Completion Report

Project Number: 44396-012
Technical Assistance Number: 7808
August 2016

India: Development of the International Center for Application of Solar Energy Technologies

Asian Development Bank

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<table>
<tr><td colspan="3">TA Number, Country, and Name:

TA 7808-IND: Development of the International Center for Application of Solar Energy Technologies</td><td colspan="2">Amount Approved: $2,000,000

Revised Amount: $2,000,000</td></tr>
<tr><td colspan="2">Executing Agencies:
The Indian Institute of Technology Jodhpur and the Government of Gujarat</td><td>Source of Funding:
Japan Fund for Poverty Reduction</td><td>Amount Undisbursed:
$ 1,037,961</td><td>Amount Utilized:
$ 962,039</td></tr>
<tr><td>TA Approval Date:

17 May 2011</td><td>TA Signing Date:

27 September 2011</td><td>Fielding of First Consultant:

7 May 2012</td><td colspan="2">TA Completion Date
Original: 30 June 2013 Actual: 31 August 2015

Account Closing Date
Original: 30 June 2013 Actual: 25 July 2016</td></tr>
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Description: The Government of India launched the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010 with an objective of establishing India as a global leader in solar energy. The JNNSM targeted 20 gigawatts (GW) of grid connected solar capacity by 2022, thus creating conducive conditions for establishing a manufacturing base for solar components. To achieve this, the government recognized the necessity of building world-class expertise and wide range of professional skills in order to indigenize technology development and manufacturing of advanced solar technologies, including prioritizing the establishment of research and development institutes to develop the much needed domestic capacity.

In this context, the government requested Asian Development Bank's (ADB) technical assistance (TA) to enhance capacity at public knowledge institutions on advanced solar technologies; to establish testing and research facilities; and to support widespread dissemination on solar energy and smart grid development. Gujarat and Rajasthan account for most of India's abundant solar energy resources and became early leaders in promoting solar energy. Hence, the TA focused on knowledge institutions in these two states. At the Indian Institute of Technology Jodhpur (IITJ) in Rajasthan, the TA supported the establishment of an International Center for Application of Solar Energy Technologies (ICASET) and in developing their capacities to implement the work program. Similarly, at Pandit Deendayal Petroleum University (PDPU) in Gujarat, the TA helped to develop the research and development facilities, their work programs including capacity building to share knowledge with state utilities and various other stakeholders in order to mainstream solar energy and smart grid technologies.

Expected Impact, Outcome, and Outputs: The expected impact was strengthened and more environmentally sound energy security through solar energy use and stable grid development for inclusive and low-carbon growth in India. The expected outcome was developed capacity in the country for policy, technology, and financing to promote solar energy and stable grid development. The expected outputs were (i) ICASET established at IITJ, (ii) technology transfer and deployment programs conducted at ICASET and state government agencies, and (iii) capacity development program conducted.

Delivery of Inputs and Conduct of Activities: IITJ (for ICASET) and the Government of Gujarat (for operations in the state of Gujarat) were the executing agencies of the TA. The TA was expected to fund six international individual consultant packages and four national individual consultant packages with a broad range of required specializations. Seven consultants were recruited as individual consultants during different phases of the TA implementation. The terms of reference of consultants were in line with the TA's objectives and scope. The performance of the consultants was satisfactory. The consultants, ADB, IITJ, and PDPU, as the implementing agency, collaboratively conducted capacity development programs for technology transfer in solar energy use and stable grid management. The productivity of the inputs (conversion into outputs) can be considered to be high since (i) the ICASET was established as planned; (ii) the technology transfer program was conducted that resulted in timely solar park development and implementation in Gujarat and Rajasthan; and (iii) the activities contributed to ADB financing several solar energy parks associated transmission lines i.e., (a) India: Rajasthan Renewable Energy Transmission Program[1]; (b) India: Green Energy Corridor and Grid Strengthening Project;[2] and (c) 2016 proposed Loan: Solar Transmission Sector Project.[3] Gujarat and Rajasthan power utilities were ones of the beneficiaries of the ADB lending program.

[1] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to India for the Rajasthan Renewable Energy Transmission Investment Program*. Manila.

[2] ADB. 2015. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to India for the Green Energy Corridor and Grid Strengthening Project*. Manila.

[3] ADB. 2015. *Project Preparatory Technical Assistance to India for Preparing the Solar Park Development and Transmission Sector Project*. Manila.

The TA was less than efficient with cost savings resulting in undisbursed amount since several private sector agencies and knowledge partners with relevant technologies and participated in the program at their own costs. These agencies were committed to technology transfer and capacity development as early adapters without utilizing the TA resources. In particular, strong investor interest in developing solar projects within solar parks was supported by the TA (Badlha Solar Park in Rajasthan and Charanka Solar Park in Gujarat) and contributed to the government's ambitious 100GW solar target by March 2022. These commitments coupled with lower costs in solar power generation, enabled the executing agencies, ADB and consultants to successfully develop capacity for mainstreaming solar energy in Gujarat and Rajasthan. In addition, the Ministry of Economy, Trade and Industry, the Government of Japan, the Institute of Energy Economics Japan (IEEJ), and New Energy and Industry Technology Development (NEDO) provided parallel knowledge support in conjunction with the TA, which reinforced Japan's visibility and thus contributing to savings under the TA. NEDO conducted knowledge programs on managing the integration of renewable into the grid at their own costs, which again resulted in cost savings under the TA. The executing agencies' performance was satisfactory as they supported the solar parks development model, thus allowing both Gujarat and Rajasthan to plan and develop large solar projects due to energy resource availability, strong support at state-level through policies and regulatory framework. The performance of ADB was satisfactory. ADB was fully compliant with all Government of India and ADB internal procedures and was successful in engaging the government at a high level regarding issues relating to solar energy and stable grid development.

In the implementation of this TA, solar energy based power generation was mainstreamed in Gujarat and Rajasthan. The TA was to be implemented over 24 months, however, completion of this TA was extended 4 times for an additional period of 26 months since (i) the solar energy development target was up-scaled in Gujarat and Rajasthan that increased the work program of the TA; (ii) other states expressed interests in success of Gujarat and Rajasthan and thus, PDPU conducted additional training programs for disseminating advanced solar and smart grid technologies to the states of Assam, Karnataka, Maharashtra, Punjab, Tamil Nadu, and West Bengal; and (iii) due to lack of financial management capacity of IITJ, an outstanding balance of $5,597.15 from advance payment facility for workshops needed to be written-off. The undisbursed amount under the TA was due to additional in-kind contributions by IA and other knowledge partners, e.g., NEDO contribution was not envisaged at the time when the TA was developed.

Evaluation of Outputs and Achievement of Outcome: The quality of outputs was high and relevant. In 2013, IITJ established ICASET and set up (i) a high temperature solar thermal laboratory for development of solar receiver elements, and (ii) optical spectroscopy laboratory for the characterisation of sources and materials over the relevant wavelength range for solar energy research and materials characterisation. With these facilities, IITJ, together with external stakeholders, worked to localize design and develop advanced solar technologies to meet the specific needs of India with aim to manufacture and deploy them domestically. In Gujarat, PDPU conducted knowledge dissemination programs on solar power and smart grid development involving more than 100 stakeholders, e.g., developers, manufacturers, power utilities, policy makers, regulators, and other stakeholders, thus greatly increasing awareness of the potential for these technologies in India.

The outcome of the TA was successfully achieved. The TA effectively (i) supported the Gujarat and Rajasthan government in formulating and implementing state-level solar energy development policy and regulatory framework, and (ii) supported development of more than ten utility-scale solar power generation projects (solar parks) in Gujarat and Rajasthan.

Overall Assessment and Rating: Overall, the TA is considered successful. The TA was relevant as it was closely aligned with India's objectives to mitigate climate change through use of solar energy. The TA was less than efficient, effective, and likely sustainable with successful results in institutional capacity development of utilities and other stakeholders, and localized advanced technologies for solar power generation in India, particularly in Gujarat and Rajasthan. The TA contributed to timely implementation of ADB's Gujarat Solar Power Transmission Project[4] through improved institutional capacity of executing agency. The TA, together with ADB's lending projects, contributed to increasing installed capacity of solar power projects in Rajasthan and Gujarat to 1,285 megawatts (MW) and 1,120 MW, respectively by 2016. Moreover, the success of mainstreaming solar in Gujarat and Rajasthan resulted in increasing national target of grid connected solar power from 20GW to 100GW, which was a major commitment of the government at the Conference of Parties 21 in Paris in 2015 along with the establishment of the Solar Energy Institute. The government is also committed to increasing the share of installed electric power capacity from renewable energy to 40% by 2030.

[4] ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to India for Gujarat Solar Power Transmission Project*. Manila.

Major Lessons: Prior to TA approval, there should have been a consensus on (i) possibility of upscaling solar energy development target; and (ii) more concrete action and financing plans with clearer roles of the private sector in technology transfer among ADB, the state government agencies, executing agencies, the private sector, and other development partners to avoid extension and cost overestimate of the TA. In addition, close monitoring of administrative matters and financial management capacity of executing agency should have been done as there were many small financial transactions due to conducting of series of workshops and other small knowledge events.

Recommendations and Follow-Up Actions: ADB will encourage south-south collaboration through sharing the best practices from India with other developing member countries planning to mainstream solar energy in their energy mix. In addition, ADB will continue to conduct cost effective capacity development work in collaboration with the public and private sector agencies and to further mainstream climate change mitigation through lending and non-lending program.

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