Cover Page for CTF Project/Program Approval Request[1]			
1. **Country/Region**	India	2. **CIF Project ID#**	(CIF AU will assign ID.)
3. **Investment Plan (IP) or Dedicated Private Sector Program (DPSP)**	[X] IP [ ] DPSP	4. **Public or Private**	[X] Public [ ] Private
5. **Project/Program Title**	*Solar Rooftop Investment Program Guaranteed by India*		
6. **Is this a private sector program composed of sub-projects?**	[ ] Yes [X] No		
7. **Financial Products, Terms and Amount**			

	USD (million)	**EUR** (million)[2]
Grant	**4.75**	
Fee on grant	**0.25**	
MPIS (for private sector only)		
Public sector loan		
• Harder terms		
• Softer terms	**170.00**	
Senior loan		
Senior loans in local currency hedged		
Subordinated debt / mezzanine instruments with income participation		
Second loss Guarantees		
Equity		
Subordinated debt/mezzanine instruments with convertible features		
Convertible grants and contingent recovery grants		
Contingent recovery loans		
First loss Guarantees		
Other (please specify)		
Total	**175.00**	

8. **Implementing MDB(s)**	Asian Development Bank
9. **National Implementing Agency**	Punjab National Bank (PNB)
10. **MDB Focal Point**	*Mr. Jiwan Acharya (jacharya@adb.org)*

[1] This cover page is to be completed and submitted together with the MDB project/program proposal when requesting CTF funding approval by the Trust Fund Committee.
[2] Please also provide USD equivalent in the column to the left

11. **Brief Description of Project/Program (including objectives and expected outcomes)**

The Clean Technology Fund (CTF) Investment Plan for India was originally endorsed in November 2011 and later revised in August 2015. The revised plan reflects the government's updated and more ambitious target of deploying 100 Gigawatt (GW) solar capacity by 2022, a five-fold increase from the 20 GW goal in 2011. New objectives include 60 GW of ground-mounted utility scale solar power projects, and 40 GW in rooftop solar installations including grid-connected systems. CTF resources will catalyze investments in solar park infrastructure, transmission capacity, and rooftop photovoltaic system (PV) which will help achieve 4 GW of new installed capacity. The investment plan has a total indicative CTF allocation of $775 million, of which $530 million has already been approved by the Trust Fund Committee (TFC).

Table 1: India CTF Investment Plan Project Portfolio

Project / Program	MDB	CTF financing (US$ M)	CTF TFC Approval
Solar Park: Rajasthan	ADB	200	Jul-13
Himachal Pradesh Environmentally Sustainable Development Policy Loan (HP DPL)	World Bank	100	Nov-13
Partial Risk Sharing Facility for Energy Efficiency (PRSF)	World Bank	25	Jul-14
Solar Rooftop PV	World Bank	125	Dec-2015
	ADB	125	--
Solar Parks Infrastructure	World Bank	50	Jan-16
	ADB	50	--
Solar Parks Transmission	World Bank	30	Jan-16
	ADB	50	--
Solar PV Generation by Solar Energy Corporation of India (SECI)	World Bank	20	--
	Total	**775**	

Country Background

Fuelled by higher domestic demand and increase in manufacturing activity, India is among the fastest growing nations, recording 7.6 percent annual GDP growth in 2015. India is the world's second largest country in terms of population, estimated at 1.252 billion in 2013. The continuous growth in the economy and population, including increasing urbanization and rising aspirations of the people, are putting further pressure on India's energy demand, which currently stands third largest in the world after China and the United States and just ahead of Russia.

According to the Energy Outlook for Asia and Pacific issued by ADB in October 2013, India's energy demand more than doubled from 693 million tons of oil equivalent (Mtoe) in 2010 to 1,442 Mtoe in 2035. Despite this high energy demand, per capita consumption of electricity remains low at about 0.78 megawatt-hour (MWh), versus the world average of 3.03 MWh/capita per capita and OECD countries average of 8.07 MWh/capita (IEA, 2015). A quarter of the population (237 million people) does not have access to electricity, with large proportion residing in rural areas.

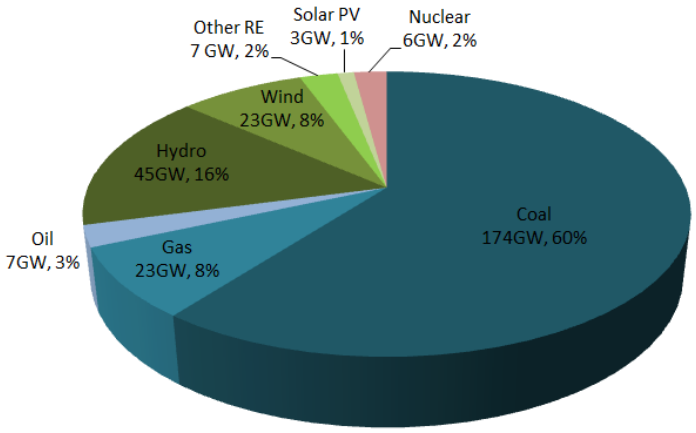
Figure 1: Number and share of people without access to electricity by state in India, 2013

	Population without access (million)			Share of population without access		
	Rural	Urban	Total	Rural	Urban	Total
Uttar Pradesh	80	5	85	54%	10%	44%
Bihar	62	2	64	69%	19%	64%
West Bengal	17	2	19	30%	7%	22%
Assam	11	0	12	45%	9%	40%
Rajasthan	10	0	11	22%	2%	17%
Odisha	10	0	11	32%	4%	27%
Jharkhand	8	0	9	35%	4%	27%
Madhya Pradesh	7	1	8	16%	3%	12%
Maharashtra	6	1	6	11%	2%	7%
Gujarat	2	2	3	7%	6%	6%
Chattisgarh	2	0	3	14%	6%	12%
Karnataka	1	0	1	5%	1%	3%
Other states	3	2	6	2%	2%	2%
Total	**221**	**16**	**237**	**26%**	**4%**	**19%**

Source: IEA (2015) India Energy Outlook, World Energy Outlook Special Report

The Indian power system is among the largest in the world with about 288GW of installed capacity, largely dominated by fossil fuels, particularly coal which represents 60% of the total capacity, followed by hydropower (16%), natural gas (8%) and wind (8%), as shown in Figure 2. Overall, renewable energy sources – hydropower, wind, and solar – covers only about 27% of the total capacity.

Figure 2: Installed Capacity, 2014



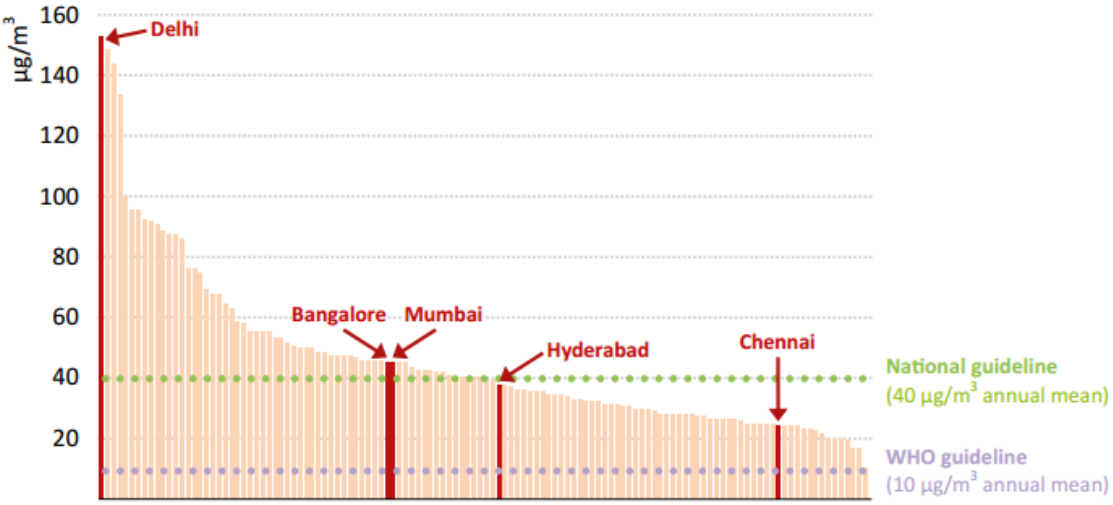
Source: IEA (2015) India Energy Outlook, World Energy Outlook Special Report

Growing demand for coal is the main factor behind the country's increasing CO2 emissions. Currently, India is the world's third largest emitter of carbon emissions behind the Peoples Republic of China and the USA, although per capita emissions are far lower. India's total

emissions are 3,013.8 million tons of carbon dioxide equivalent (tCO2e) with large share coming from energy sector (2,126.5 million tCO2e); this is about 6.96% of the total global emissions in 2012.[3] The increasing use of inefficient back-up diesel generators both at household and industrial levels due to unreliable and unpredictable power supply has worsened local air pollution.

Based on Figure 3 below, out of the 124 cities in India (for which data exist), only Pathanamthitta City (with a population of 38 000), meets the World Health Organization (WHO) guideline for fine particulate matter (PM2.5) concentrations. Delhi exceeds this guideline by fifteen-times. In terms of PM2.5 levels, India has 13 of the world's 20 most-polluted cities and an estimated 660 million people in areas in which the government's own national air quality standards are not met (IEA, 2015). GoI recognizes that its coal-centered energy mix and rising pollutant emissions, partly due to reliance on back-up diesel generation, pose a threat to India's sustainable development.

Figure 3: Average annual particulate matter concentration in selected cities in India



Source: IEA (2015) India Energy Outlook, World Energy Outlook Special Report

To address the growing concerns on public health and potential risks of climate change, the government issued the 2008 National Action Plan for Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. Under this action plan is the Jawaharlal Nehru National Solar Mission (JNNSM) with the ultimate objective of making solar competitive with fossil-based energy options through long term policy and large scale deployment. The GoI recently has announced revolutionizing solar energy development in the country, targeting 100 GW grid connected solar capacity by 2022, of which 40GW will be rooftop solar PV systems.

Rooftop solar PV is gaining momentum, as it is becoming increasingly cost competitive with electricity from the grid in many parts of India with grid prices rising at about 5-10% annually across the country. As of 2015, about 350 MW of rooftop solar PV projects had been completed (i.e. less than one percent of the target of 40GW). Maharashtra, Tamil Nadu and Gujarat are the leading states with close to 30% share (>100 MW) of total rooftop capacity. Most of the early

[3] http://www.wri.org/blog/2015/06/infographic-what-do-your-countrys-emissions-look

adopters of rooftop solar have been commercial and industrial consumers mainly used as back up during events of supply interruptions and to displace daytime reliance on diesel-fired generators.[4]

A number of barriers are preventing the deployment of rooftop solar PV systems in the country; these barriers include (i) lack of commercial debt financing options for developers, installers and aggregators; the only widely used business model has been the "direct sale" model where the customers have to pay for the rooftop PV system in full, upfront, to the solar integrator or installer; (ii) lack of capacity to provide sustained institutional and technical support for continued scale-up efforts for rooftop solar systems, including in areas such as the certification and enforcement of quality and technical standards; (iii) weak coordination between central and state government agencies as well as between government agencies and private stakeholders that are involved in the implementation of rooftop solar PV; (iv) low consumer awareness on cost, technical performance, economic benefits, and financial options; and (v) poor financial situation of distribution companies (discoms) which discourages them from speedily implementing net metering and other rooftop solar policies that have been announced by state governments and regulators.

To address the identified barriers above and to accelerate the adoption of rooftop solar systems in the country, GoI has initiated a number of strategies and programs. The capital subsidies and accelerated depreciation are the two main financial instruments implemented by the GoI to expand the rooftop solar market. However, the capital subsidy model used by Ministry of New and Renewable Energy (MNRE) and Solar Energy Corporation of India (SECI) has not been successful due to poor implementation and lack of funds; the accelerated depreciation (equivalent to 25% of the capital cost of the system) is expected to continue at least until March 2017. Going forward, greater provision of debt-financing and net-metering are expected to be the main policy tools. So far, 25 states and union territories have put in place net-metering guidelines (draft and approved) for rooftop solar installations.[5]

MNRE is leading the implementation of Grid Connected Rooftop and Small Solar Power Plants Program (GRSPP). The program promotes grid connected solar rooftops through provision of subsidies, development of business models, creating an enabling environment for private investment, and raising consumer awareness. The program is being implemented in partnership with multiple central and state agencies including state nodal agencies for renewable energy, SECI, financial institutions, public sector units, municipal corporations, private sector channel partners, and discoms. These rooftop solar PV plants will be set up in residential, commercial, industrial, institutional sectors in the country ranging from 1 kWp to 500 kWp capacity. The program provides Central Financial Assistance (CFA) equal to 30% of total rooftop solar PV system costs from National Clean Energy Fund to residential and institutional customers. The program covers both project and programmatic approaches and all business models of rooftop solar including the customer owned, third party owned and utility owned models.

To rapidly scale up the installation of solar rooftop systems in India, GOI requested the domestic

[4] Bridge to India. 2015. India Solar Handbook. Available: http://dev.bridgetoindia.com/wp-content/uploads/2015/06/BRIDGE-TO-INDIA_india-solar-handbook_2015_online-1.pdf. Other sources.

[5] Bridge to India. 2015. India Solar Handbook. Available: http://dev.bridgetoindia.com/wp-content/uploads/2015/06/BRIDGE-TO-INDIA_india-solar-handbook_2015_online-1.pdf. Other sources.

banking sector to immediately mobilize designated solar rooftop financing facilities/programs, including as a part of the bank's low cost housing loan program. In the same context, GoI also requested financing support from ADB, KfW, and World Bank, which focus more on commercial scale solar rooftop projects.

Project Description

The proposed ***Solar Rooftop Investment Program (SRIP)*** is one of the three engagements under the revised India CTF investment plan for which GoI has requested support from ADB. The proposed investment program, in parallel with the other solar projects, will help the GoI achieve its new solar targets of 100 GW installed capacity, demonstrate important economies of scale in solar generation, increase efficiency while reducing transaction costs and unit costs of solar power, and address pressing environmental concerns including carbon emissions.

The GoI has requested CTF cofinancing for the Project be increased to $175 million from the $125 million indicated in the Revised IP of 2015. The additional $50 million will be reallocated from the ADB Solar Park Infrastructure project. Analysis conducted during project preparation concluded that achieving the targeted investments is critically dependent on the cost and scale of finance. As such, additional concessional funds from the CTF will more rapidly facilitate the market transformation required to meet the Government's ambitious targets.

The proposed SRIP of $500 million (composed of $170 million CTF loan, $5 million CTF grant and $325 million ADB loan) will be a sovereign-guaranteed ADB multitranche financing facility (MFF) which will provide financial intermediation loans to Punjab National Bank (PNB). The program will provide (i) a comprehensive institutional capacity and market development program and (ii) a designated solar rooftop financing facility to provide the debt financing to help the country meet its 40 gigawatts (GW) solar rooftop capacity target by 2022. The program intends to support solar rooftop systems on commercial, industrial, institutional (government and public sector) buildings and – at a later stage when the market is further developed – residential buildings in India.

The investment program aims to promote energy efficiency and renewable energy, maximize access to energy for all, and promote energy sector reform, capacity building and governance through increased lending to solar rooftop projects. The program will facilitate installation of at least 400 MW solar rooftop capacity with generation output of 631 GWh annually. The Project has three main outputs:

Output 1: Improved solar rooftop market infrastructure and pipeline subproject development

CTF will finance the implementation of a technical assistance (TA) of $4.75 million which will help PNB develop robust solar rooftop business capacity and accelerated market development. These institutional capacity and market development activities will generate a steady flow of subprojects to PNB (i.e., built a "deal pipeline") which will be closely coordinated and synergized with investments of the GOI and other development partners.

Activities under this output include support for: (i) GOI mandate (central and state level) for

government entities and public institutions to install solar rooftop systems on their buildings; (ii) Preparation of a feasibility study for GOI to develop the concept of a project risk guarantee fund to increase the risk appetite of private sector developers to enter the solar rooftop sector; (iii) MNRE channel partners, which are primarily private sector solar rooftop developers, to develop a viable long-term bankable subproject pipeline; (iv) Discoms to implement guidelines on net metering policy, gross metering, and feed-in-tariff; (v) Discoms to develop procedures, data requirements, application forms staffing responsibilities and service standards for responding to customer requests for grid connected rooftop systems; (vi) State nodal agencies in selected states, central electricity regulatory commission, and central electricity authority to meet the renewable energy purchase obligations targets set by GoI; and (vii) conduct awareness campaigns among all stakeholders, in particular rooftop owners on the available business models and their technical and commercial benefits.

Output 2: Improved PNB institutional capacity

PNB will create a rooftop solar lending facility and will on-lend funds to other financial intermediaries (e.g., banks and/or non-bank finance companies) or directly to rooftop solar developers/users. PNB will ensure that all investments undertaken as part of the facility meet the required minimum technical standards for rooftop solar systems in India.

Activities include: (i) PNB will establish an institutional structure creating designated units at its headquarters and selected branches that specialize in providing financing for solar rooftop installations; (ii) PNB will set up internal procedures for loan origination, screening, financial and technical reviews, approval, and monitoring of subprojects. An administration manual and credit risk manual will be developed which will detail out the eligibility criteria, technical performance requirements and appraisal guidelines for the assessment of potential subprojects.

In parallel with this output, it is expected that designated PNB staff will be trained on the solar rooftop-specific financial credit/risk model developed by the United States Agency for International Development (USAID) through complementary capacity building support by December 2016. This will further strengthen the establishment and operation of a solar rooftop project credit/risk rating system to facilitate subproject assessment, appraisal and pricing.

Output 3: Increased funding to PNB

The investment program will provide $500 million directly to PNB for onlending of the equivalent ADB funds in local currency either through other financial intermediaries (e.g., banks or finance companies) or directly, to subborrowers, e.g., solar rooftop developers. Activities include: (i) disbursement of the $495 million in OCR and CTF loans during the program implementation period; and (ii) leverage of the ADB program to catalyze private sector equity and debt financing.

The project's main beneficiaries are property owners through lowered power tariff payment and/or rental fees, private sector solar rooftop project developers through access to long-term and competitively priced funding and local utility companies such as power off-takers through additional electricity supply.

Financing

ADB will provide PNB with $500 million in programmatic funds composed of $325 million from ADB ordinary capital resources (OCR) and $175 million from CTF financing of which $170 million will be extended under softer concessional terms and $5 million will be extended in the form of a grant. The program will use ADB's MFF modality to deliver a series of loans from 2016 – 2022. The MFF is expected to have 3 tranches: tranche 1 ($100 million from 2016-2018 – to be funded entirely by the CTF loan); tranche 2 ($150 million from 2018-2020 – to be funded by a mix of CTF and OCR); and tranche 3 ($250 million from 2020-2022 – to be funded by OCR).

The investment program will catalyze $300 million subborrowers' equity and an additional $200 million of unrestricted funds bringing the investment to a total of $1 billion.

Table 2: Financing Plan

Source	Amount ($ million)	Share of Total (%)	Tranche 1 ($ million)	Tranche 2 ($ million)	Tranche 3 ($ million)
Asian Development Bank[1]	325.0	32.5	0.0	75.0	250.0
Clean technology fund (loan)	170.0	17.0	95.0	75.0	0.0
Clean technology fund (grant)[2]	5.0	0.5	5.0	0.0	0.0
Subborrowers' own fund[3]	300.0	30.0	60.0	90.0	150.0
Unrestricted sources[4]	200.0	20.0	40.0	60.0	100.0
Total	1,000.0	100.0	200.0	300.0	500.0

[1] Asian Development Bank funds are ordinary capital resources (loan funds).
[2] Includes MDB fee of $250,000
[3] The subborrowers' equity of 30% of the total subproject cost is indicative. The range of the equity share in a subproject structure is typically between 25% - 35%, depending upon the nature of the subproject.
[4] Unrestricted sources can be from, e.g., participating financial institutions' own funds or government support.

The availability of the ADB funds will be subject to the government's submission of related periodic financing requests, execution of the related loan and project agreements for each tranche, and fulfillment of terms and conditions and undertakings set forth in the framework financing agreement.

The CTF loan is requested at softer terms with a service charge of 0.25% per annum on the disbursed and outstanding loan balance and 40-year maturity, including a 10-year grace period, with principal repayments at 2% for Years 11-20 and at 4% for Years 21-40. Principal and service charge payments accrue semi-annually. A management fee equivalent to 0.45% of the total loan amount ($540,000) will be charged, to be capitalized from the loan proceeds, following the effectiveness of the loan.

The proposed SRIP will help develop the emerging rooftop solar market in India. It will support the implementation of MNRE's GRSPP program, with a focus on mobilizing private sector investments and commercial lending, increasing deployment of rooftop solar, and thereby contributing to the achievement of GoI's rooftop solar installation targets, while also reducing emissions. The proposed SRIP is aligned with GOI's NAPCC and JNNSM in promoting solar energy. It is consistent with ADB's Energy Policy (2009) by (i) promoting energy efficiency and renewable energy, (ii) maximize access to energy for all, and (iii) promoting energy sector

reform, capacity building, and governance.[6] The investment program is also consistent with ADB's (i) Financial Sector Operational Plan where financial intermediation is recognized as an important instrument for on-lending including for infrastructure, and (ii) country partnership strategy (CPS) for India, 2013–2017,[7] with respect to the energy sector road map to expand clean and renewable energy capacity and financial sector development to catalyze infrastructure investments, including through investment funds and credit lines. The SRIP also contributes to the ADB objective to double its annual climate financing from the current level of $3 billion to $6 billion by 2020. Finally, the SRIP supports India's Intended Nationally Determined Contribution, which includes the targets to lower the emissions intensity of gross domestic product by 33% to 35% by 2030 below 2005 levels, and to increase the share of non-fossil based power generation capacity to 40% of installed electric power capacity by 2030.

12. **Consistency with CTF investment criteria**

(1) Potential GHG emissions savings

The emission reduction potential of the SRIP is estimated at 441,700 tons of carbon dioxide equivalent (tCO2e) annually, or about 11 million tCO2e over 25 years lifetime of the rooftop solar technologies.

631 GWh X 700 t/GWh = 441,700 tons CO2e / year

These estimates assume 400 MW of capacity operating at 18% plant load factor, displacing an equivalent of 631 GWh per year of "thermal-based" power in the baseline scenario. The baseline scenario assumes "thermal-based power generation" using a combination of imported coal and diesel generation sets. The weighted average emissions factor of 700 t/GWh is more conservative than the 830 t/GWh for typical[8] for baseline scenario as well as the grid emission factor for India[9]. The emission factor accounts for decreasing emissions intensity associated with higher RE penetration rates. If black carbon emissions are included, assuming that the solar output is mainly displacing diesel-fired backup generators during peak demand, the effective GHG reductions would be significantly higher.[10]

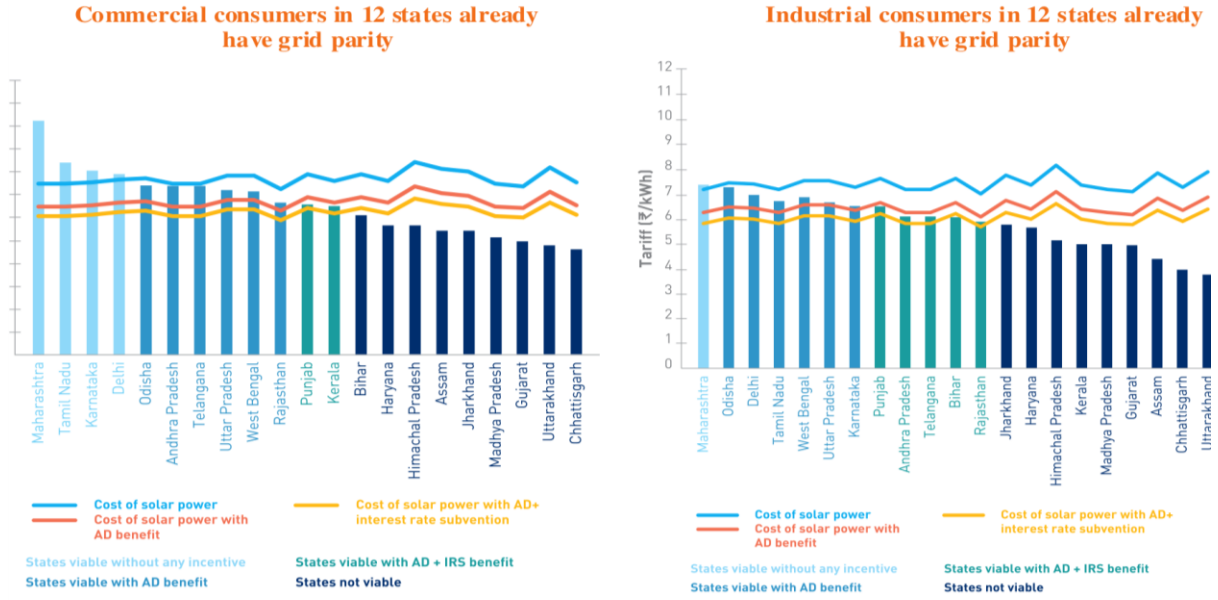
Rooftop Solar Potential. India has an enormous solar energy potential. The estimated total solar energy capacity is about 750 GW.[11] As of January 2016, the total installed grid-connected and

[6] ADB. 2009. *Energy Policy*. Manila.
[7] ADB. 2013. *Country Partnership Strategy: India, 2013–2017*. Manila.
[8] 830 kg/MWh for coal generation from supercritical plants; 650 kg/MWh for diesel generation sets; 10.7% of T&D losses; the emission factor was computed assuming 8 hours of electricity consumption comprised of 7 hours of grid connection supplied by coal and 1 hour use of captive diesel generation set, taking into account T&D losses in the grid; the actual calculation is as follow: 830/(1-10.7%) *7/8 + 650*1/8 = 895
[9] 980 kg/MWh, from CO2 Baseline Database for the Indian Power Sector, Central Electricity Authority
[10] For example, Appendix 4 of the Revised CTF Investment Plan for Indonesia 2013, notes an emissions factor for low efficiency diesel generators including black carbon of 1.3 tCO2/MWh.
[11] Ministry of New and Renewable Energy. 2014. *State wise Estimated Solar Power Potential in the Country*. Available: http://mnre.gov.in/file-manager/UserFiles/Statewise-Solar-Potential-NISE.pdf (as of November 2014).

off-grid/captive solar power capacities were only 5.5 GW, or about 0.7% of the total potential.[12] The total rooftop solar potential in India is estimated to be 124 GW,[13] while the existing solar rooftop capacity in the country is estimated at about 221 megawatt (MW), or 0.2% of the total potential.[14] Under the 40 GW target, about 70% (28 GW) would be solar rooftop projects on large commercial, industrial, and institutional buildings – called aggregated – while 30% (12 GW) would be for residential properties.

The aggregated solar rooftop market in India is commercially viable and developing rapidly. Grid parity is being achieved particularly on solar rooftop installations on buildings owned by commercial and industrial entities which pay higher electricity tariffs than other consumers in India. This means that solar rooftop power's levelized cost of electricity is becoming lower than that purchased from the power grid. The tariff from solar rooftop systems has been declining steadily to the current level of about Rs. 7 per kilowatt hour (kWh), versus the tariff from the power grid at about Rs. 9-12 per kWh. This cost factor underpins the fundamental bankability of the commercial solar rooftop business models. As shown in Figure 4 below, rooftop solar has reached grid parity among commercial and industrial customers in 12 states.

Figure 4: Grid parity status of rooftop solar



Source: Bridge to India, 2015

In addition, 19 out of 29 states in India have issued solar policies. A net-metering policy that is critical to solar rooftop power development has also been enacted in 24 out of 29 states. The renewable energy purchase obligations (RPO) targets have been set by the Government of India.[15]

[12] Ministry of New and Renewable Energy. 2015. Physical Progress (Achievements). http://www.mnre.gov.in/mission-and-vision-2/achievements.
[13] The Energy and Resources Institute. 2014. *Reaching the Sun with Rooftop Solar*.
[14] Bridge to India. 2015. India Solar Handbook. Available: http://dev.bridgetoindia.com/wp-content/uploads/2015/06/BRIDGE-TO-INDIA_india-solar-handbook_2015_online-1.pdf. Other sources.
[15] MNRE. 2015. Solar RPO and REC Framework. http://mnre.gov.in/file-manager/UserFiles/Solar%20RPO/solar-RPO-requirement-by-2022.pdf

As of June 2015, the Reserve Bank of India identified renewable energy as a priority lending sector to facilitate banking lending to the solar rooftop sector.[16]

Furthermore, the outlook of the rooftop solar market is highly positive. There is an urgent need to increase the retail electricity tariffs in order to restore the financial health of the discoms. The cost of rooftop solar power will continue to decline, due to the reduction of component costs and other factors, e.g., more efficient installation procedures. These factors, combined with lower cost of financing will make rooftop solar systems even more competitive and commercially viable, to the benefit of all consumers.

(2) Cost-effectiveness

The program's cost-effectiveness is summarized in Table 3, assuming 25-year operational lifetime.

Table 3: Avoided Greenhouse Gas Emissions and CTF Cost-Effectiveness

Case	Annual Avoided Emissions (million tCO_2e)	Lifetime Avoided Emissions (million tCO_2e)	CTF$ / tCO_2e	Total Project $ / tCO_2e
Phase 1 CTF-funded: 400 MW (Before Replication & Scale-up)	0.44	11.0	15.91	90.91[a]
Phase 2 Scale-up: 1000 MW (Assuming PNB implements Phase 2 for additional 600 MW)	1.10	27.5	6.36	77.82[b]
Phase 3 Replication & Scale-Up: 28 GW national target	30.90	772.5	0.23	54.36[c]

CTF = Clean Technology Fund; GHG = greenhouse gas; tCO2e = tons of CO_2 equivalent.
Note:
[a] In Phase 1, installed cost is assumed to be $2.5 million per MW.
[b] In Phase 2, installed cost is assumed to decline $1.9 million per MW in Phase 2; total cost of 1000 MW is $2.14 Billion.
[c] In Phase 3, total estimated cost to finance 28 GW aggregated target is assumed at $42 billion (assuming average cost of $1.5 million per megawatt). Further cost reductions in solar systems will improve cost-effectiveness.

Reduced cost of low carbon technologies and practices. With increased deployment and global learning rate of 18% to 22%, it is expected that solar PV module costs will continue to decline. In India, rooftop plants have become economically viable as they produce clean electricity at about 7 rupees/kWh without any subsidy in 2013, as compared from 17.91 rupees/kwh in 2010. The drop in PV cost is brought mainly by falling capital costs, project development at scale, and reverse auctions carried out by the GOI under the JNNSM. With the decline in cost, energy sector has witnessed rapid development with installed solar capacity increasing rapidly from 18 MW to about 3800 MW during 2010-2015. This early program success enabled GoI to consider increasing its national target to 100GW by 2022, a significant increase from the initial target of 20GW.

The SRIP, through PNB, will accelerate the rooftop program evolution by allowing private sector developers and aggregators to have access to working capital to buy the required inventory and aggressively acquire customers, and push for large-scale deployment of roof top solar PV systems among customers using different business models. The roll-out of the rooftop solar systems under

[16] Reserve Bank of India. 2015. *Priority Sector Lending Targets and Classification*. Available: https://rbidocs.rbi.org.in / rdocs/notification/PDFs/PSLGUID0A65BF4E0A884F60999E748C58EA7F88.PDF

various business models will provide continued learning and economy of scale benefits which can help facilitate further reductions in cost of PV in the future, i.e., the program will facilitate a virtuous cycle of solar development, and will facilitate the development of scalable business models for grid-connected rooftop PV. The ADB program may consider supporting small-scale residential solar rooftop financing when such market matures during the program implementation.

3) Demonstration potential at scale

Scope for avoided annual GHG emissions. The proposed SRIP will directly contribute towards achieving GOI's objective of 40 GW of rooftop solar power by 2022, initially focused on the target of 28 GW aggregated projects on large commercial, industrial, and institutional buildings. SRIP will promote market development and large-scale adoption of rooftop solar PV which at present has quite low uptake among commercial and industrial consumers, despite its increasing grid parity. CTF financing will help address major barriers to the deployment of rooftop solar, which include lack of commercial financing, technical skills, and consumer awareness.

Scale-up in Phase 2 will deliver an additional 600 MW rooftop solar capacity. The expected emission reduction for both Phase 1 and 2 (i.e., 1,000 MW rooftop solar capacity) is estimated at 1.1 million tCO2e annually or 27.60 million tCO_2e over the 25-year lifetime of rooftop solar installations.

Transformation Potential. SRIP has high transformational potential as it will enable and contribute to the large-scale deployment of rooftop solar PV technologies in India. And as one of the largest commercial banks with extensive branch network throughout the country, PNB will be instrumental in supporting the roll-out of the program. CTF funds will help catalyze pilot project origination and help transform the market by accelerating investment in and deployment of rooftop systems at scale, fully consistent with CTF design and operational guidelines.

Through SRIP, ADB will work closely with GOI and development partners to develop the aggregated solar rooftop markets. The CTF grant will improve institutional strengthening and technical capacity improvement of PNB on rooftop solar financing, particularly on loan origination and risk assessment. The proposed MFF modality will help develop building blocks under the first tranche and associated technical assistance, with important non-lending covenants to be followed by subsequent tranche(s) focusing on onlending of funds. For replication, lessons learned during early implementation will be captured to help and inform other local commercial banks establish similar lending facilities. The project administration manual will contain M&E framework to monitor implementation progress, assess disbursement performance, as well as strategies to capture lessons and sharing of experiences.

CTF guidance defines transformation potential based on 3 scenarios:

(a) Scenario 1 -- a baseline trajectory of GHG emissions for the targeted sector.
(b) *Scenario 2* -- the trajectory of reduced emissions that would result directly from the CTF

co-financed project alone.

(c) *Scenario 3* -- the trajectory of reduced emissions that would result if the CTF co-financed project were to be replicated throughout the targeted area, region, and/or sector. [17]

A project's relative transformational potential can be measured by the ratio of emissions reduction potential between Scenario 3 and Scenario 2.

Defining Scenario 1 is somewhat problematic: given the rapid evolution of utility scale solar power in India and new domestic coal production, the baseline is actually a moving target. For purposes of discussion, forecasts circa 2011 (when the original IP was endorsed) can be taken as a baseline: 260 GW of new thermal capacity dominated by coal, plus 20 GW of new solar capacity. In 2011, domestic coal output had been flat for several years at around 500 million tons per year (Mt/y), and the rate-limiting factor for new coal-fired capacity was the import terminal and intermodal transshipment capacity. Today, domestic coal production is projected to increase by more than 500 Mt/y in the near future, and possibly by more than 1 billion t/y by 2020[18]. This increase in domestic coal output will allow rapid development of new coal fired capacity which in turn may crowd out investment in solar capacity. Therefore, the 100 GW overall solar target and the 40 GW rooftop target are not considered to be business-as-usual.

In Scenario 2, SRIP will result in avoided GHG emissions of 0.44 MtCO2e/year. In Scenario 3, if Phase 2 PNB-funded scale-up is successfully implemented it would result to more than double emission savings of about 1.1 MtCO2e/year. The 1000 MW would cover about 3.5% of the total 28GW aggregated solar rooftop target. Taking into account the parallel investments by World Bank, the transformation potential is more than 10. The aggregate capacity supported by World Bank, KfW, and other investors can be expected to drive down the levelized cost of energy (LCOE) to reach grid parity and coal parity (RE < C) – which is the tipping point for energy sector transformation – in the foreseeable future.

(4) Development impact

The proposed rooftop solar investment program will support the delivery of additional 400 MW solar capacity to the country's energy mix which is expected to help the country achieve (i) energy security, (ii) increase access to quality and reliable energy, (iii) employment generation; and (iv) environmental benefits.

Energy security and economic benefits. The proposed additional 400 MW solar capacity will help diversify the country's energy mix and address power shortages the country is experiencing. Currently, more than 70% of the country's total 288 GW installed capacity is from fossil fuel (i.e.

[17] Transformation potential is defined in paragraphs 15 - 17 of the *CTF Investment Criteria for Public Sector Operations* dated 9 February 2009.

[18] Krishna N. Das and Tommy Wilkes. 2016. *India leads Asia's dash for coal as emissions blow east*. Reuters, India edition; 6 October 2015. The article notes that the Magadh mine in Jharkand State is projected to produce 1.5 billion tons/year by 2020, which would be sufficient for well over 280 GW of new coal fired capacity.

coal, oil and gas); while only 3 GW or just about 1% is from solar power despite its huge technical potential estimated at 750 GW[19]. The development and deployment of solar power capacity, through the implementation and replication of SRIP, will help reduce the country's dependence on coal. In 2013, India produced almost 340 million tons of coal equivalent (Mtce), but it also imported some 140 Mtce – roughly 12% of the world's coal imports (61% from Indonesia, 21% from Australia, 13% from South Africa) to meet power requirements. Coal import has grown in recent years due to domestic production failed to keep up with the surging coal demand, making the country among the world's largest importers of coal. According to Energy Outlook, coal imports will continue to increase from 144 M tons in 2013 to reach 410 M tons in 2040.[20]

The program is expected to deliver economic benefits from the increased availability and reliability of power supply. This would result in reduced investment and costs among households and industries on small diesel generators, large-scale captive power, or batteries and inverters to serve as back-up system during power interruptions, particularly during periods of peak demand. Cost associated with these back-up systems can be avoided and funds utilized for other needs. The additional power generation supports economic activities and improves the livelihoods of individuals through the provision of lighting, heat, refrigeration, and other household amenities.

Increase access to reliable and quality energy. The development of rooftop solar energy will have significant benefits in terms of the reliability and security of electricity supply. SRIP will facilitate additional electricity output of at least 631 GWh annually, enabling utilities to improve service, and expand connections to serve new customers. Assuming the GOI target of providing 1,000 kWh per person per year, the additional output will be sufficient to supply more than 631,000 people, or about 126,200 households.

The energy output from the program will be fed into the grid, and it is not possible to determine the specific end-users. However, using the World Bank methodology[21] for calculating inferred access to electricity for residential use from power generation projects, the proposed project will be able to benefit an estimated of 280,000 new customers or about 56,000 household beneficiaries[22].

The methodology and assumptions used for the inferred access: 631 GWh expected annual energy output. Transmission and distribution losses assumed at 10 percent. The net generation of 567.9 GWh was allocated for residential and non-residential use. Based on the pattern from International Energy Agency's (IEA) Energy Balance Database for 2013 report[23], India's residential consumption was 35% and non-residential use was 65%. Using these patterns, the disaggregated amount of electricity generated for non-residential use (i.e. industries, businesses,

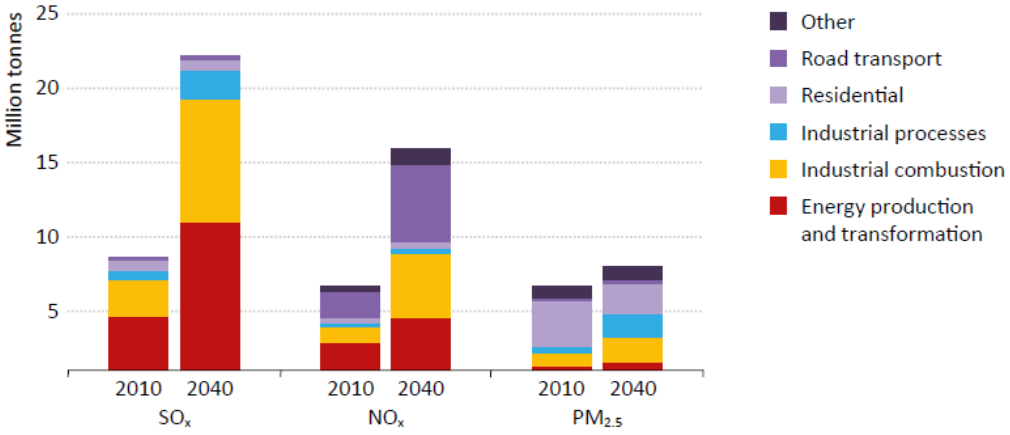
[19] Estimated by India's National Institute of Solar Energy based on the assumption that 3% of wasteland in each state can be used for solar power projects, plus an assessment of the potential for rooftop solar.
[20] IEA (2015) India Energy Outlook, World Energy Outlook Special Report. As noted above, domestic production is increasing but some imports will still be required as most domestic coal has low heating value which is not suitable for all types of boilers.
[21] World Bank (2014). Available: https://www.openknowledge.worldbank.org/bitstream/handle/10986/17370/853760BRI0ADD00for0collection0title.pdf?sequence=1
[22] Average number of household members in India is 4.8.
[23] IEA. 2015. Energy Balances of Non-OECD Countries.

transport and agriculture) is 369.14 GWh/year; while residential consumption is 198.77 GWh/year. India's 755 kWh per capita consumption of electricity is higher than the 2010 average global consumption per capita of 685 KWh; given these, it was assumed that new electricity generated is directed to new connections. As a result, the 198.77 GWh/year would benefit approximately 263,000 new consumers.

Employment opportunities. SRIP is expected to generate local employment opportunities by supporting various rooftop solar business models, third party aggregators, developers, and subcontractors for installation and operation and maintenance (O&M). Additional value-added employment will be created in solar industries, including manufacturing and energy services for rooftop solar systems supply and delivery chain. The program will also produce skilled and accredited staff rooftop PV inspectors whose services will be required by lenders for smooth functioning of the program.

Environmental and health benefits. The installation of rooftop solar systems will help minimize or displace coal and diesel in power generation, thus avoiding carbon emissions and other air pollutants. As shown in Figure 5, emissions of sulphur oxides (SOx), nitrogen oxides (NOx) and PM2.5 are expected to increase by 2040 with largest contribution from energy production and transformation. The combustion of coal and oil products contributes to pressing air quality problems in many areas, as well as to global greenhouse gas (GHG) emissions. The extent of local air pollution is already a large and growing problem in India that already takes a heavy toll on public health.

Figure 5: Emissions of NOx, SOx and PM2.5 by sector, 2010 and 2040



(5) Implementation potential

The proposed SRIP supports MNRE's GRSPP and is fully aligned and consistent with the government's action plan and solar mission strategies. There is a strong commitment from the government to implement the program. The GoI requested this financial assistance in October 2015 to be part of the ADB Country Operations Business Plan.

PNB will be the executing/implementing agency of SRIP. PNB is a GOI majority-owned large public sector bank, which has demonstrated experience and proven track record managing

renewable energy programs. It was established in 1895 and nationalized in 1969. As of 30 September 2015, the GoI held a 62.1% stake in the bank. PNB is one of the "Big Four Banks" in India with total assets of INR6.3 trillion ($95.6 billion) and about 5% of total market share. PNB has a total of 6,635 domestic branches and is able to originate solar rooftop subprojects throughout India as its branch network covers the entire country. Moody's gives PNB a "Baa3" rating with a positive outlook based on high standalone credit strength and a high level of systemic support. PNB has a strong energy sector team but would need capacity to develop its specific solar rooftop credit risk assessment skills and implement a rating system specific for solar rooftop investments to facilitate subloan selection, credit review, approval, and pricing. PNB has the financial management capability to administer the MFF. Its overall financial management control risk is moderate.

ADB will manage the CTF technical assistance grant implementation but with sufficient counterpart commitment and support (e.g. from PNB, MNRE, and/or SECI). The ADB loan funds will be provided to PNB on a reimbursement basis on the Indian rupee (INR) equivalent amounts upon subproject financial closure.

Leverage: The $175 million CTF co-financing will leverage $325 million from ADB; the combined $500 million fund will catalyze $300 million subborrowers' equity and an additional $200 million from unrestricted sources (e.g., participating financial institutions' own funds or government support). The CTF leverage ratio will be greater than 1:4. The softer concessional terms of CTF will bring down the overall cost of ADB funds to PNB to improve subproject bankability. The total $1 billion program will contribute to about 2.3% of total investment requirement of around $42 billion to fund 28 GW aggregated rooftop solar capacity by 2022.

Table 4: CTF Leverage Ratio

Case	Cofinancing ($ Million)	CTF Leverage Ratio
Phase 1 Project: 400 MW	$ 825 ADB: 325 Subborrowers' equity: 300 Unrestricted sources: 200	1:4.7 [825/175 = 4.7]
Phase 2 Scale-up: 1000 MW (Assuming PNB implements Phase 2 with additional 600 MW)	$1,965 ADB: 325 Subborrowers' equity: 600 Unrestricted sources: 540 PNB: 500	1:11 [1965/175 = 11.23]

(6) Additional costs and risk premium

The value addition of SRIP, through CTF support, is the provision of comprehensive institutional capacity and market development TA to catalyze a major solar rooftop sector binding constraint – lack of long-term bank debt financing in India. It will contribute to the development of the enabling environment of the sector in order to generate a steady flow of pipeline subprojects that can then be financed by PNB.

Because ADB's MFF will finance PNB's operations for eligible solar rooftop subprojects over

time, the viability of PNB as a financial intermediary is the best available proxy for the economic and financial performance of the overall project. According to ADB guidelines,[24] the most important criteria for determining the appropriateness of a financial intermediary's performance are capital adequacy, asset quality, management quality, earnings, liquidity, and sensitivity to market risk. For PNB, the status of most of these indicators is satisfactory and improved during FY2001—FY2015. ADB loans' dollar exchange rate risk could be mitigated through foreign currency and interest rate swap transactions, or avoided altogether through PNB's absorption of the dollar in its offshore operations.

The economic evaluation shows the proposed program is economically viable compared to conventional thermal alternatives. The investment program has also significant local, regional, and global environmental benefits which will increase the economic rate of return. The decline in the tariff from solar rooftop system versus the tariff from the power grid underpins the fundamental bankability of the commercial solar rooftop business models in the country. There are two main types of business models emerging in the solar rooftop sector in India, namely: (i) Capex business model and (ii) Opex business model. Under the Capex model, a property owner procures and owns the system while an engineering, procurement, and construction (EPC) contractor/developer is engaged for construction and commissioning of the system. This type of solar projects could be grid-connected or off-grid. Under the Opex model, an EPC contractor/developer/utility company procures, owns and installs the solar rooftop system and usually enters into a long-term power purchase agreement (PPA) with the property owner and/or power off-taker. According to the financial analyses on a number of prevailing market case projects, both of these commercial solar rooftop business models are bankable, yielding an average financial rate of return between 12-16% when the PPA is at least 15 years. When accelerated depreciation is available to further incentivize the developers, the subproject equity return could be about 22%. The payback period is generally 7-8 years.

While the financial and economic analyses are consistent with ADB investment requirements, the rooftop solar market is still at a nascent stage and successful evolution is not assured: rooftop development and aggregation are still being established as business lines; commercial financing is generally not available, so most participants still encounter first-mover risks; rooftop solar has achieved grid parity in some parts of India, but not everywhere; and, as noted above, rapid expansion of low-cost domestic coal supplies could crowd out investment in solar power.

Additional CTF investment criteria for private sector projects/ programs	
(1) Financial sustainability	n/a
(2) Effective utilization of	n/a
(3) Mitigation of market distortions	n/a
(4) Risks	n/a

13. **For DPSP projects/programs in non-CTF countries, explain consistency with FIP, PPCR, or SREP Investment Criteria and/or national energy policy and strategy.**

n/a

14. **Stakeholder Engagement**

[24] ADB. 2005. *Financial Management and Analysis of Projects*. Manila (Section 6.4. Assessing FI Performance). http://www.adb.org/sites/default/files/pub/2005/financial-governance-management.pdf

The key stakeholders are central government, discoms, state nodal agencies, central electricity authority, central electricity regulatory commission, accredited rooftop PV inspectors, co-financers, commercial and industrial sectors, including other government entities and public institutions (central and state level) which GoI will mandate the installation of solar rooftop systems on its buildings, and other development partners. These stakeholders will be consulted in a series of meetings and interviews throughout the implementation of the program.

One of the activities under the TA is to conduct awareness campaigns and consumer education targeting rooftop owners. As mentioned low consumer awareness hinders the deployment of the technology and systems on a nation-wide scale. The awareness campaigns and consumer education will tackle rooftop solar PV cost and technical performance characteristics, rooftop requirements, economic benefits, financial options, and contractual O&M options.

15. **Gender Considerations**

The implementation of SRIP and its eventual roll will benefit women and children. The available and reliable electricity at night, will give more time for women to do other household chores and/or engage in livelihood activities such as handicrafts, sewing, and food processing. Children can have more time to study; hence, improving their performance at school. It is also expected to improve access to media such as television and radio which can result to greater awareness of gender issues and rights among women and girls. Moreover, reliable electricity can facilitate improved social service provisions such as schools, hospitals, and other social utilities.

16. **Indicators and Targets**

Project/Program Timeline	
Expected start date of implementation	July 2016
Expected end date of implementation	December 2022
Expected investment lifetime in years (for estimating lifetime targets)	25
Core Indicators	**Targets**
GHG emissions reduced or avoided over lifetime (tons of CO_2-eq)	11.04 million tCO2e
Annual GHG emissions reduced or avoided (tonnes of CO_2-eq/year)	441,700 tCO2e
Installed capacity of renewable energy (MW)	400 MW
Number of additional passengers using low-carbon transport per day	n/a
Energy savings cumulative over lifetime of investment (MWh)	n/a
Annual energy savings (MWh/year)	n/a
Identify relevant development impact indicator(s)	**Targets**
Job creation	*To be determined*

17. **Co-financing**

	Please specify as appropriate	Amount (in million USD)
• MDB 1	ADB	325
• MDB 2 (if any)		
• Government	Participating financial institutions' own funds or government support	200

• Private Sector		
• Bilateral		
• Others (please specify)	Subborrowers own fund (i.e. equity)	300
Total		825
18. **Expected Date of MDB Approval**		
June 2016		

Version December 9, 2014

Review of India's Proposed Solar Rooftop Investment Program with CTF Financing

March 2016

Review of Solar Rooftop Investment Program with CTF Financing

The draft Report and Recommendation of the President (RRP, the primary document for ADB Board consideration) and CTF funding application (the CTF "cover sheet") for the proposed Solar Rooftop Investment Program (SRIP, hereafter referred to as "the Project") were reviewed for consistency and eligibility for CTF co-financing. The comments based on documents made available for the review are summarized in the table below. This review was conducted by Pil-Bae Song, ADB Consultant; Visiting Professor at Korea Development Institute School of Public Policy and Management. The Project has been subject to the Asian Development Bank's internal peer review process as well. Based on the documents reviewed, the Project is consistent with both CTF and ADB eligibility requirements.

Criteria	Comments	Project Team Responses
Eligibility for Clean Technology Fund (CTF) financing	The Project concept is included in the Revised CTF Investment Plan for India (IP) which was endorsed by the Trust Fund Committee in 2015. The Revised IP elucidates a programmatic approach with funding allocations to ADB and World Bank to support solar energy development with cofinancing for transmission, solar parks infrastructure and rooftop solar. The Project scope and outputs reflect the concept note appended to the Revised IP. The Project is similar to the solar rooftop project funded by World Bank for which CTF cofinancing was approved in late 2015. As intended in the revised IP, the Project is essentially a twin of the World Bank operations, but through a different financial institution, in this case the Punjab National Bank (PNB). This is ADB's first use of the multi-tranche financing facility (MFF) modality combined with Financial Intermediation (FI) for CTF; this modality supports programmatic investments to support the rapidly evolving rooftop solar	Noted.

Criteria	Comments	Project Team Responses
	power market. The Project fulfills the 6 CTF eligibility criteria for public sector operations, consistent with the recently approved World Bank project. A detailed examination of each criterion is not presented herein but some specific points are raised below.	
Aggregation of Multiple Subprojects Relative to Potential GHG Emissions Savings, Cost-effectiveness, Demonstration Potential at Scale, and Potential for Replication and Scale-up	The Project in general and the potential GHG emissions savings in particular appear to be dependent on aggregating multiple rooftop installations into subprojects. Given that the rooftop market is still in a nascent stage of development, the use of CTF in the first tranche is appropriate with respect to reducing initial development risk. Further, a modest amount of CTF grant is appropriate to support implementation in the first tranche. Based on the early experience noted in paras. 8-10 of the RRP, has aggregation been successful and could it be a barrier to accelerating development? Relative to the discussion of Transformation Potential, what is the prospect for further multilateral bank support for rooftop solar development beyond the proposed Project? Are there rate-limiting factors in the hardware and service supply chain that would constrain market development?	Based on recent experience, aggregation does not appear to be a particular challenge in terms of solar developers' expertise. Rooftop owners are generally receptive to the installations, and partly on this basis aggregation was identified as a logical approach for scaling up investments. Assuming that the SRIP Project is successful, further market development will require commercial financing. The need for concessional finance should decline during the next 5 years, but multilateral bank support could still add value to overall solar program development considering the need to rapidly expand power supplies

Criteria	Comments	Project Team Responses
		to under-served customers.
On-lending through other financial intermediaries for market acceleration	The RRP provides limited detail on the possible end-use of funds between other financial intermediaries and solar developers. PNB has numerous branches which should provide sufficient entry points for funding flowing into the market, but it should be beneficial to overall market development if other financial institutions participate, e.g., commercial banks with no government ownership and other private sector entities. Table 4 of the draft RRP suggests that the overall risk of the Project is low, but notes that MNRE has an important leadership role, while PNB has limited incentives to develop solar institutional capacity.	Solar development in India during the last few years has evolved rapidly, and is expected to continue to grow in large part due to the overall demand for new power capacity. It follows that the rooftop solar market will have to grow in terms of more developers and more financial institutions. At this point, it is extremely difficult to predict the number of other financing entities which may come into the market. The MFF + FI modality does allow flexibility in terms of adapting to evolving market conditions. Based on due diligence conducted, the overall project risk is low. MNRE's role is important in the early stages of development, but as the market matures its role in subproject pipeline development will diminish. Likewise, PNB is still on the learning curve with respect to rooftop financing, but the potential for expanding this into a mainstream business line is enormous. The requested CTF grant will support implementation in a learning-by-doing mode to address the identified risks in

Criteria	Comments	Project Team Responses
		a systematic manner. Lessons learned from other RE development projects using financial intermediaries will also be incorporated into the Project going forward.
Technology and Price Risks	There are no details presented on technical specifications, so it is assumed that the proposed investments will use readily available technology from commercial vendors, and that there are no major technical risks to be mitigated. Prices for rooftop installations are generally higher than ground-mounted, i.e., about twice as expensive today. The RRP discussion of tariffs and grid parity is quite optimistic, while the CTF application notes installed costs are expected to decline to $1.5 / Watt in the foreseeable future.	The Project will rely on an expanding supply chain of hardware and services, and will avail of readily available technologies as well as new technologies which come into the market. While the learning rates for solar systems worldwide are encouraging, it is difficult to estimate country-specific learning rates for rooftop systems specifically. This is actually one of the reasons why GOI is requesting the softer CTF terms and conditions, i.e., more concessional terms and maximum amount financing are desired in the Project's first tranche to facilitate bulk purchasing effect as well to accelerate the rooftop solar market evolution.
Interaction with Discoms and other new energy services	As evidenced in other countries, (e.g., the US) rooftop solar with net metering can be quite disruptive with respect to traditional utility operations. It would be useful to note the receptivity of Discoms and potential beneficial impacts on improving overall electricity service and quality.	The rooftop solar program is expected to have positive impact on Discoms behavior and operations. In particular, continued reduction in system costs and off-take tariffs will provide some relief to financially-stressed Discoms.

Criteria	Comments	Project Team Responses
	Regarding end use of solar power, there is a nascent market for charging of electric vehicles (including 2- and 3-wheelers) e.g., in Cambodia and Vietnam. Is there any prospect for solar EV charging in the near term?	The elements of a virtuous cycle are coming into place. This type of end-use is not being specifically promoted by the SRIP Project but this market can be expected to develop as experience is gained in DMCs.