

Summary of Terminal Evaluation

1. Outline of the Project		
Country: India		Project title: Research Partnership for Application of Low Carbon Technology for Sustainable Development
Issue/Sector: Energy Efficiency / Climate Change		Cooperation scheme: Technical Cooperation (SATREPS)
Division in charge: Industrial Development and Public Policy Department		Total cost: (as of Terminal Evaluation) Approx. 276 million JPY
Period of Cooperation	(R/D): 12 th March, 2010	Partner Country's Implementing Organization: The Energy and Resources Institute (TERI)
	Project Period: May 2010 ~ March 2014	Supporting Organization in Japan: Institute for Global Environmental Strategies (IGES), Kyoto University (KU)
<p>1-1 Background of the Project</p> <p>India has experienced continuously high economic growth in recent years, and meanwhile energy demand has increased dramatically. According to the document entitled “Integrated Energy Policy Document (2006)” of the Planning Commission of India, if the current annual economic growth rate of 8-9% is to be maintained till the year of 2030, the supply of primary energy would be required to triple, while an estimated six-fold increase in the supply capacity of electric power is considered indispensable. With the increase of energy supply and demand, the environmental burden is growing. For example, those obsolete power facilities are not only poor in generating efficiency, but also problematic in environmental aspect in that they discharge more hazardous substances causing environment pollution as compared with those newly developed environment-friendly facilities. Moreover, with the emission of Green House Gas (GHG) like CO₂ tending to increase sharply, India has become one of the largest CO₂ emitter in the world. It is apprehended that GHG emission in India would be soaring proportionately to the rapid growth of economy.</p> <p>Accordingly, the introduction of low carbon technologies (LCTs) become an urgent task to reduce or mitigate the emission of CO₂ expected to further increase drastically in the near future. In this regard, it is desirable to adopt applicable international technologies and establish them domestically. With this view, the Government of India (GoI) requested the Government of Japan (GoJ) to support the implementation of “Research Partnership for Application of Low Carbon Technology for Sustainable Development” (hereinafter referred to as “the Project”) under Science and Technology Research Partnership for Sustainable Development (SATREPS) program.</p> <p>In the Project, with The Energy and Resources Institute (TERI) as counterpart on the Indian side, Institute for Global Environmental Strategies (IGES) and Kyoto University (KU) jointly conduct the research on the Japanese side. The period of cooperation is from May 2010 to March 2014.</p> <p>As the remaining Project period became 6 months as of September 2013, this terminal evaluation was implemented in order to identify the remaining tasks to be achieved by the end of the Project, and to draw recommendations and lessons learned for future activities.</p>		

<p>1-2 Project Overview</p> <p>(1) Overall Goal The applications of low carbon technologies are promoted.</p> <p>(2) Project Purpose A framework to promote low carbon technologies is proposed.</p> <p>(3) Outputs</p> <p><u>[Output 1]</u> Appropriate and promising technologies to achieve GHG reduction as co-benefit are identified.</p> <p><u>[Output 2]</u> Effects of specialized low carbon technologies are evaluated through pilot projects.</p> <p><u>[Output 3]</u> Facilitation measures considering stakeholders' roles, institutional affairs and capacity building systems are formulated.</p>	
<p>(4) Inputs (at the time of Terminal Evaluation)</p> <p><u>1) Japanese side:</u></p> <p>a) Long-term expert: Two persons</p> <p>b) Short-term expert: Approximately 52 persons, dispatched in 17 times from June 2009 to July 2013 (The 3 trips in 2009 were taken with budget from Japan Science and Technology Agency (JST).)</p> <p>c) Equipment:</p> <ul style="list-style-type: none"> • Gas Heat Pump (GHP) 2 units, respectively including: Indoor unit, outdoor unit, pipe joint, transformer Equipment Cost: GHP 2 units approx. 21 million JPY • Electric Heat Pump (EHP) 2 units, respectively including: CO₂ refrigerant electric heat pump, heat exchangers for hot and cold water system, water circulation pumps (hot and cold side), Control board Equipment Cost: EHP 2 units approx. 69 million JPY <p>d) Counterpart Trainings in Japan: 7 persons (thirteen times in total)</p> <p><u>Indian side:</u></p> <p>a) Assignment of Counterparts: 18 persons in total (including three full-time researchers)</p> <p>b) Provision of facilities: Daily necessities, office spaces and other relevant facilities for Japanese experts, depending on needs.</p> <p>c) Local cost: 8.1 million INR (approx. 13 million JPY) (Including estimation until Project end)</p>	
<p>2. Evaluation Team</p>	
<p>Members of Evaluation Team</p>	<p>(1) Mr. Toru KOBAYAKAWA (Leader) Advisor, Industrial Development and Public Policy Department, JICA</p> <p>(2) Mr. Shunta YAMAGUCHI (Cooperation Planning) Special Advisor, Industrial Development and Public Policy Department, JICA</p>

	<p>(3) Mr. Hiroshi ISHIZATO (Evaluation Analysis) Senior Consultant, Esperanza Co., Ltd.</p> <p>(4) Dr. Kenji YAMAJI (SATREPS Evaluation Leader) Programme Officer (Low-Carbon Energy System Area), Research Partnership for Sustainable Development Division, JST</p> <p>(5) Ms. Misato UNOSE (SATREPS Evaluation Planning) , Assistant Programme Officer, Research Partnership for Sustainable Development Division, JST</p>	
Period of Review	September 29th to October 12th, 2013	Type of Evaluation: Terminal Evaluation
3. Results of Evaluation		
3-1 Summary of Achievements		
(1) Output 1: Fully achieved		
<p>1) In view of the needs of India, LCTs with cross-sectorial characteristics and applicable to energy-intensive processes, appropriate / applicable LCTs relevant to Indian conditions available in Japan were identified. Therefore, the Indicator, “Appropriate / applicable low carbon technologies relevant to Indian conditions available in Japan in terms of technology cooperation are listed” has been fully achieved.</p> <p>2) Suggestions on the improvement of GHP and EHP technologies are put forward and reflected in the draft final report (DFR⁶). Therefore, the Indicator, “Improvements of relevant low carbon technologies are documented” has also been fully achieved.</p>		
(2) Output 2: Partially achieved		
<p>1) Impact assessment report for GHP and EHP is in the process of development and documentation of experience and knowledge acquired so far from the detailed study (DS⁷) and baseline study is reflected in the DS reports and the DFR. Therefore, the Indicator, “Number of pilot project documentation listed in Japanese low carbon technologies”, which actually refers to the completion of the Final Report, is considered to be partially achieved.</p> <p>2) The tentative results of analysis as of August 2013 show that CO₂ reduction by GHP is expected to be 30-40% as compared to existing A/C, while that of EHP is to be 30-50% as compared to existing systems like boiler and chiller. Therefore, the Indicator, “Amounts of CO₂ reductions by demonstration of technologies” is considered to be almost achieved, as the tentative results need only to be further justified by more data arising from the operation of the pilot projects.</p>		
(3) Output 3: Partially achieved		
<p>Recommendations regarding the facilitation are now in the process of finalization. Although the tentative recommendations have been formulated and reflected in the DFR, further elaboration based on the results of pilot projects are needed. Accordingly, the Indicator, “Measure to facilitate low carbon technology transfer from Japan to India taking into consideration the technology needs,</p>		

⁶ Draft of the final report which will be finalized by the end of the research project.

⁷ Report which is submitted to SME selected for pilot project. It is based on in-depth site investigation, and provides details about how to customize the proposed technology to fit to the condition of the investigated site as well as the expected impact.

opportunities and barriers” is regarded to be partially achieved.

(4) Achievement of Project Purpose:

Partially achieved as of the end of September 2013, and expected to be fully achieved by the end of March 2014.

Against the Verification Indicator of Project Purpose, “Recommendations/ suggestions regarding the promotion of low carbon technologies as co-benefits are published”, achievements are identified as follows:

- 1) Although the pilot projects are still in the process of implementation, the framework with recommendations / suggestions for promoting LCTs based on the results and knowledge acquired so far is in the making, and the Final Report, though still in draft, is expected to be published subsequently.
- 2) The other publications of research results relevant to the Project are listed below:
 - Publications of research papers and other writings: 6 (1 research paper , 5 other writings)⁸
 - Presentations in international and domestic academic conferences: 8 (international 4, domestic 4)
 - Verbal presentations in international and domestic academic conferences: 20 (India 18, Japan 2)

3-2 Summary of Evaluation Results

(1) Relevance: Very high

1) Relevance to Indian Policy

- The 12th Five Year plan (2012-2017) states the need of India to adopt low carbon strategy for inclusive growth in order to improve the sustainability of its growth process and issues a list of twelve focus areas including that of “Energy Efficiency Programs in the Industry”. It also stresses that the industrial sector is one of the largest consumers of energy, and that improving the efficiency of energy use is critical for energy security, improving industry profitability and competitiveness, and reducing the sector’s overall impact on climate change.
- The National Action Plan for Climate Change (NAPCC) lays out eight missions for the country to fulfill through by 2017, and as part to them, the National Mission on Enhanced Energy Efficiency (NMEEE) targets various energy efficiency concerns in the country including that of small and medium enterprises (SME). While the SMEs accounts for about 45% of manufacturing output and 40% of exports of India, energy conversion processes in these companies remain inefficient. Therefore, the Project’s purpose to promote LCTs focusing on SMEs is highly compatible to the above-mentioned Indian policy.

2) Relevance to Japanese ODA Policy toward India

⁸ 1 research paper: “Research on Application of Low Carbon Technologies in India” by Tomohiro Shishime, Yuki Shiga and Abdessalem Rabhi, in 2011. (Environmental and Sanitary Engineering Research)
5 other writings (review paper, book, etc.): 1) “Environmental Issues and Sustainable Development in India” by Yasuhiro Sakai, Haruko Ishikawa, and Yuki Shiga in 2009 (Environmental Management), 2) “Cooperation with Asian Countries (Summary)” by Kotaro Inoue and Sawako Takeuchi (“Section Meeting of Energy, Science and Technology”, 2011, Science Council of Japan), 3) “Climate Change Remedies and Environmental Business in India” by Yuki Shiga in 2011 (Business i. ENECO December 2011), 4) “Chapter 6 : Achieving Environmentally Sound Development in Asia through the Transfer of Low Carbon Technology” by Rabhi, A. and Shiga, Y. in 2012 (IGES White Paper IV 2012), 5) “Technology Transfer as a Measure to Tackle Global Warming in Asia” by Shiga, Y. and Rabhi, A in 2012. (Policy Brief No19, IGES)

- The Project contributes to the following three medium-term policy objectives for India set in Japanese FY 2007.
 - Promotion of economic growth along with strengthening bilateral economic interactions
 - Poverty reduction and social sector development
 - Cooperation in the field of environment, climate change and energy
 - As part of the actions taken to fulfill the above-mentioned policy objectives, JICA supports the MSME Energy Saving Projects for two phases by providing financial assistance to MSMEs through Small Industries Development Bank of India (SIDBI), and through refinance scheme of SIDBI to Primary Lending Institutions and Non-banking Financial Companies, also providing technical assistance to those financial institutions, thereby contributing to environmental improvement, sustainable economic development.
 - The Project not only covers the field of environment, climate change and energy, but also contributes to strengthening bilateral economic interactions through introducing Japanese LCTs to India. It focused on Business to Business Technology Application, introducing Japanese LCT with capacity building targeting especially the SMEs. Further, by improving energy efficiency, the Project will be able to pave the way to identification of other co-benefits effects such as improving work place environment. Therefore, its relevance to Japanese ODA policy toward India is very high.
- 3) Relevance to the Key Points of India-Japan Energy Dialogue
- The 7th Meeting of India-Japan Energy Dialogue between the Planning Commission of India and METI of Japan also evidences the relevance of the Project. The Joint Statement of this meeting states that “both sides decided to share information in the sectors where consumption of energy has been growing in recent years, such as steel, cement, machine tools, inverter air conditioners and transport, including in relation to SME”. Accordingly, the specific fields of LCT and the sectors for application targeted in the Project all fit into the key points of the Dialogue.
- (2) Effectiveness: High, with significant improvement since the start of pilot projects
- Output 1 has been fully achieved, though there was a more than one year delay in the implementation process of Activities under Output 1 due to various reasons.
 - The two Activities under Output 2 have been partially and mostly accomplished in spite of the fact that the installation and start of operation in the GHP and EHP pilot plants were far behind schedule at the time of Mid-term Review. Accordingly, the indicators set to verify the achievements of Output 2 have almost been realized as of the end of September 2013.
 - The two activities under Output 3 have respectively been fully and partially achieved, while Indicator 3.1 which requires the formulation of recommendations of measures to facilitate LCT transfer is partially achieved, as the tentative results have been achieved and need only to be further elaborated on based on the results of pilot projects. Therefore, Output 3 is partially achieved and expected to be fully achieved by the end of the Project.
 - As a result of achievements in the above-mentioned Outputs and Activities, the Project Purpose

has been partially achieved by September 2013 and is expected to be fully realized by the end of March 2014.

(3) Efficiency: Significantly improved and satisfactory

- The efficiency of the Project has improved towards the end of the Project and is satisfactory considering the challenges of matching Japanese LCT and Indian SME's demand. However, the process of identifying suitable LCTs and pilot SMEs relevant to Output 1 took more time than initially envisaged and delayed more than one year from the original plan, which has affected the subsequent implementation of Output 2 and 3.
- Despite the delay occurring at the early stage of the Project as well as its unfavorable influence on the subsequent stages, efficiency has been largely improved owing to the joint efforts of all concerned parties of the Project, the effective functioning of the cooperative research framework and the project implementation and monitoring system, the efforts made by the two sides to promote information sharing, and especially the strong commitment of C/P to the Project.

(4) Impact: Expected to be high subject to the achievement of the project purpose

- The outreach and dissemination activities have led to greater awareness of clean technologies available in Japan among business associations and SMEs in India. The presentations made in seminars and especially the annual Energy Forums about the project in India, workshops conducted at cluster level and visit by Japanese experts have resulted in this change. The information of the project has been covered by the Indian newspapers and media which has attracted the interest of other business associations. In addition, the project highlight has been placed in the internet, and has been made widely known to SMEs through the online platform SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing). The results of the GHP pilots were also published as a case study in SAMEEEKSHA newsletter which is shared with the stakeholders at a large scale. The dissemination activities will be scaled-up once the results from the pilot projects are available.
- However, as the soaring price of natural gas is posing a threat to the adoption of GHP technology in India, the trend of gas price is an uncontrollable external factor worthy of close monitoring.

(5) Sustainability: Potentially high

1) Organizational Aspect

- After the implementation of pilot projects, concerned SMEs as well as local engineers continuously learn and maintain the equipment for day to day operation. Discussion has started seriously how to approach to relevant policy makers and private sectors.
- The exit strategy needs to be developed by the end of the project in order to sustain and disseminate the LCT introduced widely. The research partners, IGES and TERI are expected to make efforts to secure resources for activities like awareness raising, capacity building and additional feasibility studies to identify potential for technology diffusion.

2) Financial Aspects

- The feasibility studies revealed the high initial cost of LCTs and availability of regular after-services as key issues. These aspects cannot be solved under the Project framework. However, the Project can emphasize the necessity of addressing the issues by efforts both from Japanese producers as well as Indian and Japanese policy makers.
- It is encouraging that some international assistance agencies like UNIDO and Climate Works Foundation (USA) have visited TERI to express their interest in the Project. Meanwhile, TERI has contacted government agencies other than those member agencies of JCC, such as Ministry of Micro, Small, Medium Enterprises (MoMSME) to inform them of the Project outcomes.

3) Technical Aspects

- TERI engineers have gained the practical knowledge sufficiently through joining the field survey with Japanese experts, including the initial assessments of various technologies in terms of their applicability to the Indian conditions. Through real time implementation of LCTs under the existing SMEs, Indian engineers have many opportunities to develop and sustain their technical capacities.
- Training workshops and on-the-job training need to go further to teach them knowhow of trouble-shooting in addition to the preventive knowledge of “dos and don’ts” and daily maintenance. Activities related to best operation practices in CAs and IFs need to be taken forward appropriately for further dissemination given the large scope of energy savings and GHG reductions in this regard.
- The knowledge that TERI has acquired through this project can be utilized for the implementation and promotion of LCTs and practices through its regular energy audits and related projects in the industry sector.

3-3 Factors Contributing to the Progress of the Project

(1) Factors Related to Planning

- No contributing factors were found related to the planning of the project.

(2) Factors Related to the Implementation Process

- Close and collaborative relations between Japanese experts and Indian C/Ps have facilitated the catching-up process of the Project’s implementation since the time of Mid-term Review.
- As C/P on the Indian side, TERI is playing an indispensably important role in the Project with a commendably strong sense of ownership. The contribution made by TERI includes not only participating in the implementation of project activities under all the three Outputs, but also undertaking the responsibility of management and monitoring regarding the pilot projects, including the work of coordination between the Japanese side and SMEs on the Indian side.

3-4 Factors Affecting the Progress of the Project

(1) Factors Related to Planning

- Insufficient basic information collection prior to the commencement of the Project accounts for the necessity to familiarize Japanese experts to Indian SMEs through a preliminary field survey which could not produce concrete results at the initial stage, thus leading to the delay in the achievement of Output 1.

(2) Factors Related to the Implementation Process

- The project's implementation planning and schedule management did not seem to be well performed at the initial stage, which resulted in the failure to shorten the period of delay.

3-5 Conclusion

The project has demonstrated two advanced low carbon technologies (EHP and GHP) from Japan at SME units in India. Initial analyses show that the energy savings are in the range of 30-50%. The benefits of the technologies—in terms of energy savings (reduced energy costs) and reduced carbon emissions will be further confirmed after additional data collection. The soft technologies studied shall also offer many opportunities to reduce energy consumption in SMEs at relatively low costs. The Project has very high relevance with Indian and Japanese policies, addressing Indian SMEs' needs for enhancing energy and cost savings by introducing Japanese low carbon technologies.

On the other hand, implementation of the Project was much delayed especially during the first half due to various reasons. During the second half after the mid-term review, progress has been improved including the pilot project implementation and data collection. However, with only six months remaining up to the end of the project period, even more intensive activities would be required in order to fully achieve the project purpose. To this end, it is imperative not only to draw and disseminate lessons learned from the pilot project but also to develop capacities of the project stakeholders for ensuring project sustainability.

3-6 Recommendations

(1) Compilation of the Final Report

During the remaining project period, the findings and recommendations to introduce, replicate and disseminate advanced LCTs to SMEs in India shall be compiled and finalized in the final project report. It is important to clearly specify the implementation process which the project had taken, in order to draw lessons from joint research efforts under actual LCT applications. Regarding hard LCTs namely EHPs and GHPs, it is strongly recommended that the project continues to collect necessary data from project sites to conduct more precise data analysis which shall lead to development of MRV protocols. For soft LCTs such as induction furnace and air compressor system, it is recognized that the capacity building activities have been widely conducted, and SMEs are expected to adopt the proposed best operation practices. However quantitative evaluation needs to be performed to confirm the actual impacts of these activities. Compiling the outputs of this joint research shall lead to future scientific and

academic documentation and shall contribute to the achievement of the project purpose.

(2) Enhancing Activities for Future Replication and Dissemination of LCTs

In order to create awareness on the benefits of the LCTs, and their applicability in different industries, a series of workshops/ seminars at cluster and state levels and feasibility studies in different industrial applications are needed. IGES and TERI may plan to carry out dissemination exercise in the future with cooperation from other project partners including the private sector technology suppliers from Japan.

For future replication and dissemination of LCT's and best practices, technical aspects such as innovation and cost reduction potential shall be explored with financial aspects such as identification of payback periods and necessary incentives. Moreover, the possibility of utilizing other incentives schemes shall be investigated (e.g. credit lines provided by SIDBI). These recommendations shall be made together with identification of specific roles and responsibilities of related stakeholders.

(3) Ensuring Sustainability of Pilot Projects

The EHPs and GHPs installed at the SME's shall be utilized as a showcase, therefore, it would be important that this new technology is utilized at the pilot sites even after the completion of the project. In order to secure the sustainability of this technology, there shall be more emphasis on the capacity building for SMEs to conduct trouble-shooting by themselves. Other options, such as making maintenance contracts, including supervision activities and provision of spare parts, between SMEs and suppliers shall also be explored with necessary facilitation by TERI and IGES.

3-7 Lessons Learned

(1) Customization of LCTs

The LCTs that were customized in Japan require further fine tuning after their installation and implementation in the pilot sites in India. Therefore the study of actual operation conditions at the initial stage of the project and follow up services after commissioning shall be required.

(2) Institutional Arrangements

TERI and industrial associations played an important role to identify potential SMEs and to facilitate the adaptation of LCTs. Therefore, a strong local partner with relevant networks is critical for the success of the project.

(3) Consensus Development

For smooth implementation and effective project management in Science and Technology Research Project, it is necessary to set consensus-based targets, clarify verifiable indicators and share them with stakeholders at the initial stage of the project.