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

Lessons from Seven Developing Countries

WORLD BANK GROUP

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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.

This report is the first chapter of *“The Role of the Public Sector in Mobilizing Commercial Finance for Grid-Connected Solar Projects: Lessons Learned and Case Studies,”* that comprises the case studies that have supported the analysis.

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

AfDB	African Development Bank
ASPIRE	Accelerating Sustainable Private Investments in Renewable Energy
CIF	Climate Investment Funds
CSP	concentrated solar power
CTF	Clean Technology Fund
EUR	Euro
FIT	Feed-in tariff
GW	gigawatt
IBRD	International Bank for Reconstruction and Development
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IPP	independent power producer
kW	kilowatt
kWh	kilowatt hour
MASEN	Moroccan Agency for Solar Energy
MW	megawatt
MWac	megawatt alternative current
MWh	megawatt hour
ONEE	Office National de l'Electricité et de l'Eau Potable
PPA	power purchase agreement
PV	photovoltaic
REIPPPP	Renewable Energy Independent Power Producer Procurement Program
SREP	Scaling-Up Renewable Energy Program
US\$	United States Dollar
VRE	variable renewable energy

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 represents the three pillars and the five forms of public support of the analytical framework.

Figure 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 presents specific examples under each of these categories and lists the case studies where these interventions have been relevant.

Table 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	<ul style="list-style-type: none"> • 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) 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Credit guarantees • Payment and liquidity guarantees • Indemnity agreements • Other payment security mechanisms 	<ul style="list-style-type: none"> • 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 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.

Table 2 Evolving scope of public interventions with the penetration of variable renewable energy

	Penetration of variable renewable energy (VRE) in local power market		
	Inception	Ramp-up	Saturation
	First set of plants have insignificant impact at overall system level; effect is barely noticeable.	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.	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 ^c			
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

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 2.

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.

Figure 2 Relevance of public support for VRE grid integration and operational capacity of the grid operator according to private investors

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 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 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.

Figure 3 Importance of adequate land and power evacuation infrastructure according to private investors

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).

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 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 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 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

Table 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

Figure 4 Importance of legal and regulatory frameworks for private investment in renewable energy according to private investors

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 has 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 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 Solar² 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 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.

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

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; preapproved indicative terms for financing, guarantees, and insurance; and legal, technical, and financial advisory services to support governments from project preparation to contract award.

Figure 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.

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).

Table 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

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 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 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.

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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 operational ability 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 attract commercial capital according to private investors