INTERNATIONAL SOLAR ALLIANCE

CATALYTIC FINANCING FOR SCALING-UP SOLAR IN SOUTH ASIA

Bangladesh | Bhutan | India | Maldives | Nepal | Sri Lanka

Country Insights and Blueprint of Financial Interventions

FOREWORD

The International Solar Alliance (ISA) in collaboration with the Asian Development Bank, proudly presents this comprehensive report on the Development of Catalytic Finance for Scaling Solar in South Asia. This document explores the financial interventions necessary for larger solar energy penetration in six South Asian countries: Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka. It captures the dynamic landscape of solar adoption, highlighting emerging solar energy segments and the key challenges faced, while addressing the financing needs of the sector thus, providing crucial interventions through the influx of catalytic capital for solar into the countries.

Solar energy offers a strong roadmap towards a low-carbon, robust, and inclusive global energy ecosystem. Globally, solar installations are projected to reach 10 TW by 2030, and potentially scaling up to 60 TW by 2050. Achieving this ambitious goal requires an innovative financing mechanism, greater private sector participation, and patient capital from all financing stakeholders. To enable this, catalytic financial interventions are crucial to mitigate the risks for the private sector participants and to build an enabling ecosystem for enterprises, governments, and consumers.

In this journey of solar deployment, the South Asian region holds the potential of 938 GW of solar capacity development, of which only about 3.8% has been realised thus far. Given that this region is also home to about a quarter of the global population, the impact of solar energy deployment on global energy is profound. With approximately about 80% of the energy production in the region comings from fossil fuels and the power generation sector accounting for 68% of the emissions in the region, highest amongst all sectors, the need for an accelerated solar energy deployment in the region is immense.

Based on the assessment of the six south Asian countries, it is imperative for scaling solar deployments driven by coherent policy measures and government support, amounting to a declared cumulative target of nearly 67 GW. However, this endeavour requires a massive capital influx estimated at around $60 billion. While the private sector investment will be predominant in project development it falls upon the development agencies, bilateral and multilateral financing institutions, and public agencies to derisk the sector. Therefore, the catalytic measures for financing provided in this report become crucial for the advancement of solar sector in the South Asian region.

As the ISA, we continue to support the government of six South Asian Countries, drive policy advocacy, develop innovative financing measures, and champion the cause of solar deployment. Our commitment to making solar energy accessible to all remains unwavering. We extend our gratitude to all the National Focal Points (NFPs) of the participating countries, ISA partner Asian Development Bank, consultants and all stakeholders contributing to this collective endeavour.

Dr Ajay Mathur
Director General, ISA

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Multiple countries in South Asia have made ambitious net zero targets to address climate change, including Bangladesh's proposal for 2050 and India's commitment for 2070. This calls for accelerating the clean and renewable energy transition. The region has immense renewable energy prospects, especially for solar energy which holds a potential of 939 GW.[1] However, only 3.8% of the total potential has been developed so far.[2]

Several critical barriers exist to solar energy development in the region. Key challenges, across stakeholder groups, include:

- **Enterprises**
  - **High upfront Capex:** financial institutions tend to offer high cost and short-term finance, posing challenges for solar developers in managing high upfront capital requirements with low or no project margins.
  - **High working capital needs:** for large-scale deployment of solar energy, especially in the utility-scale, C&I rooftop solar and floating solar segments, the need for working capital is high and makes access to affordable and viable finance a key challenge.
- Projects
  - **Lack of assured returns:** self-sustainability of funding and business models is yet to be established for certain segments in certain countries, such as floating solar in India or rooftop solar in Sri Lanka; this leads to uncertainty on commercial returns for developers and investors.
  - **Reluctance among lenders:** financiers perceive solar projects as high risk due to uncertainties in project commissioning, lack of bankable projects, lack of sectoral knowledge and experience of financiers, and limited capacity to conduct due diligence.
  - **Generation and asset risks:** solar projects are typically located at distant locations that require a strong infrastructure to handle variable power generation and ensure a stable and reliable electricity supply and even though the region's ability to integrate solar generation into the existing transmission network has grown, grid unavailability remains a key concern. Limited transmission capacity and delays

1 One Sun, One World, One Grid: Energy Integration in South Asia, SAREP, December 2022
2 Ibid.

in upgrading and building transmission lines impede the solar power off-take.

- **Ecosystem**
  - **Inadequate policy initiatives:** the region faces an overall lack of established and segment-specific technical standards and regulations for promotion and development of solar energy; further, there are limited incentives and multiple permissions required in certain countries for solar-powered installations that act as a deterrent.
  - **DISCOM reluctance:** this is the primary cause for slow up-take of rooftop solar, comprising delays in approvals and installations; it can be attributed to either reluctance to part with C&I consumers, who typically pay high electricity tariffs to DISCOMs and/or existing financial crisis of DISCOMS.
  - **Low consumer awareness:** although consumer awareness has been increasing, there continues to be a lack of understanding of the benefits of solar-energy installations, subsidies, and technologies amongst consumers resulting in poor sub-optimal uptake.

KEY OPPORTUNITIES FOR FINANCING INTERVENTIONS

While multiple challenges exist, the impact and investment opportunity for solar-powered energy generation in South Asia remains high. Key opportunities, across stakeholder groups, include:

- **Enterprises**
  - Equity investments to encourage and undertake proof of concept and support innovation and technological disruption by solar enterprises in the region.
  - Equity investments in early and growth-stage enterprises could help develop a pipeline of >10MW rooftop solar and 50 MW of floating solar installations.
- **Projects**
  - Debt capital to government-owned financial institutions for on-lending to project special purpose vehicles (SPVs) and/or project financing for installation of mid- to large-scale solar parks/hubs and floating solar projects.
  - Debt capital, especially in local currency and at concessional rates, could enable financing for projects with aggregated C&I rooftop solar with cumulative capacity of over 10 MW.
- **Ecosystem**
  - Combination of investment funding with technical assistance could provide the needed handholding support for effective policy development on pertinent topics such as, project preparation, technical and feasibility studies, standardized competitive bidding process, technical standards, net metering policies and implementation, and tax incentives, among others.
  - Training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria could increase credit deployment due to improved technical and commercial understanding of the sector.

STRUCTURE OF THE REPORT

As part of this report, the focus is on six countries of South Asia, namely Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka. The report deep dives into the solar sector of each country and relevant segments therein. For the overall sector and at each segment-level, landscape analysis and investment assessment are undertaken which includes the current status, solarization potential, investment needs, and key challenges.

This is followed by catalytic financing recommendations for addressing the challenges and accelerating solar energy deployment in the countries and region at large. Taking the approach of a Catalytic Financing Facility for Solar in South Asia (CFFSSA), the report elaborates on the overall framework, composition, investment economics and theory, use case, and share across segments and instruments. It also includes a detailed roadmap for the deployment of funds customized for each country and segment. This includes, nature of financing, financing recipient,

instruments, purpose and expected outcomes. The report concludes with key impact areas through the envisaged financing facility.

KEY COUNTRY FINDINGS AND RECOMMENDATIONS

- Bangladesh

Renewable energy accounts for a low share of only 4.53% (1,179.13 MW) of the total power generation mix in Bangladesh. Solar energy accounts for a significant 80.2% (945.06 MW) share of renewable energy; however, forms a meager 3.6% of the total installed capacity. Bangladesh demonstrates high solarization potential and is the most cost-effective among all other renewable energy technologies. The total potential capacity for solar energy in Bangladesh stands at 240 GW. To exploit this potential, the government aims to install renewable energy capacity of 3,864 MW by 2041. Solar energy would account for 50% of the targeted renewable energy capacity for 2041.

Three key solar segments emerge as focus areas demonstrating critical solarization potential for Bangladesh: (i) Solar Park; (ii) Rooftop Solar; (iii) Productive Use of Solar. Combined, the three solar technologies present a capacity potential of 9.5 GW requiring USD 8.63 billion. However, despite the huge potential, scale has not been achieved due to a host of financing, technical and policy challenges. Key barriers include lack of long-term finance, limited domestic funding options, obsolete grid and transmission infrastructure, inadequate energy storage policy, and lack of regulated tariffs and competitive bidding process.

To address the barriers, the facility proposes to combine concessional capital with risk mitigation measures and capacity building to enable commercial viability of solar deployment. The fund would use catalytic capital from public or philanthropic sources to increase private sector investment towards solar energy in Bangladesh. The fund envisages blending of different types and sources of capital. This would allow for increased access to low-cost capital across the key stakeholder categories in the solar ecosystem of Bangladesh – commercial financial institutions, solar enterprises, government agencies. Public or philanthropic investors would provide funds on below-market terms i.e., concessional capital to lower the overall cost of capital. They would also provide guarantees offering an additional layer of protection to private investors, thereby enabling commercial credit enhancement to solar enterprises.

- Bhutan

At present, over 99% of Bhutan's installed capacity comes from hydropower. However, its generation is heavily susceptible to variation in rainfall patterns and the impacts of climate change. Further, there is a substantive increase in energy demand during winter months with peak power demand. Currently, Bhutan is meeting this demand by importing mostly coal-based power from India. This is impacting both self-reliance for internal energy demand and Bhutan's carbon negative status. Hence, the Government of Bhutan (GoB) is looking to develop alternate sources of renewable energy focusing on solar and wind energy.

Solar radiation in Bhutan varies from 1,600 to 2,700 kWh/m2/year, giving it a high solar potential. The DRE–MOEA, Bhutan estimated theoretical solar potential at 6 terawatts (TW) and restricted technical solar potential at 12 GW. While the theoretical potential of 6 TW of Bhutan is based on the solar irradiation in the entire country, the technical potential is restricted to 0.2%, considering only regions with optimum infrastructure for solar deployment. This potential could be harnessed for average annual photovoltaic production of 91 GWh DC and 81 GWh of AC. Under its Alternate Renewable Energy Policy (AREP), Bhutan plans to install 5 MW of solar power capacity, which is under consideration to be increased to 500 MW by 2025 and further to 1 GW by 2034. The AREP also offers substantial incentives like import duty and sales tax exemptions on imported plants and equipment, customs duty exemption for purchase of spare parts for renewable energy projects and allows reinvestment as tax deductibles.

Bhutan requires approximately USD 650 million considering its target of 500 MW for scaling solar power by 2025 and further USD 40-45 million considering development of floating solar projects of 40-42 MW capacity. Grants from partner countries and development financial institutions (DFI) are the current primary financial instruments for financing. Currently, private sector in Bhutan lacks the capacity to finance 1 MW or greater capacity projects. Larger projects require funding by a consortium of local banks as individual banks may not have the requisite capacity.

The Catalytic Financing Facility for Solar will be focusing on promoting deployment of capacity across the three key segments of ground mounted utility scale solar, floating solar, and rooftop solar projects. The facility, apart from providing concessional debt and grant, also envisages providing payment guarantee, first loss facility for risk mitigation of lenders and project developers. Further, the technical assistance facility proposed under this fund will be helpful in bringing policy level support, conducting technical feasibility studies, and capacity building of various stakeholders in Bhutan.

- India

Solar energy is one of the fastest growing segments of renewable energy growing from 2.8 GW in 2016 to 71.7 GW in August 2023. Utility scale solar has been key in propelling this growth. The current installed capacity of utility scale solar stands at with an installed capacity of 55.52 GW. Other key solar segments driving growth in the sector include rooftop (11.08 GW), off-grid solar (2.63 GW) and hybrid-solar (2.55 GW). Further, there is immense potential for floating solar. The operational capacity of floating solar stands at around 300 MW while 1.8 GW capacities are at different stages of development.

Even though the solar sector has grown significantly in the past decade, potential solar segments including rooftop and floating solar segments are yet to attain scale. The rooftop solar is crucial for improving the quality of power and meeting the growing demand for electricity – the electricity demand of India is projected to double by 2030. However, growth in the rooftop solar segment has been deterred by challenges such as lack of affordable financing, reluctance of distribution companies or DISCOMS, inconsistent net-metering policy along with low consumer awareness on benefits of solar technologies. Further, the floating solar segment remains a crucial segment for building India's utility-scale solar capacity considering the low land requirement. As it is an emerging segment, the financing in the segment is limited with high upfront capital requirements and inadequate policy incentives.

Apart from rooftop and floating solar, productive use of solar energy has significant potential for diversifying energy needs in off-grid areas and ensuring livelihoods of population. However, lack of access to finance for enterprises as well as consumers and lack of consumers' awareness on key solar technologies, costs and benefits, amongst others remain critical challenges that deter scaling-up of the segment.

The catalytic financing facility for India is envisaged as a blended financing facility providing concessional finance along with risk mitigation instruments and grants for technical assistance. The facility aims to enhance solar deployments and increase solar generation capacity. Increased solar based generation would improve the share of solar energy in the overall energy mix of India resulting in reduction of CO2 emissions. Furthermore, the fund would enable in catalyzing additional investments into India's solar sector by removing the financial, technical, and policy barriers.

- Maldives

As of 2021, the total installed power capacity in Maldives stood at 600.5 MW with renewable energy sources comprising 6.4% (38.5 MW) of the total capacity (a significant 44% away from the 50% target set out for 2015). Even though solar energy accounted for 100% of the share within renewable sources (36.5 MW), it forms a low 6% of the total installed capacity. With solar irradiance of 5.4–6.4 kWh per m2 and 280–300 sunny days per year, Maldives demonstrates immense prospects for solar energy. Annual solar PV output is estimated to be 1,530–1,600 kWh per kilowatt peak with low seasonal variability. Further, solar energy is more cost effective than diesel-powered generation with bidding prices at ~USD 0.11 per kWh in 2019, while the cost of diesel-powered generation averages from USD 0.19 to USD 0.33 per kWh.

Two key solar segments emerge as focus areas demonstrating critical solarization potential for Maldives, i) Floating Solar; ii) Rooftop Solar. Combined, the two solar technologies present a capacity potential of 259.9 MW requiring USD 233.9 million. Given the paucity of land and a 100% electrification rate, ground-mounted solar and decentralized technologies such as solar home systems and mini-grids do not hold a significant prospect in the island nation. Despite immense impact and investment potential, key financing, technical and policy challenges remain. Key barriers include inadequate domestic financing options, limited integration of battery and storage capacities, and the weak financial position of state-owned utilities.

The financing facility would help address the

financial, technical, and policy barriers and enable commercially viable investments into solar energy of Maldives. Proposing the usage of catalytic capital from public or philanthropic sources, blending of different types and sources of capital would be undertaken. This would allow for increased access to low-cost capital across the key stakeholder categories in the solar ecosystem of Maldives – commercial financial institutions, solar enterprises, government agencies. Public or philanthropic investors would provide funds on below-market terms i.e., concessional capital to lower the overall cost of capital. They would also provide guarantees offering an additional layer of protection to private investors, thereby enabling commercial credit enhancement to solar enterprises.

- Nepal

With an installed capacity of 2.68 GW, Nepal has significantly increased its generation capacity in the past decade. However, it is primarily dependent on hydropower resources to fulfil its electricity demand. Even though Nepal has abundant hydropower resources, the country faces severe electricity shortages in the winter months due to run-off-river (ROR) nature of hydropower plants that are impacted from low rainfalls in winter months. Further, hydropower resources alone would not be adequate to fulfil the growing electricity demands in Nepal. The Ministry of Energy, Water Resources and Irrigation (MoEWRI) has estimated the electricity demand electricity demand at 20,073 GWh by 2030 in Business-As-Usual (BAU) scenario-87% higher than the current electricity consumption of 10,693 GWh.

To reduce its dependency on hydropower and to address the seasonal energy deficits, in 2016 the Government of Nepal (GoN) laid out a plan to incorporate 5-10% of other renewable energy in the total generation mix by 2026, mainly by integrating solar energy. The country has around 120.2 MW of solar installed capacity including 86.94 MW of utility scale, 30 MW rooftop solar and 3.26 MW off-grid solar capacities.

With a solar potential of 50,000 terawatt-hours per year, Nepal's solar energy resources are around 100 times more than its hydropower resources. Further, Nepal's commercial potential for grid-based generation stands at 2.1 GW. In addition, large parts of Nepal receive solar electricity irradiation in the range between 1,400 to 1,600 kWh/m2/year. Although the GoN has provided necessary impetus to the solar sector, there exist critical challenges in scaling-up solar. Lack of a strong policy and regulatory environment remains a roadblock for scaling-up solar energy in Nepal. Setting-up solar projects in Nepal requires multiple approvals and licenses, which increases the gestation period significantly. Further, developers are required to make most of the end-to-end arrangements from commissioning to installation of projects leading to significant time and cost overruns due to delays in approvals. Moreover, access to affordable long-term finance remains a significant challenge, primarily on account of the high-risk perception of the investors.

The Catalytic Financing Facility for Solar aims to infuse investments in the solar segments demonstrating potential of scaling-up in Nepal, thereby unlocking commercial capital. Four key solar segments emerge as focus areas demonstrating critical investment and impact potential for Nepal, i) Utility Scale Solar; ii) Floating Solar; iii) Rooftop Solar; and iii) Productive Use of Solar. The design of the facility seeks to address specific barriers in focus segments through a combination of commercial capital along with risk mitigation measures. The facility also includes technical assistance for strengthening the capacity of key stakeholders, policy building, and awareness creation to create an enabling environment for scaling-up the sector. The financing facility for Nepal is envisaged to include concessional finance along with risk mitigation instruments and grants for technical assistance. The facility aims to enhance solar deployments and increase solar generation capacity. Increased solar based generation would improve the share of solar energy in the overall energy mix of Nepal resulting in reduction of CO2 missions. Further, the fund would enable additional investments into the solar sector in Nepal by removing the financial, technical, and policy barriers.

- Sri Lanka

Sri Lanka's power generation is dominated by (65%) of fossil fuels. However, solar-based energy generation is gaining pace. As of 2023, solar energy constitutes 12% of the total energy mix in Sri Lanka, with an installed capacity of 771 MW. Currently, utility-scale solar projects have 131 MW of cumulative installed capacity, while rooftop solar projects account for 640 MW. Sri Lanka plans to generate 70% of its electricity using renewable sources by 2030. To meet this target,

the country is projected to increase installed solar capacity to 4,659 MW by 2030. About 35% of this will be contributed by roof-top solar and the rest by utility-scale solar plants and off-grids. Solar irradiation in Sri Lanka varies from 1,247 to 2,106 kWh/m2/year, which is optimum for generating adequate solar energy. This optimum radiation provides substantial potential for Sri Lanka to add around 16,000 MW of solar power by 2050 through solar parks, solar rooftops, and floating solar projects.

Despite high solar irradiation potential and ambitious solar energy targets, critical regulatory and financial challenges persist for the segment. Under the utility scale segment, accessibility of finance and poor capacity of the financial institutions are the key challenges. Lack of innovative financing instruments, asset-liability mismatch, and lack of long-term financing are key challenges that restrict access to finance. Also, current economic and political crises expose investors and project developers to high foreign exchange volatility, uncertain project development costs, and sovereign risk, apart from the high cost of project finance. These financial risks are further aggravated by regulatory risks like delay in obtaining land permits, obsolete transmission infrastructure, and the absence of a clear policy for the transition from feed-in tariffs to competitive tariffs. For solar rooftop projects, key challenges include a non-viable tariff by the Ceylon Electricity Board (CEB), a capital expenditure-based model, and a long waiting period for grid connection and approval. Key concerns of foreign investors in investing in Sri Lanka are policy inconsistency, difficulties in opening and doing business, and high exchange rate risks.

Sri Lanka requires approximately USD 3.5–4 billion by 2030 to meet its solar power generation targets of 3.8 GW. Sri Lanka has a project pipeline of 1,150 GW in the utility-scale solar segment. Under solar rooftop, the Sri Lankan government plans to achieve 1,000 MW of capacity installation by. Sri Lanka offers multiple incentives to investors and project developers. It presents strategies to ensure the delivery of reliable, cost-effective, and sustainable energy services to the country to be more energy self-reliant and meet its 2030 renewable energy goal. It also offers zero tax and import duties on imported solar panels. Apart from this, the Sri Lanka Sustainable Energy Authority and Invest Sri Lanka play pioneering roles in investment promotion and facilitation in Sri Lanka's solar sector. Most of the projects in Sri Lanka are developed through public-private-partnership (PPP) financing. International donor aid and foreign government funding are the primary sources for the installation of solar projects in Sri Lanka. Local banks are not able to fund large projects due to a liquidity crunch. Also, private equity investment is not very common in the power sector, and domestic corporations are also not open to exploring the PE option.

The Catalytic Financing Facility for Solar will focus on promoting the deployment of capacity across the ground-mounted utility scale and floating segments. By providing low-cost debt for the creation of shared infrastructure, it will facilitate the development of large-scale solar parks. The performance-based guarantee proposed in the fund, through mitigation of payment risk due to asset performance, technical issues, and breakdowns, provides risk-bearing capacity to the commercial lenders to lend to project SPVs. The fund will also provide project financing floating solar projects through the deployment of concessional debt and risk mitigation measures. To support the enterprises offering innovative solutions for floating solar deployment, the fund will also provide concessional debt and insurance premium support. The fund can enable increased solar energy share in the overall energy mix of Sri Lanka while ensuring renewable energy development.

BLUEPRINT OF THE CATALYTIC FINANCING FACILITY FOR SOLAR IN SOUTH ASIA

The Catalytic Financing Facility for solar aims to infuse investments in the emerging solar segments across target countries. The proposed facility is designed to take a co-investment or blended approach, combining patient development capital with commercial capital to reduce the overall cost of capital while de-risking investments. The facility will de-risk incoming capital with a combination of risk mitigation mechanisms such as payment guarantees, partial credit guarantees and others, while building the ecosystem through capacity development of stakeholders. The concessional capital will assume a high-risk position while commercial capital will be in a low-risk position enabled by grants that provide risk mitigation measures. The capital flowing through the capacity is expected to largely provide debt to

the enterprises and projects while equity, grants, and technical assistance will receive the rest of the share.

Key benefits of the facility are seen across two primary pillars – reducing the cost of capital for project deployment which will lead to reduced tariff of solar energy to consumers; and reduced risk profile through payment guarantee mechanisms and increased agility in the ecosystem with technical assistance. Further, the design of the facility seeks to address specific barriers in focus segments through a combination of commercial capital along with risk mitigation measures to enable commercial viability of the focus segments.

IMPACT ENVISAGED

Through the envisaged facility, that combines debt, equity, risk mitigations instruments, and grant capital for technical assistance, there exists a potential to leverage additional capital of USD 61 billion. The Facility holds the potential to install 67 GW of solar energy by 2030. This could result in a generation of 2.8 million GWh at CUF of 19% over 25 years. Further, the Facility could lead to an estimated CO_2 emission reduction of 1.9 billion tons over the lifetime of the projects and generation of an additional carbon credit revenue of USD 9.7 billion.

SECTION 1

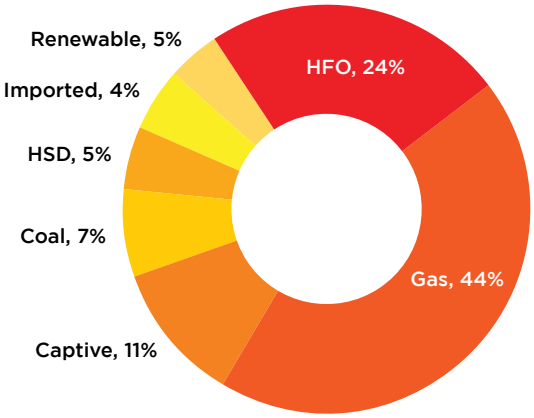
Country-wise Findings and Solar Financing Recommendations

CHAPTER 1
BANGLADESH

SOLAR ENERGY SECTOR OVERVIEW

The energy sector in Bangladesh is highly dependent on fossil fuels such as natural gas, oil, and coal, which are the main sources of power generation in the country. As of June 2023, the installed power capacity in Bangladesh was 26 GW. Nearly 44% of the total capacity came from natural gas, 6.8% from coal, 24.14% from heavy fuel oil (HFO), 5.16% from high-speed diesel (HSD), and 4.53% from renewable sources. The balance was derived from captive power plants (10.77%) and imported from neighboring countries (4.46%).[1]

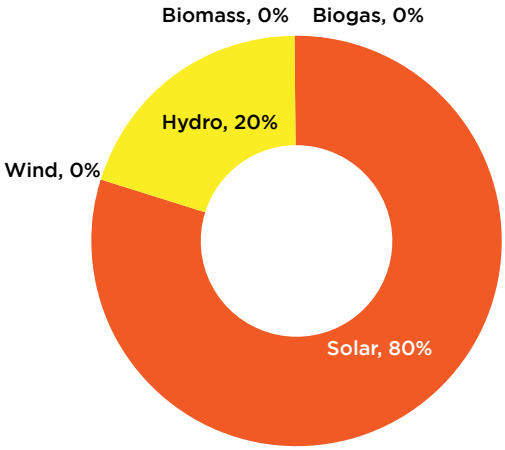
Figure 1: Total Installed Capacity, in %, by Source | 2023



Source: National Database of Renewable Energy: Sustainable and Renewable Energy Development Authority (SREDA) (as of June 2023)

Renewable energy accounts for a low share of only 4.53% (1,179.13 MW) of the total energy mix. Solar energy accounts for a significant 80.2% (945.06 MW) share of renewable energy; however, forms a meager 3.6% of the total installed capacity. This comprises of 365.1 MW (38.6%) of off-grid solar, and the remaining 579.96 MW (61.4%) as on-grid solar.[2]

Figure 2: Total Installed Capacity, in %, by Source | 2023



Source: National Database of Renewable Energy: Sustainable and Renewable Energy Development Authority (SREDA) (as of June 2023)

1 National Database of Renewable Energy: Sustainable and Renewable Energy Development Authority (SREDA) (as of June 2023)
2 Ibid.

Table 1: Solar Technologies in Bangladesh, by Number and Size | 2023

Solar Technology	Number	Size (MW)
Solar Park	10	461
Rooftop Solar except Net Metering	207	66.4
Net Metering Rooftop Solar	1,880	70.08
Solar Irrigation	2,842	51.9
Solar Home System	6,037,689	263.79
Solar Mini Grid	28	5.8
Solar Charging Station	14	0.28
Solar Street Light	297,691	17.1
Solar Powered Telecom	1,933	8.06
Solar Drinking Water System	82	0.09

Source: National Database of Renewable Energy: Sustainable and Renewable Energy Development Authority (SREDA) (as of June 2023)

Solarization Potential of Bangladesh

Bangladesh demonstrates high solarization potential and is the most cost-effective among all other renewable energy technologies. According to the National Solar Energy Roadmap, the total potential capacity for solar energy in Bangladesh stands at 240 GW.[1] To exploit this potential, the government introduced the 2016 Power System Master Plan (PSMP) with the aim to install renewable energy capacity of 2,470 MW by 2021 and 3,864 MW by 2041.[2] Solar energy would account for 50% of the targeted renewable energy capacity for 2041. As per Bangladesh's Nationally Determined Contributions (NDCs), in a conditional scenario, the country aims to deliver 4,114.3 MW of renewable energy projects by 2030. This would primarily comprise of 2,227 MW (55.3%) of grid-connected solar.[3]

Three key solar segments emerge as focus areas demonstrating critical solarization potential for Bangladesh:

- Solar Park: developed either via the Engineering, Procurement and Construction (EPC) or the Independent Power Producer (IPP) mode with only non-arable land to be used for installation; power generated from solar parks is fed directly into the transmission network of the Power Grid Company of Bangladesh (PGCB).
- Rooftop Solar: includes rooftop solar developed through net metering and without; exists for residential, commercial & industrial, and government sectors with two key business models of CapEx and OpEx.
- Productive Use of Solar, with a focus on Solar Irrigation Pump (SIP): developed either via a fee-for-service model or an ownership model (individual farmer or farmer group) with pump capacity varying from 10 W–405 W.

Combined, the three solar technologies present a capacity potential of 9.5 GW requiring USD 8.63 billion. However, despite the huge potential, scale has not been achieved due to a host of challenges.

1 National Solar Energy Roadmap 2021-2041, Ministry of Power, Energy and Mineral Resources - Government of People's Republic of Bangladesh, December 2020
2 Ibid.
3 Nationally Determined Contributions (NDCs) 2021 - Bangladesh (Updated), Ministry of Environment, Forest and Climate Change - Government of People's Republic of Bangladesh, August 2021

Case Study: National Solar Energy Roadmap 2021-2041

The National Solar Energy Roadmap 2021-2041 presents three possible solar PV deployment scenarios: the base or Business-as-Usual (BAU) case, the medium, and the high case scenarios, with the projected solar PV installed capacity to be 6 GW, 20 GW, and 30 GW by 2041, respectively.

The Roadmap recommends deployment of the high case scenario. Solar PV base target for high case will cover up to 30 GW by 2041, of which 40% would be covered by large-scale solar projects and ~40% will be covered by rooftop solar systems. For the case to be feasible, greater impetus by the government and reliable international financial support would be required. For instance, the land accretion and reclamation as per the Bangladesh Delta Plan 2100 will have to be realized and nearly 5% of the land will have to be allocated to the development of the Solar Power Hubs.

Source: National Solar Energy Roadmap 2021-2041, Ministry of Power, Energy and Mineral Resources - Government of People's Republic of Bangladesh, December 2020

Scenario		2020	2030	2041	Cumulative
BAU	Solar PV Capacity Target (MW)	546	1,961	3,493	6,000
	Annual Electricity Generation (MWh)	851,760	3,059,160	5,449,080	9,360,000
	GHG Emission Reduction (MtCO2 eq.)	570,679	2,049,637	3,650,884	6,271,200
Medium Case	Solar PV Capacity Target (MW)	546	4,795	14,659	20,000
	Annual Electricity Generation (MWh)	851,760	7,480,200	22,868,040	31,200,000
	GHG Emission Reduction (MtCO2 eq.)	570,679	5,011,734	15,321,587	20,904,000
High Case	Solar PV Capacity Target (MW)	546	7,743	21,711	30,000
	Annual Electricity Generation (MWh)	851,760	12,079,080	33,869,160	46,800,000
	GHG Emission Reduction (MtCO2 eq.)	570,679	8,092,984	22,692,337	31,356,000

Investment Needs and Landscape

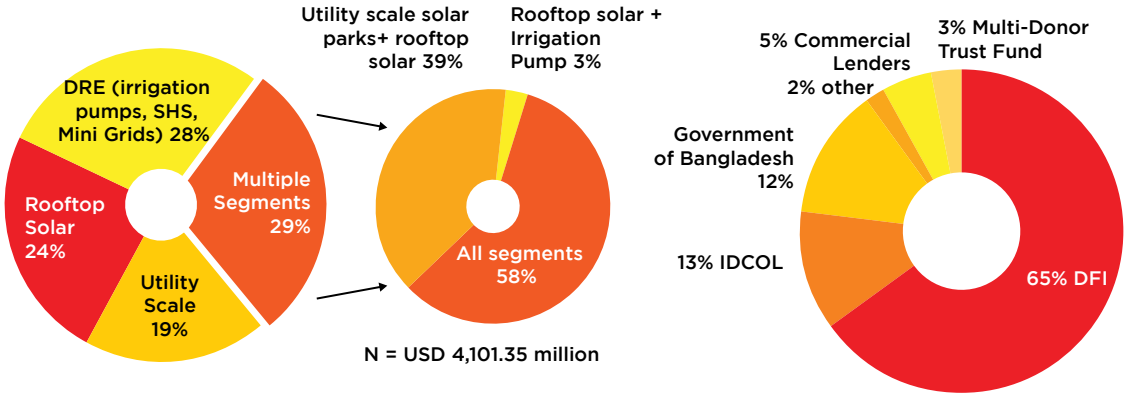
Long-term finance

Domestic financing institutions and commercial banks have not yet developed the appetite to offer long-term debt, i.e., for more than 15-20 years. However, Power Purchase Agreements (PPAs) are, typically, for a period of 20-30 years. Further, the cost of lending and project risk remains high due to financial institutions extending short-term debt to credit long-term solar energy projects. This leads to an asset-liability mismatch, as solar energy companies end up financing long-term projects with short-term financing.

Inadequate domestic funding options

Participation from local financial institutions is largely limited to Infrastructure Development Company Limited (IDCOL). The private equity industry (including venture capital) is currently at a nascent stage. Further, the bond market in Bangladesh is yet underdeveloped. Only a few corporate bonds (non-power sector) that have been issued have been privately placed, with only one listed on the Dhaka Stock Exchange. Most of the lending is for very short-term periods. Due to this, solar energy companies resort to funding projects through accumulated earnings or long-term multilateral loans. However, accumulated earnings are often limited, and long-term multilateral loans are bound by country and sector limits.

Figure 3: Funding for Solar Energy, by Segment and Investor Type



Note: Analysis of 14 blended finance facilities specific to solar sector in Bangladesh | Source: Intellecap Research

Grid and transmission infrastructure

Renewable power is intermittent in nature. The national grid in Bangladesh is not robust and reliable enough to absorb shock due to recurrent fastening in and fastening out power beyond a certain capacity. There is a need for severe and effective grid integration study. The current lack of studies on variable renewable energy integration into the existing grid infrastructure can lead to potential problems of unavailability of grid for absorbing incoming solar power. This will not only be detrimental to the grid but also lead to losses for the project developers and investors. It is, therefore, a key challenge inhibiting rapid scaling-up of grid-connected solar energy in Bangladesh.

Energy storage policy

It is unclear what role, if any, energy storage can play in the power sector under the current Electricity Act. The latest version of the PSMP excludes the endorsement and plans for energy storage that were included in the previous version. Including clear policy guidelines on energy storage can provide a market signal to spur development and direct regulatory authorities to begin implementing targeted regulations. The Bangladesh Energy Regulatory Commission (BERC) Licensing Regulations 2006 do not include rules for licensing of energy storage technologies.

Regulated tariff and competitive bidding process

Bangladesh lacks a regulated tariff structure/ incentive for large solar Independent Power Producer (IPP) projects, in addition to a lack of transparent competitive bidding process. Most IPPs have been awarded on an unsolicited basis with tariffs determined through bilateral negotiations with the developers. The development of solar parks must move to competitive bidding which could also enable tariff regulation in the solar sector. Further, to develop an IPP project, the developer needs to organize more than 30 permits which can prove to be a daunting challenge.

FINANCING INTERVENTIONS ACROSS EMERGING SOLAR SEGMENTS

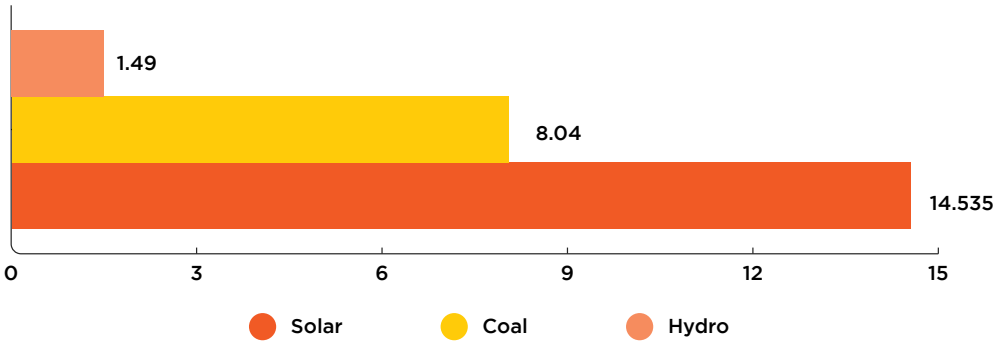
Utility-Scale Solar

Current Status

Utility-scale solar or solar park installations in Bangladesh have witnessed a steep growth from 2017-2023, increasing at a Compound Annual Growth Rate (CAGR) of 131.4%. The 109.7% increase in installed capacity from 2020 (50 MW) to 2023 (461 MW)[1] could be attributed to completion of multiple projects that had been under development.

Solar Park projects are developed either via the EPC or the IPP model. Currently, majority of the projects in Bangladesh are following the latter. At present, there is only one-off taker for solar power in the country. The power generated from solar parks is fed directly into the transmission network of the Power Grid Company of Bangladesh (PGCB)[2]. The PPAs are signed by the Bangladesh Power Development Board (BPDB)[3] with the IPP for a term of 20 years on a commercial basis. Only non-arable land can be used for installing solar park projects. Offered tariffs range from BDT 11.23/kWh (~USD 0.1195) to BDT 17.84/kWh (~USD 0.1899). This is more expensive than coal (BDT 8.04/kWh (~USD 0.073)) and hydro (BDT 1.49/kWh (~USD 0.014)).

Figure 4: Electricity Tariffs in Bangladesh, by Source, in BDT | 2023



Solarization Potential

Bangladesh plans to install 4.9 GW of solar park projects by 2041[4], requiring an investment of ~USD 4.48 billion. Given the unavailability of land as one of the biggest concerns for large-scale solar project implementation, the National Solar Energy Roadmap 2021-2041 has envisioned the building of Solar Power Hubs to meet the targets. Solar Power Hubs are defined as clusters of solar power plants, the combined capacity of which should be at least 500 MW. Eleven solar power hubs are proposed to be developed on land stretches identified[5].

1 National Database of Renewable Energy: Sustainable And Renewable Energy Development Authority (SREDA) (as of June 2023)
2 Power Grid Company of Bangladesh (PGCB) owns and operates the national power grid and is the sole organization entrusted with transmission of power across the country.
3 Bangladesh Power Development Board (BPDB) is responsible for planning and developing the national power infrastructure, and operating majority of the power generation facilities.
4 National Solar Energy Roadmap 2021-2041, Ministry of Power, Energy and Mineral Resources - Government of People's Republic of Bangladesh, December 2020
5 Ibid.

Table 2: Upcoming Solar Hubs in Bangladesh

Prospective Location	Capacity (MW)	Land Requirement (km2)[1]	Potential Land Availability (km2)[2]	Timeframe
Kaptai Lake	500	5	750	2021-2041
Kurigram	500	5	120	2031-2041
Rangpur, Nilphamari	600	6	170	2031-2041
Gaibandha	1,300	13	266	2031-2041
Jamalpur	1,200	12	320	2031-2041
Sirajganj	1,200	12	317	2021-2041
Tangail	500	5	60	2031-2041
Rajbari	600	6	137	2031-2041
Munshiganj	1,500	15	292	2031-2041
Pabna	1,600	16	400	2021-2041
Payra Port adjacent area[3]	500	5	-	2021-2041
Meghna Estuary	2,000	20	1,000	2021-2041
Total	12,000	120	3,832	2021-2041

Source: National Solar Energy Roadmap 2021-2041, Ministry of Power, Energy and Mineral Resources - Government of People's Republic of Bangladesh, December 2020

The individual solar power plants located within the Hubs' territory could be owned by either the public utilities or private developers, allocated through a competitive bidding process. The government is expected to play a key role in planning and implementing the solar power hubs. In addition to identification of suitable locations, the government shall execute the land acquisition process, develop the land, and take up the construction of the necessary civil and electrical transmission infrastructure. The principal rationale behind the solar power hubs is to tap into the benefit of the economies of scale and reduce key risks such as land risk and power evacuation risk which will increase the attractiveness of the project. This can lead to lower solar tariffs, eventually achieving parity with coal and hydro-based power plants. The cost of civil and electrical construction can be expected to be minimized to a considerable extent. Further, with the government organizing land, the opportunity is likely to become more appealing to the project developers and investors[4].

Challenges

Lack of project financing

Domestically sourced low-cost debt financing to large infrastructure and power projects is only provided by government-owned infrastructure-focused non-banking financial institutions (NBFIs) - Bangladesh Infrastructure Finance Fund Limited (BIFFL) and IDCOL. Further, the corpus invested is not substantially large to meet funding required for implementing large number of solar park projects.

1 Typically, 1 km2 of land is required for installing 100 MW solar PV capacity using present technology. This requirement will be lower in the future considering the higher efficient solar PV panels
2 Existing and reclaimed land from river banks
3 Significant land near the Payra port area were earmarked for coal based power plants development but recently the government has decided to discourage coal based power generation plants. Some of the earmarked areas, and also other adjacent areas of Payra port (suitable for solar project development) can be used for the development of a solar power hub.
4 Ibid.

Scarcity of land

Large-scale solar power plants require vast stretches of land, and the Government of Bangladesh allows for only fallow, vacant lands to be used for solar PV project development. There are very few non-agricultural lands, and they lie mostly in the north-western part of the country, in the riverbanks and islands, sand bars and in coastal regions. These areas are far away from the national grid facilities or are limited by the grid capacity. Further, Bangladesh has a flat terrain which is prone to flooding and majority of the suitable land for solar project development is on the riverbanks. Most of the land available for solar PV projects, therefore, needs to be backfilled, which adds to the project cost.

Lack of technical standards

Nationally recognized technical standards and codes for large solar parks are largely unavailable in Bangladesh. Unless these codes and standards are developed, additional studies and analysis must be undertaken by the developers that can add to the cost of project deployment. Moreover, significant assumptions are made in the absence of standards which compel the developers to take risks and that results in risk premiums.

Financing interventions

The Government of Bangladesh has laid increased emphasis on solar park development, particularly via solar power hubs. The proposed funding focuses on:

- Need for project financing to facilitate deployment of solar power hubs (at least 500 MW in capacity).
- Need to lower the high cost of insurance required to protect assets of the solar power hubs.
- Assistance required on effective policy design and execution for a competitive bidding process to enable private sector led solar power deployment and affordable and commercially viable tariffs.
- Lack of BESS integration requires long-term capital assistance and guarantees for risk mitigation.
- Financing instruments include debt for projects, capital for insurance premium, debt, and grant for BESS.

The proposed facility could support market development, increased enterprise, and project bankability, and provide technical assistance for strengthening state-owned utilities and improve efficient design and implementation of BESS and VRE integration policies.

Table 3: Envisaged Deployment of Funds for Utility-Scale Segment in Bangladesh

Nature of Financing

Project financing for solar hubs

Financing Recipient

Government-owned financial institution

Fund to provide debt to a government-owned FI, such as BIFFL and IDCOL, that would on-lend to project special purpose vehicles (SPVs)

Instrument

Debt

- Interest rate: 2%
- Term: 25+5 years
- Local currency financing
- Collateral: Structured to match the generated cash flows / asset-based collateralization
- Average solar IRR = 8-10%

Purpose

Shared infrastructure

- Evacuation infrastructure
- Site access
- Land development

Expected Outcomes

- Facilitate creation of Solar Power Hubs: 11 proposed; at least 500 MW in capacity
- Reduce land risk: GOB to procure land as part of Solar Power Hubs
- Enable economies of scale: demand aggregation for procurement across hubs
- Reduced overall cost of generation and average cost of supply (ACoS) to discom

Nature of Financing

Insurance premium for assets of the solar power hubs

Financing Recipient

Insurance companies

Fund to cover cost of property risk insurance for utility-scale solar park developers as a risk mitigation instrument

Instrument

Insurance premium support

- Cost covered for first two years
- Insurance underwriting: Risk engineering, assessment, rating, specify coverage, T&C, and exclusions

Purpose

Construction / Pre-revenue stage

Mitigate damage or loss of assets and related risks

Expected Outcomes

- Lower overall cost of financing by offsetting insurance cost
- Improve the overall IRR of the project and improve project cashflows, leading to enhanced likelihood of securing debt financing

Nature of Financing

Technical Assistance

Financing Recipient

Bangladesh Energy Regulatory Commission

Instrument

Grant

Purpose

Policy development

- Conduct project preparation, including technical and feasibility studies
- Design transparent competitive bidding process, including pre-bid consultation to ensure sync with procurement guidelines

Expected Outcomes

- Standardized competitive bidding policy and model bidding documents
- Model PPA document development
- Feasibility studies for upcoming sites for solar hubs

Financing Recipient

IPPs

Purpose

Construction and development

Conduct project preparation, including technical and feasibility studies

Design transparent competitive bidding process, including pre-bid consultation to ensure sync with procurement guidelines

Expected Outcomes

- Feasibility studies on BESS and VRE integration at IPP-led projects
- Development of policies for solar and storage IPP projects

Financing Recipient

Commercial lenders

Purpose

Construction and development

Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria, including:

- Pre-investment due diligence and post-investment monitoring & evaluation
- Integration of Environmental Impact Assessment (EIA) / climate risk and Environmental, Social, Government (ESG) risk rating

Expected Outcomes

- Feasibility studies on BESS and VRE integration at IPP-led projects
- Development of policies for solar and storage IPP projects

Rooftop Solar

Current Status

Bangladesh has 137.36 MW of installed rooftop solar capacity, including 60.24 MW of rooftop solar without net metering and 70.12 MW with net metering[1]. The latter has witnessed a steep growth trajectory, increasing at a CAGR of 63.34% from 2019 to 2023. Bangladesh published its net metering guideline in July 2018 to encourage power consumers of industrial, residential, government and commercial buildings to adopt rooftop solar.

Rooftop solar projects are developed either via the Capex or Opex model. In the Capex model, the owner of the roof owns the rooftop solar assets and invests the required equity and capital for deployment. While in the Opex model, third-party Renewable Energy Service Company (RESCO) leases rooftop space from a roof-owner to install the solar system, generate and sell the entire electricity generated to the rooftop owner under a power purchase agreement executed between the RESCO and the roof-owner. Currently, most of the projects in Bangladesh follow the Capex model. The BPDP has implemented the highest number of net metering rooftop solar projects.

Solarization Potential

Bangladesh plans to install 3.9 GW of rooftop solar projects by 2041[2], requiring an investment of ~USD 3.5 billion. Regulatory mandates from the government are driving the adoption of rooftop solar. New buildings with a power load of more than 2 kW are mandated to cover 4% of their load with power from a renewable energy system to get connected to the grid. To be commissioned, rooftop solar projects must comprise grid-connected solar systems with installed capacity from 50 kW to 5 MW (AC capacity with a flexibility of 10%)[3]. Further, decreasing costs of rooftop solar are encouraging adoption. The estimated cost of rooftop solar (cost per MW in USD million) is expected to decrease from USD 0.62 million in 2021 to about USD 0.5 million in 2030. Installing 1 MW of rooftop solar by investing BDT 53.1 million (~USD 482,819) is estimated to get a return of over BDT 100 million (~USD 909,265) in 20 years. For perspective, grid tariff with VAT for each unit of electricity is currently set at BDT 8.09 (~USD 0.074), while the same for rooftop solar shall be BDT 6.02 (~USD 0.055)[4].

Rooftop solar for the Commercial & Industrial (C&I) segment holds the most potential, particularly for the Ready-made Garment (RMG) and textile industries, given the 42 million square feet of rooftop space provided by these industries. Rooftop solar C&I systems are also more cost-effective. Over a 30-year project life of rooftop solar solutions, the charge of electricity production is less than BDT 5 per unit (~USD 0.045), making it more economical than gas-generated power. Further, factories could decrease grid-based power consumption by anywhere between 5% and 20% by transitioning to rooftop solar. Commercial buildings could also potentially provide a surplus of 10 MW of electricity to the grid by using their unused rooftop[5].

Challenges

High initial investment and relatively small ticket size

The upfront capital requirements for rooftop solar plants are quite high, making access to affordable and viable finance a key challenge. In addition, the increase in import duties on solar modules and inverters by 37% has further driven up costs[6]. Further, net metering rules for residential rooftop solar state that the maximum installation capacity for a residential building should not surpass 100 kW, while for C&I

1 National Database of Renewable Energy: Sustainable And Renewable Energy Development Authority (SREDA) (as of June 2023
2 National Solar Energy Roadmap 2021-2041, Ministry of Power, Energy and Mineral Resources - Government of People's Republic of Bangladesh, December 2020
3 Bangladesh Energy Regulatory Commission (Tariff For Roof Top Solar PV Electricity) Regulations, 2016 (Draft), Bangladesh Energy Regulatory Commission - Government of People's Republic of Bangladesh, 2016
4 Idcol plans big for industrial rooftop solar, The Daily Star, December 2021
5 Rooftop solar power -- a sustainable option for Bangladesh, The Financial Express, November 2019
6 Tax on Solar Panels and Investors, CPD Power and Energy Study, July 2023

the maximum allowable installation capacity has been set at 500 kW. This results in credit requests for relatively small ticket sizes, which is not attractive for commercial financial institutions.

Lack of private investments for residential and C&I rooftop solar projects

The Guideline for Implementation of Solar Power Development Programme states that installing rooftop solar system by private investors based on Build-Own-Operate (BOO) IPP models is only for the roofs of Government and semi-Government establishments. This disallows private investors from developing rooftop solar systems for residential and C&I customers. Further, residential rooftop solar is less viable due to relatively low power tariffs, between BDT 3.33–9.98/kWh (~USD 0.035–0.11/kWh). On the other hand, typical household consumption ranges between 200-300 kWh/month, therefore paying BDT 5.36 (~USD 0.067) per kWh.

LCOE of a rooftop solar system is at least USD 0.69/kWh, based on turnkey costs of USD 1,000/kW and a discount rate of 5%, interest rate of 9%. The payback period is ~8 years, with the project IRR coming to ~12% over 20 years. This does not result in an attractive investment option.[7]

Quality concerns of solar equipment

Bangladesh lacks sufficient testing facilities, such as accredited testing laboratories, for imported solar panels and inverters to ensure high quality. Further, limited monitoring from the Bangladesh Standards and Testing Institute (BSTI) results in market penetration of sub-standard solar equipment.

Restrictive net metering guidelines

Rooftop solar C&I customers are allowed a maximum installation capacity of 500 kW, and for residential consumers the same is set at 100 kW. Further, Bangladesh mandates the output Alternating Current (AC) capacity of a renewable energy converter to be a maximum of 70% with respect to the sanctioned load of the consumer; on the other hand, 70% of the sanctioned load is specified as the maximum permissible generator size.[8] However, many factories have large-sized roofs capable of producing more than the sanctioned load, and if they were incentivized to produce the extra electricity, they would be more interested in installing solar panels.

Financing interventions

There is significant potential for rooftop solar installations for residential and C&I consumers, particularly the RMG and textile industry of Bangladesh. The proposed funding focuses on:

- Commercial financing required for meeting the huge C&I potential, particularly of the RMG industry.
- Need for innovation in C&I sectors, and funding for early-stage enterprises.
- Lack of BESS integration requires long-term capital assistance and guarantees for risk mitigation.
- Financing instruments include commercial debt for established enterprises, equity for early-stage enterprises.

The capital from the proposed facility could support market expansion and support ensure the commercial viability of the segment. Technical assistance from the facility could support effective updates to the net metering guidelines and their due implementation.

7 Mission Report, Business models for selected Renewable Energy Technologies
8 Rooftop Solar: A Sustainable Energy Option for Bangladesh, IOSR Journal of Mechanical and Civil Engineering, June 2020

Table 4: Envisaged Deployment of Funds for Rooftop Solar Segment in Bangladesh

Nature of Financing

Enterprise financing for established enterprises

Financing Recipient

Commercial lenders

Fund to provide debt to a commercial lender that would on-lend to rooftop solar enterprises operating at a growth to mature stage

Instrument

Grant

- Interest rate: 2-3%[9]
- Term: 15+3 years[10]
- Local currency financing
- Collateral: Structured to match the generated cash flows / asset-based collateralization
- Average solar IRR = 8-10%[11]

Purpose

Growth to mature stage enterprises

- Diversify product and revenue streams
- Invest in working capital
- Expand market and consumer base

Financing Recipient

Commercial lenders

Fund to provide partial credit guarantees to commercial lender that would on-lend to rooftop solar enterprises operating at a growth to mature stage

Instrument

Partial credit guarantees

- Amount: Lowest level required to mobilize funds / <25% of total assets / USD 250 million[12]
- Term: <15 years
- Cost: front-end + guarantee + commitment fee
- NPL ratio = 8.2% (Dec '22)[13]

Purpose

Growth to mature stage enterprises

Mitigate damage or loss of assets and related risks

Expected Outcomes

- Leverage impact potential of rooftop solar for C&I, from the RMG and textile industry
- Mitigate high-risk perception of commercial lenders
- Facilitate CapEx model and enable market expansion
- Lower overall cost of financing, catalyze commercial capital, and diversify funding sources
- Enable commercial viability of projects

9 Partial Credit Guarantees: ADB (as of June 2023)
10 Partial Credit Guarantees: ADB (as of June 2023)
11 Stakeholder consultations conducted by Intellecap
12 Public Sector Financing: ADB (as of June 2023)
13 Bangladesh Bank Annual Report, Bangladesh Bank, January 2023

Nature of Financing

Enterprise financing for innovative enterprises

Financing Recipient

Government-owned financial institution

Fund to provide debt to a government-owned FI, such as BIFFL and IDCOL, that would on-lend to highly innovative rooftop solar enterprises operating at an early to growth stage for C&I sectors such as, RMG, textile, cold storage, agro processing, and plastics

Instrument

Grant

- Interest rate: 2-3%[14]
- Term: 15+3 years[15]
- Local currency financing
- Collateral: Structured to match the generated cash flows / asset-based collateralization
- Average solar IRR = 8-10%[16]

Purpose

Early to growth stage enterprises

- Technical compliance monitoring
- Project development support
- Performance monitoring support

Expected Outcomes

- Drive technology-based innovation
- Access to low-cost debt in local currency from local financial institutions
- Enable bankability
- Support project development and performance monitoring

Financing Recipient

Enterprises

Fund to provide equity to rooftop solar enterprises operating at an early stage (seed to pre-seed) and offering tech- enabled solutions for C&I

Instrument

Equity

- Amount: USD 100,000 – 4 million [17]
- Holding period: <10 years
- Local currency financing
- 50% of total investments considered successful for investment profitability
- Average solar IRR = 8-10%+300 bp

Purpose

Early stage enterprises

- Proof of concept
- Mitigate market risk
- Competitive marketing
- Establish and expand customer base

Expected Outcomes

- Drive technology-based innovation
- Demonstrate business case, and catalyze PE / VC funding, and diversity of capital sources
- Create bankable pipeline of enterprises

14 Partial Credit Guarantees: ADB (as of June 2023)
15 Ibid.
16 Stakeholder consultations conducted by Intellecap
17 ADB Ventures Investment Fund I: ADB (as of June 2023)

Nature of Financing

Technical Assistance

Financing Recipient

Bangladesh Energy Regulatory Commission

Instrument

Grant

Purpose

Construction and development

- Design effective net metering policies and ensure implementation
- Design fiscal incentives – tax holidays, lower corporate income tax, accelerated depreciation

Expected Outcomes

- Effective and efficient implementation of net metering policies
- Increase private sector deployment for rooftop solar in the C&I sector

Financing Recipient

Enterprises

Purpose

Pre-construction and development

- Pre-disbursal training for early-stage enterprises: development of business plan; business and financial management; operational planning
- Post-disbursal capacity building for growth to mature stage enterprises: sales and marketing; business expansion; financial management; fund utilization, including credit use and repayment

Expected Outcomes

- Effective and efficient implementation of net metering policies
- Increase private sector deployment for rooftop solar in the C&I sector

Financing Recipient

Commercial lenders

Purpose

Pre-disbursal of loan

Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria, including:

- Pre-investment due diligence and post-investment monitoring & evaluation
- Integration of Environmental Impact Assessment (EIA) / climate risk and Environmental, Social, Government (ESG) risk rating

Expected Outcomes

- Increase credit deployment due to improved technical and commercial understanding of the solar sector
- Improved knowledge on segment-specific risk models and due diligence criteria

BESS for Solar Park and Rooftop Solar

Table 5: Envisaged Deployment of Funds for BESS Segment in Bangladesh

Nature of Financing

Project financing for BESS component of utility-scale and rooftop solar projects

Financing Recipient

Commercial lenders

Fund to provide PCGs to commercial lenders as a risk mitigation instrument

Instrument

Partial credit guarantees

- Amount: Lowest level required to mobilize funds / <25% of total assets / USD 250 million [1]
- Term: <15 years
- Cost: front-end + guarantee + commitment fee
- NPL ratio = 8.2% (Dec '22)[2]

Purpose

Construction and development

Development of battery bank infrastructure for IPP-based utility-scale solar projects and rooftop solar projects

Financing Recipient

Commercial lenders

Fund to provide long-term debt finance to commercial lenders to on-lend to IPPs and rooftop solar enterprises for funding construction and development of BESS integration

Government of Bangladesh

Fund to offer Government for supporting IPPs according to PPA and implementation agreement; amt. linked to performance

Instrument

Long-term debt financing

- Share: up to 50%
- Interest rate: 2%
- Term: <15 years, including <4 years grace
- Local currency financing | IRR: 8-10%[3]

Tariff buydown grant

- Share: up to 10%
- Reduce the impact of financial costs of IPPs on the tariff
- Local currency financing
- IRR: 8-10%[4]

Expected Outcomes

- Risk mitigation for commercial lenders – increased private investor interest.
- Funding battery storage to address issues of intermittent power and ensure energy security and reliability.
- Increased revenue for IPPs due to increased amount of energy supply.
- Enable access to capital for financing high upfront costs and eventually reduce cost of BESS.
- Increase project bankability through feasibility studies.
- Reduce overall cost of BESS applications.

1 Public Sector Financing: ADB (as of June 2023)
2 Bangladesh Bank Annual Report, Bangladesh Bank, January 2023
3 Stakeholder consultations conducted by Intellecap
4 Stakeholder consultations conducted by Intellecap

Productive Use of Solar Technologies

Current Status

Bangladesh has a total of 2,842 SIPs installed, amounting to a cumulative capacity of 51.9 MW[1]. SIP installations in Bangladesh have witnessed a declining trend during the COVID-19 pandemic years; prior to which it was on a steady rise from 2015-2019 (48.66%), increasing from 2.6 MW to 12.7 MW during that period. In comparison to diesel and electric pumps, the number of SIPs is minuscule, with 1.24 million diesel pumps irrigating approximately 3 million hectares and 0.34 million electric pumps covering 2.3 million hectares in 2018-19.[2]

SIPs could be deployed either via a fee-for-service model or an ownership model (individual farmer or farmer group). In the fee-for-service model, the project sponsor (non-governmental organization (NGO) / microfinance institution (MFI) / private entity) owns the irrigation pump. Farmers get a pumped water supply for an agreed fee. The sponsor identifies farmers, selects suppliers, operates the pump, and sells water to farmers. The implementing agency provides grants, soft loans, and technical support to project sponsors. The supplier installs the pump and provides after-sales service. The ownership model is similar to the fee-for-service model save for the nature of the arrangement i.e., the owner of the system will be a farmer or farmer group. The owner(s) will either create their own irrigation demand and/or serve nearby farmers as well. In this case the farmers will take a loan from the sponsor or the implementing agency while providing the full amount of the equity requirement.[3]

IDCOL is the primary agency working to mainstream SIPs in Bangladesh. Most of the donor aid and government funding for the promotion of solar irrigation in Bangladesh goes through IDCOL, which finances the purchase of solar pumps through a mix of loans and grants.

Solarization Potential

Bangladesh plans to install 700 MW of SIPs projects by 2041[4], requiring an investment of ~USD 650 million. All the 1.3 million diesel pumps in Bangladesh could be replaced with SIPs and installed capacity from solar irrigation could be 6,000 MW. The government has allocated USD 0.60 billion to replace all diesel-powered pumps with SIPs. Further, IDCOL has a target to finance 10,000 solar irrigation pumps by 2030. The World Bank, KfW, GPOBA, JICA, USAID, ADB and Bangladesh Climate Change Resilience Fund (BCCRF) are supporting this initiative. One solar irrigation pump can replace about 8-10 diesel pumps and thus can reduce emission of CO2 of about 32 tons per year. With successful implementation of IDCOL's 10,000 SIPs, around 0.5 million tons of CO2 emission will be reduced per annum.[5]

The decreasing costs of pumping systems would also help drive adoption. Costs have fallen 40% since 2010. The cost of a 40 kW pumping system is estimated at USD 50,000. Extrapolating this to MW-scale, cost per MW could decrease from USD 1.3 million in 2021 to USD 1.16 million in 2030. Further, SIPs incur 20-25% less irrigation charges than diesel pumps, resulting in higher profit from agricultural activities and generation of 57% higher income for farmer families.[6]

1 National Database of Renewable Energy: Sustainable And Renewable Energy Development Authority (SREDA) (as of June 2023)
2 Solar Irrigation in Bangladesh: A Situation Analysis Report, International Water Management Institute, September 2022
3 Ibid.
4 National Solar Energy Roadmap 2021-2041, Ministry of Power, Energy and Mineral Resources - Government of People's Republic of Bangladesh, December 2020
5 IDCOL Annual Report 2021, IDCOL, December 2021
6 Solar Irrigation in Bangladesh: A Situation Analysis Report, International Water Management Institute, September 2022

Challenges

Reliance on grant-based funding

SIPs depend on subsidies to operate successfully and require funding of at least 50% of the cost as grant support or lease finance to be competitive with diesel pumps. Remaining costs may be met through a combination of equity, concessional loans, or lease finance. However, without necessary support from the government and development partners, implementation of SIPs would be difficult. For instance, IDCOL aims to implement 181 MW by 2025; however, the success of the program entirely depends on the availability of grant financing and policy support.

Weak financial viability

Sponsors earn revenue from the fee-for-service model from selling water. However, the water price charged to farmers is regulated to be lower or on-par with the cost of diesel pumping. This makes the financial viability of this model weak. Further, marginalized farmers require financial assistance, primarily in the form of grants to adopt SIPs. This drives up the SIP cost of implementation.

Lack of technical capabilities

For the participating agencies to achieve their SIP targets, they need to have adequate technical capabilities, proper organizational structure, and strong technical provisions. This would ensure proper operation and maintenance. However, local offices, project developers and farmers lack such capabilities.

Actual installation and uptake likely to be small

Even though the NDC roadmap for Bangladesh highlights the immediate role of solar-powered pumps in shifting away from diesel-based irrigation, it cautions of a slower uptake given the government's commitment to grid extension to rural areas which may result in the replacement of diesel pumps with grid-connected electricity.

Financing interventions

Productive Use of Solar Technologies is important for taking the solar narrative in off-grid areas from access to clean energy to generating livelihoods. Productive use technologies are specifically crucial for the agriculture sector, particularly the smallholder farmer population that accounts for around 14 million households in the country. The proposed funding focuses on:

- Innovative and catalytic funding for productive use of solar technologies, so far absent among other financing facilities
- Capital assistance required for demand aggregation and reduced reliance on grant and subsidy funding
- Financing instruments include RBF for projects, low-cost debt / equity for enterprises

This could support development of anchor loads, improve reliability of power required for irrigation while driving down costs, and improving economic viability.

Table 6: Envisaged Deployment of Funds for Productive Use of Solar Segment in Bangladesh

Nature of Financing

Project level financing for Project sponsor (NGO / MFI / Private entity)

Financing Recipient	Instrument	Purpose
Commercial lenders Fund to provide results-based financing to project sponsor that owns the PUE appliance (for e.g., solar pump)	**Results-based financing (RBF)** • Tranche #1 to identify farmers, select suppliers, install, and operate pumps, and sell water to farmers • Tranche #2 for customer expansion if #1 is successful	**Fee-for-service model business model** Solar pump owner charges a pre-determined fee from the farmers on a per acre or water units used basis

Expected Outcomes

- Facilitate demand aggregation via the fee-for-service model
- Ensure accountability from project sponsors
- Reduce reliance on pure-play grant-based funding and government subsidies

Nature of Financing

Enterprise level financing innovative enterprises

Financing Recipient	Instrument	Purpose
Commercial lenders Fund to provide results-based financing to project sponsor that owns the PUE appliance (for e.g., solar pump)	**Debt and Equity** • Debt terms: Interest rate: 2-3%[7] | Term: 15+3 years[8] | Local currency financing | Collateral: Structured to match the generated cash flows / asset-based collateralization | Average solar IRR = 8-10%[9] • Equity terms: Amount: USD 100,000 – 4 million[10] | Holding period: <10 years | Local currency financing | 50% of total investments considered successful for investment profitability | Average solar IRR = 8-10%+300 bp	**Fee-for-service business model / Early to growth stage enterprises** • Technical monitoring facility • Demonstrate business case • Establish and expand customer base

Expected Outcomes

- Reduce reliance on grant-based funding and subsidies, diversify sources of capital, and enable commercial and economic viability of the segment
- Drive technology-based innovation and demonstrate business case
- Create bankable pipeline of enterprises

7 Partial Credit Guarantees: ADB (as of June 2023)
8 Ibid.
9 Stakeholder consultations conducted by Intellecap
10 ADB Ventures Investment Fund I: ADB (as of June 2023)

Nature of Financing

Technical Assistance

Financing Recipient

Bangladesh Energy Regulatory Commission

Instrument

Grant

Purpose

Pre-Construction and development

Conduct RDD&C – research, development, demonstration & commercialization – investments to establish proof of concept and business case

Expected Outcomes

- Drive innovation
- Catalyze diverse sources of capital
- Reducing reliance on grant-based funding and subsidies

Financing Recipient

Enterprises

Purpose

Construction and development

- Facilitate demand aggregation
- Provide training and support to unlock carbon credits
- Pre-disbursal training for early-stage enterprises: business plan development, business and financial management, operational planning

Expected Outcomes

- Increased SIP deployment through demand aggregation
- Catalyze diverse and private sources of capital
- Increase farmer incomes through unlocking of carbon credits

Financing Recipient

Commercial lenders

Purpose

Pre-disbursal of loan

Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria, including:

- Pre-investment due diligence and post-investment monitoring & evaluation
- Integration of Environmental Impact Assessment (EIA) / climate risk and Environmental, Social, Government (ESG) risk rating

Expected Outcomes

- Increase credit deployment due to improved technical and commercial understanding of the solar sector
- Improved knowledge on segment-specific risk models and due diligence criteria

CHAPTER 2
BHUTAN

SOLAR ENERGY SECTOR OVERVIEW

High dependency on hydropower (99.7% by installed capacity) renders Bhutan's power sector vulnerable to climate change impacts, while also raising energy security concerns. Bhutan's peak electricity demand was around 760 MW during 2022[1] and is expected to reach 900 MW by 2024. To put this in perspective, the peak electricity demand in the country was at 487 MW in 2021[2]. However, typically, the total generation drops to about 400[3] MW during the dry seasons (December–March) due to which Bhutan needs to import energy from India.

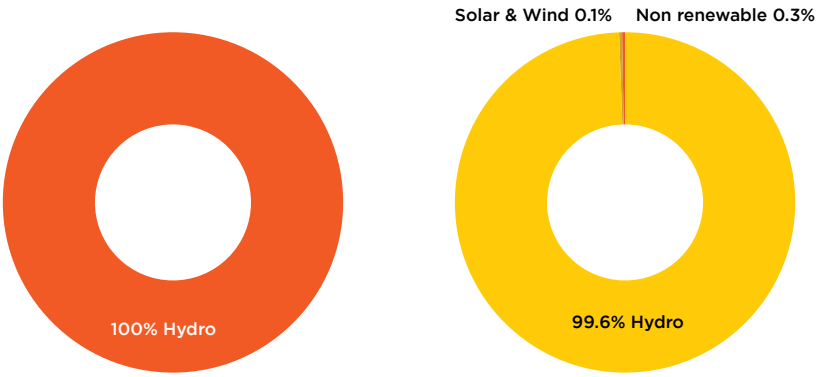
The domestic demand for power continues to increase at around 9% annually owing to greater demand across the industrial operations. The incremental generation has been unable to keep up with the demand, due to the long gestation period of hydropower plants. This chasm between supply and demand of power has led to the need for diversification of power sources.

Current Status of Solar Energy Sector in Bhutan

Bhutan has one of the largest hydropower repositories in Asia with potential to generate 37 GW[4] of energy. Over 99 percent of the country's current installed capacity of 2.3 GW[5] comes from hydropower. Currently, the total installed capacity of renewable energy other than hydropower in Bhutan stands at 9 MW. Of all the renewable energy sources, solar power generation has emerged as the most viable option to diversify the country's energy mix.

However, the generation from hydropower plants decreases in the winter, which leads to a power deficit. Further, hydropower plants are highly capital intensive, have high gestation periods, and require extensive rehabilitation procedures. Also, the current hydropower plants are mostly on run-of-river (RoR) type which are more susceptible to variation in rainfall patterns and the impacts of climate change. Compared to hydropower, solar power generation can be decentralized, can utilize fallow land, and has low gestation period as commissioning and construction of solar power plants require a shorter span of time. Further, the cost of generation for solar power is low compared to that of hydropower due to decrease in solar panel costs since 2009[6].

Figure 5: Energy Generation and Installed Capacity Mix in Bhutan



Energy generation mix: 8875 GWh | Installed capacity mix: 2343 MW (2023)[7]
Source: IRENA, Domestic Tariff projection document (2040)

1 Electricity generation planning in Bhutan, DRE, RGoB
2 Bhutan Electricity Authority
3 Bhutan Power System masterplan 2040
4 Bhutan Power System masterplan 2040
5 Bhutan Electricity Authority
6 Third Pole- Bhutan ramps up Solar energy ambition
7 Electricity generation planning in Bhutan, DRE, RGoB

Solar PV in Bhutan has been implemented in both the on and off grid segments, but only at pilot scale. Currently there are only demonstration projects developed by DFIs like JICA, UNDP and ADB.

Department of Energy, Bhutan, had set a previous target of 5 MW (as per Alternative Renewable Energy Policy, 2013) but DoE plans to revise it to **700 MW** by 2025 and 1,000 MW by 2034[1] in the proposed revised AREP. Department of Economic Affairs has identified 9-10 land parcels for the deployment of utility-scale solar projects with a cumulative capacity of 308 MW.

Primary challenges in scaling up solar in Bhutan include:

a. **Low demand-side pull** – Currently demand side pull from domestic and industrial consumers is lacking due to subsidized tariff of hydropower-based electricity. However, as Bhutan is hilly country, some of the population is still secluded and transmission of grid is costly, and they would be keen to adopt low cost off grid solutions. Average per unit cost of electricity in Bhutan is around USD 0.07, which is further subsidized to the tune of 30% to 90% depending upon type of consumers. For households (LV consumers), the subsidized cost is USD 0.02 per unit. However, the electricity tariff in Bhutan is increasing gradually which provide potential for solar project developer to meet this tariff in the future.

a. **Inadequate financing supply-side push** – At present, supply side push is only from the multilateral and developmental organizations like ADB, UNDP and JICA. These organizations have established one demonstration project each in the utility-scale and rooftop solar segments. However, the local ecosystem of project developers, equipment manufacturers and O&M is lacking due to high cost to import the equipment and lack of market.

a. **Low government focus on solar** – Current hydropower generation is mostly dependent on run-of-river (RoR) type hydropower plants, which are **more susceptible to variation in rainfall patterns and the impacts of climate change.** Hence, Bhutan government is looking for developing **alternate sources of renewable energy** focusing on solar and wind. Bhutan has long and dry winters with low rainfall, thereby requiring import of energy from India to fulfil its power demand. The hydropower projects are also very capital intensive and add to the government debt. According to the data from 2017, debt related to hydropower development is about 80% of GDP.

Solarization Potential of Bhutan

Solar irradiation in Bhutan varies from 1,600 to 2,700 kWh/m2/yr, giving it a high solar potential. This irradiation is better than many solar-rich countries, such as Germany and the UK... The Department of Renewable Energy, Ministry of Economic Affairs, RGoB Bhutan has an estimated theoretical solar potential of 6 terawatts (TW) and restricted technical potential of around 12 GW . While the theoretical potential of 6 TW of Bhutan is based on the solar irradiation across the entire country, the technical potential is restricted to only 0.2% as it is based on land availability, transmission network and infrastructure, and other factors.

Annual average photovoltaic production potential in Gwh stands at 91 GWh/year) for DC for Solar Home System (SHS) and mini-grids, and 81.5 GWh/year for AC systems (for utility-scale and rooftop solar). District wise potential of annual average photovoltaic production potential (in million kWh/hour) has been provided in Annexure 1.

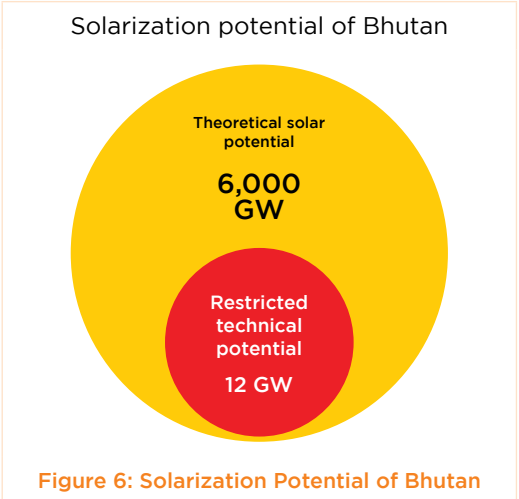
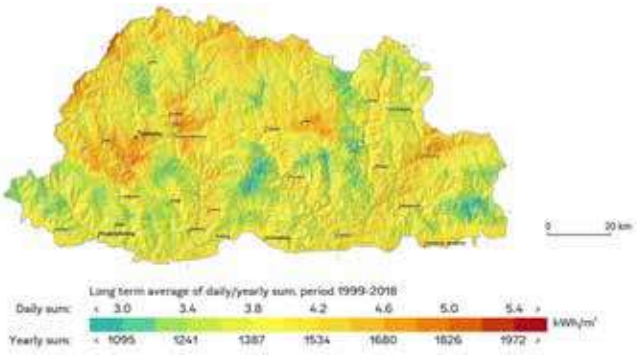


Figure 6: Solarization Potential of Bhutan

1 Ministry of Energy and Natural Resources, Bhutan

Figure 7: Solar Resource Potential by Location for Bhutan



Solar radiation range for Bhutan - Global Horizontal Irradiation map of Bhutan for energy yield calculation and potential assessment of PV technologies

Investment needs and landscape

Finance for solar projects from domestic sources

There is a high-risk perception and low understanding among financiers regarding solar energy due to lack of considerable track record of projects in the country. This results in a lack of domestic finance for both small- and large-scale solar projects. Therefore, domestic financial institutions prefer to finance solar projects with >1 MW capacity. Further, low capital base of government insurance or PF funds further affect availability of finance for large-scale solar projects.

Currently, DFIs and the Government of Bhutan (GoB) are the major investors in the solar sector in Bhutan. Among DFIs, ADB is the most prominent investor. Further, GoB is exploring funding from the World Bank and European Investment Bank for financing solar farm projects.

Some of the key programmes being implemented to enhance solar deployments in Bhutan are as follows:

- ADB has approved USD 18.26 million financing for the construction of the first utility-scale solar power plant in Bhutan with a total capacity of 17.38 MW. The components of financing include USD 8.26 million concessional loans and USD 10 million grants. Further, the government of Bhutan is contributing USD 990,000 to the financing facility.
- ADB has committed USD 1 million for providing knowledge support and technical assistance through its project 'Promoting Energy Security and Transition Project'.
- Gross National Happiness Commission (GNHC), UNDP Bhutan, and Government of Japan have installed Bhutan's first 180 kW Pilot Grid-Tied Ground-Mounted Solar Power Plant at Rubesa, Wangdue Phodrang
- The Ministry of Economic Affairs (MEA) is implementing pilot rooftop solar projects across 300 households. The GoB is supporting the programme through financial assistance.

Key funding sources for RE projects in Bhutan

Source		Type of funding	Quantum of funding	Example
भारत सरकार GOVERNMENT OF INDIA	Co-funding by Part countries	Grant, Debt	>USD 200 Mn	**Kurichu, Tala and Chukha hydro power plants- By Indian govt.** 60% of grant and 40% loan financing model, (RoI 1(1.75% and repayment Reriod -12 years)

JICA UNDP ADB	Bi and multilateral ADB agencies	Debt, Grant	>USD 10 Million	• ADB: Grant Loan for setting up first utility scale solar project of 17.38 MW at Sephu • UNDP- 83 KW grid connected rooftop solar, UN House Thimphu- 100% grant
BOB BANK OF BHUTAN	Bank of BOB Bhutan	Debt	Mostly small size loans	• Provide large sum of loans to state power corporations • Provides smaller value loans to entrepreneurs and residents for RE projects at interest rate of 8.5-13% with RR expectation of >15%

Regulated tariff and PPA process

Despite high solar irradiation potential, critical regulatory challenges persist for the scaling up solar power project installations. Lack of feed in tariff for the renewable energy segment in Bhutan limits participation of the private sector project developers to install solar plants. Further, inadequate developer-friendly PPA process with the only utility deters private investors from investing in the segment. Department of Energy and Bhutan Electricity Authority is in the process of formulating the Feed-in-Tariff policy.

Presence of subsidized hydropower-based electricity tariff

The key challenge barring commercial and residential customers from installing rooftops is the low cost of power. Currently, hydropower-based electricity tariff is subsidized even for commercial and industrial users (~USD 5 cents/ kWh). It is not feasible for on-grid solar projects to meet these tariff rates, considering the high capital costs associated with them. Apart from this, taxes and duties on the imported components are the key regulatory challenges.

FINANCING INTERVENTIONS ACROSS EMERGING SOLAR SEGMENTS

Utility-Scale Solar

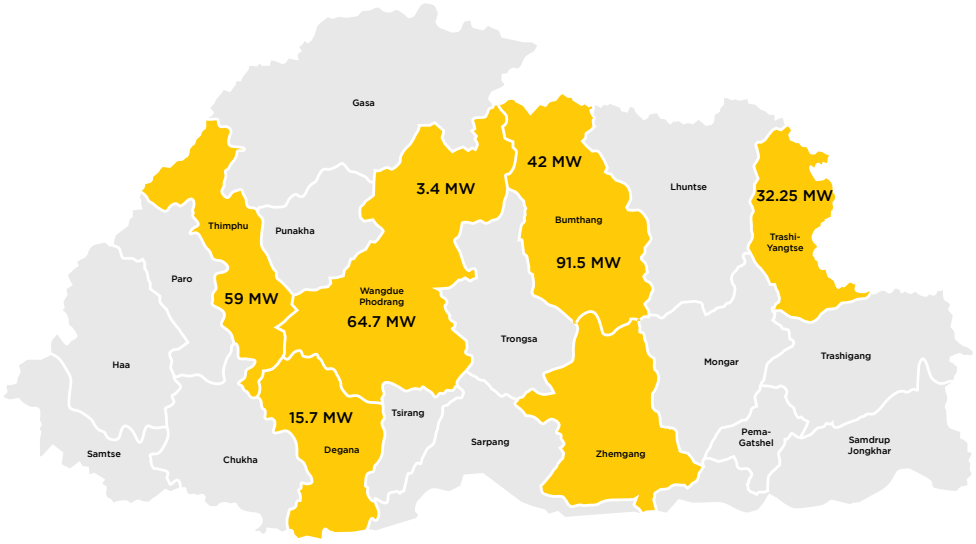
Current Status

At present, Bhutan only has one demonstration project of around 180 kW set up at Rubesa, Wangdue Phodrang generating 263,000 kWh/annum to serve 80-90 households. A 17.38 MW utility-scale plant is currently under construction. It is expected that considering mostly mountainous terrain, large forest cover, and resulting land challenges, the size of utility-scale plants in Bhutan will be in the range of 20-30 MW. Apart from one utility-scale demonstration project, there are some demonstration roof-top solar projects as well, but no significant projects that have been funded by private sector.

Solarization Potential

Department of Economic Affairs, Government of Bhutan has identified seven sites across the country to install ground-mounted utility-solar projects with a combined capacity of 308 MW. The technical feasibility of these sites is yet to be undertaken.

Figure 8: Land Parcels and Potential Capacity Identified by Economic Affairs Department, Bhutan



Source: Ministry of Economic Affairs, RGoB, Third Pole

Challenges in Development of Utility-scale Solar in Bhutan

High cost of capital

Availability of adequate and affordable financing for the solar sector is one of the key impediments in Bhutan. The current cost of capital from domestic financial institutions stands at 12 to 14% while the average period of lending ranges from 7 to 10 years which is short, considering solar sector requires longer period of lending. Further, there is a lack of new and innovative methods of financing projects in the sector.

Historical lack of policy and regulatory direction

Even though a draft regulatory framework has been prepared and the revised Alternative Renewable Energy Policy (2013) document acts as a guideline for the sector, there is a lack of defined policy and

regulatory guidelines for energy diversification goals of Bhutan. This has proven to be a challenge for stakeholders in the sector as it does not allow visibility of upcoming capacity to investors and developers. Further, existing policies for the sector do not include non-financial incentives for enabling growth.

Import dependence for technology and equipment

Local manufacturing of most components and equipment in Bhutan is limited, with the country dependent on India and China to cater to its demands. While the imports already make solar equipment dearer for developers in Bhutan, the prices of solar modules have also witnessed an upward trend over the past 2 years due to supply chain disruptions caused by COVID-19 restrictions. Further, increasing prices of polysilicon, an important component in manufacturing of solar modules, have increased from around USD 10 per kg in 2020 to USD 44 per kg in 2021. This has driven the price of solar modules up and restricted solar project development in the country.

Lack of grid infrastructure to support solar integration

The grid infrastructure is obsolete and still not developed to allow the penetration of variable and intermittent solar power into the national utility grid. Consequently, there is a high risk of revenue loss due to high transmission and distribution losses.

Low access in international funding

Bhutan struggles to access international funding sources and grants for solar projects, which could be essential for large-scale initiatives. Limited access to global funding opportunities of the local FIs also slow down the expansion of solar energy.

Financing interventions

It is one of the key focus areas of the government to meet the domestic energy demands through addition to grid-based power and for meeting the overall solar target. The capital from the facility shall focus on developing the market from its nascent stage, development of institutional capacity, policy formulations and enabling enterprises and other stakeholders to create a conducive ecosystem for scaling the segment.

Table 7: Envisaged Deployment of Funds for Utility-Scale Solar Segment in Bhutan

Nature of Financing

Project financing for ground mounted solar

(Average project cost- ~USD 22 Million per project of 20 MW avg size (for ground mounted solar)

Financing Recipient	Instrument	Purpose
Department of Renewable Energy (DRE) Fund provides concessional long-term debt to DRE. DRE contribution up to 20-30% of the project cost Project implemented by IPP or DGPC[1]	**Concessional debt** • Concessional debt up to 50-60% of the project cost • Interest rate: 1% during grace period; 1.5% during amortization period • Term: >20 years • Collateral: Sovereign guarantee **Grant** • For Viability gap Funding	**Cost of construction of the project**

1 *Intellecap research |#DGPC- Druk Green Power Corporation, ADB Renewable Energy for Climate Resilient Project- Loan agreement

Expected Outcomes

- Proof of concept for the floating solar project established.
- Capacity building of the government and implementing agency
- Improved knowledge on segment-specific risk models and due diligence criteria

Nature of Financing

Technical Assistance (TA)

Financing Recipient	Instrument	Purpose
Department of Renewable Energy	Grant	• Preparation of model documents to build capacity on the bidding process. • Policy formulation for combined hydro+ Solar power withdrawal • Integration of Environmental Impact Assessment (EIA) / climate risk

Expected Outcomes

- Standardized competitive bidding policy and model bidding documents.
- Model PPA document development

Floating Solar

Floating solar plants set up in Bhutan's hydropower reservoirs can boost its utility-scale solar capacity. It has multiple advantages over ground-mounted solar projects, including:

1. Floating technology provides higher generation efficiency as compared to ground-mounted solar projects because of the cooling effect of the water on the modules. Solar panels tend to operate more efficiently in cooler environments, which can lead to increased electricity production.
2. Floating solar projects are deployed on water bodies, typically hydropower reservoirs, and do not require land. This is especially important in the context of limited land availability in Bhutan.

Multiple synergies exist between floating solar and hydropower plants including proximity to grid systems within the premises of the hydropower stations, which reduces the cost of developing transmission networks. Bhutan can harness its unique water resources, increase solar energy production, reduce environmental impact, and enhance energy sustainability. This approach can complement Bhutan's existing hydropower capacity and contribute to the country's goals of energy diversification and environmental stewardship.

Current Status

Currently feasibility studies are underway by ADB and Government of Bhutan to understand the potential of the segment. The Technical Assistance agency has been engaged by ADB to assess the technological feasibility, financial viability, and environmental safety implications of current reservoirs, with the aim of determining the optimal design for floating solar installations and their associated grid connections. The executing agency will be e Department of Energy of the Ministry of Economic Affairs while implementing agency will be Druk Green Power Corporation (DGPC).

Solarization Potential

Floating solar plants set up in Bhutan's hydropower reservoirs can boost its utility-scale solar capacity. The surface area of the existing hydropower plant reservoirs is around 140 hectares[2]. The surface of the reservoirs is open and available for floating solar to generate 28–42 MW of power. There is potential to install 9 floating solar projects, six in existing reservoirs and three in upcoming reservoirs of hydropower plants.

Table 8: List of Existing Hydropower Plants to be Explored for Installing Floating Solar Projects

S. No	Name of hydropower plants	Installed Capacity in MW
1	Chhukha	336
2	Kurichhu	60
3	Basochhu-I	24
4	Basochhu-II	40
5	Tala	1,020
6	Dagachhu	126

Source: Power System Masterplan 2040

Challenges

Lack of bankable models

Floating solar has considerable potential of scaling-up in Bhutan given its large hydropower reservoirs. However, currently there are no projects being implemented in Bhutan. Hence, there is no bankable model present in this segment. Consequently, financing floating solar projects is a challenge without proof of technical and commercial viability.

Lack of institutional capacity to develop projects

Floating solar is an emerging segment in Bhutan. Although, the segment has considerable potential to scale up, there is also a lack of technical expertise for taking up bathymetric and hydrographic studies essential for establishing techno-commercial feasibility of projects.

Financing interventions

This segment is suitable for scaling-up keeping in view the reservoir area of 140 hectares[3] of hydropower in Bhutan. Further, there is no land requirement for this segment and can be complementary to hydropower. The facility will focus on taking up feasibility studies to ascertain technical and financial viability of the projects, policy formulation, developing guidelines for installations and enterprise support.

2 ADB Technical Assistance Report- Kingdom of Bhutan: Promoting Energy Security and Transition Project
3 ADB Project document

Table 9: Envisaged Deployment of Funds for Floating Solar Segment in Bhutan

Nature of Financing

Project financing for floating solar

(Average project cost- ~USD 25 Million per project of 20 MW avg size (for ground mounted solar)

Financing Recipient

Concessional long-term loan to DRE

DRE contribution must be incorporated (up to 20-30% of the project cost)

Project implemented by IPP or DGPC#

Instrument

Concessional debt + payment guarantee

- Concessional debt up to 50-60% of the project cost
- Interest rate: 1% during grace period; 1.5% during amortization period
- Term: >20 years | Collateral: Sovereign guarantee
- Payment guarantees to mitigate the offtake risk

Grant

- Grant of up to 20-30% of the project cost
- For development of shared infrastructure

Purpose

Cost of construction of the projects

Expected Outcomes

- Reduced cost of project deployment
- Shared infrastructure development helps in mitigating land risks and evacuation risk
- Gradually based on the constant revenue realization from the project, grant component could be replaced by debt components from local FIs and help in unlocking the private capital.

Nature of Financing

Technical Assistance (TA)

Financing Recipient

Department of Renewable Energy

Instrument

Grant

Purpose

- Establish transparent competitive bidding process, including pre-bid consultation to ensure sync with procurement guidelines.
- Conduct technical and feasibility studies on potential of installing utility solar at the identified sites

Expected Outcomes

- Standardized competitive bidding policy and model bidding documents.
- Model PPA document development

Rooftop Solar

Current Status

The rooftop solar segment in Bhutan is currently non-existent except for a few small-scale projects. Currently there is only one 83 KW grid connected rooftop solar at UN House in Thimphu. The primary demand is expected to come from government buildings and commercial & industrial establishments which require uninterrupted power supply for operations.

Upcoming capacity

- **Roof mounted solar PV on 300 rural households to enable them to sell surplus power to the country's grid.** This is a pilot project being undertaken by Ministry of Economic Affairs, RGoB
- **80-kW decentralized solar PV plant** to provide reliable and sustainable electricity supply to the Aja Ney community which is inside the Bumdeling Wildlife Sanctuary.

Solarization Potential

The potential for scaling up rooftop solar installations is substantial in both residential and commercial & industrial (C&I) sectors. By implementing a combination of feed-in tariffs and the prosumer model, Bhutan can stimulate the adoption of rooftop solar. A decentralized renewable energy system, with a focus on grid-connected rooftop solar PV panels, has the capacity to bolster the current electrical grid. It could be achieved by injecting surplus electricity generated by rooftop users into the grid.

Challenges

High upfront cost

The initial investment required for rooftop solar installations is a barrier for many individuals and businesses. Limited capital support from the local FIs and lack of availability of long-term funding at adequate interest rate hinders the installation of rooftop solar projects.

Poor understanding of the Rooftop solar project economics

Domestic financial institutions not keen to finance solar rooftop projects due to comparatively low IRR projections of the solar projects also due to lack of established guidelines for financial institutions to guide them on financing rooftop solar projects.

Lack of technical human resource domestically

There is lack of skilled and semi-skilled human resources who understand solar PV technology and undertake installation and maintenance of the rooftop solar. Also, currently there is no training center to train local human resource.

Lack of established net metering-policy

Although GoB has laid out the draft regulatory framework and the revised Alternative Renewable Energy Policy (2013), the country does not have any defined policies for determining the tariff structure or modalities to guide consumers regarding the compensation for selling power back to the grid from rooftop solar plants. The GOB has indicated that the principle to determine tariffs for selling power will be laid out in the further revision to the AREP 2013 policy which is in the draft stage.

Poor awareness amongst consumers regarding the financial benefits of rooftop solar technology

As rooftop solar is still at a nascent stage, the consumers lack understanding of the benefits of rooftop solar in terms of lesser fluctuations in electricity and other quality aspects, economics of usage in longer term as tariff of hydropower-based electricity is increasing and cost of solar PV cell is declining due to advancement in the technology. This would be a potential challenge in the uptake of the rooftop segment.

Financing interventions

Considering the role of the segment in reducing grid load and decentralization of systems, the segment has a huge potential for scaling up. Further, scaling the segment would be key for electrification of off-grid households across Bhutan. The facility is likely to focus on creating awareness, policy formulation, market development and enterprise support.

Table 10: Envisaged Deployment of Funds for Rooftop Solar Segment in Bhutan

Nature of Financing

Project financing for rooftop solar

(For installing rooftop solar at Government-owned Establishments)

Financing Recipient

DRE

ADB to provide concessional debt to DRE for installing rooftop solar on proposed 1,000 government buildings.

Early-stage enterprise

ADB to provide debt to rooftop solar enterprises operating at an early stage (seed to pre-seed)

International enterprises

Mitigate high risk perception

Instrument

Concessional debt

- Interest rate-1% during grace period; 1.5% during amortization period | Term: >7 years | Collateral: Structured to match the generated cash flows / asset-based collateralization

Purpose

Installation of Rooftop solar at the government buildings under CAPEX model

Expected Outcomes

- Leverage impact potential of rooftop solar for C&I, particularly for the government sector
- Mitigate high-risk perception of commercial lenders due to proof of concept
- Facilitate CAPEX model, enable market expansion by enabling smaller players
- Lower overall cost of financing and ensured commercial viability of project

Nature of Financing

Project financing for rooftop solar

(C&I and Residential Customers)

Financing Recipient

Commercial Banks + NBFCs

Local commercial banks + NBFCs to lend to households, businesses and enterprises

Enterprises

Both local and foreign enterprises to install solar under OPEX model

C&I and residential customers

Subsidy + Concessional loan for installation of rooftop under CAPEX model

Instrument

Concessional debt in Result based finance mode

Amt.: 60% of project cost | Interest rate-1% during grace period; 1.5% during amortization period | Term: <10 years + 1 year grace | Repayment: Quarterly

First loss guarantee to enterprises

First loss guarantee to cover financial loss on project failure

Purpose

- Installation of Rooftop solar at the government buildings under CAPEX and OPEX model
- The fund can assist local FIs to explore securitization of fund in case of residential and small C&I rooftop solar installation

Expected Outcomes

- Address challenge of high upfront cost required
- Mitigate high risk perception of the enterprises and lenders
- Facilitate OPEX model, market expansion by enabling smaller players
- Create increased demand for stable source of power even in the winter months
- Demonstrate business case, create bankability, and catalyse commercial capital

Nature of Financing

Technical Assistance (TA)

Financing Recipient

Department of Renewable Energy

Instrument

Grant

Purpose

Capacity building and policy formulation

- Design net metering policies and ensure implementation.
- Design fiscal incentives – tax holidays, lower corporate income tax, accelerated depreciation

Expected Outcomes

- Standardized rooftop solar policies
- Development of fiscal incentives for all stakeholder categories

Financing Recipient

Enterprises

Instrument

Grant

Purpose

Business model development

- Pre-disbursal training for enterprises: business plan development; business and financial management; operational planning; etc.
- Post-disbursal: sales and marketing; business expansion – product development and diversification, market expansion; financial management – fund utilization, loan process and documentation, loan repayment; etc.

Expected Outcomes

- Innovative business models suited for Bhutanese ecosystem.
- Financial model assistance
- Capacity building

CHAPTER 3
INDIA

SOLAR ENERGY SECTOR OVERVIEW

Current Status of Solar Energy Sector in Bhutan

The power sector in India is largely dominated by non-renewable energy sources that account for 56.3%[1] of the total installed capacity of 425.4 GW[2]. Although the share of renewable energy sources has been growing rapidly, coal still has the major share in the total installed capacity (207.04 GW[3]). The share of renewable energy has grown significantly with an annual growth in generation of 12.84%[4]. The current installed capacity of renewable energy stands at 186.1 GW[5], accounting for 43.7%[6] of the total installed capacity. Amongst all renewable energy sources, solar energy is one of the fastest growing segments.

Figure 9: Installed Capacity Mix, 425.4 GW | 2023

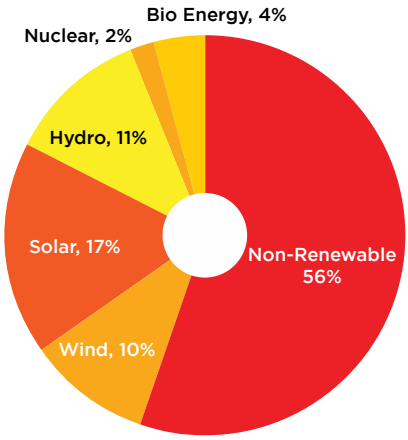
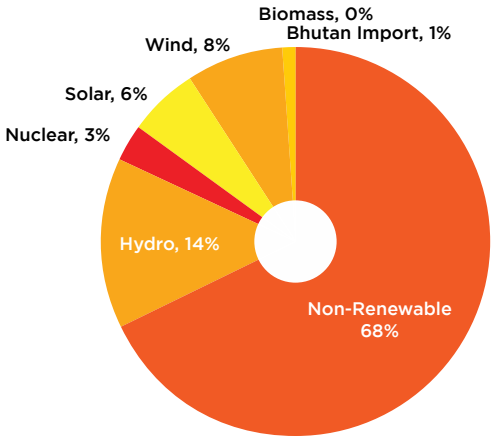


Figure 10: Power Generation Mix, 1,624.5 BU | 2023



The solar sector in India has grown multi-fold from 2.8 GW[7] in 2016 to 71.7 GW[8] in August 2023 - growing at the Compound Annual Growth Rate (CAGR) of 33.5%[9]. The growth in solar sector has mainly been propelled by the utility scale sector through the deployment of ultra-mega solar parks. Other key segments driving growth in the sector include rooftop and off-grid solar. Of the total solar installed capacity, the ground-mounted utility scale segment has the major share of 55.52 GW[10], followed by 11.08 GW[11] of rooftop solar, 2.63 GW[12] of off-grid solar and 2.55 GW[13] of hybrid-solar. Besides these, India has demonstrated immense potential for floating solar, which currently stands at less than 300 MW of operational capacity.

Ministry of New and Renewable Energy (MNRE), Government of India, has supported the growth in solar sector through its policy initiatives over the years as part of the National Solar Mission (NSM). MNRE's schemes for development of 20,000 MW of Solar Parks and Ultra Mega Solar Power Projects have been instrumental in driving growth in the utility scale solar. Further, the Government of India (GoI) has been implementing 'Grid-connected Rooftop Solar Programme Phase II' to incentivize residential sector consumers while the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana (PM KUSUM) scheme aided in scaling-up solar pumps in India.

1 Ministry of Power, Government of India, 2023
2 Ibid.
3 Ibid.
4 Ministry of Power, Government of India, Accessed in October 2023
5 Ibid.
6 Ibid.
7 State-wise installed capacity of grid interactive renewable power, MNRE, March, 2014
8 Ibid.
9 Intellecap Research
10 State-wise installed capacity of renewable power, MNRE, September, 2023
11 Ibid.
12 Ibid.
13 Ibid.

Even though solar energy has the highest share in the renewable energy mix (40.1%[14]), it accounts for only 16.9%[15] of the total installed capacity. Solar sector is integral to reduce India's dependency on conventional sources of energy and support the government's agenda of sustainable growth. Alongside policy initiatives, improved access to finance would be critical for scaling solar in India.

Solarization Potential of India

India has immense solar potential assessed at 748 GW, assuming 3% of the waste land area to be covered by solar power plants. With an annual energy incidence of approximately 5,000 trillion kWh and majority of the regions in India receiving irradiation of 4-7 kWh per sq. m per day[16], solar power has significant scalability potential.

The Central Electricity Authority (CEA) has recently laid out the National Electricity Plan (NEP) for the 10-year period of 2022-32. According to the NEP 2022-2032, the likely installed capacity for the year 2031-32 is estimated to be 900.4 GW[17], of which renewable-based capacity is estimated at 596.3 GW (66.2%)[18]. Contribution of solar energy to the renewable installed capacity is estimated to be the highest at 364.5 GW[19], 72% of the total renewable capacity. Further, the NEP estimates that the share of non-fossil fuel-based capacity is likely to increase to 57.4% by the end of 2026-27 and reach 68.4% by the end of 2031-32 from around 42.5% as on April 2023. To support the additional power generation capacity of India for the period 2022-32, CEA estimates the financing requirement of around USD 406.4 billion (INR 33,600 billion)[20].

Investment needs and landscape

While India has charted its solar success story and has significant potential for further scaling, significant investments are required to scale up the emerging segments that are dealing with the following challenges:

Investment for land acquisition for solar projects

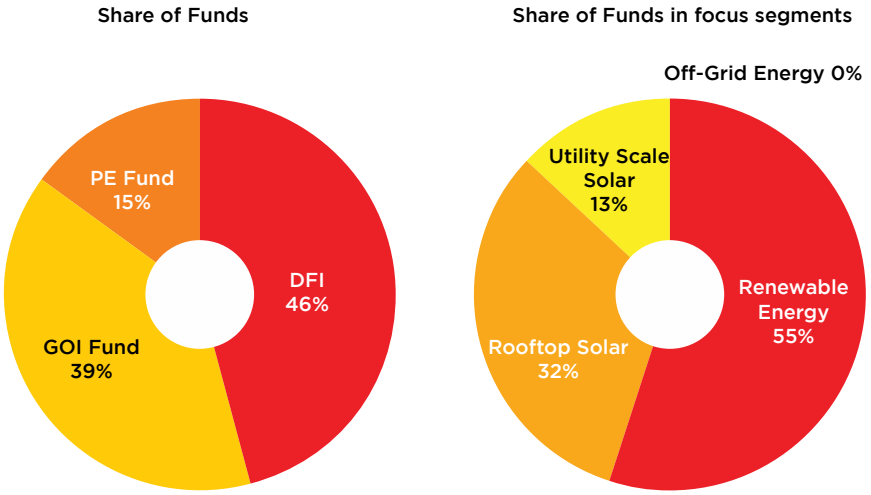
Acquiring large tracts of land for large-scale solar projects continues to be a major roadblock for developers in India. The target of 292 GW[21] for solar installed capacity, set by the GoI, would require at least 6 lakh hectares of land. However, due to scarcity of land, it is would be a challenge to acquire land for solar projects. Even with on-going efforts of the Central and State governments to ease the challenges through the 'Development of Solar Parks and Ultra Mega Solar Projects' that enables in development of all necessary infrastructures and clearances for setting-up solar projects. The floating solar projects are also being included under this initiative; however, very few floating solar have been covered under it so far. There still exist numerous hurdles in obtaining clearances and approvals due to multiplicity in laws governing land between Central and State Government leading to time and cost escalations.

Access to finance

Despite the cost-competitiveness of solar energy, access to affordable and long-term financing is crucial for the growth of the solar sector. However, securing long-term affordable financing continues to be a significant challenge in the sector. For instance, Bank of Baroda (BoB) offers term loans for solar projects from USD 11,989 (INR 10 lakhs) to USD 0.5 million (INR 5 Crore) for a maximum period of 5 years at the rate of 4% above 9.50% BRLLR (Baroda Repo Linked Lending Rate) plus strategic premium.[22] Further, mismatch between operational lifecycle of the solar projects and amortization period for loan is specifically challenging for small and mid-size enterprises that lack credibility and appropriate partnerships for securing debt. In addition, the existing financing facilities are focused mainly on utility scale solar while other potential segments remain underserved.

14 Ministry of Power, Government of India, 2023
15 Ibid
16 Solar Overview, Ministry of New and Renewable Energy, Accessed in October, 2023
17 National Electricity Plan 2022-32, Central Electricity Authority, Ministry of Power, GoI, October 2023
18 Ibid.
19 Ibid.
20 Ibid.
21 Floating solar projects gain traction as land remains a limited resource in India, Money Control, August, 2023
22 Bank of Baroda, Accessed in October 2023

Figure 11: Current Status of Funding in Focus Solar Segments[23]



Quantum of funds = USD 7,740.8 Mn

Inadequate transmission infrastructure

Solar projects are typically located at distant locations that require a strong infrastructure to handle variable power generation and ensure a stable and reliable electricity supply. Although India's ability to integrate solar generation into the existing transmission network has grown, grid unavailability remains a key concern. Limited transmission capacity and delays in upgrading and building transmission lines can impede the off-taking of solar power generated through large-scale plants. This can severely impact the revenues, which can lead to dampened investor sentiment and can impede the growth of solar power projects.

Uncertain policy and regulatory environment

Uncertainties in policy and regulatory frameworks create hurdles for solar developers as well as investors. Since power sector falls in the concurrent list of India's constitution, there exists difference in the policies and regulations governing land acquisitions of the State and Centre. The conflicting policies of the Centre and the States lead to delays in acquiring land and thereby setting-up projects. Further, frequent changes in policies and regulations lead to uncertainties. For instance, there have been frequent changes in the permissible capacity for net-metering in rooftop solar segment. Earlier consumers were permitted to install 1 MW capacity which was reduced to 10 KW. Post the 2020 amendment of the Electricity (Rights of Consumer) Rules, the minimum capacity was set at 500 KW for housing societies with a limitation of 10KW/ house. In addition to this, there is a lack of a single-window clearance leading to delays in approvals and longer gestation periods for projects to operationalize.

23 Intellecap Research

FINANCING INTERVENTIONS ACROSS EMERGING SOLAR SEGMENTS

Floating Solar

Current Status

Floating solar is an emerging segment in India. At present, India has around 1.8 GW[1] of floating solar capacity at various stages of development including about 300 MW[2] of operational installed capacity. National Thermal Power Corporation (NTPC) has installed India's largest floating solar project at Ramagudam with 100 MW[3] installed capacity on the reservoir of its thermal power plant. The project was set-up through Bharat Heavy Electricals (BHEL) with the cost of USD 51.26 million[4] (INR 423 crore). Some of the upcoming floating solar projects in India include 600 MW of floating solar on Omkareshwar dam by Rewa Ultra Mega Solar Limited (RUMSL), National Hydroelectric Power Corporation's (NHPC) 300 MW project at Rengali reservoir in Angul, Odisha and a 100 MW floating solar project by Solar Energy Corporation of India Limited (SECI) at the Getalsud Dam in Ranchi, Jharkhand.

Due to the numerous benefits of floating solar, the segment has immense potential. Compared to ground-mounted and rooftop solar, the land requirement of floating solar projects is minimum (required primarily only for evacuation arrangements). However, floating solar projects have an estimated 5-7%[5] extra generation as compared to ground-mounted solar plants, consequently reducing the levelized cost of electricity (LCOE).

Policies for Floating Solar in India

Some of the supporting policy initiatives of government to boost growth in the segment:

- The Ministry for New and Renewable Energy was allocated Rs. 5,753 crore (USD 788.45 million) and Rs. 300 crore (USD 41.12 million) for the 'Green Energy Corridor' scheme under the Union budget 2021-22.
- The government has provided an additional Rs. 1,000 crore (USD 137.04 million) to Solar Energy Corporation of India (SECI) and Rs. 1,500 crore (USD 205.57 million) to Indian Renewable Energy Development Agency under the Union Budget 2021-22.
- To promote domestic solar manufacturing in the country, customs duty on solar inverters has been increased from 5% to 20%.

1 Floating solar: A small but vital role for India's sunrise sector, The Third Pole, May 2022
2 Centre weighs financial aid for nascent floating solar projects, The Mint, June, 2023
3 India's largest floating solar power project commissioned, Press Information Bureau, Accessed in October, 2023
4 Ibid.
5 Higher generation and lower landed cost make floating solar appealing: Interview, Mercom Clean Energy Insights, May, 2023

Other incentives

The GoI has been formulating key policies to provide push to the floating solar segment. Some of the key initiatives that have been planned include:

- Since, the cost of generation is higher in floating solar in comparison with ground-mounted and rooftop solar segments, the GoI has been provisioning for higher subsidies (higher than capital subsidy of 30% provided under rooftop solar) for floating solar projects to reduce the cost of generation since generation and ensure viability of projects.
- Plan for a plug-and-play model for floating solar projects where winning bidders could set-up plants fast as infrastructure would be set-up at project sites prior to bidding.

Solarization Potential

Due to the presence of a large number of waterbodies, there lies huge potential for developing floating solar on surface of water bodies. About 18,000 km2 of water surface across various states and Union Territories (UT) is suitable for floating solar projects with a potential to generate 280 GW of solar power. The factors determining the potential of floating solar projects include percentage of water surface area coverage, water level variations, the purpose of the water body, and proposed plant location. Maharashtra (15.5 GW), Karnataka (10.5 GW) and Telangana (6.1 GW) have the highest potential for floating solar amongst other states in India. Despite immense potential for scalability, the segment has not grown significantly due to existing challenges.

Challenges

Limited financing

Financing in the floating segment is limited since the segment is currently at a nascent stage in India and has higher capital requirements compared to ground-mounted solar. Most of the floating solar projects have been supported by the GoI by mobilizing funding from Multi-lateral Development Banks (MDBs) such the World Bank. For instance, the World Bank extended a loan of USD 200 million as a part of its 'Innovation in Solar Power and Hybrid Technologies' program. The 100 MW floating solar project in Getalsud reservoir in Jharkhand is being supported through the World Bank's assistance and commercial borrowings. In addition to this, the Viability Gap Funding (VGF) mechanism is yet to be extended to the floating solar segment where the tariff rates are compared to ground-mounted solar-leading to a gap of 25-30% in financing. Further, higher tariff rates in the floating solar segment deter private sector investments. Tariff for floating solar projects ranged from USD 0.038-0.047 (INR 3.2-3.9) per unit, compared to USD 0.028-0.035 (INR 2.3-2.9) per unit of ground-mounted solar projects.

High upfront costs

Floating solar system costs 15-30% more than ground mounted systems. The costs are higher due to inclusion of floating structures, mooring systems, and submerged water cables. Further, there are few domestic manufacturers of mooring and anchoring components for floating solar in India, creating a huge dependency on imports.

Lack of technical expertise

Limited technical-know how has been one of the significant challenges in the segment. Since the floating solar segment is at an emerging stage, there are no specific standards or guidelines. Moreover, only a handful of companies have on-ground construction and operational experience due to limited capacity development.

Lack of incentives for floating solar

At present, floating solar lacks the policy support provided to other segments- (i) 'Grid Connected Rooftop Solar Programme' for construction of rooftop solar projects; and (ii) 'Development of Solar Parks

and Ultra Mega Solar Power Projects' programme for utility scale solar projects. Further, the Production Linked Incentives (PLI) scheme has not yet been extended to this segment. As a result, the floating solar developers face challenges due to lack of locally manufactured equipment-leading to greater lead times and exposure to import and foreign exchange risks.

Financing interventions

Floating solar has immense scalable potential due to the land-use advantages and ability to add to the grid-based power generation. The proposed financing facility focuses on the:

- Need for project financing to enable shared infrastructure - development of project site and evacuation infrastructure.
- Need to lower the high cost of insurance required to protect assets of the solar project.
- Assistance required on effective policy design and execution for a competitive bidding process to enable private sector led solar power deployment and affordable and commercially viable tariffs.
- Financing instruments include debt along with performance guarantee for projects, equity for enterprises, and capital for insurance premium.

Recognizing the current market of floating solar in India, the proposed facility could support in market development enabling markets to mature, deployments to attain scale and ensuring enterprise and project bankability. Further, the technical assistance through the financing facility would enable in standardizing policy and bidding guidelines and processes, enhancing technical capacities for taking up hydrographic and bathymetric assessments, strengthening the business models of enterprises, thereby reducing delays in commissioning of projects and improving utilization of funds.

Table 11: Envisaged Deployment of Funds for Floating Solar in India

Nature of Financing

Project financing

Financing Recipient

Project Special Purpose Vehicle

Fund would lend to public sector banks such as SBI, PNB and others who on-lend to project special purpose vehicles

Instrument

- Interest rate: 2%
- Term: 25+5 years grace period
- Local currency financing
- Structured to match the generated cash flows / asset-based collateralization
- IRR of debt: 9 to 11%
- IRR of equity: 12-13%
- Government to issue guarantee to ADB

Purpose

Shared infrastructure

- Project site development
- Evacuation infrastructure

Expected Outcomes

- Economies of scale achieved by reducing the cost of construction, energy evacuation
- Improved viability by reducing tariff of floating solar projects to achieve price parity with ground-mounted projects
- Reduced overall cost of generation and average cost of supply (ACoS) to DISCOMS

Financing Recipient

Commercial lenders

Fund to provide to performance guarantee on behalf of the project to commercial lender who finances the project

Instrument

Performance guarantees (PG)

- EMD amount: 2% of project cost; 4% if the procurer specifies site; 5% if generator specifies site
- Tenor for performance guarantee: 5 to 10 years

Purpose

Commercial operation

- Mitigate payment risk due to asset performance issues

Expected Outcomes

- Reduced project related risks due to non-performance of assets and sub-optimal energy generation
- Enhance project efficiency and performance

Nature of Financing

Insurance premium for assets of the solar project

Financing Recipient

Insurance companies

Fund to cover cost of property risk insurance for utility-scale solar park developers as a risk mitigation instrument

Instrument

Insurance premium support

- Cost covered for first two years
- Insurance underwriting: Risk engineering, assessment, rating, specify coverage, T&C, and exclusions

Purpose

Construction / Pre-revenue stage

Mitigate damage or loss of assets and related risks

Expected Outcomes

- Lower overall cost of financing by offsetting insurance cost
- Improve the overall Internal Rate of Return (IRR) of the project and improve project cashflows, leading to enhanced likelihood of securing debt financing

Nature of Financing

Enterprise financing for EPC companies

Financing Recipient

Commercial lender/ PE funds

- The fund provides concessional capital to commercial lenders on-lending to established EPC companies (such as BHEL)
- Equity investments facilitated through PE funds

Instrument

Debt/Equity

- Interest rate: 2%
- Term: 25+5 years
- Local currency financing
- Collateral: Structured to match the generated cash flows / asset-based collateralization
- IRR of debt: 9 to 11%; IRR of equity: 12-13%

Purpose

Construction and Operation

- Diversify product and revenue streams
- Invest in working capital
- Expand market and consumer base

Financing Recipient

Commercial lenders

Fund to provide partial credit guarantees to commercial lender that would on-lend to floating solar EPC companies

Instrument

Partial Credit Guarantee (PCG)

- 25% of the project or max USD 250 million
- Term: 15 years
- Maximum limits may increase based on the credit rating of the entity being on-lent

Purpose

Commercial Operation

Mitigate credit payment risk for lenders

Expected Outcomes

- Lower overall cost of financing, catalyze commercial capital, and diversify funding sources
- Mitigate high-risk perception of commercial lenders
- Enable commercial viability of projects
- Improve the scale of operation of floating solar projects

Nature of Financing

Technical Assistance

Financing Recipient

Indian Renewable Energy Development Agency

Instrument

Grant

Construction and Operation

Policy development

- Trainings for policymakers and DISCOMS to develop technical capacity for conducting potential assessment studies and defining targets for the segment
- Developing an understanding of segment specific risks
- Designing comprehensive policies and guidelines and
- Designing incentives and support mechanisms such as subsidies and tax benefits

Expected Outcomes

- Standardized policies and regulations for bidding, agreements on water rights and water bodies, safety requirements, certification and testing
- Standardized guidelines and technical specifications on setting-up floating structures
- Enhanced technical capacities for taking up hydrographic and bathymetric assessments

Financing Recipient

EPC companies

Construction and Operation

Pre-post disbursals

Provide training for technical understanding on:

- Pre-disbursal: For detailed site assessment and feasibility study, designing the floating structures, anchoring systems, and electrical systems and developing an operations and maintenance plan for floating solar projects
- Post-disbursal: For business expansion; financial management; fund utilization, including credit use and repayment

Expected Outcomes

- Improve technical capacities of EPC companies for increased up-take of projects
- Strengthened business models and financial planning of enterprises
- Reduced delays in commissioning and commercial operation
- Improved utilization of funds and timeliness in repayments

Rooftop Solar

Current Status

Rooftop solar segment plays a crucial role in achieving the renewable energy target of India. After a lull period from 2015 to August 2022 – a period of underwhelming growth of rooftop solar, the segment has grown significantly from 7.5 GW installed capacity in September 2022 to 11.08 in September 2023 with a CAGR of 3.31%. Increasing consumer awareness has been the key accelerator of growth in the segment. In addition to this, the launch of 'National Portal on Rooftop Solar' has eased the process for application for residential sector consumers waiting for DISCOMS (Electricity Distribution Companies) to finalize tender and empanel vendors. Maharashtra and Gujarat account for 45% of the total installed capacity. The growth in the segment has significantly been led by the presence of industrial players who contribute nearly 50% of the total installed capacity in the segment.

Solarization Potential

India's rooftop solar market potential is estimated at about 124 GW . With the extension 'Grid-connected Rooftop Solar Programme Phase II' for 4 years from 2022 to 2026 for achieving target of 40 GW installed capacity, the segment would need significant additional push. Even though growth in the segment has significantly picked-up, it is still behind the target capacity, with only 27.7% achievement. In addition to the central and state government's financial incentives and subsidies, the DFIs such as the World Bank, Asian Development Bank (ADB), Green Climate Fund (GCF) and United States Agency for International Development (USAID) have funded the residential and Commercial and Industrial (C&I) rooftop solar segments, through solar financing facilities.

Some of the major financing facilities dedicated to rooftop solar include:

- USD 165 million 'Rooftop Solar Program for Residential sector' by The World Bank
- USD 650 million 'Grid-Connected Rooftop Solar Program' by The World Bank
- USD 500 million 'Solar Rooftop Investment Program' (SRIP) led by ADB, and
- USD 250 million 'Line of Credit for Solar Rooftop Segment for Commercial, Industrial and Residential Housing Sectors' funded through GCF

Challenges

Unavailability of affordable financing

Even though the Ministry of New and Renewable Energy (MNRE) has directed Local Financing Institutions (LFIs) to extend loans for rooftop solar at subsidized rates (since it is covered under the priority sector lending), the cost of capital extended to the segment remains high. This is primarily due to the high-risk perception, mainly for the capital expenditure (CAPEX) model. Although, most banks offer debt at subsidized rates, the interest rates remain as high as 10-14%[6] Further, the required ticket size of funding is smaller in the rooftop solar segment due to lower capacity of systems (10 KW for individual consumers and 500 KW for housing societies).However, there is a lack of small ticket size funding in the segment at present. High cost of transaction associated with small ticket size of funding and lack of creditworthiness of small or medium size solar companies are two main factors for absence of small ticket size of funding.

Reluctance of DISCOMS in promoting rooftop solar

Reluctance of DISCOMS is the primary cause for slow up-take of rooftop solar in India. Even with the government's provision to conduct technical feasibility assessment and distribution of licenses, there are delays in approvals and installations of rooftop solar projects. This is on account of two major reasons: (i) reluctance to part with C&I consumers, who typically pay high electricity tariffs to DISCOMs; and (ii) existing financial crisis of DISCOMS. With the ongoing financial crisis, as the penetration of rooftop solar increases, DISCOMs are likely to let go of a large part of their revenues which are also used to cross subsidize the agricultural consumer segment. Therefore, it is perceived that the implications of rooftop solar penetration across high-paying consumers of DISCOMs will be felt across all consumer segments.

Inconsistency of the net-metering policy

Inconsistency in the net metering policy is a significant challenge for slow growth of the rooftop solar segment in India. Frequent changes in the permissible capacity, from 1 MW capacity to 10 KW, have led to uncertainties, . The latest amendment considers installations above 500 KW capacities for net billing or gross metering and installations up-to 500 KW for net-metering. In addition to this, the state regulatory commissions are allowed to choose to introduce time-of-the-day tariff to incentivize storage of solar energy or feeding-in the grid in peak hours. Further, there is lack of uniformity in implementation of the net-metering policy across the states since each state has its own policy for the solar sector leading to confusions and delays.

Lack of awareness of consumers and risk perception of developers

Although consumer awareness has been increasing in the segment, there is still a persistent lack of understanding of the benefits of rooftop solar segment, subsidies, and technologies amongst consumers resulting in poor off-take in the rooftop segment. Further, higher transaction costs due to the smaller system size and payment security risks perceived by the developers has contributed to limited adoption in the segment.

Financing interventions

There is significant potential for rooftop solar installations for C&I consumers that account for over 50% of the current installations in the segment, particularly in the rooftop leasing model in India. The proposed financing facility focuses on:

- Commercial financing required for meeting the huge rooftop solar potential in the C&I segment
- Need for small ticket-size funds at attractive terms for seed-to-growth stage enterprises
- Financing instruments including commercial debt for established enterprises, equity for early-stage enterprises along with Letters of Credit (LOC) as risk mitigation mechanisms

The capital from the proposed facility could support market expansion and ensure commercial viability of rooftop solar systems. Technical assistance from the facility could support in reforming the net-metering

6 Financial Options, National Portal for Rooftop Solar, Accessed in October, 2023

policies, developing model documents/guidelines for standardizing design and installation practices and maintenance of rooftop solar system other regulatory reforms. Furthermore, the technical assistance could also support in strengthening business models of enterprises for improved installation capacities and reducing delays in installations. This could also help to reduce the reluctance of DISCOMs in promoting rooftop solar installations.

Table 12: Envisaged Deployment of Funds for Rooftop Solar in India

Nature of Financing

Enterprise financing for Rooftop solar developers

Financing Recipient	Instrument	Purpose
Commercial lenders/ PE funds • Fund to provide debt to a commercial lender that would on-lend to established and innovative enterprises • ADB would make equity investments through PE funds in growth stage enterprises	**Debt/Equity** • Interest rate: 2%[7] • Term: 25+5 years • Local currency financing • Collateral: Structured to match the generated cash flows / asset-based collateralization • IRR of debt: 9 to 11%; IRR of equity: 12-13%	**Early and growth stage** • Diversify product and revenue streams • Invest in working capital • Expand market and consumer base
Financing Recipient	**Instrument**	**Purpose**
Commercial lenders ADB to issue letter of credit to issuing bank on behalf of DISCOMS	**Letter of Credit** • Amount: LoC for one month's billing • Tenor: Maximum 24 months • Default rate in payment to developers: Maximum 15% (in Maharashtra)	**Commercial operation** Mitigate risk due to project delays, quality issues, or disputes between the parties

Expected Outcomes

- Lower overall cost of financing, catalyze commercial capital, and diversify funding sources
- Facilitate the rooftop-leasing model in the C&I segment
- Enable small-ticket size funding for enterprises through demand aggregation
- Enable low-cost financing to innovative tech-based solutions that lack proof of concept
- Establish bankability of enterprises
- Reduce risks of developers due to non-payment by DISCOMs
- Mitigate lender's high risk perception

7 Management's Discussion and Analysis and Condensed Quarterly Financial Statements, Asian Development Bank, September 2022

Nature of Financing

Technical Assistance

Financing Recipient

Enterprises

Instrument

Grant

Purpose

Pre-post disbursals

Provide training for technical understanding on:

- Pre-disbursal: For developing business plans (early stage enterprises), customer acquisition plan, marketing, and developing an operations and maintenance
- Post-disbursal: For business expansion; financial management; fund utilization, including credit use and repayment

Expected Outcomes

- Improved capacity of enterprises to design, install and operate rooftop systems is optimal
- Minimize the risk of technical issues and performance problems of developers
- Strengthened business models of enterprises

Financing Recipient

Indian Renewable Energy Development Agency

Purpose

Policy Develpment

- Organizing workshops and training programmes for policymakers for:
- Reforming net-metering policies for resolving the inconsistencies across states/regions
- Developing model documents/guidelines for standardizing design and installation practices and maintenance of solar rooftop systems
- Developing supportive policies and mechanisms to incentive enterprises and consumers

Expected Outcomes

- Strengthened policies for the segment
- Improved coordination amongst central and state government functionaries
- Standardized process of design, installation, and maintenance of rooftop solar systems
- Increased uptake of rooftop installations

Financing Recipient	Purpose
DISCOMS	**Pre-post PPA** Workshops for awareness creation on: • Pre-PPA: Updating DISCOMS on their role in facilitating the rooftop leasing model, financial and economic benefits of rooftop solar both for consumers and the utility, cost-effectiveness and revenue generation potential of the rooftop solar model • Post-PPA: Benefits of regularly engaging with developers, industry associations, consumer groups to understand their perspective and challenges, trainings on project evaluation, inspection, maintenance, and customer support.

Expected Outcomes

- Mitigate the reluctance of DISCOMS in promoting rooftop solar models
- Improved uptake of rooftop solar
- Reduce hassles due to delays in approvals and permissions

Productive Use of Solar Technologies

Current Status

Decentralised renewable energy technologies have now moved beyond the purview of energy access into the productive use segment where they are applied for livelihood generation in India. Primary among these technologies are solar pumps, solar milling, solar cooling, solar heating etc. In India, the key focus has been on agricultural technologies and solar pumps. The GoI has been implementing the PM KUSUM with an aim to add solar capacity of 30.8 GW[8] by 2022 with total central financial assistance of USD 4.2 billion[9] (Rs. 34,422 Crore). The three components of the scheme include (i) Component A – Setting up of 10 GW of decentralized ground/stilt mounted solar power plants on barren/fallow/pasture/marshy/ cultivable land of farmers; (ii) Component B -Installation of 2 million stand-alone solar pumps in off-grid areas; and (iii) Component C – Solarization of 1.5 million grid-connected agriculture pumps through individual pump solarization and feeder level solarization.

The PM KUSUM scheme has benefitted 0.24 million[10] farmers across India. Further, the achievement of the scheme under its various components has been indicated below:

Table 13: Achievements of PM KUSUM Yojana[11]

Components	Installed (Capacity/Nos)
Component A	113.08 MW
Component B	244,373 (Nos)
Component C	1,519 (Nos)

Other productive-uses of farm and off-farm solar technologies have been indicated in the table below.

8 Progress of Implementation of PM KUSUM Yojana, Press Information Bureau, August, 2023
9 Ibid.
10 Nearly 2.46 lakh farmers have benefitted from PM-KUSUM Scheme: Union Minister for Power and New & Renewable Energy, Press Information Bureau, August 2023
11 Ibid

Table 14: Popular Productive-Use Solar Technologies

Farm technologies	Off-farm solar technologies
• Solar water pumps • Solar refrigerators and freezers • Solar rice-huller and polishers • Solar biomass cold storage room • Solar flour mill	• Solar sewing machine; solar weaving machine • Agarbatti making machine • Solar fence • Puffed rice making machine • Solar sugarcane juicer

Financing in the segment is presently limited and available through blanket financing facility covering the entire renewable energy segment. DFIs such as United Nations Industrial Development Organization (UNIDO), KFW and ADB have financed the segment through various programmes implemented by them. Further, various impact investment funds such as Hamsa solar Fund I, Norwegian Climate Investment Fund and others financed the segment through equity-based financing.

Solarization Potential

Productive use of solar energy holds immense potential in ensuring energy security, diversifying energy needs and ensuring livelihoods of population, especially in off-grid areas where households face challenge in due to unscheduled power cuts and low voltages. Agriculture sector in India accounts for 22%[12] of the power consumption. In line with the objective of making agriculture diesel free by 2024, solarization of agriculture sector through productive use of solar technologies has the potential of improving quality of power and resolving the challenges of accessing grid-connected power in remote farm locations. Further, growth of productive use of solar technologies could spur entrepreneurial activities in rural areas.

Challenges

Inadequate financing options

One of the key challenges in the segment is lack of access to enterprise level financing and affordable financing for end-users. Enterprises in this segment are perceived as capital-intensive by investors since they require capital in the research and demonstration phases. Further, capital is required for streamlining their manufacturing and accelerating deployment of technology. Financiers perceive risk in lending to end-consumers due to lack of borrower's credit history. Further, financiers are reluctant in lending to consumers with borrowing requirement below USD 1,220 (INR 1 lakh) due to high transaction cost of lending.

Lack of awareness and capacity of consumers

Lack of awareness of consumers regarding technologies and their benefits is a challenge that limits adoption of productive-use solar technologies. Further, lack of financial capacity of borrowers, who are most often individuals, to navigate through the credit appraisal process required by lenders is also a challenge that persists in the segment.

Financing interventions

Productive use of solar technology has immense potential to support the livelihoods of rural inhabitants while also generating local entrepreneurship opportunities. The proposed facility focuses on the:

- Need for innovative and catalytic funding for productive use of solar technologies.
- Providing capital assistance for demand aggregation to reduce reliance on grant and subsidy-based funding.
- Providing financing instruments including low-cost debt / equity for enterprises along with result-based FLDG.

12 Decentralised solar setups give power access to small farmers, facilitate innovations, Mongabay, June, 2022

This could improve reliability of power, ensure cost savings, and improve scale of operations by targeting farmer groups or communities and drive innovations. Technical assistance for commercial lenders could enable improved flow of credit to the segment, and for consumers it could improve consumer awareness on cost economics of adoption of solar technology solutions.

Table 15: Envisaged Deployment of Funds for Productive Use of Solar in India

Nature of Financing

Enterprise financing for innovative enterprises

Financing Recipient	Instrument	Purpose
Commercial lenders/ PE funds • Fund provides debt to a commercial lender that would on-lend to enterprises with innovative solutions • ADB would make equity investments through PE funds to growth stage enterprise	**Debt/Equity** • Interest rate: 2% • Term: 25+5 years • Local currency financing • Collateral: Structured to match the generated cash flows / asset-based collateralization • IRR of debt: 9 to 11% • IRR of equity: 12-13%	**Early to growth stage** • Scale enterprises with community-based business model to ensure scale • Ensure commercial scalability of the product
Commercial lenders ADB would provide FLDG to the commercial lender where enterprises undertaking consumer financing for farmer groups /community	**Result-based FLDG** • Agreement between OEM and commercial lender on terms of financing • Agreement between OEM and consumers (farmers/ others) on terms of financing • Incentivize financial institutions lending to enterprises • Incentivize enterprises training farmer groups or communities	**Installation and operation** Mitigate risk due to default in payment by enterprises

Expected Outcomes

- Lower overall cost of financing, catalyze commercial capital, and diversify funding sources
- Improved credit flow to innovative enterprises lacking proof of concepts
- Mitigate high-risk perception of commercial lenders on-lending to consumers
- Improve scale of operations by targeting farmer groups or community
- Improved up-take of productive use of solar energy solutions by consumers
- Drive innovation

Nature of Financing

Technical Assistance

Financing Recipient

Commercial lenders

Instrument

Grant

Purpose

Pre-post disbursals

Organize training programmes, workshops to develop understanding of FIs on:

- Pre-disbursal: For understanding of risks associated with the segment, existing business models, conducting credit appraisals, structuring loans that are appropriate for PUE segment
- Post-disbursal: For developing monitoring mechanisms

Expected Outcomes

- Improved credit flow to the PUE enterprises
- Improved knowledge on segment-specific risk models and due diligence criteria

Financing Recipient

Consumers

Purpose

doption

Campaigns and awareness programmes for:

- Raising awareness on existing PUE technologies, costs and benefits of its adoption
- Providing information on financial incentives, subsidies and available support
- Empowering consumers with understanding of installation and maintenance of PUE technologies

Expected Outcomes

- Improved awareness amongst consumers regarding cost economics of adoption of solar technology solutions
- Improved adoption of productive use of solar energy technology solutions
- Improved knowledge amongst consumers on financial incentives and subsidies

CHAPTER 4
MALDIVES

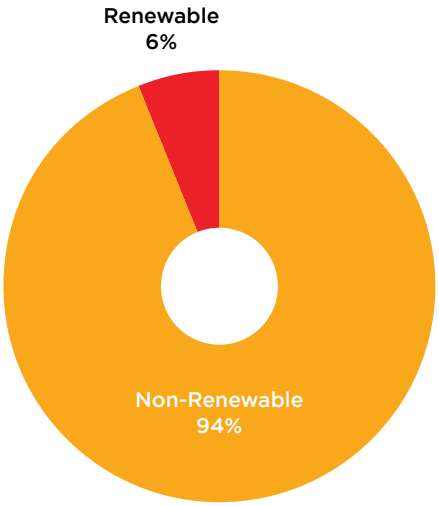
SOLAR ENERGY SECTOR OVERVIEW

Maldives set out the agenda for environmental planning, protection, and management through the first National Environment Action Plan (NEAP) formulated in 1990. However, the country did not place renewable energy targets until the NEAP Phase 3 in 2009 wherein it was mentioned that, by 2015, 50% of the total electricity generated in the island nation would be from renewable energy sources[1]. The NEAP 3 was followed by the 2010 National Energy Policy which sought to achieve carbon neutrality in the energy sector by 2020[2]. However, the Maldives Scaling Up Renewable Energy Investment Plan (SREP-IP) 2013-17 eventually help establish the renewable and solar energy targets with respect to installed capacity and investment requirements. Key planned interventions as part of the SREP-IP include:[3]

- Investment of USD 69.5 million towards installation of 19 MW of renewable energy, including 15 MW of solar PV and 4 MW of waste to energy in the Greater Male region
- Finance renewable energy projects in 10 small electricity consuming islands, power system upgrades in 15 islands to become ready for large scale renewable energy deployment, and increased share of renewable electricity up to 30% in 30 islands.

As of 2021, the total installed power capacity in Maldives stood at 600.5 MW with renewable energy sources comprising a meagre 6.4% (38.5 MW) of the total capacity (a significant 44% away from the 50% target set out for 2015). Even though solar energy accounted for 100% of the share within renewable sources (36.5 MW), it forms a low 6% of the total installed capacity.[4]

Figure 12: Total Installed Capacity by Source | 2021



Despite the low share of solar energy in the total national energy mix, the sector has witnessed a steep growth in Maldives, increasing from 0.07 MW to 16.48 MW from 2008 to 2018 (CAGR of 71.71%). Solar energy utilization is primarily driven by electricity consumption in the tourism (resorts and residential islands) and fisheries sector which together account for more than 30% of the GDP of Maldives. In the tourism industry, several resorts operating on individual islands in the Maldives have developed their own solar energy generation capacities in the form of rooftop and floating solar systems. Applications of solar energy in the fisheries sector include using refrigeration to create ice for fish preservation, post-harvest processing, powering cooling systems, and remote lighting on boats, among others. Two state-owned utility companies primarily undertake solar installations, namely the FENAKA Corporation Limited (Fenaka)[5] and the State Electric Company Limited (STELCO).[6]

Imported fossil fuels continue to be the most important source of energy for Maldives with fuel imports accounting for ~10% of its GDP. Approximately half of the fuel imports are for electricity generation with 80% of the fuel imports being diesel. Even though Maldives achieved universal access to electricity in 2008; imported diesel, shipped in small quantities by boat to islands, results in one of the highest costs for power generation (across the whole South Asia) with even the most efficient power plants in the country producing electricity at USD 0.23–0.33 per kWh. For many of the smaller inhabited islands, generation costs could up as high as USD 0.70 per kWh.[7] This is primarily due to lack of economies of scale and poor

1 NEAP 3
2 National Energy Policy and Strategy 2010
3 SREP-IP
4 Government of Maldives
5 Fenaka is a state-owned utility company that provides electricity, water, and sewerage services in the Maldives. Fenaka is working on expanding its solar energy and diesel hybrid capacities and has a current solar energy capacity of 8,245.6 kW.
6 STELCO is the largest government-owned utility company in Maldives and has a total installed capacity of over 90 MW. In 2020, STELCO launched a new solar center and now offers solar rooftop installation and monitoring services.
7 ADB - Roadmap for the Energy Sector 2020-2030

infrastructure resulting in frequent grid losses. Further, operational and maintenance costs are high given the imported fuel must be repeatedly transported from the Greater Male region to the outer islands since most islands lack adequate fuel storage facilities. With per capita electricity consumption standing at 1840 kWh per year and electricity demand projected to grow at 7% per annum[8], there is an urgent need for Maldives to diversify its energy sources and reduce its dependence on imported fossil fuels. Currently, very few islands in the Maldives have renewable energy sources feeding into their grids.[9]

The National Strategic Action Plan (SAP) for Maldives (2019–2023) includes new renewable and solar energy targets for 2023, including the increase of share of renewable energy in the national energy mix by 20% compared to 2018 levels, installation of at least 10 MW of solar PV under net metering regulation, and increasing renewable energy storage capacity to 30 MWh.[10] The Maldives Energy Sector Roadmap outlines two scenarios that could enable Maldives to increase its renewable energy generation capacity and accelerate net zero transition. The Transformation Scenario aims to achieve the unconditional and a large part of the conditional GHG emission reduction targets as established in Maldives' NDC. This would result in a moderate transformation leading to 44% share of renewable energy in the energy matrix and 53% reduction in diesel compared to business as usual. It entails 435.1 MW of total installed capacity by 2030, including 244.1 MW (56%) of solar energy, required an investment of USD 1.2 billion. On the other hand, the Paradigm Shift Scenario represents a large national effort for a truly transformational change in the country to achieve its vision of net zero by 2030. This would result in a 100% share of renewable energy and 100% reduction in diesel compared to business as usual. This scenario would require 879.6 MW of installed capacity by 2030, including 334.6 MW (38%) of solar energy and demonstrates an investment requirement of over USD 2.2 billion.[11]

Solarization Potential of Maldives

With solar irradiance of 5.4–6.4 kWh per m2 and 280–300 sunny days per year[12], Maldives demonstrates immense prospects for solar energy. Annual solar PV output is estimated to be 1,530–1,600 kWh per kilowatt peak with low seasonal variability. Further, solar energy is more cost effective than diesel-powered generation with bidding prices having reduced from about USD 0.21 per kWh in 2014 to nearly USD 0.11 per kWh in 2019. This is significantly lower than the cost of diesel-powered generation, which averages from USD 0.19 to USD 0.33 per kWh.[13]

By 2030, Maldives could potentially produce 418 GWh electricity from solar energy. This would include 335.6 MW of installed capacity, including 140.7 MW of ground-mounted solar, 150 MW of floating solar and 44.9 MW of rooftop solar. Resort islands are projected to make up a significant portion (84.5 MW) of the potential installed capacity. Further, the Preparing Outer Island Sustainable Electricity Development (POISED) Project will support 30.2 MW of solar PV installations. Maldives is also looking to increase its existing hybrid diesel-solar power plants while upgrading the existing diesel power plants (to hybrid). By 2030, the country could add 24 MW of new hybrid power plants and upgrade 83 MW of diesel power plants to hybrid. [14]

Given the paucity of land and a 100% electrification rate, ground-mounted solar and decentralized technologies such as solar home systems and mini-grids do not hold a significant prospect in the island nation.

Moreover, to reduce dependence on fossil fuels, adoption of solar PV with battery storage (BESS) to displace diesel generation in the five major islands of Maldives – Greater Male, Addu, Fuvahmulah, Hulhumeedhoo, and Thimarafushi – has the potential to benefit more than 480,000 people.[15]

8 Island Electricity Data Book 2019
9 World Bank - ARISE
10 National Strategic Action Plan (SAP) for Maldives (2019–2023)
11 Maldives Energy Sector Roadmap (to be published)
12 Global Solar Atlas - Maldives
13 ADB - Brighter Future for Maldives Powered by Renewables
14 ADB - Brighter Future for Maldives Powered by Renewables
15 ESMAP and WBG - Energy Storage Roadmap for the Maldives

A minimum capital investment of USD 44.5 million to install 29.6 MW of solar PV and USD 35.8 million for 26.4 MWh of BESS would save the Maldives USD 96.4 million on diesel and lube oil expenses over 20 years (2020–2040). In addition, it could defer USD 17.5 million in capital expenses of diesel generator purchases, reduce carbon externalities by USD 13 million, and reduce total CO2 emissions of the Maldives by 445,000 tons.[16]

Table 16: Solar PV and BESS Potential to Displace Diesel Generation

Source	Greater Male	Addu	Fuvahmulah	Hulhumeedhoo	Thimarafushi
Solar PV Capacity (MW)	10	11.6	5	2	1
BESS Capacity (MW)	10	8.4	5	2	1
BESS Energy Capacity (MWh)	40	33.6	20	8	4
Diesel Capacity (MW)	211.3	24	7.6	1.6	1.2
Solar PV Investment (USD million)	14.3	16.8	8.4	3.4	1.7
Battery Investment (USD million)	12.8	12.8	6.4	2.6	1.3
Diesel and Lube Oil Savings (USD million)	32.2	34	18.8	8	3.4
CO2 Reduction (kilo tons)	140.2	163.5	89.5	37.3	14.8
PV + BESS LCOE (USD per kWh)	0.14	0.097	0.111	0.111	0.111

Source: ESMAP and WBG - Energy Storage Roadmap for the Maldives

Investment Needs and Landscape

Maldives to meet its renewable and solar energy targets set as part of the National Strategic Action Plan (SAP) for Maldives (2019–2023), requires investments worth USD 1 billion across the value chain of generation, transmission, and distribution. Specifically, the installation of at least 10 MW of solar PV under net metering regulation and increase of BESS capacity to 30 MWh by 2023 is estimated to require USD 60–90 million each.[17] If Maldives is able to achieve 70% of its total national energy mix to be sourced from renewable energy, estimates suggest that by 2040, the net present value of benefits in terms of fuel import and subsidy savings would outweigh the investment costs. [18]

Multilateral agencies such as the World Bank and the Asian Development Bank are the primary investors in the solar energy sector of Maldives. In addition to funding new installations, investments are increasingly flowing towards BESS. For instance, both the Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) and The Accelerating Renewable Energy Integration and Sustainable Energy (ARISE) projects of the World Bank have a dedicated BESS component to ensure integration of variable solar energy and reliable supply in a cost-efficient manner. Further, the Preparing Outer Islands for Sustainable Energy Development (POISED) project by the Asian Development Bank (ADB) has commissioned BESS systems of 7 MWh in more than 50 outer islands in Maldives. On the other hand, domestic funding for the sector is limited to the Bank of Maldives demonstrating a crucial lack of local commercial sources of capital.

16 ESMAP and WBG - Energy Storage Roadmap for the Maldives
17 World Bank - ARISE
18 World Bank - Maldives Development Update

Table 17: Key Existing Financing Facilities for Solar Energy in Maldives

Financing Facility	Financiers	Objective
Green Loan[19]	Bank of Maldives	Finance green technology to create a more sustainable community; it is also Shariah compliant, thereby available for both personal and business customers, and the BML Islamic Green Financing

Features

- Personal Banking Customers: Amount: MVR 50,000–500,000 without any additional security | Interest rate: 12% p.a.
- Personal and Business Customers: Amount: MVR 50,000–20 million with additional security | Interest rate: 10% p.a.
- 15% equity required for facilities with additional security
- Tenors: financing below MVR 500,000, tenor is up to 5 years; financing above MVR 500,000, tenor is up to 20 years

Financing Facility	Financiers	Objective
Solar Power Development and Energy Storage Solution[20]	Asian Infrastructure Investment Bank (AIIB)	Increase generation capacity from renewable energy sources and to facilitate the integration of renewable energy into Maldives' grid infrastructure

Features

- Development of 36 MW solar power project and 50 MWh of BESS
- USD 20 million sovereign-backed loan for 31 years

Financing Facility	Financiers	Objective
Accelerating Sustainable System Development Using Renewable Energy Project[21]	Asian Development Bank (ADB)	Improve energy security and sustainable transition of the power sector in Maldives and increase the share of renewable energy in Maldives' power generation mix

Features

- USD 73.43 million to increase private sector investments in renewable energy
- USD 3.83 million for de-risking solar IPP projects
- USD 7.97 million for renewable energy penetration using new technologies
- USD 5.14 million for capacity building of relevant regulators
- USD 5.55 million for disaster-resilient, innovative and gender- and socially-inclusive renewable energy-based farming technologies pilot-tested and promoted

19 Bank of Maldives – Green Loan
20 AIIB – Solar Power Development and Energy Storage Solution
21 ADB – Accelerating Sustainable System Development Using Renewable Energy Project

Financing Facility	Financiers	Objective
Preparing Outer Island Sustainable Electricity Development (POISED) Project[22]	Asian Development Bank (ADB), Strategic Climate Fund, Islamic Development Bank, European Investment Bank, Japan Fund for the Joint Crediting Mechanism	Replace inefficient diesel-based power generation grids with hybrid systems, including solar PV and diesel with BESS and EMS, to reduce both - the cost of electricity and the emissions, as well as lower the subsidy burden on the government budget

Features

- Install equipment for solar diesel hybrid grids on 160 islands
- USD 38 million grant from ADB
- USD 12 million grant from the Strategic Climate Fund
- USD 10 million loan from the Islamic Development Bank
- USD 50 million loan from the European Investment Bank
- USD 5 million grant from the Japan Fund for the Joint Crediting Mechanism

Financing Facility	Financiers	Objective
Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE)[23]	World Bank, Clean Technology Fund	Enable private sector investment in PV infrastructure development; and diversify the investment base in Maldives through developing a local market and expertise in renewable energy

Features

- USD 122 million of grant, guarantee, and loan for solar PV risk mitigation
- USD 36 million IDA guarantee
- USD 17 million CTF concessional loan with 40-year maturity for BESS
- USD 3 million CTF grant for technical assistance

Financing Facility	Financiers	Objective
Accelerating Renewable Energy Integration and Sustainable Energy (ARISE)[24]	World Bank, Clean Technology Fund	Demonstrate the operational and economic feasibility of innovative renewable energy technologies and battery energy storage solutions (BESS)

Features

- USD 122 million of grant, guarantee, and loan for solar PV risk mitigation
- USD 36 million IDA guarantee
- USD 17 million CTF concessional loan with 40-year maturity for BESS
- USD 3 million CTF grant for technical assistance

22 Asian Development Bank – POISED Project
23 World Bank - ASPIRE Project
24 World Bank - ARISE Project

Financing Facility	Financiers	Objective
CIF Technical Assistance (TA) Facility for Clean Energy Investments[25]	Climate Investment Fund	Address key barriers in policies, regulations, and capacity to enable further scale up of renewable energy and mobilize private sector investment

Features

- USD 150,000 for enabling offshore floating solar PV and other innovative technologies
- USD 150,000 to support the design and implementation of a revised net metering solution

Source: Intellecap Research

Two key solar segments emerge as focus areas demonstrating critical solarization potential for Maldives, i) Floating Solar; ii) Rooftop Solar. Combined, the two solar technologies present a capacity potential of 259.9 MW requiring USD 233.9 million. Given the paucity of land and a 100% electrification rate, ground-mounted solar and decentralized technologies such as solar home systems and mini-grids do not hold a significant prospect in the island nation.

25 CIF - TAF Project

FINANCING INTERVENTIONS ACROSS EMERGING SOLAR SEGMENTS

Floating Solar

Current Status

Floating solar PV systems is being explored as an alternative to ground-mounted PV in Maldives. These are platforms moored in the sea with mounted PV arrays on top. The PV floating platforms are connected to the grid of the island using a submarine cable. The floating solar PV platforms must be placed in areas close to the islands and with low wave activity to ensure their operation.

The first floating solar power plant in Maldives was installed by Swimsol, a private Austrian developer, in 2014. It had a capacity of 15 kW. Since the first installed floating solar system in 2014, multiple installations have been undertaken in the island nation; however, their long-term sustainability and cost efficiency is still being determined.

Solarization Potential

The Road Map for the Energy Sector (2020–2030) for Maldives estimates 150 MW of installed capacity potential by 2030 for floating solar under the paradigm shift scenario i.e., 100% renewable energy share in electricity generation compared to a business-as-usual (BAU) situation. As a part of the base case scenario i.e., 44% renewable energy share and 53% reduction in fossil fuels against BAU, the Road Map estimates 110 MW of total installed capacity by 2030. The potential for floating solar is majorly driven by the resort, industrial and agricultural islands, and the Greater Male region, presenting 60 MW each of estimated installed capacity by 2030.[1]

Table 18: Floating Solar Potential by Location | 2030

Location	Base Case	Paradigm Shift
Resorts, Industrial, and Agricultural Islands	20 MW	60 MW
Greater Male Region	60 MW	60 MW
Other Inhabited Islands	30 MW	30 MW

Source: Maldives Energy Sector Roadmap, Asian Development Bank (to be published)

Challenges

Lack of private investment

Investments in the floating solar segment in Maldives are limited to multilateral agencies and the Government of Maldives. The private investment climate is very nascent with developers and lenders perceiving Maldives to be a high-risk market. This is primarily due to the weak financial position of the state-owned utilities resulting in high off taker risk, lack of cost-reflective tariffs, and currency inconvertibility risks. Moreover, the floating solar PV systems are a relatively new technology which further restrains private commercial investors from funding given the lack of technical know-how. However, incentivizing private investments would be crucial given opportunities for public financing are increasingly becoming limited due to the Government of Maldives facing substantial foreign debt burden and high risk of debt distress.

Limited pipeline of projects impacting investor's confidence

Despite a potential of 150 MW by 2030, currently only 10 MW of floating solar is in the pipeline in Maldives.[2]

1 Maldives Energy Sector Roadmap, Asian Development Bank (to be published)
2 Project Appraisal Document - Accelerating Renewable Energy Integration and Sustainable Energy, World Bank, November 2020

Development of a robust pipeline would not only attract investors but also help the Government track progress against designated targets. Pipeline development would require identification of appropriate project sites, pre-feasibility and feasibility studies, preparation of safeguard instruments, and technical and transaction advisory for the tendering process.

Lack of technical know-how

Maldives has limited experience in building and operating floating solar PV with respect to both, the number of projects and size of individual projects. This also limits the technical know-how required to sustainably operate such systems and ensure their commercial viability. There is a need for capacity building programs that provide training to conduct feasibility studies, understand relevant policy and regulatory frameworks, develop standard contracts, incorporate different risk allocation, and gain necessary skills for constructing and operating floating solar systems.

Financing interventions

The resort, industrial and agricultural islands in Maldives are the primary driving force behind floating solar deployment. The proposed funding focuses on:

- Need to establish techno-commercial viability of the floating solar technology
- Need to leverage the huge potential offered by inhabited and resort islands
- Commercial and concessional capital in combination with risk mitigation instruments are required to lower the high cost of capital required in deploying floating solar systems
- Financing instruments include debt for established and innovative enterprises combined with partial credit guarantees and capital support for insurance premium

The proposed facility is likely to focus on market development, increased enterprise and project bankability, and technical assistance for strengthening state-owned utilities and efficient design and implementation of BESS and VRE integration policies.

Table 19: Envisaged Deployment of Funds for Floating Solar in Maldives

Nature of Financing

Enterprise financing for established enterprises

Financing Recipient	Instrument	Purpose
Commercial lenders The fund to provide debt to commercial lenders that would on-lend to established floating solar enterprises, such as Swimsol and Renewable Energy Maldives (REM)	**Debt** • Interest rate: 2%[3] • Term: 25+5 years[4] • Local currency financing • Collateral: Structured to match the generated cash flows / asset-based collateralization • Average solar IRR = 8-9%[5]	**Growth to mature enterprises** • Diversify product and revenue streams • Invest in working capital • Expand market and consumer base

3 Public Sector Financing: ADB (as of June 2023)
4 Ibid
5 Project Appraisal Document - Accelerating Renewable Energy Integration and Sustainable Energy, World Bank, November 2020

Financing Recipient

Commercial lenders

The fund to provide partial credit guarantees to commercial lenders as a risk mitigation instrument

Instrument

Partial credit guarantees

- Amount: Lowest level required to mobilize funds / <25% of total assets / USD 250 million[6]
- Term: <15 years
- Cost: front-end + guarantee + commitment fee
- NPL ratio = 6% (Dec '22)[7]

Purpose

Growth to mature enterprises

Mitigate credit payment risk for lenders

Expected Outcomes

- Lower overall cost of financing, catalyze commercial capital, and increase private-sector led development
- Mitigate high-risk perception of commercial lenders to attract commercial and private capital into the sector
- Enable techno-commercial viability of projects
- Improve the scale of operation of floating solar projects

Nature of Financing

Enterprise financing for innovative enterprises

Financing Recipient

Commercial lenders

The fund to provide debt to commercial lenders that would on-lend to innovative floating solar enterprises operating at an early-stage and offering tech-enabled solutions for floating solar

Instrument

Debt

- Interest rate: 2%[8]
- Term: 25+5 years[9]
- Local currency financing
- Collateral: Structured to match the generated cash flows / asset-based collateralization
- Average solar IRR = 8-9%[10]

Purpose

Early to growth enterprises

- Diversify product and revenue streams
- Invest in working capital
- Expand market and consumer base

Expected Outcomes

- Drive technology-based innovation, particularly for hybrid models that leverage solar and ocean energy
- Demonstrate business case, create bankability, and catalyze commercial capital
- Create bankable pipeline of enterprises
- Support project development and performance monitoring

6 Public Sector Financing: ADB (as of June 2023)
7 Maldives Monetary Authority Annual Report, Maldives Monetary Authority – Republic of Maldives, 2023
8 Public Sector Financing: ADB (as of June 2023)
9 Ibid.
10 Project Appraisal Document - Accelerating Renewable Energy Integration and Sustainable Energy, World Bank, November 2020

Nature of Financing

Insurance premium for floating solar assets

Financing Recipient

Commercial lenders

The fund to cover cost of insurance, such as property risk insurance or general liability insurance, floating solar developers as a risk mitigation instrument

Instrument

Debt

- Cost covered for first two years
- Insurance underwriting: Risk engineering, assessment, rating, specify coverage, T&C, and exclusions

Purpose

Early to growth enterprises

Mitigate damage or loss of assets and risks inherent to construction and installation

Expected Outcomes

- Lower overall cost of financing by offsetting insurance cost
- Improve the overall IRR of the project and improve project cashflows, leading to enhanced likelihood of securing debt financing

Rooftop Solar

Current Status

Rooftop solar projects in Maldives are developed via a net-metering tariff scheme, or by the private sector after signing Power Purchase Agreements (PPA) with STELCO or through a utility-level rooftop solar PV as undertaken by the POISED project. With respect to the former, the Net Metering and Interconnection of Renewable Energy Installations to Distribution Network Regulation was launched in 2015 in Maldives. Individuals installing renewable energy on their rooftops get paid within six months for excess units generated from installation. However, regulatory barriers remain regarding remuneration mechanisms for larger installations. The installation of rooftop solar projects in the Greater Male' Region has been successful in the past two years because of the net-metering tariffing system offered to building owners.

PPAs with STELCO started in 2014 with the Six Island Solar PV Project in 2014 becoming the first project in Maldives completed under a PPA signed between STELCO and Renewable Energy Maldives (REM). A total of 652 kW PV panels were installed on six different islands. Currently, the ASPIRE project is supporting installations of solar PV panels through PPA contracts with STELCO. For instance, the ASPIRE project supported a PPA contract for 1.5 MW of rooftop solar PV in Hulhumale wherein the private developer was awarded as an IPP through international competitive tendering. The IPP would sell electricity to STELCO at a fixed price of USD 0.21 per kWh under a 20-year PPA. This price is lower than the all-in cost of diesel-based power generation in Maldives.[11]

Solarization Potential

Cumulatively, Maldives has the potential to install 109.9 MW of rooftop solar by 2030. The Road Map for the Energy Sector (2020–2030) for Maldives estimates 99.9 MW of installed capacity potential by 2030 for rooftop solar under the paradigm shift scenario i.e., 100% renewable energy share compared to a BAU situation. As a part of the base case scenario i.e., 44% renewable energy share and 53% reduction in fossil fuels against BAU, the Road Map estimates 49.2 MW of total installed capacity by 2030. In addition, the

11 Project Appraisal Document - Accelerating Sustainable Private Investments in Renewable Energy, World Bank, January 2020

SAP 2019-2023 has set a target for at least 10 MW of rooftop solar PV installation under net metering by 2023.[12]

Table 20: Rooftop Solar Potential by Location | 2030

Location	Base Case 44% renewable energy share	Paradigm Shift 100% renewable energy share	Year
Rooftop PV: Resort Islands	20 MW	60 MW	2020-2030
Rooftop PV: Addu	4.6 MW	4.6 MW	2020-2025
Rooftop PV: Hulhumale	11 MW	11 MW	2020-2030
PV Panels: Gulhifalhu / Thilafushi	12.3 MW	23 MW	2020-2025
PV Panels: Villingili	1.3 MW	1.3 MW	2020-2030

Source: Maldives Energy Sector Roadmap, Asian Development Bank (to be published)

The Greater Male region holds the highest potential for rooftop solar installations in the Maldives. The installation of rooftop solar PV panels in the Greater Male' Region has increased in the past five years reaching more than 3 MW at the beginning of 2020. The base case scenario estimates that up to 14.5 MW of rooftop PV panels under net-metering tariffing conditions can be installed, while the paradigm shift scenario increases this target to 20 MW. With respect to commercial / industrial customers, the base case scenario estimates 10 MW of commercial rooftop solar project; while the paradigm shift scenario estimates 18 MW, all under a PPA arrangement. Depending on the roof-top surface utilized, estimates suggest that Male has the potential to generate a yearly average of 4.75 GWh to 8 GWh of electricity from rooftop solar systems.[13]

Challenges

Difficulty in aggregating investments

Aggregating investments towards rooftop solar has proven to be difficult due to private investors showcasing concerns with respect to payment defaults from state-owned utilities, currency convertibility issues, and the limited experience of utilities with public-private partnerships. The concerns are exacerbated due to the relatively small market size, lack of a national grid, remoteness of most islands, and the scarcity of rooftop space. Multilateral agencies and the Government of Maldives have attempted to mitigate some of these concerns.[14]

Limited experience with IPPs

State-owned utilities have a limited track record with respect to PPAs with IPPs – STELCO has only entered into two PPAs, while Fenaka has no experience with IPPs. Financial, technical, and legal advisors need to be engaged to develop standardized project documents that meet international standards of tendering and contracting.

Financing interventions

There is significant potential for rooftop solar installations for residential and C&I consumers, particularly the resort industry of Maldives. The proposed funding focuses on:

- Aggregation of private-led development is required to fully realize the potential of rooftop solar, particularly for C&I and public buildings
- BESS integration needs significant capital to address power intermittency issues, reduce reliance on diesel-power generation and fossil fuel imports, and lower cost of electricity

12 Brighter Future for Maldives Powered by Renewables, Asian Development Bank, November 2020
13 Brighter Future for Maldives Powered by Renewables, Asian Development Bank, November 2020
14 Maldives SREP Investment Plan 2013-2017, Ministry of Environment and Energy – Republic of Maldives, October 2012

- Financing instruments include debt and partial credit guarantees for enterprises

There is significant potential for rooftop solar installations for the resort islands of Maldives. The capital from the proposed facility could focus on market expansion and support to ensure its commercial viability.

Table 21: Envisaged Deployment of Funds for Rooftop Solar in Maldives

Nature of Financing

Enterprise financing for established enterprises

Financing Recipient	Instrument	Purpose
Commercial lenders The fund to provide debt to a commercial lender that would on-lend to rooftop solar enterprises operating at growth-to-mature stage	**Debt** • Interest rate: 2%[15] • Term: 25+5 years[16] • Local currency financing • Collateral: Structured to match the generated cash flows / asset-based collateralization • Average solar IRR = 8-9%[17]	**Growth to mature stage enterprises** • Diversify product and revenue streams • Invest in working capital • Expand market and consumer base
Financing Recipient	**Instrument**	**Purpose**
Commercial lenders The fund to provide partial credit guarantees to commercial lenders that would on-lend to rooftop solar enterprises operating at growth-to-mature stage	**Debt** • Amount: Lowest level required to mobilize funds / <25% of total assets / USD 250 million[18] • Term: <15 years • Cost: front-end + guarantee + commitment fee • NPL ratio = 6% (Dec '22)[19]	**Growth to mature enterprises** Mitigate credit payment risk for lenders

Expected Outcomes

- Leverage impact potential of rooftop solar for the resort industry, and enable aggregation of private-led development
- Mitigate high-risk perception of commercial lenders
- Lower overall cost of financing, and catalyze commercial capital
- Enable commercial viability of projects, and scale rooftop solar installations, facilitating a robust project pipeline
- Enable commercial viability of projects

15 Public Sector Financing: ADB (as of June 2023)
16 Ibid.
17 Project Appraisal Document - Accelerating Renewable Energy Integration and Sustainable Energy, World Bank, November 2020
18 Public Sector Financing: ADB (as of June 2023)
19 Maldives Monetary Authority Annual Report, Maldives Monetary Authority – Republic of Maldives, 2023

BESS for Floating and Rooftop Solar

Table 22: Envisaged Deployment of Funds for BESS in Maldives

Nature of Financing

Project financing for BESS component of floating and rooftop solar projects

Financing Recipient

Commercial lenders

Fund to provide PCGs to commercial lenders as a risk mitigation instrument

Instrument

Partial credit guarantees

- Amount: Lowest level[20] required to mobilize funds / <25% of total assets / USD 250 million
- Term: 25+5 years
- Cost: front-end + guarantee + commitment fee
- NPL ratio = 6% (Dec '22)[21]

Purpose

Construction and development

Development of battery bank infrastructure for floating and rooftop solar projects

Financing Recipient

Commercial lenders

Fund to provide long-term debt finance to commercial lenders to on-lend to IPPs and rooftop solar enterprises for funding construction and development of BESS integration

Instrument

Long-term debt financing

- Share: up to 50%
- Interest rate: 2%
- Term: <15 years, including <4 years grace
- Local currency financing | IRR: 8-10%[22]

Financing Recipient

Government of Maldives

Fund to offer Government for supporting IPPs according to PPA and implementation agreement; amt. linked to performance

Instrument

Tariff buydown grant

- Share: up to 10%
- Reduce the impact of financial costs of IPPs on the tariff
- Local currency financing
- IRR: 8-10%

Expected Outcomes

- Risk mitigation for commercial lenders – increased private investor interest.
- Address variability of power output and allow continuous service despite fluctuations in supply and demand.
- Smooth the supply of electricity and reduce the need for back up diesel generation.
- Lower system cost by offsetting peak load.
- Enable access to capital for financing high upfront costs and eventually reduce cost of BESS.
- Increase project bankability through feasibility studies.
- Increase efficiency of existing generators by replacing their reserve requirements.
- Propagation of innovative technological solutions for energy management systems for BESS deployment, especially in the micro grids segment.

20 Public Sector Financing: ADB (as of June 2023
21 Maldives Monetary Authority Annual Report, Maldives Monetary Authority – Republic of Maldives, 2023
22 Stakeholder consultations conducted by Intellecap

Technical Assistance for Floating and Rooftop Solar

Nature of Financing
Technical Assistance

Financing Recipient
Enterprise

Instrument
Grant

Purpose
Pre- and post-disbursal of loan

- Provide training to undertake project-level techno-economic analysis, including economic costs and benefits, installation and battery sizing, round-trip efficiency, response time, etc.
- Capacity building for BESS integration to avoid power intermittency

Expected Outcomes

- Increased and efficient end-to-end deployment of floating and rooftop solar projects, including development and O&M
- Regular power supply and reduced reliance on diesel-powered generation

Financing Recipient
FENAKA, STELCO, MoECCT

Purpose
Pre-construction and development

- Training to conduct pre-bid consultation to ensure sync with procurement guidelines, and design a transparent competitive bidding process
- Policy-based training to design segment-specific targets, and develop national guidelines and policies for safe disposal and recycling of batteries

Expected Outcomes

- Effective implementation of net metering policies
- Efficient implementation, commercialization, and monitoring of projects

Financing Recipient
Commercial lenders

Purpose
Pre-disbursal of loan

- Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria
- Pre-investment due diligence and post-investment M&E
- Integration of Environmental Impact Assessment (EIA) / climate risk and
- Environmental, Social, Government (ESG) risk rating

Expected Outcomes

- Increase credit deployment due to improved technical and commercial understanding of the solar sector
- Improved knowledge on segment-specific risk models and due diligence criteria

CHAPTER 5
NEPAL

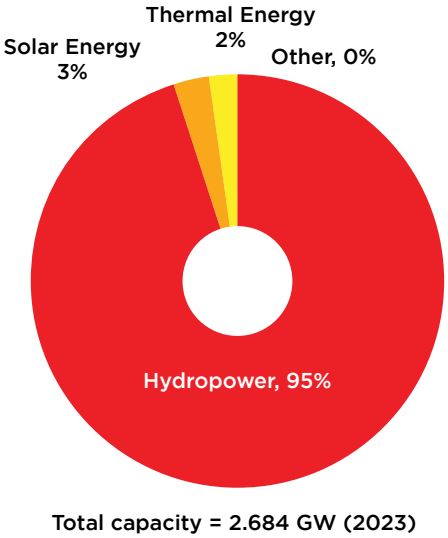
SOLAR ENERGY SECTOR OVERVIEW

Current Status of Solar Energy Sector in Nepal

Nepal has trebled its installed capacity from 0.8 GW[1] in 2010 to 2.684 GW[2] in 2023 – primarily through hydropower sources. Hydropower is the predominant source of power with 94.6% of electricity generated through it. Other sources of power in the country include solar energy (3.2%), thermal energy (2%) and bagasse-based energy (0.2%). Access to electricity in the country is over 95%[3] and around 5.31 million[4] people have access to grid-based electricity.

Hydropower remains a priority area for the Government of Nepal (GoN) due to abundant availability of hydro resources. However, hydropower generation has its own set of challenges. Even though Nepal remains energy surplus in summers (wet season) with peak hydropower generation, it faces acute power shortages in the winter months (dry season). This is primarily due to the run-off-river (ROR) nature of hydropower plants in the country. Winters in Nepal are long and dry with low rainfall, providing inadequate flow to rivers leading to low power generation. Further, accessibility and operation of hydropower stations located at high elevations remains a challenge in winters leading to unreliable power supply in winter months. To address the energy shortages in the winter months, the Nepal Electricity Authority (NEA) imports electricity from India at relatively higher market prices. Although Nepal has been able to reduce the quantum of power imported from India to meet its electricity requirements, it still remains dependent for power on India to meet the demand during winters.

Figure 13: Installed Capacity Mix | 2023



Total capacity = 2.684 GW (2023)

Hydropower resources alone would not be able to meet the growing demand for electricity in Nepal. The MoEWRI has estimated the electricity demand electricity demand at 20,073 GWh by 2030[5] in BAU scenario which would be 87% over the current electricity consumption of 10,693 GWh[6]. The electricity demand in other scenarios is expected to grow further compared to the current electricity consumption.

The need for diversification of power generation sources to reduce dependence on hydropower, addressing the problem of seasonal variation, declining solar module prices, and growing electricity demand along with supportive policies have necessitated the shift towards solar energy sector in Nepal. At present, Nepal has around 120.2 MW of solar installed capacity including 86.94 MW[7] of utility scale solar, 30 MW[8] rooftop solar, and 3.26 MW[9] off-grid solar capacities.

With a focus on using clean and green energy, the GoN introduced numerous programmes and policies to promote integration of other renewable energy into its grid-based power generation. In 2016, the GoN laid out a plan to incorporate 5-10%[10] of renewable energy, primarily solar energy, in the total generation mix by

1 Tariff Based Competitive Procurement of Solar Power In Nepal, USAID, June, 2022
2 Annual Report, Nepal Electricity Authority, 2022-23
3 Ibid.
4 Ibid.
5 Electricity Demand Forecast Report 2015-2040, MoEWRI
6 Ibid.
7 Ibid.
8 Techno-Economic Feasibility Study of Net-metering Implementation in Rooftop Solar PV in Nepal, Journal of the Institute of Engineering
9 Annual Report, Alternative Energy Promotion Centre, 2021-22
10 Ibid.

2026. Furthermore, GoN announced plans to procure solar projects only through a competitive process and included a tariff-based procurement of solar projects.

Solarization Potential of Nepal

With a solar potential of 50,000 terawatt-hours per year, Nepal's solar energy resource stands at around 100 times more than its hydropower resources[11]. Furthermore, estimated commercial potential for on-grid solar PV systems in Nepal is 2.1 GW[12]. Large parts of Nepal have immense solar energy potential with specific solar photovoltaic (PV) electricity output capacity within the range of 1,400 kWh/kWp to 1,600 kWh/kWp and average daily total ranging from 3.8 to 4.4 kWh/kWp/m^2 [13]. Eight sites in Nepal (including Simikot, Bidar, Jomsom airport, Pokhara airport, Nepalgunj Manikpur airport, Kathmandu airport, Khandbari and Biratnagar airport) are suitable for solar photovoltaic power production based on solar climate zones, which also coincide with the position of airports or regionally important cities. Amongst the eight locations, Jomsom has the highest potential solar power output.

Investment Needs and Landscape

Even though Nepal has been making significant strides in adding solar to its overall energy mix to reduce its dependency on a single source of power, there exist critical challenges in scaling-up the resource deployment. The existing challenges in the solar sector have been elaborated below:

Conducive policy and regulatory environment

Although the MoEWRI has established guidelines for promotion of solar energy in Nepal, the policy and regulatory landscape for solar sector is still at a nascent stage with restrictions and complex processes. Setting-up a solar project, primarily solar projects with 1 MW or above installed capacity, requires multiple licenses – survey, generation and construction licenses - all of which are provided by Department of Electricity Development (DoED) to solar developers. Further, developers are required to apply for permissions to link solar projects into the national grid. In addition to this, solar developers are required to make arrangements for power evacuation to the NEA sub-stations and for any extra land required for setting-up transmission and distribution lines. The delays in acquiring the requisite licenses and permissions often leads to cost and time overruns for solar projects, deterring developers and investors from the sector.

NEA, the sole off-taker in Nepal, reduced the benchmark electricity purchase price from USD 0.055/kWh (NRs. 7.30/kWh) to USD 0.045/kWh (NRs. 5.94/kWh)14 in view of the global falling prices of solar panels. In contrast, the prices of solar panels have increased due to geopolitical situations across the globe leading to supply chain disruptions. Consequently, developers have been facing challenges in establishing profitable project economics and attracting investments for their projects. Even though, the GoN has taken significant steps to ease the commissioning of projects, policy and regulatory challenges remain critical roadblocks for scaling-up of solar in Nepal.

Access to finance

Access to long-term affordable finance due to limited financing options is a significant challenge in Nepal's solar sector. At present, a handful of local financing institutions in Nepal lend for solar projects. Institutions that lend offer high cost and short-term finance, posing challenges for solar developers in managing high upfront capital requirements with low or no project margins. For instance, Nepal Merchant Banking and Finance Ltd (NMB) offer debt at 10-12% [1 to 3% above base rate (9.85%)] for a period up-to 5 years for solar projects.[15]

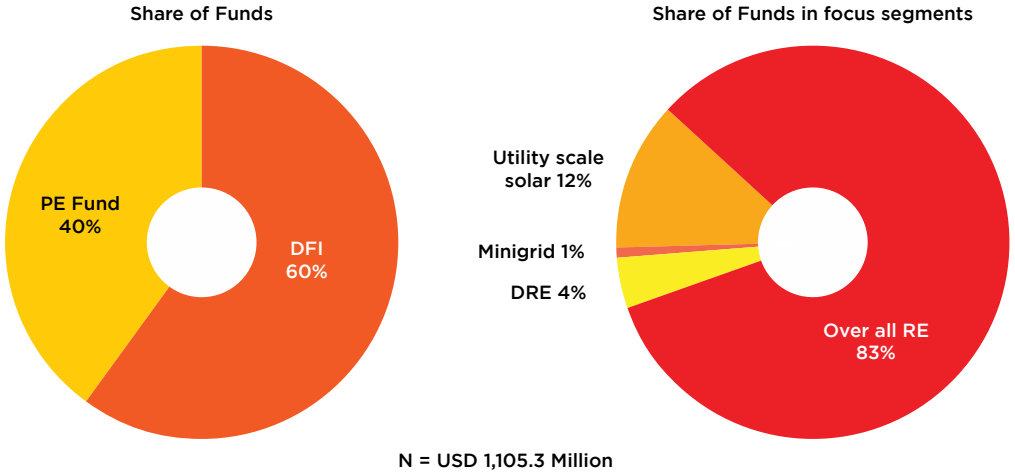
As Nepal's solar sector is at a nascent stage, it is perceived as a high-risk sector by financiers and investors,

11 Solar Energy with pumped storage hydro in Nepal, International Hydropower Association, 2021
12 Renewable Energy in Nepal: Potential, Policy and Challenges, Nepal Agriculture Engineers' Society, 2023
13 Solar Resource And Photovoltaic Potential of Nepal, The World Bank, March, 2017
14 Call for favourable policy to raise share of solar power in energy mix, The Kathmandu Post, October 17, 2023
15 Nepal Merchant Banking and Finance Limited, Accessed on October 21, 2023

especially by foreign investors. Lack of adequate risk management products to hedge the interest rate and foreign currency risks are critical factors that have contributed to this high-risk perception. [16]Further, lack of credit rating certified by external credit rating agency and unclear regulatory and policy ecosystem for financing have added to the existing challenges of access to long-term financing. Additionally, there is a lack of scale in the existing private sector financing in the absence of bankable projects and business models resulting in dependence on Multi-lateral Development Banks (MDBs) and Development Financing Institutions (DFIs) for financing.

DFI such as Asian Development Bank (ADB), KfW, The World Bank amongst others and the GoN are the major funders in Nepal's energy sector with majority of the funds directed to the development of overall renewable energy sector. At present, hydropower projects remain the major recipient of the total renewable energy funding in Nepal. In the absence of a dedicated solar financing facility that caters to the development of solar sector specifically, segments such as rooftop solar and productive use of solar technologies remain underserved with no targeted funding.

Figure 14: Current Status of Funding in Focus Segments[17]



16 Overview of Foreign Direct Investment in Nepal, Nepal Economic Forum, March 7, 2022
17 Intellecap Research

FINANCING INTERVENTIONS ACROSS EMERGING SOLAR SEGMENTS

Utility-Scale Solar

Current Status

Utility scale solar is one of the major solar segments in Nepal with a total installed capacity of 86.94 MW[18]. Of the installed capacity, 25 MW is through Nuwakot solar farm, and 61.94 MW is through Independent Power Producers (IPPs).

Table 23: IPP Solar Power Projects in Nepal[19]

Project Name	Location	Installed Capacity (MW)
Solar Project	Lalitpur	0.684
Bishnu Priya Solar Farm Project	Nawalparasi	0.96
Butwal Solar Project	Rupandehi	8.5
Mithila Solar PV Electric Project	Dhanusha	10
Chandranigahpur Solar Project	Rautahat	4
Belchautara Solar Project	Tanahun	5
Dhalkebar Solar Project	Dhanusha	1
Dhalkebar Solar Project	Dhanusha	3
Simara Solar Project	Bara	1
Grid Connected Solar PV project	Nawalparasi	5
Som RadhaKrishna Solar Farm Project	Kaski	4
Grid Connected Solar Project	Morang	6.8
Grid Connected Solar Project	Nawalparasi	2
Solar PV Project	Banke	10
TOTAL		**61.94**

Due to the prominence of the segment, there has been an influx of capital in the utility scale solar through various sources. For example, total outlay of USD 440 million in form of debt and grant under South Asia Sub-regional Economic Cooperation Power System Expansion Project have resulted in signing of contract with 5 IPPs of a total size of 24 MW[20], out of which 3 IPPs (with size of 11 MW) have commenced construction. This is supported through Viability Gap Funding (VGF) provided to the project developers by the USD 20 million grants[21] under the Scaling up Renewable Energy in Low Income Countries Program (SREP) of the Climate Investment Funds (CIF) administered by the ADB as a part of the project.

Equity-based funding from the private sector is primarily focused on the overall renewable energy sector. For example, only one 5 MW capacity solar farm project at Shuklagandaki Municipality of Tanahun was funded as part of the Dolma Impact Funds I & II in which the total fund size was USD 411.5 million[22].

18 Annual Report, Nepal Electricity Authority, 2022-23
19 Ibid.
20 Nepal : South Asia Subregional Economic Cooperation Power System Expansion Project, Asian Development Bank
21 $20 Million Grant to Spur Private Sector Solar Power Investment in Nepal, Asian Development Bank: News Releases (accessed on December 8, 2016)
22 Dolma Impact Fund

Solarization Potential

Utility scale solar projects have immense potential in Nepal with 2.1 GW commercial potential for grid-based generation. At present, 29 MW[23] capacities of utility-scale solar projects in construction phase and another 24.2 MW[24] are at various stages of development. Further, 760.89 MW[25] capacities of projects have received survey license and 99.36 MW[26] capacity projects have received survey license.

Table 24: Utility-Scale Solar Projects Under Construction and Various Stages of Development

Project Name	Location	Installed Capacity (MW)
Lamahi Solar Project	Dang	3
Duhabi Solar Project	Sunsari	8
Purwanipur Solar Project	Parsa	8
Solar (PV) Project (1032)	Banke	10
Bhrikuti Grid-tied Solar Project	Kapilvastu	8
Suarya Bidyut Project, Shivshakti	Jhapa	10
Grid-connected Solar Project	Surkhet	1.2
Birendranagar, Surkhet Baigundhura Solar Power	Jhapa	5
TOTAL		**53.2**

Challenges

Lack of affordable long-term finance

At present, very few local financing institutions engage in lending for utility-scale solar projects in Nepal. NMB and Nepal Infrastructure Bank Limited (NIBL) are amongst the few banks of financing utility-scale solar projects in Nepal. Financiers perceive utility-scale solar projects as high risk due to uncertainties in project commissioning and lack of bankable projects. As a result, the current solar financing landscape in Nepal is not conducive for utility-scale solar developers. At present, local banks offer short-term (up-to 5 years) debt at 12-12.5% interest rates[27] for solar projects in Nepal, making access to affordable long-term finance a significant challenge for utility-scale solar developers. In addition to this, lack of sectoral knowledge and experience of financiers and their limited capacity to conduct due diligence are hurdles that limit flow of credit to the segment.

High upfront capital requirements and low project margins

Solar developers in Nepal are required to fulfill multiple commercial and financial criteria for ascertaining their ability to take up utility-scale solar projects. The financial obligations of solar developers include bearing cost of bidding documents, submission of bid security fee, furnishing performance guarantee in addition to obtaining survey and construction licenses, arranging for land for project and any additional land for power evacuation, transmission and distribution, all of which require high upfront capital leaving room for negligible or no margins. Developers have a very thin margin since majority of their fund is deployed towards projects – 45 to 50% of the cost for purchasing panels, 25 to 30% for inverters and cables, 10% for purchasing land and 10 to 12% for civil works and boundary fencing[28]. Furthermore, the reduction of benchmark power purchase price from USD 0.055/kWh (NRs. 7.30/kWh) to USD 0.045/kWh

23 Annual Report, Nepal Electricity Authority, 2021-22y
24 Ibid.
25 Construction License: Solar, Department of Electricity Development, Accessed on October 21, 2023
26 Survey License: Solar, Department of Electricity Development, Accessed on October 21, 2023
27 Stakeholder Consultation
28 Nepal Solar Week 2022

(NRs. 5.94/kWh)[29] by NEA has been adversely affecting the solar developers who made initial investments based on USD 0.055/kWh price-20% difference between the present and earlier purchase price. As a result, establishing project bankability remains a challenge for solar developers in the utility-scale solar in Nepal.

Lack of technical expertise

Solar developers in Nepal face significant challenges due to lack of technical understanding and skills to manage large-scale and complex projects as so far, solar power development has largely been in the off-grid segment, primarily pertaining to solar home systems. Furthermore, this has time and cost implications on the projects deterring prospective investment in the segment.

Uncertainty in project commissioning

The NEA is the sole state-owned utility in Nepal and engages in Power Purchase Agreement (PPA) signing with IPPs. The NEA had halted signing PPAs with IPPs for a period of three years from 2019[30] due to lack of clarity on the government's role in bearing additional expenses and policy uncertainties. Consequently, it led to delays in project commissioning for which PPA approvals were submitted and sought from the NEA-creating ambiguity. Further, project developers perceive the bidding process, PPAs, and contract enforcement to be lacking transparency due to the complex and time taking processes.

Lack of conducive policies and regulations

Since 2019, the NEA had set power purchase price at USD 0.055/kWh (NRs. 7.30/kWh)[31]. As of 2022, the NEA reduced the benchmark price to USD 0.045/kWh (NRs. 5.94/kWh) - adding to the woes of the solar developers who made initial investments based on earlier benchmark price[32]. Furthermore, the move of NEA to reduce benchmark price lacked involvement of solar industry stakeholders resulting in discontentment amongst them[33].

Financing interventions

Utility scale solar is the most predominant solar segment in Nepal and has significant scalability potential. The proposed financing focuses on:

- Need for project financing to enable establishment of shared infrastructures - development of project site and evacuation infrastructure for solar park.
- Assistance required on effective policy design and execution for a competitive bidding process to enable private sector led solar power deployment and affordable and commercially viable tariffs.
- Financing instruments include debt along with performance guarantee for projects and debt for enterprises.

The proposed facility could support the market development, deployments to attain scale and ensure enterprise and project bankability. Further, the technical assistance through the financing facility would enable in improving knowledge about the solar sector, strengthening institutional and capacities for project management, strengthening business models of enterprises, and increasing flow of credit to the segment.

29 Call for favourable policy to raise share of solar power in energy mix, The Kathmandu Post, October 17, 2023
30 NEA Puts on Hold Numerous Applications for PPA, IPP look to produce 11,000 MW of Electricity, Urja Khabar: Energy for Prosperity, July 30, 2022
31 Ibid.
32 Utility Seeks Bids to Supply Power to Grid, The Kathmandu Post, June 15, 2023
33 Stakeholder Consultation

Table 25: Envisaged Deployment of Funds for Utility-Scale Solar in Nepal

Nature of Financing

Project financing establishment of solar park

Financing Recipient

NEA

Fund to lend to NEA. The NEA would further on-lend to project special purpose vehicle (SPV) through commercial partner banks such as NMB

Instrument

Debt

- Interest rate: 1% during grace period; 1.5% during amortization period[34]
- Term: 32+8 years[35] grace period
- Local currency financing
- Structured to match the generated cash flows / asset-based collateralization
- IRR of debt: 17%[36]
- GoN to issue guarantee to ADB

Purpose

Shared infrastructure

- ILand development
- Development of roads, water supply and drainage
- Establishment of solar park transmission infrastructure

Expected Outcomes

- Support NEA in achieving grid-parity prices for solar
- Support establishment of large-scale solar parks with private sector participation
- Reduced risks of land acquisition
- Enable economies of scale: minimize cost of civil and electrical construction
- Reduced overall cost of generation and average cost of supply (ACoS) to NEA

Financing Recipient

Commercial lenders

ADB to provide performance guarantee to the commercial lender on-lending to project SPV

Instrument

Performance Guarantee (PCG)

- EMD amount: 5-10% of the project cost
- Tenor: 5 to 10 years

Purpose

Commercial Operation

- Ensure quality and performance of installations
- Mitigate payment risks associated with AT&C losses and curtailing

Expected Outcomes

- Ensure quality and performance of installations
- Mitigate payment risks associated with AT&C losses and curtailing

34 Management's Discussion and Analysis and Condensed Quarterly Financial Statements: 30 September 2022, Asian Development Bank, November 2022
35 Ibid.
36 Stakeholder Consultation

Nature of Financing

Enterprise financing (IPPs)

Financing Recipient

NEA

Fund to lend to NEA. The NEA would further on-lend to established enterprises through commercial partner banks such as NMB

Instrument

Debt

- Interest rate: 1% during grace period; 1.5% during amortization period[37]
- Term: 32+8 years[38] grace period
- Local currency financing
- Structured to match the generated cash flows / asset-based collateralization
- IRR of debt: 17%[39]
- GoN to issue guarantee to ADB

Purpose

Installation and Operation

- Installation
- Operation and maintenance

Expected Outcomes

- Lower overall cost of financing, catalyze commercial capital, and diversify funding sources
- Reduced cost of capital for installation, operation and maintenance
- Economies of scale achieved by reducing the cost of construction and installation costs
- Reduced overall cost of generation and average cost of supply (ACoS) to NEA

Financing Recipient

NEA

Fund to lend to NEA. The NEA would further on-lend to established enterprises through commercial partner banks such as NMB

Instrument

Outcome-based VGF

- Interest rate: 1%[40]
- Repayment period: 32 years +8 years[41] grace period
- Charges: loan processing + commitment fees + any other charges
- GoN to provide guarantee on the VGF loan amount
- Incentives based on energy generation

Purpose

Commercial Operation

- Mitigate off-taker risk
- Ensure viability of the project

Expected Outcomes

- Enable grid parity by compensating the developer for difference in price of actual generation and tariff
- Reduced risk of NEA (sole off-taker in Nepal)
- Mitigate lender's risk associated with off-take of the power generated by the project

37 Management's Discussion and Analysis and Condensed Quarterly Financial Statements: 30 September 2022, Asian Development Bank, November 2022
38 Ibid.
39 Stakeholder Consultation
40 Management's Discussion and Analysis and Condensed Quarterly Financial Statements: 30 September 2022, Asian Development Bank, November 2022
41 Ibid.

Nature of Financing

Technical Assistance through AEPC

Financing Recipient

Enterprises

Instrument

Grant

Purpose

Pre-post disbursals

- Enable grid parity by compensating the developer for difference in price of actual generation and tariff
- Reduced risk of NEA (sole off-taker in Nepal)
- Mitigate lender's risk associated with off-take of the power generated by the project

Expected Outcomes

- Increased operational efficiency of solar projects
- Ensured timeliness in project operation
- Strengthened business models and financial planning of enterprises

Financing Recipient

Government

Purpose

Policy building

- Building understanding of the solar sector and project management skills
- Designing effective policies for the solar sector and defining targets
- Designing model technical designs, bidding documents, M&E process and environmental and social safeguards

Expected Outcomes

- Improved knowledge and understanding of the solar sector
- Strengthened institutional and capacities for project management
- Strengthened technical capacities to undertake specific tasks

Financing Recipient

Commercial lenders

Purpose

Pre-post disbursals

- Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria
- Conduct workshops and provide training on pre-investment due diligence and post-investment M&E

Expected Outcomes

- Increase credit deployment due to improved technical and commercial understanding of the solar sector
- Improved knowledge on segment-specific risk models and due diligence criteria

Floating Solar

Solarization Potential

At present, there are no floating solar projects in Nepal. However, floating solar projects have immense potential of complementing Nepal's existing hydropower projects. A feasibility study conducted for floating solar on Kulekhani dam demonstrated that 1 MW of floating solar could prevent water evaporation loss of 8,000 m3.[42] If 50%[43] of the area of the reservoir is utilized, 100 MW of floating solar could be installed conserving 800,000 m3 of water annually. Further, the storage capacity of Kulekhani dam could be maximized due to increased generation capacity from 315 GWh to 461 GWh annually.[44] Increased generation by 46% could enable in meeting the intra-day peak power requirements while maximizing the storage. Currently, there are 2 hydropower projects of the NEA's subsidiary companies with a total capacity 478.1 MW and 141 hydropower projects of IPPs with the capacity of 1,477.03 MW in Nepal,[45] for which the GoN is yet to conduct potential assessment for floating solar projects. Further, the NEA plans to develop reservoir projects namely Dudhkoshi Storage (635 MW), Budhigandaki (1,200 MW), and Tanhaun (140 MW, currently under construction). These could also be explored for floating solar projects.

Challenges

High upfront costs

In the absence of floating solar projects in Nepal, there are no established bankable business models at present in the country leading to high-risk perception amongst financiers and investors to invest in the floating solar segment. Further, solar developers willing to set-up floating solar projects would require high upfront capital costs – 20–25%[46] more than ground mounted systems due to the inclusion of floating structures, mooring systems and submerged water cables.

Lack of technical expertise and knowledge

Since floating solar segment is a relatively new segment in Nepal, there is limited technical knowledge amongst key stakeholders ranging from government, solar developers, and other stakeholders. Further, there is a lack of trained technicians, installers, operators etc. in the floating solar segment that would be crucial for setting-up projects. Along with lack of knowledge and technical expertise amongst key stakeholders, there are scattered efforts in conducting potential assessment for floating solar in Nepal. As a result, there is limited discourse on scaling-up the segment.

Financing interventions

Even though, there are no floating solar projects in Nepal, the segment has immense scalability potential and ability to add to the grid-based power generation. The proposed financing facility focuses on:

- Need for project financing to enable establishment of shared infrastructures - development of project site and evacuation infrastructure.
- Assistance required on effective policy design and execution for a competitive bidding process to enable private sector led solar power deployment and affordable and commercially viable tariffs.
- Financing instruments include debt along with and PCGs.

Recognizing the current state of floating solar in Nepal, the proposed facility could support market development and create an enabling environment for scaling-up the segment. Technical assistance through the financing facility would focus on strengthening capacities of government stakeholders for assessing technical and commercial viability of floating solar projects, improving coordination between regional governments, standardizing documents/guidelines and processes.

42 Solar and Hydro: A Match Made by Nature, The Kathmandu Post, February 12, 2023
43 Ibid.
44 Ibid.
45 Annual Report, Nepal Electricity Authority, 2022-23
46 Catching the Wave: Floating solar rides on favourable market dynamics, Renewable Watch, March 26, 2020

Table 26: Envisaged Deployment of Funds for Floating Solar in Nepal

Nature of Financing

Project financing

Financing Recipient

NEA

Fund to lend to NEA. The NEA would further on-lend to project through commercial partner banks such as NMB

Instrument

Debt

- Interest rate: 1% during grace period; 1.5% during amortization[47] period
- Term: 32+8 years[48] grace period
- Local currency financing
- Structured to match the generated cash flows / asset-based collateralization
- GoN to issue guarantee to ADB

Purpose

Shared infrastructure

- Development of roads, water supply and drainage
- Establishment transmission infrastructure

Expected Outcomes

- Support NEA in achieving grid-parity prices for solar
- Reduced risks of land acquisition
- Enable economies of scale: minimize cost of civil and electrical construction
- Reduced overall cost of generation and average cost of supply (ACoS) to NEA

Financing Recipient

Commercial lenders

Fund to provide to performance guarantee on behalf of the project to commercial lender who finances the project

Instrument

Partial Credit Guarantee (PCG)

- Quantum: 25% of the project cost or total assets or 50% of net worth or USD 250 million[49]
- Tenor: >15 years or match the full term of the debt instrument
- Fees: Front-end + guarantee fee+ commitment fees
- Counter guarantee by GoN to issue guarantee to ADB

Purpose

Commercial Operation

- Cover the risk associated with non-payment

Expected Outcomes

- Reduce on-lender's risk due to non-performance of project
- Ensure timeliness in commercial operation of the project

47 Management's Discussion and Analysis and Condensed Quarterly Financial Statements: 30 September 2022, Asian Development Bank, November 2022
48 Ibid.
49 Private Sector Financing, Asian Development Bank

Nature of Financing

Technical Assistance through AEPC

Financing Recipient	Instrument	Purpose
Government	Grant	Policy development

- Organizing workshops and training to:
- Develop technical and commercial understanding of the solar sector, segment specific risks
- Capacity building for technical and commercial feasibility
- Develop policies framework for promoting floating solar in Nepal and specific policies related to feed-in tariffs
- Set permitting and licensing requirements
- Develop manuals for documentation and application processes, environmental impact assessment and water body regulations
- Develop model documents for bidding , technical standards, model power purchase agreements, and environmental and social safeguards documents

Expected Outcomes

- Strengthened capacities for assessing technical and commercial viability of floating solar projects
- Improved coordination between regional governments
- Standardized bidding documents, PPA agreements, E&S safeguard documents
- Standardized process and guidelines for establishment of floating solar

Rooftop Solar

Current Status

According to MoEWRI, electricity demand in Nepal is estimated at 20,073 GWh[50] by 2030 in BAU scenario – an estimated growth of 87% over the current electricity consumption of 10,693 GWh (2023).[51] Rooftop solar could play a crucial role in meeting this growing energy demand. At present, 1.1 million[52] homes with a cumulative 30 MW[53] of capacity have been installed with rooftop solar in the country. The GoN provided the required push to scale-up rooftop solar in urban areas through its Urban Solar Rooftop Programme to address the load shedding problems due to erratic grid-based electricity supply.

50 Electricity Demand Forecast Report 2015-2040, MoEWRI
51 Annual Report, Nepal Electricity Authority, 2022-23
52 The Potential for Rooftop Photovoltaic Systems in Nepal, Multidisciplinary Digital Publishing Institute, January 9, 2023
53 Ibid.

The Urban Solar Rooftop Programme is being implemented by GoN through AEPC in the electrified areas of Nepal since 2013-14. The programme was initiated with the aim to improve reliability and affordability of electricity in the face of recurrent load-shedding and increasing demand for electricity owing to the growing population, rapid urbanization and industrial developments. Further, the programme aimed at popularizing renewable energy and energy efficient technologies in the urban areas-reducing their dependency on the national grid and reducing the load of the NEA.

The components of the programme include capital subsidy to improve the affordability of transition to solar technologies.

System Category	System Capacity	Capital Subsidy (USD)	Subsidy in interest bank
Domestic	>=200 W	USD 150 (Nrs 20,000)	75% with the system capacity of >500 W
Commercial	>1,500 W	USD 150 (Nrs 20,000)	50% with the system capacity of >1,500 W

To support the consumers in setting-up rooftop solar projects, the AEPC has partnered with four banks to provide credit to consumers at 9% interest rate. The identified banks include Civil Bank, Himalayan Bank, Nepal Investment Bank and NMB Bank.

The GoN laid out the net-metering policy in 2018 for supporting rapid growth in the segment. The net-metering policy allows developers who wish to connect rooftop solar power to national grid to file application with the NEA. On approval of the application, the NEA pays developers for any excess energy supplied to the grid at the existing tariff rate of USD 0.045/kWh (NRs. 5.94/kWh).[54] However, the policy level push has not been adequate to enable the adoption of rooftop solar in the country.

Solarization Potential

Nepal has an immense potential for rooftop solar, especially in the urban areas. In 2015, the Ministry of Federal Affairs and Local Development mandated all commercial, institution and private houses with plots larger than 3,422.5 sq. ft. and roofs larger than 2,500 sq. ft. to install rooftop solar with an aim to meet 25% of their energy requirements through solar.[55] This mandate resulted in focus towards rooftop solar installation in urban areas. The total rooftop solar potential in urban areas of Nepal has been estimated at 6.5 TWh[56] per annum while the potential theoretical output of rooftop solar ranges from 50 GWh per annum in Butwal to 637 GWh[57] per annum in Kathmandu.

Challenges

Uncertainty on the net-metering policy

The GoN laid out the net-metering policy in 2018 through the MoEWRI's directive to scale-up rooftop solar segment. However, due to the GoN's focus on augmenting its hydropower resources, the solar sector has received less attention, especially rooftop solar sector. In alignment with the GoN, the NEA accorded lesser priority to the segment by halting the net-metering without any public notice in July, 2022. The sudden discontinuation of net-metering affected the willingness of solar developer and financiers to take-up rooftop solar projects in the absence of clarity on the next steps. Further, the net-metering policy was announced at the time when the country was lurching under partial load-shedding due to erratic supply of grid-based power. Since the country recovered from the electricity deficit, owing to abundant electricity generated by hydropower, the NEA has been reluctant to purchase excess power generated by rooftop

54 Call for favourable policy to raise share of solar power in energy mix, The Kathmandu Post, October 17, 2023
55 Ibid.
56 The Potential for Rooftop Photovoltaic Systems in Nepal, Multidisciplinary Digital Publishing Institute, January 9, 2023
57 Ibid.

solar systems-leading to uncertainty amongst developers on taking up grid-connected rooftop solar projects.[58]

Lack of affordable and innovative financing

Compared to the large-scale solar projects that could add to the grid-based power generation, rooftop solar projects assume lower priority. With the existing reluctance of NEA in purchasing excess power from rooftop solar consumers, there is limited uptake of rooftop solar. As a result, financiers perceive the segment to be high risk leading to limited financing in the segment. Lack of credit history of customers, especially in the residential segment, and lack of bankable business models are some of the prominent reasons for this high-risk perception. Consequently, there exist challenges in accessing affordable long-term financing. Currently, the local financial institutions offer debt at 12% to 12.5%[59] rate of interest in Nepal. Further, due to high upfront cost for consumers in the capital expenditure (CAPEX) model and developers in the Renewable Energy Service Company (RESCO) model, there is reluctance amongst consumers and developers in the segment to take-up projects pointing towards a lack of an innovative method of financing in the segment to mitigate risks.

Lack of awareness among consumers

Lack of understanding on the benefits, economics and technologies amongst rooftop solar consumers is a significant challenge for scaling-up adoption of rooftop solar in Nepal. Consumers, specifically in the CAPEX models, lack clarity on the application processes, any incentives available, taxation requirements, and association documentation challenges.

Reluctance of developers

The MoEWRI has classified solar projects into three categories based on their installed capacity- (i) 500 W to 10 kW: domestic producers; (ii) 10-500 kW: organizational producers; and (iii) more than 500 kW: commercial producers.[60] The limitation on the size of projects for domestic consumers (10 kW) is a deterrent for the RESCO model solar developers because of their reluctance to take-up smaller sized projects.

Financing interventions

Rooftop solar has significant potential for scaling-up, especially in the C&I segment in the RESCO model. The proposed funding facility focuses on:

- Need for enterprise financing for meeting the C&I potential.
- Assistance required on designing effective net-metering policies, standardizing process and guidelines for rooftop solar systems, improving knowledge of key stakeholders on solar segment and segment specific risks and opportunities, strengthening business models of enterprises and improving knowledge of consumers on solar technologies.
- Financing instruments include commercial debt for seed to pre-seed and growth stage along with Outcome-based FLDG as risk mitigation.

The proposed facility could support market development and ensure commercial viability projects by supporting enterprises. Technical assistance from the facility could support in designing effective net-metering policies, developing model documents/guidelines for standardizing design and installation practices and maintenance of rooftop solar systems. Furthermore, the technical assistance could also support in strengthening business models of enterprises for improved installation capacities and reducing delays in installations and improving the consumer awareness on solar technologies and its costs and benefits.

58 Call for Reconnecting Rooftop Solar Plants to Grid, The Kathmandu Post, December 24, 2022
59 Stakeholder Consultation
60 Guidelines released on selling energy into the grid, The Kathmandu Post, October 20,2023

Table 27: Envisaged Deployment of Funds for Rooftop Solar in Nepal

Nature of Financing

Enterprise financing for developers

Financing Recipient

AEPC

Fund to lend to AEPC who would further on-lend to commercial partner banks such as NMB. Commercial lenders to lend funds to early stage (seed to pre-seed and growth stage) enterprises to meet their working capital needs

Instrument

Debt

- Interest rate: 1% during grace period; 1.5% during amortization period[61]
- Term: 32+8 years grace period[62]
- Local currency financing
- Structured to match the generated cash flows / asset-based collateralization
- IRR of debt: 15%[63]
- GoN to issue guarantee to ADB

Purpose

Early and growth stage

- Installation of rooftop solar projects
- Operation and maintenance

Expected Outcomes

- Reduced cost of capital for installation, operation and maintenance
- Facilitate establishment of rooftop solar systems for commercial and industrial (C&I) in RESCO model

Financing Recipient

Commercial lenders

Fund to lend to AEPC who would further on-lend to established enterprises through commercial partner banks such as NMB to create a first loss guarantee escrow

Instrument

Outcome-based FLDG

- First loss guarantee on loans provided to the developer
- Financial incentives to developers based on pre-defined milestones or for each installation

Purpose

Commercial operation

First loss guarantee to cover financial loss on project failure

Expected Outcomes

- Ensure viability of the enterprise
- Enable incentivizing enterprises setting-up rooftop solar projects
- Risk mitigation of commercial lender due to payment default by enterprises

61 Management's Discussion and Analysis and Condensed Quarterly Financial Statements: 30 September 2022, Asian Development Bank, November 2022
62 Ibid.
63 Techno-Economic Feasibility Study of Net-metering Implementation in Rooftop Solar PV in Nepal, Journal of the Institute of Engineering, October 2020

Nature of Financing

Technical Assistance through AEPC

Financing Recipient

Government

Instrument

Grant

Purpose

Policy building

- Organizing workshops and training to:
- Develop technical and commercial understanding of the solar sector, segment specific risks
- Design guideline for building standards and certifications post-installations, licensing, monitoring and quality control
- Develop manuals for documentation and application processes
- Formulate effective net-metering policies

Expected Outcomes

- Improved capacity of enterprises to design, install and operate rooftop systems is optimal
- Minimize the risk of technical issues and performance problems of developers
- Strengthened business models of enterprises

Financing Recipient

Commercial lenders

Purpose

Pre-post disbursals

Provide training on:

- Pre-investment: For technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria
- Post investment: Monitoring and evaluation during repayment period

Expected Outcomes

- Improved credit disbursals to the segment
- Improved knowledge on segment-specific risk models and due diligence criteria

Financing Recipient

Enterprises

Purpose

Pre-post disbursals

Organizing workshops and training:

- Pre-disbursal: For site assessment and feasibility assessment to determine the potential for rooftop solar; ensuring safety and quality standards, conducting performance testing; developing and implementing a comprehensive operation and maintenance plan
- Post disbursals: For business expansion; financial management; fund utilization, including credit use and repayment

Expected Outcomes

- Strengthened capacity of enterprises to design, install and operate rooftop systems
- Ensured efficiency of rooftop solar system
- Improved utilization of finance and timeliness in repayment
- Improved commercial viability of the projects

Financing Recipient

Consumers

Purpose

Pre-adoption

Awareness creation on:

- Cost economics, benefits of installation of solar rooftop systems; types of technologies available in the market and most suitable technology for adoption
- Usage and maintenance of technologies
- Information on rooftop space requirements, building standards and certification requirements

Expected Outcomes

- Improved knowledge of consumers on solar technologies, cost and benefit of installations
- Improved adoption of rooftop solar systems by consumers
- Improved capacities of consumers regarding key requirements for setting-up rooftop solar systems

Productive Use of Solar Technologies

Current Status

Recognizing the importance of productive use of energy (PUE) in livelihood generation, the GoN implemented the Renewable Energy Subsidy Policy through Alternative Energy Promotion Center (AEPC) with a focus on off-grid application. The policy was revised in 2016 to cover 40%[64] of the cost of equipment and installation by providing subsidies.[65] Productive use of energy has been an important component of the policy to incentivize industries and enterprises that produce material and services using renewable energy and generate employment primarily in the rural areas. The policy focused on solarization of agriculture by including subsidies of up-to 60%[66] to communities and private companies for solar irrigation pumps.

64 Renewable Energy Subsidy Policy, 2073 BS, Ministry of Population and Environment, Government of Nepal, May 2016
65 Renewable Energy Subsidy Policy, 2073 BS, Ministry of Population and Environment, Government of Nepal, May 2016
66 Ibid.

Currently, over 2,300 SIPs[67] are installed across Nepal. Other productive use applications in agriculture such as water mills useful for mechanical applications like hulling and grinding and solar dryers have been covered under the ambit of the policy.

The GoN implemented the National Rural and Renewable Energy Program (NRREP) through APEC from 2012 to 2017 with an aim to utilize productive use of renewable energy for employment generation through Micro, Small and Medium Enterprises (MSMEs) and poverty reduction in rural Nepal.[68] Solar energy remained an integral part of the programme to enable the transition to renewable energy and reduce dependency on biomass. Even though productive use of energy, especially solar energy, has received policy level focus, the financing in the segment is limited – mainly through donor funded programmes such as NRREP.

Solarization Potential

Productive use of solar energy holds immense potential in Nepal especially in agriculture and MSME sectors for generating stable incomes and livelihoods. Nepal is primarily an agrarian economy with majority of smallholder farmers who rely on rain-fed agriculture. Of the 1.8 million hectares[69] of irrigable land, only 39%[70] is currently irrigated – mainly through diesel pumps owing to lack of grid connectivity. Solar Irrigation Pumps (SIPs) offer significant potential of de-carbonizing agriculture by replacing the diesel pumps with SIPs and augmenting farm income through cost savings. Furthermore, other productive use appliances including solar refrigerators, dryers, and poultry and cattle fences amongst others have significant potential for scaling-up in agriculture.

Productive use of solar energy offers significant potential for generating livelihoods in rural areas of Nepal that lack connectivity to the grid. Around 7.5%[71] of the population lacks access to grid-connected electricity in Nepal, mostly in the rural areas. Productive use of solar could ensure power reliability while stabilizing rural incomes.

Challenges

Inadequate affordable financing

Absence of bankable business models and limited participation of local financing institutions are two major challenges that limit access to affordable financing in the segment in Nepal. At present, the financing to the segment is primarily through the Central Renewable Energy Fund (CREF) of the AEPC that mobilizes government and international finances through capital subsidies and credit. However, local financing institutions offer limited and high cost of capital.

Lack of affordability of productive use technologies

The market for productive use of solar technologies remains fragmented with low adoption rates. Lack of affordability and high dependence on government subsidies are the primary causes of low adoption rates. At present, the consumers receive as high as 60%[72] subsidy for purchase and installation of SIPs under the Renewable Energy Subsidy Policy 2016. In addition, very few financial institutions in Nepal offer financing in the segment due to high-risk perception of consumers who lack creditworthiness to avail finance.

Lack of awareness of consumers

Lack of awareness of consumers on technologies, cost economics and its benefits are challenges that limit adoption of productive use solar technologies in Nepal. Further, consumers lack the capacity to navigate through the credit appraisal process resulting in low adoption of productive use solar technologies.

67 Renewable Energy Development in Nepal: Potential, Policies and Challenges, Nepal Agricultural Engineering Students' Society, 2023
68 Productive Use Energy: Overview of PEU Component, Alternative Energy Promotion Centre
69 Solar Irrigation in Nepal: A Situation Analysis Report, International Water Management Institute, 2021
70 Ibid.
71 Annual Report, Nepal Electricity Authority, 2021-22
72 Renewable Energy Subsidy Policy, 2073 BS, Ministry of Population and Environment, Government of Nepal, May 2016

Financing interventions

Productive use of solar offers significant scalability potential in solarization of agriculture and supporting the rural livelihoods. The proposed funding facility focuses on:

- Need for innovative and catalytic funding for productive use of solar technologies.
- Capital assistance required for demand aggregation and reduced reliance on grant and subsidy funding.
- Financing instruments that include low-cost debt for enterprises along with result-based grants.

This could improve reliability of power, ensure cost savings, and improve scale of operations by targeting farmer groups or communities. Further, it could drive innovations by supporting enterprises with innovative technological solutions. Technical assistance could enable enterprises to strengthen business models, strengthening capacity of government stakeholders and improving segment specific understanding of commercial lenders for improved flow of credit to the segment.

Table 28: Envisaged Deployment of Funds for Productive Use of Solar in Nepal

Nature of Financing

Enterprise financing for established enterprises

Financing Recipient

AEPC

- Fund to lend to APEC who would further on-lend to commercial partner banks such as NMB.
- Commercial lenders to lend to enterprises in the growth stage providing technology solutions in productive use of solar.
- Financing for the purpose of meeting working capital needs of enterprises, expansion of business and technology up-gradation

Instrument

Debt

- Interest rate: 1% during grace period; 1.5% during amortization period[73]
- Term: 32+8 years grace period[74]
- Local currency financing
- Structured to match the generated cash flows / asset-based collateralization
- IRR of debt: 17%[75]
- GoN to issue guarantee to ADB

Result-based grants

- Share of grants: 20% of the financing
- Incentivizing FIs on-lending enterprises in the segment: Based on the number of disbursals and quantum of disbursals
- Incentivizing enterprises training farmers/ community groups for adoption of productive use solar technology

Purpose

Growth stage

- Establish bankable business models
- Establish and expand customer base
- Enable lesser margins of DRE enterprises
- Make productive use solar technologies affordable

Expected Outcomes

- Lowered overall cost of financing and diversified funding sources
- Reduced high-risk perception of commercial lenders
- Incentivize commercial lenders to on-lend to the segment
- Drive innovation
- Improved uptake of productive use of solar energy solutions by consumers

73 Management's Discussion and Analysis and Condensed Quarterly Financial Statements: 30 September 2022, Asian Development Bank, November 2022
74 Ibid.
75 Stakeholder Consultation

Nature of Financing

Technical Assistance through AEPC

Financing Recipient

Government

Instrument

Grant

Purpose

Policy building

Conduct workshops and training programmes for:

- Building understanding of the solar sector and project management skills
- Designing effective policies for the solar sector and defining targets
- Designing model documents M&E process and environmental and social safeguards

Expected Outcomes

- Improved knowledge and understanding of the solar sector
- Strengthened institutional and capacities for project management
- Strengthened technical capacities to undertake specific tasks

Financing Recipient

Enterprises

Purpose

Pre-post disbursals

- Pre-disbursal training on business and financial management and operational planning
- Post-disbursal capacity building for business expansion; financial management; fund utilization, including credit use and repayment

Expected Outcomes

- Strengthened business models and financial planning of enterprises

Financing Recipient

Commercial lenders

Purpose

Pre-disbursals

- Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria
- Conduct workshops and provide training on pre-investment due diligence and post-investment M&E

Expected Outcomes

- Increase credit deployment due to improved technical and commercial understanding of the solar sector
- Improved knowledge on segment-specific risk models and due diligence criteria

CHAPTER 6
SRI LANKA

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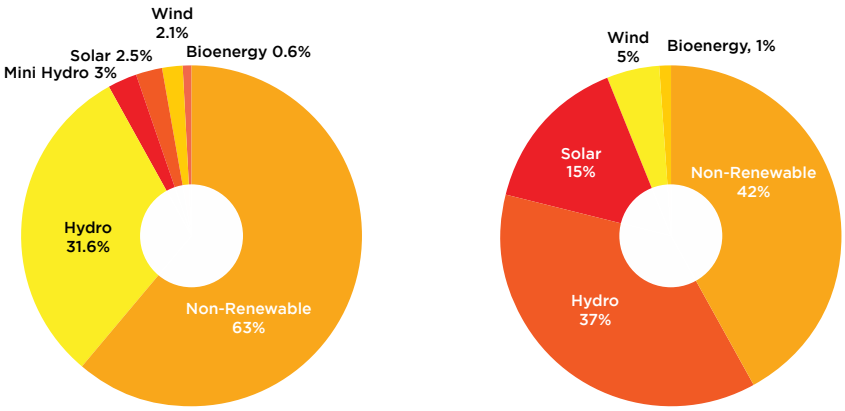
AAVISHKAAR GROUP

SOLAR ENERGY SECTOR OVERVIEW

Current Status of Solar Energy Sector in Sri Lanka

Sri Lanka's energy generation is highly fossil fuel dependent, with 63% of electricity in 2021 derived from imported fossil fuel. Considering the projected electricity demand growth rate of 5.5% per annum (from 2023 to 2047)[1] and rising cost of coal imports, Sri Lanka government is promoting renewable energy-based power generation to limit coal usage beyond 2030. As of 2022, with installed capacity of 771 MW[2], solar energy constitutes 15% of the total installed capacity mix in Sri Lanka, and 2.5% of the total energy generation mix.

Figure 15: Energy Generation and Installed Capacity Mix of Sri Lanka | 2022



Energy generation mix: 15.76 GWh (2020)[3] | Installed capacity mix: 5.02 GW (Sept 2022)[4]

Existing solar projects

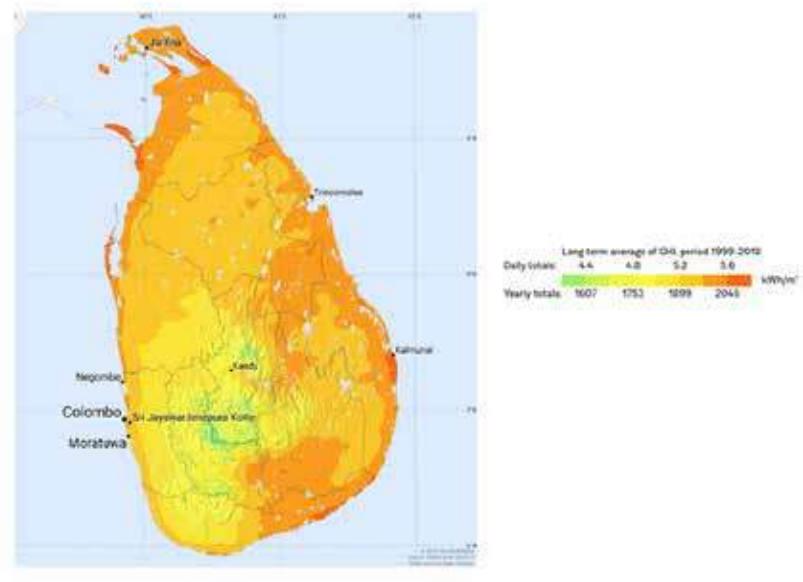
As of 2022, solar energy constitutes 15% of the total installed capacity mix in Sri Lanka. Currently utility-scale solar projects have a cumulative installed capacity of 131 MW, while rooftop solar projects account for 640 MW of the installed solar capacity. Installed rooftop solar capacity has grown from 94 MW in 2017 to 640 MW in 2023 at CAGR of over 30% per annum. Off grid solar-based energy generation is limited to areas where the national grid is unavailable and is generally short-term in nature. Most of the projects are owned by private developers. Solar PV in Sri Lanka has been implemented in both on and off grid, but at a small scale. For instance, 20 MW Laugfs Solar Power Station in Hambantota is the single largest solar power station in the country. Apart from rooftop and ground-mounted utility-scale solar, Sri Lankan government is also focusing on promoting floating solar projects. In 2019, the Sri Lankan government approved the development of a 100 MW floating solar plant on the Maduru Oya Reservoir.

Solarization Potential of Sri Lanka

Sri Lanka, being located within the equatorial belt, has substantial potential in solar resource. Solar radiation (GHI) in Sri Lanka varies from 1,247 to 2,106 kWh/m2/yr[5] which is optimum for generating adequate solar energy. The below presented global horizontal irradiation map represents the irradiation potential of the Sri Lanka.

1 Long Term generation Expansion Plan, Ceylon Electricity board (2023-2042)
2 Progress Report, 2022-Ministry of Power and Energy
3 IRENA, Progress Report 2022, Ministry of Power and Energy, Sri Lanka
4 Ministry of Power Sri Lanka, 2022; Long Term generation Expansion Plan, Ceylon Electricity board (2023-2042)
5 IRENA, Global Solar Atlas, EQ International

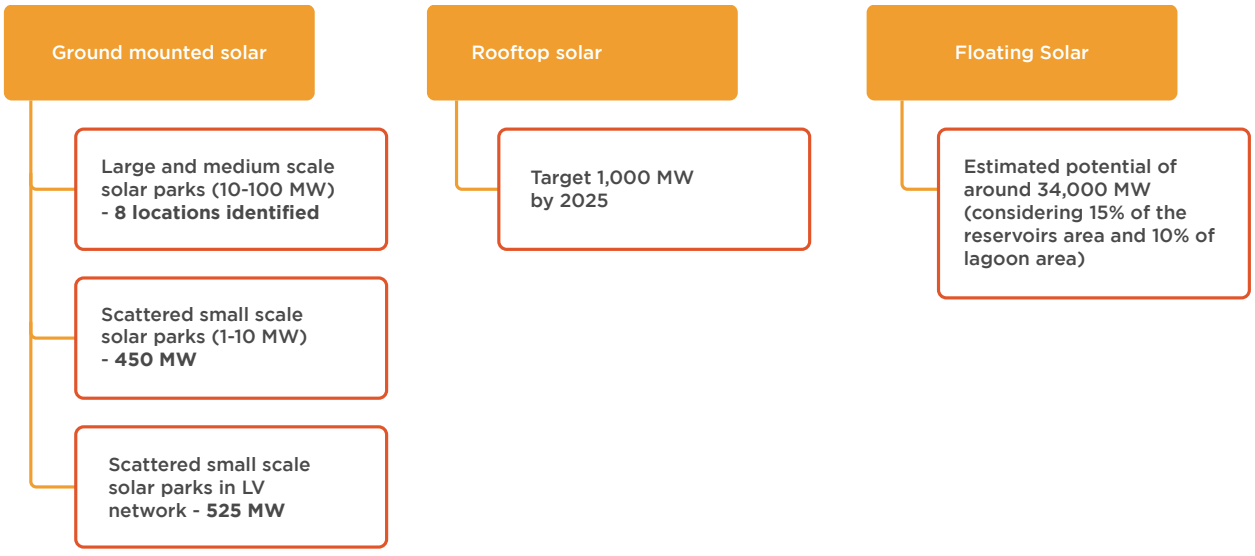
Figure 16: GHI Map of Sri Lanka for Potential Assessment of PV Technologies



By 2050, around 16 GW of electricity can be added by harnessing the country's solar power resources. Solar potential of the country has been mapped into following categories.

Three key solar segments emerge as focus areas demonstrating critical solarization potential for Sri Lanka are, i) Solar parks; ii) floating solar; iii) rooftop solar. Combined, the three solar technologies present a planned capacity of 6.24 GW by 2030.

Figure 17: Key Solar Segments in Sri Lanka



Projects planned under key segments[6]

6 Invest Sri Lanka, The Live Mint, Saur energy, Ministry of Power, Sri Lanka

Focus segment	Capacity planned
Utility-scale solar (ground mounted)	Around 1,150 MW of utility scale projects with capacity of up to 500 MW are planned
Utility-scale solar (Floating)	Projects of 100 MW capacity are under consideration
Rooftop solar	Target to reach 1,000 MW of rooftop solar by 2025 supported by ADB funded Battle for Solar scheme

Key Drivers

Due to increased government focus on increasing renewable energy and active participation by the domestic and international private sector the installed capacity of solar in Sri Lanka has grown at significant pace. Some of the key drivers facilitating scaling of solar power are:

- Increasing cost of production of coal-based energy: High import cost of coal, further increased by the devaluating currency is adding to the import cost.
- Government policies and focus to limit non-RE based energy: Government of Sri Lanka targets to generate 70% of the energy from RE sources by 2030. Sri Lanka National Energy Policy, 2019, and net-metering policy are key steppingstones towards achievement of this target.
- Availability of international finance for solar installation: availability of concessional loan for 1,000 MW rooftop installation under Battle for Solar Energy project is a primary driver for the segment.

Investment Needs and Landscape

Despite having high solar irradiation potential, and solar energy targets, critical regulatory and financial challenges persist for the segment. Under the utility-scale segment, accessibility of finance and poor capacity of the financial institutions are the key challenges. Lack of innovative financing instruments, asset liability mismatch, and lack of long-term financing are key challenges impeding access to finance. Also, current economic political crises expose investors and project developers to high foreign exchange volatility, uncertain project development cost and sovereign risk apart from high cost of project finance. These financial risks are further aggravated by the regulatory risks like delay in obtaining land permits, poor supporting transmission infrastructure, absence of clear policy for the transition from feed-in tariffs to competitive tariffs. For solar rooftop projects, key challenges include non-viable tariff by Ceylon Electricity Board (CEB), capital expenditure-based model, poor grid transmission structure and long waiting period for grid connection and approval.

Key concerns of foreign investors in investing in Sri Lanka are policy inconsistency, difficulties in opening and doing business and exchange rate risks.

Domestic financing for solar projects of >10 MW

Most of the large-scale projects in Sri Lanka are developed under the PPP mode of financing. International donor aid and funding by foreign governments are primary sources for installation of solar projects in Sri Lanka. Chinese and Indian governments have funded multiple RE (hydro and solar) projects in Sri Lanka. For example, India's EXIM Bank extended USD 100 million line of credit for 20 years at 1.75% RoI for projects in the solar energy sector. Existing small utility-scale solar projects are funded either by project developer's equity or foreign JV partner equity or through syndicated loan from local or foreign financial institutions (FI).

JICA, ADB, AIIB, KfW, SDF, The World Bank, French Development agency, USAID, Kuwait Fund are the major DFIs funding RE projects. Domestic FIs have supported some small-scale projects (<10 MW) either through direct lending or through credit lines secured from DFIs or through loan syndication. However, domestic FIs are not able to fund large projects due to liquidity crunch and regulatory constraints including limited availability of long-term debt, small average size of banks, single borrower limits, and inability to syndicate loans. Private equity investment is not common in the power sector; domestic corporates are also not open to explore PE option. Key funding sources for RE projects in Sri Lanka is mapped below:

Source		Type of funding	Quantum of funding	Example
भारत सरकार GOVERNMENT OF INDIA	Partner countries	Grant, Debt	USD 10-100 Million	• India's EXIM Bank extended USD 100 million line of Credit for 20 years at 1.75% RoI for solar projects • Japanese Sri Lanka Friendship Corporation (JSF) has also invested USD 25 million
UNDP THE WORLD BANK ADB	DFIs, Bi and multilateral agencies	Debt, Grant	USD 1-100 Million	• ADB issued credit line of US $50 million for government's Rooftop Solar PV Power Generation Project to offer 80-100% debt financing for 10 years
BANK OF CEYLON BOC HNB Bankers to the Nation	Local Commercial Banks	Debt	For rooftop projects up to 50 KW capacity	• Subsidized loans at 6-8% RoI under ADB funded rooftop solar PV generation project (Soorya Bala Sangramaya Programme / Battle for Solar Energy program)

Improvement in Tariff structure

Sri Lanka lacks a cost-reflective tariff structure. The current inconsistency in switching between feed-in tariffs and other incentives generates confusion among investors, undermining their interest in the renewable energy sector.

Currency depreciation

Sri Lanka does not have a well-established hedging market to address foreign currency risks, and the domestic market's maximum tenor for cross-currency swaps is limited to one year. This duration is inadequate for energy infrastructure loans, which typically require tenors extending beyond 10 years. Tis poses significant risks to the foreign investors as the receivables will be in the local currency.

Optimum government procurement processes

There is a lack of standard procurement procedure in Sri Lanka. Procurement procedures sometimes deviate from established global standards, creating a perceived deficiency in efficiency and transparency within the process. This lack of transparency has resulted in project delays. A notable instance is the tender for the 300 MW CCGT plant at Kerawalapitiya, which experienced a delay due to an unclear bid award process. The international bidders contested the tender results. Initially awarded to CEB's subsidiary Lakdanavi, the bid was ultimately granted to a foreign private sector entity following a decision from the Procurement Appeal Board.

FINANCING INTERVENTIONS ACROSS EMERGING SOLAR SEGMENTS

Utility-Scale Solar

Current Status

At present, utility-scale ground-mounted solar projects have an installed capacity of 131 MW. Most of the projects are owned by private developers, developed through the independent power producer (IPP) model. In 2019, the Sri Lankan government announced that it was planning to set up 28 small solar power projects in the country with the agreement of selling the power to Ceylon Electricity Board. The Japan-Sri Lanka Friendship Corporation (JSF) has also invested USD 25 million through the Board of Investment to develop solar power capacity for Sri Lanka's national grid. The Corporation has set up Katunayake, a solar panel manufacturing facility. India has also extended a USD 100 million line of credit to Sri Lanka in 2021 to finance various solar energy projects.

Table 29: Upcomintg Large Scale Solar Projects in Sri Lanka

Project name	Capacity (MW)	Estimated project cost (USD)
Rooftop Power Generation project	100	85 million
Siyambalanduwa Solar Park	100	100 million
Poonaryn Peninsula Wind-Solar Hybrid Energy Park	150-200	168 million
Maduru Oya Reservoir Floating Solar Power Plant (planned)	100	Not available
Total	**450**	

Financing of projects

Both domestic and foreign private and government funding have played crucial roles in the establishment of solar projects in Sri Lanka. However, the financing landscape for most significant infrastructure projects in the country primarily relies on international debt capital flows. These flows come in the form of either concessional or commercial terms, often supported by sovereign guarantees.

The Ceylon Electricity Board (CEB) has funded certain projects through direct loans from Development Finance Institutions (DFIs) and commercial banks, with backing from a guarantee provided by the Ministry of Finance, Sri Lanka. Additionally, concessional loans from DFIs and donors, on-lent to CEB by the Government of Sri Lanka and guaranteed by the government, have been instrumental in project financing. However, due to its weakened financial position, the CEB currently faces challenges in raising debt. Its capacity to secure funds is limited, with a potential constraint of raising approximately USD 300 million through 2026 from domestic banks, contingent on obtaining government guarantees. While domestic banks have actively supported various project finance transactions for small-scale Independent Power Producer (IPP) projects, typically up to 10 MW, their ability to provide long-term debt is constrained by factors such as the small average size of banks, single borrower limits, limitations in syndicating loans, and a restricted background in project finance.

International banks have also contributed to project financing, either directly or through credit lines extended to local banks. However, the current involvement of local banks in infrastructure financing is restricted due to the limited availability of long-term debt, the modest average size of the banks, constraints related to single borrower limits, challenges in syndicating loans, and a relatively limited experience and capability in project finance.

Solarization Potential

By 2030, Government of Sri Lanka planned to install 2.47 GW of ground-mounted solar[1] which will require an additional investment of around USD 1.3 billion in additional to the planned investment. The government of Sri Lanka is promoting the establishment of all large, medium, and small-scale solar parks with capacities ranging from 1 MW to 100 MW. Eight locations have been identified for the setting up of solar parks with 10 to 100 MW capacities.

Table 30: Planned Domestic Projects in Sri Lanka

Plant size	Number of plants	Total capacity
75 kW	7,000	525 MW
1 MW	105	105 MW
1-10 MW	NA	150 MW
10 MW	2	20 MW
100 MW	2	200 MW
150 MW (solar-wind hybrid)	1	150 MW
Total		**1,150 MW**

Source: Progress Report, 2022-Ministry of Power and Energy

Challenges

Lack of availability low-cost finance with longer term period

Due to the short-term nature of domestic banks' sources of funds, they struggle to offer loan tenures greater than 10 years, this exposes long-term solar utility PPA projects of 20 years span to refinancing risks. Also, the limited asset base of domestic FIs limits their ability to fund large scale capital projects. Lack of long-term financing also increases the cost of finance and project risk.

No dedicated funding support for the utility-scale solar projects

Larger projects (>10 MW) developed by IPPs on a Build-Own-Operate-Transfer (BOOT) scheme have been able to mobilize some international financing, but this financing has typically required a guarantee for CEB's payment obligations from the Government of Sri Lanka. There is no dedicated financing facility to fund the development of utility-scale solar projects in Sri Lanka. The existing financing facilities are utilized for financing the rooftop solar and solar home system (SHS) segments. Poor financial health of the utilities and CEB is a cause of concern to the funders and financial institutions have concerns over the contract enforcement over long term (off taker risk). In addition to this, currency risk and the change in law risk further affects the bankability of the projects for both domestic and foreign investors.

Additional upfront financial burden for project developers

In contrast to international best practices, in Sri Lanka, the project developer has to consider key risks like payment security risk, political risks and termination risks. This results in high upfront payment requirement to the developer after the PPA contract award. For example, in a recent bid invited for 100 MW utility scale solar projects at Siyambalanduwa, the successful bidder has to make an upfront payment of USD 1.45 million to Sri Lanka Sustainable Energy Authority (SLSEA) for preliminary project development activities undertaken, furnish a preliminary obligation bond of USD 3.4 million to Ceylon Electricity Board, and furnish a USD 8.93 million construction performance bond after getting the preliminary obligation bond returned.

Limited availability of transmission infra to evacuate the power generated

The supporting transmission infrastructure to withdraw the power generated by utility scale solar power projects is not available and given the weak financial positions of the country utilities, there have been

1 Renewable Energy Resource Development Plan 2021-26 (draft)

setbacks in actualizing plans for the development of this essential infrastructure.

Financing interventions

The fund will deploy concessional debt along with performance-based guarantees for development of shared infrastructure for solar parks under SPV mode. The details of the project financing and technical assistance proposed in the fund are mentioned below:

Table 31: Envisaged Deployment of Funds for Utility-Scale Solar in Sri Lanka

Nature of Financing

Project financing establishment of solar Parks

Financing Recipient	Instrument	Purpose
Govt. of Sri Lanka/ Ceylon Electricity Board (CEB) The fund would lend to CEB who would further on-lend to project special purpose vehicle (SPV) through commercial partner banks.	**Concessional debt** • Interest rate: SOFR + 0.6% less a credit of 0.1% and a maturity premium of 0.20 • Term: >16 years • Structured to match the generated cash flows / asset-based collateralization. • IRR of debt: 12%* • Government of Sri Lanka to issue guarantee to ADB	**Shared infrastructure** • Land development • Development of roads, water supply and drainage • Establishment of transmission infrastructure

Expected Outcomes

- Support establishment of large-scale solar parks with private sector participation
- Reduced risks of land acquisition
- Minimize cost of civil and electrical construction
- Reduced overall cost of generation and average cost of supply (ACoS) to discom

Financing Recipient	Instrument	Purpose
Commercial lender ADB to provide performance guarantee to the commercial lender on-lending to project SPV	**Performance-based guarantees** • Performance bond amount: 7-10% of the project cost • Tenor: 2 to 10 years	**Commercial operations (Risk mitigation)** Mitigate payment risk due to asset performance, technical issues, and breakdowns.

Expected Outcomes

- Reduce performance related risks of the project by ensuring the project runs at an optimum level.
- Reduce on-lender's risk due to non-performance of project.
- Ensure timeliness in commercial operation of the project

Nature of Financing

Technical Assistance (TA) for enterprises

Financing Recipient	Instrument	Purpose
Ceylon Electricity Board	Grant	Pre- and post-disbursal of loan • Pre-disbursal training on business and financial management; designing and engineering of solar plants; procurement and construction management and operational planning. • Post-disbursal capacity building for business expansion; financial management; fund utilization, including credit use and repayment

Expected Outcomes

- Increased knowledge of capital and operational costs supply chain requirements
- Increased operational efficiency of solar projects.
- Ensured timeliness in project operation.

Nature of Financing

Technical assistance for capacity building of government officials

Financing Recipient	Instrument	Purpose
Ceylon Electricity Board	Grant	• Building understanding of the solar sector and project management skills • Designing effective policies for the solar sector and defining targets • Designing model technical designs, bidding documents, M&E process, and environmental and social safeguards

Expected Outcomes

- Improved knowledge and understanding of the solar sector.
- Strengthened institutional and capacities for project management.
- Strengthened technical capacities to undertake specific tasks

Nature of Financing

Technical assistance for capacity building of commercial lenders

Financing Recipient	Instrument	Purpose
Ceylon Electricity Board	Grant	• Provide training on technical and commercial understanding of the solar sector and segment-specific risk models and due diligence criteria. • Conduct workshops and provide training on pre-investment due diligence and post-investment M&E

Expected Outcomes

- Increase credit deployment due to improved technical and commercial understanding of the solar sector
- Improved knowledge on segment-specific risk models and due diligence criteria

Rooftop Solar

Current Status

Sri Lankan government has set a target to develop 1,000 MW of capacity in the rooftop solar segment by 2025. Installed capacity has grown from 94 MW in 2017 to 640 MW in 2023 at CAGR of over 30% per annum. Higher acceptance by domestic and industrial users due to comparative cost of power and subsidies has supported the uptake of the segment.

With ADB and local FIs mobilizing capital, the rooftop solar segment has already received and will receive additional capital inflows that enabled deployments to attain scale and the market to mature. Hence, rooftop solar has not been considered for funding.

Solarization Potential

Under its Renewable Energy Resource Development Plan 2021-26, Government of Sri Lanka planned to install rooftop solar of 1.34 GW by 2030. Finance for most of this capacity is planned to be supported by ADB-funded Battle for Solar scheme. Sri Lanka is targeting to install 1000 MW of rooftop solar by 2030. Also, phase II of this project for additional financing of USD 50 million is under discussion.

Challenges

Existing business models limiting access

The existing business models are capital expenditure based (CAPEX model), which excludes a certain proportion of customers who cannot afford the upfront cost, as well as customers who do have the required rooftop space to install the rooftop solar system.

Assuring self-sustainability of the funding model

The ongoing Battle for Solar scheme supported by the ADB low-cost finance resulted in decent uptake of the funds by the consumers. However, the projects need to be self-sustainable in terms of returns to sustain even after receiving the debt at commercial interest rates.

Fear of dishonor of solar tariff promised under the net-accounting and net plus scheme.

The current fixed tariff of LKR18/unit makes the rooftop projects unviable. The tariff has to be increased to LKR29-30/unit for making rooftop projects viable. Currently the applicable solar tariffs schemes are under

the Net-accounting and Net-plus schemes are attractive for solar system owners. However, this tariff is higher than the CEB's average realized tariff from consumer and adds to the financial burden of the utilities. This limits the capacity of utilities support the rooftop solar by providing the applicable tariffs to the consumers in the future.

Lack of awareness of consumers and risk perception of developers

Poor understanding of the benefits of rooftop solar segment, subsidies, and technologies amongst consumers (both residential and the C&I segments) has been one of the challenges resulted in poor off-take in the rooftop segment. Consumers are concerned regarding the high upfront cost of Solar PV, low battery life and poor after-sales service.

Financing interventions

To ensure the stability in supply of electricity of solar power and to compensate for the issue of intermittency of the solar power sources, BESS is an importance component, the fund proposes to offer concessional debt for development of battery bank infrastructure for floating and rooftop solar projects. Details of the structure is mentioned below:

Table 32: Envisaged Deployment of Funds for BESS in Sri Lanka

Nature of Financing		
Project financing for BESS component of floating and rooftop solar projects		
Financing Recipient	**Instrument**	**Purpose**
Commercial lenders The fund to provide long-term debt finance to commercial lenders to on-lend floating and rooftop solar enterprises for funding construction and development of BESS integration. The fund to provide Partial Credit Guarantee (PCGs) to commercial lenders as a risk mitigation instrument.	**Concessional debt** • Interest rate: SOFR + 0.6% less a credit of 0.1% and a maturity premium of 0.20 |Term: >16 years • IRR of debt: 12% • Partial Credit Guarantee • 25% of the total project cost (in project finance transactions) • 50% of net worth (in bank transactions)	**Construction and development** Development of battery bank infrastructure for floating and rooftop solar projects
Financing Recipient	**Instrument**	**Purpose**
SLSEA The fund to offer to offer GoM for supporting IPPs according to PPA and implementation agreement; amount linked to performance.	**Tariff buydown grant** Share: up to 10% | Reduce the impact of financial costs of IPPs on the tariff	**Construction and development** • Development of battery bank infrastructure for floating and rooftop solar projects

Expected Outcomes

- Risk mitigation for commercial lenders – increased private investor interest.
- Address variability of power output and allow continuous service despite fluctuations in supply and demand.
- Smooth the supply of electricity and reduce the need for back up diesel generation.
- Lower system cost by offsetting peak load.
- Enable access to capital for financing high upfront costs and eventually reduce cost of BESS.
- Increase project bankability through feasibility studies.
- Increase efficiency of existing generators by replacing their reserve requirements.

Floating Solar

Current Status

Floating solar plants have the potential to enhance Sri Lanka's utility-scale solar capacity. Their advantages over ground-mounted solar installations include a reduced need for land area, the ability to synchronize with existing hydropower plants, and improved operating efficiency for solar panels, attributed to the cooler conditions above the water surface.

In 2020, Sri Lanka established its first floating solar power experimental facility with a total capacity of approximately 46 kWp, situated in the ponds of the Killinochchi premises at the University of Jaffna. The project received funding and technological support from Current Solar AS, a Norwegian developer specializing in floating photovoltaic solar systems. A collaborative effort between the Western Norway University of Applied Sciences and the University of Jaffna, this initiative received backing from the Royal Norwegian Embassy in Colombo. The plant, connected to the utility through a net metering connection, generates an average monthly power output of around 5000 kWh. Notably, this project demonstrated that floating solar systems are expected to achieve 4-5% higher power yield (kWh/kWp) compared to land-based systems.

The Sri Lanka Sustainable Energy Authority has pinpointed several potential reservoir sites for the development of large-scale floating solar projects. Comprehensive techno-economic assessments for each of these resource locations are essential to inform long-term investment decisions[2].

Furthermore, the Sri Lanka Sustainable Energy Authority has been tasked with constructing two solar floating stations, each capable of generating one megawatt (MW) of solar electricity. A Korean engineering company will oversee the development of these projects, located at Chandrika Wewa in Embilipitiya, Sabaragamuwa Province, and Kirilbban Wewa in the UVA Province. An agreement has been formalized between the Korea Institute for Advancement of Technology (KIAT), a Korean Government enterprise, and the Power & Energy Ministry of the Government of Sri Lanka. As part of this agreement, the Korean Government is contributing a USD 5.2 million grant for the establishment of Sri Lanka's inaugural floating solar power station. Anticipated to be operational by December 2024, these floating plants mark a significant step towards sustainable energy in the country[3].

Solarization Potential

Floating solar potential is identified in both natural water bodies as well as the reservoirs of large-hydro power plants. Sri Lanka has an estimated potential of around 1.5 GW for natural water body-based and around 0.9 GW for reservoir-based floating solar power projects[4]. This estimation was done considering a conservative 5% of the surface areas of natural water bodies with surface areas 10 km2 or above and similarly 10% of the surface areas of reservoirs. District wise details with estimated floating solar potential

2 CEB- Long term Expansion plan 202-2041
3 Ceylon Today, accessed on Nov 11, 2023
4 Renewable Energy Resource Development Plan 2021-2026

are provided in Annex 1. To achieve this potential an investment of USD 2 billion would be required by 2030.

Challenges

Infrastructural challenges

Poor and inefficient T&D infra- Lack of availability of transmission infrastructure to integrate solar power: Poor and inefficient Transmission and Distribution (T&D) infrastructure in Sri Lanka can be a significant barrier to the effective integration of floating solar power into the national energy grid. This limitation can lead to congestion in the grid, making it difficult to efficiently transmit electricity from the production point to the end-users. Adding to this, poorly maintained or outdated T&D infrastructure result in voltage fluctuations and energy losses during electricity transmission. These fluctuations can affect the stability and quality of the power supply, impacting the performance of floating solar systems.

Regulatory challenges

Uncertainty in tariff structure make revenue stream unpredictable: Similar to ground mounted utility scale solar, the revenue streams from floating solar projects may be uncertain as there is volatility in electricity prices or if regulatory frameworks for feed-in tariffs or power purchase agreements due to lack of guidelines on the feed-in -tariff.

Financial Challenges

- **Low capacity of the domestic financial institutions to fund large floating solar projects:** Liquidity crunch of local FIs and poor economic situation of the country detracts private investors. The upfront costs associated with designing, manufacturing, and installing floating solar systems can be relatively high. Without availability of low-cost finance for longer duration Investors may be hesitant to commit significant capital.
- **Lack of technical understanding of the floating solar projects among financiers:** Knowledge about the sector among FIs to evaluate the floating solar projects is lacking, this results in inability to evaluate the project finance proposals and ultimately fund them. Lack of a proven track record for floating solar projects in Sri Lanka can make investors cautious. They may be more inclined to invest in technologies and projects with a history of successful implementation and operation.
- **Increased concern on currency risk among the project developers:** The fluctuation of exchange rates poses a risk for foreign investors. If the local currency depreciates significantly against the currency in which project financing is denominated, it can affect the overall project economics and investor returns.

Financing interventions

Floating solar holds significant potential in Sri Lanka. The proposed fund likely to provide concessional debt along with partial risk guarantee to attract private sector finance in this segment and to establish proof-of-concept project for further scaling of this segment in Sri Lanka. The details of the fund structure for floating solar projects are mentioned below:

Floating solar (project financing)

Table 33: Envisaged Deployment of Funds for Floating Solar in Sri Lanka

Nature of Financing

Project financing for both (natural body based and reservoir based floating solar projects)

Financing Recipient

Sri Lanka Sustainable Energy Authority

The fund would lend to SLSEA who would on-lend to project through commercial partner banks

Instrument

- Concessional debt
- Interest rate: SOFR + 0.6% less a credit of 0.1% and a maturity premium of 0.20
- Term: >16 years
- Structured to match the generated cash flows / asset-based collateralization.
- IRR of debt: 12%*
- Government of Sri Lanka to issue guarantee to ADB

Purpose

Shared infrastructure

- Development of roads, water supply and drainage
- Establishment transmission infrastructure

Expected Outcomes

- Support CEB in achieving grid-parity prices for solar.
- Reduced risks of land acquisition
- Enable economies of scale: minimize cost of civil and electrical construction.
- Reduced overall cost of generation and average cost of supply (ACoS) to discom.

Nature of Financing

Project financing for both (natural body based and reservoir based floating solar projects)

Financing Recipient

Commercial Lenders

ADB to provide performance guarantee to the commercial lender on-lending to project to cover the risks

Instrument

Partial Risk Guarantee (PRG)

- Quantum: 25-40% of the project cost
- Tenor: >15 years or match the full term of the debt instrument
- Fees: Front-end + guarantee fee+ commitment fees
- Counter guarantee by Government of Sri Lanka to issue guarantee to ADB

Purpose

Political and operation risk mitigation

Cover the risk associated with non-payment due to the political risks, local currency convertibility risk, expropriation, political violence, and breach of contrac

Expected Outcomes

- Reduce on-lender's risk due to non-performance of project due to political or operational risk.
- Ensure timeliness in commercial operation of the project.

Nature of Financing

Technical Assistance for government

Financing Recipient

Sri Lanka Sustainable Energy Authority/ Ceylon Electricity Board

Instrument

Grant

Purpose

Policy development and capacity building

- Trainings for policymakers and discoms to develop technical capacity for designing policies
- Conduct potential assessment studies
- Defining targets for the segment
- Organizing workshops and training to:
  - Develop technical and commercial understanding of the solar sector, segment specific risks, other country specific risks
  - Capacity building for conducting technical and commercial feasibility
  - Develop policies framework for promoting floating
  - Set permitting and licensing requirements
  - Develop manuals for documentation and application processes, environmental impact assessment and water body regulations
  - Develop model documents for bidding , technical standards, model power purchase agreements, and environmental and social safeguards documents

Expected Outcomes

- Standardized policies and regulations for bidding, agreements on water rights and water bodies, safety requirements, certification, and testing
- Standardized guidelines and technical specifications on setting-up floating structures
- Enhanced technical capacities for taking up hydrographic and bathymetric assessments
- Strengthened capacities for assessing technical and commercial viability of floating solar projects
- Improved coordination between regional governments
- Standardized bidding documents, PPA agreements, E&S safeguard documents
- Standardized process and guidelines for establishment of floating solar

Nature of Financing

Technical Assistance for EPC companies

Financing Recipient

Sri Lanka Sustainable Energy Authority/ Ceylon Electricity Board

Instrument

Grant

Purpose

Construction and operation

Provide training for technical understanding on:

- Detailed site assessment and feasibility study
- Designing the floating structures, anchoring systems, and electrical systems and
- Developing an operations and maintenance plan for floating solar projects

Expected Outcomes

- Improve technical capacities of EPC companies for increased up-take of projects.
- Reduced delays in commissioning and establishment of projects
- Improved technical knowledge on execution of projects

Floating solar (innovative enterprises and insurance)

To further support the floating solar segment in Sri Lanka, the fund proposes to offer concessional debt for early to growth enterprises working on innovative solution for the floating solar segment. The fund also proposes to cover the cost of insurance premium for the first two years for the floating solar assets to mitigate damage or loss of assets and risks inherent to construction and installation. Details of the fund structure proposed for innovative enterprises and insurance premium for floating solar assets is mentioned below:

Table 34: Envisaged Deployment of Funds for Innovative Enterprises for Floating Solar in Sri Lanka

Nature of Financing

Enterprise financing for innovative enterprises

Financing Recipient

Commercial lenders

The fund to provide debt to commercial lenders that would on-lend to innovative floating solar enterprises operating at an early-stage and offering tech-enabled solutions for floating solar.

Instrument

Concessional debt

- Interest rate: SOFR + 0.6% less a credit of 0.1% and a maturity premium of 0.20 | Term: >16 years
- Structured to match the generated cash flows / asset-based collateralization |IRR of debt: 12% (Intellecap analysis)
- Government of Sri Lanka to issue guarantee to ADB

Purpose

Early to growth

- Technical compliance monitoring
- Project development support
- Performance monitoring support

Expected Outcomes

- Drive technology-based innovation, particularly for hybrid models that leverage solar and ocean energy.
- Demonstrate business case, create bankability, and catalyse commercial capital.
- Create bankable pipeline of enterprises.
- Support project development and performance monitoring

Nature of Financing

Insurance premium for floating solar assets

Financing Recipient

Insurance companies

The fund to cover cost of insurance, such as property risk insurance or general liability insurance, floating solar developers as a risk mitigation instrument

Instrument

Insurance Premium Support

- Cost covered for first two years.
- Insurance underwriting
  - Risk engineering, assessment, and rating
  - Specify coverage, T&C, and exclusions

Purpose

Construction / Pre-revenue stage

Mitigate damage or loss of assets and risks inherent to construction and installation.

Expected Outcomes

- Lower overall cost of financing by offsetting insurance cost
- Improve the overall IRR of the project and improve project cashflows, leading to enhanced likelihood of securing debt financing.

SECTION 2

Blueprint of the Catalytic Financing Facility for Solar in South Asia

CHAPTER 7
BLUEPRINT OF THE REGIONAL CATALYTIC FINANCING FACILITY

Fund Objective

The Catalytic Financing Facility for Solar in South Asia (CFFSSA) aims to infuse investments in solar technologies demonstrating the highest impact and investment potential, thereby unlocking commercial and concessional capital. The proposed approach would seek to address the barriers discussed in the above chapters through a combination of concessional capital with risk mitigation measures and capacity building that enables commercial viability of the focus solar technologies i.e., utility-scale ground-mounted solar, rooftop solar, floating solar, and productive use of solar technologies.

Capital from the fund would be furnished to financial institutions, solar enterprises, and regulators with the objective of addressing stakeholder specific challenges resulting in an enabling ecosystem for scaling solar energy deployment.

- **Financial Institutions:** reduce cost and perceived risk of financing solar projects and enterprises; adequately appraise solar projects and their associated risks; and develop mitigating strategies.
- **Solar Enterprises:** enable and increase access to low-cost finance; drive technology-based innovation; demonstrate business case and support scale up; and enable bankability and economies of scale.
- **Policymakers:** work with relevant government agencies for efficient deployment of solar energy; create an enabling environment; and enable, effective project management and monitoring.

By removing the financial, technical, and policy barriers, the fund would enable commercially viable investments into solar energy. Through solar energy, the share of renewables in the overall energy mix of South Asia would increase multifold resulting in CO2 emission reduction and carbon credit generation.

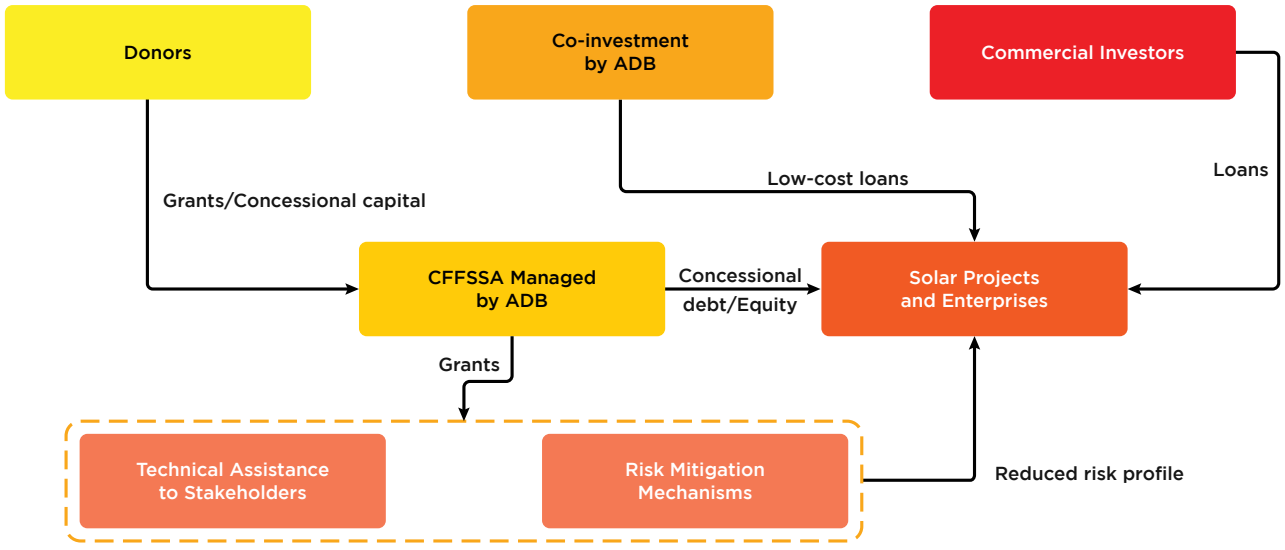
Fund Design Framework

The CFSSA seeks to undertake blended finance as a structuring approach to use catalytic capital from public or philanthropic sources to increase private sector investment towards solar energy in South Asia. The Fund would undertake blending of the following different types and sources of capital:

- Commercial debt to solar projects and enterprises from commercial investors
- Low-cost loans as co-investment to solar projects and enterprises from ADB
- Concessional debt / equity to solar projects and enterprises from MDBs and DFIs
- Grants/concessional capital for TA and risk mitigation mechanisms from donors and ADB

This would allow for increased access to low-cost capital across the key stakeholder categories in the solar ecosystem of South Asia – commercial financial institutions, solar enterprises, government agencies. Public or philanthropic investors would provide funds on below-market terms i.e., concessional capital to lower the overall cost of capital. They would also provide guarantees offering an additional layer of protection to private investors, thereby enabling commercial credit enhancement to solar enterprises.

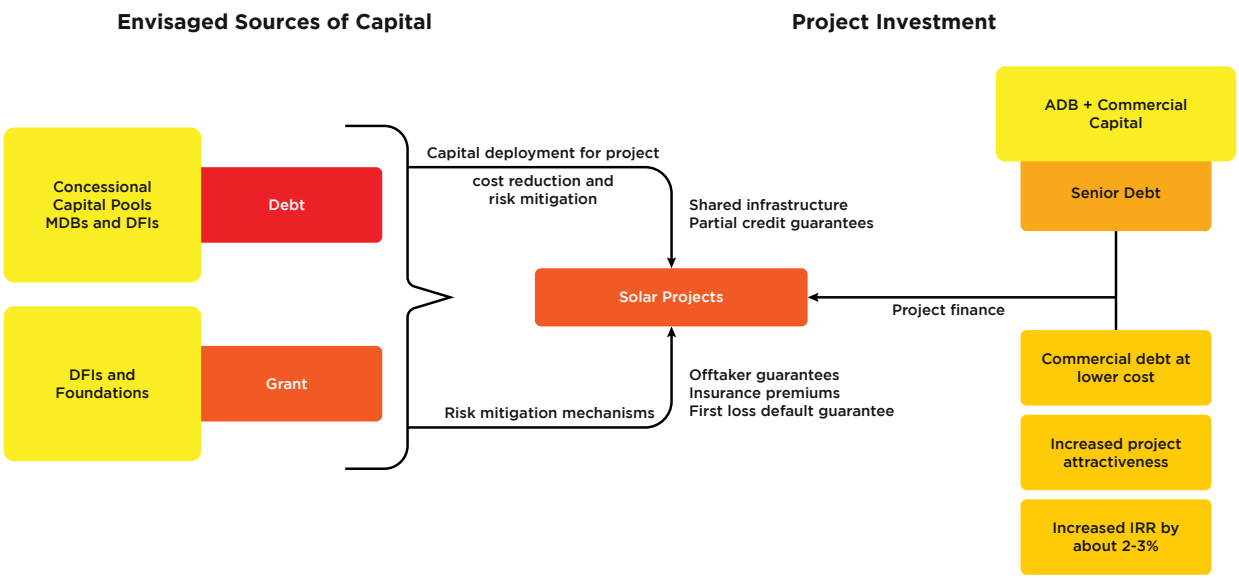
Figure 18: Framework for Co-Invested Capital Deployment through CFFSA



The CFFSSA would be managed by ADB with strategic guidance provided by ISA. The facility is envisaged as a USD 250 mn facility comprising of three distinct financing components:

- **Concessional capital** i.e., high-risk position taken by MDBs and DFIs for capital deployment for reduction in project costs
- **Grants for risk mitigation** i.e., off taker guarantees, insurance premiums and first-loss default guarantee, from DFIs and Foundations
- **Senior debt** i.e. low-risk position from ADB and commercial investors at relatively lower cost than the market for project finance

Figure 19: Co-Investing Facility – Composition and Investment Economics of CFFS



Capital Deployment Thesis

Given the nascency and high impact and investment potential of the emerging segments of floating and rooftop solar, the largest allocation of the CFFSSA would be earmarked for the same. 32% of the facility would be for floating solar while 25% for rooftop solar. This would be followed by utility-scale ground-mounted solar (23%), which, while not nascent, requires high Capex. Productive use of technologies would account for 10% of the facility. The remaining 10% of the facility would be earmarked for technical assistance.

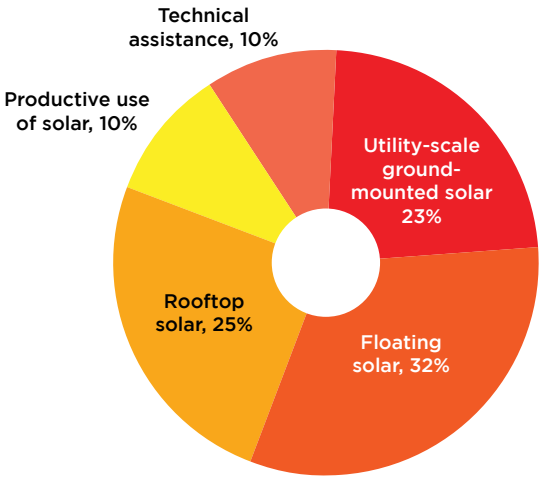


Figure 20: Segment-wise Share of CFFSA

With respect to the financing instruments, debt would be the largest instrument – 60% of the facility – for capital deployment in the region as the fund focuses on emerging segments in early-stage to growth markets. Equity would form 20% of the CFFSSA. Both forms of instruments, as mentioned above, would be mobilized from multiple sources with the aim of having a mix of concessional and commercial capital. 10% of the facility would be earmarked for risk mitigation instruments mobilized via grants. The remaining 10% would be used for providing technical assistance for all stakeholders – policymakers, financiers, and entrepreneurs.

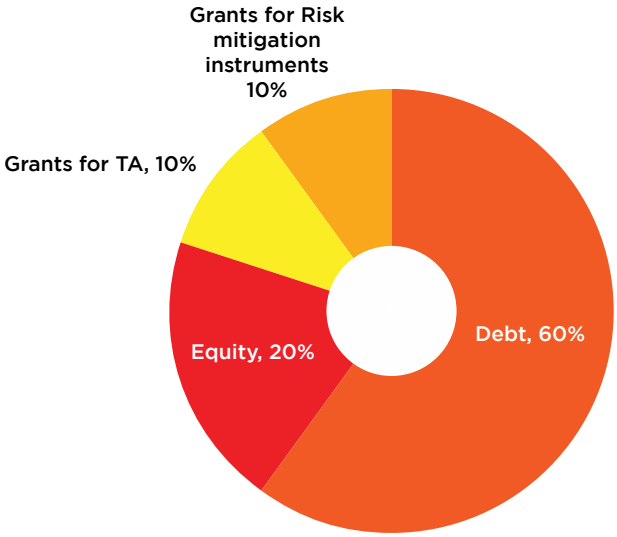


Figure 21: Instrument-wise Share of CFFSA

Investment Theory

The investment theory of CFFSSA is focused on accelerating solar deployment in South Asia by mobilizing investments for solar projects and enterprises from diverse capital sources, including DFIs and private investors. While debt is envisaged to be primarily used for project finance, equity would be aimed at solar enterprises. To facilitate the capital flow, grants would be used for risk mitigation and technical assistance. The strategic aim of investments undertaken via CFFSSA is twofold:

Reduced cost of capital

- **Improved feasibility:** Increased affordability of projects due to concessional capital at rate of interest of 8-10%, around 6-8% less than commercial capital (currently at ~14-18%).
- **Better economics:** Reduction in cost of solar generation and tariffs to consumers due to overall reduction is cost of projects.
- **Increased returns:** Demonstrated improvement in project IRR by around 40% due to introduction of concessional capital.

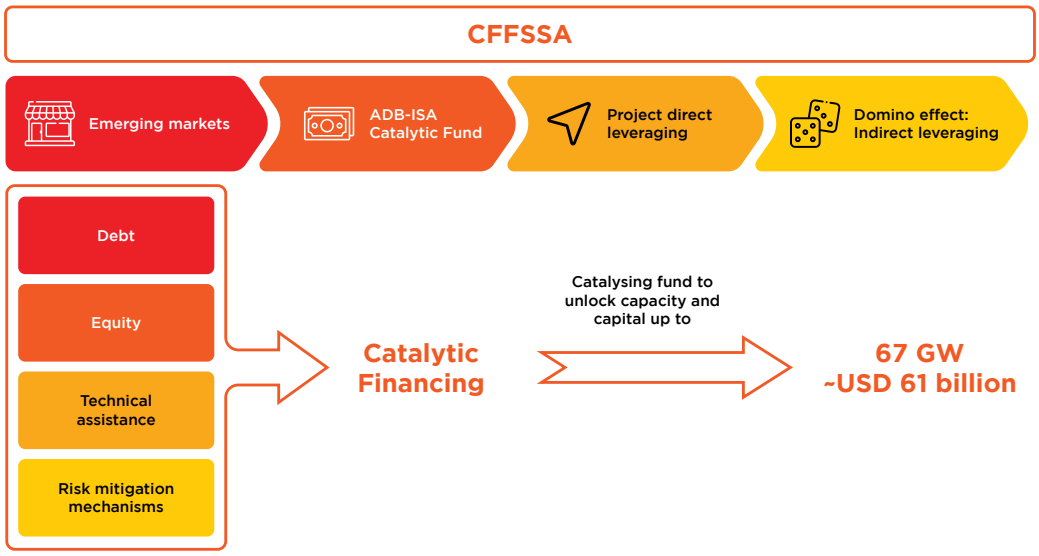
Reduced risk profile

- **Improved payments:** Improved payments to developers through payment guarantee mechanisms and lender interest through partial-credit guarantee mechanisms.
- **Enabled ecosystem:** Increased agility in the ecosystem including policy and regulatory measures, strategic direction, and blueprints for scaling solar.
- **Enhanced capacity:** Increased awareness among stakeholders including governments, financiers, enterprises, and customers.

CHAPTER 8
ENVISAGED IMPACT OF THE REGIONAL CATALYTIC FINANCING FACILITY

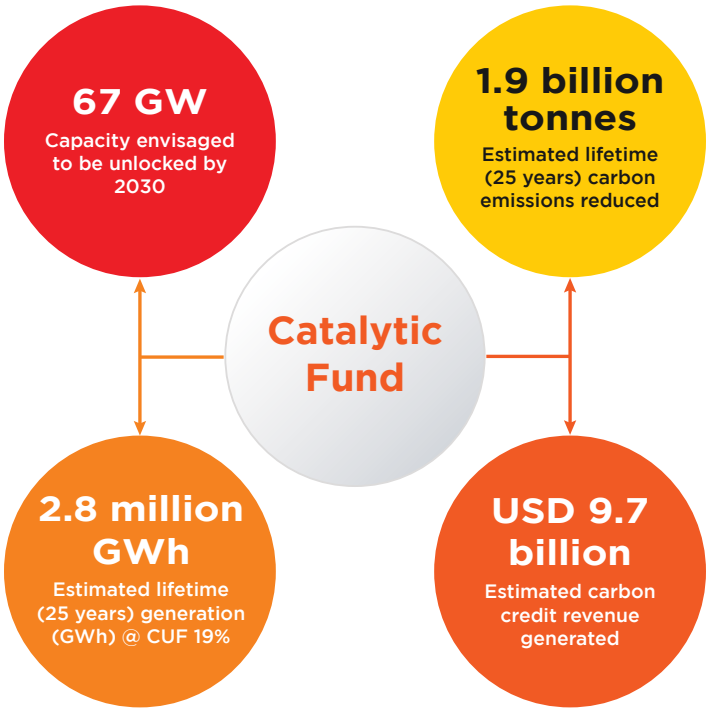
Through the envisaged CFFSSA, that combines debt, equity, risk mitigation instruments and grant capital for technical assistance, there exists a potential to unlock capital of USD 61 billion to scale up solar deployment in the target countries. The fund will play the role of de-risking the private sector capital that will form most of the funding required for development of solar energy resources in the countries. The following graphic gives a snapshot of the leverage provided by the catalytic capital required to unlock capacities of around 67 GW in South Asia by 2030.

Figure 22: Capital Unlocked through CFFSA



With the potential to install 67 GW of solar energy by 2030, the funding facility can unlock several direct benefits. This could result in a generation of 2.8 million GWh at CUF of 19% over 25 years. Further, the facility could lead to an estimated CO2 emissions reduction of 1.9 billion tons over the lifetime of the projects and generation of carbon credit of around USD 9.7 billion.

Figure 23: Climate Impact through CFFSA



In addition, the technical assistance component could lead to multiple benefits envisaged across stakeholder groups, as highlighted below.

Policy institutions

- Increased understanding of segment specific risks
- Standardized policies for emerging segments
- Improved coordination between state/ county and central governments
- Standardized guidelines and model bidding documents
- Reduced time for approvals and permissions

Enterprises

- Strengthened business and financial models
- Increased geographical reach
- Reduced project risks
- Ensured timeliness in commercial operation
- Improved gestation periods
- Increased operational efficiencies of projects

Financial institutions

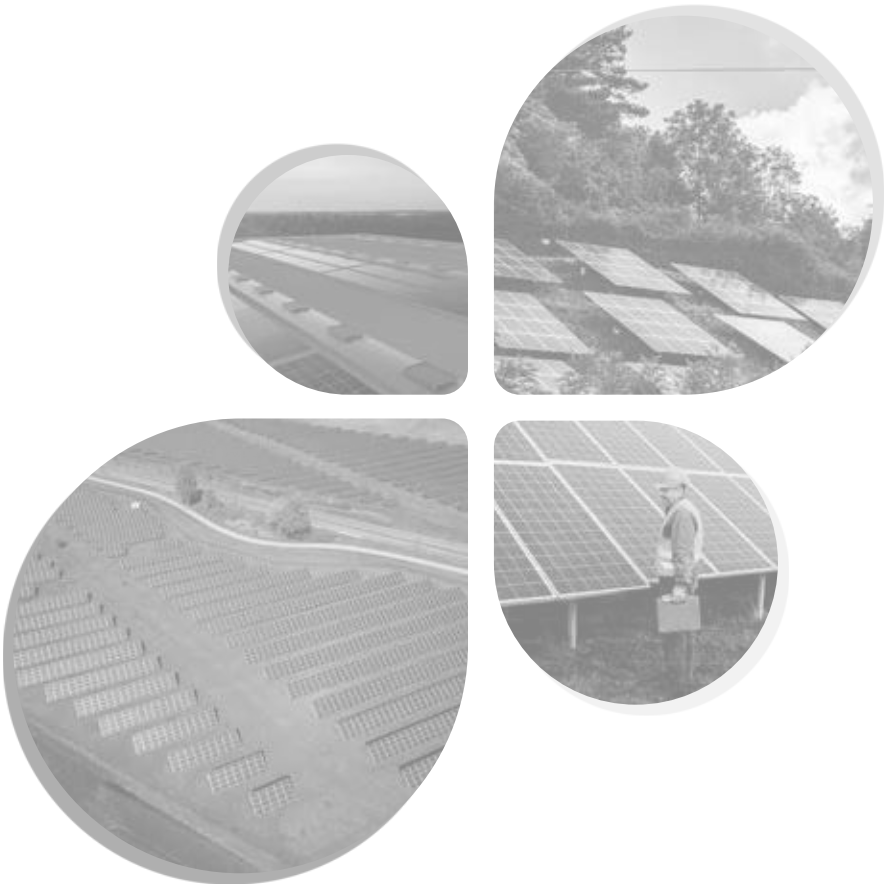
- Improved credit flow to enterprises in specific solar segments
- Enhanced knowledge on segment-specific risk models and due diligence criteria
- Increased utilization of funds and timeliness in repayments

DISCOMS

- Mitigated DISCOM reluctance in promoting rooftop solar
- Improved approval processes
- Increased participation in solar capacity development
- Improved perspective of co-existence with decentralized solar capacity

Consumers

- Improved knowledge on existing technologies, costs and benefits of adopting solar solutions
- Enhanced awareness on financial incentives for adopting solar technologies.



INTERNATIONAL SOLAR ALLIANCE

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