forecast demand. These tenders are technology neutral; bidders are free to package bids as they see fit, using a mix of generation technologies. However, Chile's auctions have been using blocks for bidding, and the 8:00 A.M.–5:59 P.M. block is a natural fit for solar PV production (Box 2.1).

Box 2.1 The Auction Process in Chile

Distribution companies must procure their energy through non-technology–specific public auctions carried out by the National Energy Commission (CNE) and enter into long-term contracts with the winning bidders. All auctions are technology neutral. Contracts are allocated solely on the basis of the lowest levelized cost of electricity. Prices are fixed in U.S. dollars on a per MWh basis and indexed to the price of oil, U.S. inflation, and other parameters; payments are made in Chilean pesos. There is no requirement in Chile's auctions to disclose generation type, although some companies choose to do so. Companies can use their existing generation assets to meet their contractual obligations in which case no new capacity is built.

Solar PV was first included in a winning bid in 2013 when a private developer, ENEL, announced that it would use solar plants in conjunction with wind and conventional generation to supply a portion of the energy it is required to deliver as one of two winners of the 2013/01 auction.

To encourage the uptake of renewables and increase competition, in 2014 the National Energy Commission (CNE) approved new resolutions. It introduced a time block system in which generators bid for specific time periods throughout the day, as opposed to having to supply energy on a 24-hour basis. Each supplier presents a bid with different energy supply quantities and prices for any of the time blocks defined in the tender process. The most recent auctions defined the time blocks as follows: (i) night block: 11:00 P.M.–7:59 A.M.; (ii) day block: 8:00 A.M.–5:59 P.M.; (iii) peak block: 6:00 P.M.–11:59 P.M.; and (iv) 24-hour block. Solar energy projects typically participate in the day block (8:00 A.M.–5:59 P.M.).

Auction 2013/02, which took place in 2014, was the first auction to use the block system. It had relatively strong solar participation, as generators took advantage of the new block system. It is difficult to calculate the amount of solar won in each contract, however, because bidders bid for specific amounts of energy to be supplied, which are not tied to specific plants.

In 2015 the tender program was further modified through Law 20.805, which centralized tendering in the hands of the CNE. To increase the competitiveness of renewables, the length of the contracts was increased from 15 to 20 years. The new auction rules also specified a time period of three to five years from the time of the auction until delivery of energy.

The CNE then began scheduling auctions a year in advance, to enable new entrants to prepare effectively. Every year the CNE issues a demand report, which shows a demand curve and identifies upcoming auctions. The impact of these developments transpired in the 2015–17 auctions, which resulted in record-low market prices.

The 2015/02 auction was remarkably successful. All five winners (among 31 bidders) were renewable energy providers, and four had never previously won a contract in Chile. Prices declined by 26 percent from the previous auction.

The most astonishing results were revealed the following year, in the 2015/01 auction, which took place in 2016 for delivery starting in 2021. Eighty-four bidders presented bids for a combined 84 TWh to compete for a 12.4 TWh allocation. The average contracted price fell to US$47.6 per MWh. The lowest bid was a PV project submitted at US$29.1 per MWh for delivery in 2021, one of the lowest rates for PV in the world at that time. The results of these auctions significantly exceeded the targets the government established in *Energy Agenda 2014–2018.* The average price of electricity in the 2016 auction was 68 percent less than the marginal cost in 2013.

In 2017 the block system was further optimized by allowing bidders to bid by quarter block, to help encourage the use of small hydro plants and allow maximization of plant efficiencies, allowing prices to fall even further. As in previous tender rounds, only renewable projects were successful. Although the 2017 round was relatively small, it reinforced the trend of declining prices established in the larger auction of October 2016.

Most of the energy contracted in these tenders has yet to be commissioned. Some stakeholders noted that projects that bid on the 2014 auction are experiencing delays in commissioning. Given the extremely low bids in the auction rounds in 2016 and 2017, there is some skepticism as to whether all bidders will be able to deliver.

The redesigned auctions accomplished much of what they set out to do. Prices have fallen dramatically, in line with increased competition. As blocks have become narrower, bidders for solar PV have been able to further optimize their pricing, resulting in lower prices. "In general, we praise the good work made by the Comisión Nacional de Energia since 2014: strong and good changes in the regulation but made with the close participation of the market players, with clear goals (kill the existing oligopoly, unlock the market, and decrease the energy prices). The most efficient intervention was probably the deep reform of the distributors' tenders," indicated a respondent to the survey conducted for this study.

IPPs can also directly contract with unregulated customers and generation companies to supply electricity at a negotiated price. Finally, they can sell on the spot market where they are paid at the spot price of the node at which they are connected to the grid. On the spot market, the price of energy fluctuates hourly according to supply and demand. The system is divided into specific nodes, which are individual transmission-level substations. Prices can vary by node depending on the supply and demand characteristics of the specific node at a given time. Plant operators can also elect to sell their power output through all three channels (spot market, private off-take arrangement, and competitive tendering).

Local Financial Market

Chile has one of the strongest credit ratings in Latin America. Its long-term debt in foreign-denominated and local currency is rated A+ and AA– by Standard and Poor's (13 July 2017) which indicates a strong capacity to meet its financial capacity. Chile is well served by both local and international banks lending in both local and foreign currency.

Evolution of the Grid-Connected Solar Market

Chile took the first step toward promoting renewable energy in 2004, with implementation of the Short Law I, which enabled nondiscriminatory access for small renewable energy producers. The following year, the Short Law II further modified the regulatory regime by allowing small renewable energy providers to sign long-term PPAs with distribution companies. It also mandated that electricity sold from generators to distributors for regulated customers be procured through open and competitive processes.

By 2012 only 2.4 MW of solar PV had been commissioned, but hundreds of projects had obtained development permits, demonstrating that investors saw Chile as a promising market. Encouraged by the falling price of solar PV globally, developers saw an opportunity to build merchant plants that sold power on the spot market or sign private PPAs with mining companies interested in lowering their cost of power, at the time typically provided by diesel. Some of the first merchant solar plants in the world were commissioned in Chile in 2013. Since then, more than 800 MW of solar capacity has been developed on a merchant basis or through PPAs with industrial customers (Fitzmaurice 2016).

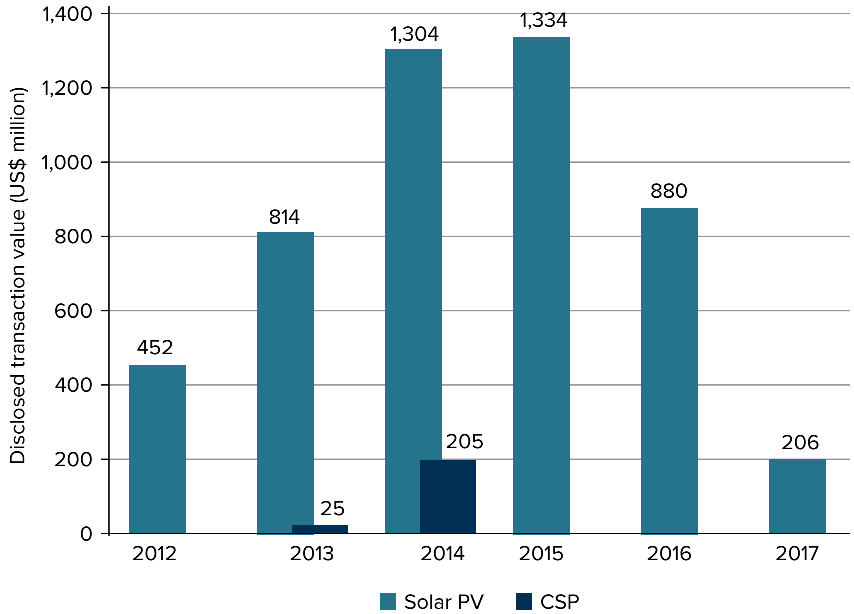
CSP has had a slower growth trajectory, despite exceptional quality resources. A total of 40 MW of capacity has been commissioned, primarily to provide steam to mining projects, rather than to generate power. Chile's first CSP plant—the 10 MW Minera el Tesoro solar thermal installation, which delivers steam for a copper mine owned by Antofagasta plc—was commissioned in 2012. In 2013 the Ministry of Energy and the Chilean Economic Development Agency (Corfo) ran a technology-specific tender for the construction of the first CSP plant in Latin America. The Cerro Dominador project was subsequently put on hold because of financial difficulties of the developer but reached financial close in May 2018, raising US$758 million financing. Cerro Dominador, a 210 MW combined solar PV and CSP plant with 17.5 hours of thermal storage, is under construction, and other electricity-focused CSP projects are under development. The success of the Cerro Dominador project combined with growing demand for sustainable baseload generation could pave the way for further CSP market development. In the Energy Roadmap 2018–22, the Chilean government indicates its commitment to evaluate the barriers to CSP and other technologies that increase the flexibility of power systems.

Mobilization of Commercial Finance

Limited information is available in the public domain on the project structure and financing arrangements of solar projects in Chile, due to the private and confidential nature of some of these transactions. Based on disclosed transaction values, over US$5.2 billion has been invested in both solar PV and CSP projects in Chile over the 2012–17 period (Figure 2.6). Many of the large international developers—including Actis, SunEdison, EDF Energies Nouvelles, ENEL, Green Power—have invested in Chile's solar market. Initial merchant projects included development finance institution loans.

The first merchant solar project in Chile—the 29 MW La Huayca II, financed by IFC, the German bilateral development agency DEG, and the Canada Climate Change Fund—was commissioned in 2013. La Huayca II was also

Figure 2.6 Commercial investment in solar projects in Chile 2012–17



Source: BNEF 2017.

one of the first debt-financed PV projects in the world that could sell its power output to the spot market without feed-in or subsidized tariffs (IFC 2013). Solar plants in the private off-take market also involved development finance institutions, either alone or in consortium with local and international commercial banks. For example, the 25 MW Pozo Almonte project, commissioned in 2013, was financed by the Inter-American Development Bank, on the back of a 20-year PPA with CODELCO (a state-owned copper mining company). The same year, IFC, the Overseas Private Investment Corporation (OPIC), and Rabobank financed the 100 MW Amanecer plant, in conjunction with SunEdison. The deal involved a contract with the CAP Group, a large Chilean iron ore miner and steel producer. Subsequent projects were financed by local and international banks without the participation of development finance institutions. All CSP projects have been entirely financed by the private sector.

Effectiveness of Public Sector Intervention

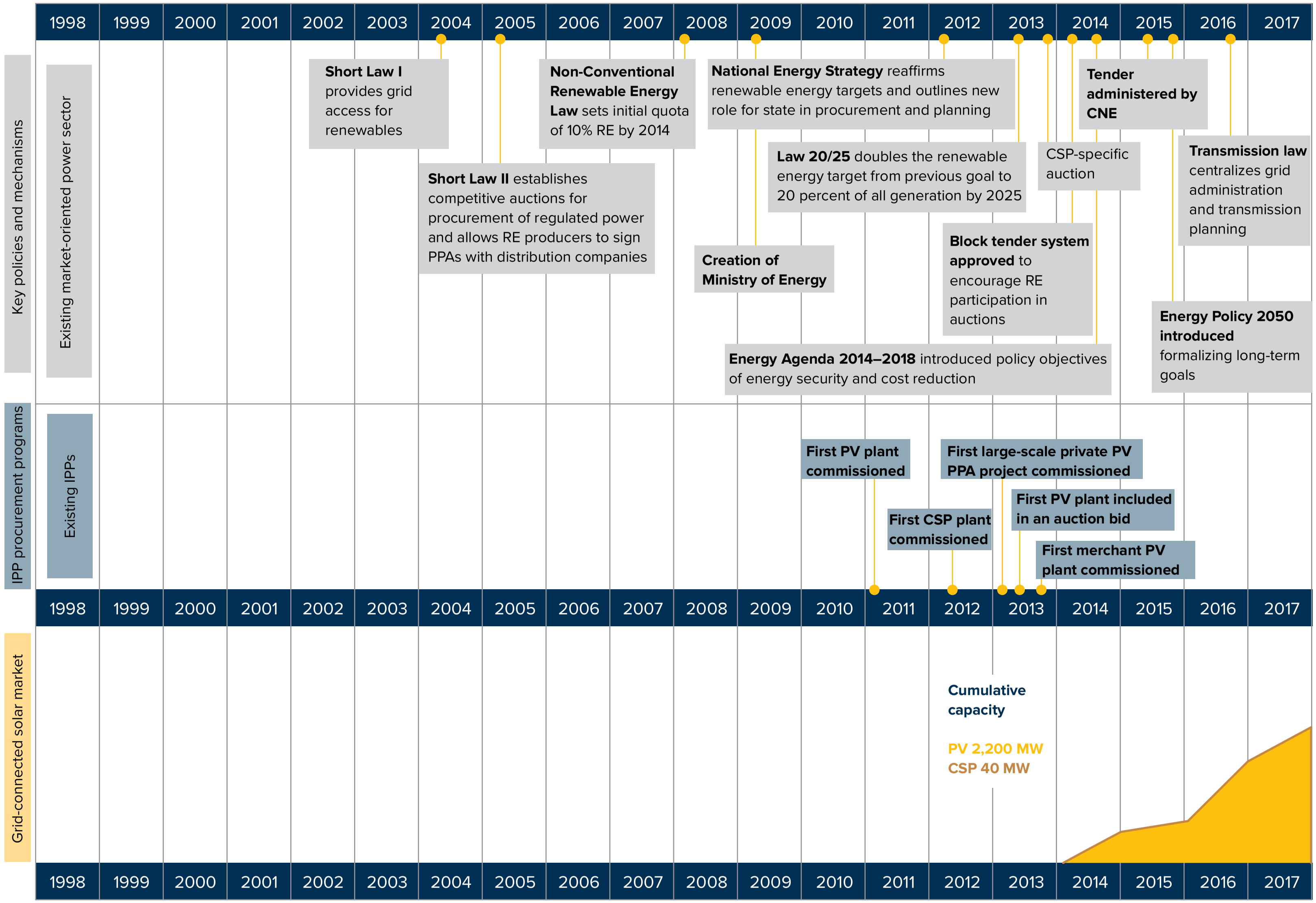
The Chilean electricity sector is grounded in privatization reforms that took place more than 30 years ago via the Electricity Act and have been refined over decades. Chile is credited to be the most attractive emerging market for clean energy investment thanks to its strong government policies, demonstrated track record of attracting investment in clean energy, and commitment to decarbonization despite grid constraints (BNEF 2018). Figure 2.7 presents the chronology of key public actions that led to the establishment of a robust enabling environment.

Legal, Policy, and Regulatory Framework

Chile took the first step toward promoting renewable energy in 2004, with implementation of the Short Law I, which enabled nondiscriminatory access for small renewable energy producers and allowed them to sell their power output at the relevant spot price. The law also exempted small energy producers (with installed capacity of less than 9 MW) from paying transmission fees and reduced the fees for plants whose installed capacity ranged from 9 to 20 MW.

The Short Law II, implemented in 2005, further modified the regulatory regime, allowing small renewable energy providers to sign long-term PPAs with distribution companies. It also mandated that electricity sold from generators to distributors for regulated customers be procured through open and competitive processes.

Figure 2.7 Timeline of public interventions and market development in Chile



In a context of rising prices and supply-side challenges, the Non-Conventional Renewable Energy Law, passed in 2008, marked an important moment in Chile's solar story. The law's primary function was to mandate a renewable energy portfolio standard, which was designed as Chile's principal mechanism to encourage development and investment in renewable energy. The standard required utilities with more than 200 MW of capacity to generate at least 10 percent of their electricity from renewable sources by 2024, effectively setting policy goals for the procurement of renewable energy. A 5 percent interim goal was set for 2014, which would be increased every year until 2024. Penalties were mandated for noncompliance. Although the direct impact of the law was diluted by the fact that the renewable energy portfolio standard was eventually altered to apply only to new generation, it signaled to private investors that the government was serious about renewable energy procurement. In 2013 the government passed the 20/25 law, which doubled the renewable energy portfolio standard target to 20 percent by 2025.

In 2010 Chile passed the Energy Ministry Law. It created the Ministry of Energy and assigned it with oversight of the Energy Regulatory Commission. The law ended a framework that grouped energy with mining sector activities.

Starting in 2012, the government released a series of policy documents that outlined its vision for the energy sector. The National Energy Strategy 2012–30 was followed by the Energy Agenda 2014–18 (issued in May 2014), the Energy 2050 (issued in December 2015), and the Energy Roadmap 2018–22 (issued in May 2018). Energy 2050 calls for increasing the share of renewable energy, connecting the two separate grid systems, and modifying the auction system to encourage competition and renewable energy. At the core of the policy was the goal of decreasing costs while increasing security and diversity of supply. Energy Roadmap 2018–22 includes low-emission energy as one of the seven strategic areas, promoting the development and scale-up of different renewable energy sources for power and heat.

In 2016 Chile passed the Transmission Law, which addresses the challenges of grid congestion and planning caused by the rapid scale-up of renewable energy generation. The law centralizes generation planning and grid administration and modifies transmission toll payments to foster renewables.

The fact that many international banks and development finance institutions have financed private PPAs and merchant projects attests to their faith in the Chilean legal framework. Further evidence of its strength is the fact that courts have consistently upheld private PPAs signed by renewable energy IPPs and large private off-takers, such as mining companies. Given the dramatic changes in spot prices in recent years, some large mining companies have tried to extricate themselves from PPAs signed when solar was much more expensive via legal proceedings. In general, the courts have sided with the IPPs—a positive signal for the electricity sector as a whole.

The regulatory framework for renewable energy in Chile is generally straightforward. The regulator has considerable capacity and experience with IPPs. This process for connecting to a distribution network is clear, with specific timelines allocated to each step. Connection at the transmission level is governed by open access. Environmental permits are required for all solar projects larger than 3 MW. Depending on the size and the situation of the plant, they can take up to a year to process. The large number of permitted PV projects—for almost 13,000 MW in capacity—attests to the ability of developers to procure the necessary permits.

Planning, Technical, and Operational Capacity

Generation Planning

Chile has adopted a market-oriented approach, where power producers compete to offer the most competitive prices, regardless of the technology. The CNE issues periodic reports on projected demand and provides information on upcoming auctions. Investors are free to choose the technology or the combination of technologies to deploy to fulfill their contractual obligations. Improvements in the regulatory regime affecting the procurement of energy for regulated customers have led to higher shares of renewable energy and solar on the grid. As solar PV penetration increased, the absence of integrated planning accounting for the variability of solar and the power evacuation constraints led to congestion and, ultimately, power curtailments.

Land Availability

Land availability for the development of solar plants is not a significant concern of developers, but resistance of communities to the construction of transmission lines has created some challenges. Defining corridors for transmission lines helped deal with the issue. In northern Chile, where most solar projects are situated, there is a web of potentially conflicting claims from indigenous communities, the government, and mining concessions. Most land in this region is public; land for solar PV projects is leased from the government or made available on a project-specific basis. Securing public land can take time, but land is relatively affordable and available.

Grid Integration, Access, and Power Evacuation

Chile's congested transmission system has been widely regarded as a hindrance to the scale-up of renewable energy (AURES, 2017). Most solar plants in Chile are in the northern part of the country, the Atacama Desert, away from the load centers located in the south. The concentration of solar plants has caused significant grid congestion in some areas and strained the transmission system. During periods of high insolation, the spot price at some nodes can drop to zero and solar PV plants can be curtailed, imposing significant costs on solar IPPs and merchant plants that sell on the spot market. As a result, some solar project developments have come to a standstill because of uncertainty regarding their ability to effectively deliver the power produced.

In 2016 the government of Chile formalized its commitment to address these transmission issues by passing a major electricity transmission law. The new regulation introduces several changes, including nondiscriminatory open access to the grid and the creation of an independent national power system management entity, Coordinador Eléctrico Nacional, responsible for transmission planning and expansion. The law also gives responsibility for long-term planning of the transmission system to the Ministry of Energy by creating a role for it in defining new transmission line routes. To reduce congestion at specific nodes, the Transmission Law also calls for the creation of generation development hubs which would accommodate at least 20 percent renewable energy. They will be designed to encourage renewables and streamline the development process by including pre-approved environmental permits and planning for necessary transmission.

As the share of variable renewable energy on the grid increases, the provision of ancillary services and the availability of firm power has become increasingly important. One of the aims of the Transmission Law is to define these services. The Energy Roadmap 2018–22 calls for firm power–specific auctions and the deployment of carbon-free firm power options such as CSP, among others.

Investment in Enabling Infrastructure

Several transmission projects are under construction or have been commissioned. The interconnection of the SIC (18,016 MW) and the SING (5,488 MW) completed in November 2017, creates new market opportunities and increases the stability of the power system and the security of supply.

Direct and Indirect Financing

Solar projects in Chile have been developed without recourse to public financing, thanks to the ample liquidity and substantial project finance capacity local and international banks active in the sector. Cost-reflective tariffs and an open system with multiple channels for the sale of energy have given financiers the comfort they require to finance various types of projects. In the early stages of development of Chile's solar market, local commercial banks were hesitant to invest in what was then a new and unproven technology in Chile. The participation of development finance institutions helped reduce the perceived risk for commercial players.

The country provides technology-specific support and regulations, notably for solar, through the Support for Non-Conventional Renewable Energy Development Program. The program was established in 2012 to subsidize projects such as CSP plants and transmission lines for renewable energy projects. Launched in February 2013, support for CSP plants included a US$20 million subsidy for up to 50 percent of the project cost (IRENA 2015). However, the program has had an insignificant impact on Chile's CSP market.

Box 2.2 Financing of large-scale solar photovoltaic plants in Chile by the Clean Technology Fund

The Large-Scale Photo-Voltaic Program (LSPVP) was one of three components outlined in Chile's 2012 Clean Technology Fund (CTF) Country Investment Plan. The LSPVP allocated US$49 million, split equally between the International Finance Corporation (IFC) and the Inter-American Development Bank (IDB). The motivation for the allocation of CTF funds to large-scale PV plants was the lack of track record in Chile of financing large-scale PV plants and the fact that local banks had not financed PV projects. The LSPVP aimed to provide a demonstration effect, to increase the interest of both large consumers and local banks in participating in large-scale merchant or private off-take PV projects. The financial instruments selected, the pricing, and the terms of CTF funds were to be decided on a project-by-project basis.

IDB used its CTF funding for two large-scale merchant projects, Crucero (approved in June 2014, with US$16 million from the LSPVP) and Arica 1 (approved in December 2014, with US$8.5 million from the LSPVP). IFC did not end up using its allocation, as it had already participated in the financing of four merchant projects. In 2015 the decision was made to reallocate the remaining funds to other CTF activities in Chile.

The CTF funds were successful in catalyzing investment in large-scale merchant plants in Chile and encouraging the participation of local banks. The Crucero PV plant was the first merchant plant to include a private Chilean bank (Corpbanca) in financing. Chilean banks now play an important role in financing solar PV and merchant plants in Chile. The decision to reallocate funds demonstrates that the strong legal and regulatory framework in Chile allowed a rapid crowding-in of private capital once viability was demonstrated and capacity to structure the deals was transferred to local entities.

A similar story unfolded with CSP. In 2013 the Ministry of Energy and Corfo, the Chilean Economic Development Agency, ran a technology-specific tender for the construction of the first CSP plant in Latin America. The CTF approved a concessional loan of US$67 million, along with other donor funding, out of a total financing envelope of approximately US$400 million. The Chilean government also offered incentives, through the Support for Non-Conventional Renewable Energy Development Program, including a US$20 million grant and a concession for land in the Atacama region. The tender was awarded to the 210 MW Cerro Dominador project (110 MW of CSP and 100 MW of PV). The project was delayed by financial difficulties of the developer. In May 2018, however, the project reached financial closure, with a US$758 million financing package consisting entirely of commercial financing, demonstrating the rapid maturation of the Chilean market for renewable energy and the declining need for participation by development finance institutions.

Adapted from CIF 2012; GoC 2012; IDB 2012; IDB and IFC 2013; IDB 2014.

There are no fiscal incentives for renewable electricity in Chile. Attesting to the strong regulatory framework of the Chilean energy sector, local and international commercial banks now play an active role in financing renewable energy (Box 2.2.).

Government-Sponsored Guarantees

Off-Taker Creditworthiness

IPPs in Chile have the option of selling directly to unregulated customers through private PPAs, selling on the spot market, or participating in regulated auctions for the sale of energy to distribution companies. The strong, market-oriented, and well-entrenched framework for Chile's electricity system has limited investor concerns about off-taker creditworthiness. Consumer tariffs are cost reflective and mostly free from subsidies. Chile has one of the strongest credit ratings in the region and is seen as a stable investment destination. The willingness of both international and local banks to lend to merchant projects is a testament to the strength of the overall bankability of the system in Chile, as these projects do not have underlying PPAs to support them. Despite challenges with early merchant projects given the decline in spot prices, new merchant projects are still being financed.

Table 2.2 Effectiveness of public action in mobilizing commercial capital in Chile

Public sector action	Description	Legal, policy, and regulatory framework	Planning, technical, and operational capacity			Investment in enabling infrastructure	Direct and/or indirect public financing
			Generation planning	Grid integration, access, and power evacuation	Land/ rooftop availability		
Short Law I (2004)	Provided grid access for small renewables	✓✓		✓✓			
Short Law II (2005)	Mandated competitive auctions for procurement of regulated power	✓✓	✓✓				
Non-Conventional Renewable Energy Law (2008)	Set initial quota of renewable energy at 10 percent by 2024	✓✓✓	✓✓✓				
National Energy Strategy (2012)	Reaffirmed renewable energy targets and outlined new role for state in procurement and planning	✓	✓				
Law 20/25 (2012)	Increased renewable energy quota to 20 percent by 2025	✓✓	✓✓				
Support for Non-Conventional Renewable Energy Development Program (2012)	Subsidies for CSP plants and for transmission lines for nonconventional renewable energy projects			✓			✓
CSP specific-tender and related financing support (2013)	The Ministry of Energy and the Chilean Economic Development Agency ran a technology-specific tender for the construction of the first CSP plant in Latin America.			✓	✓		✓
Block tender system approved (2013)	Encouraged renewable energy participation in auctions by dividing procurement into blocks	✓✓	✓✓				
Energy Agenda 2012–18	Introduced policy objectives of energy security and cost reduction	✓✓	✓✓				
Administration of tenders placed under responsibility of the National Energy Commission (2015)		✓✓✓	✓✓✓				
Energy 2050 (2015)	Introduced Chile's long-term energy policy; set ambitious renewable energy targets	✓✓✓	✓✓✓				
Transmission Law (2016)	Centralized grid administration and gave Ministry of Energy a role in planning	✓✓		✓✓		✓✓	

Note: ✓✓✓: Very effective; ✓✓: Effective; ✓: Not effective.

Guarantees

Investors in the Chile's solar market did not require government-sponsored guarantees and insurance products to undertake projects as the country had a strong regulatory framework, a long history of IPPs, and a relatively strong macroeconomic structure that provided sufficient comfort.

Summary

Table 2.2 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid-connected solar market.

Key Findings and Take-Aways

Chile's market–oriented economy, long history of private investment in the electricity sector, and endowment with the world's best solar resources have been critical to the rapid scale-up of solar PV in the country. Targeted interventions by the public sector, including the restructuring of the tender process, contributed to the success of solar. The need to ensure energy security, the high costs of power supply, and the desire to diversify supply motivated the turn toward renewable energy and solar. The success of solar and other renewable energy has had the desired effect of increasing diversification and lowering costs. The rapid scale-up of solar PV has not been without challenges, however, notably grid congestion and transmission planning, which have motivated the government to take on a new role with regard to future planning.

CSP has taken more time to establish itself in Chile. In technology-neutral auctions, CSP projects have struggled to compete on price and failed to win capacity. Falling technology prices, the commissioning of the Cerro Dominador project (under construction), and a growing need for dispatchable renewable power could contribute to CSP's establishment over the next few years.

The case of Chile demonstrates that a strong and established regulatory framework that supports private investment in the electricity sector and the presence of strong off-takers are key to the rapid scale-up of solar investment. As markets mature, concessional and development finance become significantly less important. With higher penetration of variable solar power, attention should shift to addressing transmission and grid connection issues and providing adequate incentives for the provision of ancillary services and firm power.

References

AURES (Auctions for Renewable Energy Support). 2017. "Auctions for Renewable Energy in Chile: Instruments and Lessons Learnt." Report D4.4-CL. July. http://auresproject.eu/sites/aures.eu/files/media/documents/chile_final.pdf

Banco Centrale de Chile. 2019. Mis Estadísticas (database). https://si3.bcentral.cl/Siete/secure/cuadros/home.aspx

BNEF (Bloomberg New Energy Finance). 2017. Projects Database. Accessed on January 31, 2018.

———. 2018. "Climatescope: Emerging Markets Outlook 2018." November 27. http://global-climatescope.org/assets/data/reports/climatescope-2018-report-en.pdf

Chile, Ministry of Energy of Chile. 2014. Energy Agenda: A Challenge for the Country, Progress for Everyone. Santiago.

———. 2016. Energy 2050: Chile's Energy Policy. Santiago.

CIF (Climate Investment Funds). 2012. CTF funding for Chile: Concentrated Solar Power Project. September 12. http://pubdocs.worldbank.org/en/482041531492777534/1762-PCTFCL201A-Chile-Approved-decision.pdf

CNE (Comisión Nacional de Energía). 2019. Capacidad Instalada Generacion Diciembre de 2018 (database). https://www.cne.cl/en/estadisticas/electricidad/

Fitzmaurice, Rosie. 2016. "Analysis: Merchant Solar Struggles in Chile." *IJGlobal,* April 1. https://ijglobal.com/articles/99961/data-analysis-merchant-solar-struggles-in-chile

GoC (Government of Chile). 2012. Clean Technology Fund Investment Plan for Chile. April. https://www.climateinvestmentfunds.org/sites/cif_enc/files/ctf_4_chile_ip_0_0.pdf

IDB (Inter-American Development Bank). 2012. Chile CTF-IDB Concentrated Solar Power Project IDB Private Sector CTF Proposal for Submission to the CTF Trust-Fund Committee. August. http://pubdocs.worldbank.org/en/832871531492769374/1762-PCTFCL201A-Chile-Project-Document.pdf

———. 2014. "IDB Will Finance Private Sector in Construction of Photovoltaic Solar Energy Plant in Chile." Press Release. http://www.iadb.org/en/news/news-releases/2014-06-04/crucero-solar-energy-project-approved-in-chile,10836.html

IDB (Inter-American Development Bank) and IFC (International Finance Corporation). 2013. Chile Large-Scale Photo-Voltaic Program—CTF Private Sector Proposal: A Joint Submission from IFC and IDB. March. http://pubdocs.worldbank.org/en/361521531492803920/1799-PCTFCL202A-Chile-Cover-Page-and-Project-Document.pdf

IEA (International Energy Agency). 2018a. *Energy Policies beyond IEA Countries: Chile 2018.* Paris: IEA.

———. 2018b. World Energy Statistics and Balances (database). Paris. https://doi.org/10.1787/data-00510-en

IFC (International Finance Corporation). 2013. Summary of Investment Information: La Huayca II. May 21. https://disclosures.ifc.org/#/projectDetail/SII/33192

IRENA (International Renewable Energy Association). 2015. *Renewable Energy Policy Brief: Chile*. Abu Dhabi: IRENA.

UNDP (United Nations Development Program). 2018. *Human Development Indices and Indicators 2018 Statistical Update.* New York: UNDP.

World Bank. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b. *Doing Business 2018: Reforming to Create Jobs*. Washington, DC: World Bank.

———. 2018c. Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

CHAPTER 3 INDIA CASE STUDY

India has the world's second-largest population and fourth-largest economy. Over the past decade, economic growth has been strong, although it slowed in recent years (annual GDP growth was 8.2 percent in 2015 and 6.6 percent in 2017). India's service sector contributes almost two-thirds of GDP, a testament to the country's ability to leverage new technology and develop advanced technical competencies. Rural poverty and access to education remain challenges to India's economic and social development, although the government is increasingly trying to address them. Table 3.1 presents India's selected socioeconomic indicators.

Table 3.1 India's selected socioeconomic indicators

Indicators	Values
Population (2017)	1.3 billion
Land area	2.97 million km^2
Annual GDP growth (2017)	6.6 percent
Human Development Index (2017)	0.640 (medium)
Ease of doing business ranking (2018)	100th of 190
Access to electricity (2016)	84.5 percent

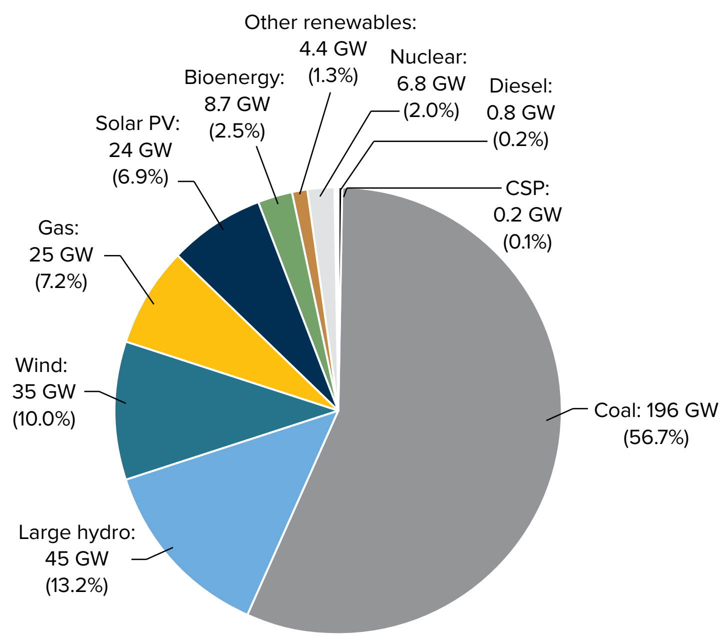
Sources: World Bank 2018a, 2018b; UNDP 2018.

Overview of India's Power Sector

Electricity Installed Capacity and Consumption

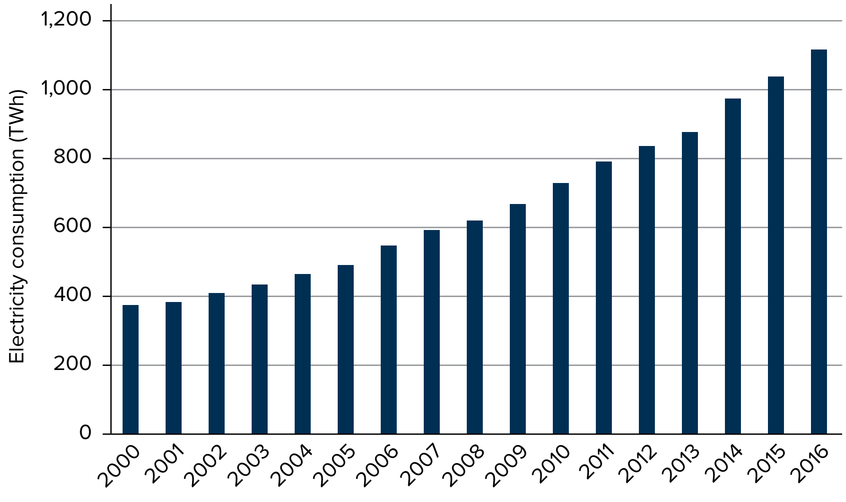
India's total installed generation capacity was approximately 346 GW by end 2018 (Figure 3.1). The power generation mix is dominated by coal, which accounts for almost 60 percent of installed capacity. Coal for power

Figure 3.1 India's power generation mix, November 2018



Source: CEA 2018.

Figure 3.2 India's electricity consumption 2000–16



Source: IEA 2018.

generation is supplied mostly from indigenous resources; imports make up about one-fifth of the consumption of coal power plants. Other power sources are gas, nuclear, and diesel. Renewable energies (including large hydro) represent one-third of the installed capacity. With 24 GW of installed capacity, solar makes up 6.9 percent of generation capacity and is growing rapidly (CEA 2018).

Economic growth, rapid urbanization, rising living standards, and significant expansion of electricity access are key drivers of India's electricity demand, which grew 7 percent a year between 2000 and 2015 (Figure 3.2). Although the overall installed capacity exceeds the peak demand and ambitious efforts to expand power generation capacity are underway, some parts of the country still face recurring power shortages. The main reasons for continuing supply-side constraints are coal supply shortages, high levels of transmission and distribution losses, congestion of regional interconnection, and the poor financial health of utilities. Some distribution companies are under such financial stress that they are unable to meet the demand (NITI 2015).

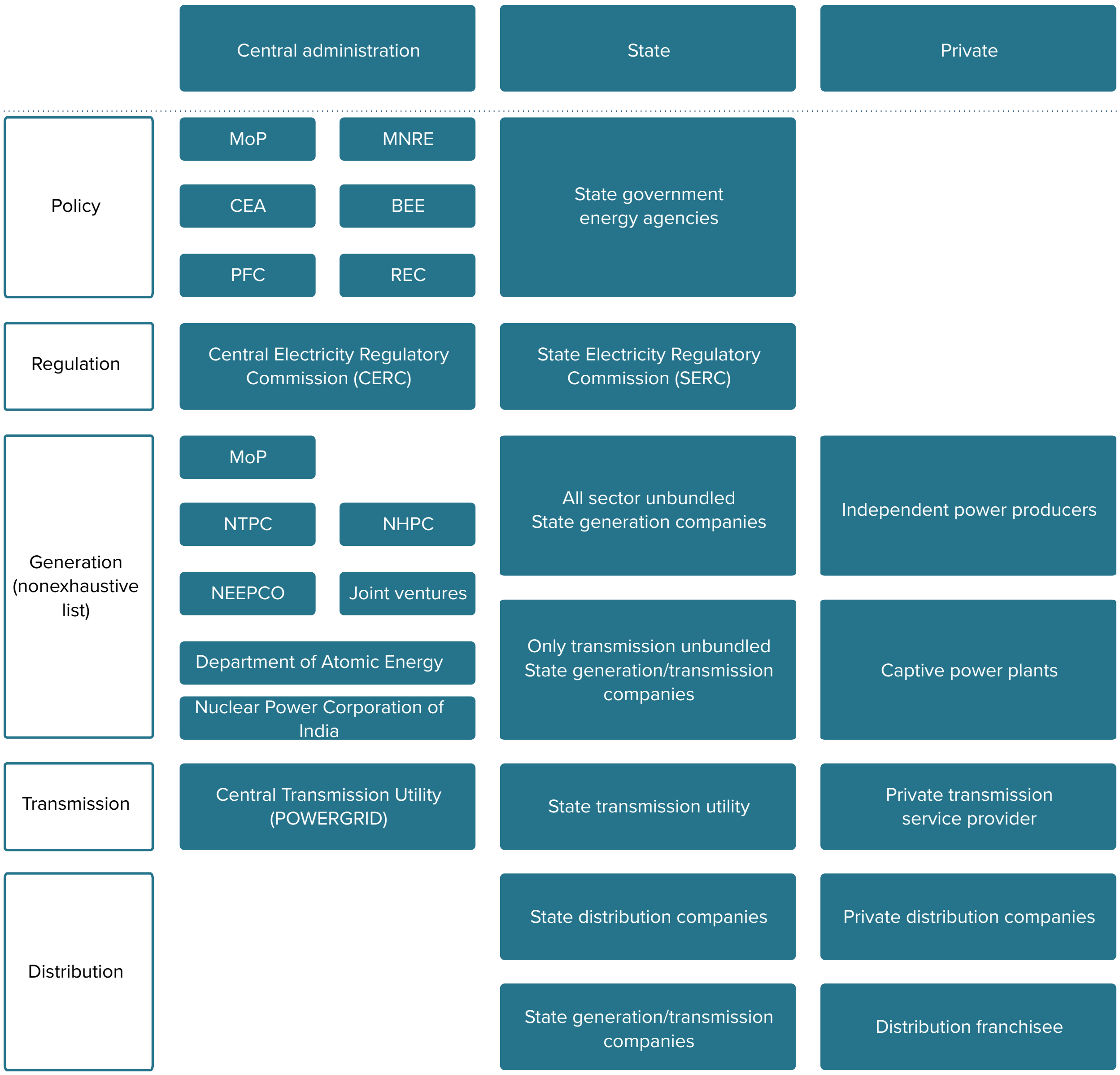
Institutional Arrangements and Key Stakeholders

Under the Indian constitution, the central and state governments oversee the power sector but the influence of the central government on energy policy at the state level is limited. As a result, the evolution of the sector and the level of penetration of renewable energy sources differ widely across states.

India's deep power sector reforms over the last 15 years, which include the unbundling of state utilities and the increase of private sector participation, have resulted in the creation of several privately held generation and distribution utilities (Figure 3.3). Approximately 45 percent of India's power generation capacity is in private hands, while the control of public power generation capacity is spread among large public players, operating under the oversight of the central and state governments.

The Ministry of Power oversees the sector and has ultimate responsibility for the development of broad policy objectives. The Ministry of New and Renewable Energy (MNRE) was established in 1992 and is responsible for formulating renewable energy policies. The Central Electricity Regulatory Commission (CERC) was set up in 1998 as a statutory body. It enforces power sector regulations at the national level while the State Electricity Regulatory Commissions (SERCs) do so at the state level. The SERCs set tariffs for electricity sales and have the mandate to promote renewable energy within the states.

Figure 3.3 Institutional framework of the power sector in India



Source: Adapted from Ahn and Graczyk 2012.
Note: MoP: Ministry of Power; MNRE: Ministry of New and Renewable Energy; CEA: Central Electricity Authority; BEE: Bureau of Energy Efficiency; PFC: Power Finance Corporation; REC: Rural Electrification Corporation; NTPC: National Thermal Power Corporation; NHPC: National Hydroelectric Power Corporation; NEEPCO: North Eastern Electric Power Corporation.

The central government introduced the Solar Energy Corporation of India (SECI) in 2011 as a way to help the MNRE implement several prominent renewable energy initiatives (the company's mandate was subsequently broadened to cover all renewable energies).

The Indian Renewable Energy Development Agency Limited (IREDA) is a key player in facilitating access to finance for renewable energy and energy efficiency projects. Its mandate includes the management of the generation-based incentives scheme, which provides projects with a premium per kWh above the power purchase agreement (PPA) price paid by the off-taker, bolstering off-taker creditworthiness.

Key Energy Policy Objectives

Since the launch of the Jawaharlal Nehru National Solar Mission in 2010, India has committed significant effort and capital to solar energy projects. The initial target of 20 GW of solar by 2022 was raised in July 2015 to 100 GW, partly because of encouraging market evolution and falling prices. These targets are in line with India's Nationally Determined Contribution (NDC), which calls for it to reduce the carbon emission intensity of its GDP by 33–35 percent compared to the 2005 level, and to have renewable energy account for 40 percent of its energy mix by 2030. This commitment is conditional on the transfer of technology and low-cost international finance from sources such as the Green Climate Fund (GCF).

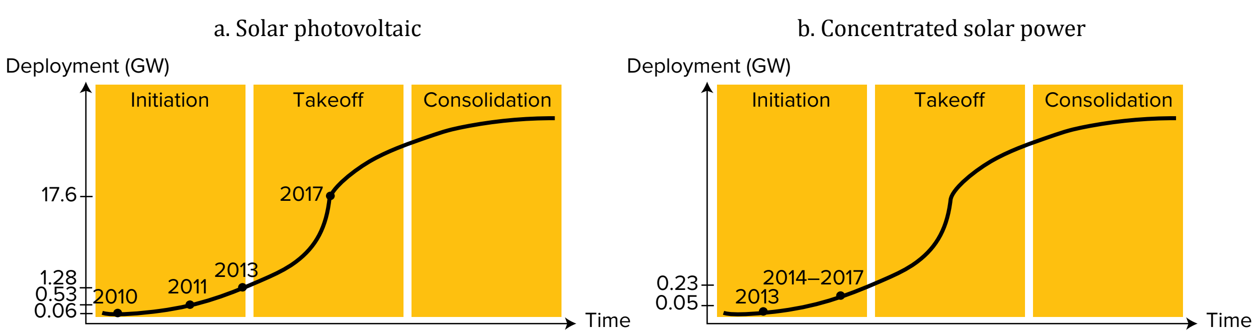
The draft of a new national energy policy, released in 2017, expands the mission by setting four objectives: energy access at affordable prices, energy security and independence, sustainability and economic growth. The policy targets universal access to electricity by 2022, but acknowledges that financial support will be required for the poor, at least in the short-term. Energy security is presented as a motivation to diversify away from coal imports. The sustainability goal is intertwined with energy security, as the government sees the deployment of solar as a way to mitigate climate change, boost domestic electricity production, and create jobs. The number of solar- and wind-related full-time equivalent jobs increased by an estimated 70,000 in 2016 alone. Affordable and increased access to electricity is expected to help the economy grow at a faster rate (NITI 2017).

India's Solar Market

India's Position in Global Solar Development

The inception of India's solar market dates from early 2010, with the launch of the National Solar Mission by then Prime Minister Manmohan Singh (Figure 3.4). The National Solar Mission envisioned a wide range of coordinated actions to promote the deployment of solar technologies across the country. Implementation started almost immediately; by the end of 2013, installed PV capacity had reached 1.3 GW (IRENA 2017). India's PV market continued growing at a rapid pace, reaching 5 GW in 2015, 18 GW in 2017, and about 24 GW in November 2018 (CEA 2018). Development of CSP has not progressed as rapidly (panel b of Figure 3.4). Total installed capacity was just 230 MW in 2017, the same as in 2014 when solar PV started to make more economic sense than CSP in terms of the levelized cost of electricity.

Figure 3.4 Phases of development of solar photovoltaic and concentrated solar power in India



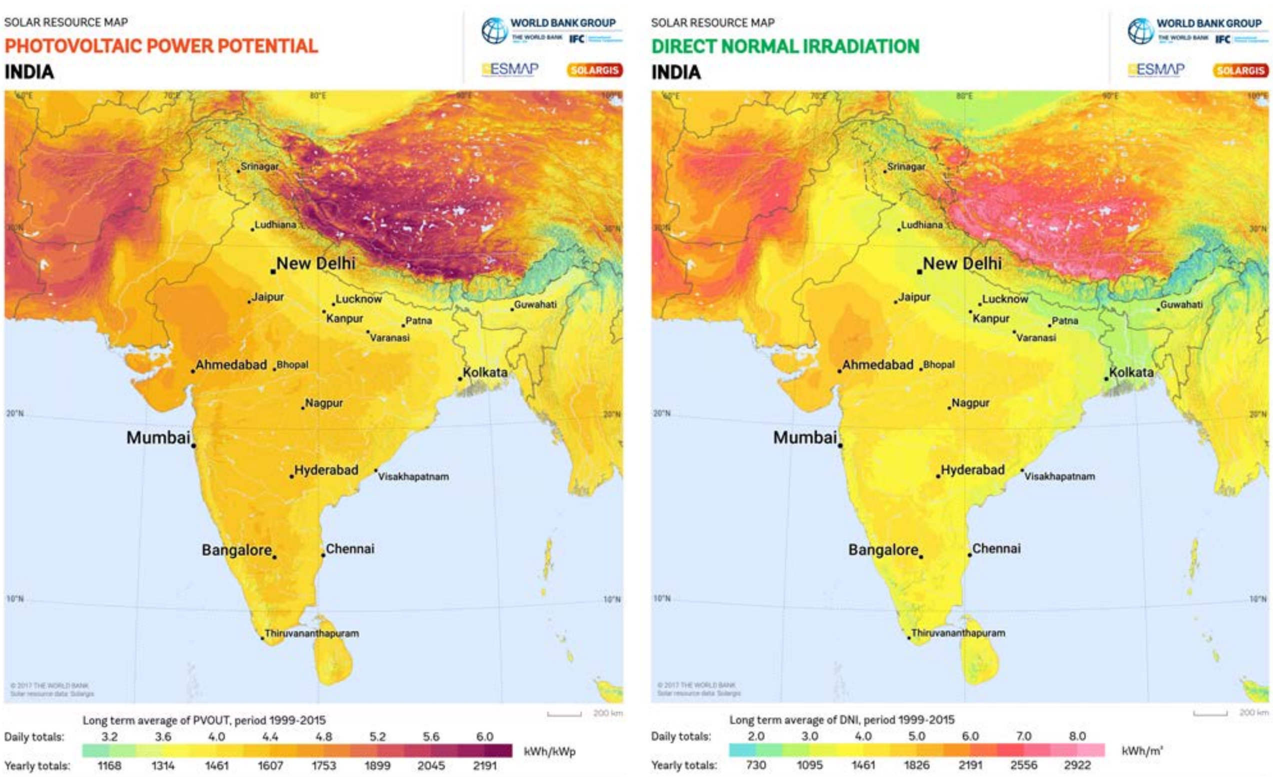
India's initial efforts to deploy grid-connected solar took place at a time when technology costs had already started decreasing globally. But solar power remained much more expensive than coal- and hydro-based generation, which represented the bulk of the country's power generation mix. The National Solar Mission documents acknowledged the fact that solar costs were significantly higher than coal and that grid parity might not occur until 2030. In 2010 prices for utility-scale solar in India were about US$0.27 per kWh for PV and US$0.29 per kWh for CSP (by 2016 solar PV prices had dropped 70 percent, CSP prices by just 12 percent [IRENA 2018]). However, the government was confident in its ability to scale up rapidly and use its vast solar energy potential, and it valued the environmental benefits of solar and its role in helping India develop and secure its own electricity production. India also had concerns about the availability of coal and the impact of rising coal prices. Finally, the National Solar Mission sought to help rural communities benefit from off-grid solar systems, shielding them from fluctuating fossil fuel prices (MNRE 2010).

Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

India is the world's third-largest electricity producer, after China and the United States. The country's potential has been estimated at 750 GW of solar, assuming that 3 percent of wasteland is open to development (MNRE 2017). However, the prospects for CSP deployment are limited by the country's average direct normal irradiation (Figure 3.5).

Figure 3.5 Photovoltaic power potential and direct normal irradiation for India



Source: World Bank 2018c.

Market Structure and Competition

Until 2003 India's power sector was characterized by vertically integrated electricity utilities in each state. The liberalization of the power market has paved the way for numerous procurement channels for solar power. The main drivers have been policies elaborated at the state level, which led to the commissioning of 8,220 MW by June 30, 2017 (Table 3.2). However, not all states were able or willing to pursue solar power development. Indeed, since inception, 10 out of a total of 29 states have installed 96 percent of India's solar power generation capacity (Mercom India 2018).

Table 3.2 Installed and allocated solar capacity in India in 2017, by procurement route (MW)

Policy level	Commissioned (MW)	In pipeline—allocated to developers (MW)
Central government policy:		
National Thermal Power Corporation (NTPC) off-take	2,065	1,700
Solar Energy Corporation of India (SECI) off-take	955	4,825
Public sector development	972	589
Other	199	80
State government	8,220	4,981
Rooftop	1,660	—
Other, including open access	1,543	75
Total	15,614	12,250

Source: Bridge to India 2017a.
Note: Data as of June 30, 2017.

Local Financial Market

India's long-term debt in both foreign-denominated and local currency is rated BBB– with a stable outlook by Standard and Poor's (November 2017). This indicates that the country's debt offers adequate protection to investors, though the creditworthiness of the state is likely to be negatively affected by adverse economic factors. Local banking is instrumental to India's economic growth. In fiscal 2016/17, Indian banks had INR 81.1 trillion (US$1.13 trillion) in loans and advances on their balance sheets, with an additional INR 36.5 trillion (US$508 billion) in investments. The industrial sector received the largest share of bank credits (INR 26.8 trillion [US$373 billion]) followed by the service sector (INR 18 trillion [US$251 billion]), personal loans (INR 16.2 trillion [US$225.4 billion]), and agriculture (INR 9.9 trillion [US$137.8 billion]) (Reserve Bank of India 2017).

Investment requirement to achieve the central government's 100 GW target for solar by 2022 is estimated at US$83 billion (of which utility and rooftop PV account for more than half) (BNEF 2017). Mobilizing this level of investment locally is possible given the depth of India's financial market, but will require significant coordination among capital providers.

Evolution of the Grid-Connected Solar Market

The liberalization of the Indian economy began in the early 1990s. With it came attempts to encourage private participation in the power sector. In 1991 private investment was permitted in power generation and distribution projects, supported by the realization that the existing model of monopolistic public ownership was highly inefficient (Ahn and Graczyk 2012). However, insignificant progress had been made by the end of the decade. The 1998 Integrated Energy Policy, developed at the central government level, called for deeper reforms to enable private participation. It cited the promotion and development of renewable energy as a way to increase India's energy independence.

It was not until the introduction of the 2003 Electricity Act that the market began to unbundle at all levels of the power sector. Separation of state-owned utilities, nonlicensed energy generation, nondiscriminatory access to the transmission network, and direct sales to consumers were some of the most notable developments that occurred after the adoption of the Act.

The first move toward the large-scale deployment of solar power in India came in 2008, with the release of the National Action Plan for Climate Change, which identified solar as a key resource. Concerns about energy security, climate change, and energy access facilitated the launch of the National Solar Mission in 2010. It planned a wide range of coordinated actions to promote the deployment of solar technologies across the country, including measures for solar heating, on-grid and off-grid, PV, CSP, ground-mounted, and rooftop power. The National Solar Mission placed a strong emphasis on energy generation, education, research, technology development and domestic manufacturing of solar components. Initiatives included the direct purchase of solar energy by the government or the payment of a premium over the agreed tariff to reduce the financial burden for the off-taker (known as generation-based incentives) (Dilip Nigam 2016).

At a time when total installed capacity of solar in India was less than 50 MW, the National Solar Mission set ambitious time-bound targets for the deployment of grid-connected solar: 1 GW by 2013, 4 GW by 2017, and 20 GW by 2022. Originally, it expressed no preference for solar PV or CSP as the target could be met by either technology. The need for specific support for CSP was later recognized, and plans to develop utility-scale pilot projects were made.

By March 2013, the solar capacity procured totaled 1,441 MW, exceeding the Phase I target of 1,000 MW. About 30 percent (or 422 MW) of the capacity installed was procured through price-based competitive procurement processes referred to as National Solar Mission Batch I and Batch II. Other projects benefited from either Gujarat's feed-in tariffs or the generation-based incentives mechanism.

The first phase of the National Solar Mission achieved impressive outcomes but also encountered several challenges. The original intent was that CSP would contribute half of the 1,000 MW target. By the end of 2013, only one of the seven CSP projects awarded under Batch I had been commissioned, and CSP capacity was 50 MW—a tenth of the expected 500 MW. Difficulties securing financing, the lack of reliable ground-measured irradiation data, and cumbersome permitting procedures were cited as the main reasons for the delays. Land acquisition and access to the grid were recognized as bottlenecks that affected both PV and CSP projects. The high dependence on foreign financing and the low participation of Indian banks raised concerns that inadequate financing would prevent a rapid scale-up of grid-connected solar under the next stages of the National Solar Mission.

Given the success of Phase I, the sharp decrease in PV module prices, and India's ambition to continue as a global leader, in June 2015 the central government announced a revised target of 100 GW MW of grid-connected solar by 2022—a fivefold increase over the initial target of 20 GW by 2022 set in 2010. The new target was split into 60 GW of ground-mounted, medium- to large-scale plants connected to the transmission grid and 40 GW of rooftop and distributed solar connected to the distribution grid.[4] The mechanisms set up during 2010–13 were continued and new schemes were introduced. These support mechanisms included the use of viability gap funding to provide capital subsidies to producers to achieve a predetermined tariff, and solar parks where the states secure land and transmission infrastructure, and lease them to developers. The solar park program targets total capacity of 40 GW (twice the initial 20 GW), with financial support of US$1.2 billion. As of June 2018, the government had approved 45 solar parks across 22 states, totaling 26 GW of planned capacity (MNRE 2018b). Most projects are at planning or preparation stage. Six solar parks have been commissioned (fully or partially), adding more than 2.4 GW of installed capacity.

Recent reports on the state of the market are encouraging. India added 9.1 GW of new utility solar power in fiscal 2017/18—equivalent to 10.4 GW when rooftop and off-grid solar are included, a 72 percent increase over fiscal 2016/17. Safeguard duties proposed to protect local industry would likely slow the speed at which projects are completed and cause uncertainty for developers and financiers (Chandrasekaran 2018).

4 Mini-grids and off-grid solar installations do not count toward the 100 GW target.

CSP has not enjoyed the same growth as solar PV since inception of the National Solar Mission. The steep drop in solar PV prices priced CSP out of recent auctions, as auction design did not value the firmness and flexibility of power that CSP can deliver. Of the seven projects planned in 2010, only one was commissioned before March 2014. MNRE was forced to downgrade its CSP target from an initial 1,080 MW to a much lower 100 MW. The presence of international financial institutions may help spur future CSP projects as PV penetration increases and its variability creates storage needs over time, which may give CSP an advantage. In the short term, CSP will play a smaller role than solar PV in meeting India's goal of reaching 100 GW by 2022.

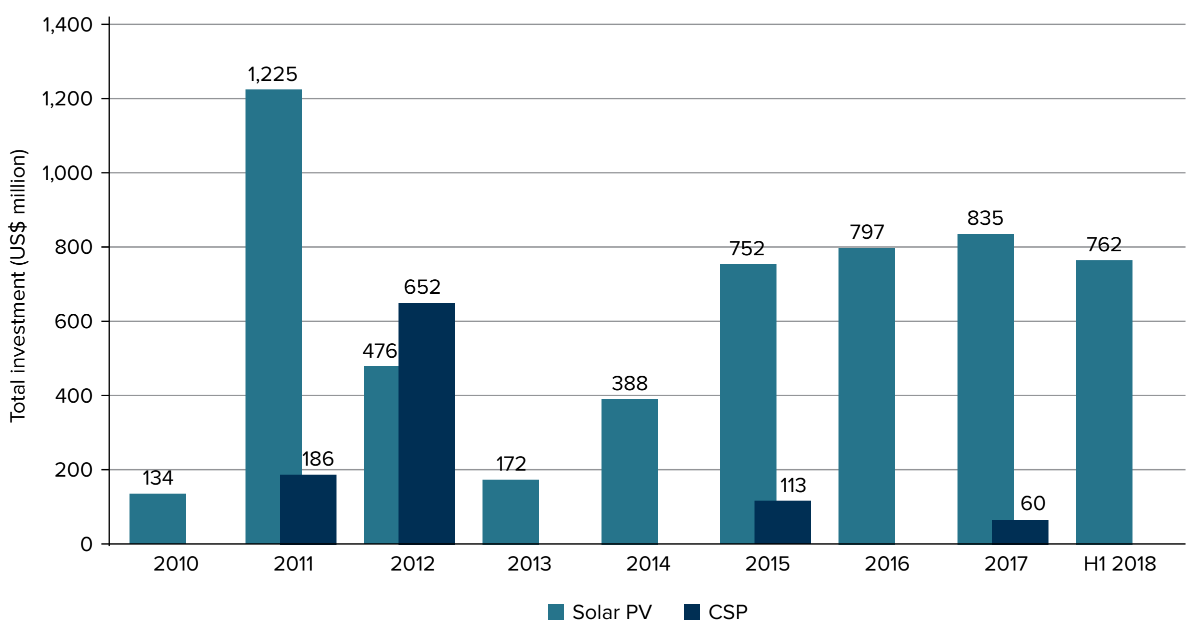
Mobilization of Commercial Finance

Since the launch of the National Solar Mission, the vast majority of investment has been in solar PV through hundreds of transactions, and there is no comprehensive account of the total commercial investment mobilized. The Private Participation in Infrastructure projects database records US$6 billion worth of investment in greenfield solar projects over the 2010–2018 period (Figure 3.6).

Equity has been provided mostly by national firms, such as Acme, ReNew, Azure Power, and Adani. Some projects are led by international investors and developers, including AES and EDF Energies Nouvelles and Actis, but they remain a minority. U.S.-based SunEdison was one of the most active international players on the Indian PV market until it filed for bankruptcy in 2016 (India-based Greenko acquired its assets in India).

Commercial banks contributed less than 25 percent of the initial investment in 2010–13, during the first phase of the National Solar Mission. Local banks have since become more active in the solar market, providing about half of the commercial debt. Indeed, the success of the first projects reduced the perceived technology risk and the improvement of the creditworthiness of distribution companies encouraged commercial banks to support IPPs.

Figure 3.6 Commercial investment in grid-connected solar projects in India



Source: World Bank 2018d.

Indian nonbanking financing institutions (including infrastructure debt funds and investment companies) provided a quarter of total debt. Among the most active are the PTC India Financial Services (PFS), a subsidiary of the Power Trading Corporation of India, and the Infrastructure Development Finance Company (IDFC), a public financial institution dedicated to infrastructure development.

Several CSP projects were abandoned at various stages of development, because of the developers' inability to achieve financial close. The limited track record of CSP technology in India, combined with the lack of accurate project-specific irradiation data, cast doubt on revenue projections and raised concerns among commercial financiers. As a result, no projects could obtain nonrecourse financing, and only a few projects proceeded, thanks to strong backing from the projects' parent companies. Stakeholders indicated that stronger public support for the CSP sector, particularly publicly funded solar measurement campaigns and pilot projects before the launch of the IPP procurement process under National Solar Mission Phase I, could have allayed financiers' concerns (Kumarankandath and Goswami 2015).

Effectiveness of Public Sector Intervention

India's market was shaped by the central and state governments, which implemented several policies and support mechanisms to boost the development of solar PV and CSP (Figure 3.7).

Legal, Policy, and Regulatory Framework

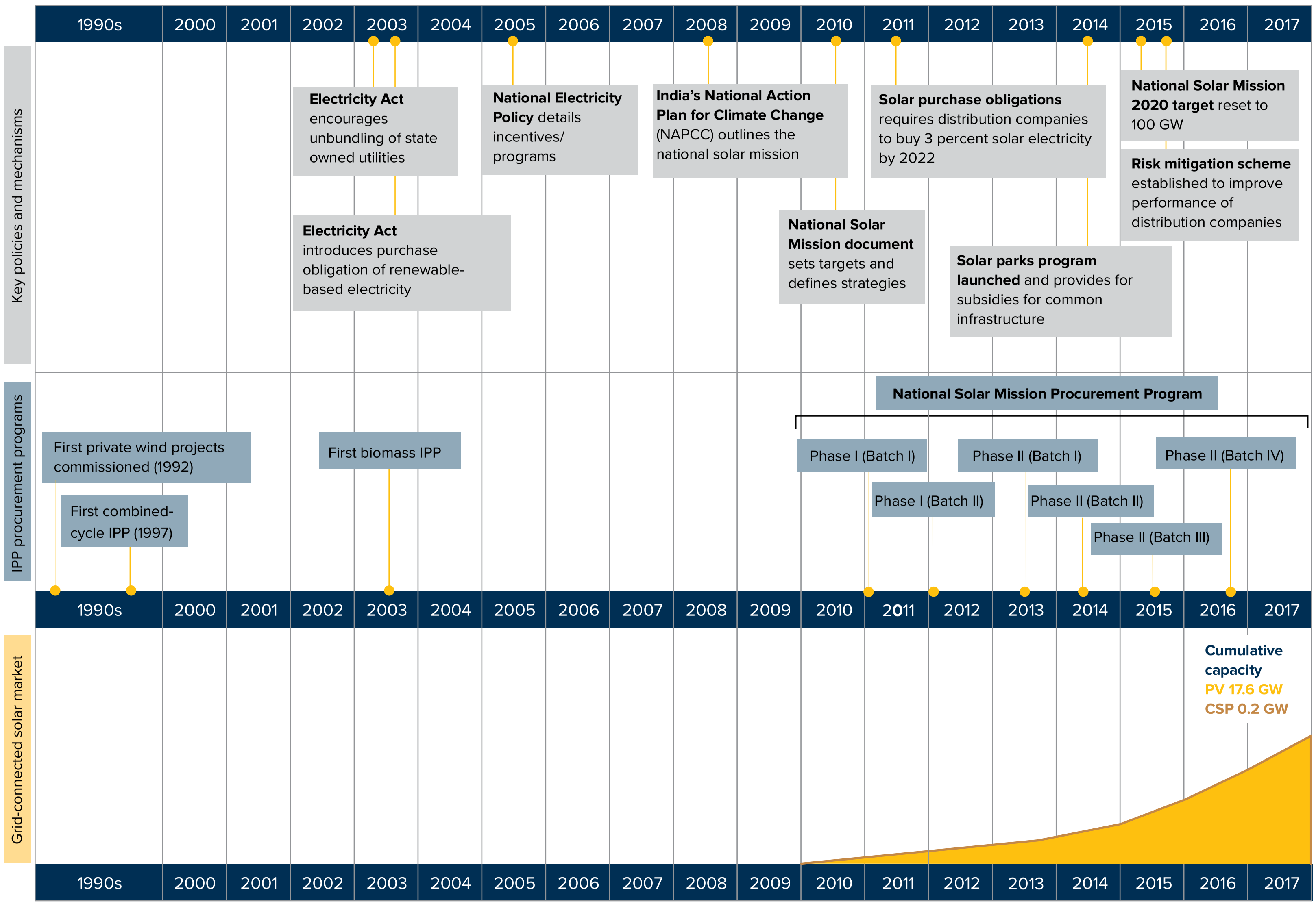
The first significant step toward the liberalization of the Indian power sector was the enactment of the 2003 Electricity Act, which initiated an in-depth unbundling process at all levels of the sector. In addition to separating state-owned integrated utilities, the following provisions of the Act affected the development of commercial grid-connected solar projects:

- Electricity generation was made a nonlicensed activity, greatly simplifying the permitting processes.
- Nondiscriminatory open access to transmission was granted to all power producers.
- Direct sales of power to distribution companies or eligible clients became possible.
- Distribution companies were obliged to procure all their future power needs through competitive processes.
- Essential elements of a preferential tariff for renewable-based electricity were introduced, as well as the framework for future mandatory renewable purchase obligations.

The 2003 Act called for the formulation of a national electricity policy, which was released in 2005. It clearly carved out a role for IPPs in the deployment of renewable energy and the increase of the overall share of nonconventional energy sources in the electricity mix. The focus at the time was on wind energy, which had benefited from a wide range of support measures since the late 1980s (including accelerated depreciation of capital investment, tax exemptions, feed-in tariffs, mandatory purchase of wind energy, and public support to research and development and pilot projects). These support measures were used as a model for solar market interventions under the National Solar Mission (Barroso and Khanna 2014).

India's regulatory framework is a complex puzzle. Decisions are made at the national level by the CERC and then implemented at the state level by the SERCs. Implementation of some support schemes has proven complex from a regulatory and institutional perspective. For instance, the solar renewable purchase obligation and the renewable energy credit trading mechanisms initiated in 2010–11 allowed the SERCs to set minimum levels of renewable energy supply. If off-takers were unable to meet these requirements because of unavailability of supply (for example, states with low solar potential), distribution companies and direct buyers could buy renewable energy certificates to bridge the gap between their purchases and the obligation. Renewable energy credits, which capture the volume of greenhouse gas emissions avoided, were sold on a dedicated market. Success has varied across India. Five states met their renewable purchase obligation targets as of fiscal year 2013/14 (Comptroller and Auditor General of India 2015). At the end of 2017, only six states did so (Greenpeace India 2018). In May 2018, the MNRE created a renewable purchase obligation compliance cell for coordination purposes (MNRE 2018a).

Figure 3.7 Timeline of public interventions and market development in India



The evolution of the fiscal environment, such as the recent changes to the general sales tax regime applicable to solar equipment, is a source of uncertainty. In July 2018, the Indian government proposed a safeguard duty on solar modules imported from China and Malaysia for a period of two years (25 percent the first year, 20 percent the next six months, and 15 percent the last six months). The measure was recommended as a way to protect the local industry, but the higher tariffs are likely to cause frustration for developers and slow deployment (Upadhyay 2018).

Planning, Technical, and Operational Capacity

Generation Planning

The National Solar Mission and subsequent revisions in targets set the national generation priorities for renewable energy, particularly grid-connected solar. Official policy documents fix short- and long-term objectives for expansion of generation capacity. With most solar capacity procured through competitive tenders, visibility in the upcoming tender processes was critical. After a lukewarm start, 2016 and 2017 witnessed a steady stream of tender announcements. The MNRE expects 30 GW in ground-mounted solar park capacity to be tendered in fiscal year 2018–19 and another 30 GW to follow in fiscal year 2019–20 (Prateek 2017).

Grid Integration, Access, and Power Evacuation

The 2003 Electricity Act guarantees nondiscriminatory access to the grid. In practice, however, grid connectivity has been a recurring challenge for solar projects. From the start of the National Solar Mission, the timely availability of power evacuation lines has been a concern and there have been delays in the commissioning of solar projects, as a result. The current PPA model does not provide compensation to IPPs in the case of loss in revenue due to power curtailment.

Land Availability

Land availability has been identified as a major bottleneck in some states. Converting land-use designations is extremely time-consuming and according to developers, requires clearances from a large number of authorities at various levels. Some states, such as Madhya Pradesh and Gujarat, have more conducive policies with respect to land acquisition than others. The solar park concept was designed in part to resolve this issue. It has proven successful. However, land can still be a barrier for the development of the parks as conflicts with local farmer organizations are common.

Investment in Enabling Infrastructure

The solar park program improved grid connectivity. Public entities lease land from citizens and prepare sites for solar PV use (establishing internal evacuation schemes, substations, layout roads, and water access). Blocks of land are then auctioned off to developers, who agree to pay up-front charges, operations and maintenance charges, land lease rent, and a development fee. The use of solar parks across India has significantly derisked the process of acquiring land and accessing the transmission grid (Box 3.1).

With the share of variable renewable energy expected to grow significantly in the coming years, there is a recognized need to improve the capacity of transmission grid operators and to amend grid codes at the federal and state levels while reinforcing interstate connectivity to avoid congestion (NITI 2017). Congestion issues are bound to arise given the rate of development in the country.

Two potential solutions have been put forward to help the transmission network keep up with generation capacity. The first is rooftop solar. The 2022 solar target includes 40 GW of rooftop and distributed solar connected to the distribution grid, up from just 250 MW in 2015.[5] Small-scale distributed solar could strengthen weak urban grids and help reduce power losses in distribution lines. With increasing concerns about the congestion of the high-voltage grid, allocating 40 percent of the global target (100 GW) to the distribution grid could delay the need for expensive reinforcement of the transmission infrastructure. The second scheme is India's Green Energy Corridor initiative, which seeks to unclog bottlenecks by connecting renewable energy–rich regions to

5 Mini-grids and off-grid solar installations do not count toward the 100 GW target.

Box 3.1 Rewa Solar Park—Driving innovation for the scale-up of solar park developments in India

Rewa Ultra Mega Solar (RUMS or Rewa Solar Park) is a 750 MW solar park covering approximately 1550 hectares, located in Rewa, a district of the Indian state of Madhya Pradesh. It was developed by Rewa Ultra Mega Solar Park Ltd (RUMSL), a joint venture between the Madhya Pradesh Urja Vikash Nigam Limited and the Solar Energy Corporation of India. In 2017, the government of Madhya Pradesh in India announced the results of the bidding process for the selection of private investors to develop (3 × 250 MW) solar plants on the project site. The project was awarded to three solar power companies at tariffs of INR 2.979, INR 2.970, and INR 2.974 for the first year. These tariffs, including the historic low INR 2.97 (about US$0.44) per kWh, were obtained without any viability gap funding to developers unlike similar large-scale projects at the time.

Mitigation of payment risk. The transaction package included a power purchase agreement with the Delhi Metro Railway Corporation (DMRC), and another one with the Madhya Pradesh Power Management Company Ltd (MPPMCL), Madhya Pradesh's distribution utility. While DMRC was an investment grade rated utility, the creditworthiness of MPPMCL was of concern for solar power developers. The PPA counterparty risk was mitigated by a three-layered payment mechanism. First, MPPMCL provided a letter of credit covering one month's worth of payment. Second, a payment security fund administered by RUMSL was designed to secure an additional three-months' worth of payment. Finally, a *Madhya Pradesh* state guarantee covers payment defaults from MPPMCL as a last resort.

Land and power evacuation. RUMSL identified the project site, undertook the preliminary works required for solar for solar power development, and secured the necessary permits and clearances (right-of-way for grid interconnection, long-term grid access, etc.). The construction of the internal power evacuation infrastructure—220/33 kV substations—was supervised by the Madhya Pradesh Power Transmission Company Ltd. All other amenities such as roads, street lighting, cable tray support structures, and drains, were the responsibility of the developers. This focus on areas where public support was the most needed allowed RUMSL to lower its lease fee to developers, compared to most solar parks in the country. All contract works were uploaded in a data room available to prequalified bidders. Photographs of the development and the power evacuation works were regularly uploaded, to allow bidders to ascertain progress on the ground as prepared their financial and technical offers. Approximately 97 percent of the land was readily available on the day of the auction.

Other forms of government support. The Ministry of Power granted status of Regional Generating Station to the Project which allowed the wheeling of the power between states free of charges and losses. Thus, the power could reach Delhi Metro up to the Delhi periphery at the same rate at which it is injected at Rewa. Power Grid Company India Ltd, the country's central transmission utility, built a 220/400 KV substation at the Rewa project site, under the interstate transmission system totally free of cost for the state and the project.

The cost of internal evacuation infrastructure was reduced through grants from the Ministry of New and Renewable Energy under the solar park scheme and loans from the World Bank and the Clean Technology Fund (CTF). CTF also provided a grant to strengthen institutional capacity building. RUMS was the first solar park in the country to use concessional financing and grants from CTF. IFC acted as transaction adviser to RUMSL for the transaction, providing expert advice to structure the project, prepare bankable project agreements, manage a wide group of stakeholders through extensive consultations and negotiations, and provide comprehensive analytical and implementation support. It is widely acknowledged that this project was a tipping point for the India solar industry, enabling the government to shift focus from viability gap funding to embrace pure market-based financing for large-scale solar investments.

Adapted from BusinessLine 2018, EnergyNext 2017, and World Bank 2017.

the western and southern power grids. The Asian Development Bank has backed three projects under the program, but transmission planning has begun only in selected states. To alleviate grid congestion and bottlenecks, the government is also considering storage. Under a World Bank–funded project, SECI will pilot battery storage solutions, both jointly with variable renewable assets in hybrid power plants and as stand-alone grid assets.

Direct and Indirect Financing

Feed-in tariff schemes have been at the core of India's push for rapid solar deployment. Through the National Solar Mission, bundling, generation-based incentives, and viability gap funding have encouraged development. Bundling provided indirect public financing by subsidizing fixed tariff procurements. Generation-based incentives gave funds directly to developers by providing IPPs with premiums over the established fixed tariff.

IPP projects procured under the various viability gap funding schemes benefited from direct public support in the form of capital investment subsidies. A total of US$1.2 billion has been approved for the 7,750 MW of PV projects being procured by SECI (estimate based on MNRE approval letters for procurement of Batches I, III, and IV of Phase II under the viability gap funding scheme).

Under the viability gap funding scheme, IPPs are invited to bid at a fixed tariff and to indicate their subsidy requirement per MW of installed capacity. The capacity on offer is awarded to the bidder with the lowest viability gap funding requirement. The scheme was designed to address affordability issues for distribution companies. Thanks to the capital subsidy, SECI is able to buy solar power, and on-sell it to distribution companies at a below-market rate. Viability gap funding was well received by private developers, because the subsidy was granted early on in the project life cycle, thus limiting the risk. At the time of inception, the fixed tariff received by developers was INR 5.45 per unit. With some state auctions receiving bids under INR 3.00 per unit, viability gap funding is no longer required to the extent it once was. The scheme may serve a new purpose in the near future by subsidizing solar PV projects associated with storage projects, to improve their affordability. SECI cancelled a 2016 auction for solar and battery projects because of higher than expected prices (Chandrasekaran 2017).

The central government has budgeted US$600 million in financial assistance to support the first 20 GW of solar parks to be set up across the country (MNRE 2017). IREDA, with the support of several international financial institutions, is providing loans to selected states for the development of solar parks.

Income tax holidays and accelerated depreciation are two ways to indirectly finance projects. Tax holidays allow developers to recoup their investment more quickly than they could if they were required to pay income taxes on initial profits. Accelerated depreciation is an accounting device used to lower the taxes payable in the first years, helping developers recoup their investments more quickly. In its guidelines for the viability gap funding scheme, SECI specifies that IPPs will receive a fixed tariff of INR 5.45 per unit if accelerated depreciation is not used and INR 4.75 per unit if it is used (MNRE 2015).

In 2015 the Reserve Bank of India added renewable energy to its priority sector lending categories. As such, domestic commercial banks must lend 40 percent of their adjusted net bank credit (or the credit equivalent of off-balance sheet exposure, whichever is higher) to renewable energy projects (Reserve Bank of India 2018).

Government-Sponsored Guarantees

Off-Taker Creditworthiness

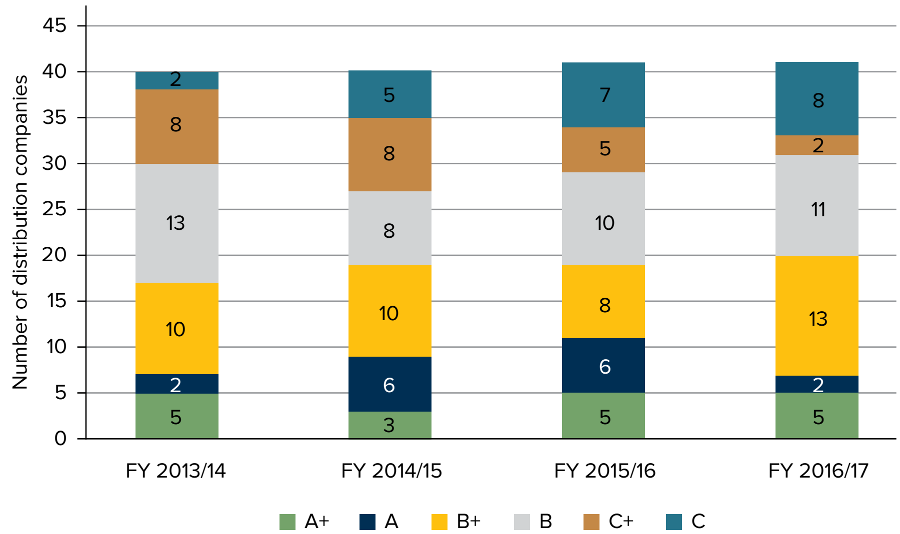
From the launch of the National Solar Mission, the poor financial performance of distribution companies prevented the large-scale development of grid-connected solar. Several schemes were set up to offer IPPs some protection against off-taker default while addressing affordability concerns for distribution companies. None of these mechanisms solved the problem, and a major source of distress among IPPs has been a delay in payments from distribution companies.

In late 2015, the government initiated a nationwide improvement program for distribution companies. The Ujwal Distribution Company Assurance Yojana (UDAY) scheme aims at reforming the financial and operational performance of utilities. One of its key interventions is the transfer of 75 percent of the distribution companies' debt to states and the restructuring of the remaining debt. Other measures include tariff revision, technical loss-reduction programs, the systematic installation of meters, and the GIS mapping of consumers.

Under the UDAY scheme, the achievements of the distribution companies are monitored in real time. Progress made to date is encouraging, and solar developers have shown cautious optimism. Most have a positive view of the scheme, although the poor results of previous attempts to restructure distribution companies' finances have cast some doubts, according to surveys of CEOs of Indian solar companies conducted in 2016 and 2017 (Bridge to India 2016, 2017b).

The financial condition of distribution companies remains the second-biggest concern (after grid-connectivity issues) in the solar sector. The Ministry of Power has released six annual reports evaluating the

Figure 3.8 Performance ratings of distribution utilities in India, 2013–17



Sources: MOP 2015, 2016, 2017, 2018.

Note: FY: fiscal year; A+: very high operational and financial performance capability; A: high operational and financial performance capability; B+: moderate operational and financial performance capability; B: below average operational and financial performance capability; C+: low operational and financial performance capability; C: very low operational and financial performance capability.

performance of utilities based on three sets of parameters: operational and reform, external, and financial. Of the 41 utilities rated, just five received the top grade, and the number of utilities receiving the lowest grade increased every year since 2015 (Figure 3.8).

Guarantees

During Phase 1 of the National Solar Mission, the government of India established a budgetary support mechanism to the MNRE. The scheme aimed to mitigate payment defaults by state utilities and distribution companies and ultimately, to ensure financial closure of projects procured through Vidyut Vyapar Nigam Limited (NVVN), the designated nodal agency for procurement of solar power (MNRE 2011). NVVN bought solar power from IPPs and on-sold it to state utilities and distribution companies, partly shielding the IPPs from off-taker risk.

The MNRE set up the Solar Payment Security Account, a third-party payment security mechanism funded by a US $100 million revolving fund. This amount was equivalent to about two months of payment at the feed-in tariff rate, given total installed capacity of 1,000 MW. The mechanism was not a true payment guarantee as NVVN was not obliged to make payments to the IPPs in the event of default by the ultimate off-taker and thus, retained complete discretion in administering it. However, it was effective in reducing the perceived off-take risk (Khanna and Garg 2013). This scheme procured 960 MW. It was extended in Phase II of the National Solar Mission.

Under the second phase of the National Solar Mission, in 2011 the central government created SECI as a separate off-taker for the purpose of providing utilities with below-market rates. SECI reduced off-taker risk for the solar park program and rooftop installations. In 2016, SECI announced the establishment of a US$200 million (INR 1,500 crore) payment security fund to ensure timely payment to solar developers. The mechanism aims to cover payment defaults to SECI by distribution companies, state utilities, and bulk consumers. It also allows SECI to meet its financial obligations under the standard bidding documents and PPAs for grid-connected solar PV projects whenever brought in force by MNRE/MOP (SECI n.d.).

India has set up similar for payment security mechanisms to support power procurement under the National Mission. There is no conclusive evidence related to their effectiveness in allaying investors' concerns.

Summary

Table 3.3 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid-connected solar market.

Table 3.3 Effectiveness of public sector action in mobilizing commercial capital in India

Public sector action	Description	Legal, institutional, and regulatory framework	Planning, technical, and operational capacity: Generation planning	Planning, technical, and operational capacity: Grid integration, access, and power evacuation	Planning, technical, and operational capacity: Land/ rooftop availability	Investment in enabling infrastructure	Direct and/or indirect public financing	Government-sponsored guarantees
Renewable purchase obligations	Renewable purchase obligations mandate that distribution companies must purchase a certain share of their energy from solar plants. This concept has been in place for more than a decade. Results are inconclusive.	✓						
Generation-based incentive	The generation-based incentive was first introduced for wind plants in 2009 and extended to solar in 2010–11. It is a premium per kWh paid to IPPs by MNRE in addition to the PPA price paid by the off-taker. The incentives are used for small-scale plants and rooftop installations connected to the distribution grid. A total of 100 MW has been implemented under the scheme so far.	✓✓					✓✓	
Accelerated depreciation	Under the National Solar Mission, solar projects were eligible for accelerated depreciation of 80 percent a year. This rate was reduced to 40 percent in April 2017. The intervention led to savings on income tax for balance sheet projects but is not attractive to special purpose vehicles.	✓✓					✓✓	
Income tax holiday	An income tax holiday was offered on 10 years of profit for solar projects. During this period, only the minimum alternate tax of 18.5 percent was due, rather than the normal tax rate of 30–33 percent. This benefit was withdrawn in April 2017. It likely enhanced the attractiveness of the solar sector for private investors.	✓✓					✓✓	
Feed-in tariff	CERC set a feed-in tariff (FIT) for fiscal 2010/11 at US$0.40 per kWh for PV and US$0.34 per kWh for CSP. Various state solar policies also include feed-in tariff mechanisms. instrumental in the early years of solar deployment.	✓✓					✓✓✓	
Viability gap funding	Introduced in 2013–14, viability gap funding is a capital subsidy provided to developers. Bidders must sell power at a fixed tariff; projects are awarded to the bidders whose requirements are lowest. Viability gap funding cannot exceed 30 percent of total capital costs. About 4 GW was procured under these schemes. With continued decrease in solar prices, it has lost its relevance.	✓✓					✓✓✓	
Payment security mechanisms	The government of India has supported the establishment of payment security funds to mitigate the payment risk. There is no evidence that these schemes have enabled a significant amount of commercial capital in the sector.							✓
Solar parks	A solar park provides land and transmission infrastructure, as well as access to roads, water, and communication. The first solar park was developed by the state of Gujarat, in 2012. Under the National Solar Mission, 40 GW of solar parks is planned. The development and construction of solar parks benefit from subsidies from the central government.			✓✓✓	✓✓✓	✓✓✓	✓✓✓	

Note: ✓✓✓: Very effective; ✓✓: Effective; ✓: Not effective.

Key Findings and Take-Aways

India has taken leaps in the past decade to transform its power sector and meet its renewable and policy goals. After the liberalization of the power market in the 2000s, the central government announced the National Solar Mission as a way to harness the country's significant solar potential, increase access to electricity, boost domestic electricity production, and take action against climate change.

The government of India and its states have been creative and flexible in their actions toward reaching their very ambitious goal of 100 GW of solar power by 2022. They have used direct and indirect financing methods to attract developers, resolve congestion issues, and mitigate off-taker risk. Numerous government and state entities were created to help bolster the solar market. Steps that would further improve India's situation include upgrading off-taker creditworthiness; expanding the electricity grid; and providing policy support that increases the flexibility of the power system, which will be needed to achieve the ambitious solar goal.

Although both solar PV and CSP were given equal opportunities to flourish at the inception of the National Solar Mission, the rapid decline in solar PV costs ultimately led to a majority market share for the technology, as the firmness and flexibility of CSP power were not explicitly valued. CSP projects continue to require the help of international financial institutions projects.

The lack of available land, the need to deploy on rooftops or floating installations, off-taker creditworthiness issues in states with the best solar resources, and the proposed safeguard duty of 20 percent could slow the deployment of solar power in India. But the market's momentum and the financial sector's steady increase in lending should keep India a global leader in solar power.

References

Ahn, Sun-Joo, and Graczyk, Dagmar. 2012. "Understanding Energy Challenges in India." Paris: International Energy Agency.

Barroso, Luiz Augusto Nobrega, and Khana, Ashish. 2014. Promoting renewable energy through auctions: the case of India (English). Live Wire. 2014/15. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/441291468034518626/Promoting-renewable-energy-through-auctions-the-case-of-India

BNEF (Bloomberg New Energy Finance). 2017. "Accelerating India's Clean Energy Transition." https://data.bloomberglp.com/bnef/sites/14/2017/11/BNEF_Accelerating-Indias-Clean-Energy-Transition_Nov-2017.pdf

Bridge to India. 2016. "India Solar Handbook." https://www.bridgetoindia.com/wp-content/uploads/2016/05/BRIDGE-TO-INDIA_India-Solar-Handbook-2016.pdf

———. 2017a. "India Solar Compass 2017 Q2." August 8. New Delhi: Bridge to India Energy Private Limited. https://www.bridgetoindia.com/wp-content/uploads/2017/08/BRIDGE-TO-INDIA_India-Solar-Compass.pdf

———. 2017b. "India Solar Handbook." New Delhi: Bridge to India Energy Private Limited. https://www.bridgetoindia.com/wp-content/uploads/2017/05/BRIDGE-TO-INDIA_India-Solar-Handbook_2017-1.pdf

BusinessLine. 2018. "Three-layer safety mesh brings down Rewa solar power tariffs." April 14. https://www.thehindubusinessline.com/companies/threelayer-safety-mesh-brings-down-rewa-solar-power-tariffs/article9640454.ece

Central Electricity Authority. 2018. "Executive Summary on the Power Sector November 2018." New Delhi. http://www.cea.nic.in/reports/monthly/executivesummary/2018/exe_summary-11.pdf

Chandrasekaran, Kaavya. 2017. "Crashing Solar Tariffs Crush Storage Plans." *Economic Times*. July 20. https://economictimes.indiatimes.com/industry/energy/power/crashing-solar-tariffs-crush-storage-plans/articleshow/59673133.cms

———. 2018. “India’s Utility Solar Capacity Grows by 72 percent in FY2018.” *Economic Times*. June 21. https://economictimes.indiatimes.com/industry/energy/power/indias-utility-solar-capacity-grows-72-in-fy18-report/articleshow/64675139.cms

Comptroller and Auditor General of India. 2015. “Chapter II: Compliance with Renewable Purchase Obligation and Availing Benefits of Clean Development Mechanism.” In Renewable Energy Sector in India. https://cag.gov.in/sites/default/files/audit_report_files/Union_Civil_Performance_Renewable_Energy_Report_34_2015_chap_2.pdf

Dilip Nigam, Shri. 2016. “The National Solar Mission: India Marching Ahead in Solar Energy.” *Akshay Urja*, 9 (6). June. New Delhi: Ministry of New and Renewable Energy.

EnergyNext. 2017. “Rewa: A Case Study.” May 10. http://www.energynext.in/2017/05/rewa-a-case-study/

Greenpeace India. 2018. “KUSUM Scheme Can Help States Fulfil RPO Targets.” https://www.greenpeace.org/india/en/issues/clean-energy/1487/kusum-scheme-can-help-states-fulfil-rpo-targets/

IEA (International Energy Agency). 2015. *India Energy Outlook.* Paris: IEA.

———. 2018. World Energy Statistics and Balances (database). https://doi.org/10.1787/data-00510-en

IRENA (International Renewable Energy Agency). 2017. Trends in Renewable Energy Installed Capacity. http://resourceirena.irena.org/gateway/dashboard/

———. 2018. *Renewable Power Generation Costs in 2017.* Abu Dhabi: IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf

Khanna, Ashish; Garg, Kanv. 2013. “Paving the Way for a Transformational Future : Lessons from Jawaharlal Nehru National Solar Mission Phase One.” Energy Sector Management Assistance Program (ESMAP). Washington DC: World Bank Group. http://documents.worldbank.org/curated/en/164861468049776027/Paving-the-way-for-a-transformational-future-lessons-from-Jawaharlal-Nehru-national-solar-mission-phase-one

Kumarankandath, Aruna, and Nayanjyoti Goswami. 2015. *The State of Concentrated Solar Power in India.* Centre for Science and Environment, New Delhi.

Mercom India. 2018. “India’s Top 10 Solar States in Charts.” https://mercomindia.com/product/india-solar-project-tracker/

MNRE (Ministry of New and Renewable Energy). 2010. Jawaharlal Nehru National Solar Mission. New Delhi.

———. 2011. Implementation of Payment Security Scheme for Grid-Connected Solar Power Projects under Phase I of the Jawaharlal Nehru National Solar Mission (JNNSM) during year 2011-2012. June 30. https://mnre.gov.in/file-manager/UserFiles/payment_security_mechansim_grid_connected_jnnsm_2011_2012.pdf

———. 2015. Guidelines for Implementation of Scheme for Setting up of 2000 MW Grid-Connected Solar PV Power Projects under Batch-III. New Delhi.

———. 2017. Annual Report 2016–2017. New Delhi. https://mnre.gov.in/file-manager/annual-report/2016–2017/EN/pdf/1.pdf

———. 2018a. Creation of Renewable Purchase Obligation Compliance Cell-reg. New Delhi.

———. 2018b. List of Solar Parks Approved under the Solar Park Scheme of MNRE as on 30-06-2018. New Delhi. https://mnre.gov.in/file-manager/UserFiles/List-of-approved-Solar-Parks.pdf

MOP (Ministry of Power). 2018. State Distribution Utilities Sixth Annual Integrated Rating. July. New Delhi.

———. 2017. State Distribution Utilities Fifth Annual Integrated Rating. May. New Delhi.

———. 2016. State Distribution Utilities Fourth Annual Integrated Rating. June. New Delhi.

———. 2015. State Distribution Utilities Third Annual Integrated Rating. August. New Delhi.

NITI (National Institution for Transforming India). 2015. Report of the Expert Group on 175GW RE by 2022. Government of India. New Delhi. http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf

———. 2017. Draft National Energy Policy. Government of India. New Delhi. http://niti.gov.in/writereaddata/files/new_initiatives/NEP-ID_27.06.2017.pdf

Prateek, Saumy. 2017. "MNRE to Tender 17 GW of Solar and over 3.5 GW of Wind Projects by March 2018." November 28. MERCOM India. https://mercomindia.com/mnre-tender-solar-wind-projects-march-2018/

Reserve Bank of India. 2017. Statistics Tables Relating to Banks in India. New Delhi. https://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications#!4

———. 2018. Priority Sector Lending: Targets and Classifications. New Delhi. https://m.rbi.org.in/Scripts/FAQView.aspx?Id=87

SECI (Solar Energy Corporation of India Limited). n.d. Draft Scheme - Setting Up Rs 1500 Cr Payment Security Fund for VGF Scheme under JNNSM. http://www.seci.co.in/web-data/docs/Payment%20Security%20Fund%20_%20Draft%20Scheme.pdf

UNDP (United Nations Development Program). 2018. Human Development Indices and Indicators 2018 Statistical Update. New York: UNDP

Upadhyay, Anindya. 2018. "India Proposes Safeguard Duty on China, Malaysia Solar Cells." July 17. Bloomberg. https://www.bloomberg.com/news/articles/2018-07-17/india-slaps-25-safeguard-duty-on-chinese-malaysian-solar-cells

World Bank. 2017. *India—Shared Infrastructure for Solar Parks Project (English)*. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/916221491098471122/India-Shared-Infrastructure-for-Solar-Parks-Project

———. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b. *Doing Business 2018: Reforming to Create Jobs.* Washington, DC: World Bank.

———. 2018c. Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

———. 2018d. Private Participation in Infrastructure (database). Washington, DC: World Bank. https://ppi.worldbank.org/data

CHAPTER 4 MALDIVES CASE STUDY

Maldives is the smallest Asian country by land area and population. It is also one of the world's most geographically dispersed countries, with 1,192 islands spread over an area of 115,300 square kilometers. Approximately 187 of its islands are inhabited, 123 are self-contained tourist resorts, and 128 are used for other industrial and commercial purposes. The country's geography makes communication difficult and transport expensive.

A middle income country, Maldives faces frequent episodes of instability related to political transitions, which raises concerns among foreign investors about political risk and breach of contract. It is a highly attractive tourist destination. Thanks to the launch of a massive public infrastructure program, the construction industry has been the main driver of its economic development. Maldives' import-dependent economy increases the country's vulnerability to global commodity prices and external shocks. The public sector is the main employer for working-age Maldivians, who represent about 60 percent of the population. Approximately 80 percent of the land area lies within one meter of sea level, exacerbating the country's vulnerability to climate change impacts. Table 4.1 presents selected socioeconomic indicators.

Table 4.1 Maldives' selected socioeconomic indicators

Indicators	Values
Population (2017)	0.436 million
Land area	300 km^2
Annual GDP growth (2017)	8.8 percent
Human Development Index (2017)	High (0.717)
Ease of doing business ranking (2018)	136th of 190
Access to electricity (2016)	100 percent

Sources: World Bank 2018a, 2018b; UNDP 2018.

Overview of Maldives' Power Sector

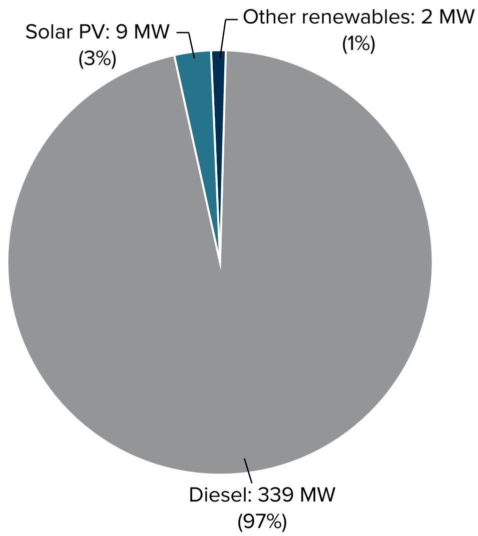
Electricity Installed Capacity and Consumption

Maldives achieved universal access to electricity in 2008. Each island has its own power system and operates small, isolated grids with thermal-based generation systems. Total installed capacity in 2017 was about 345 MW, including 9 MW of solar power (Figure 4.1). The country has no conventional sources of energy. Heavy reliance on imported fuel leaves the power system vulnerable to global fluctuations in oil prices. Importation of petroleum products often represents more than 30 percent of the country's GDP. According to the Maldivian Ministry of Environment and Energy, more than 560,000 metric tons of fuel was imported in 2017, with diesel accounting for nearly 80 percent of it (MEE 2018).

End-user tariffs are high but do not reflect the full cost of providing electricity services. The resulting financing gap is exacerbated at times of high and volatile oil prices. Fuel costs of electricity generation vary from US$0.2–US$0.3 per kWh in populated islands with larger grids, to US$0.7–US$0.9 per kWh on the smaller and isolated islands (Kohli and Braud 2016). Regulated end-user tariffs for thermal-based generation vary between US$0.14 and US$0.50 per kWh (MEE 2018).

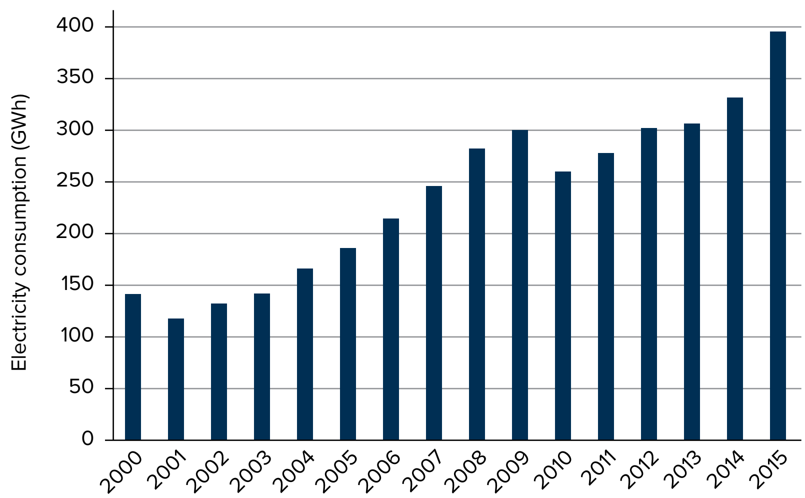
Over the last decade electricity consumption increased by about 7 percent a year (Figure 4.2) driven by the demand in Malé and its neighboring islands (Hulhumalé, Hulhulé and Vilingili, collectively referred to as the Greater Malé Region), where approximately one-third of the population resides, and which account for about 60 percent of the overall power consumption.

Figure 4.1 Power generation mix in Maldives, 2017



Sources: IRENA 2018; MEE 2018.

Figure 4.2 Electricity consumption in Maldives, 2005–15



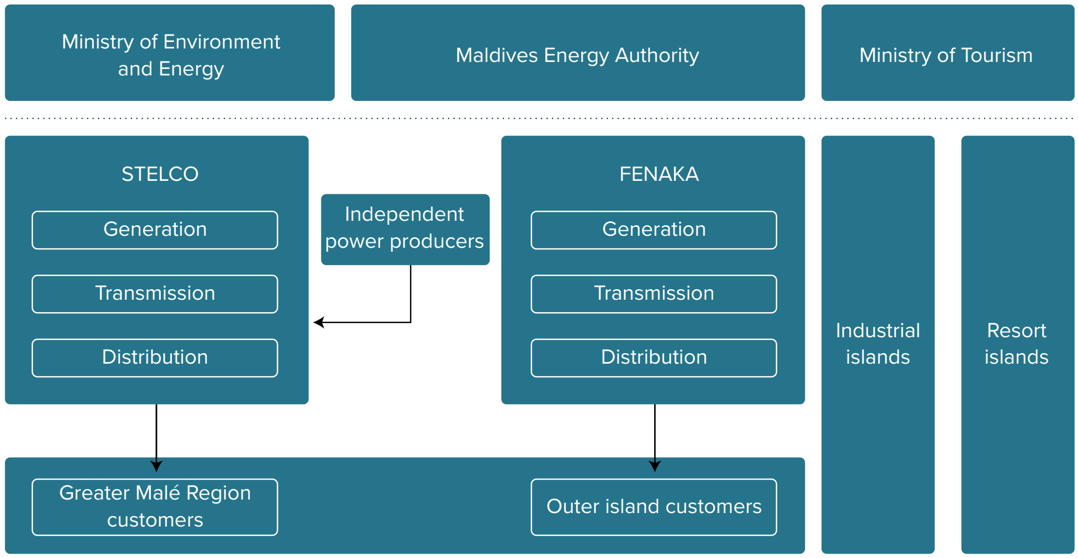
Source: UNSD 2018.

Institutional Arrangements and Key Stakeholders

Maldives' institutional framework is organized around its two vertically integrated state-owned utilities—the State Electric Company Ltd. (STELCO) and FENAKA Corporation Limited (Figure 4.3). STELCO provides electricity to the Greater Malé Region while FENAKA serves about 150 inhabited outer islands.

Two independent power producers (IPPs) sell their power to STELCO: Hulhumalé Renewable Energy Corporation, with 1.5 MW of rooftop PV installation on Hulhumalé; and Renewable Energy Maldives, with 652 kW of PV on six islands in the Greater Malé Region.

Figure 4.3 Key sector stakeholders in the power sector in Maldives



The Ministry of Environment and Energy is responsible for energy sector planning and policy. The Maldives Energy Authority regulates the sector. It sets end-user electricity tariffs, issues technical guidelines and regulations, and provides licenses to producers, among other activities.

Resort islands are leased to private companies for a period of up to 100 years following a competitive bidding process run by the Ministry of Tourism. Other islands are leased to private investors for industrial purposes such as cold storage, ice production, manufacturing and warehousing. Most of the resort and industrial islands use privately-owned diesel generators. They are not served by the state-owned utilities and neither do they benefit from government fuel subsidies.

Key Energy Policy Objectives

The overarching objective of Maldives' energy policy is to provide affordable and reliable electricity services to the population while reducing the economic, social, and environmental impact of its high dependency on fossil fuel. Meeting this objective requires increasing the national energy security by scaling up the deployment of indigenous renewable energy resources.

The 2016 Maldives Energy and Policy Strategy document outlines five objectives:

- Strengthen the institutional and regulatory framework of the energy sector.
- Promote energy conservation and efficiency.
- Increase the share of renewable energy in the national energy mix.
- Improve the reliability and sustainability of electricity service, and maintain universal access to electricity.
- Increase national energy security.

It also envisages the development of renewable energy solutions by the private sector, the creation of an enabling environment for large-scale renewable energy investment, and the establishment of innovative financing mechanisms to mitigate the impact of the high up-front cost needed to develop renewable energy projects (MEE 2016).

The government's priorities set out in its 2014–18 manifesto include the following action points:

- Minimize electricity expenses, through the introduction of hybrid systems that use renewable energy.
- Install solar panels in government and large private buildings.
- Facilitate research on wind, solar, ocean current, and wave energy.
- Develop a roadmap to produce 70 percent of energy from clean energy sources by 2020.

In its 2015 Nationally Determined Contribution (NDC), Maldives committed to reduce its greenhouse gas emissions by 10 percent by 2030, with the possibility of increasing reductions to 24 percent with adequate financing support, technology transfer, and capacity building. Overall, renewable energy development, private sector investment, and affordability of energy appear to be essential to Maldives' energy sector strategies.

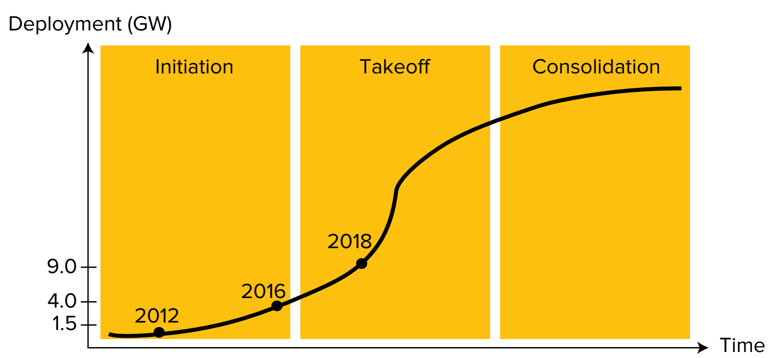
Maldives' Solar Market

Maldives' Position in Global Solar Development

Production of solar energy increased from negligible amounts in 2011 to about 9 MW in 2016 (IRENA 2018). In 2016, the government launched a program aimed at encouraging private sector investment in the solar market through competitive tenders, the Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) program. The first tender resulted in the commissioning of the 1.5 MW independent power project on Hulhumalé in 2018.

The takeoff of the solar market in Maldives took place in 2016 (Figure 4.4) At the time, the global market was booming with solar PV capacity additions growing faster than any other type of generating capacity. Global installed capacity of solar PV was just under 300 GW, and the global levelized cost of electricity for utility-scale solar PV projects was roughly US$0.15 per kWh, after declining more than 50 percent in the previous five years. Though the levelized cost of electricity generation for solar PV and thermal are not directly comparable (as PV is nondispatchable), this drastic reduction increased the attractiveness of solar investment in Maldives, where thermal generation ranged from US$0.20 to US$0.90 per kWh in 2016, depending on the island and the efficiency of the grid (Kohli and Braud 2016).

Figure 4.4 Phases of deployment of solar photovoltaic power in Maldives



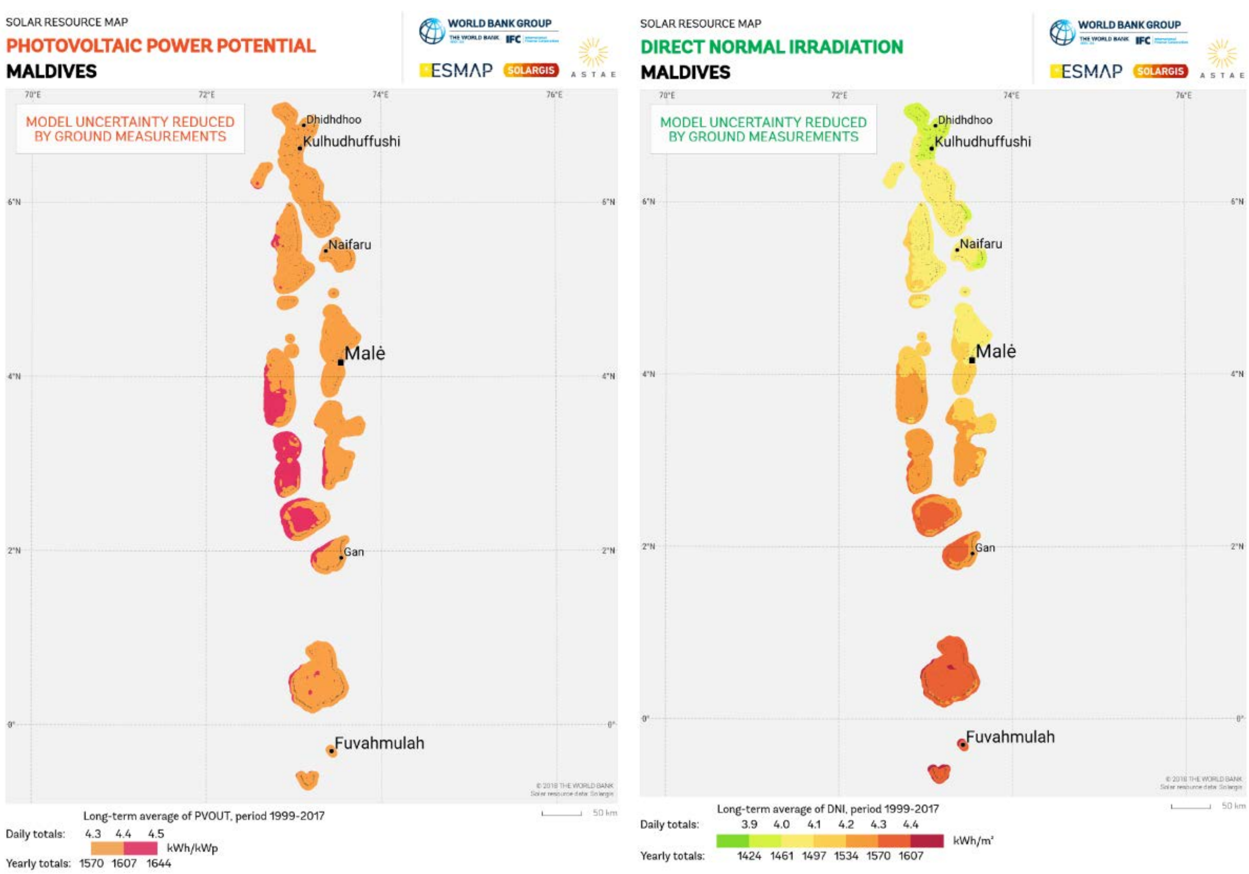
Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

Maldives has a good resource for solar PV and CSP deployment (Figure 4.5). However, with a total annual energy consumption of about 700 GWh, and a peak load varying from less than 1 MW on many islands to 60 MW in Malé, the power sector is small and the solar market potential is limited. The Greater Malé Region could potentially absorb 23 MW of solar power by 2020 (IRENA 2015). However, lack of suitable public land and rooftops, and challenges to integrate variable solar energy on weak and small grids are binding constraints to the development of the solar sector. Deploying solar PV beyond public buildings' roof space and developing floating solar projects could potentially increase solar power deployment potential in the Greater Malé Region. Though land availability is less problematic in the outer islands, these islands are sparsely populated, with low electricity consumption levels.

The predominance of small islands (between 0.2 and 5.0 square kilometers) spread over a large geographical area limits the possibility of interconnection outside the densely populated Greater Malé Region. No power interconnections link the Maldivian islands to neighboring countries or to one another and thus, each island is effectively an isolated mini-grid.[6]

Figure 4.5 Photovoltaic power potential and direct normal irradiation in Maldives



Source: World Bank 2018c.

6 The 2.1-kilometer Sinamalé bridge, completed in September 2018, links Malé and the island of Hulhulmalé. A 132 kV line is expected to be commissioned in 2019; none of the other islands have existing or planned transmission links.

Market Structure and Competition

STELCO and FENAKA procure all new generation capacity and manage the bulk of power production facilities, except on resort and industrial islands. Regulation supporting net metering was introduced in 2015, but market adoption has been relatively slow.

With only two independent solar power producers in operation in 2018, competition in the solar power generation market is limited. The market seems to be unattractive to global solar developers, as seen during the international competitive tender conducted in 2015. In addition, domestic investors lack the technical capacity to successfully compete with external investors from countries such as China or India.

Local Financial Market

Maldives' long-term sovereign debt in both foreign and local currencies was rated highly speculative by Moody's (B2/B2) (as of July 25, 2018) and Fitch (B+/B) (as of May 15, 2018), indicating the high credit risk associated with government-issued debt. The International Monetary Fund assessed Maldives to be at a high risk of external debt distress, with a limited debt repayment capacity. These assessments mean that capital markets require a high credit risk premium. In June 2017, the government of Maldives raised US$200 million on international capital markets in a first-of-a-kind bond issue. The bond was priced at 7 percent, with a five-year maturity. Maldives' major creditors are bilateral and multilateral institutions from China, Saudi Arabia, Abu Dhabi and the Organization of the Petroleum Exporting Countries Fund, with lending rates of 2 to 5 percent and maturities of 20 years or longer (IMF 2017).

Private sector–led investment is very limited outside the resort islands. Local financial institutions have not typically provided long-term financing for infrastructure projects or the renewable energy sector. Short-term debt instruments prevail in the banking system, which has substantial exposure to the construction and government sectors (IMF 2017). The lack of private sector financing is a binding constraint for the development of utility-scale solar projects by local investors, who do not have access to international capital markets. Foreign investors require adequate coverage to mitigate the low creditworthiness of public utilities and the high perceived political risk through creditworthy third-party guarantees and insurance products. Efforts to restore financial equilibrium to the sector could lead to rising volumes of local and international commercial financing in the long run.

Evolution of the Grid-Connected Solar Market

The deployment of solar PV was marginal until the early 2000s, when a number of pilot projects supported by development finance institutions and international government assistance resulted in the development of small PV or hybrid systems connected to the local mini-grids on a number of islands.[7] Toward the end of the decade, several tourist resort islands began making more significant investments to develop larger solar PV systems. In the early to mid-2010s, the World Bank, the Asian Development Bank, the Japan International Cooperation Agency (JICA), and the German government assisted in implementing a number of solar PV projects on several islands, installing systems with generating capacities ranging from 100 kW to 750 kW.[8]

In 2012, the first IPP was launched in Maldives. A local company, Renewable Energy Maldives, in partnership with German project developer Wirsol Solar AG, installed 652 kW of PV across six islands (Hameed 2015). STELCO is procuring power from these installations through a long-term power purchase agreement.

7 In 2004–05 the Japanese government supported the installation of PV power systems on Laamu Atoll. In 2005 a 12.8 kWp solar-diesel hybrid system was installed on Mandhoo Island, financed by the Global Environment Facility. With the support of USAID, in 2008 a renewable energy–based microgrid (PV, wind, diesel) was installed on North Thiladunmathi Atoll Uligamu. (Hameed 2015).

8 By late 2011, JICA had assisted in implementing projects installing PV grid-connected solar systems on the rooftops of 11 buildings in the Greater Malé Region, including government offices, hospitals, and schools. These projects added 740 kW to the Malé grid. (Hameed 2015)

Support from development finance institutions continues to be an important driver of the development of new PV installations procured by public organizations. As one of the first pilot countries of the Scaling-Up Renewable Energy Program in Low Income Countries, Maldives prepared an investment plan that defined specific investments in renewable energy in 2012 (MEE 2012). The Asian Development Bank led the Preparing Outer Islands for Sustainable Energy Development (POISED) project, which resulted in the installation of 2.5 MW solar PV systems on the rooftops of public buildings on five islands served by FENAKA (ADB 2018). In 2014 the government of Maldives, with the support of the World Bank, developed the ASPIRE program, aimed at encouraging private sector investment. The program has developed a bankable project structure to scale up commercial grid-connected rooftop PV. In March 2018, almost six years after its first privately developed solar project, Hulhumalé Renewable Energy Corporation, a private consortium, commissioned 1.5 MW of rooftop PV installations to become Maldives's second IPP. The project was awarded following an international competitive tendering process.

Mobilization of Commercial Finance

The development of commercial grid-connected solar projects in Maldives is still limited, with two solar IPPs providing slightly more than 2 MW of power. Significant solar PV projects were developed on several resort islands, primarily to save on fuel cost and to respond to the expectations of environmentally conscious travelers. Although information on the capital invested in these projects is not publicly available, they appear to have been financed entirely by their private sponsors, using corporate resources as opposed to project-based financing.

Effectiveness of Public Sector Intervention

The government has launched several initiatives that contribute to removing investment barriers and attracting commercial financing in the sector (Figure 4.6).

Legal, Policy, and Regulatory Framework

The 1996 Public Utilities Law 4/96 provides the overall legal framework governing the energy sector. It allows private sector ownership of renewable energy generation. IPPs are required to obtain operator licenses through the Maldives Energy Authority and to sell the electricity produced to the two vertically integrated state-owned utilities. There is no legal or regulatory framework specific to renewable energy projects.

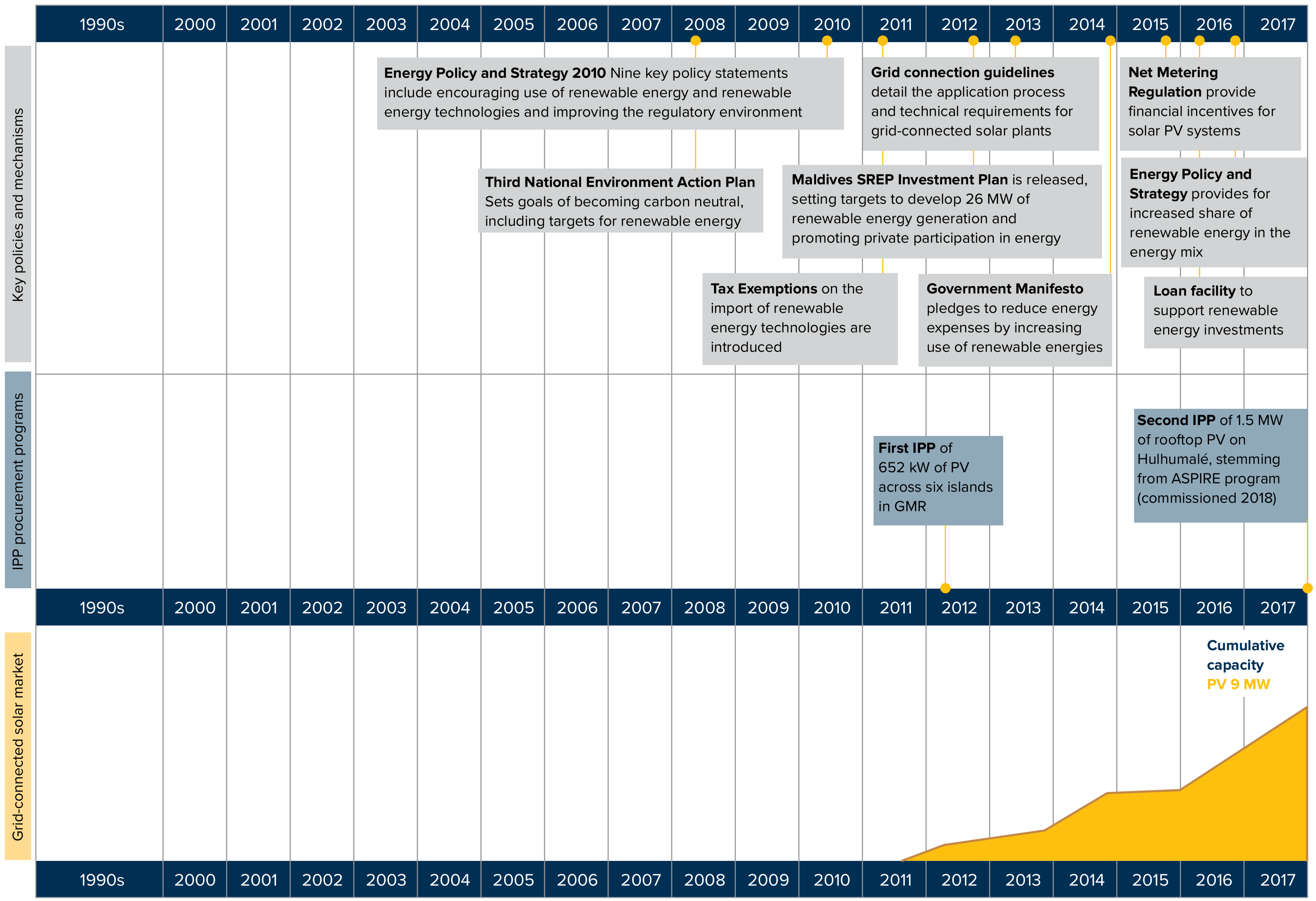
Although net metering regulations were introduced in 2015, total net metering capacity is limited to mitigating the impact on the grid to avoid grid instability and protect the financial position of STELCO. Statistics on net metering published on STELCO's website include details on the capacity allocated on each island and for each consumer segment (for example, business, domestic and government). The net metering regulations have not resulted in significant increases in solar installations. According to a local private developer, these regulations created uncertainty as it is not clear whether they replace the grid-connection guidelines issued in 2013.

Planning, Technical, and Operational Capacity

Generation Planning

There is no long-term generation planning or forecasting of supply and demand. The Maldives Energy Authority published a supply and demand survey covering 2010–12 that updated surveys conducted in 2008 and 2009. These documents served as inputs for energy planning, but do not appear to have resulted in a long-term generation plan. Since 2013 the Ministry of Environment and Energy has periodically published information on energy generation, distribution, and consumption on the inhabited islands. In 2017, for the first time, the data included information on 25 resort islands (MEE 2017).

Figure 4.6 Timeline of public interventions and market development in Maldives



Grid Integration, Access, and Power Evacuation

Access to the grid is governed by the Maldives Energy Authority's 2013 guidelines, which outline the steps and approvals required to install PV systems that are connected to the grid.

Since 2013 STELCO has limited the quantity of solar power that can be used to supply each island to 30 percent during peak times, due to concerns over the stability of the power systems. Based on the percentage ratio of variable renewable energy generated to peak load, Maldives' islands can be divided into three groups according to the following thresholds: below 10 percent, between 10 and 40 percent, and above 40 percent. Energy storage systems and tools to forecast the variability of solar power are needed to facilitate effective load following, and to maintain the integrity of the power systems in the islands belonging to the last two categories. The deployment of sufficient storage capacity will reduce the need for backup diesel generators, especially during the day, when cloudy weather conditions reduce the electricity output of PV panels.

Land Availability

Land availability is a major issue in Maldives due to the scarcity of suitable land for large-scale ground-mounted PV installations. Rooftop PV represents the most obvious viable alternative. The availability of suitable rooftop space is especially limited in the Greater Malé Region because of the high population density and the poor quality of some constructions. Lack of urban planning, zoning, and building regulations has an impact on the development of future rooftop PV projects. The government has sought to address this constraint by making public buildings available for rooftop installation. Through the ASPIRE project, it also helped aggregate rooftop space on social housing blocks to allow for development of a large enough investments to be of interest to private developers.

New technologies could help Maldives circumvent the scarcity of suitable land or rooftops. Floating PV systems are spreading rapidly around the world, although the technology is still emerging, particularly for use in marine environments. A private Austrian developer has installed two floating PV systems on resort islands. Further investigation would help determine the economic viability of deploying grid-connected floating solar PV in Maldives and the nature of the public support, if any, that would be needed to do so.

Direct and Indirect Financing

Access to local commercial financing is challenging due to the high risk perceived by the local banks, which are reluctant to support renewable energy projects. The resulting high interest rates and stringent screening processes for providing loans make it difficult for local developers to secure financing for solar projects. Thus, support from the public sector and development finance institutions has played a major role in attracting private sector interest in Maldives. Public support increased awareness of the benefits of PV, demonstrated the viability of the technology and helped strengthen stakeholders' capacity.

Key among these initiatives is the US$30 million grant funding approved in 2014, by the Climate Investment Funds, through SREP. The funding co-financed investments from the Asian Development Bank and the World Bank through the POISED and ASPIRE projects to foster the development of hybrid solar PV-diesel mini-grids on the outer islands, prepare a pipeline of subprojects that would be financed and developed by private investors selected through an international competitive bidding process, provide technical assistance for private investment in solar PV, and strengthen the capacity of public stakeholders.

In 2016 the government launched a loan facility through the Bank of Maldives (the BML green loan) to provide financing at low interest rates to individuals and businesses, for investment in the renewable energy sector. It is too early to assess the impact of this initiative on solar market development.

In terms of indirect financing, Maldives provides tax exemptions for the importation of renewable energy equipment.

Government-Sponsored Guarantees

Off-Taker Creditworthiness

One of the major concerns of potential investors in power projects in Maldives is the creditworthiness of the state-owned power off-takers, which rely heavily on government subsidies to manage their day-to-day operations. Concern by private investors is compounded by the fact that leading rating agencies and the International Monetary Fund consider Maldives' sovereign debt to be high. There is no established track record of government entities honoring their payment obligations to private developers, as most projects have been implemented by the public sector and the solar IPP market is nascent. For all these reasons, guarantee mechanisms are essential to attract private sector investment. The government supported the provision of a guarantee package from the World Bank to backstop its payment obligations under the recently procured 1.5 MW independent power plant on Hulhumalé.

Guarantees

Guarantee features were essential in providing international investors with the necessary comfort to invest in the Hulhumalé's independent power project, according to stakeholders. The SREP-funded escrow account was designed as a flexible instrument to mitigate payment delays; the guarantee from the World Bank's International Development Association (IDA) covered termination payments because of a government default (Box 4.1). Potential investors viewed the presence of the World Bank in the design and implementation of the project as an implicit political risk mitigation measure because of its rigorous due diligence processes and its convening power.

Future projects could include guarantees as an option, to be applied at the discretion of bidders. There is also interest in exploring how public financing could be used to bring down interest rates for local financing programs. Subsequent projects would determine the necessity and usefulness of the guarantee facility. The survey conducted for this study determined that a guarantee to mitigate payment risk from state-owned entities is one of the most important requirements for private sector companies to invest in the Maldives solar market.

Summary

Table 4.2 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid-tied solar market.

Key Findings and Take-Aways

Scaling-up solar power development represents an excellent opportunity for Maldives because of the country's heavy reliance on diesel-powered generation and its vulnerability to global commodity prices and climate change. The barriers to the development of commercial solar projects include an incomplete regulatory framework, grid integration issues, unavailability of adequate land, lack of planning, limited rooftop space on densely populated islands, perceived high off-taker risk and scarce domestic financing for renewable energy projects. Successful interventions undertaken to date have not yet unlocked the full potential of the market.

Key lessons from the experience of Maldives include the following:

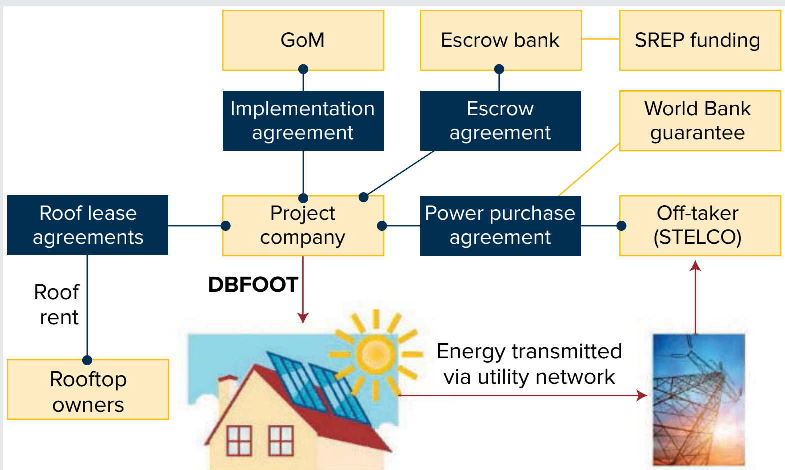
- During the early market deployment stage and in the presence of financially weak state-owned single-buyer off-takers, governments need to support guarantees and other liquidity facilities to mitigate the risk of non-payment. Guarantees provided by reputable institutional financing institutions enhance the bankability of transactions and provide comfort to international capital providers. Restoring the financial equilibrium of the power sector ultimately represents a more sustainable solution.
- Aggregation and proper planning for solar deployment are critical to secure suitable land or rooftops where limited land is available. Alternative technologies such as floating solar should also be explored.
- Scaling-up solar deployment in Maldives requires a combination of good planning and grid design, operational training, and investment in storage and energy management systems. Capacity building for

Box 4.1 Accelerating sustainable private investments in renewable energy through guarantee products in Maldives

The Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) program aims to encourage private sector investment in renewable energy and strengthen the existing regulatory frameworks. Its goal is to create a more investment friendly environment and set the stage for private investments in the sector.

As part of a market-sounding exercise, the government and its advisers found that credit enhancement from the World Bank would be key to increasing interest from the private sector. An escrow account funded by the SREP and an IDA guarantee were offered as part of the bid package to investors to mitigate the perceived payment and termination risks. The security package is intended to mitigate these risks by supporting the government's responsibilities in the event of payment delays, providing the utility with time to meet its obligations particularly during a period of financial stress. To mitigate liquidity risk, the private party, STELCO, the government, and an escrow bank would sign an escrow agreement (financed by SREP), which would to be called upon by the private party in the event of a payment delay. To mitigate the termination payment risk, the private party could call the IDA guarantee if the government failed to pay a termination payment.

Box Figure 4.1.1 Structure of the ASPIRE project



GoM: Government of Maldives
DBFOOT: design, build, finance, own, operate, and transfer

An initial 4 MW subproject was identified and prepared for implementation. It involved installing rooftop solar PV systems on public buildings in Malé (2.5 MW) and nearby Hulhumalé (1.5 MW). The project was structured under a design, finance, build, own, operate, and transfer (DBFOOT) arrangement, with the private party supplying power to STELCO at a fixed tariff under a 20-year PPA (Box Figure 4.1.1). The private party would enter into an implementation agreement with the government and a lease agreement with the rooftop owners.

A tender process was implemented under two lots, one for the 2.5 MW project and one for the 1.5 MW project. About 25 firms purchased bid documents; 4 submitted bids. No bidders passed the technical threshold for the 2.5 MW project, a result of a strict screening process. The project was in Malé, where there is less available rooftop space as well as continuous industrial development and a lack of zoning regulation and urban planning. The result is increased shading from new buildings, which would negatively affect the effectiveness of rooftop installations.

The 1.5 MW project on Hulhumalé was awarded to a Chinese-Swiss consortium, which signed a power purchase and implementation agreement in October 2015, at a tariff of US$0.21 per kWh. At the same time, rooftop solar in India had a tariff of US$0.18 per kWh. The project installed rooftop solar PV on 37 social housing blocks. Successful commissioning occurred in March 2018.

Source: Adapted from Kohli and Braud 2016.

Table 4.2 Effectiveness of public sector action in mobilizing commercial capital in Maldives

Public sector action	Description	Legal, institutional, and regulatory framework	Planning, technical, and operational capacity			Direct and/or indirect public financing	Government-sponsored guarantees
			Policy, strategy, and planning	Grid integration, access, and power evacuation	Land/rooftop availability		
Energy Policy and Strategy (2010)	Policy and strategy encourage use of renewable energy and set goal of becoming carbon neutral by 2020.	✓	✓✓				
Tax exemptions (2011)	Tax exemptions on the import of renewable energy contributed to immediate increase in production of solar energy the following year.					✓	
Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) program (2014)	Project development package included capacity building, rooftop space aggregation, risk mitigation mechanisms, and competitive IPP procurement.	✓✓✓			✓✓✓		✓✓✓
Grid-connection guidelines (2013)	Guidelines detail the application process and technical requirements for grid-connected PV.			✓✓			
Net metering regulation (2015)	Regulation aims to encourage installation of domestic and commercial rooftop PV systems. Impact appears limited,	✓		✓			

Note: ✓✓✓: Very effective; ✓✓: Effective; ✓: Not effective.

generation and transmission planning and grid integration studies will help reduce uncertainty about grid absorption capacity and determine the operational and investment needs. Providing adequate incentives (to deploy energy storage systems, for example) would stimulate commercial investment in the sector. Finally, knowledge exchange and cooperation with other island countries could be encouraged to further strengthen institutional capacity.

References

ADB (Asian Development Bani). 2014. *Proposed Grant and Administration of Grant—Republic of Maldives: Preparing Outer Islands for Sustainable Energy Development Project.* September. Project number: 46122. Manilla https://www.adb.org/sites/default/files/project-document/82419/46122-003-rrp.pdf

———. 2018. "Maldives: Preparing Outer Islands for Sustainable Energy Development Project." Project Data Sheet. https://www.adb.org/projects/46122-003/main#project-pds

Hameed, Hassan. 2015. "The Adoption of PV Systems in the Maldives: A Technological Review." *The Maldives National Journal of Research* 3 (March): 52–73.

IMF (International Monetary Fund). 2017. Staff Report for the 2017 Article IV Consultation. December 1. Washington, DC.

IRENA (International Renewable Energy Agency). 2015. *Renewable Energy Roadmap*: *Maldives*. Abu Dhabi: IRENA.

———. 2018. *Renewable Capacity Statistics 2018.* Abu Dhabi: IRENA.

Kohli, Sandeep, and Arnaud Braud. 2016. "Rooftop Solar in Maldives: A World Bank Guarantee and SREP Facilitate Private Investment in Clean and Affordable Energy." Live Wire 2016/61. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/23948

Maldives Energy Authority. 2013. Guidelines on Technical Requirements for Photovoltaic Grid-Connection. Malé.

MEE (Ministry of Environment and Energy). 2012. Maldives SREP Investment Plan 2013–2017. October. http://www.environment.gov.mv/v1/wp-content/blogs.dir/1/files/publications/20131212-Pub-Maldives-SREP-Investment-Plan-2013-2017.pdf

———. 2016. Maldives Energy Policy and Strategy 2016. November. Malé.

———. 2017. Island Electricity Data Book 2017. December. Malé.

———. 2018. Island Electricity Data Book 2018. December. Malé.

UNDP (United Nations Development Program). 2018. *Human Development Indices and Indicators 2018 Statistical Update.* New York: UNDP.

UNSD (United Nations Statistics Division). 2018. Industrial Commodity Statistics (database).

World Bank. 2014. *Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) Project*. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/402251468300650153/Maldives-Accelerating-Sustainable-Private-Investments-in-Renewable-Energy-ASPIRE-Project

———. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b. *Doing Business 2018: Reforming to Create Jobs*. Washington, DC: World Bank.

———. 2018c. Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

CHAPTER 5 MOROCCO CASE STUDY

Morocco is one of Africa's major economic hubs. It is the continent's fifth-largest economy by GDP in purchasing power parity (IMF 2018). The country has close relations with the European Union, with which it is negotiating a Deep and Comprehensive Free Trade Agreement, and it is interconnected with the European electricity grid, with which it operates synchronously. Bold economic reforms, moderate inflation, steady annual GDP growth exceeding 3 percent, improving domestic infrastructure over the past decade, and relative political stability make Morocco attractive for international investors. Notwithstanding these achievements, the country suffers from a high unemployment rate and illiteracy, particularly in rural areas. Table 5.1 presents selected socioeconomic indicators.

Table 5.1 Morocco's selected socioeconomic indicators

Indicators	Values
Population (2017)	35.7 million
Land area	446,300 km^2
Annual GDP growth (2017)	4.1 percent
Human Development Index (2017)	Medium (0.667)
Ease of doing business ranking (2018)	69th of 190
Access to electricity (2016)	100 percent

Sources: World Bank 2018a, 2018b; UNDP 2018.

Overview of Morocco's Power Sector

Electricity Installed Capacity and Consumption

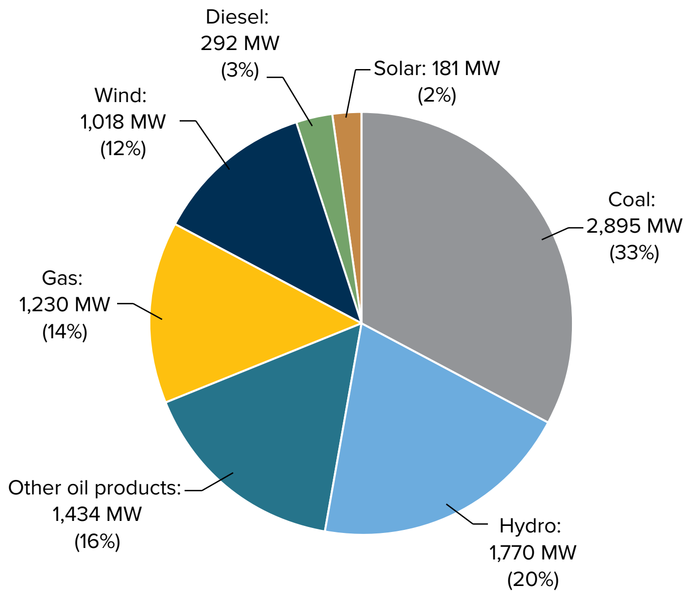
Morocco had a total installed capacity of about 8.8 GW in 2017, for a peak demand of 6.2 GW. The electricity arm of the state-owned National Agency for Water and Electricity (Office National de l'Electricité et de l'Eau Potable [ONEE]) generates about 35 percent of the country's electricity needs, relying mostly on coal but also on hydro, wind, natural gas, fuel oil, and solar. Another 47 percent comes from private generation and includes the 1,360 MW Jorf Lasfar coal plant. Wind and solar plants combined represent 14 percent of the total installed capacity (Figure 5.1).

Demand for electricity in Morocco is driven by industry. The largest consumers are mines, cement plants, and the steel industry. Demand rose by an average annual rate of 5.7 percent between 2000 and 2016 (Figure 5.2). This trend is expected to continue, driven by steady economic growth. In 2017, Morocco's total energy demand amounted to 37,217 GWh, with approximately 6,000 GWh (or 16 percent) imported from Spain, through an underwater power interconnection crossing the Straits of Gibraltar.

Institutional Arrangements and Key Stakeholders

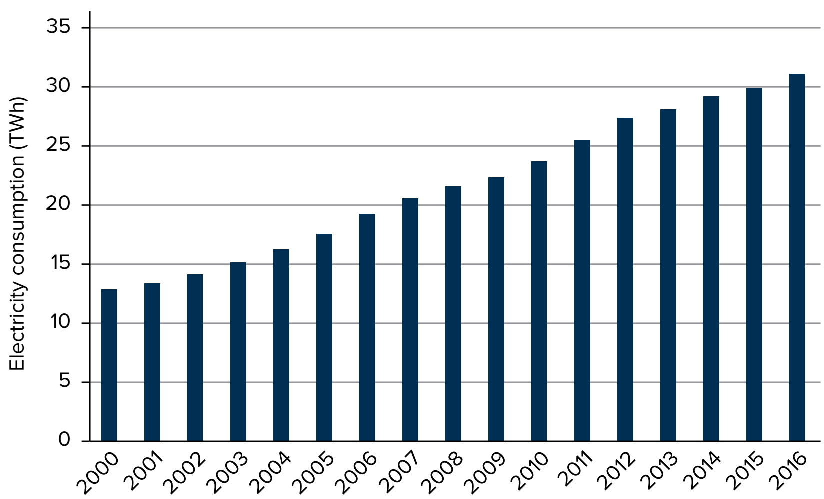
Morocco's electricity sector is structured around the vertically integrated state-owned utility, ONEE, the wholesale off-taker of the electricity generated by IPPs (Figure 5.3). ONEE has the monopoly on transmission but not distribution. It operates under the tutelage of the Ministry of Energy, Mines and Sustainable Development (MEMDD). MEMDD establishes the legal framework for the sector and ensures implementation of the national energy strategy. It also supervises the operations of the Moroccan Agency for Solar Energy (MASEN).

Figure 5.1 Installed electricity power generation capacity in Morocco, 2017



Source: ONEE 2018.

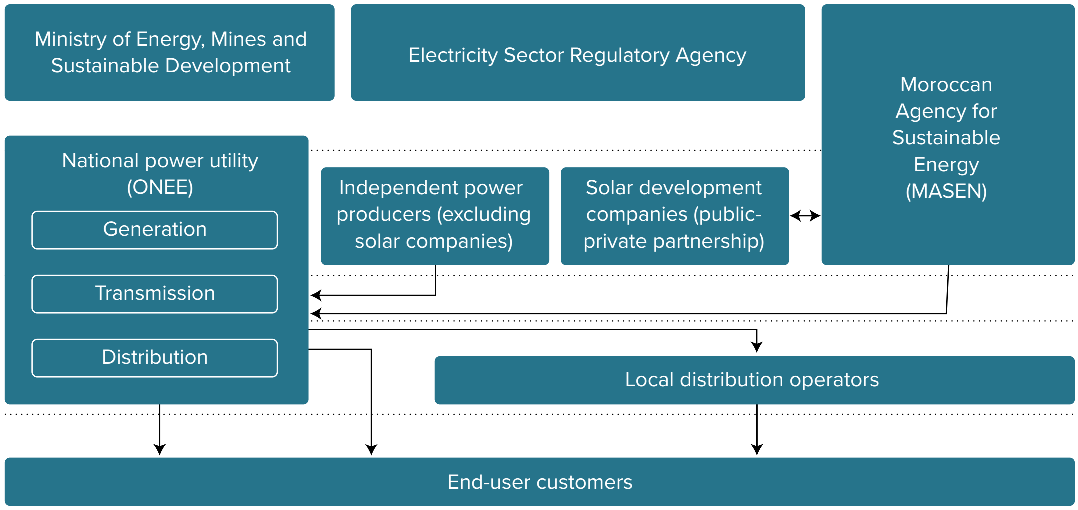
Figure 5.2 Final electricity consumption in Morocco 2000–16



Source: IEA 2018.

MASEN was set up in 2010 as a limited liability, publicly owned company that is governed by private law. It implements government policy for the development of renewable energy. It is involved at every level of the renewable energy value chain: research and innovation, support to the local industry, communication and promotion, and project development. It is also the anchor investor in Morocco's flagship Noor solar projects, developed in partnership with the private sector. Eleven power operators distribute power in four urban centers (Casablanca, Rabat, Tangier and Tetouan) and in rural areas, under the supervision of the Ministry of Interior. The National Electricity Regulatory Authority (*Autorité Nationale de Régulation de l'Electricité* [ANRE]), established in 2016, will regulate the sector once it becomes fully operational.

Figure 5.3 Institutional framework of the power sector in Morocco



Key Energy Policy Objectives

Morocco's national energy strategy outlines several objectives which include: security of supply through optimization of the energy mix, deployment of reliable and competitive technologies, development of national expertise, promotion of energy efficiency, competitiveness of prices paid by electricity consumers, and protection of the environment. The need to develop alternative sources of energy to reduce exposure to oil price volatility and to transition toward sustainable economic pathways is also affirmed in the country's national strategy for sustainable development and in its National Determined Contribution (NDC) to climate change, which pledges to unconditionally reduce greenhouse gas emissions by 17 percent by 2030 compared with a business-as-usual scenario.

Morocco emphasizes the development of renewable energy to achieve its key policy goals and has set targets for the share of solar in the country's installed capacity of 14 percent by 2020 and 20 percent by 2030.[9] It seeks to become a regional leader in renewable energy development, through research and development, knowledge management, and manufacturing.

Morocco's Solar Market

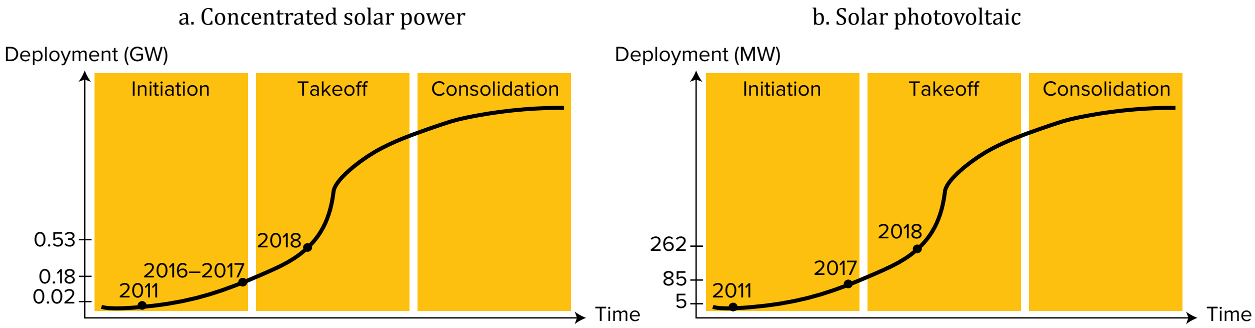
Morocco's Position in Global Solar Development

Morocco's solar power market began to take shape in 2010 with the publication of the Moroccan Solar Plan. It called for the development of 2,000 MW of solar energy by 2020 and the creation of MASEN. Morocco's CSP market has taken off rapidly since its inception, in 2010 (Figure 5.4). The first 20 MW CSP plant was commissioned in 2011 (as part of ONEE's Ain Beni Mathar gas/solar complex), followed by the commissioning in 2016 of 160 MW out of a 580 MW CSP development in Ouarzazate.

For the international donor community, supporting CSP in Morocco was as an opportunity to introduce renewable energy in the Middle East and North Africa, accelerate the CSP learning curve, and develop a global public good that would contribute to the deployment of CSP worldwide. With the successful mobilization of substantial low-cost concessional funding in support of Morocco's solar ambitions, 2010–11 saw concerted efforts from all key public stakeholders to kick-start the implementation of the country's solar strategy.

9 These targets correspond to the objectives of providing 42 percent of installed electrical power from renewable sources in 2020 and 42 percent by 2030.

Figure 5.4 Phases of deployment of concentrated solar power and solar photovoltaic power in Morocco



The deployment of solar PV in Morocco has lagged that of CSP. ONEE is developing the Noor-Tafilalt project, which consists of three solar PV plants for 40 MW each that would feed into decentralized power grids (World Bank 2015). In November 2016, MASEN announced the selection of a developer for the 177MW Noor PV 1 program (MASEN 2016b).

Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

Morocco is endowed with good solar resources, allowing for the development of both CSP and PV projects. Its total potential for solar was estimated in 2010 at 20,000 MW, with maximum direct normal irradiation of 2,556 kWh per square meter per year, making it very suitable for development of CSP (Figure 5.5). The recent developments have only begun to tap Morocco's vast potential for grid-connected solar. The power market is sizable and additional generation capacity will be needed to meet the growing electricity demand.

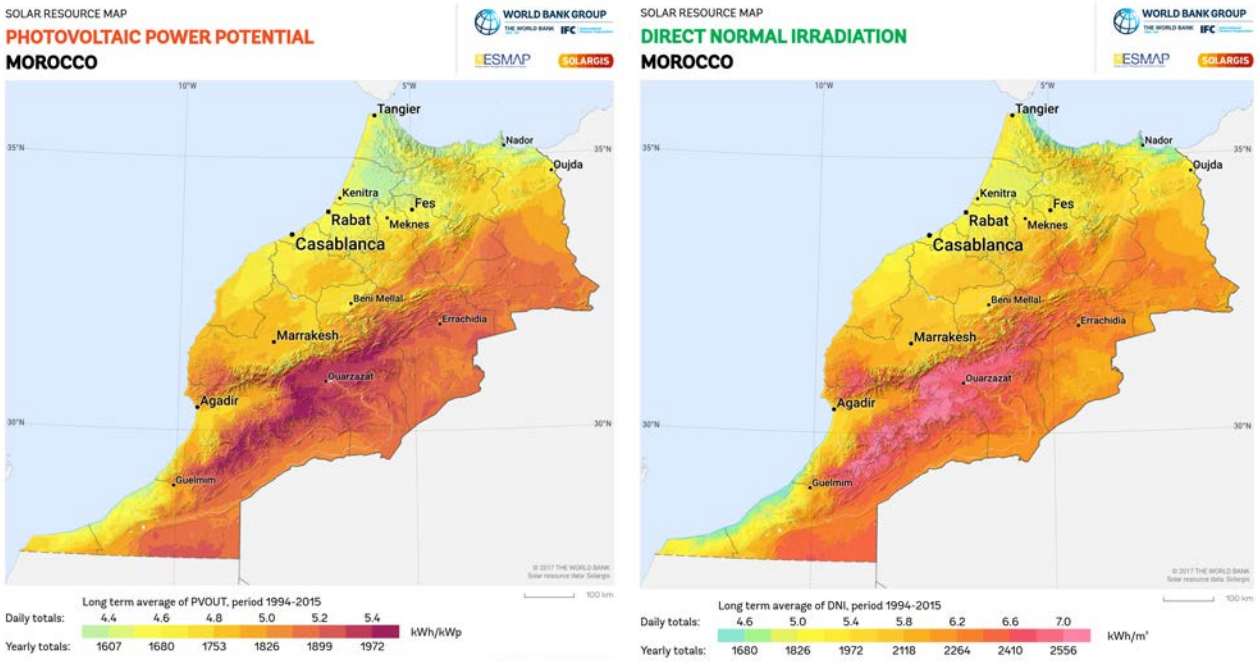
Market Structure and Competition

ONEE is the sole buyer of bulk electricity power in Morocco. It supplies the market through its own plants, power purchased from IPPs, and power imports. There is limited private sector activity in the solar market outside MASEN-led projects. Although the market regulations provide for direct power sales from private developers to eligible customers, the incomplete regulatory framework represents a major constraint for the development of the private market segment. The newly created electricity regulator is expected to address this gap when it becomes fully operational. Prospective private developers are nevertheless undertaking upstream project development activities, approaching potential off-takers to discuss tariffs and negotiate grid access.

Local Financial Market

Morocco is considered an attractive destination for investment, thanks to its political stability and sustained economic growth. The banking sector is one of the most developed in the region, and improvements in economic fundamentals have helped resolve previous liquidity shortages (ITA 2017). The country's long-term debt in foreign-denominated and local currency is rated BBB by Fitch Ratings (November 13, 2018), which indicates adequate credit protection for investors despite a vulnerability to adverse economic conditions. The Moroccan dirham is pegged to the euro (60 percent) and to the U.S. dollar (40 percent), partially mitigating foreign exchange risk for foreign investors.

Figure 5.5 Photovoltaic power potential and direct normal irradiation in Morocco



Source: World Bank 2018c.

Evolution of the Grid-Connected Solar Market

The early introduction of IPPs and the development of wind power in the power sector paved the way for the later successes of the solar market in Morocco. In the early 1990s, in a context of power supply shortages, the Moroccan electricity sector was opened to private investment with the objective of providing power at competitive prices and diversifying the generation mix, which was then dominated by imported oil and drought-sensitive hydroelectric resources. The 1,360 MW Jorf Lasfar coal plant, completed in 2001, became the country's first independent power plant, with a total investment of US$1.5 billion.[10] Several other independent power plants were developed in subsequent years, including the 50 MW Compagnie Eolienne de Detroit, the first privately financed wind farm in Africa.

The early 2000s saw continuing efforts to deploy wind energy, with strong private participation. Morocco's interest in fully exploiting its renewable energy resources was formalized in the New National Energy Strategy, in 2009. It formulated a clear target for the deployment of solar: 2,000 MW was to be developed before 2020 under the Moroccan Solar Plan. The years 2009–10 saw the coordinated launch of a series of public measures in support of the implementation of the Solar Plan, notably the adoption of Law 13-09 on Renewable Energy and the creation of MASEN, whose mandate was limited to solar energy.

MASEN considered the opportunities offered by both CSP and PV and elected to put initial emphasis on CSP with thermal storage, for several reasons. First, the economics were more favorable for CSP than for PV. To meet the needs of the country's power system, with electricity demand peaking in the evening, the possibility to store solar energy in the day and dispatch it at night was a key advantage. Second, CSP was able to contribute to the country's industrial development and to position Morocco as a CSP pioneer, with the potential to export its know-how to the rest of the African continent and world. Third, Morocco possesses one of the best direct

10 The project was financed with 33 percent equity. The debt was sourced from the U.S. Export-Import Bank, the Overseas Private Investment Corporation, and 50 commercial banks.

normal irradiation resources in the world. Fourth, CSP development involves longer lead times than PV plants. More importantly, low-cost concessional financing was available for CSP projects in 2010. CSP was therefore one of the very few dispatchable renewable technologies with the potential to become economically viable with targeted public subsidies.

In 2010 MASEN started its activities with the development of the 580 MW Ouarzazate solar complex. A first phase of 160 MW (Noor I) was tendered through an international competitive bidding process. It elicited strong interest among international players and was eventually awarded to the consortium led by ACWA Power from Saudi Arabia. The PPA was signed in 2012; construction started in 2013 and was completed in 2016. MASEN then successively launched procurement processes for two additional CSP plants in Ouarzazate (Noor II and III).

MASEN developed its CSP projects through a public–private partnership (PPP) model, with innovative features (Box 5.1). This model allowed Morocco to channel low-cost public financing to bridge the commercial viability of the technology; undertake a substantial portion of the development activities, and potentially reduce the risk premium that would be required by private investors; and subsidize the tariff at which ONEE would buy the power output, to limit the impact on end-user consumers.

Box 5.1 Morocco's public–private partnership model for concentrated solar power

Many countries have established dedicated agencies to promote renewable energy. The MASEN integrated approach is unique in several respects. Initiated in 2010, this model prefigures the solar park model that is now being developed worldwide.

MASEN drives the project development process by conducting site identification, feasibility studies, land acquisition, and construction of common infrastructure, which it leases to the project company. It also takes 25 percent of the equity in the project company and acts as its sole lender by providing all of the debt capital. It mobilizes long-term financing from international and domestic markets on the back of a sovereign guarantee and on-lends it to the project company. Initial projects were funded through loans from development finance institutions.

For the development of CSP projects, MASEN played the role of an intermediary off-taker. It signed 25-year power purchase agreements (PPAs) with the project company, based on the competitively determined price of solar electricity, and subsequently entered into a power sales agreement with ONEE, based on the high-voltage tariff. In line with a generic convention signed by MASEN and the government in October 2010 and specific conventions signed for each project, the government compensated MASEN for the difference between its generation cost and the tariff its receives from ONEE. This arrangement was essential to guarantee the financial sustainability of MASEN and ensure the affordability for end-user customers. To develop and promote Moroccan know-how, private developers committed to sourcing a sizable fraction of the equipment, works, and services from local companies. The resulting "industrial integration ratio"—the ratio between local expenses and total capital costs—was closely monitored.

Public sector action reduced several risk factors for the private sector:

- Financing risk: The public sector mobilized all the debt financing and on-lent it to the project company.
- Counterparty risk: MASEN acted as intermediary power off-taker, and the state guaranteed the financial equilibrium of the CSP projects.
- Land availability and power evacuation: MASEN identified and secured the land for solar development and ensured that suitable power transmission lines were available to evacuate the power.
- Licensing and permitting: MASEN secured all the permits and authorizations needed to develop the project.
- Common infrastructure: MASEN developed the facilities needed and provided the common infrastructure services (water, roads, security) to the project company.

This model—in which the public sector takes on a substantial amount of risk to allow the private partner to focus on operational and technical matters—was at the heart of Morocco's CSP success story at a time when CSP was not commercially viable.

Table 5.2 Grid-connected solar projects in Morocco, December 2018

Project name	Ownership model	Sponsor	Technology	Capacity	Status
Ain Beni Mathar	Public ownership (ONEE)	ONEE	CSP (gas/solar hybrid)	20 MW CSP + 450 MW gas	In operation
Noor I (Ouarzazate)	Public-private partnership	ACWA Power	CSP parabolic trough + thermal storage	160 MW, three-hour storage	In operation
Noor II (Ouarzazate)	Public-private partnership	ACWA Power	CSP parabolic trough + thermal storage	200 MW, more than seven-hour storage	Commissioning stage
Noor III (Ouarzazate)	Public-private partnership	ACWA Power	CSP tower + thermal storage	150 MW, more than seven-hour storage	Commissioning stage
Noor IV (Ouarzazate)	Public-private partnership	ACWA Power	Photovoltaic	72 MW	Under construction
Noor Laayoune				85 MW	
Noor Boujdour				20 MW	
Noor Midelt	Public-private partnership	To be announced	Hybrid PV + CSP with thermal storage	Up to 2 × 400 MW, including CSP capacity of 150–190 MW	Under development
Noor Tafilalt	Public ownership (ONEE)	ONEE	PV	3 × 40 MW	Under construction
Noor PV II	To be announced	To be announced	PV	800 MW	Under development
Private PV projects	Private independent power producer	Private developers	PV	Not disclosed	Under development

As solar PV became more cost competitive, the government started introducing this technology as well. A trio of solar PV plants, referred to as NOOR PV I, was procured in 2016 in partnership with a private developer, selected competitively. MASEN and the private developer jointly own the project development company, with MASEN providing the debt capital. The project company is responsible for developing the common infrastructure. MASEN continues to be an intermediary off-taker, but public subsidies are not needed to buy-down the tariff from the solar PV facility, as MASEN realizes a positive margin from purchasing and on-selling the power to ONEE. MASEN's role is consistent with its approach of tailoring the scope of its intervention to the context, considering the commercial viability of the technology and the potential impact of the different financing options available.

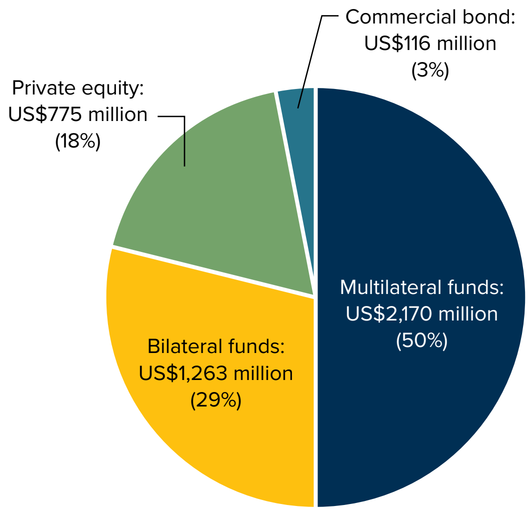
Finally, MASEN is conducting a bidding process for NOOR Midelt, a CSP and PV hybrid totaling up to 800 MW, and it announced the upcoming launch of the procurement process for another 800 MW of solar PV capacity (NOOR PV II). Hybridization is considered a promising way to make the most of the low cost of PV and the dispatchability of CSP with thermal energy storage, delivering baseload electricity at a lower cost to the grid (IEA 2014). Table 5.2 presents the status of utility-scale solar projects in Morocco in December 2018.

Mobilization of Commercial Finance

Total investment in grid-connected CSP and solar PV projects in Morocco amounts to about US$4.3 billion[11] (Figure 5.6). The CSP projects were driven largely by concessional public funding mobilized by the government of Morocco through MASEN.

11 This analysis excludes public projects undertaken by ONEE (the Ain Beni Mathar gas/solar plant and the Noor Tafilalt plants), both of which were procured through public tenders.

Figure 5.6 Investment in grid-connected solar projects involving private sector capital in Morocco 2010–17



Source: World Bank 2018d.

Commercial finance for MASEN's first three CSP projects was predominantly private equity and represented approximately 24 percent of the total investment. A blend of grants, concessional and non-concessional debt was provided to MASEN, which then provided equity and concessional debt from those resources to the project development company.

As the market matures and technology costs decrease, MASEN has the opportunity to transition toward increased mobilization of commercial finance, either foreign or local. It has already started turning to capital markets, with the issuance of US$116 million of the country's first green bonds, launched in November 2016 as Morocco hosted the COP22, to fund solar PV projects. The bond was subscribed, in dirhams, by two commercial banks, a pension fund, and a private insurance company (MASEN 2016a).

In November 2016, MASEN and a commercial bank, Attijariwafa Bank, announced the signing of a memorandum outlining the basis of a collaboration to facilitate the mobilization of private financing for renewable energy projects. Public concessional financing was critical to initiate the market transformation and position Morocco as a pioneer in the adoption and development of clean technologies.

Effectiveness of Public Sector Intervention

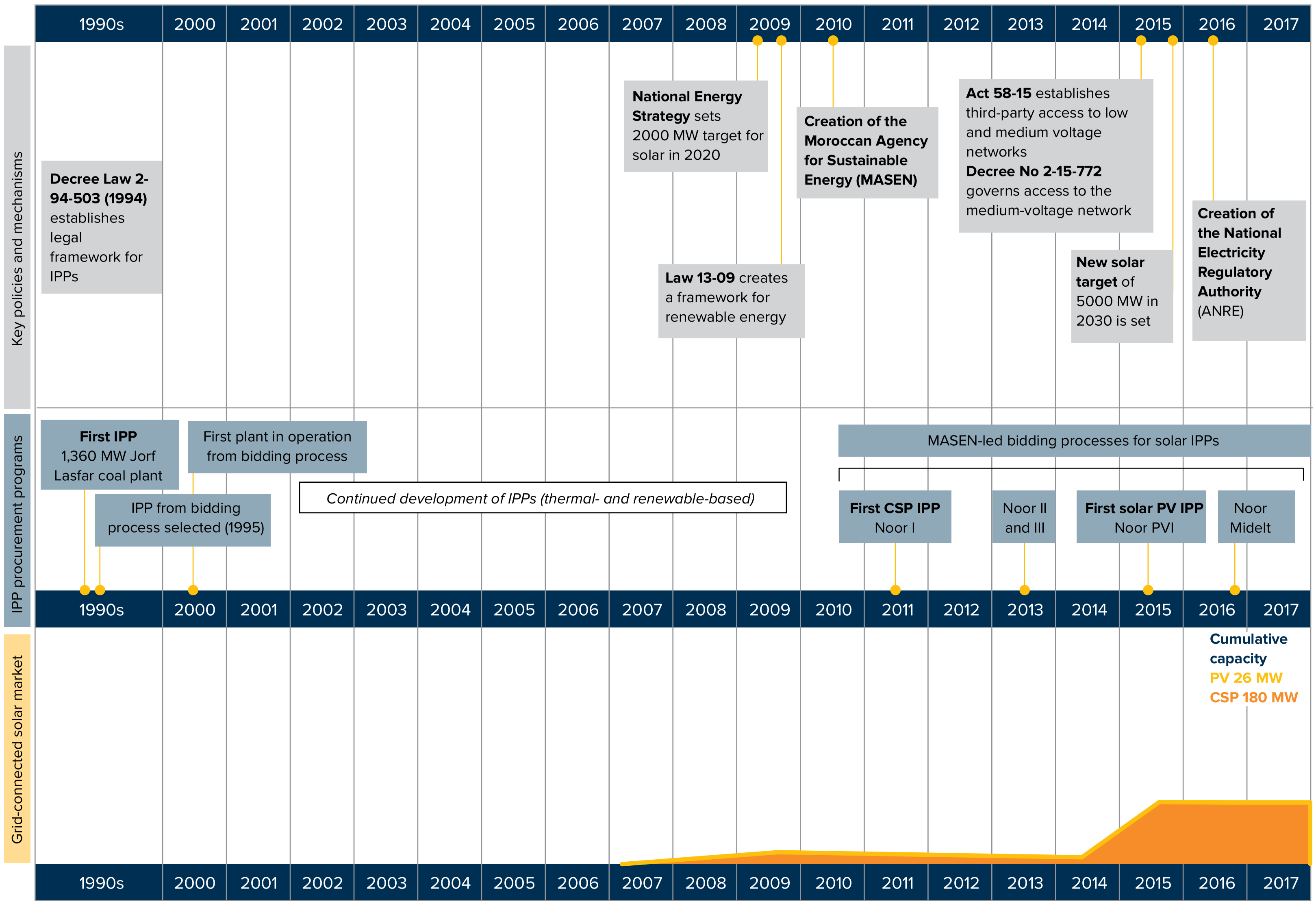
Since its inception, Morocco's solar market has been shaped almost entirely by the vision of the public authorities and targeted policy support (Figure 5.7).

Legal, Policy, and Regulatory Framework

The Moroccan legal framework is conducive to the involvement of private developers in the generation, transmission, and sale of power to customers connected to the high- and medium-voltage power system. The first step toward the liberalization of the sector took place in 1994, with Decree-Law No. 2-94-503, which allowed the then National Electricity Agency to enter into PPAs with private developers. This step was followed in 2009 by Law 13-09 on renewable energy, which included the following provisions:

- The right of private companies to produce electricity from renewable sources, to purchase it from eligible producers and to access the national grid at all voltage levels.

Figure 5.7 Timeline of public interventions and market development in Morocco



- The possibility for renewable energy power developers to build and operate transmission lines, including interconnection with neighboring countries, should the national electricity grid be unable to evacuate the power produced.
- The option to sell power directly to medium- and high-voltage customers.

The framework was complemented by laws and amendments allowing self-generation and acquisition of the surplus by ONEE (2014), third-party access to the grid (2015), and the creation of a regulatory agency (2016). Act No. 58-15 of 2015 allowed the sale of surplus renewable energy generated for self-consumption to ONEE and established the basis of the low-voltage electricity market.[12] In 2016 Acts 37-16, 38-16, and 39-16 transferred to MASEN the responsibility to develop all sources of renewable energy, including wind.

The regulatory framework has not kept pace with legal evolution. Private developers have had the legal right to access the medium- and high-voltage grids since 2009, but the corresponding market—a handful of very large customers in the high-voltage market—is limited. A potential market of thousands of customers for private off-take projects was created with publication of Act 58-15. in 2015, which legally opened access to low- and medium-voltage networks, and Decree No 2-15-772, which governs access to the national medium-voltage network.[13] In the absence of a functioning regulator, procedures and rules for third-party access are unclear.

Wheeling charges are negotiated on a case-by-case basis, and accessing the grid operated by ONEE can be a long and uncertain process. Furthermore, although the 13-09 Law calls for the definition of solar development zones, the corresponding zoning work has not been fully carried out, which creates uncertainty regarding the selection of potential sites by private developers. Injection of solar power on the low-voltage network is also legally permitted, which could in theory open the door to grid-connected rooftop projects, but the corresponding regulatory framework is still in the making.

The incomplete regulatory framework has not been an issue for the projects developed by MASEN, as it ÓÅÃÕÒÅÄ all the ÒÅÑÕÉÒÅÄ authorizations and ÈÁÎÄÌÅÄ ÔÈÅ grid-connection issues. It is an obstacle for private off-take and rooftop solar projects. As a result, these two market segments are yet to take off.

Planning, Technical, and Operational Capacity

Generation Planning

Morocco's renewable energy targets have become increasingly ambitious. The 2009 Moroccan Solar Plan set a target of 2 GW to be developed before 2020. Subsequently, in the wake of the Paris Agreement and COP22 in Marrakech, the government announced more ambitious targets. The 2016 National Strategy for Sustainable Development set a target of 52 percent renewable energy capacity by 2030, of which 5,000 MW was to come from solar. Private investors interviewed considered the fact that generation planning documents are not publicly available to be an impediment to their efforts to develop projects.

Grid Integration, Access, and Power Evacuation

As the provider of common infrastructure, MASEN secures grid access and connection for all the projects it develops. Coordination with ONEE to implement the required grid reinforcements does not appear to have raised issues, perhaps because of the political support enjoyed by the projects. In addition, the government's decision to promote CSP projects with thermal storage helped manage the integration of variable renewable power and avoid curtailment.

Grid access is a challenge for solar projects that are not led by MASEN. Information on transmission line development and planned network expansion is not publicly available. Solar development zones have not been defined, even though the law requires doing so. The lack of transparency in the definition of wheeling charges, negotiated on a case-by-case basis, creates additional ambiguity. Faced with the threat of potential

12 Sale of the surplus was limited to 20 percent of the annual energy generated by the project owner.
13 The decree for access to the low-voltage network has not been passed yet.

loss in revenue and in the absence of a clear regulatory framework and market rules, distribution companies are reluctant to cooperate with private developers for grid access. The processing of grid-connection requests can also take considerable time, with an uncertain outcome.

Land Availability

MASEN identified and secured the land rights for the solar projects it developed. Prospective developers of projects not led by MASEN cite land acquisition as a concern. Proper zoning for solar projects is lacking, and the variety of ownership regimes applicable to rural and agricultural land makes the land acquisition process problematic. In addition, complex rules apply to community-owned land, which represents 42 percent of the total land area, and land owned by public agencies (World Bank 2008).

Direct and Indirect Financing

Public financing has been critical to the take-off of the CSP and PV markets in Morocco. Concessional loan providers have included the Clean Technology Fund, the French Development Agency, the African Development Bank, Germany's KfW, the European Investment Bank, and the World Bank (Box 5.2). Projects have also received grants from the Neighborhood Investment Facility of the European Commission and the German Ministry of Environment. The blending of highly concessional loans and grants reduced the financing terms and the budgetary support borne by the government of Morocco.

The main rationale for mobilizing public financing to support the development of CSP was the fact that as a relatively nascent technology, CSP was perceived as a risky investment and required high up-front capital investment that commercial investors could not provide. There was a clearly stated objective from international finance institutions to contribute to the development of the CSP industry in Morocco, part of a larger effort to reduce the technology cost on a global scale.[14] Doing so required providing large and predictable amounts of long-term concessional funds.

In June 2014 the Clean Technology Fund (CTF) approved a US$23.95 million concessional loan to co-finance three solar PV plants of 25 MW each, owned and operated by ONEE. The capacity of the plants was later increased to 40 MW each; they are still under construction. Further, there is no evidence that their development will play a role in attracting private investors in the solar market. Instead, the solar PV plants developed by MASEN, in partnership with the private sector, are expected to be commissioned before the ONEE-led project.

Going forward, the main challenge will be to design a balanced model that preserves the key factors that made past developments a success while allowing for more private participation and reducing the pressure on public finances.

Government-Sponsored Guarantees

Off-Taker Creditworthiness

The government subsidizes the CSP projects by compensating MASEN for the difference between the tariff it pays for the power produced and the one it receives from ONEE. In doing so, it ensures that MASEN can meet its financial obligations as the primary off-taker of the power. The resulting financial burden on the state's finances is expected to be at least partially offset by savings on imported fuels as solar electricity displaces conventional thermal electricity and by profits on the sale of power generated by PV plants. MASEN is expected to realize a positive gross profit margin from the sale of the power generated from its solar PV plants, as its off-take price is lower than its resale tariff. Going forward, the development of PV-CSP hybrid projects and further cost reductions in both technologies will provide direct cross-subsidies between PV and CSP and reduce the reliance on public subsidies.

In theory, off-take risk is not expected to be a major concern for developers in the private segment, as they could diversify their client base to avoid large exposure to a single off-taker or economic sector. However, factors such

14 At the time, the levelized cost of electricity for CSP was US$0.30–0.40 per kWh. In early 2018, the cost had fallen to about US$0.07 per kWh.

Box 5.2 Impact of financing from the Clean Technology Fund on the development of concentrated solar power in Morocco

The support of the Clean Technology Fund (CTF) to the Morocco CSP market originated as part of a regional program for the Middle East and North Africa region approved in December 2009, to support large-scale deployment. The CTF aimed to provide US$750 million in concessional funds to the region and to leverage additional public and private funds to support the development of about 1 GW of CSP capacity. Participating countries were Algeria, Egypt, Jordan, Libya, Morocco, and Tunisia.

These countries originally proposed an indicative pipeline of generation projects totaling 900 MW. However, almost all the projects experienced delays, for many reasons, including the instability from the Arab Spring and indecisiveness regarding the implementation of large-scale investment projects.

Morocco seized this opportunity to fast-track the implementation of its vision to become a regional pioneer in the deployment of solar technologies. In June 2011, the CTF Trust Fund Committee approved the allocation of US$197 million of CTF funds as the first phase of its support of the 500 MW solar complex, the Ouarzazate I Concentrated Solar Power project (Noor I). This financing was followed by a concessional loan of US$238 million, approved in June 2014, for the Noor II and III projects; and a further loan of US$50 million approved in June 2017 for the Noor-Midelt project.

CTF funding came at a critical time for Morocco. It facilitated a market transformation for several reasons. First, CSP combined with thermal storage was relevant to the needs of the sector, and stakeholders were aligned with that vision. Second, the country leveraged the technical assistance provided through the CSP program to develop its solar strategy. Third, the scale and the predictability of funds provided a further incentive to align aspirations with clear implementation steps. Fourth, the strong commitment and high-risk appetite of CTF donors, expressed through the allocation of several millions of dollars to this promising but not yet commercially viable technology, led other development partners to co-finance the initiative. Fifth, CTF financing helped reduce the cost of CSP-based electricity. It is estimated that the low-cost debt provided by the CTF and other international financial institutions reduced the levelized cost of electricity for Morocco's first CSP project by about 25 percent compared with commercial financing. The financing reduced the fiscal outlay necessary to bridge the price difference between CSP-based electricity and conventional electricity generation and lowered the tariff risk faced by investors.

In 2018 Morocco was the largest recipient of CTF financing for solar portfolio, with US$485 million of funding commitment.

Adapted from CIF n.d.

as the large number of private developers and the small number of financially viable clients reduce the effectiveness of that strategy. It is too early to assess off-takers' creditworthiness in this market segment, which is yet to take off.

Guarantees

Sovereign-backed guarantees were instrumental to allow MASEN to fulfill its role. The company would not have been able to raise the funds it did from development finance institutions without a sovereign guarantee that covers its financial commitments. And as a newly formed entity with no track record, MASEN would not have been a credible CSP power off-taker without the letter of comfort and assurances provided by the government of Morocco.

Summary

Table 5.3 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid-tied solar market.

Table 5.3 Effectiveness of public sector action in mobilizing commercial capital in Morocco

Public sector intervention	Description	Legal, institutional, and regulatory framework	Planning, technical, and operational capacity			Direct and/or indirect public financing	Government-sponsored guarantees
			Policy, strategy, and planning	Grid integration, access, and power evacuation	Land/rooftop availability		
Law 13-09 on Renewable Energy (2009)	The law created a strong legal framework, but implementation through decrees and regulations remains incomplete.	✓✓					
New National Energy Strategy (2009)	The strategy set a 2,000 MW target for solar in 2020. Backed by strong and unwavering political support, it sent a clear signal to private players.		✓✓✓				
Creation of MASEN as a solar agency (2010)	MASEN's staff and technical expertise have made it instrumental in creating the conditions for private sector participation.	✓✓✓	✓✓✓				
Establishment of the MASEN public–private partnership (PPP) model (2010)	This unique PPP scheme has been very successful in closing complex projects and attracting technical know-how from reputable private partners.			✓✓✓	✓✓✓	✓✓✓	✓✓✓
Decree No. 2-15-772 on third-party access to medium-voltage grid (2015)	This decree opened up a huge potential market for private off-take solar projects, but the regulatory framework is not fully in place. Some projects are under development; none has reached financial closure.	✓		✓			
Law 58-15 (2015)	This law allows renewable energy–based self-producers to sell their surpluses on the national grid and allows third-party access to the medium-voltage grid. The corresponding regulatory framework is still incomplete.	✓		✓			
Concessional financing of the Noor-Tafilalt solar PV plants (2014)	The government of Morocco mobilized US$23.95 million from the Clean Technology Fund to co-finance 3 × 40 MW publicly-owned solar PV plants. The investment conceived as a demonstration project to attract private sector financing in further deploying solar PV in the country. The plants are under construction.					✓	
National Strategy for Sustainable Development (2016)	The strategy set a new target of 5,000 MW solar capacity for 2030. The new target provides a solid basis for continued public support.		✓✓✓				
Creation of National Electricity Regulatory Authority (ANRE) the power sector regulator (2016)	ANRE is not yet fully operational.	✓					

Note: ✓✓✓: *Very effective;* ✓✓: *Effective;* ✓: *Not effective.*

Key Findings and Take-Aways

Stakeholders highly praise the Moroccan solar experience. The factors that explain its success include the strong and unwavering support from the political leadership. MASEN's status as a commercial company with public ownership allowed it to benefit from strong government support while operating according to private sector management principles. Strong alignment with other public sector entities, primarily with ONEE, strongly contributed to turn policy objectives into projects.

Several take-aways emerge from Morocco's experience:

- MASEN's unique PPP model enabled the country to launch its solar program and leverage the availability of substantial public financing to meet its objectives, given the level of maturity of the technology at that time. It was particularly well suited to the context in 2010, when global CSP capacity was limited. Low global deployment, high up-front capital costs, and high perceived technology risk required large amounts of public financing to accelerate the learning curve and bridge the commercial viability of the technology. CSP-specific technology risk and prices have declined. The risk that the development of large-scale, long-duration, cost-effective storage technologies erodes the competitive advantage of CSP is growing, partly because solar PV is decreasing and battery technology advancing. There is nevertheless an opportunity to transition toward the mobilization of more commercial financing for the development of CSP projects.
- Public support in the form of sovereign guarantees greatly enhances the creditworthiness of utilities with no established reputation of honoring commercial obligations toward private developers or weak capacity.
- Mitigating the risks that the public sector is in a better position to manage at lower cost and within a shorter timeframe than commercial investors can help decrease the levelized cost of electricity and improve the affordability of the power produced for end-user customers.
- Clear regulations and proactive stakeholder engagement can help unlock a market segment for commercial investment in solar. The private off-take market would potentially benefit from the full operationalization of the regulatory authority, the establishment of clear rules and streamlined procedures for grid access, the definition of wheeling charges at all voltage levels, and the publication of grid expansion plans.

References

CIF (Climate Investment Funds). n.d. Projects in Middle East and North Africa Region https://www.climateinvestmentfunds.org/country/middle-east-and-north-africa-region

IEA (International Energy Agency). 2014. *Technology Roadmap Solar Thermal Electricity.* Paris: IEA. https://www.iea.org/topics/renewables/technologyroadmaps/

IEA. 2018. World Energy Statistics and Balances (database). https://doi.org/10.1787/data-00510-en

IMF (International Monetary Fund). 2018. World Economic Output (database). https://www.imf.org/external/pubs/ft/weo/2018/02/weodata/index.aspx

ITA (International Trade Administration). 2017. *Morocco: Banking Systems, International Trade Administration.* U.S. Department of Commerce, Washington, D.C. https://www.export.gov/article?id=Morocco-Banking-Systems

MASEN (Moroccan Agency for Solar Energy). 2016a. November 4. "Masen, African climate finance pioneer, issues Morocco's first ever Green Bond." Press release. http://www.masen.ma/media/uploads/documents/2016_11_04_Masen_issues_Moroccos_first_Green_Bond_cbN0Iin.pdf

———. 2016b. "Masen selects the developer of the 3 NOOR PV I solar power plants and signs contracts securing their financing." Press release. November 16. http://www.masen.ma/media/uploads/documents/2016_11_16_Masen_selects_the_developer_of_the_3_Noor_PVI_solar_power_p_r5TA5W3.pdf

ONEE. 2018. ONEE Chiffres Clés 2017 Energie Electrique. Casablanca. www.one.ma

UNDP (United Nations Development Program). 2018. *Human Development Indices and Indicators 2018 Statistical Update.* New York: UNDP.

World Bank. 2008. *Maroc: Marchés fonciers pour la croissance économique au Maroc: Héritage et structures foncières au Maroc.* Rapport No. 49970. Washington, DC : World Bank. http://documents.banquemondiale.org/curated/fr/639221468274187453/Heritage-et-structures-foncieres-au-Maroc

———. 2015. *Morocco—Clean and Efficient Energy Project (English)*. Washington, DC : World Bank Group. http://documents.worldbank.org/curated/en/344261468052477656/Morocco-Clean-and-Efficient-Energy-Project

———. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b. *Doing Business 2018: Reforming to Create Jobs*. Washington, DC: World Bank.

———. 2018c. Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

———. 2018d. Private Participation in Infrastructure (database). Washington, DC: World Bank. https://ppi.worldbank.org/data

CHAPTER 6 THE PHILIPPINES CASE STUDY

The Philippines is an archipelagic country located in East Asia. A lower-middle income country, it is one of the most dynamic economies in the region, with an average annual GDP growth of 6.4 percent between 2000 and 2017. The dynamism of its economy is rooted in its strong consumer demand, competitive workforce, and buoyant tertiary industry. However, the growth pattern has failed to provide good jobs for the majority of the Filipinos. Despite a notable decrease in poverty in recent years (from 26.6 percent in 2006 to 21.6 percent in 2015), the country remains split along an urban-rural divide. Poverty in rural areas is significantly higher than the national average and more than three times that in urban areas. Although a large share of the working-age population has transitioned out of agricultural jobs, most of them are employed in low-end service jobs. As a result, average real wages have remained stagnant. The private sector's reluctance to invest and create more and better quality jobs reflects the country's weak investment climate for firms of all sizes (World Bank 2014, 2018d). The country also faces challenges linked to its geography, and its vulnerability to natural disasters, including earthquakes and cyclones. Table 6.1 presents selected socioeconomic indicators.

Table 6.1 The Philippines' selected socioeconomic indicators

Indicators	Values
Population (2017)	104.9 million
Land area	1.2 million km^2
Annual GDP growth (2017)	6.7 percent
Human Development Index (2017)	Medium (0.699)
Ease of doing business ranking (2018)	113rd of 190
Access to electricity (2016)	91 percent

Sources: World Bank 2018a, 2018b; UNDP 2018.

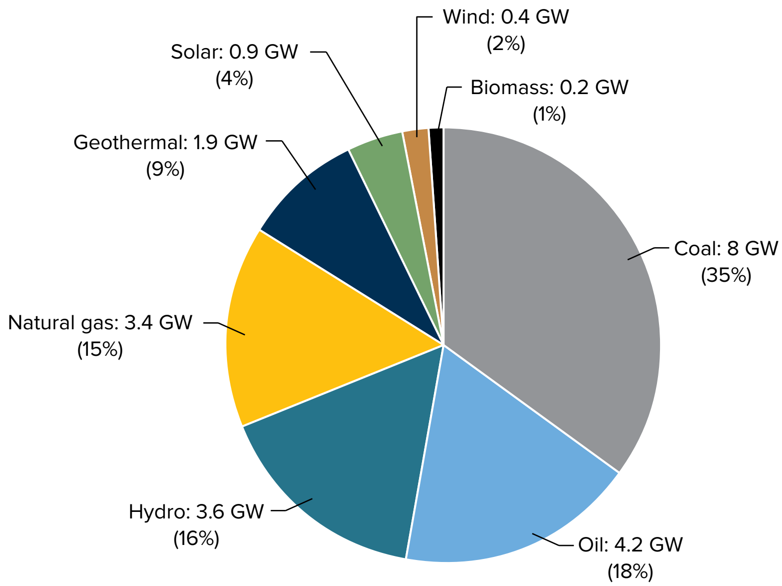
Overview of the Philippines' Power Sector

Electricity Installed Capacity and Consumption

The Philippines' energy sector is market oriented, having gone through an extensive privatization process beginning in the early 1990s. The sector has long struggled with the high cost of electricity compared with its neighbors, dependence on imported fuels, and ongoing difficulty matching generation capacity with growing demand. The country has three large electricity grids serving the three major island groups (Luzon, Visayas and Mindanao), with no interconnections to neighboring countries. The largest grid is Luzon, with installed capacity of 15.4 GW. Visayas and Mindanao each have about 3.4 GW of generation capacity. The Visayas and Luzon grids are connected through underwater cables. Plans to connect the Mindanao grid are under discussion. The rest of the country is served by either nonprofit electricity cooperatives or private utilities that cover specific areas, on a franchise basis. In 2017 the Philippines had total installed generation capacity of 22.7 GW. Renewables, including hydro, represented about 31 percent of overall generation capacity, of which 885 MW was solar PV (Figure 6.1). There are no CSP installations in the country.

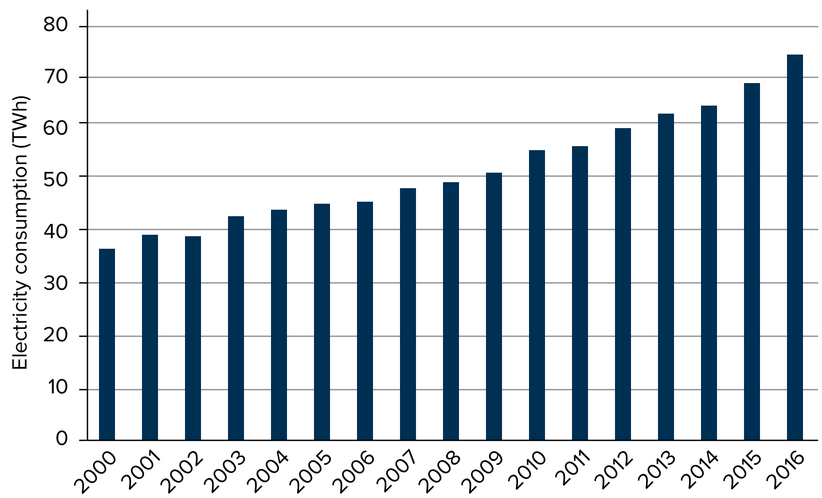
Since 2000 power consumption has grown at an average annual rate of 4.5 percent (Figure 6.2). Over the same period, installed capacity grew by only 2.5 percent, from 15.1 GW to 22.7 GW. Energy demand is expected to increase at an even faster pace over the next decade. By 2040, peak demand is expected to increase by about four times from 12,213 MW in 2015 to 49,287 MW in 2040 under the high GDP growth scenario. This increase is translated to a 6 percent annual average growth rate from 2016 to 2040.

Figure 6.1 Installed power generation capacity in the Philippines 2017



Source: Department of Energy 2018.

Figure 6.2 Electricity consumption 2000–16



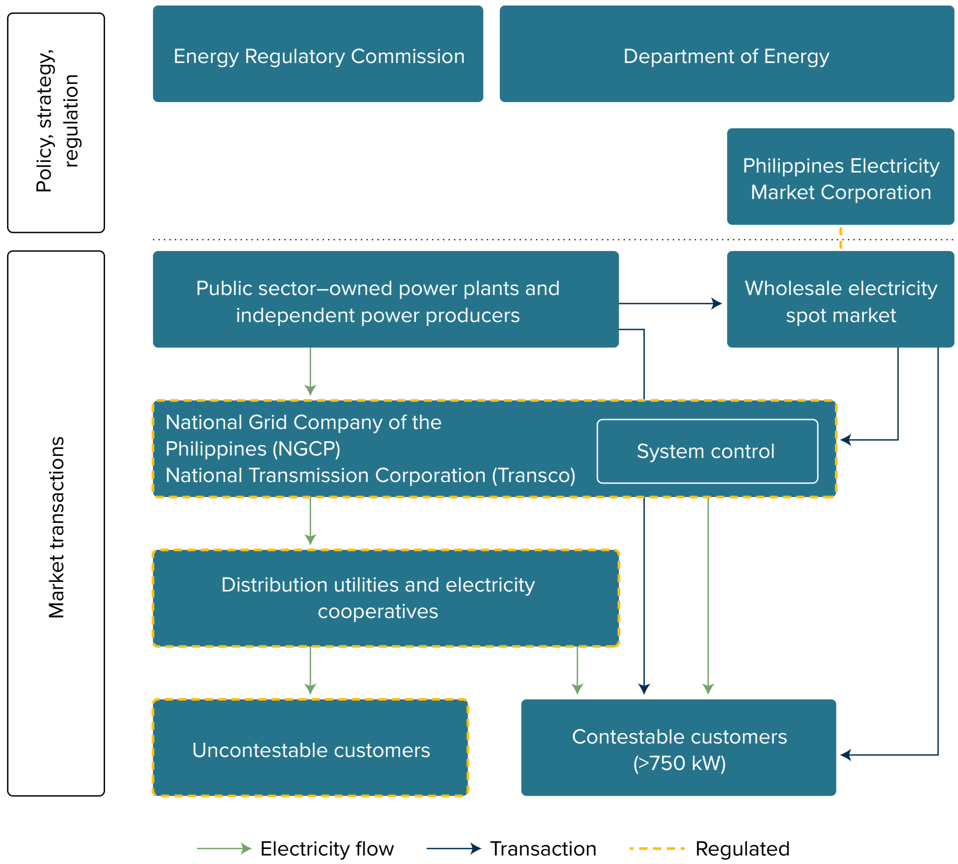
Source: IEA 2018.

Mindanao is expected to have the highest annual average growth at 8 percent, followed by Visayas at 7 percent and Luzon at 5 percent (DOE 2016a).

Institutional Arrangements and Key Stakeholders

The Philippines' energy sector is market oriented, with unbundled generation, transmission, and distribution subsectors (Figure 6.3). The electricity sector is designed to be fully cost reflective. The Electrical Power Reform Act of 2001 (EPIRA) resulted in the privatization of government assets, the establishment of procurement of generation through independent power producers (IPPs), and the creation of a wholesale electricity spot market (WESM) for trading energy. Distribution was divided into larger private distribution utilities and smaller electricity cooperatives and privatized.

Figure 6.3 Institutional arrangements in the power sector in the Philippines



The Department of Energy (DOE) oversees the sector and is responsible for overall policy development and implementation. Two bodies within the DOE handle renewable energy. The Renewable Energy Board (NREB) is composed of various government and private stakeholders. It provides policy input to the DOE on issues related to renewable energy. The Renewable Energy Management Bureau provides technical support to the DOE and the NREB.

The Energy Regulatory Commission (ERC) is an independent, quasi-judicial agency that oversees the entire energy sector. Its mandate is to promote competition, encourage market development, ensure customer choice, and penalize the abuse of market power. To carry out its mandate, the ERC issues rules and regulations, sets technical standards, and reviews power purchasing agreements (PPAs) between IPPs and regulated distribution utilities.

Established in 2006 in Luzon and expanded to Visayas in 2010, the WESM is managed by the publicly-owned Philippines Electricity Market Corporation (PEMC). The WESM is not yet functional in Mindanao. Spot market transactions account for about 9 percent of the total energy purchased in Luzon and Visayas (Ocampo 2015).

The National Transmission Company (TransCo) owns all transmission assets on behalf of the government. The National Grid Company of Philippines (NGCP) is responsible for power transmission, operations and maintenance, system operations, planning, and engineering. The right to operate, maintain, and expand the transmission grid was granted to private investors, through the NGCP, to a consortium of Filipino companies and the State Grid Corporation of China (SGCC).

Distribution utilities and electricity cooperatives supply contestable customers, who have a peak demand of less than 750 kW and buy energy at regulated rates. Uncontestable customers have a peak demand greater than 750 kW and can enter into a retail supply contract with a licensed retail electricity supplier; electricity prices for these contracts are not regulated.

Key Energy Policy Objectives

The overall government objectives for the power sector are to widen and diversify the supply base to satisfy Philippines' growing demand for energy. Meeting them requires increasing generation in Luzon, Visayas, and Mindanao and significantly increasing investment in transmission. The government also wants to continue working toward the full liberalization of the power market and divestment of government-owned generation assets (DOE 2016b).

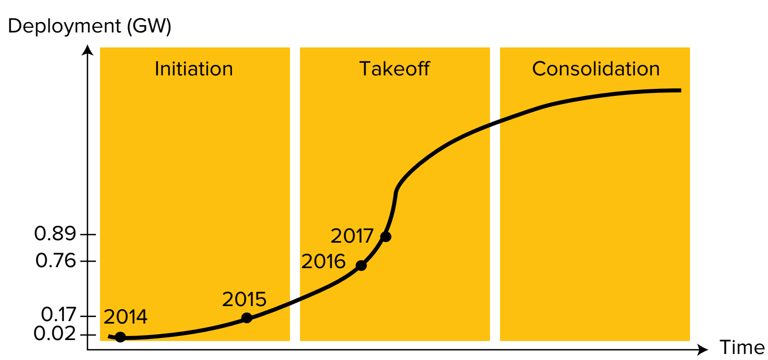
In 2011 the National Renewable Energy Policy (NREP) set policy objectives to encourage renewables, calling for an increase of 15,304 MW of renewable energy by 2030—three times the 2010 level of 5,438 MW. The headline figure included a target of 285 MW for solar. The plan also called for the development of CSP, starting in 2020.[15] When the policy was drafted, the authorities were concerned about the variable nature of PV, as well as its cost (NREB 2011). In 2017, the DOE released a renewable energy roadmap which did not include updated targets given the government's preference for a technology-neutral and least-cost approach to the development of new projects (DOE 2016c).

The Philippines' Solar Market

The Philippines' Position in Global Solar Development

In 2010, the adoption of the Renewable Energy Act was seen as a major step to foster the development of renewable energy in the Philippines. Given the high cost of solar compared with other generation sources at the time, the country opted for a feed-in tariff policy to stimulate the solar market. The ERC released the rates and targets for the feed-in tariff program in 2012. Market inception in the Philippines began in 2014 (Figure 6.4). Four years later, almost 900 MW of PV had been added to the grid.

Figure 6.4 Phases of deployment of photovoltaic solar power in the Philippines



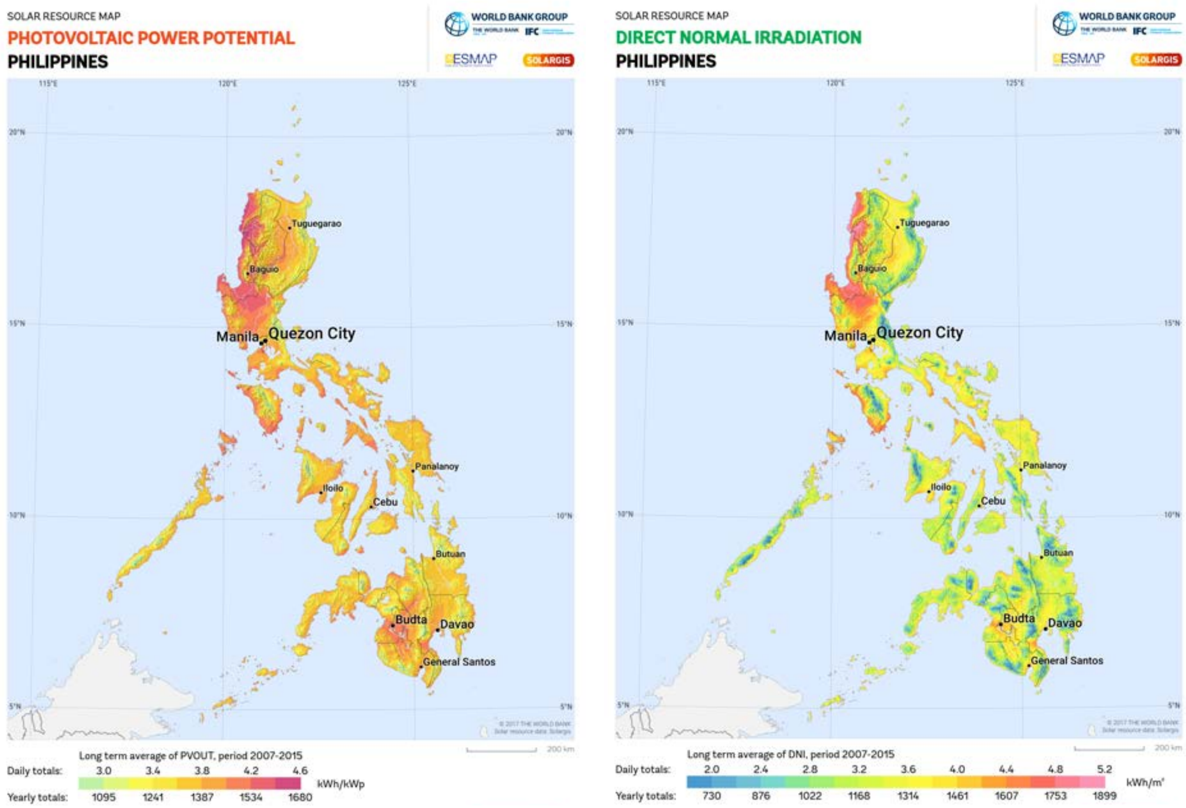
Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

The Philippines has moderate solar resources, with an average solar irradiance distributed relatively evenly across the country (Figure 6.5). Interest in renewables and solar PV has been driven by the country's dependence on imported fuels to meet demand (about half of supply [IRENA 2014]), increasing demand growth, and its fragmented island geography.

15 As no CSP projects are currently under development in the Philippines, this case study does not look at CSP.

Figure 6.5 Photovoltaic power potential and direct normal irradiation in the Philippines



Source: World Bank 2018c.

Market Structure and Competition

Three different mechanisms can be used to sell utility-scale energy production in the Philippines: PPAs with distribution utilities; PPAs with private consumers; and direct sale to the wholesale electricity market. The bulk of the electricity production is sold through long-term contracts between electricity producers and distribution utilities. Contracts are fulfilled between counterparties based on a negotiated contract price or a PPA. The WESM provides a mechanism for the purchase and sale of electricity not covered by bilateral contracts. Electricity sold on the WESM is priced according to the supply and demand characteristics of specific nodes or geographic locations on the grid. Prices are set hourly and governed by a strict dispatch hierarchy based on the marginal price of generation (the lowest-cost generation plants are dispatched in priority) (WESM 2016). As of February 2018, there were over 150 independently operated power plants in the Philippines, an indication of the robustness of the market competition.

Local Financing Market

The Philippines has a good reputation with investors. Macroeconomic fundamentals—including low inflation, financial stability, and strong economic growth, forecasted to grow at 6.8 percent a year over the medium term—are strong. Local banks are relatively liquid and have a reasonable access to hard currencies, thanks largely to significant foreign remittances. They are consequently able to offer attractive rates in both dollars and pesos. The country's long-term debt in foreign-denominated currency is rated BBB with a positive outlook (April 26, 2018) by Standard & Poor's. Such rating reflects adequate credit protection and is generally satisfactory to investors. In general, the Philippines is known for adhering to the rule of law and honoring commercial agreements. In 1999, the Philippines was one of the first country in southeast Asia to introduce IPPs and thus, it is familiar with this type of contractual arrangement.

Evolution of the Grid-Connected Solar Market

Until 2008, there was little activity in the Philippines' solar market. The first PV plant built was the 1 MW CEPALCO plant, funded by a US$4 million grant from the Global Environment Facility. The plant was connected to a private utility on the island of Mindanao and combined with an existing hydroelectric plant.

Developer interest increased following introduction of the 2008 Renewable Energy Act, which included a range of policy tools to encourage the uptake of renewables. Solar developers began to consider entering into bilateral PPAs with either distribution utilities or electricity cooperatives that relied on expensive diesel generation, and for which solar PV was becoming a competitive option. By 2012 the DOE had awarded service contracts for solar PV, equivalent to about 500 MW, granting project development rights to potential investors (KPMG 2013).

A feed-in tariff concept was initially contemplated by the Renewable Energy Act. At the time the Act was developed, feed-in tariff programs were common around the world, as the price of solar was higher than that of alternative sources of generation. In July 2012, the ERC introduced a feed-in tariff program to be awarded on a first-come, first-serve basis for projects that had achieved at least an 80 percent construction completion rate. By 2016, following two rounds of feed-in tariffs, the government had procured almost 900 MW of solar PV, which included almost 300 MW of projects that did not qualify for the feed-in tariff (Box 6.1).

Box 6.1 Feed-in tariffs in the Philippines

The Renewable Energy Act originally contemplated a feed-in tariff program to encourage development of renewable energy. It took several years for the DOE and the ERC to develop the program. A resolution released by the ERC on July 26, 2010, laid out the rules for the program.

The program was structured as a payment-for-difference scheme, where the difference between the spot price of electricity and the feed-in tariff would be paid for directly by consumers through a feed-in tariff allowance, set annually by the ERC, and administered by the NGCP. The resolution required the allowance to be included as a separate line on consumers' bills. It also mandated priority connection and dispatch to the grid for feed-in tariff projects.

On July 27, 2012, another ERC resolution approved the feed-in tariff rates and set installation targets for various technologies. Solar was initially given a 50 MW cap at a tariff of PHP 9.68 (US$0.22) per kWh. The tariff was set to decline by 6 percent a year after year one and was fixed for a period of 20 years.

In 2013 the guidelines for the program were released. They included stipulations that Certificate of Endorsements (COEs) for feed-in tariff projects would be granted on a first-come, first-served basis once 80 percent of the project had been constructed.

The "race to feed-in tariff" meant that developers were required to shoulder significant risk at the development and construction stage of their projects, making it difficult for banks to finance projects at financial closure. Consequently, most feed-in tariff projects were financed on balance sheets or with the support of engineering, procurement, and construction companies willing to take on project risk. Once projects received their feed-in tariff COE, local banks were generally willing to refinance projects using traditional project finance.

By the time the first round of feed-in tariff was closed, the government had awarded 108 MW of projects with a COE (Box Table 6.1.1). In 2014 the DOE endorsed an expansion of the cap to 500 MW. The government saw solar as an effective way to rapidly increase energy supply, which was under threat because of a combination of a hot summer and low precipitation (IRENA 2017).

Box Table 6.1.1 Outcome of feed-in tariff procurement rounds in the Philippines

Round	Target (MW)	Tariff (US$/kWh)	Amount contracted (MW)
1	50	0.22	108
2	450	0.192	418
Total	500		526

(continues)

Box 6.1 Continued

The ERC approved the expansion, with a revised tariff of PHP 8.69 (US$0.192) per kWh on March 27, 2015. The Philippines ended up procuring a total of 526 MW of solar that qualified for the feed-in tariff. Almost 300 MW of solar was built that did not qualify for the feed-in tariff. Projects that did not qualify were forced to identify alternative off-take arrangements. Most have resorted to selling power on a merchant basis on the WESM (often at a considerable loss) while trying to negotiate PPAs with electricity cooperatives or distribution utilities. The conclusion of agreements with distribution utilities has been complicated by regulatory uncertainty over procurement policy and the difficulty of securing approval from the ERC.

The commissioning of solar plants in 2015 and 2016 had a significant impact on the price of electricity sold in the spot market. As the marginal cost of generation for solar PV can fall to zero (because there is no direct fuel cost), it is prioritized in the dispatch hierarchy on the WESM. Consequently, solar PV has offset peaking diesel and heavy fuel oil plants selling to the WESM, but at a much lower average marginal cost, reducing the average spot market price from more than PHP 6 per kWh in June 2016 to about PHP 3 per kWh five months later, according to monthly WESM reports. The dramatic change in the spot price has put pressure on the feed-in tariff allowance, which now must make larger payments to feed-in tariff plants, given the increased difference between the feed-in tariff and the spot market price. The fact that the feed-in tariff allowance can be adjusted only annually has created a lag in reimbursements by NGCP to IPPs of as much as seven months.

Another unintended consequence of the feed-in tariff has been a significant consumer backlash. Although the overall effect on prices has been negligible, given lower spot prices, many customers have reacted negatively to the increase in the tariff line on their bill, leading to scepticism of the program and renewable energy in general.

The feed-in tariff program was successful in rapidly scaling up private investment in solar in the Philippines. At the same time, the accelerated pace of development has had ramifications in terms of grid planning and spot market pricing.

Sources: Stakeholder interviews; IRENA 2017.

After the closure of the second feed-in tariff round, the market for larger scale grid-connected solar PV came to a standstill as no clear policy direction had been given with respect to continued solar procurement.

Mobilization of Commercial Finance

All the solar PV projects built in the Philippines have been financed with commercial debt and equity. Due to the unique nature of the feed-in tariff program and the fact that private investment is constitutionally limited to 40 percent in foreign ownership, most plants were built and financed by local investors and developers. Both private and government-owned banks in the Philippines were eager to lend to projects involved in the feed-in tariff program on a corporate finance basis (that is, with limited recourse to project assets). Because the financing predominantly came from private sources, detailed project-level information is not readily available. However, the cumulative investment for the grid-connected solar PV projects that have achieved financial close is estimated at US$2.1 billion (BNEF 2017).

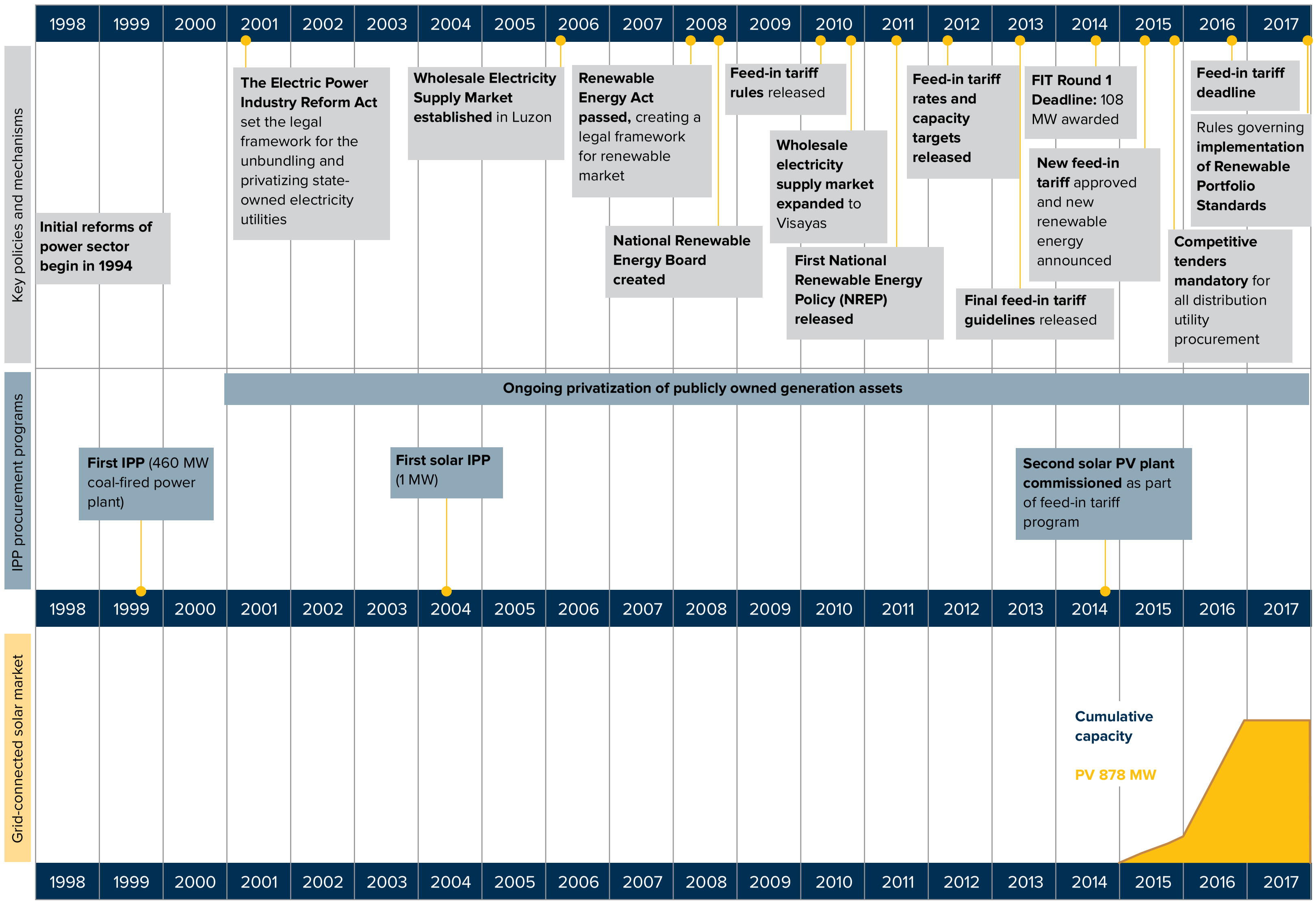
Effectiveness of Public Sector Intervention

Public interventions have heavily influenced the development of the solar market in the Philippines (Figure 6.6).

Legal, Policy, and Regulatory Framework

The Electric Power Industry Reform Act (EPIRA) provides the overall framework for investment in the energy sector in the Philippines. It firmly entrenches the role of private capital, independent power producers, open access to the grid, and the separation of generation, transmission, and distribution assets. The legal framework

Figure 6.6 Timeline of public interventions and market development in the Philippines



implemented under EPIRA was critical to enabling investment in solar. In addition, the country's proven record of private investment in the power sector stimulated the renewable energy sector.

The Renewable Energy Act (Republic Act No. 9513 of December 16, 2008) provides the framework for investment in renewables. In addition to regulatory and fiscal incentives to develop renewable energy projects, the main policy tools proposed were feed-in tariffs; renewable portfolio standards (RPS), which introduced a minimum percentage of renewable energy generation for on-grid systems; a market enabling the trade of renewable energy credits; net metering; and the green energy option, a mechanism to provide consumers with the option to be supplied through renewable energy sources.

The Act also offered fiscal incentives to accredited renewable energy projects, equipment manufacturers and suppliers. These fiscal incentives include a seven-year tax holiday and duty-free importation of equipment. Unlike other provisions which took several years to be implemented, the fiscal incentives immediately came into effect and benefited accredited market participants.

The feed-in tariff was successful in scaling up investment in solar PV, but subsequent progress has been limited. However, on December 30, 2017, the DOE published Circular No. DC2017-12-0015 promulgating the rules and guidelines for the implementation of RPS for on-grid areas. These rules require distribution utilities, electricity suppliers, generation companies supplying directly connected customers, and other mandated energy sector participants to source or produce a minimum share of electricity—initially set at 1 percent of net electricity sales or annual energy demand for the next 10 years—from their energy mix from eligible renewable energy resources, including solar. The minimum requirement will be enforced in 2020, 2018 and 2019 being transition years.

The capacity of the regulator, an onerous permitting process, and challenges related to the broader political context have constrained the scale-up of private investment in solar following the implementation of the feed-in tariff scheme. In the years that directly followed the adoption of the Renewable Energy Act, ERC's understanding of solar was limited, which delayed project approvals. Initial applications from electricity cooperatives were held up because of ERC's misunderstanding of AC/DC ratios. The ERC used DC and not AC plant size to calculate tariffs, which resulted in prices that were too low to support project economics. The issue was eventually addressed when the solar association hired an international consulting firm to facilitate a seminar on solar financial modeling. Technical capacity remains an issue that is further compounded by a high turnover and an unfamiliarity with renewable energy technologies, including at the highest levels of the organization.

Although the ERC successfully implemented the feed-in tariff program, slow approval process and lack of understanding of the specific characteristics of solar generation affected off-take arrangements (for example, PPAs with electricity cooperatives and contestable customers). The ERC must approve all contracts between distribution utilities and electricity cooperatives. Doing so can take time, and the outcome, especially in terms of tariffs, is uncertain (the tariff requested or negotiated with the utility may not be the tariff ERC approves). Since 2015, competitive procurement by distribution utilities is mandatory. This requirement has not eliminated the final ERC approval.

A similar barrier exists for PPAs with private off-takers. In order to sell power to contestable customers, power producers must obtain a retail license, a time-consuming process regulated by the ERC. In addition, they must pay wheeling charges to use the grid to transport power. However, these charges are levied on the installed capacity and not on the energy produced, which puts solar PV plants at a significant disadvantage because they generally have a lower capacity factor than conventional generation.

Planning, Technical, and Operational Capacity

Generation Planning

The Renewable Energy Act mandates the preparation of an NREP and biannual updates. The NREP is the policy document that outlines renewable energy targets and policy goals for the implementation and scale-up of renewable energy. The first NREP was published in 2011, three years after the Renewable Energy Act was enacted. It called for 285 MW of solar. An update was never released. An interim document released by the DOE in 2016, the Renewable Energy Roadmap 2017–2030, states that short-term objectives are to update the NREP and complete implementation of the Renewable Energy Act (including the renewable portfolio standard, the renewable energy market, and the green energy option). The Roadmap does not include a new capacity target for solar.

Grid Integration, Access, and Power Evacuation

The scale-up of renewable energy and solar in particular has caused major challenges to the grid. Load-flow studies must be completed in order to receive a connection agreement. However, during the implementation period of the feed-in tariff policy, so many developers applied for connection permits that it was difficult for the NGCP to ascertain the total amount of PV that was going to be built. Consequently, there have been congestion issues. The island of Negros is the most extreme example. Because of limited availability of suitably zoned land, about half of the total PV built for the feed-in tariff was situated on Negros, an island with a peak load of 300 MW. Although Negros is connected to other islands, the transmission capacity is not sufficient to evacuate all the power and grid upgrades will not be undertaken in the short-term. Low local demand and grid capacity has led to the costly curtailment of some of the solar PV plants on the island (WESM 2017). The NGCP has been hesitant to approve new variable generation in some areas of the grid because of oversupply.

Land Availability

Land availability is a significant challenge in the Philippines. The Renewable Energy Act included a system to allocate rights to developers by dividing the country into blocks, for which developers can apply as a first step for obtaining a renewable energy service contract. This process is completely independent of any existing land ownership. The fact that developers can acquire the rights to develop a block without any ownership rights over the land itself has led to conflicts between developers and landowners. Further complicating matters is the fact that most land suitable for solar development is zoned for agriculture. One of the reasons that many plants were built on Negros was the existence of suitable, industrial-zoned land. Changing the zoning from agricultural to industrial land to build a power plant requires permission at regional and national levels, a very cumbersome process that can take two years or more.

Direct and Indirect Financing

The development of solar projects in the Philippines did not involve public financing other than the fiscal incentives provided through the Renewable Energy Act. Well-capitalized and liquid banks allowed most projects to secure project-based financing at competitive rates in local and foreign currency. The combination of the stringent qualification criteria of the feed-in tariff program and the constitutional requirement that local firms own at least 60 percent of all generation projects, led to relatively low participation of foreign capital in the large-scale solar projects.

Government-Sponsored Guarantees

Off-Taker Creditworthiness

As a whole, the sector is cost reflective, which reduces off-taker risk. Both government-owned development banks and local private banks have supported renewable energy projects with feed-in tariff contracts. Off-taker risk remains a challenge for projects that sign PPAs directly with electricity cooperatives and distribution utilities, as not all of these entities have an investment grade rating. Although Meralco, the distribution utility that serves Manilla, is rated investment grade (BBB–) by Standard & Poor's (as of June 22, 2017), smaller electricity cooperatives especially do not have a credit rating and thus, potentially present a higher credit risk for investors.

Guarantees

Lenders and investors in solar projects did not require state-backed guarantees, partly because the market already had a well-established privatized electricity sector with cost-reflective tariffs and a history of successful IPPs. In addition, local banks are well capitalized and were willing to take the risks associated with the feed-in tariff payments. Because of the race-to-feed-in tariff, many projects were initially financed on balance sheet to meet the requirements of the program.

Summary

Table 6.2 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid-tied solar market

Key Findings and Take-Aways

The feed-in tariff (FIT) program was successful in catalyzing almost 900 MW of privately financed, grid-connected solar PV in the Philippines. Because of characteristics of the Filipino market— including constitutionally mandated national share ownership, a liquid banking sector, and a FIT program that required projects to be built before qualification—most of the capital invested in solar PV projects in the Philippines was sourced locally.

The presence of a relatively strong framework for private investment in power and cost-reflective tariffs helped ensure investor interest in the FIT program. Access to finance was not a challenge to scaling up investment in solar. Adequate financing from local banks and both domestic and international investors was forthcoming and reasonably priced.

The FIT program demonstrated that there is significant technical and financial capacity to develop solar in the Philippines. Since the close of the second round of the FIT program, the government has promulgated rules for the implementation of renewable energy standards for on-grid areas, offering new perspectives for private investment in the grid-connected solar market.

The rapid scale-up of solar PV during the FIT program has put significant strain on sections of the transmission network. Investment in transmission is required to reduce congestion. Future transmission planning and coordination with generation siting is important to ensure the smooth integration of PV.

Table 6.2 Effectiveness of public sector action in mobilizing commercial capital in the Philippines

Public sector action	Description	Legal, institutional, and regulatory framework	Planning, technical, and operational capacity			Direct and/or indirect public financing
			Generation planning	Grid integration, access, and power evacuation	Land/rooftop availability	
Electric Power Industry Reform Act (EPIRA) (2001)	EPIRA established the framework for unbundled and privatized electricity sector.	✓✓✓				
Renewable Energy Act (2008)	The Renewable Energy Act enabled investment in renewable energy and solar in the Philippines. It included fiscal incentives and policy tools.	✓✓	✓	✓	✓	✓✓
Creation of the National Renewable Energy Board (NREB) (2008)	The NREB provides policy advice and serves as a forum for stakeholder input.		✓			
Feed-in tariff program (2012–16)	The program procured more than 500 MW of solar PV.	✓✓	✓✓			
Mandated competitive procurement (2015)	An Energy Regulatory Commission regulation mandates competitive procurement for all energy procured by distribution utilities.	✓	✓			
Implementation of Renewable Portfolio Standard (2017)	Circular No. DC2017-12-0015 promulgated rules and guidelines governing the implementation of the renewable portfolio standards for on-grid areas.	✓✓				

Note: ✓✓✓: Very effective; ✓✓: Effective; ✓: Not very effective.

References

BNEF *(*Bloomberg New Energy Finance*)*. 2017. Projects database. Accessed on January 31, 2018.

DOE (Department of Energy). 2016a. Power Development Plan 2016–2040. Manila.

———. 2016b. Philippines Energy Plan 2017–2040. Manila.

———. 2016c. Renewable Energy Roadmap 2017–2040. Manila.

———. 2018. 2017 Power Statistics. April 30. https://www.doe.gov.ph/sites/default/files/pdf/energy_statistics/01_2017_power_statistics_as_of_30_april_2018_summary_05092018.pdf

IEA. 2018. World Energy Statistics and Balances (database). https://doi.org/10.1787/data-00510-en

IRENA (International Renewable Energy Agency). 2014. *The Philippines*: *Solar, Wind and Bioenergy Resource Assessment.* Abu Dhabi: IRENA.

———. 2017. *Renewables Readiness Assessment*: *The Philippines*. Abu Dhabi: IRENA.

KPMG Global Energy Institute. 2013. "The Energy Report Philippines." https://assets.kpmg/content/dam/kpmg/ph/pdf/InvestmentGuide/2013PHInvestmentGuideInvestmentGuideTheEnergyReportPhilippines.pdf

NREB (Renewable Energy Board). 2011. National Renewable Energy Policy. Manila.

Ocampo, Melinda. 2015. "Wholesale Electricity Spot Market." Presentation at the Thematic Multi-sectoral Meeting on Power. August 11. http://industry.gov.ph/wp-content/uploads/2015/08/Wholesale-Electricity-Spot-Market-WESM-101-by-Melinda-Ocampo-PEMC-President.pdf

UNDP (United Nations Development Program). 2018. *Human Development Indices and Indicators 2018 Statistical Update.* New York: UNDP

WESM (Wholesale Electricity Spot Market). 2016. WESM Market Manual: Price Determination Methodology Issue No. 1. https://www.doe.gov.ph/sites/default/files/pdf/issuances/annex_a_revised_price_determination_methodology.pdf.

———. 2017. Monthly Summary Report. June.

World Bank. 2014. *Philippines—Country partnership strategy for the period FY2015–2018* (English). Washington, DC. http://documents.worldbank.org/curated/en/328351468332470964/Philippines-Country-partnership-strategy-for-the-period-FY2015-2018

———. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b*. Doing Business 2018: Reforming to Create Jobs.* Washington, DC: World Bank.

———. 2018c*.* Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

———. 2018d. The World Bank in the Philippines: Context. September 27. http://www.worldbank.org/en/country/philippines/overview#1

CHAPTER 7 SENEGAL CASE STUDY

Senegal is a low income country located on the westernmost point of the African mainland. Its economy grew at an average rate of 3.8 percent a year between 2008 and 2017; the average GDP growth has exceeded 6 percent since 2015. This performance is attributed to the government's ambitious economic reforms and investment projects. Mining, construction, tourism, fisheries, and agriculture are the main contributors to growth and the primary sources of employment in rural areas, home to about 70 percent of the population. Table 7.1 presents selected socioeconomic indicators.

Table 7.1 Senegal's selected socioeconomic indicators

Indicators	Values
Population (2017)	15.8 million
Land area	192,530 km^2
Annual GDP growth (2017)	6.8 percent
Human Development Index (2017)	Low (0.505)
Ease of doing business ranking (2018)	140th of 190
Access to electricity (2016)	64.5 percent

Sources: World Bank 2018a, 2018b; UNDP 2018.

Senegal has a stable political climate, with three peaceful political transitions since independence, in 1960. Financial markets have expressed confidence in the economy, as the country successfully issued Eurobonds in 2014, 2017, and 2018. However, heavy dependency on imported fuels for electricity production and high exposure to oil price volatility have constrained the government's ability to improve the economic welfare of its citizens.

Overview of Senegal's Power Sector

Electricity Installed Capacity and Consumption

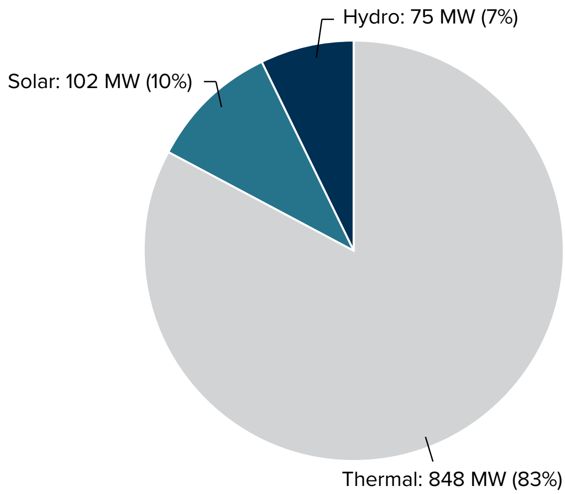
Senegal has total installed capacity of 1,025 MW (Figure 7.1), with a predominance of thermal-based power generation. Heavy fuel oil and diesel-powered turbines make up 83 percent of total generation capacity. Grid-connected solar power represented about 10 percent (or 102 MW) of total installed capacity in 2018. Senegal's hydropower generation is supplied from the Senegal River Basin Authority power plants located in Mali.[16] Regional power interconnections under construction will enable imports from Guinea.

By the end of 2017, seven IPPs operated about 350 MW of installed capacity and sold power to Senelec through long-term agreements. Three of these privately owned generation facilities are thermal-based (diesel and heavy fuel oil). The remaining four are solar PV plants were commissioned in 2016 and 2017.

Senegal's power sector is emerging from a power crisis, characterized mainly by a generation deficit, a high cost of power, and an unreliable supply. Electricity consumption almost quadrupled since 2000, to 3.7 TWh in 2016, an annual average increase of 9 percent (Figure 7.2). Power demand expectations remain strong, driven by the mining sector, business activities, industrial projects, and connection of new residential and small commercial customers, especially in rural areas, where only a third of the population is connected to

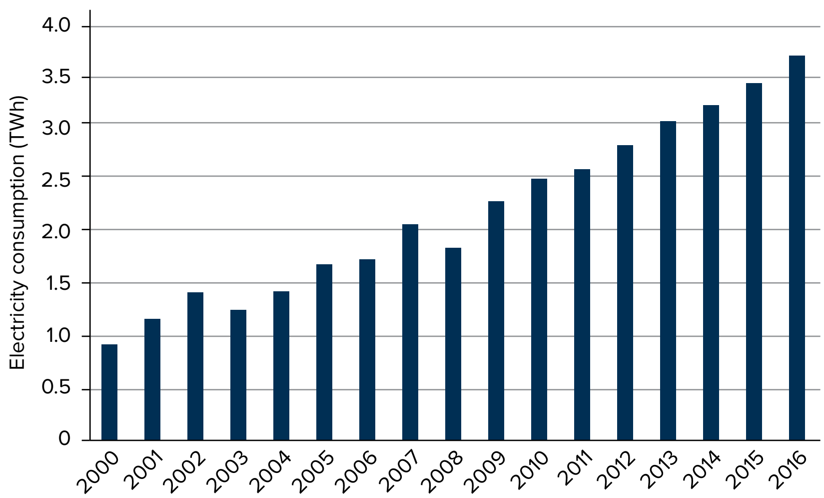
16 The Senegal River Basin Authority is an interstate organization set up in 1972 to manage the Senegal River and its drainage basin. Its member countries are Senegal, Guinea, Mali, and Mauritania. Senegal receives about 33 percent of the power generated by the Manantali (200 MW) plant and 25 percent of the power generated by the Felou (60 MW) plant.

Figure 7.1 Installed electricity generation capacity in Senegal



Source: Senelec 2018.

Figure 7.2 Electricity consumption 2000–16



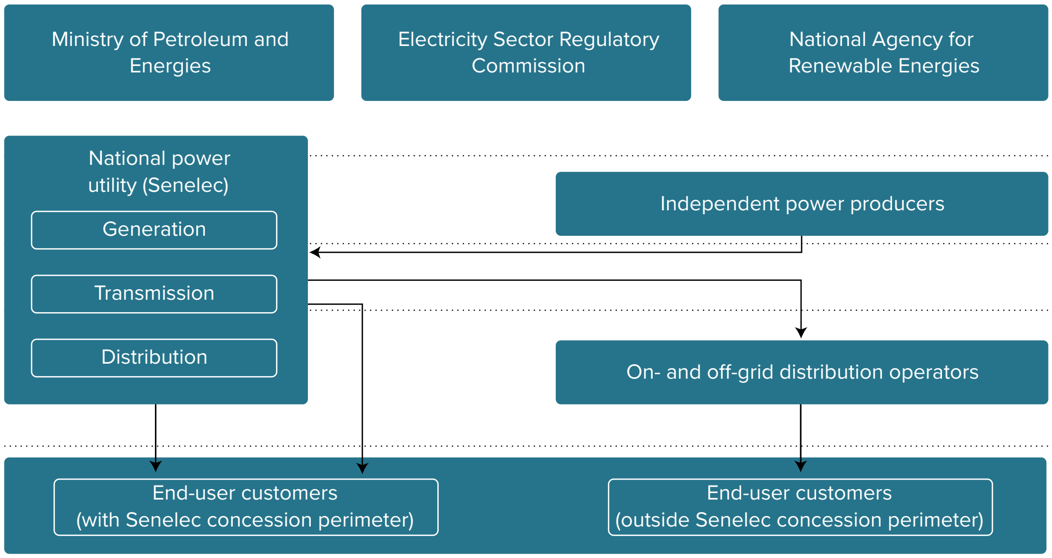
Source: IEA 2018.

the grid. To serve the growing electricity demand, an additional 690 MW of generation capacity is expected to be commissioned by 2020 and use various sources of power, including renewable energies.

Institutional Arrangements and Key Stakeholders

The national power utility, Senelec, produces about 60 percent of the total electricity generated in Senegal. It also operates and maintains most of the country's power infrastructure and is the single buyer of the power generated by independent power producers (IPPs). This status is expected to come to an end in 2019. Senelec operates within a specific concession perimeter. The distribution of electricity services in rural areas is entrusted to private concessionaires, who either buy their power in bulk from Senelec or generate it from decentralized solar and hybrid solar-diesel systems (Figure 7.3).

Figure 7.3 Institutional framework of the power sector in Senegal



The Ministry for Petroleum and Energy (MPE) implements the energy sector policy, defines national sector plans, sets power sector standards, and grants licenses and concessions. The Electricity Sector Regulatory Commission (CRSE) is responsible for regulating the generation, transmission, and distribution of electricity. It supervises the concession and licensing process; determines, modifies, and approves the tariff structure; and can advise on power sector decrees and regulation. The National Agency for Renewable Energies (ANER) was established in 2013 to promote the deployment and the use of renewable energies.

Key Energy Policy Objectives

Senegal's energy policy was framed in 2014 by the Emerging Senegal Plan (*Plan Senegal Emergent* [PSE]), as a document outlining the government's medium- to long-term priorities. It identifies energy as a "vital issue" for the country's economic development and calls for rapid deployment of an additional 1,000 MW to cope with growing demand. It also emphasizes the need to develop domestic resources, including natural gas, solar, and wind.[17] In addition, the energy policy is shaped by a strong commitment to expand energy access in rural areas, source at least 15 percent of its energy needs from domestic resources (excluding biomass) by 2025, and generate 20 percent of its electricity from renewable energies by 2017 (MEDER 2015).

In 2008 a sector-specific document, the Energy Sector Policy Letter (*Lettre de Politique de Développement du Secteur de l'Energie* (LPDSE), set a broad objective for renewable energy to cover 15 percent of the country's energy needs. This objective was confirmed in the 2012 revision of the LPDSE.[18] Although solar is listed among the sources of renewable energy to be developed, the LPDSE does not set specific quantitative targets.

Senegal has identified the energy sector as one of its main sources of greenhouse gas emissions and set specific targets for the development of renewable energies, including an unconditional target of 160 MW for solar PV. Under conditional targets (based on the availability of financial support from donors), solar targets were set at 200 MW for solar PV and 50 MW for solar CSP. Recent announcements by government officials indicated that electricity from renewable sources will reach 30 percent of installed capacity by 2025. The global direction is clearly set by the PSE and LPDSE, but the quantitative targets announced in official speeches have fluctuated.

17 Promising discoveries in recent years show that Senegal may have important natural gas resources.
18 The LPDSE is under revision. The revised issue is likely to set a more ambitious target for renewable energy-based electricity.

Senegal's Solar Market

Senegal's Position in Global Solar Development

Senegal has been one of the pioneers of West Africa's solar development. Its solar policy and legal framework began to take shape between 2008 and 2010; solar projects were selected for development in 2012 and 2013. In 2014, the global levelized cost of electricity for utility-scale solar PV projects was rapidly approaching US$0.15 per kWh, after declining more than 50 percent between 2010 and 2014. At these prices, investing in solar was not only attractive, as solar PV was considered a proven technology, but also competitive with Senegal's own electricity prices, which averaged about XOF 117.44 (U$0.23) per kWh in 2014; although the attributes of variable power delivered by solar PV are not the same as dispatchable power from diesel generators and heavy fuel oil and therefore any direct price comparison may be misleading.

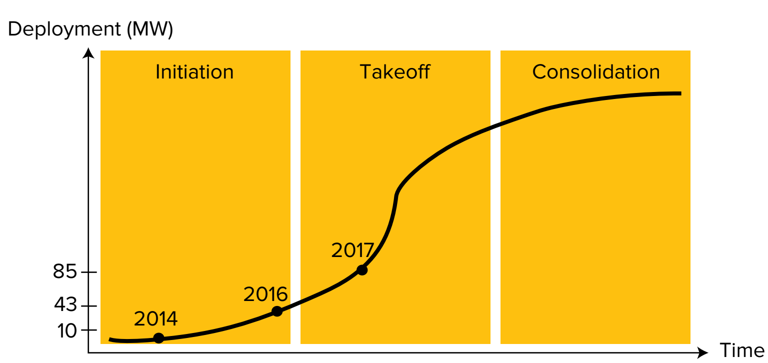
After a prolonged development phase, the construction of Senegal's first IPPs started in 2015. The first 20 MW came on line in 2016, quickly followed by three other projects (Table 7.2).

Table 7.2 Solar projects in Senegal, June 2018

Project name	Procurement route	Sponsor	Capacity (MW)	Status
Diass	Public tender	Senelec	25	Construction
Kahone	Unsolicited bid	Energy Resources Senegal	20	Construction
Kahone and Touba-Kael	Competitive tender	Engie-Meridiam	60	Development
Malicounda	Unsolicited bid	Solaria	22	Operational
Sakal (Baralé Ndiaye)	Unsolicited bid	EDS-Eximag	20	Construction
Senergy II (Dagana, Bokhol)	Unsolicited bid	Greenwish	20	Operational
Senergy (Santhiou, Mekhe)	Unsolicited bid	Meridiam	30	Operational
Ten Merina Ndakhar	Unsolicited bid	Meridiam	30	Operational
Total			227	

The rapid deployment of solar PV in Senegal has led to the country moving from the initiation phase to the market take-off phase within three years, as the installed solar PV capacity reached 102 MW (Figure 7.4).

Figure 7.4 Phases of deployment of photovoltaic solar power in Senegal



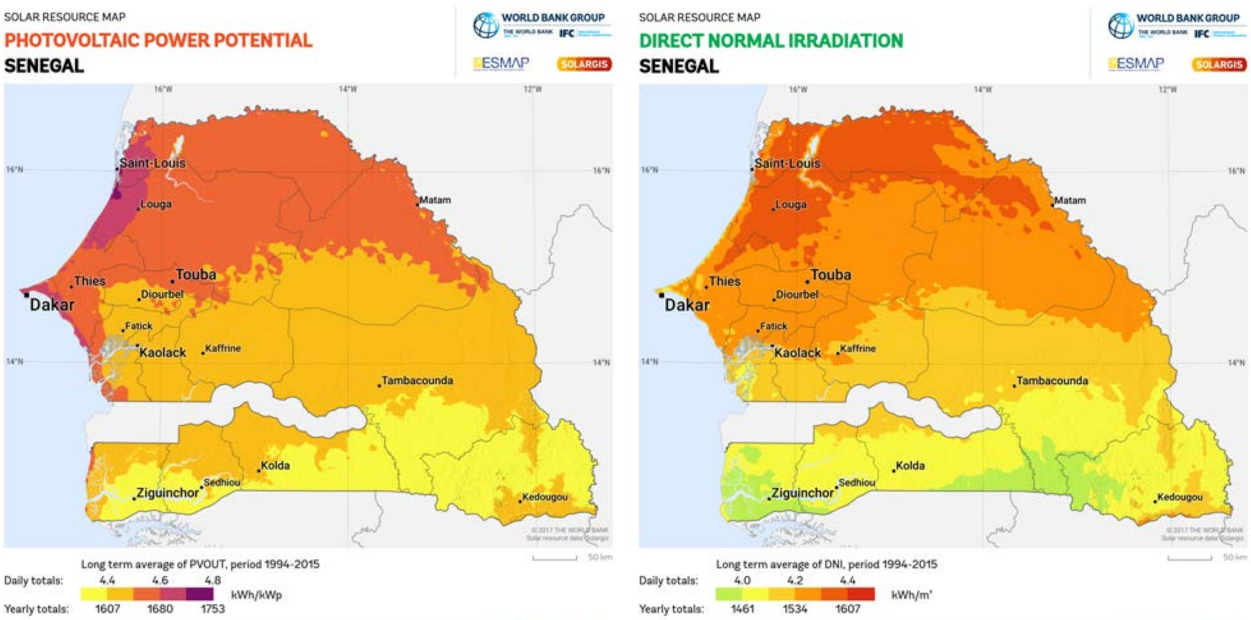
Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

With 225 MW already operational or in the pipeline, solar PV will soon represent about 20 percent of Senegal's installed capacity. Grid absorption capacity is likely to limit the development of the Senegalese solar market in the short term. However, several improvements are expected in generation, transmission, and dispatching capability, including interconnections to neighboring countries, and upgrades to Senelec's dispatch center. They could open the door to further development of the country's vast solar potential. In the longer term, Senegal's deeper integration into the regional West Africa Power Pool's power exchange system should expand the potential market size.

The quality of the solar resource varies across the country, with higher solar irradiance in the north (Figure 7.5).

Figure 7.5 Solar photovoltaic power potential and direct normal irradiation in Senegal



Source: World Bank, 2018c.

Market Structure

Senegal's power market follows a single-buyer model, with Senelec as the wholesale power off-taker. The utility had the exclusivity for transmission and distribution within its concession area for an initial period of 10 years from March 31, 1999. This period was extended until 2019, with a study currently underway to inform the government's decision on the market structure beyond 2019.

Grid-connected solar projects are procured by the public sector for its own account or through IPPs. Initial projects emanated from unsolicited proposals. The regulator has since opted to launch competitive tenders instead. Direct sales from IPPs to industrial customers are expected to take off after the expiration of Senelec's exclusivity period and the introduction of third-party access, announced for 2019.

Local Financial Market

Recent reforms in Senegal have contributed to improving the business. As a result, the country has become an attractive destination for foreign investment over the past few years, with foreign direct investment inflows increasing by a factor of three between the period 2005–07 and the year 2017 (UNCTAD, 2018).

Senegal's long-term sovereign debt, in both foreign and local currencies, was considered highly speculative by Moody's (Ba3) (rating as of April 13, 2017) and Standard & Poor's (B+) (rating as of July 15, 2018). The

International Monetary Fund assessed Senegal to be at low risk of external debt distress (IMF 2017). The country is a frequent borrower on the West Africa regional stock exchange and international capital markets. In 2017 it raised US$1.1 billion denominated in U.S. dollars with a 16-year maturity at an interest of 6.25 percent. Its first Eurobond issue, in 2009, raised US$200 million, at a maturity of five years and a yield of 9.25 percent. The difference is an indication of improved confidence.

Local financing is available mostly for shorter term loans and on terms that are not conducive to project financing. As a result, local commercial banks have not been involved in the financing of solar projects. Senegalese institutional investors, such as the sovereign wealth fund, have invested in the sector.

Evolution of the Grid-Connected Solar Market

Senegal formally opened the power market to private investment in 1998, ending Senelec's monopoly in generation and distribution. Several thermal-based IPP projects were built since the late 1990s, giving Senelec an opportunity to build its capacity to deal with private developers and negotiate power purchase agreements. It was only in 2008, in a context of sharp increases in oil prices and decreases in the cost of solar PV panels, that the government formally started considering the procurement of solar projects.

The 2008 energy policy recognized the country's important solar potential, though no solar-specific target was set. When the legal framework was set up in 2010, a feed-in tariff scheme was originally envisioned as an incentive to private developers, in line with similar developments in Europe at that time. But the decrease in global PV prices, as well as the willingness of private developers to bid for tariffs in competitive auctions, rendered the concept obsolete before it was implemented, and it was abandoned. By then the government had received many unsolicited proposals.

In the aftermath of Senegal's severe power crisis in 2011, the government set up an ad hoc procedure to deal with unsolicited proposals and select the projects that would be allowed to move forward. After a first round of selection, the ad hoc selection committee shortlisted 46 solar projects to enter negotiations with Senelec, the single-buyer off-taker. On December 31, 2013 nine solar PV projects totaling 180 MW, mostly sponsored by local developers, signed memoranda of understanding for a nonnegotiable tariff of about XOF 65 (US$0.14) per kWh, which was considered low at the time.[19] According to developers, by that point most international players had quit the negotiation process believing that the proposed PPAs were not bankable for a multitude of reasons including the creditworthiness of the off-taker, and the lack of transparency and efficiency of the PPA process.

Most of the developers selected in 2012–13 were small local players, with limited experience in project development. Some of them sought more experienced developers to partner with, others ended up selling their projects, creating an opportunity for international developers and investors, as the commercial viability of the projects signed in 2013 became increasingly attractive. Indeed, during 2012–16, the sharp decline in global PV prices considerably improved project economics. Senelec's creditworthiness as an off-taker also improved substantially, thanks to the combined effects of the global decrease in oil prices (Senelec's largest cost item) and the implementation of a robust energy sector recovery program, which resulted in improvements in the management and commercial performance of Senelec and more efficient operations (Senelec 2016; World Bank 2016).

After a prolonged development phase, in 2015 construction works started on Senegal's first solar plants. The first plant, Senergy II Bokhol (20 MW), was inaugurated in October 2016, quickly followed by a second one, Malicounda (22 MW), in November 2016. In 2017 Senergy PV Senthiou Mekhe (30 MW) and Ten Merina (29.5 MW) became operational. Two other independent power plants (Sakal [20 MW] and Kahone [20 MW]) and one Senelec-led project financed by KfW (Diass [25 MW]) are nearing completion (Table 7.2).

Procurement of new privately developed solar projects is led by the regulator and follows a competitive tendering process. A first competitive process was launched in 2016, under the Scaling Solar initiative (Box 7.1).

19 Solar IPPs procured through competitive bidding in South Africa at that time were offering an average tariff of US$0.21 per kWh. The 2013 PPA included annual indexation of 1.5–2.5 percent, making the price escalate quickly.

Box 7.1 The Scaling Solar program in Senegal

The Scaling Solar program is a World Bank Group initiative that aims to accelerate private development of large-scale, grid-connected solar projects in emerging markets. The program involves several innovative features designed to stimulate the participation of top-tier investors, level the playing field for project developers through a transparent award process, significantly reduce the time between project award and financial closure, reduce development and financing costs, and ultimately deliver cheap and affordable tariffs to the grid. The approach creates market competition, through the selection of private developers following an international competitive bidding process. The tender package comprises fully developed and bankable project agreements associated with pre-approved financing terms, credit enhancement, and risk management financial instruments available to all qualified bidders. The program also enhances institutional capacity, by providing legal, technical, and financial advisory services to support governments from project preparation to contract award.

In October 2017, Senegal launched a request for proposals for the procurement of up to 100 MWac of solar capacity under the Scaling Solar program. Thirteen pre-qualified bidders participated in the tender. The results were published in April 2018. Two projects totaling 60 MWac were awarded to a consortium of international developers. The resulting tariff for the first year is EUR 0.038 (US$0.047) per kWh for the first plant and EUR 0.03987 (US$0.049) per kWh for the second, a record low for Sub-Saharan Africa.

Mobilization of Commercial Finance

Limited information is available in the public domain regarding the commercial capital invested in the grid-connected commercial plants that have achieved financial close in Senegal since 2016. The public private infrastructure database records three out of six transactions, and an estimated invested capital of US$101 million (World Bank 2018c).

The lead project sponsors are all private international developers or investors: Meridiam, Greenwish, Eiffage, and Solaire Direct (Engie) from France; Energy Resources, Solaria Group, and Chemtech from Italy; and EDS from the United States. The bulk of the debt was mobilized through private sector windows of international financial institutions, such as Proparco (France), BIO (Belgium), and FMO (the Netherlands). Green Africa Power, a fund established by the Private Infrastructure Development Group (PIDG) and funded by the United Kingdom and Norway, provided the debt for the 20 MW Senergy II.

Institutional investors have also invested in the solar market. Senegal's Sovereign Fund for Strategic Investments (le Fonds souverain d'investissement stratégiques [FONSIS]) and the Caisse des Dépôts et Consignations (a public institution managing official deposits) are shareholders in two power plants.[20] These investments were concluded on a commercial basis. Local commercial banks were not involved in their financing.

Effectiveness of Public Sector Intervention

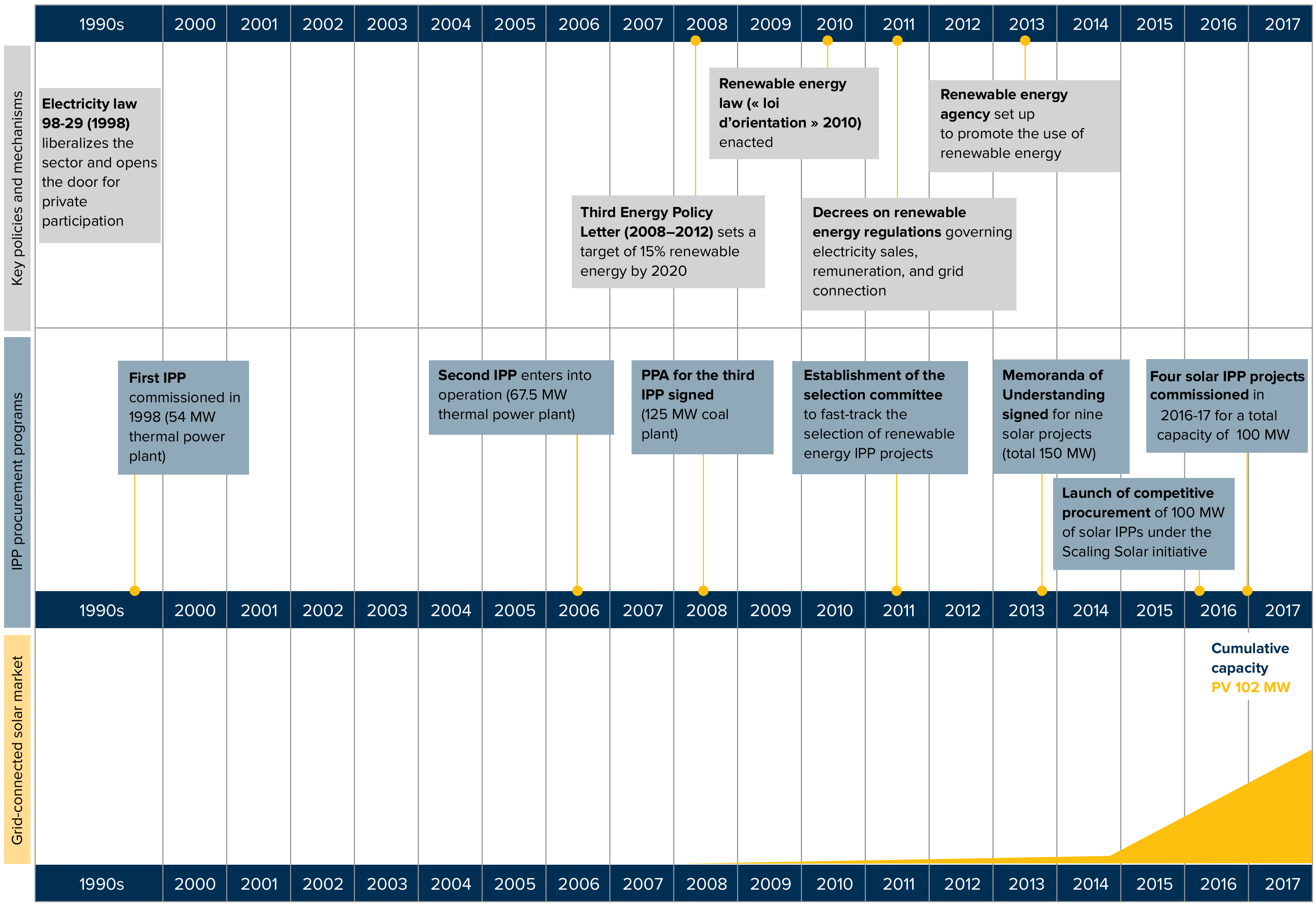
Senegal's solar market is going through a rapid development phase, shaped by various public interventions that were instrumental in increasing the competitiveness of the solar power market and creating a favorable enabling environment (Figure 7.6).

Legal, Policy, and Regulatory Framework

The 1998 Energy Sector Law instituted a licensing regime for electricity generation and established an independent regulatory authority to attract private investment. It was followed in 2010 by the Renewable Energy Law, which created a specific framework for renewable energy development. Its application decrees specified the conditions of sale and remuneration of renewable energy production and the grid-connection requirements, and established the role of the regulator to launch tenders for the procurement of new generation capacity and determine tariff-setting mechanisms.

20 FONSIS has a 32 percent share in the 30 MW Santhiou Mekhe plant; the Caisse des Dépôts et Consignations owns one-third of the 20 MW Senergy II plant.

Figure 7.6 Timeline of public interventions and market development in Senegal



Not all provisions of the Renewable Energy Law have been implemented. For instance, by-laws that should have defined the law's customs duty exemptions for renewable energy equipment have not been enacted. The fiscal incentives provided for in the application decree are not reflected in the Investments Code. Notwithstanding these gaps, Senegal's legal framework is relatively investor friendly and has led to the development of multiple commercial solar PV projects.

Senegal has an adequate and clear institutional framework that defines the roles and responsibilities of each organization. The reality on the ground however sometimes differs from what was legislated. For example, before 2016 Senelec led negotiations with prospective investors with little or no involvement by the Electricity Sector Regulatory Commission. Since then, the regulator has been empowered to procure new generation capacity from private developers. The transparency and efficiency of the selection, negotiation, and licensing procedures increased as a result. The involvement of the National Agency for Renewable Energies in the development of utility-scale renewable energy has remained very limited, as the agency focuses on decentralized energy for rural electrification.

Although the regulatory guidelines are relatively clear, the administrative processes for obtaining permits (exemptions, land, environmental clearance, and so forth) are complex. Applications for concessions for electricity distribution and licences for power generation are submitted to the Ministry of Energy, which send them to the regulator for further processing. The regulator then returns them to the ministry for issuance of the relevant document. This process results in numerous delays and is a source of uncertainty for prospective investors.

With Senelec's single-buyer status ending in 2019, eligible clients will be able to buy power directly from IPPs. However, the establishment of clear and transparent third-party access to the grid will require new rules and regulations that are yet to be developed. Regulations for net metering and the definition of a feed-in tariff for the surpluses from the renewable energy generated for self-consumption are also in the making. New market segments could therefore be created for solar power in the near future, but doing so will require important regulatory changes.

Planning, Technical, and Operational Capacity

Generation Planning

Senegal's energy policy emphasizes the development of renewable-based electricity, but there is no formal target for the development of grid-connected solar power. Senelec's 2017–30 generation plan provides for 185 MW of solar power to the grid over the period. Recent announcements by government officials mentioned that 250 MW of solar were expected to be commissioned in the near term. The lack of a single generation planning document that could be used as a reference does not appear to have hindered solar project developments to date.

Grid Integration, Access, and Power Evacuation

Grid access is guaranteed by the Renewable Energy Law; developers do not cite lack of access as an issue. However, Senelec is not sufficiently prepared for its new role as a dispatcher and transmission system operator tasked with integrating a large share of variable renewable energy. The system also lacks spinning reserve required for smooth grid integration. The corresponding costs—borne by Senelec—might add to the price paid to private developers. In addition, the requirement in the PPAs for Senelec to take delivery of the power supplied or pay a penalty for failure to do so (the take-or-pay clause), combined with a significant risk of curtailment because of grid instability, might also increase the financial burden for Senelec. IPPs have raised concerns related to grid performance (for instance, power cuts and fluctuations that affect plant operations).

The situation seems to be improving. Investments and capacity building activities are planned in the near future to reinforce Senelec's dispatching capacity. A grid code with specific provisions for variable renewable energy is under preparation. The installation of batteries, to better manage the variability of solar power, is also under consideration. Hydropower is also playing a role in managing variability. The Manantali dam (located in Mali) is already stabilizing the Senegalese grid. When the power interconnection to Guinea is completed, the stabilizing role of hydropower could potentially increase. These actions are likely to improve the ability of the grid to absorb solar power, but given the small size of Senegal's power system, grid absorption capacity is likely to remain a limitation for significant scale-up.

Land Availability

Land availability was not identified as an issue for solar projects in Senegal by the developers interviewed for this study. Local governments welcome solar projects on their territory because of the expected social, economic, and financial benefits. One private developer set a precedent by implementing several local community development projects and letting the municipality in which the project is located have 5 percent of the shares in the project and a seat on the board of directors of the project company. Administrative procedures to secure land are long and cumbersome, however, involving various levels of jurisdiction. Some projects have been able to obtain only land leases instead of straight ownership rights.

Direct and Indirect Financing

None of the independent solar power projects developed so far has benefitted from direct financing from the government, and no direct financing is expected in the near term. Private sponsors financed their projects through equity and debt from development finance institutions and institutional investors.

Government-Sponsored Guarantees

Off-Taker Creditworthiness

The creditworthiness of Senelec has always been a concern for private developers, as evidenced by the requirement of a sovereign guarantee and payment liquidity mechanism to ensure the bankability of the first thermal-based power purchase agreements in the late 1990s to the early 2000s. Senelec's financial performance is highly dependent on global oil prices. Its concession agreement provides for an automatic fuel price adjustment mechanism to compensate the utility for revenue shortfalls. Since 2011, Senelec has been highly dependent on direct subsidy transfers from the government channeled through the special fund for electricity. As part of the electricity sector reform program launched in 2011, the government implemented initiatives to improve the technical, operational, commercial, managerial, and financial performance of Senelec. International finance institutions are supporting these efforts through technical assistance and investment financing.

With solar power now much cheaper than most of Senelec's conventional power (based on heavy fuel oil and diesel), solar power tariffs seem to be affordable for the utility. In November 2017, Senelec's long-term debt was rated AA (low risk) by Bloomfield Investment Corporation, a credit rating agency established in 2013 that works largely in Africa. Through its 2018 bond issue, Senelec raised the equivalent of US$65 million on the West African Economic and Monetary Union, at a coupon rate of 6.5 percent with a maturity of seven years, attesting to its increased creditworthiness on local and regional financial markets.

Guarantees

Government-backed guarantees and liquidity payment facilities, such as escrow accounts covering at least three months worth of power purchase payments and letters of credit from commercial banks, have been critical in attracting private developers. They are expected to remain attractive features in the short-to-medium term.

Summary

Table 7.3 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid-tied solar market.

Key Findings and Take-Aways

In a mix dominated by expensive imported fuels, solar has become an extremely competitive option in recent years. Lengthy permitting processes, partial implementation of the legal framework, and an initial lack of institutional capacity in dealing with solar projects hindered the development of the first solar projects in Senegal.

Table 7.3 Effectiveness of public sector action in mobilizing commercial capital in Senegal

Public sector action	Description	Legal, institutional, and regulatory framework	Planning, technical, and operational capacity: Policy, strategy, and planning	Planning, technical, and operational capacity: Grid integration, access, and power evacuation	Planning, technical, and operational capacity: Land/rooftop availability	Direct and/or indirect public financing	Government-sponsored guarantees
Energy Sector Policy Letter (LPDSE) (2008)	The 2008 energy policy letter set a target of 15 percent for renewable energy that contributed to raising private sector appetite for solar power.		✓✓				
Renewable Energy Law and decrees (2010 and 2011)	The law created an adequate framework for renewable energy development.	✓✓✓				✓	
Ad hoc procedure for unsolicited bids (2012)	The procedure, set up to deal with unsolicited bids, resulted in nine developers signing a memorandum of understanding for solar power development.	✓✓	✓				
Creation of the National Agency for Renewable Energies (ANER) (2013)	ANER was set up to promote the use of renewable energy but has not been involved in grid-connected solar projects.	✓					
Guarantee to back purchase power agreements (PPAs) for solar independent power producers (2014–15)	All PPAs are backed by a sovereign guarantee and a three-month escrow account or letter of credit.						✓✓✓
Launch and implementation of the Scaling Solar program (2016)	Competitive solar procurement package that includes bankable project agreements, pre-approved financing, and insurance terms and advisory services to the government	✓✓✓	✓✓		✓✓✓		✓✓

Note: ✓✓✓: Very effective; ✓✓: Effective; ✓: Not very effective.

After a slow start, Senegal's achievements in attracting commercial finance for grid-connected solar have been remarkable. Increased transparency in the procurement mechanisms and the provision of guarantees to cover the payment obligations of the public off-taker under the contractual agreements facilitated success. The involvement of development finance institutions in the financing package of these first projects reinforced their attractiveness and contributed to the initial development of the market.

The capacity of the grid to absorb variable power is the key limitation to further significant solar developments. Senelec's capacity as a dispatcher and transmission system operator needs to be significantly reinforced. The transition from an integrated market structure dominated by thermal generation to a more liberalized market integrating a wide diversity of power sources will represent an additional challenge for the power sector. The solar market would also benefit from streamlined procedures and clearer regulations.

Several lessons emerge from Senegal's experience:

- Investors require sovereign guarantees to invest in countries that are in their initial phases of development and have financially weak state-owned off-takers.
- In countries with partially developed legal and regulatory frameworks, initiatives such as Scaling Solar can help de-risk transactions and attract commercial financing at very attractive terms.
- In relatively small and weakly interconnected power markets, grid absorption capacity can become an issue as soon as solar plants are commissioned. Better system planning, upgrades to dispatching, and investments in grid infrastructure are needed to prevent power curtailment. The rationale for undertaking these investments should include the economic benefits arising from improved reliability of electricity services.

References

IEA. 2018. World Energy Statistics and Balances (database). https://doi.org/10.1787/data-00510-en

IMF (International Monetary Fund). 2017. *Senegal Fifth Review under the Policy Support Instrument and Request for Modification of Assessment Criterion—Debt Sustainability Analysis.* December 4. IMF Country Report No 18/8. Washington, DC.

MEDER (Ministry of Energy and Development of Renewable Energies). 2015. Stratégie Nationale de Développement des Énergies Renouvelables au Sénégal 2016–2020. November. Dakar.

Senelec. 2016. Plan Stratégique 2016–2020. Dakar.

———. 2018. Chiffres clés. http://www.senelec.sn/espace-institutionnel/chiffres-cles/

UNCTAD (United Nations Conference on Trade and Development). 2018. World Investment Report 2018 Country Fact Sheet: Senegal. http://unctad.org/fdistatistics

UNDP (United Nations Development Program). 2018. *Human Development Indices and Indicators 2018 Statistical Update.* New York: UNDP.

World Bank. 2016. *Senegal—Electricity Sector Support Project: Additional Financing (English)*. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/593131470244330855/Senegal-Electricity-Sector-Support-Project-additional-financing

———. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b. *Doing Business 2018: Reforming to Create Jobs*. Washington, DC: World Bank.

———. 2018c. Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

———. 2018d. Private Participation in Infrastructure (database). Washington, DC: World Bank. https://ppi.worldbank.org/data

CHAPTER 8 SOUTH AFRICA CASE STUDY

South Africa is an upper-middle income country and the second-largest economy in Africa (after Nigeria). It is home to the fifth-largest population on the continent with 56.7 million people. The country is endowed with abundant supplies of natural resources, boosted by well-developed financial, telecommunications, energy, and transport infrastructure services. Services contribute to the largest share of the economy, followed by industry and agriculture. South Africa's economic policy has focused on controlling inflation while empowering a broader economic base. The country faces structural challenges, including high inequality and unemployment rates (the official unemployment rate averages 27 percent). Economic growth has decelerated in recent years, slowing to an estimated 1.3 percent in 2017, down from 5.4 percent in 2007 (World Bank, 2018a). The recent governance crisis and lack of coordinated political action has contributed to the high indebtedness of public utilities and increased volatility, generating uncertainty among investors and leading to a decline in South Africa's competitiveness. The country's political leadership is committed to undertaking the reforms needed to restore investor confidence in the economy. Table 8.1 presents selected socioeconomic indicators.

Table 8.1 South Africa's selected socioeconomic indicators

Indicators	Values
Population (2017)	56.7 million
Land area	1.2 million km^2
Annual GDP growth (2017)	1.3 percent
Human Development Index (2017)	Medium (0.699)
Ease of doing business ranking (2018)	82nd of 190
Access to electricity (2016)	84%

Sources: World Bank 2018a, 2018b; UNDP 2018.

Overview of South Africa's Power Sector

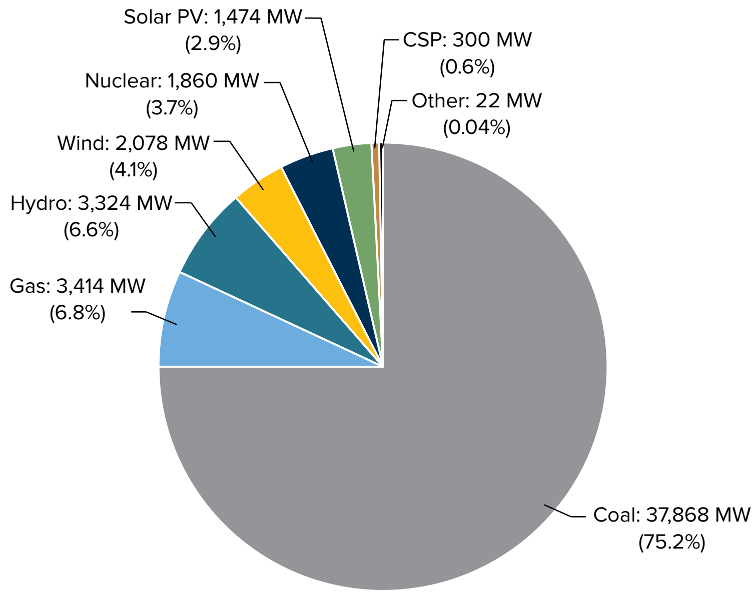
Electricity Installed Capacity and Consumption

South Africa has the largest and the most developed power market in Sub-Saharan Africa. It has an average annual net electricity output of 240 TWh out of which 93 percent is produced by Eskom, the national power utility's own generation, 4 percent is from independent power production, and 3 percent represents purchases from neighboring countries.

Electricity data for the year ending March 2018 show that nominal installed capacity totaled 50 GW, for a peak demand of about 35 GW. The energy mix is dominated by coal, followed by gas, hydropower, wind, nuclear, and solar. Coal supplies about 85 percent of the electricity produced and represents 75 percent of installed capacity. The power sector contributes roughly half of the country's carbon emissions. Renewable energy plants, excluding hydro and pumped storage facilities, represent 14 percent of total installed capacity; solar PV and CSP capacity account for 3.5 percent of that total (Figure 8.1).

South Africa invested massively in its power generation capacity in the 1970s and 1980s. By the end of the 1990s, its electricity was among the cheapest in the world, with an average price of US$0.025 per kWh, as most capital expenditures were paid off and prices were close to the marginal cost of production. These low tariffs did not include adequate provisions for future investment. By the end of 2004, it became apparent that the country would face a power supply deficit unless new investments were made, and specific actions were implemented to change the demand profile. The government supported the launch of

Figure 8.1 Nominal installed capacity for electricity generation in South Africa, March 2018



Source: Eskom 2018.

a US$40 billion power plant construction program and allowed above-inflation tariff increases. The implementation of this program will increase the total electricity installed capacity by 7 GW by 2021, which will be supplemented by a 2 GW capacity increase from IPPs, over the same period.

South Africa trades power with its neighbors through the Southern Africa Power Pool (SAPP). It supplies electricity to a limited number of end-user customers across its borders and to the power utilities of Botswana, Lesotho, Mozambique, Namibia, Swaziland, and Zimbabwe. Power imports come predominantly from the Cahora Bassa hydropower facility in Mozambique. Cross-border purchases of electricity amounted to 7.7 TWh during the year ending March 2018 (Eskom 2018).

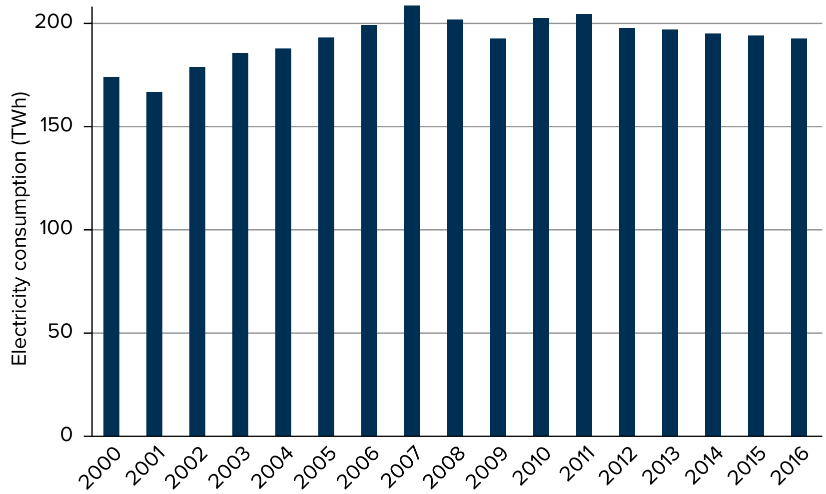
South Africa experienced several nationwide load shedding episodes, in 2007–08 and 2014–15, partly attributed to delays in new capacity additions and suboptimal maintenance of existing plants. Electricity demand has been moderate, on the back of a slow economic growth, a volatile commodity market affecting the mining industry, and increases in electricity prices which hamper consumers' ability to increase their electricity demand. In parallel, the development of renewable energy production and small-scale applications, and the advent of self-generation increase the attractiveness of alternative energy supply solutions for consumers and is changing the demand patterns for on-grid services. On aggregate, power consumption has increased at a modest 0.6 percent annually between 2000 and 2016 (Figure 8.2).

Institutional Arrangements and Key Stakeholders

Eskom is South Africa's state-owned national electricity utility and the nation's primary electricity supplier (Figure 8.3). It owns and operates 30 power stations and about 381,000 kilometers of high-, medium-, and low-voltage power lines. It is vertically integrated across the electricity value chain, generating, transmitting, distributing, and selling power to bulk-buyer municipalities, mining companies, industrial, commercial, agricultural, and residential customers.

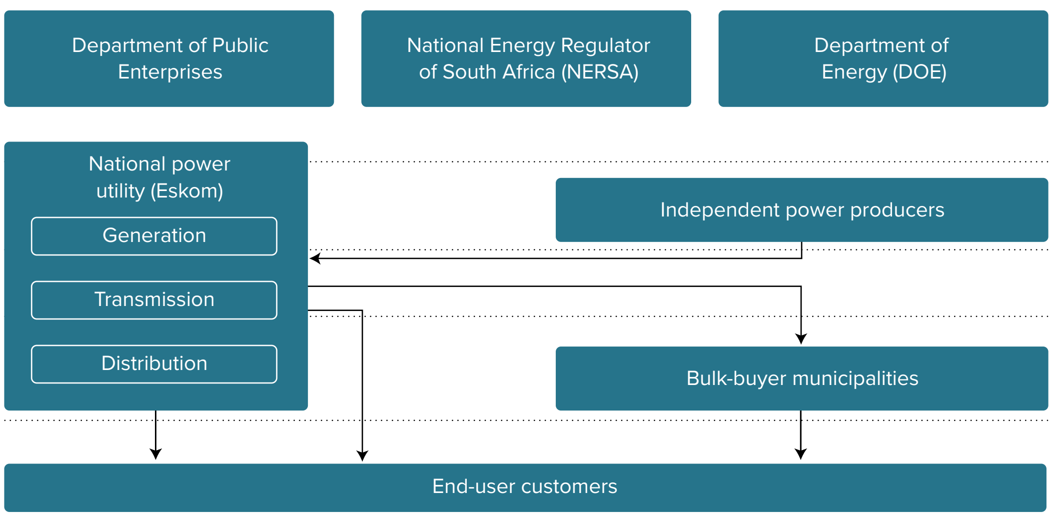
Eskom operates under the supervision of its shareholder ministry, the Department of Public Enterprises, and the Department of Energy (DOE), which sets the energy policy agenda. The National Treasury provides financial oversight.

Figure 8.2 Electricity consumption 2000–16



Source: IEA 2018.

Figure 8.3 Key institutional stakeholders in South Africa's power sector



The DOE oversees the energy sector and has ultimate responsibility for its overall development. Together with other sector players, it elaborates the Integrated Resource Plan, which defines the long-term needs for generation capacity.

The electricity industry is regulated by National Electricity Regulator of South Africa (NERSA), which issues licenses, develops regulatory rules and technical guidelines and codes, and determines the tariff that Eskom is allowed to charge its customers.

Key Energy Policy Objectives

South Africa's energy policy is guided by the National Development Plan 2030, an all-encompassing policy document published in 2012 that identifies energy infrastructure as a critical foundation for the country's economic activity and growth (NPC 2013). The plan sets the basis for South Africa's energy transition, with the ambition of procuring at least 20,000 MW of renewable electricity by 2030 while decommissioning 11,000 MW of aging coal-fired power stations. Other key policy objectives for the power sector include strengthening regional cooperation, supplying power at a competitive price to industry, and ensuring access for all. The last objective translates into a target of 90 percent grid access by 2030, with the remaining population served through off-grid technologies. Affordability is considered as crucial as access itself: keeping electricity bills in check is an important objective, to be met through both subsidies (such as the Free Basic Electricity allocation for eligible households) and efforts to reduce the cost of service.[21]

South Africa's climate change mitigation commitments also shape its energy policy. The development of renewable energy was one of the priority areas identified in the 2008 Long-Term Mitigation Scenario and the 2011 National Climate Change Response White Paper to curb South Africa's CO_2 emissions. South Africa's Nationally Determined Contribution (NDC), released ahead of the 2015 COP21 in Paris, defined peak, plateau, and declining emissions trajectory ranges, with an objective for emissions by 2025 and 2030 of 398–614 million tons of CO_2 equivalent and provided that the transition to a low carbon economy is not detrimental to the country's capacity to address poverty and inequality.

Development of two large-scale coal-based plants over the past decade, Medupi and Kusile each with a capacity of 4.8 GW, appears to be at odds with South Africa's emission reduction ambitions. With the release of the draft 2018 Integrated Resource Plan by the Department of Energy, the path to a drastic reduction in coal generation appears nevertheless clearer. The plan proposes a clear target to reduce the share of coal to less than half of the country's total installed capacity by 2030 by developing wind, natural gas, solar, and hydropower at a fast pace.

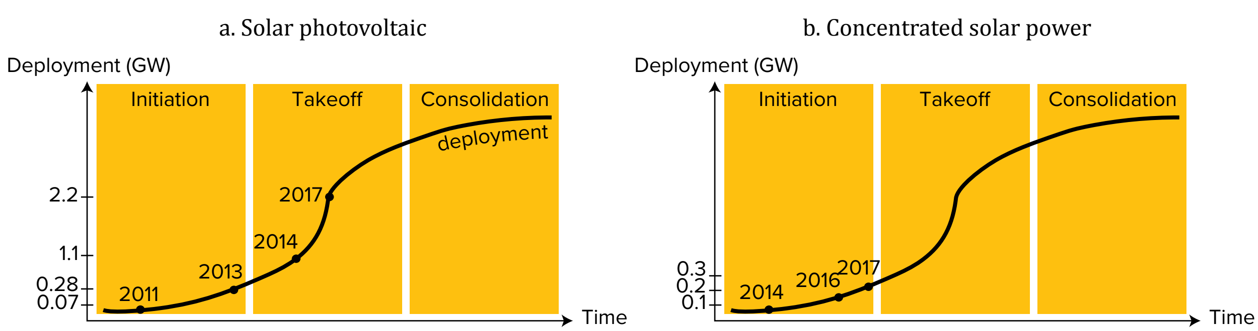
South Africa's Solar Market

South Africa's Position in Global Solar Development

Following an inconclusive attempt to introduce a feed-in tariff in 2009, South Africa embarked on a large auction-based public procurement program for renewable energy in 2011. This rapid shift to a competitive bidding process is at least partly explained by the global context at the time. With renewable technology costs rapidly declining, the rationale for an administratively fixed price had become weak even before it was implemented. At the time, feed-in tariffs were still the most common procurement mechanism for solar and renewable energy at large. Only a limited number of countries (notably India and Brazil) were procuring renewable-based power through competitive bidding or auctions (IRENA 2015). South Africa was among the pioneers of what later became a global move from feed-in tariffs toward price competition.

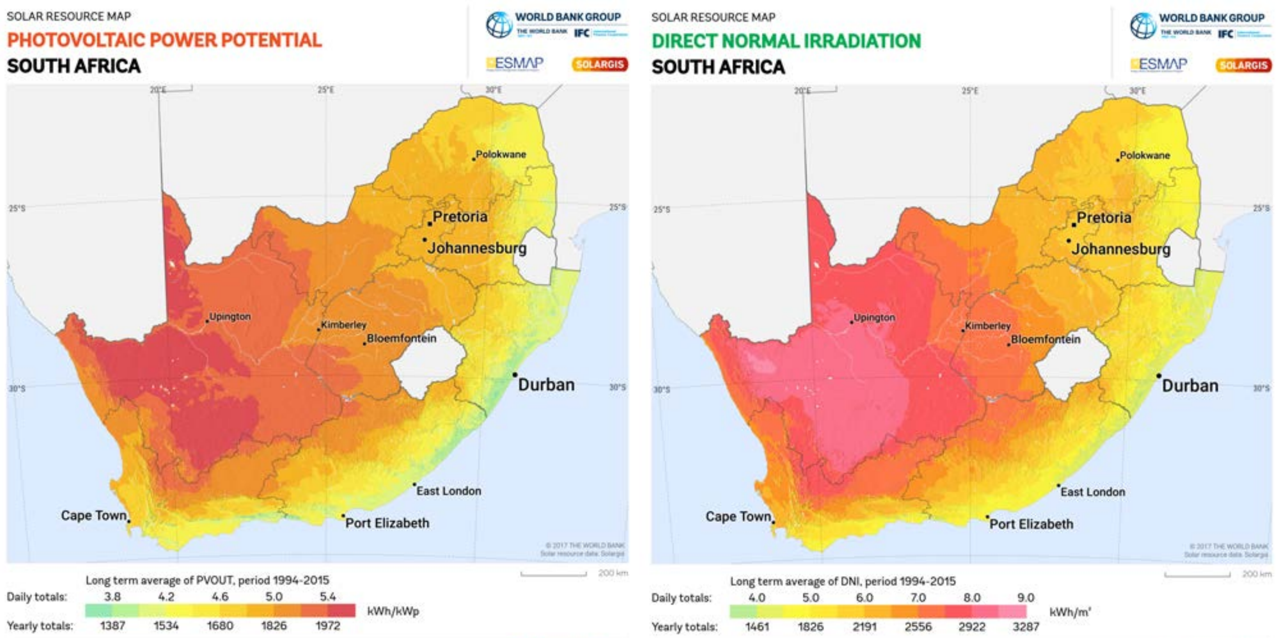
The inception of South Africa's solar market began in 2011 with the launch of the Renewable Energy Independent Power Producer Procurement Program (REIPPPP), which was a concerted effort by the Department of Energy, Eskom, and the National Treasury, that was backed by a sustained political commitment to renewable energy. The program kick-started the market for solar IPPs. Total solar PV capacity reached 260 MW in 2013, 1 GW in 2014, and more than 2.2 GW by the end of 2017. A first 100 MW of CSP was commissioned in 2014; the total CSP installed capacity at the end of 2017 was 300 MW (Figure 8.4).

Figure 8.4 Phases of development of solar photovoltaic and concentrated solar power in South Africa



21 The government launched Free Basic Electricity in 2003, to help indigent households meet their basic energy needs. It provides an average of 50 kWh per month per household—enough power to provide basic water heating using a kettle, basic ironing, and power for a small television set and radio. One million customers benefit from Free Basic Electricity, according to Eskom's website.

Figure 8.5 Photovoltaic power potential and direct normal irradiation in South Africa



Source: World Bank, 2018c.

Country-Specific Factors Affecting the Development of the Solar Power Market

Market Size and Potential

South Africa has more than 2,500 hours of sunshine a year, on average. It has excellent global horizontal radiation suitable for development of solar PV throughout the country and direct normal irradiation levels in some areas that exceed 3,000 kWh per square meter per year, placing it in among the best places in the world for development of CSP (Figure 8.5).

The draft Integrated Resource Plan released in August 2018 by the DOE proposes technology-specific targets for the development of the power generation mix by 2030. As these targets are meant to govern the allocation of capacity offered to developers in future procurement processes, they represent a de facto cap on the market size. The target for solar PV capacity addition by 2030 is 5.7 GW, which represents a sizable market. The draft plan does not make room for new CSP capacity;[22] only projects currently in operation or at an advanced development stage are considered, bringing CSP capacity to 600 MW in 2030.

Market Structure

South Africa's electricity market is vertically integrated. Eskom is the single buyer and the main counterparty to all electricity trade contracts; direct sales such as from an IPP to large industrial consumers, are not permitted. The government has contemplated unbundling Eskom and establishing a liberalized power market, but the envisaged reforms have not been carried out and are not likely to happen in the near term.

South Africa is part of the Southern African Power Pool (SAPP), which includes 12 countries, 9 of which are interconnected. Grid-connected solar projects are procured exclusively through public competitive tenders, launched under the REIPPPP.

22 This decision seems to be based on the high CSP tariffs recorded up to the REIPPPP round 3.5 in 2014/15. There is scope to revisit this position in the light of the significant reduction in the levelized cost of CSP that has been achieved globally, since then.

Local Financial Market

South Africa has a sophisticated, well-regulated, and established financial sector. Its stock exchange is Africa's largest and is among the top 20 in the world. The total value of all traded shares exceeds the country's GDP, an indication of the high level of liquidity of the market.

In April 2017, two of the three leading credit rating agencies downgraded South Africa's long-term foreign currency rating from investment grade, an indication of a heightened risk of default on the back of sluggish economic growth.[23] The third credit agency, Moody's, affirmed South Africa's investment grade rating in March 2018. The availability of domestic capital within the South African market is robust.

Evolution of the Grid-Connected Solar Market

The first private power generation projects in South Africa, in the early 2000s, were thermal-based. After the privatization of the 600 MW Kelvin coal-powered plant in 2001, the DOE initiated a competitive process to procure 1,000 MW of peaking capacity in 2004. The process encountered challenges, and the plants were commissioned only in 2015 and 2016.[24] Between 2007 and 2009, in a context of sharp imbalances between demand and supply, Eskom launched several ambitious competitive IPP procurement programs for thermal power. Success was limited, with a total of 373 MW thermal power capacity procured in 2011 from six IPPs—much less than the several GW targeted.[25]

Lack of capacity to run large, sophisticated procurement programs, as well as potential conflicts of interest between Eskom's power generation ambitions and its role as power purchaser and transmitter, partly explain the difficulties these first procurement programs encountered. In addition, the corresponding framework was not fully operational. Only in 2006 did South Africa start to put the necessary regulations for independent power generation in place. In 2009 it issued guidelines for the competitive procurement of IPPs.

Policy interest in renewable energy started in the late 1990s and early 2000s. In 2003 South Africa released the Renewable Energy White Paper, which recognized the potential for utility-scale, grid-connected CSP; PV was considered only for off-grid applications, because of its prohibitively high cost at that time.

In 2008–09 the policy began to translate into procurement mechanisms. Amid growing concerns about CO_2 emissions, the DOE prepared the first Integrated Resource Plan 2010–2030, which introduced clear, time-bound targets for the development of solar power. In 2009 the regulator, NERSA, published a feed-in tariff for renewable power.[26] At the time, many countries were implementing feed-in tariff schemes. Private developers interpreted both the feed-in tariff and the Integrated Resource Plan as strong signals that the South African market for solar was about to open.

In the context of rapidly decreasing prices for several renewable energy technologies, the feed-in tariff concept quickly became obsolete, and no capacity was procured under that scheme. In 2011 the DOE announced that renewable energy IPPs would be procured through competitive bidding and initiated the REIPPPP. Projects would be selected mainly on the offered price per kWh, but other criteria were also considered (Box 8.1).

The REIPPPP drew lessons from early attempts at procuring thermal IPPs. In particular, the program offered adequate risk allocation arrangements, materialized through a strong standard contractual package. It also introduced a guarantee mechanism on payments, which addressed concerns of the private sector regarding the creditworthiness of Eskom.

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23 According to the South African Reserve Bank, the impact of the downgrades on financial markets was fairly muted, as reflected by movements in domestic government bond yields, the currency, and the sovereign risk premium (SARB 2017).

24 Only two firms bid on the project in 2007. Negotiations with the preferred bidder (AES) broke down in 2008; they resumed with the other competitor (GDF Suez, now Engie). A deal was signed in 2013. The 335 MW Dedisa Peaking Power plant came on line in 2015. The 670 MW Avon plant came on line in 2016.

25 The IPPS signed five-year PPAs signed under the Medium-Term Power Purchase Program (MTPPP). The PPAs have since been renewed.

26 The tariff published in 2009 offered US$0.49 per kWh for PV and US$0.26 per kWh for CSP. In comparison, Germany's feed-in tariff for ground-mounted solar at that time was about US$0.4 per kWh, albeit in the geographic context of a much weaker solar resource.

Box 8.1 Procurement by independent power producers in South Africa

Under the REIPPPP, procurement rounds (bidding windows) are launched at regular intervals. The competition is technology specific, with caps on the total capacity to be procured in each round for each technology. The capacity offered is determined by ministerial determinations issued by the Department of Energy, in line with the needs for new generation capacity identified in the Integrated Resource Plan.

Projects are selected based on the offered price per kWh (70 percent of the evaluation, subject to a price cap) and on economic development criteria (30 percent of the evaluation), which include considerations of local content, job creation, the participation of people previously in top management, the contribution to socioeconomic development, and so forth.

To implement the program, an ad hoc unit, the IPP Office was created, with experienced staff seconded from the National Treasury and the Department of Energy. The IPP Office also had access to high-quality private advisory assistance, which it drew on to design the bidding process. Advisers also drafted standardized agreements that define the relationship among parties. These documents provide that the government stands behind Eskom in the event of late or nonpayment. To minimize the corresponding liability for the government, a specific arrangement is concluded with Eskom and NERSA that allows Eskom to include in its tariff an allocation to cover payments to IPPs, hence ensuring that the off-taker has sufficient funds to honor its obligations toward the seller. Box Table 8.1.1 provides an overview of the REIPPPP on grid-connected solar.

Box Table 8.1.1 Outcomes of the REIPPPP for solar projects

Bidding window	Solar PV		CSP	
	MW	Number of projects	MW	Number of projects
1	627	18	150	2
2	417	9	50	1
3	435	6	200	2
3.5			200	2
4	813	12		
Total	2,292	45	600	7

All the projects selected in bidding windows 1, 2, and 3, and one of the two in bidding window 3.5 reached financial closure rapidly after being selected; most are now operational. After two years of delay, the remaining ones saw their PPAs signed in April 2018.

Adapted from Eberhard and Naude 2017; DoE 2018.

Several procurement rounds (bidding windows) took place under the REIPPPP from 2011 to 2015. They resulted in a total of more than 2.3 GW of grid-connected PV projects and 600 MW of CSP projects. Most of these projects achieved financial closure 9–12 months after being awarded and are now in commercial operation or at an advanced stage of construction. According to project developers and financiers, the program introduced a clear, transparent, and efficient procurement process that all stakeholders viewed as open and fair.

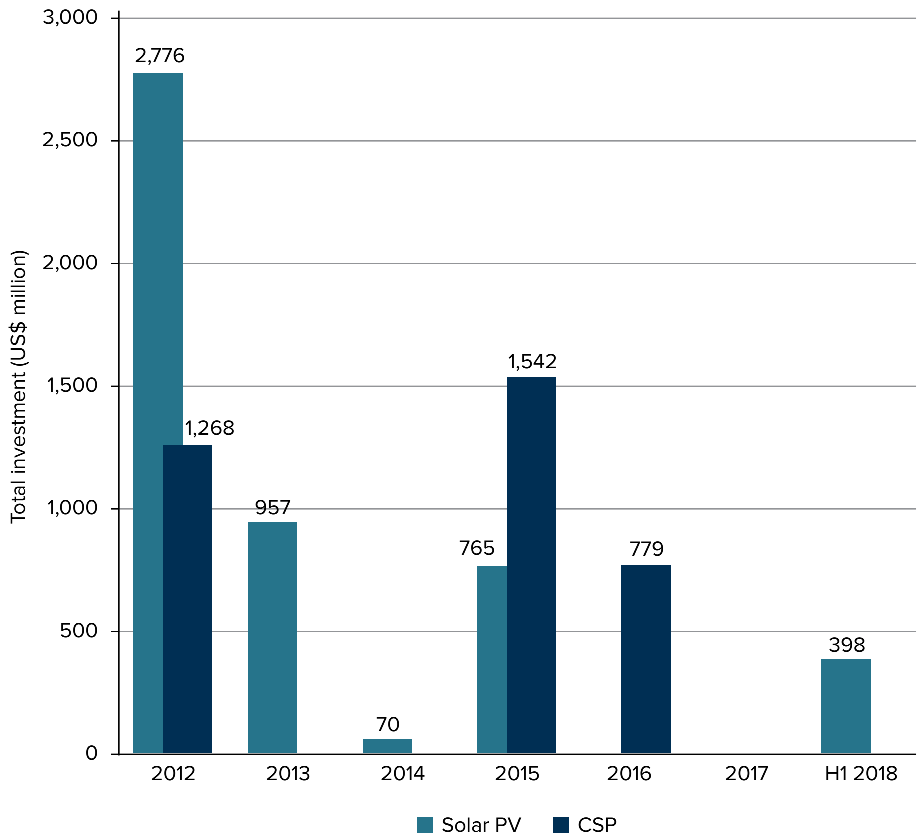
The technology-specific nature of the program also ensured that CSP projects succeeded, even where its price did not decline as rapidly as that of solar PV. A specific time-of-day tariff mechanism was introduced in the 2013 procurement round. Electricity generated during peak hours (4:30–9:30 P.M.) was remunerated at a rate equivalent to 270 percent of the base rate. This feature acknowledged the value of the dispatchability of CSP and its ability to cover evening peaks by using thermal storage. It has proven an innovative instrument to foster the inclusion of storage and promote CSP.

Projects selected in the initial procurement rounds quickly moved forward, but projects selected in 2014 and 2015 saw the signing of their PPA delayed until 2018. Between 2015 and 2017, procurement of renewable IPPs slowed. The delay can be attributed at least in part to the increasing misalignment between Eskom's interests and its obligations as the sole buyer of renewable energy power. In a context of sluggish demand growth, and while Eskom was developing its own generation capacity, the utility has been reluctant to enter into new PPAs. The take-or-pay nature of these PPAs, and the obligation to dispatch renewable in priority, was also considered at odds with Eskom's interest in reducing its overall power generation costs. Recent changes in the political landscape and Eskom's leadership, combined with the developers' acceptance of a PPA rate lower than originally bid, appear to have been instrumental in unlocking the PPA process.[27] The South African government announced the upcoming launch of a new procurement round, suggesting that the REIPPPP process is likely to resume in the near future.

Mobilization of Commercial Finance

Since 2011, 31 solar PV projects and 6 CSP projects have reached financial closure, for a total investment of more than US$8 billion (Figure 8.6). These projects were financed with commercial capital.[28] Large international players (for example, ENEL Green Power, Scatec Solar, and Denham Capital) invested equity in projects, as well as pre-financial close equity during the project development phase. The debt was mostly sourced from domestic commercial banks (including ABSA, the Standard Bank, the Rand Merchant Bank, and Investec, among

Figure 8.6 Commercial investment in grid-connected solar projects in South Africa



Source: World Bank 2018d.

27 In September 2017, the DOE announced that the outstanding PPAs would be signed with renegotiated tariffs of R 0.77 (US$0.059) or lower; the average bidding tariff was R 0.85 (US$0.065).

28 Only one public solar project was initiated over this period, the Eskom 100 MW Kiwano CSP. Despite strong financial support from several international finance institutions and the Clean Technology Fund since 2010, the project was cancelled.

others) reflecting the considerable liquidity and deep experience with project finance of the South African financial sector.

Two public institutions, the Development Bank of Southern Africa and the Industrial Development Corporation, contributed about 10 percent of the total debt. Their role was predominantly to arrange financing to allow previously economically disadvantaged population groups and local communities to acquire shares in the project development companies, which was a requirement outlined in the tender package.

For CSP projects, equity was provided almost entirely by international sponsors. The International Finance Corporation (IFC) and the African Development Bank (AfDB) blended their own resources with concessional funding from the Clean Technology Fund (CTF) to support the first CSP projects. In the 2011 procurement round, KaXu (100 MW) and Khi (50 MW), received concessional financing from the CTF as well as loans from IFC and the European Investment Bank. In 2013, the Xina CSP project (50 MW) was backed by Africa Development Bank, CTF, and IFC funding. Two South African public institutions, the Industrial Development Corporation and the Public Investment Corporation, also provided a significant share of the equity to these projects.

Public institutions, notably international development banks and climate funds, such as the CTF, were more significant in the CSP market than in the PV market. CSP projects in all procurement rounds came very close to the price caps set by the bidding rules. The innovative blended finance structure helped reduce the financing cost, increase market confidence, and attract a diverse group of investors, which facilitated the provision of local currency financing to mitigate the negative impact of foreign currency fluctuation.

Effectiveness of Public Sector Intervention

The grid-connected solar market in South Africa has evolved since the 1990s (Figure 8.7).

Legal, Policy, and Regulatory Framework

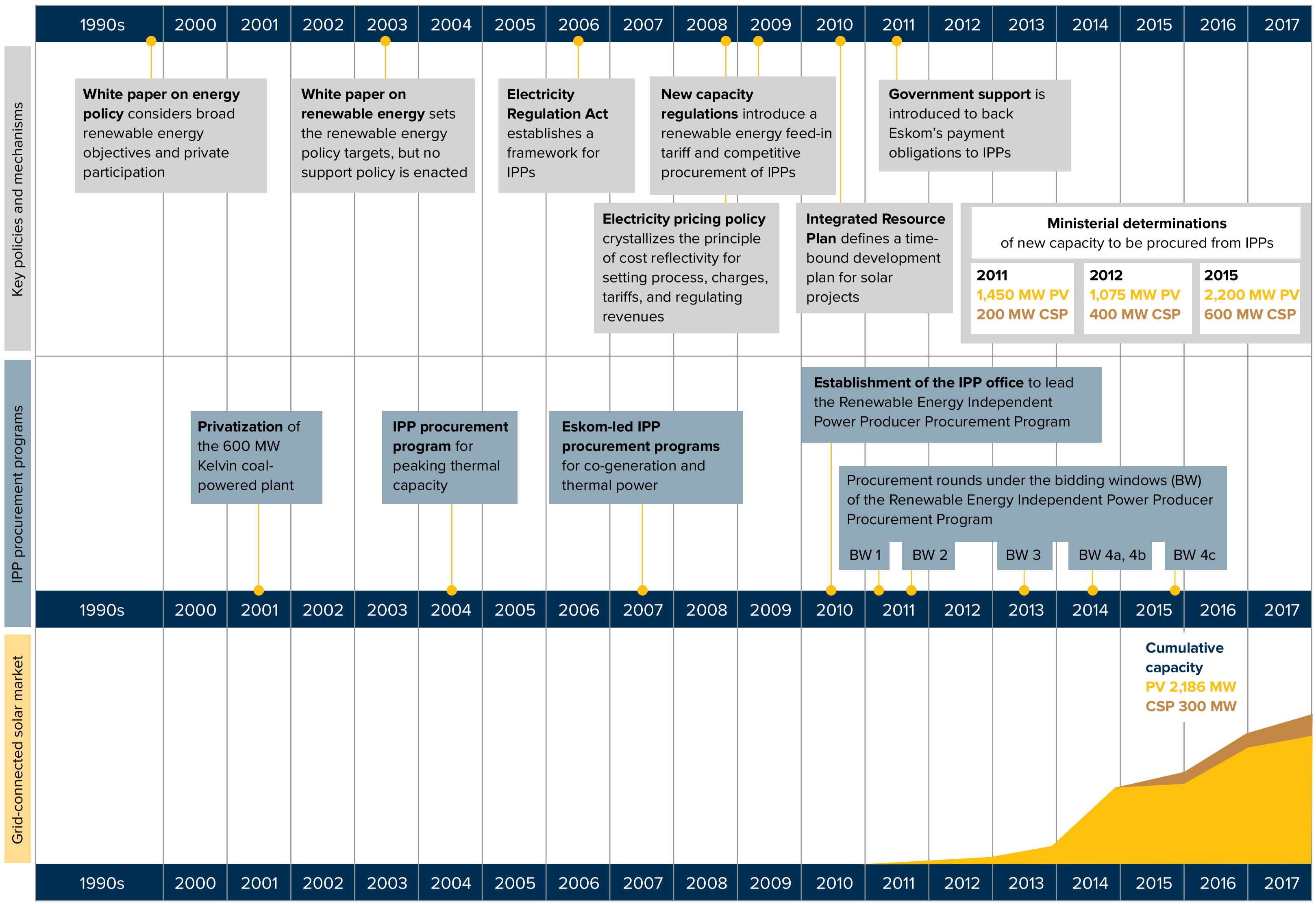
A sound legal framework is in place for the procurement of solar IPPs by the public sector. The 2006 Electricity Regulation Act established a regulatory framework for independent power generation and defined the regulator's role, in particular with regard to issuing licenses. The National Energy Act of 2008 defined the sector-wide planning process, of which the Integrated Resource Plan is an important component. The 2008 Electricity Pricing Policy outlines the guiding principles for the determination of tariffs. The policy specifically determines that the pricing structures for electricity purchases from power producers should be based on either the contractual commitments between the buyer and the seller, or on a regulatory methodology that would enable an efficient operator to recover the underlying cost of providing the electricity services and earn a reasonable margin of return. The 2009 Electricity Regulations on New Generation Capacity, which were revised in 2011, introduced guidelines for the competitive procurement of IPPs. They also enabled Eskom to pass through the cost of power procured from IPPs to its customers. However, the full application of the tariff adjustment mechanism is restricted by the actions of the regulator.

Many observers view the vertical separation of Eskom and the establishment of an independent system operator as the next step required to develop a competitive power generation market (Teljeur et al. 2016). These reforms would help resolve the potential conflict of interest between Eskom's power generation ambitions and its role as off-taker and transmission system operator. A draft law toward that end was presented to Parliament in 2011.[29] The Independent Systems and Market Operator (ISMO) Bill aimed to establish a system and market operator separate from Eskom. It was not enacted.

The processes for obtaining permits are clear and were streamlined under the REIPPPP. The role of the regulator, NERSA, is clearly defined. NERSA has been one of the key players facilitating the rapid deployment of solar,

29 The President of the Republic of South Africa announced a decision to unbundle Eskom into three state-owned utilities in his State of the Nation Address of February 7, 2019.

Figure 8.7 Timeline of public interventions and market development in South Africa



in coordination with other public entities. Conversely, the hurdles experienced by the IPP projects selected in the latest rounds of the REIPPPP, and the two-year delay in signing the PPA, has cast doubt on the reliability of this otherwise well-defined project development framework.

South Africa's grid code was not designed to accommodate variable renewable energy IPPs; amendments to the code remain a work in progress. The code has not been a barrier to the significant scale-up of solar in South Africa, however, as IPPs have managed to reach commercial operations and successfully evacuate power onto the grid.

Planning, Technical, and Operational Capacity

Generation Planning

The National Energy Act of 2008 clearly defines the national generation planning process. The Integrated Resource Plan of 2010 fixes long-term objectives for the expansion of generation capacity. Ministerial determinations were issued, more precisely defining the generation capacity to be developed in the short term and whether it would be done by Eskom or sourced from IPPs.[30] Licenses granted by NERSA cannot exceed the targets fixed by the ministerial determinations. The planning process was implemented smoothly between 2010 and 2015 and was instrumental in allowing the rapid development of grid-connected solar.

The planning process has been on hold for several years. Revision of the Integrated Resource Plan 2010, expected in 2012–13, is still in progress. A draft of the long-awaited revised version was released in August 2018 for public comment. The proposed addition of PV capacity generation to 2030 is 5.7 MW. For CSP, only the projects currently at an advanced development stage are considered; there is no plan for further capacity expansion. Once finalized, this updated document, which governs the procurement of renewable IPPs, will be key to the future development of grid-connected solar.

Land Availability

Land availability is not a barrier to the development of private solar projects in South Africa. Most land is in private hands, and the rules to acquire land are clear. The country has a comprehensive and fully mapped record of land and real estate, which makes it easy to determine property owners and enforce ownership rights.

Grid Integration, Access, and Power Evacuation

Nondiscriminatory access to the grid is defined in Electricity Regulation Act of 2006. Eskom has an obligation to connect IPPs to the grid at the cost of the project developer. In practice, developers taking part in procurement rounds must accept the terms of a nonnegotiable connection agreement and are required to obtain budget quotations for grid connection from Eskom before submitting their bids. These requirements put pressure on Eskom, which had to establish a dedicated unit to cope with the increasing number of connection requests related to the rapid development of renewable energy.

IPPs are required to pay for the connection of their project to the grid (referred to as "shallow" development costs). But the multiplication of renewable energy projects created a need for deeper grid reinforcement. The cost of these reinforcements was not initially anticipated. A 2014 amendment to the grid code now allows Eskom to charge these "transformation" costs to IPPs, but this measure has brought in changes to initial quotations issued to IPPs, leading to unresolved disputes.

The problem is exacerbated by the general lack of alignment of solar and wind developments with Eskom's grid, as developers are entirely free to select their project sites. As a result, the majority of the solar projects are located in the northeastern part of the country, where there is abundant supply of good quality solar resources, while the largest load centers are in the south. This concentration threatens the reliability and the stability of the power systems. A new transmission development planning approach, as well as the introduction of a

30 Between August 2011 and August 2015, three ministerial determinations fixed a total target of 1,200 MW of CSP and 4,725 MW of PV to be procured as IPPs.

Renewable Energy Development Zone (REDZ), have been proposed to help reduce uncertainties regarding the spatial location of future generation plans in relation to the grid.

The addition of variable renewable power requires more flexible grid operation. Eskom acknowledges the need to enhance its renewable energy forecasting abilities and to increase the availability of flexible, dispatchable generation units to respond to variations in renewable energy output (Eskom 2018).

Investment in Enabling Infrastructure

South Africa's targets for the development of wind and solar PV capacities (12 GW and 8 GW, respectively, by 2030) require infrastructure to manage the variability of these resources and successfully integrate them into the national grid. In 2018, Eskom launched a battery storage program. The program aims to enable a higher penetration of variable renewable energy (including solar PV power) by improving the reliability of the power systems through:

- Grid-connected batteries and substations close of the location of the non-dispatchable plants in the Northern Cape; and
- Technical assistance to support the final design, procurement and supervision of energy storage infrastructure, strengthen Eskom technical capacity in sustainable operation and maintenance of large-scale batteries, and prepare the enabling environment for further private investment in variable renewable energy capacity using storage.

When completed, the program is expected to deliver at least 1,440 MWh of storage per day. It is co-financed by a US$655 million package provided by the World Bank, the African Development Bank and the Clean Technology Fund (World Bank 2018e).

Direct and Indirect Financing

All grid-connected IPPs have been financed on a commercial or quasi-commercial basis, where concessional and commercial funding were blended to offer an attractive financing package. The early involvement of development finance institutions in the first two South African CSP projects also helped establish a track record that facilitated the mobilization of private financing to the next generation of CSP projects. The participation of South African public financing institutions reinforced local ownership and helped ensure local buy-in. According to private developers and financiers, the participation of international development institutions in CSP projects helped build sponsors' and investors' confidence, given the complexity of the projects. Furthermore, it attested to the quality and bankability of individual projects and was seen as guaranteeing government support and fair treatment by local authorities.

The 2009 Electricity Regulations on New Generation Capacity allows Eskom to pass on the cost of power procured from IPPs to its customers. IPPs selected between 2011 and 2013 sell energy to Eskom at an average tariff of US$0.10–0.35 per kWh for PV and US$0.17–0.34 per kWh for CSP. The difference between these tariffs and Eskom's average generation cost of about US$0.03 per kWh is passed through to Eskom's customers.

Government-Sponsored Guarantees

Off-Taker Creditworthiness

The creditworthiness of the off-taker is a cause for growing concern. In the early 2000s, Eskom's credit rating was higher than the rating of the government. Since 2008 it has continuously deteriorated. In February 2018, Standard & Poor's downgraded Eskom's long-term corporate credit ratings to CCC+, which implies that in the event of adverse business, financial, or economic conditions, the utility is unlikely to have the capacity to meet its financial commitments.

The fundamentals of Eskom's revenues and expenses point to further deterioration. Sluggish economic growth combined with the effect of energy efficiency efforts have resulted in a decline in power consumption. Eskom's revenues are also constrained by the fact that it has not been able to obtain the full tariff increases it requested. Moreover, as the cost of coal has continued to increase, the utility's fuel expenditures are expected to grow.

Construction of three large power stations (Ingula, Medupi, and Kusile), with significant delays and cost overruns, has further degraded Eskom's financial situation.

Guarantees

In the context of Eskom's deteriorating credit rating, a key factor explaining the rapid deployment of solar and other renewable energies in South Africa was the support provided by the government. Instead of a traditional government guarantee, the DOE committed to backstop the payment obligations of Eskom under the PPAs through specific provisions of the implementation agreement signed with the winning bidders. The support mechanism was laid out in the Guarantee Framework and Support Agreement (GFSA) between the government and Eskom. It allowed Eskom to raise domestic debt financing to support its capital expansion program. This mechanism, which was systematically used for all projects, provided the necessary comfort to allow project developers to achieve financial closure within 9 to 12 months of the signing of the commercial agreements.

The ability of the government to continue providing the same level of support, and its attractiveness to the private sector, appears questionable, however, as South Africa's credit rating has continued to decline. Over the long run, this deterioration could reduce the appetite of international investors. At the moment, the situation does not appear to significantly deter international investment in grid-connected solar—and the continued availability of domestic debt should somewhat alleviate this concern.

Summary

Table 8.2 assesses the effectiveness of public sector initiatives in attracting commercial investment in the grid- solar market.

Key Findings and Take-Aways

South Africa's experience with the development of grid-connected commercial solar projects has been a success. Since 2011, 31 solar PV projects and 6 CSP projects have reached financial closure, for a total investment of more than US$8 billion. Total PV capacity was 2.2 GW by the end of 2017, and CSP capacity reached 300 MW.

This success was in part made possible by preexisting factors: a business environment that is generally conducive to private investment, with a strong, liquid local banking sector; an enabling legal framework that allowed private participation in power generation as well as foreign ownership; and a well-developed private land market. The quality of the country's solar resource, among the best in the world, and the size of the potential solar market (estimated at 30 GW for CSP and 40 GW for PV) were also powerful factors explaining private developers' interest.

In this favorable context, a well-designed competitive procurement process, combined with the government support to back Eskom's off-take obligations unlocked the commercial grid-connected solar market and opened the door for participation by international developers with considerable experience and capacity. The efficient design of the bidding process as well as the high quality of the contractual documents, which reflect a deep understanding of the private sector's perspective, helped ensure a high response rate to the tenders. However, the rapid deployment of solar PV led to unanticipated investments to alleviate network constraints and maintain the stability of the power system.

Over the short-to-medium term, the public sector needs to invest in grid and power systems infrastructure. Large-scale grid-connected batteries are yet to reach commercial viability and require concessional and public financing to offset their high up-front cost. The Eskom battery storage program is expected to foster a greater penetration of variable renewable energy, particularly solar PV, and contribute to the decarbonization efforts. Moreover, storage and ancillary services could be provided through the regional electricity grid, allowing other countries such as Namibia and Botswana, to successfully deploy and integrate solar PV capacity.

Overall, the single-buyer public procurement model was extremely efficient in jumpstarting South Africa's solar market but created bottlenecks in 2015–17. There is now an opportunity to move toward a more liberalized

Table 8.2 Effectiveness of public action in mobilizing commercial capital in South Africa

Public sector action	Description	Legal, institutional, and regulatory framework	Planning, technical, and operational capacity		Investment in enabling infrastructure	Direct and/or indirect public financing	Government-sponsored guarantees
			Generation Planning	Grid integration, access, and power evacuation			
Electricity Pricing Policy (2008)	The Electricity Policy Planning defined the guiding principles for the setting prices, charges, tariffs, and regulation of revenues	✓✓					
Electricity Regulations on New Generation Capacity (2009, 2011)	The Electricity Regulations on New Generation Capacity set the rules for the competitive procurement of independent power producers (IPPs). They allow Eskom to pass through the cost of power procured from IPPs to its customers.	✓✓✓					
Integrated Resource Plan (2010)	The Integrated Resource Plan defines a time-bound development plan for solar and establishes a framework for subsequent procurement of solar power.		✓✓✓				
Creation of the IPP Office and launch of the REIPPP program (2011)	The creation of an independent, ad hoc structure to pilot the Renewable Energy Independent Power Producer Procurement Program (REIPPP) is considered instrumental to the success of South Africa in mobilizing commercial capital.	✓✓✓	✓✓				
Government support to back power purchase agreements (2011)	Government support was introduced to back Eskom's payment obligations to IPPs. The guarantee may be the most important factor in the subsequent rapid development of private solar generation.						✓✓✓
Eskom battery storage program (2018)	Investment and technical assistance for the installation of grid-connected batteries and construction of new substations to facilitate the integration of non-dispatchable solar (and wind) power into the grid	✓	✓✓	✓✓✓	✓✓	✓✓✓	

Note: ✓✓✓: Very effective; ✓✓: Effective; ✓: Not effective.

market structure. Private players are investigating captive solar projects for industrial and commercial consumers, as well as direct sales to municipalities, but this will require an adjustment to the current legal and regulatory framework.

References

DOE (Department of Energy). 2018. Independent Power Projects (database). https://www.ipp-projects.co.za/ProjectDatabase https://www.ipp-projects.co.za/ProjectDatabase. Pretoria.

Eberhard, Anton, and Raine Naude. 2017. *The South African Renewable Energy IPP Procurement Programme: Review, Lessons Learned and Proposals to Reduce Transaction Costs*. Cape Town: University of Cape Town Graduate School of Business.

Eskom. 2018. Integrated Report 2018. http://www.eskom.co.za/IR2018/Documents/Eskom2018IntegratedReport.pdf

IEA. 2018. World Energy Statistics and Balances (database). https://doi.org/10.1787/data-00510-en

IRENA (International Renewable Energy Agency). 2015. *Renewable Energy Auctions*: *A Guide to Design.* Abu Dhabi: IRENA.

NPC (National Planning Commission). 2013. National Development Plan 2030: Our future—make it work. Pretoria: NPC. https://www.gov.za/issues/national-development-plan-2030

SARB (South African Reserve Bank). 2017. Quarterly Bulletin No 284. June. Pretoria: Economic Research and Statistics Department. http://www.resbank.co.za

Teljeur, E., F. Sheik, T. Kolobe, and D. da Costa. 2016. *Electricity Supply Industry Restructuring*: *Options for the Organisation of Government Assets.* Pretoria and Johannesburg: Trade and Industrial Policy Strategies and Business Leadership.

UNDP (United Nations Development Program). 2018. *Human Development Indices and Indicators 2018 Statistical Update.* New York: UNDP.

World Bank. 2018a. World Development Indicators (database). Washington, DC: World Bank. http://datatopics.worldbank.org/world-development-indicators/

———. 2018b. *Doing Business 2018: Reforming to Create Jobs*. Washington, DC: World Bank.

———. 2018c. Global Solar Atlas (database). Washington, DC: World Bank. https://globalsolaratlas.info/

———. 2018d. Private Participation in Infrastructure (database). Washington, DC: World Bank. https://ppi.worldbank.org/data

2018e. *Disclosable Restructuring Paper—South Africa—Eskom Renewables Support Project—P122329 (English).* Washington, D.C. : World Bank. http://documents.worldbank.org/curated/en/390371543618515176/Disclosable-Restructuring-Paper-South-Africa-Eskom-Renewables-Support-Project-P122329

APPENDIX: SURVEY OF PRIVATE INVESTORS

Description of Survey Respondents

A survey conducted for this report collected country-specific data related to factors that drive investments in on-grid solar projects, the perceived effectiveness of financial risk mitigation interventions, and the importance of nonfinancial public sector actions in developing the market. It was sent to 362 potential respondents, who could complete it online between December 18, 2017, and March 15, 2018. Fifty-one participants completed the survey, providing 61 country-specific responses. Figures A.1–A.3 describe the respondents.

Figure A.1 Typology of respondents

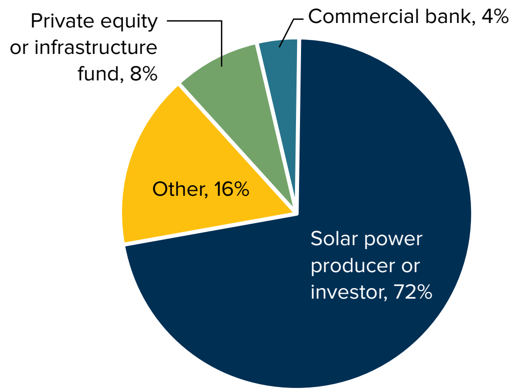


Figure A.2 Grid-connected solar capacity managed by respondents

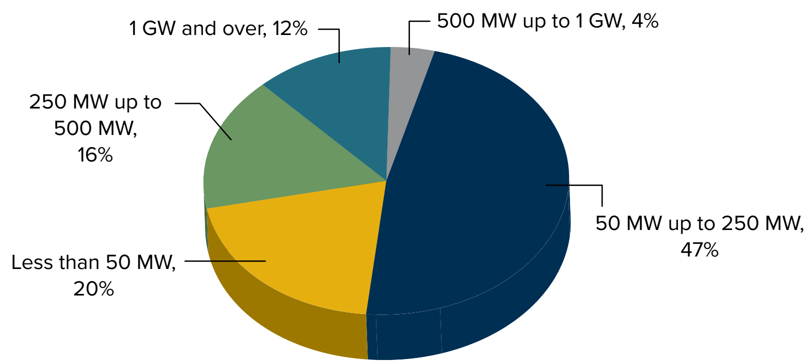
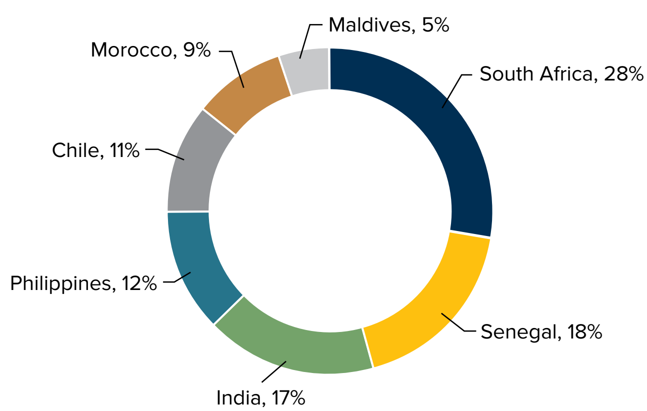


Figure A.3 Country-specific survey responses



Survey Questionnaire

Part I Commercial Capital Investment Drivers

What has been the relative importance of the elements listed below in your decision to pursue an investment opportunity in [selected country], whether or not it resulted in actual investment?

- Renewable energy generation targets included in country national and sector policies
- Power generation planning accounting for solar projects
- Existing or planned power evacuation lines
- Clear legal framework for private sector investment in the renewable energy projects
- Clear regulatory framework (including licensing and permitting)
- Capacity of the grid operator to manage variable sources of energy
- Track record of honoring payments for power purchased
- Availability of project financing in local currency
- Robust procurement and market mechanisms (for example, feed-in tariff, auctions, tenders)
- Availability of suitable land or rooftop as applicable
- Grid-connected solar projects in operation in the country

Part II Financial Public Sector Interventions

Do you consider the following elements to be critical to your investment decision in [selected country]?

- Project derisking through government financing of up-front development cost
- Direct financing of infrastructure (for example, equipment, civil works) by the government
- Payment guarantee for power purchased
- Credit guarantee for commercial debt
- Political risk insurance (for example, covering terrorism, expropriation, currency inconvertibility)
- Fiscal incentives (for example, exemption or rebate on imported goods, corporate tax)
- Indexation of power purchase revenues to hard currency (for example, euro, US dollar)
- Tariff subsidy mechanism

Part III Nonfinancial Public Sector Interventions

Based on your specific experience, how would you rate the importance of the elements listed below in attracting commercial financing for grid-connected solar project in [selected country]?

- Power generation master plan accounting for solar power development
- Development of solar parks
- Bankable standard project agreement templates (for example, PPA, concession agreement, and so forth)
- Robust power dispatch capabilities of the grid operator including adequate tools and systems to manage variable renewable energy
- Grid integration study confirming grid absorption capacity of variable renewable energy
- Grid code defining technical and operational specifications for connection to the grid
- Technical assistance to improve regulatory and licensing regime for private sector investment
- Technical assistance to improve the operational and financial performance of the state-owned power utility

Aggregated Survey Results

Figure A.4 Drivers of commercial investment in grid-connected solar power according to private investors

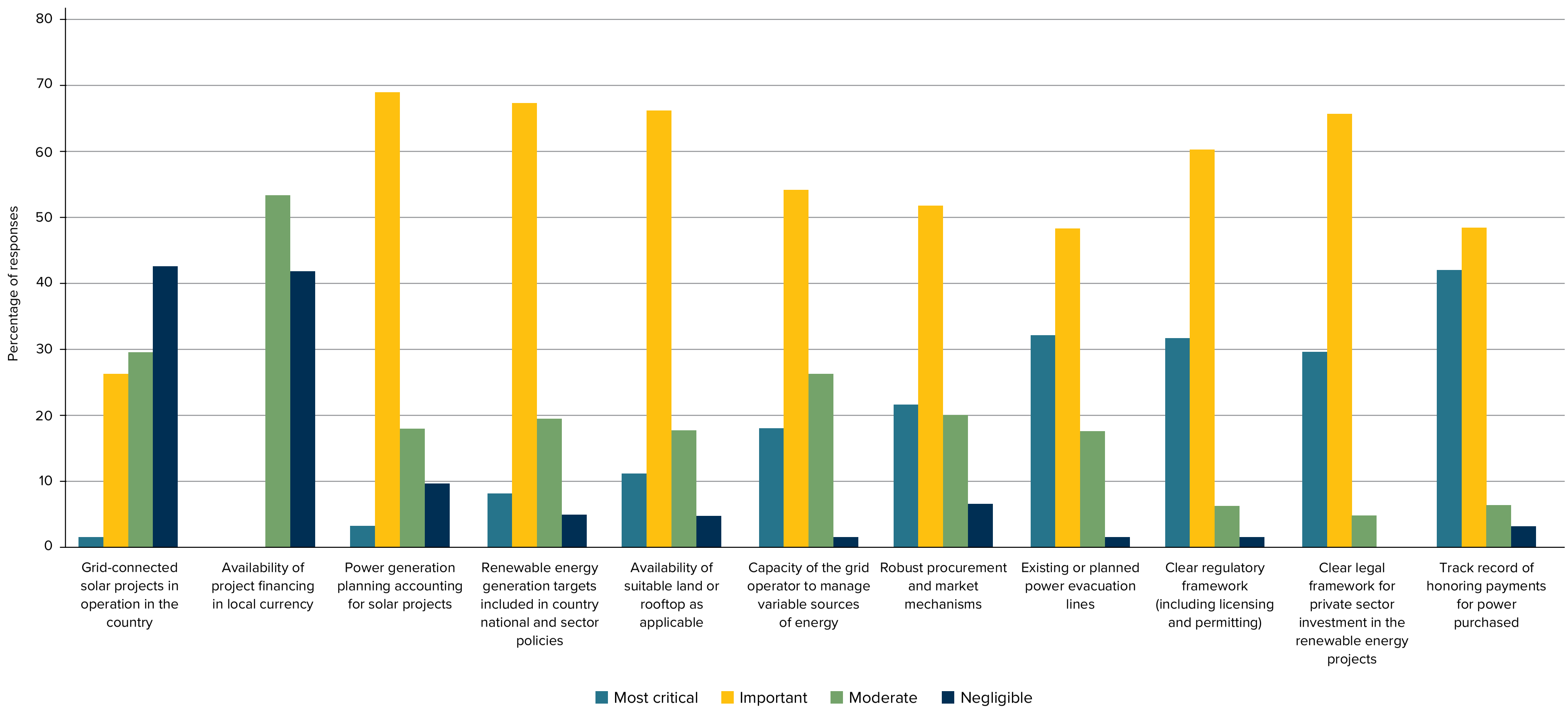
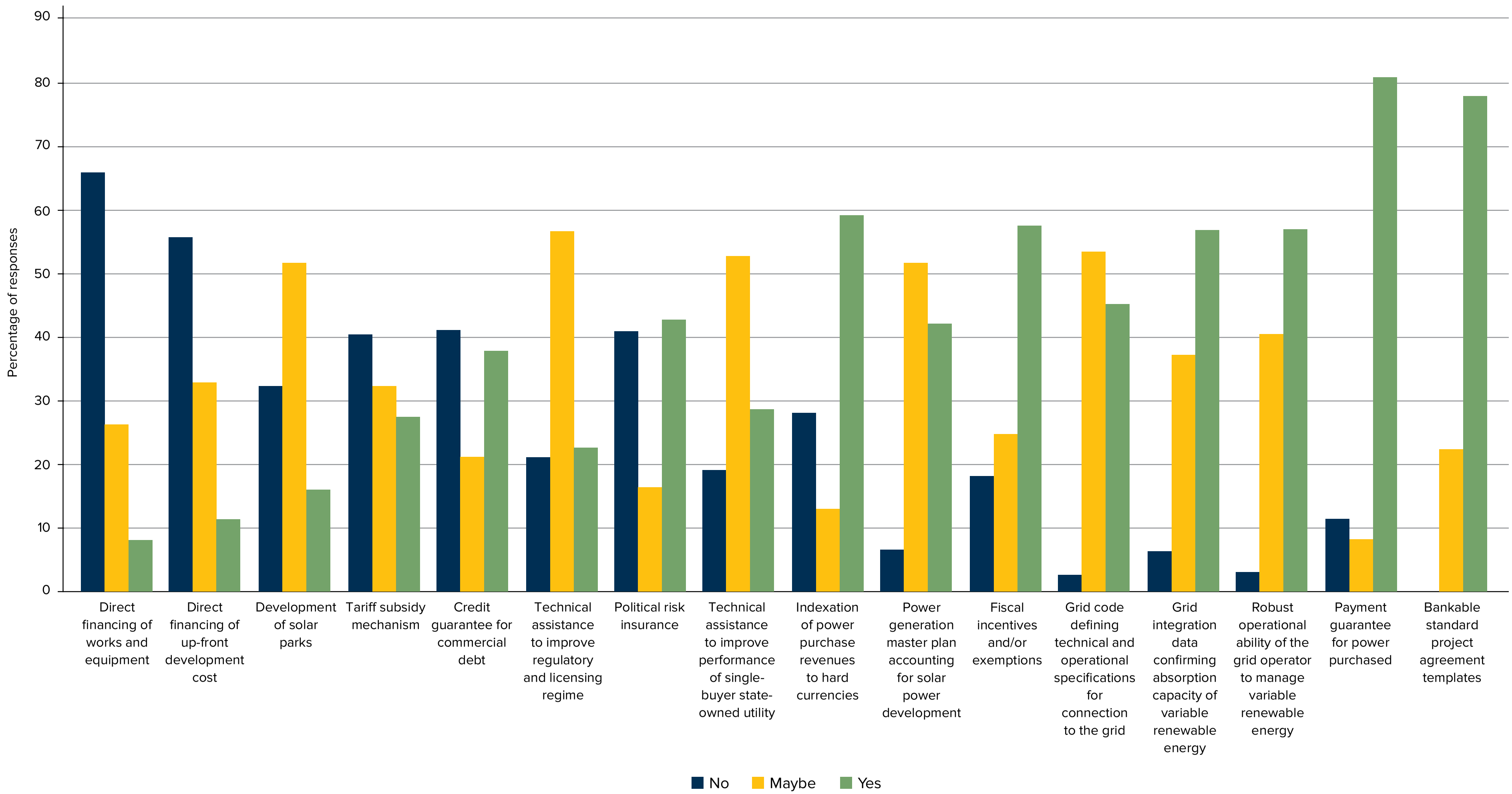


Figure A.5 Public sector interventions needed to leverage commercial capital according to private investors



GLOSSARY OF TERMS

Auction (or competitive bidding process): Selection process designed to competitively procure (or allocate) goods and services in which the award is made to a prequalified bidder based on a financial offer. In the most common type of auction, potential buyers bid for a product, and the highest bid price wins. In electricity auctions, the bidding process is designed to select the lowest price. In this "reverse auction," the lowest bidder is the winner.

Concessionality: Implied subsidy embedded in a concessional loan. It is commonly measured by its grant element, the difference between a loan's nominal (face) value and the present value of the sum of the discounted future debt service payments to be made by the borrower.

Curtailment: Involuntary reduction in the output of a power generator, typically because of system dispatch constraints.

Demand-side response: Wide range of actions that can be taken on the customer side of the electricity meter in response to particular conditions within the electricity system (such as peak period network congestion or high prices).

Feed-in tariff: Pricing support mechanism offering a fixed payment to renewable energy producers, per unit of energy generated and injected into the electricity grid.

Fiscal incentive: Economic incentive that provides individuals, households, or companies with a reduction in their contribution to the public treasury via income or other taxes, or with direct payments from the public treasury in the form of rebates or grants.

Government-sponsored guarantees: Legally enforceable undertaking given by a government or on behalf of a government that binds the government into providing the specified resources if the risk events contemplated under the guarantee occur.

Levelized cost of electricity: Constant unit cost of electricity per kWh of a payment stream that has the same present value as the total cost of building and operating a power plant over its useful life, including a return on equity.

Marginal cost of production: The marginal cost of production is the change in total cost that comes from making or producing one additional item.

Market-based instruments or price-based mechanisms: Policy instruments that use markets, price, and other economic variables to provide incentives.

Net metering: Regulated arrangement in which utility customers who have installed their own generating systems pay only for the net electricity delivered from the utility (total consumption minus on-site self-generation).

Off-taker: Purchaser of electricity generation output.

Power purchase agreement: Legal contract between an electricity generator (the project developer) and a power purchaser (the government, a distribution company, or any other consumer).

Renewable portfolio standard: Quota-based policy that mandates that electricity suppliers procure a given proportion or share of energy produced from renewable energy sources.

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