Supplementary Appendix X: Cofinancing with the Clean Technology Fund

A. Background

i. The Clean Technology Fund

1. The 2005 Gleneagles G-8 Summit in July 2005 stimulated a concerted effort by the development community to broaden and accelerate support to developing countries relating to energy access and climate change through the Clean Energy Investment Framework (CEIF).[1] Pursuant to the CEIF, in 2008 the donor community committed approximately $6.1 billion to the new Climate Investment Funds (CIFs) to be invested through the MDBs.[2] About $5.2 billion equivalent was pledged to the Clean Technology Fund (CTF) for climate change mitigation in developing countries.[3] ADB's Board of Directors approved the use of CTF resources on 5 November 2009.[4] The partnership agreement was approved on 18 March 2010.

2. The joint MDB mission for India was conducted in August 2011, and the CTF Country Investment Plan (CIP) was endorsed in November 2011. Project and loan documentation includes a separate cofinancing agreement for the CTF funds, similar to that for other official cofinancing.[5]

3. The design of the CTF acknowledges some of the operational problems and limitations of the Clean Development Mechanism (CDM) and the Global Environment Facility (GEF); for example, the concepts of "financial additionality" and "incremental cost financing" are <u>not</u> included in the CTF design, investment plan guidance, and eligibility criteria for public sector projects. Rather, CTF supports transformational investments which "speed up or deepen market penetration of a low carbon technology relative to business as usual" (paragraph 15 of *Clean Technology Fund, Investment Criteria for Public Sector Operations*, 9 February 2009).

4. CTF seeks to leverage donor financing with commercial bank financing and private sector-led investments. CTF generally targets energy efficiency (EE), renewable energy (RE), and cleaner transport opportunities, and includes consideration for non-climate benefits and development impacts. CTF is "technology-agnostic." Newly commercialized technologies may be supported, but CTF is not intended to be a substitute for venture capital to support new technology development.

5. The CTF principles and objectives are fully consistent with the *ADB Strategy 2020* emphasis on inclusive and environmentally sustainable growth; private sector development and operations; and investment focus on infrastructure, environment (including climate change), and financial sector development. CTF is also fully consistent with the *ADB Energy Policy 2009* focus on clean energy development, in particular the emphasis on energy efficiency and renewable energy; access to energy for all; and energy sector reforms, capacity building, and governance.

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[1] ADB's Energy Efficiency Initiative was launched at approximately the same time.

[2] The participating MDBs are the World Bank Group (including its private sector window the International Finance Corporation [IFC]), the African Development Bank, the Asian Development Bank, the European Bank for Reconstruction and Development, and the Inter-American Development Bank. World Bank is the trustee of the CIFs.

[3] Details can be found at www.climateinvestmentfunds.org

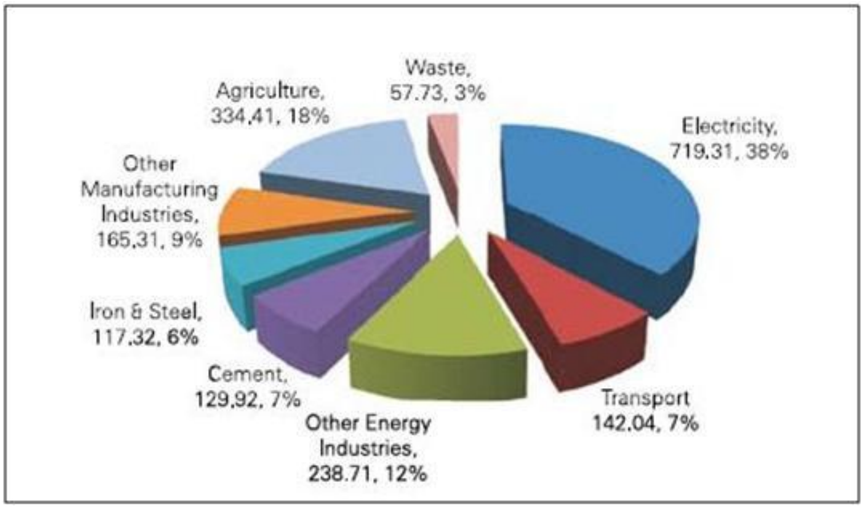
[4] ADB Board Paper R215-09, November 2009.

[5] The detailed mechanics of funds transfer are covered in the "Financial Procedures Agreement between Asian Development Bank and the International Bank for Reconstruction and Development as Trustee of the Trust Fund for the Clean Technology Fund," dated 18 March 2010.

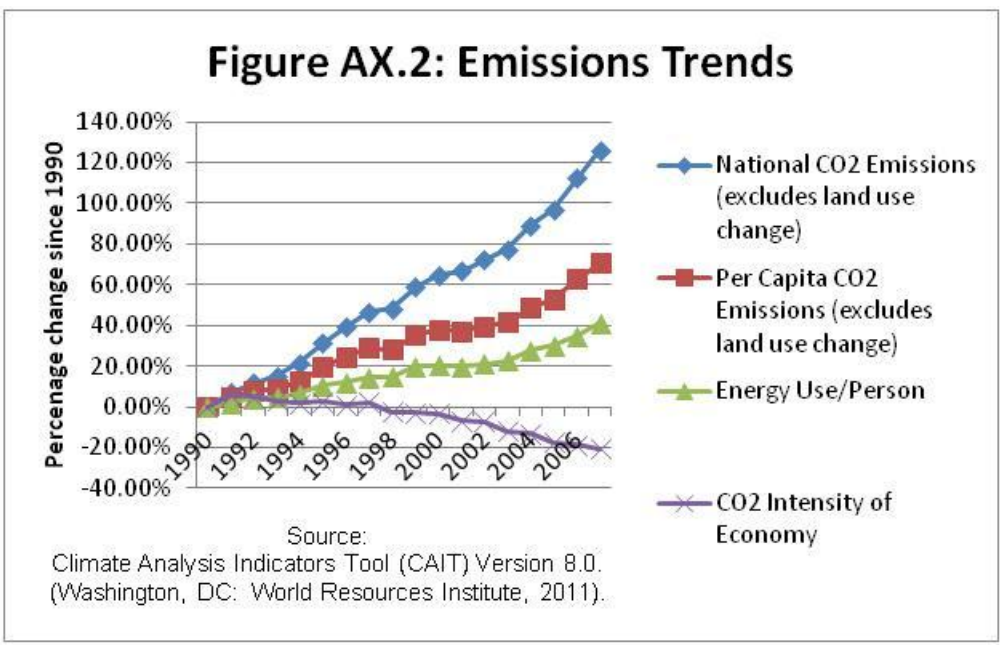
ii. India’s GHG Emissions Profile and Development Context

6. In 2007, India’s greenhouse gas (GHG) emissions were 1904 million tons of carbon dioxide equivalent ($MtCO_2e$), with net emissions of 1727 $MtCO_2e$ when removal via carbon sinks is considered. The largest shares of emissions are from electricity generation (38%), agriculture (18%) and other energy industries (12%)[6] (see Figure AX.1). Heavy reliance on fossil fuels is reflected in trends of total GHG emissions, per capita emission, and energy use per person, which are increasing despite a reduction in GHG intensity of the economy as shown in Figure AX.2.

Figure AX.1: Greenhouse Gas Emissions Distribution across Sectors, 2007



Source: Interim Report of the Expert Group on Carbon Strategies for Inclusive Growth, May 2011



[6] Interim Report of the Expert Group on Low Carbon Strategies for Inclusive Growth, May 2011

7. In early 2010, India announced that it intends to voluntarily reduce its carbon intensity by 20-25% by 2020 against a 2005 baseline. This commitment has been made within the context of a very large proportion of the citizens that continue to live with no access to electricity and other forms of commercial energy. *"In 2005, a total of 412 million people in India had no access to electricity, with 380 million of them (92% of total population) living in rural areas and 32 million in urban areas (IEA, 2007). According to recent IEA estimates, India is today 64.5% electrified, with an urban electrification rate reaching 93.1% and a rural rate of only 52.5*"[7]. Others with access often have to cope with poor and erratic availability of electricity and other fuels. With constraints faced in resource availability and in delivery mechanisms, traditional means of energy supply are falling short. This is likely to be the case in the foreseeable future so that energy access will continue to remain a problem. Catering to ever increasing energy demands and finding viable low carbon alternatives to fossil fuel use is one of India's top most priorities. In particular, the electricity sector which constitutes more than 65% of India's commercial energy requirements has to take a lead in this regard to put the country on a low carbon growth path.

8. The largest share of greenhouse gas emissions in India will continue to be from the power sector, including captive generation, for the next 2 decades. The Expert Group on Low Carbon Strategies for Inclusive Growth concluded that sustaining 8 percent economic growth will require an increase in installed capacity from about 200 GW today to 320-342 GW in year 2020. Related GHG emissions from electricity could be in the range of 1263 to 1609 $MtCO_2e$ per year from the current 719 $MtCO_2e$ per year.[8] Extending these trends for another 10 years implies an additional doubling of new generation capacity and doubling of GHG emissions. If coal retains the current share of about 65% of the supply base, about 260 GW of new coal-fired power would be added during the next 2 decades.

9. Based on the projections noted in paragraph 8, flattening the growth in fossil power emissions would require new RE and EE interventions with equivalent baseload capacity of as much as 260 GW over the next 20 years.[9] Assuming $1 billion per GW installed capacity as a benchmark for coal-fired power plants, a minimum of $260 billion of investment is required to achieve grid parity and to begin flattening the emissions trajectory: ***this equates to additional financing needs of more than $13 billion per year in the near term.*** Equivalent RE capacity currently costs more than fossil power plants, thus in order to avoid consumer price shocks a significant part of the total cost must be offset by low or negative cost EE investments in the near term (which are being addressed under other components of the CIP). Over the long-term, new business models and financial instruments are needed to scale up RE capacity and complementary investments in new grid technologies, energy storage, and other low-carbon systems.

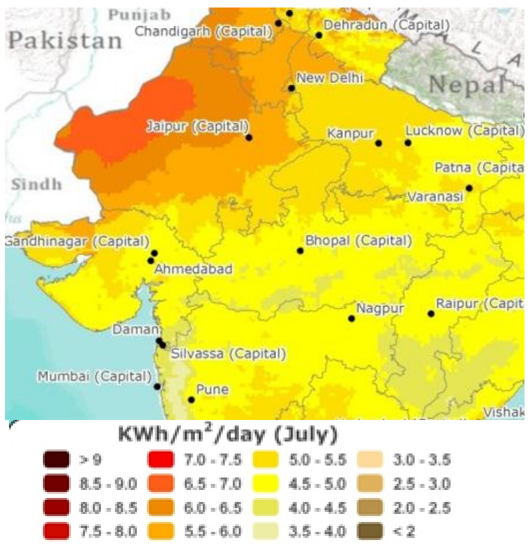
iii. National RE Development and CTF Investment Plan Context

10. Solar and wind power have the largest potential of India's RE resources[10] and the state of Rajasthan (in particular Western Rajasthan) has among the best solar and wind resources in India as shown in Figures AX.3, AX.4, AX.5 and Table AX.1. Solar is the least developed with respect to grid-connected capacity. Solar power technologies can deliver partial baseload and load-following capacity, and can be deployed for a variety of "last mile" and off-grid distributed generation solutions. Modern concentrating solar power plants with integrated thermal storage

[7] International Energy Agency, "Comparative Study on Rural Electrification Policies in Emerging Economies"
[8] As shown in Table 3.7 (p.42) of the Interim report of expert group on low carbon strategies for inclusive growth.
[9] A recent report by World Bank indicates that up to 280 GW of coal fired power may be added during the next 2 decades. World Bank. 2010. *Unleashing Renewable Energy Potential in India*.
[10] With the exception of large hydropower which is estimated at 150 GW.

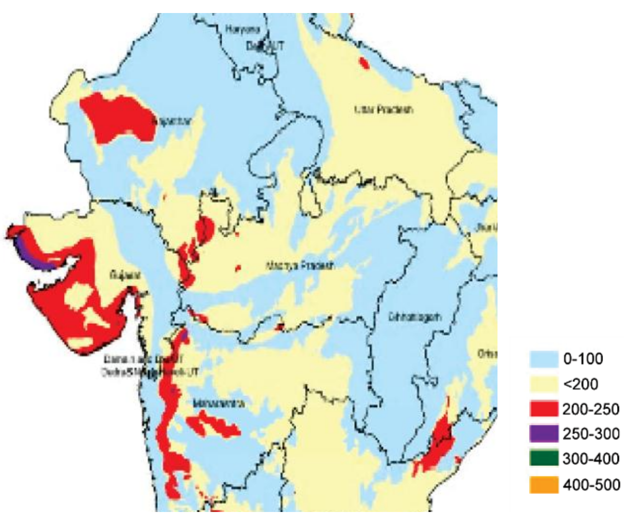
can deliver up to 17 hours per day of output, which allows almost full-time baseload operations. Large-scale grid-connected solar power is the most promising with respect to scale up and replication potential, with GW-scale solar parks under development, and is the highest priority RE resource for CTF support in India. As discussed above (paragraphs 7 – 9), additional financing of at least $13 billion per year is needed to flatten India's GHG trajectory and ***at the macro-economic level concessional funds are needed to buy down the costs and cover additional risks of large-scale grid-connected RE deployment in order to reach grid parity***. At present, the policy and regulatory frameworks have facilitated substantial commercial investment in RE-based generation under both national and state level schemes, and significant public sector funds to support the expansion of the transmission system to accommodate increasing shares of intermittent RE output is one of the highest priorities for concessional funding.

Figure AX.3: Solar Resource Potential in Rajasthan, India – Global Horizontal Radiation



Source: National Renewable Energy Laboratory and Solar Energy Center, India

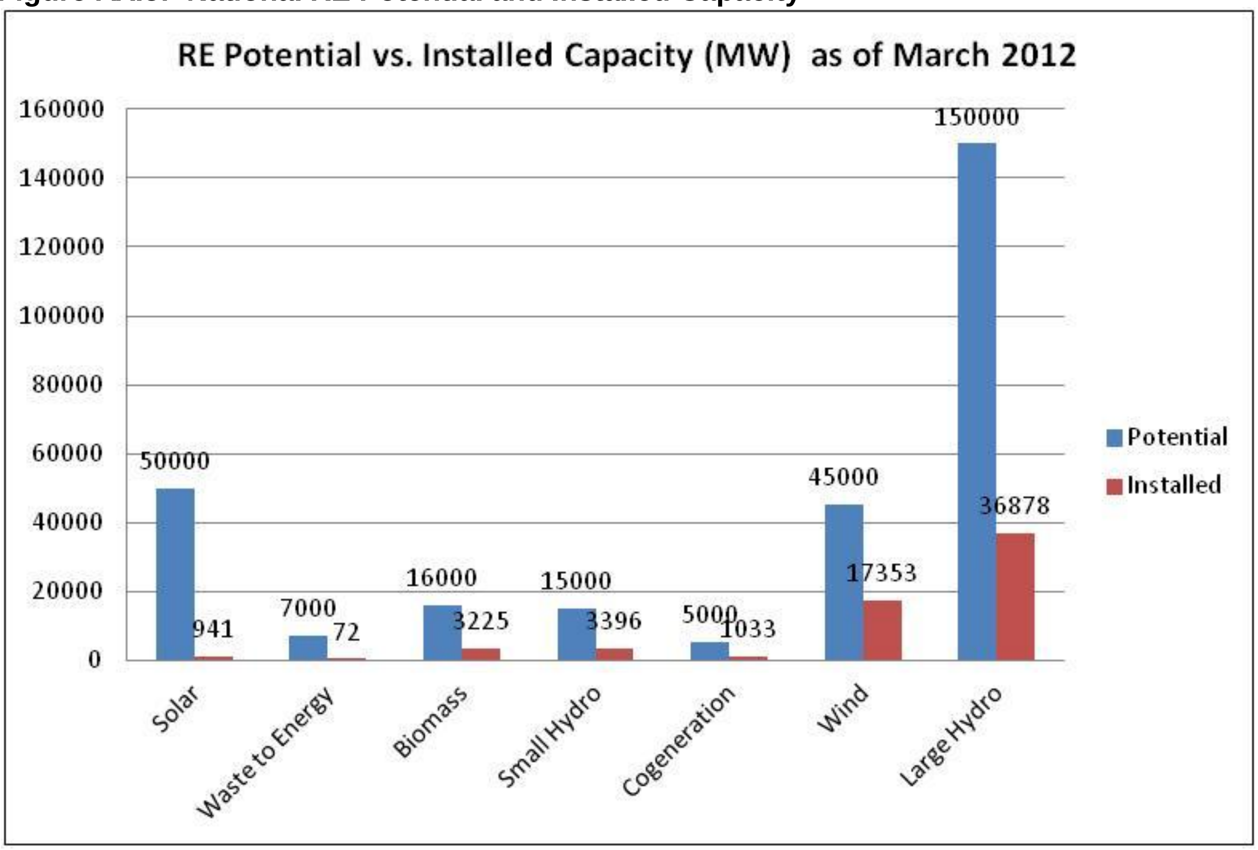
Figure AX.4: Wind Resource Potential in Rajasthan, India – 50 meter height



Source: Center for Wind Energy Technology, India

11. The Jawaharlal Nehru National Solar Mission (JNNSM) will be supported through investments in GW-scale solar parks and next-generation solar-hybrid generation plants which will deliver baseload-equivalent solar power to the grid. Cognizant of challenges compared to other energy sources, the Government of India (GoI) embarked on its endeavor to mainstream solar energy with the ambitious target of 20 GW under JNNSM. India has a comparative advantage to other countries for solar energy development in terms of (i) higher solar radiation ranging from 4 to 7 kilowatt-hours (kWh)/square meter/day across the country, (ii) large areas of non-arable land, particularly in the western states of Gujarat, Maharashtra, and Rajasthan, and (iii) relative proximity of solar power plants to population centers with increasing electricity demand (i.e., the major cities of the western states including the greater Delhi and Mumbai metropolitan regions). Under the JNNSM, the market for solar power is underpinned by renewable energy purchase obligations (RPO) imposed on electricity distribution utilities. A variety of tariff instruments are being utilized including feed-in tariffs, reverse auctions, and generation-based incentives.

Figure AX.5: National RE Potential and Installed Capacity



Source: Installed Waste to Energy, Cogeneration, and large hydro are from: Energy Statistics 2012. Central Statistics Office, National Statistical Organization, Ministry of Statistics and Program Implementation, Government of India; www.mospi.gov.in. Biomass, small hydro, solar, and wind are from MNRE as of 31 March 2012 (cited in Report on Green Energy Corridors 7 July 2012, by PGCIL). Large hydro potential from CEA 2011 (as of 30th April 2011).

12. India's solar parks are a departure from traditional project-by-project solar power development, and represent a plan to achieve greater economies of scale and leverage private sector investment. Under the solar park scheme, state government agencies facilitate site

preparation, leveling, land allocation and develop common infrastructure, including construction power, water infrastructure, access roads, security, power evacuation, and related services. Private investors are invited to lease pre-defined parcels in the park from state agencies, and obtain power purchase agreements with relevant electric distribution utilities. Some of the parks are expected to include solar technology manufacturing facilities. This innovative public-private partnership (PPP) scheme streamlines the development timeline, reduces development costs, and addresses some of the replication and scale-up issues faced by stand-alone project approaches. ADB plays an honest broker role to provide comfort to public and private sector participants.

13. India’s solar parks are arguably ambitious in terms of (i) introducing innovative public-private partnership models, (ii) demonstrating new systems to optimize the dispatch and utilization of solar and wind power, and (iii) the scale of development which is larger than those of many other developing countries. In the CTF CIP endorsed in November 2011, GoI proposed to utilize concessional financing to support the solar park models in Gujarat, Rajasthan and Maharashtra. ADB financing to the state power agencies includes the power evacuation system for renewable energy generated e.g. in Western Rajasthan and solar power operations centers with state-of-art grid technology. CTF co-financing will be tailored to specific needs of the various states and solar park developments.

14. Table AX.1 summarizes the proposed solar and wind capacity expansions in selected RE-rich states. Of the 6 states listed, the western states of Gujarat, Maharashtra, and Rajasthan are expected to have exportable RE surpluses in the near future. Rajasthan is notable in that it has the highest solar capacity expansion proposed, it expects to have the largest solar generation capacity of any state by 2018, it currently has the highest share of RE in the grid mix of the 3 western states, and it has the most time-critical need for investment in the transmission network to facilitate optimum utilization of intermittent RE. Additional transmission system costs and risks will be incurred relative to conventional grid design because (i) the transmission system utilization ratio of solar and wind power evacuation is relatively lower at 20-30% compared with 80% for conventional base-load power evacuation, and (ii) it requires additional grid technology investment, e.g., advanced systems and equipment to stabilize power flow, voltage, and frequency. These additional financial and technical challenges hamper sustainable development and optimum RE utilization in India.

Table AX.1: Solar and Wind Development Plan for RE-Rich States (MW)

State	**Existing Capacity (March 2012)**		**Additional capacity**		**Total Capacity installed by 2018**		**Current RE Share (%)**
	Wind	*Solar*	*Wind*	*Solar*	*Wind*	*Solar*	
Tamil Nadu	6,370	7	6,000	3,000	12,370	3,007	41.9
Karnataka	1,783	6	3,223	160	5,006	166	24.2
Andra Pradesh	392	92	5,048	285	5,440	377	5.5
Gujarat	2,600	600	5,083	1,400	7,683	2,000	15.6
Maharashtra	2,460	17	9,016	905	11,476	922	14.3
Rajasthan	2,100	200	2,000	3,700	4,100	3,900	23.1
Total	***15,705***	***922***	***30,370***	***9,450***	***46,075***	***10,372***	n/a

Source: Report on Green Energy Corridors (2012) - Ministry of New and Renewable Energy

B. CTF Eligibility of the Rajasthan Transmission Investment Program

i. Proposed Transformation

15. The lack of transmission infrastructure has constrained RE development all over the world, including large markets such as the US and the People's Republic of China. The Rajasthan transmission investment program is an integral part of the national and state programs to accelerate and deepen market penetration of RE-based electricity, including the national goal of 20 GW of solar capacity by the year 2022. The proposed investments will support Rajasthan's planned solar and wind power expansion from the current 2.3 GW to 8 GW by 2018 (see Table AX.1), and ultimately to at least 28 GW by 2030. The additional costs and risks associated with these aggressive RE targets demonstrate the macro-economic need for concessional funds. In Rajasthan, subsidies are not needed at the moment for new generation capacity, and per state policy, any carbon finance (if available via CDM) is made available to the distribution company purchasing the renewable electricity; therefore, ***the transmission investment program is the logical entry point for concessional funds***.

16. The Rajasthan state owned transmission company (RRVPNL), with legal obligations to connect new RE plants under open access provisions, is required to expand and strengthen the high-voltage transmission "backbone" and begin investments in "green grid" technology to facilitate the GW scale-up in RE capacity. Under business-as-usual (BAU), new generation capacity would be provided by coal and natural gas, with transmission system utilization of about 80%. Under the proposed investment program, the transmission system utilization may be as low as 20-25% with a best case of about 50%, i.e., about 12 hours per day at rated capacity (the ultimate utilization factor will depend on the mix of PV, wind and solar thermal with significant storage).[11] The cost of developing long transmission lines from remote resource rich regions particularly in Western Rajasthan to load centers is accentuated by these low load factors. While RRVPNL operates under a cost plus tariff regime, publicly owned utilities at present at present forego a return on equity in order to lessen pressure on consumer tariffs. The estimated financial rates of return on transmission investment are not commercially attractive and in the medium-term, RRVPNL may not be in a position to have sufficient retained earnings to finance <u>accelerated</u> grid expansion; alternatively stated, the relatively low FIRRs may not enable commercial financing at the scale necessary to keep up with RE generation expansion.

17. CTF will provide value addition through the Rajasthan Renewable Energy Transmission Investment Program (the Program) via programmatic cofinancing for critical grid expansion to facilitate ultimate addition of 5700 MW[12] of solar and wind generation capacity (including other sources of financing), of which at least 4300 MW is expected to be directly supported by the Program by 2018. ***This investment program is one of the largest CTF proposals to date with respect to the RE generation capacity being supported***. This will also be the first instance of CTF cofinancing within an ADB multi-tranche financing facility (MFF).

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[11] The transmission system utilization will be vary depending on the mix of solar PV, concentrating solar thermal, and other RE. In the near term, wind and solar PV are expected to account for most of the generation capacity additions. In the BAU scenario, the transmission system would evacuate power from fossil-fuel power plants running at 80% output, vs. 19% for solar PV, 22% for wind and 23% for CSP.

[12] Refer Table AX.1.

ii. Proposed Investments

18. The overall Rajasthan Investment Plan for renewable energy envisaged a quantum advance in development of solar and wind power at scale, resulting in the installation of nearly 5700 MW of wind and solar power between 2012-2018. The ADB supported Rajasthan Renewable Energy Transmission Investment Program will support the development of the in-state transmission network to evacuate and transmit at-least 4300 MW of new renewable energy capacity over this period. The indicative investment and financing plan for renewable energy in Rajasthan is shown below in Tables AX.2 and AX.3. The rationale for CTF support is summarized below in Table AX.4 and discussed further below.

19. Transmission system expansion to be supported under the ADB Program will be mobilized through a multi-tranche financing facility (MFF), which comprises a series of project loans with total investment of $800 million including CTF ($200 million) over a period till 2018. The financing plan for the MFF and Project 1 is as indicated below in Tables AX.2 and AX.3. Results indicators are presented in Table AX.5 and AX.6. CTF financing is expected as $ 198 million of concessional loans and $2 million of grant for implementation support for system studies and capacity development. This is covered in three tranches as outlined below.

Table AX.2: Indicative Investment and Financing Plan for RE in Rajasthan

Investment Plan (Billion $)	2012 to 2018
Renewable energy generation	9.5
Regional transmission infrastructure	0.6
State transmission infrastructure	0.8
Other related infrastructure	0.3
TOTAL	**11.2**

Tentative Financing Plan (Billion $)	2012 to 2018
Private renewable energy sponsors	2.9
Renewable energy lenders	6.8
Inter-state transmission utility (Debt. Equity,Internal)	0.6
RRETIP (MFF)	0.8
Other Government Support	0.1
TOTAL	**11.2**

[a] Generation capacity cost assumes average $2.0 million per MW for solar and $1.0 million per MW for wind capacity.
[b] Carbon finance is not available as under the existing Rajasthan policy 100% of any carbon revenue (if available in the future) goes to distribution off-takers.
Source: ADB estimates based on discussions with Government of Rajasthan and Green Corridor Report

Table AX.3: Financing Plan ($ million)

Source	Project 1	Project 2	Project 3	Total	Share of Total (%)
ADB – Ordinary Capital Resources	62.0	150.0	88.0	300.0	37.5
ADB - Clean Technology Fund[a]	90.0[b]	70.0	40.0	200.0	25.0
Rajasthan	127.0	104.0	76.0	300.0	37.5
Total	**279.0**	**324.0**	**203.0**	**800.0**	**100.0**

[a] Under the Climate Investment Funds
[b] Includes $2 million grant for technical assistance and the MDB fee
Source: Asian Development Bank estimates.

Table AX.4: Summary Assessment of CTF Eligibility

CTF Investment Criteria	Rajasthan Transmission Program
Potential for GHG Emissions Savings	High, with high potential for replication and scale up: The proposed investments will facilitate the State's plan for up to 3,700 MW of new solar capacity and up to 2,000 MW of new wind capacity in Rajasthan under the investment plan resulting in the total solar and wind capacity to be evacuated out of the entire state of Rajasthan reaching 8,000 MW by 2018 compared to a baseline of 200 MW of solar and 2100 MW of wind in 2012. The ADB Program will support creation of instate transmission network connecting to inter-state transmission network. Assuming 22% capacity factor for wind, 19% capacity factor for solar PV and 23% capacity factor for solar CSP, electricity output would approximately reach 10,433 GWh/y. Assuming a conservative estimate of only about 4300 MW to be incrementally installed by 2018, the electricity output would approximately reach 7761 GWh/y. Assuming a conservative grid emissions factor of 0.7 tons CO_2e / MW-h, avoided emission will be about 5.4 Million tons/year CO2e from 4,300 MW. Over a time-period of 25 years (useful lifetime of transmission projects are significantly higher than 25 years), avoided emissions will be about 135 million tons CO2e for 4,300 MW. Further replication and scale up potential is at least 2.5 times in Rajasthan alone (Rajasthan expects to reach 28 GW of installed capacity of renewable energy by 2030), with corresponding emission avoidance of about 13.5 Million tons / year CO_2e, and total emission avoidance of 339 million tons CO_2e over 25 years. Future integration of thermal storage with CSP plants could increase load factor and the emissions avoidance from solar generation.
Cost-effectiveness	CTF funds will be leveraged by other sources of public funding at 1:4 for the Program (200:800), <u>not including</u> private sector investments in generation capacity estimated at about \$10 billion and inter-state transmission investments under the overall national program. If all expected investment in new generation capacity and inter-state transmission is considered, the leverage factor is higher than 50:1. Direct emission avoidance: CTF \$200 million / 5.4 million ton CO_2e / year = \$37 / ton CO_2e / year Over a time period of 25 years, cost effectiveness is CTF\$1.5 per ton CO_2e With replication and scale up of only 2.5:1: CTF\$0.6 / ton CO_2e
Demonstration Potential at Scale	Replication and scale-up potential is very high within India (up to 50 GW as shown in Figure AX.4, and possible greater as shown in Figure AX.5), other parts of Asia, and globally.
Development Impact	Development impact accrues mainly from displacement of future coal-fired power capacity and offset or displacement of diesel and gasoline (petrol) fired generator sets with substantial ecological and public health co-benefits
Implementation Potential	The proposed solar parks are first-of-a-kind in terms of scale and design, which present first-mover risks. Private sector interest in generation is demonstrably high, indicating strong chance of success and replication at gigawatt scale. Rajasthan has planned for 4 solar parks to be constructed. Bidding is on-going in 2013 for solar projects to be implemented at Phase 1 of Bhadla that have resulted in tariffs as low as 6.45 Rs/kWh (\$0.12 US cents per kwh).
Additional Costs and Risk Premium	The additional costs of solar energy systems, transmission utilization, cost of high levels of renewable energy penetration and first-mover risks indicate clear need for concessional support.

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

Table AX.5: Results Indicators and Performance Indicators

Result	Indicator	Baseline[a]	Target	Data Source & Means of verification
Avoided GHG emissions	tCO_2e reduced or avoided annually	0	> 5.4 $MtCO_2eq/y$	MOEF
Increased Financing mobilized for low-carbon development	Leverage factor	n/a	1:4	MDB cofinancing agreements
Increased supply of RE [b]	Installed capacity (MW)	2,300	> 4,300 MW linked to the Investment Program in Rajasthan (2018)	MDB project monitoring
Energy Savings [c]	design output (GWh/y)	n/a	>7,761 (incremental)	MDB project monitoring

Source: MDB staff estimates.

Notes: [a] Baselines are set in 2012 unless otherwise noted.

[b] Baseline capacity is 200 MW solar and 2100 MW wind as shown in Table AX.1. The ADB supported projects will support evacuation of at-least 4,300 MW of renewable energy by 2018.

[c] Energy savings are the avoided fossil fuel generation output calculated based on load factors of 19% for solar PV, 22% for wind and 23% for CSP.

Co-benefits at the Transformative Impact Level

20. **Reduced cost of low carbon technologies and practices.** A recent report published by the International Renewable Energy Agency (IRENA) notes that the global learning rate (cost reductions associated with doubling of capacity) for solar PV is 18 – 22%. The rapid drop in PV costs since 2009 have been driven to some extent by Germany's feed-in tariff policy and investment tax credits in the United States which created new demand and, in turn, a rapid expansion in global manufacturing capacity. At current cost reduction trends, installed PV system costs are projected to be about $1 per watt in 10 years (at parity with coal). India's solar program supports this global momentum, and may in fact accelerate the learning rate as new PV manufacturing capacity is expanded in India. The cost of private sector PV projects in India has fallen from a high of 17.91 rupees/kwh in 2010 to about 7 rupees/kwh in 2013 due to falling capital costs, project development at scale and reverse competitive bidding carried out by the Government of India under the JNNSM. The global learning rate for CSP has been much lower than PV, but is expected to improve as new manufacturing capacity is built; it is difficult to predict the impact of the Rajasthan program on global learning rates at present. As installed system costs drop, the potential for additional solar resource development increases, and land availability will be the rate-limiting factor on ultimate solar capacity. Figure AX.5 shows an optimistic scenario of up to 85 GW of solar capacity development including off-grid applications.

21. **Energy security.** India is a net importer of fossil fuels, and utility-scale RE development directly benefits energy security. Imports of coal, petroleum-based fuels, and liquefied natural gas depend on fuel trans-shipment capacity, and some large supercritical power projects are experiencing significant coal supply issues. Using a conservative assumption of 400 tons of coal required to produce 1 GWh of electricity, the 4,300 MW of new RE capacity will facilitate avoided coal consumption of about 3.1 million tons per year.

22. **Improved enabling policy and regulatory environment for low carbon technologies and practices.** As outlined in the CIP, India has an ambitious national program and policy framework for low carbon development, including a voluntary commitment to reduce GHG

intensity 20-25% by year 2020 from the year 2005 baseline. The Rajasthan program is fully consistent with the policy framework to meet the GHG objectives. The program will create synergy through accelerated development of GW-scale RE capacity, and will support billions of dollars of private sector investment in new RE capacity.

Co-Benefits at the Outcome Level

23. **Access to energy co-benefits:** The Program will facilitate additional electricity output of at-least 7,761 GWh/y. Assuming the GOI target of providing 1,000 kWh per person per year, the additional output will be sufficient to supply more than 7 million people, and well over 1 million households. Energy security will be improved via diversification of supply and an improved transmission network. As noted above, avoided consumption of coal is estimated at 3.1 million tons per year. The additional electricity output will also improve reliability of supply to industries and businesses. Avoided fuel imports will have a complementary effect, as freight transport capacity will be freed up for other goods.

24. **Health co-benefits.** Health benefits will accrue mainly at the local and national level from avoided power plant emissions of conventional pollutants including particulate matter (PM), nitrogen oxides (NOX), sulphur oxides (SOX), mercury and other toxic compounds present in coal, and coal ash. Additional electricity supplies may result in household switching to electricity for cooking which would disproportionately benefit females.

25. **Employment co-benefits:** The Program is expected to create substantial employment benefits during construction as well as implementation period. Additional value-added employment will be created in solar industries, including manufacturing and energy services. The Program will also support livelihood opportunities for communities in Western Rajasthan using technical assistance. The potential employment benefits cannot be quantified at present.

26. **Gender and local community co-benefits:** High fluoride levels in water create health problems for local communities. The Program is expected to support the creation of infrastructure for water supply and treatment for communities in Western Rajasthan. A state level framework for community related interventions (with gender specific elements) in areas adjacent to renewable energy parks would be developed and supported through RREC. This includes support for development and rolling out a community development fund with gender targets and financial support through RREC. Needs based alternative livelihood training and vocational programs with RREC support would also be taken up.

iii. Potential GHG Reductions

27. The solar park approach and the technical integration of wind and solar in Western Rajasthan in the transmission system would demonstrate the commercial and technical viability of developing large scale projects through a partnership between the public and private sectors. These projects will provide business models that can be replicated in India and elsewhere in the region. Successful demonstration of utility-scale solar projects will facilitate development of the local solar PV and solar thermal industries which are required to enable long-term low-carbon development.

28. The proposed transmission investments will connect more than 4,300 GW of new RE capacity to the grid primarily in western Rajasthan. Assuming additional electricity output of 7,761 GWh/y (as shown above in Table AX.4) and a grid emissions factor of 0.7 tons CO_2e / MWh (700 t/GWh), the estimated GHG emission avoidance works out to :

7,761 GWh/y x 700 t/GWh = ***5.4 million tons CO_2e / year***

29. The grid emissions factor used in this calculation is quite conservative compared to published emissions factors,[13] and thus anticipates future RE capacity additions which will reduce the GHG intensity of the grid mix. The estimate is also conservative as it is based on electricity output primarily from a more modest expansion of renewable energy capacity by the end of the Program in 2018.

30. Technology risk is considered to be low for the proposed transmission investments in Tranche 1. As solar power generation technology evolves, e.g., adding thermal storage to utility-scale concentrating solar power plants, generation output could reach 35-50% plant load factor.

iv. Cost-Effectiveness

31. The CTF funds will be leveraged at 1:4 for the MFF, not including private sector investments in generation capacity estimated at $9.5 billion. Cost-effectiveness is calculated as follows:

CTF $200 million / 5.4 million tons CO_2e / year = $37 / tons CO_2e / year

32. Over a 25 year period, cost effectiveness is CTF$1.5 per ton CO_2e. With replication and scale up of only 2.5:1, cost effectiveness is CTF$0.6 / ton CO_2e. Replication potential is much higher, as discussed below.

v. Demonstration Potential at Scale (Transformation Potential)

33. As discussed above, solar and wind comprise India's largest RE resources (exclusive of large hydropower), and solar alone could theoretically provide more than half of current grid-connected generation output. The transformation potential[14] is conservatively estimated to be more than 5 for solar power development, given the 35 GW objective for solar power by 2030 (of which 13 GW is expected in Rajasthan). Learning rates may result in increased potential (as discussed above in paragraph 20). Some market observers predict that ultimate solar potential could be more than 80 GW, as shown in Figure AX.5.

vi. Development Impact

34. New investment in transmission infrastructure to facilitate GW-scale RE development will improve energy security, avoid GHG emissions, and avoid conventional pollutant emissions with substantial public health benefits. Furthermore, as an indigenous and non-tradable energy source, new RE capacity serves as a natural hedge against the volatility of fossil fuel prices. CTF cofinancing will help mobilize future commercial investments for replication and scale up, which will stimulate economic growth and facilitate the long-term transition to low-carbon development. The proposed investments will contribute to the near-term goal of adding more than 4,300 MW of solar and wind power to the grid by the end of the Program (5,700 MW is the planned target), and facilitate replication and scale to 28 GW of renewable energy including

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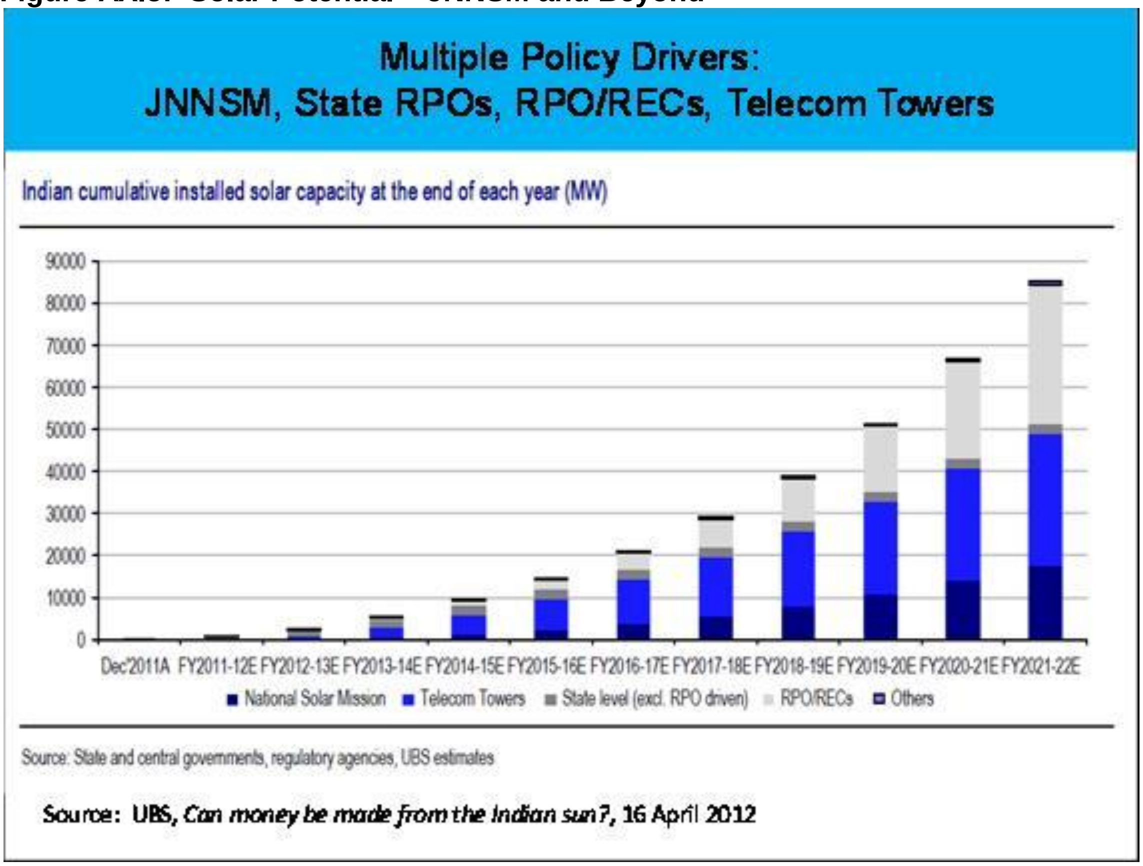
[13] See published emissions factors for India grids at: http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver6.pdf

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

solar (13 GW) and wind power (15 GW) in Rajasthan alone by 2030. As noted above, the nationwide replication and scale up potential is much higher.

35. The direct impact accrues from additional clean energy supplies, more reliable electricity services, and offset and displacement of fossil-fuel emissions including avoided fuel costs. The macro-economic impact accrues from solar industry and market development within India as outlined in the JNNSM and broader policy framework for low-carbon development.

Figure AX.5: Solar Potential – JNNSM and Beyond



vii. Implementation Potential

36. ADB is actively engaged with the key agencies developing the solar parks in Rajasthan, and is also engaged with MNRE, IREDA and local banks for the development of renewable energy projects. In addition, ADB is facilitating discussions between the utilities and the private sector through initiatives such as the Asia Solar Energy Forum and the Regional Task Force.

37. The Program has been developed in a strong policy context at the national and state level (discussed above). Expanded RE capacity, especially new solar capacity, is a high priority as evidenced by the policy and regulatory framework which is spurring billions of dollars of investment in RE generation capacity. The proposed transmission project(s) have been the subject of thorough feasibility assessments and due diligence. The individual power plants are at varying stages of development, with active demand for expanded transmission system capacity. A procurement plan is included in the Framework Financing Agreement as well as the

MFF Facility Administration Manual. The Tranche 1 transmission project has cleared the DEA readiness checklist, and the MFF is on track for negotiations and Board approval in Q3 2013. Advanced procurement and retroactive financing was approved by ADB Management and procurement in 2012. Approvals have been provided to commence procurement in June 2013.

Additional Costs and Risk Premium

38. Financing available through CTF and ADB will provide a catalytic role to support the development of the transmission network and RE capacity in Rajasthan including reduction of the risks and addressing technical challenges associated with the development of large scale RE projects and RE integration into transmission networks including development of renewable energy control centers, forecasting mechanisms, and stabilization equipment. RE resources are “as is, where is” in nature and are not located in convenient proximity to consumers, compared to fossil fuels which can be readily transported to power plants constructed in relative proximity to load centers. Thus, all of the transmission investments to be supported by CTF are “additional” to a business-as-usual scenario. As shown in Table AX.2 above, the total additional investment for transmission and related public sector infrastructure for RE development is $1.7 billion.

39. The private sector, which is expected to provide most of the investment for solar generation capacity, perceives higher risks in (i) the implementation of new policy and regulatory frameworks; (ii) adaptation of technologies proven in developed countries into the India local context; (iii) technical risks on issues such as sufficient solar irradiance and water availability; and (iv) general project development, *inter alia* land acquisition, safeguard clearance, off-take risk, and power evacuation. To mitigate perceived risks by the private sector and accelerate investment, GoI and state governments have been implementing innovative public-private partnerships (PPP) through solar park and advanced CSP pilot project development with support from the Asian Development Bank since 2008.

40. The Rajasthan investments are part of the of first GW-scale solar parks being developed in India, and as such there is no operational history for this scale of operations. Successful demonstration of this GW scale operation is necessary to achieve the longer-term replication and scale up to 13 GW of solar capacity in Rajasthan by 2030. Alternatively stated, individual projects may have very low technical risks but the overall program still presents first-mover risk. In India and almost all other countries with GW-scale RE programs, grid integration of large-scale intermittent RE power plants is a significant barrier to RE expansion. The proposed transmission investment program will enable large-scale grid integration and delivery of the benefits that co-located solar and wind plants can provide.

41. The renewable purchase obligation (RPO) and renewable energy certificates (REC) policy framework supports the generation and off-take ends of the system but not the transmission "middle man." Alternatively stated, the policy and regulatory framework has reduced the development risk in the generation subsector, as demonstrated by significant commercial investments that have been mobilized already. RPO enforcement and REC market risks are moderate to high and cannot be readily mitigated. Concessional funds will reduce the overall financial risk by reducing cost of capital.

42. The transmission system must evolve to handle the intermittent output and system stability, which may translate to future system modifications in order to reach optimum operations. There may be significant variations in utilization, e.g., a worst-case of 10% utilization during low-sun / no-wind conditions, and high of as much as 40% or more utilization with high-

sun and complementary high-wind conditions. The difference in transmission system utilization between BAU and RE scenarios directly impact consumers in terms of higher transmission tariffs (fixed transmission costs are recovered from distribution companies and low utilization increases consumer tariffs).

43. Under the current electricity regulatory regime, RRVPNL is entitled to earn return on equity (ROE), but given the overall sector outlook, all public sector electric utilities currently forego the allowed return on equity resulting in the transmission business being sub-commercial. The project may be financially viable since the real FIRR of 3.5% is higher than a weighted average cost of capital of 1.3% (based on public sources of capital). With a single-digit FIRR, the return is approximately equivalent to risk-free returns that can be obtained in India after adjusting for tax and inflation. CTF will improve overall financial attractiveness and will help the transmission utility undertake the required investments in advance of future regulatory adjustments where transmission business will be allowed higher tariffs and ROE.

44. The solar and wind generation capacity additions that have been made over the last two years have depended on residual capacity of existing lines and sub-stations in the transmission grid. The existing transmission capacity is increasingly constrained and at current rates of new RE generation expansion, the system is becoming overloaded in 2013. Without additional external financing, this transmission system expansion will continue to be delayed due to lack of funding from governments, as well as the transmission utility's financial position. GOI, GOR, and ADB are working on a roadmap for the utility to generate sufficient internal resources to finance part of future transmission investments. ADB and CTF financing can play a critical role in bridging this funding gap. The indicative financing plan for the Rajasthan RE Transmission Investment Program is shown above in Table AX.3.

45. In the absence of ADB and CTF financing, GOI would have to consider alternate funding sources for the proposed projects including through its constrained budgetary resources with a risk of further delays. Pursuant to ADB guidance, the project is considered financially viable (FIRR > WACC), but in the broader India investment context, the project is clearly not very commercial. In case the transmission project was evacuating conventional thermal energy, higher load factors would have resulted in a 50-75% decrease in the transmission tariff on the customer (i.e., the RE transmission cost is at least 50% higher than the business-as-usual scenario).

46. This sub-commercial rate of return justifies the use of CTF in accordance with paragraph 25 (b) of the *CTF Investment Criteria for Public Sector Operations* (2009), and paragraph 20 (b) ii and paragraph 25 (a)[15] and (b) of the *Clean Technology Fund Financing Products, Terms, and Review Procedures for Public Sector Operations* dated 15 December 2011.

47. Carbon finance is not available as according to Rajasthan Solar Policy 2011 any CDM benefits contractually belong to the distribution company off-takers. The lack of carbon finance justifies the use of CTF in accordance with the *CTF Investment Criteria for Public Sector Operations* (2009), paragraph 28.[16] RRVPNL is in discussions on a financial restructuring program under which the utility may claim a return on equity by 2021, linked to sector turnaround plan approved by Government of Rajasthan and Ministry of Power. Consequently,

[15] Paragraph 25 (a) specifically refers to the risk of "the intermittence of solar and wind resources."

[16] Likewise, the lack of financial support from the Global Environment Facility justifies the use of CTF resources in accordance with the *CTF Investment Criteria for Public Sector Operations* (2009), paragraph 29.

DSCR and debt equity ratio for RRVPNL are expected to reach acceptable levels by 2023. Given these financial constraints, softer CTF terms and conditions are requested.

C. Coordination with Donors and other Multi-lateral Development Banks

48. Support for the RE program, including the proposed Rajasthan investments, was the subject of early discussions with major donor agencies and other MDBs during preparation of the CIP. ADB has maintained open communication with these stakeholders during project preparation and will continue to liaise with donors and other MDBs during implementation.

D. Pricing and Loan Terms of CTF projects

49. The loan terms for CTF financing are presented in Table AX.7. These are the "base" terms for public sector projects. The softer pricing terms and conditions are requested for the proposed Rajasthan project in accordance with paragraph 20 (b) ii of the *Clean Technology Fund Financing Products, Terms, and Review Procedures for Public Sector Operations* dated 15 December 2011. A total of $ 198 million is requested as CTF softer concessional loan and $2 million as a grant for technical assistance for implementation support and capacity building.

Table AX.7: Proposed CTF Loan Terms

CTF Loans	Maturity	Grace Period	Principal Repayments Year 11-20	Principal Repayments Years 20-40	MDB Fee a/	Service Charge b/	Grant Element c/
Softer Concessional	40	10	2%	4%	0.18%	0.25%	~75%

Source: Climate Investment Funds. *Clean Technology Fund Financing Products, Terms, And Review Procedures For Public Sector Operations*, [revised] December 15, 2011.

Notes:

a/ The borrower will have two options for payment of MDB fees: (a) a fee of 0.18% of the undisbursed balance of the loan, in which case the fee payments will accrue semi-annually after loan signing, or (b) a fee equivalent to 0.45% of the total loan amount, payable in a single lump sum amount, which may be paid by the borrower out of its own resources or capitalized from the loan proceeds following the effectiveness of the loan. The fees are to be retained by the MDB for its lending and supervision costs.

b/ The service charge is charged on the disbursed and outstanding loan balance. Principal and service charge payments accrue semi-annually to the CTF trust fund.

c/ Grant element is calculated using the IDA methodology (assumptions: 6.33% discount rate for harder loans; 6.43% discount rate for softer loans; semi-annual repayments; 8-year disbursement period).