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Co-innovation of low-carbon technologies for Small and Medium Enterprises

A framework for strengthening technology cooperation between Japan and India

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Co-innovation of low-carbon technologies for Small and Medium Enterprises: a framework for strengthening technology cooperation between Japan and India

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Abstract

Japanese companies have pioneered the development of a large number of low-carbon technologies (LCTs). As a rapidly expanding economy with burgeoning energy requirements, India offers a significant potential market for Japanese LCTs. The industry sector in India accounts for a significant share of commercial energy use and hence carbon dioxide (CO_2) emissions. India's small and medium enterprises (SMEs) form the backbone of the industrial sector and there is reasonable scope to reduce energy consumption and CO_2 emissions by introducing LCTs in SMEs. Since the conventional technology transfer model is often too static and unsustainable to meet the current technology needs of recipient countries, this paper proposes a collaborative approach to innovate, manufacture and scale-up LCTs available in Japan for the Indian market.

The paper draws lessons from two successful technology cooperation projects between India and Switzerland in SME sectors. These projects have involved the design, development and dissemination of LCT solutions. The experience gained from these projects could be useful for other bilateral technology collaborative projects.

Technology cooperation between Japan and India would lead to a substantial reduction in greenhouse gases (GHGs). Of course, the promising LCTs to be covered under the ambit of co-innovation needs to be identified. The paper discusses three LCTs that have the potential for widespread adoption in India and offers opportunities for co-innovation as examples. A framework is proposed for co-innovation encompassing the development, manufacture and dissemination of LCTs for the Indian market.

1 Introduction

India is the world's third-largest emitter of CO_2, despite its low per capita CO_2 emissions (IEA 2021). Like the rest of the world, the country is heavily dependent on fossil fuels to meet its energy requirements. Furthermore, the South Asian region is also particularly vulnerable to various climatic changes. India's nationally determined contribution (NDC) under the Paris Agreement includes a commitment to reduce the emissions intensity of GDP by 33%-35% below 2005 levels by 2030. The industry sector is the largest consumer of commercial energy and accounts for about 45% of India's

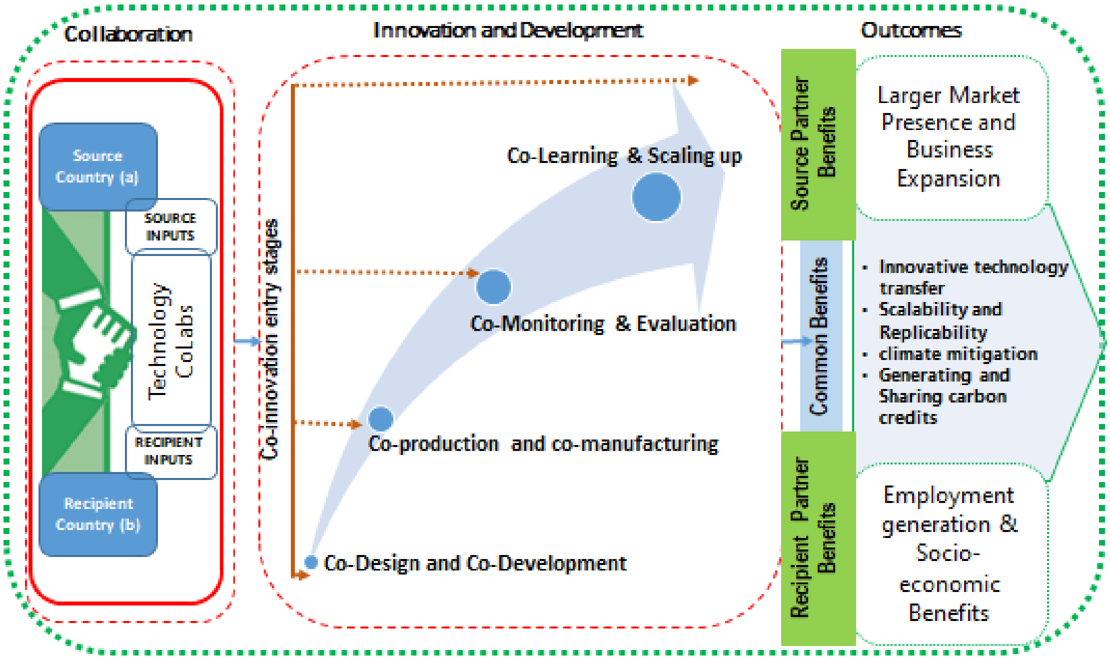
total energy used. Improving the energy efficiency of industries is therefore important for mitigating GHG emissions and tackling climate change.
The small and medium enterprise (SME) sector constitutes more than 90% of all industrial enterprises in India. The sector plays an important role in the Indian economy, contributing around 45% of the manufacturing output. Energy efficiency is particularly important for the sector, where a large number of units continue to depend on obsolete, low-efficiency technologies resulting in wasteful energy consumption and reduced profitability. The SME sector is a significant source of carbon emissions. There are several energy-intensive SME sub-sectors such as secondary iron & steel and aluminium processing, glass, refractory, clay bricks, textiles, and food processing. In addition, a large number of energy-intensive products like air compressors, electric motors, submersible pumps, and industrial furnaces are manufactured in small-scale industries. These industries have remained largely underserviced for several decades from a technology perspective. Most SMEs use energy inefficient manufacturing processes. Additionally, the inefficient products manufactured by them result in high overall life cycle energy consumption. Thus, the promotion of cost-effective LCT solutions for the sector is a high priority to achieve climate mitigation and sustainable development goals (SDGs).

Closing the greenhouse gas (GHGs) mitigation gap demands greater technology collaboration among developed and developing countries. However, levels of technology transfer are currently woefully insufficient to narrow these gaps. While the literature on technology transfer blames limited cooperation on various barriers ranging from high initial costs to poor fits with local contexts (Ockwell, 2008; Worrell, 2001), one of the more fundamental challenges is the lack of active involvement by the recipient country in conceptualising, manufacturing and scaling of technologies. This challenge suggests that the conventional technology transfer model is often too static and unsustainable to meet current technology needs. For a more dynamic and viable model, the technology donor (source) and recipient (host) countries should work to collaborate, from the technology conceptualisation to production and finally to scaling-up.

India, as a rapidly growing economy with growing energy requirements, offers a huge potential market for globally renowned Japanese LCTs, looking in particular at Indian industries that are striving to find ways to reduce energy costs. However, this Indian market remains largely untapped for Japanese LCTs. Stakeholders in both Japan and India often lack the required information, knowledge and expertise to bring down costs and ensure sustainable transfer and large-scale diffusion of LCTs. Co-innovation can help bridge this gap and offers a collaborative and iterative approach for joint innovation, manufacturing and scale-up of technologies by source and host countries for accelerating progress on sustainability (Figure 1).

Co-innovation can help overcome several of the barriers to the traditional technology transfer approach, which is akin to the sale of a product or technology. First, co-innovation has the potential to address cost concerns, thereby facilitating smooth and efficient sharing of technical know-how across borders. Second, a co-innovation approach can give impetus to sustainability, through collaboration in the development and implementation technology. This approach will make sure that the technology transfer can be replicated and has a trickle-down effect in the economy rather than being a one-off event. Finally, co-innovation facilitates replicability and scalability of the introduced technology since the product can reach a wider set of beneficiaries and results in larger impacts in addressing climate change.

Figure 1: The co-innovation approach to strengthening technology cooperation



Source: Authors

Between 1995 and 2000, TERI with support from the Swiss Agency for Development and Cooperation (SDC), worked on the development and demonstration of cleaner technologies for two small-scale Indian industries – foundry and glass. Climate change necessitates further rapid collaboration across several sectors. In this paper, we focus our attention on three major energy-intensive SME sectors, namely textile weaving, aluminium smelting and agricultural pump-set as these illustrate the opportunities and challenges to promoting co-innovation. Through empirical evidence emerging from technological collaboration as part of the TERI-SDC project, we propose a framework to accelerate co-innovation between India and Japan which illustrates the need to focus on how LCTs are selected, designed, produced and deployed for greater replicability and accelerated environmental benefits.

2 Technology cooperation projects undertaken by India and Switzerland

The SDC recognised the need and potential for bringing about technological innovation in the Indian SME sector. In the absence of locally available efficient technologies in India, SDC realised that a technology cooperation programme was needed to develop and demonstrate new efficient technologies for this sector. With support from SDC, TERI successfully undertook co-innovation projects to demonstrate and replicate energy-efficient furnaces among small-scale foundry and glass industries in India.

In selecting a technology for demonstration, existing technologies had to be evaluated. The answer is not as simple as finding and importing the best technology available in the world. Thereafter, from among the available options, the most appropriate one, i.e., the one most suited to adaptation to meet local needs and conditions, had to be selected and developed for demonstration and eventual dissemination. The new technology should work on fuels and raw materials that are locally available. As far as possible, it should resemble the technology already being used in the area; for this would help make it acceptable to and easily adaptable by local people; it must be easy for them to use (perhaps with training); and it must suit local conditions.
To ensure the participatory development of the technologies, the project teams worked closely with key stakeholders (owners, operators industry associations, local government institutions, NGOs). The success of any intervention is measured by its sustainability. Capacity building therefore formed a vital component of the project's interventions.

The interventions led to the successful development and demonstration of new efficient furnaces for these two sectors. Local capacities to construct, install, commission and maintain the technology had to be developed in line with SDC's 'model' of innovation diffusion (Pal, 2006). To make sure that the workers understood and implemented best operating practices in daily operation of the plant, the project team engaged with workers over the course of many weeks (Pal, 2006). These improved smelting technologies led to a significant increase in energy efficiency and brought about reductions in greenhouse gas emissions (COSMILE, 2008).

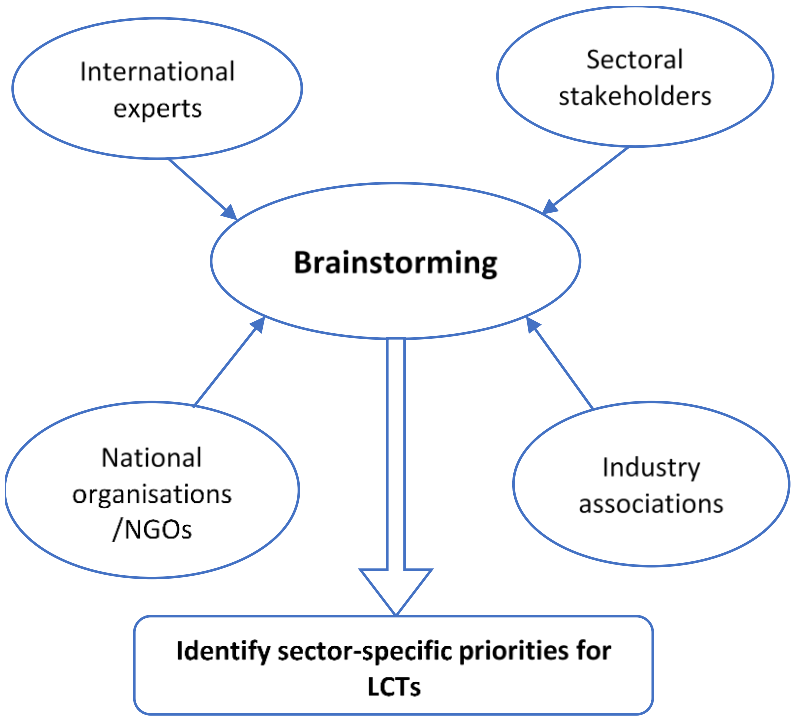
3 Key elements of co-innovation

The experiences of TERI during the technology cooperation interventions with SDC show that some of the key elements for successful a co-innovation programme are as follows:

- It is crucial to provide support to build low-carbon innovation capabilities in developing countries, thereby achieving several of the SDGs. The SME sector in developing countries offers tremendous potential to reduce CO_2 emissions at lower costs. Thus, LCT co-innovation in SMEs is an important component of a wider process of promoting innovation in developing countries.
- SME stakeholders (industry, technology and service providers, support institutions) lack the inherent technological capacity and financial muscle to undertake research and development (R&D) activities. It is necessary to identify such SME sub-sectors/clusters in developing countries (preferably enterprises with similar technological bases and operating practices) and then develop tailor-made co-innovation programmes that focus on these groups of enterprises.
- It is important to develop R&D and demonstration (RD&D) programmes specifically aimed at addressing the specific needs of SMEs.

- In the context of climate change, RD&D programmes need to be developed with support from multilateral/bilateral organisations.
- Technologies, which are selected for co-innovation, should be identified after a needs assessment for the sector.
- Technologies selected for co-innovation do not necessarily have to be 'state-of-the-art technologies existing in the developed country.
- For co-innovation to succeed and be sustainable in the long term, systematic action research is required under a participatory approach (Figure 2).
- A nodal research/academic institution in the recipient country is required to anchor the action research programme.
- A tailored approach to low-carbon innovation is required for each developing country due to differences in local circumstances.
- Sufficient attention needs to be given to the 'soft' human and institutional development component for ensuring that that the benefits of the technologies are replicated on a sustainable basis.

Figure 2: Collaborative approach for identifying technology



Source: Authors

4 Imperatives in selecting technologies and local partners for co-innovation

As is well known, new technologies are primarily developed in industrialised nations but most potential users of these technologies are in developing countries. Therefore, the first step in co-innovation is to identify mature technologies that are available in developed nations, but which are likely to have a huge market in developing nations like India.

When selecting a technology for co-innovation, evaluation should be carried out to check if the technology can adapt to local needs. The co-innovation process must be participatory. That is, it should involve local firms and be built on local skills and knowledge. Simultaneously, the local firms must be provided (through training and other capacity-building programmes) with the information and skills required to service and maintain the technology over the long term.

5 Opportunities for co-innovation between India and Japan

There are immense opportunities to undertake co-innovation with LCTs used/produced by the SME sector in India. Certain criteria can be applied to shortlist technologies for co-innovation. Some of them could include technology needs assessment, potential for replication, energy savings and other benefits; techno-economic viability; potential technology partners in Japan, and their ability and willingness to cooperate.

Based on work experience by the author through working on identification of new and efficient technological options for SMEs, the following three LCTs offer good opportunities for co-innovation between India and Japan:

i. Automatic looms (textile sector)
ii. Efficient smelting furnaces (secondary aluminium sector)
iii. Energy efficient agricultural pump-sets (pump manufacturing sector)

5.1 Automatic looms (textile sector)

Globally, India is the second largest producer of textiles. About 95% of the 2.8 million looms installed in India are semi-automatic conventional shuttle looms. Adoption of automatic looms in place of the conventional shuttle looms will increase productivity as well as increasing the efficiency and quality of the fabric produced. At present, there are no manufacturers of automatic looms in India. Japan has some of the leading manufacturers of automatic looms like Tsudakoma and Toyota. However, the penetration of Japanese looms in Indian market remains low mainly due to high costs. Looking at the market potential in India, this technology is an ideal candidate for co-innovation.

5.2 Efficient smelting furnaces (secondary aluminium sector)

Aluminium is the second most used metal after steel. Secondary aluminium processing which includes conversion of ingots and scrap to casted and extruded products is concentrated among SME sector.

The energy consumption and consequently GHG emissions from the secondary aluminium sector are quite high. Most units use conventional inefficient oil-fired smelting furnaces. Some of the leading manufacturers of smelting furnaces in Japan are Nihon Kohnetsu and Sanken Sangyo. At present few SME aluminium units can afford to buy smelting furnaces available in industrialised countries like Japan. Joint development of an energy-efficient smelting furnace for the aluminium industry with Japanese experts will significantly reduce energy consumption and GHG emissions.

5.3 Energy-efficient agricultural pump-sets

Agricultural pumps are a major consumer of electricity. More than 20 million agricultural pumps are in operation in India and about 2 million pumps are added annually. Most agricultural pumps manufactured in India have low efficiency and poor reliability. It would be a good opportunity to improve the efficiency of the locally-made agricultural pumps by up to 40% through co-innovation between Indian and Japanese agricultural pump manufacturers like Xylem and Tsurumi. Large-scale adoption of energy-efficient pumps would lead to huge electricity savings with consequent reduction of GHG emissions.

6 Main barriers to co-innovation

Some of the major barriers to realising co-innovation can be categorised into the following groups:

Information gap: Stakeholders in both Japan and India often lack the required information, knowledge and expertise to bring down the cost of LCTs.

Financial barrier: Lack of capital and high costs are some of the financial barriers to the adoption of LCTs.

Lack of in-country capacity: The benefit of technology transfer can only be realised with the presence of necessary institutional capacity for the indigenisation of technology. Co-innovation could be facilitated if accompanied by adequate training of local staff.

Policy inadequacies: There is a need to develop appropriate policy measures (e.g. tax incentives, technical infrastructure, training) to encourage co-innovation in the recipient country.

Appropriateness of the new technology: Technologies are generally developed to cater to local requirements, such as quality of fuel, ambient conditions, degree of automation, etc.

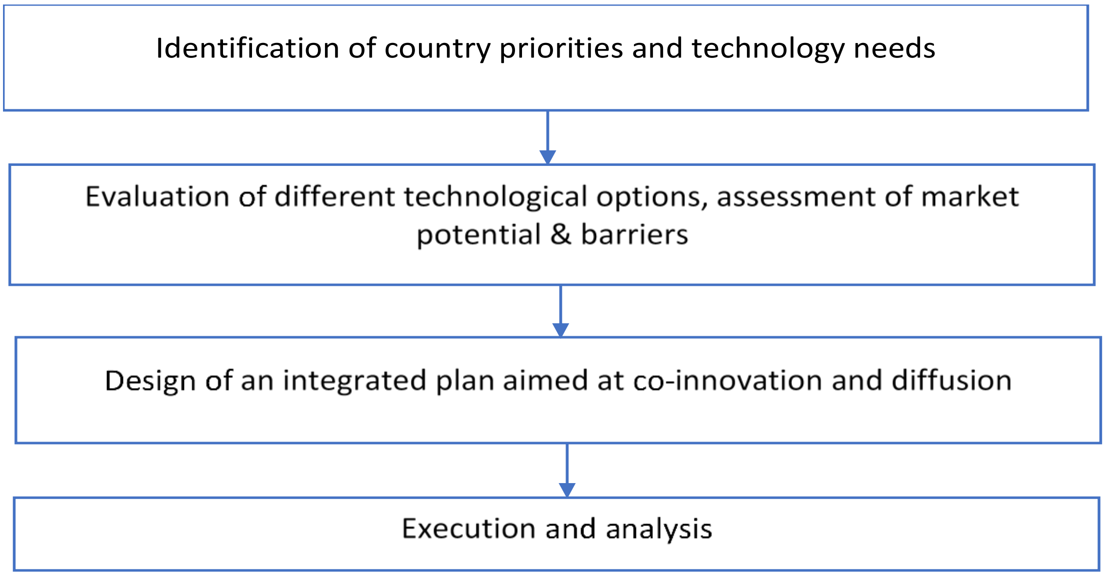
Intellectual Property Rights (IPR): Weak IPR regimes in developing countries may discourage Japanese firms from investing in these countries. It is necessary to reinforce IPR regimes to encourage transfer of new technologies from the public and private sectors.

Lack of initiatives to transfer public technologies: To promote research collaboration between countries, bilateral agreements between governments, tax incentives, tariff reductions and joint technology development programmes (under the UN charter) can be applied. These measures will also promote co-innovation.

7 Proposed stages of co-innovation framework

Any framework to accelerate co-innovation and transfer of LCTs needs to tackle these issues for sustainable technology transfer.

Figure 3: Stages in the development of a co-innovation framework



Source: Authors

The stages in development of a co-innovation framework are provided in Figure 3.

7.1 Identification of country priorities and technology needs

There is a need to understand the current status of technology and examine the requirements of various sectors to ensure that an appropriate match is made between available technologies and country-specific conditions. For widespread adoption, technological innovations should consider socio-economic parameters.

7.2 Assessment of various technological options

The technical and market feasibility of all technological options must also be carried out. Options with significant market potential are most conducive for co-innovation and diffusion. Market research and sector-specific studies can help identify and gather information on barriers such as financial issues or a lack of training and skills, and then collate the views of user groups.

7.3 Development of an integrated plan for co-innovation and diffusion

Detailed planning and implementation will be needed for technology transfer, and successful co-innovation and diffusion. This process should be flexible and long-term, involving international and local experts. A ‘one-size-fits-all approach may not be ideal for co-innovation. For prompt project implementation and improved coordination among different stakeholders, an independent body could be the nodal organisation at the country level. The main functions the nodal organisation would be:

- Undertake diagnostics studies to understand the baseline technology to assess energy consumption, productivity, operating practices and so on.
- Identify the right technology and provider.
- Develop and demonstrate the improved technology.
- Perform post demonstration M&V studies and documentation of results.

- Technology dissemination in various clusters/regions by conducting awareness workshops.
- Seed the markets, i.e. provide support to make the new technology available through local manufacturers.
- Establish policy dialogue with government agencies.
- Identification of new areas for co-innovation for the future.

8 Conclusion

Globally, Japanese companies are well-known for their LCT products. India, a rapidly expanding economy with growing energy requirements, offers a sizable and largely untapped market for Japanese LCT products. Co-innovation can enhance cooperation between Japanese and Indian firms and facilitate the successful transfer of LCTs between the two countries. There is an immense opportunity to adapt and deploy Japanese LCT products for the Indian SME sector, as well as good scope to scale up collaborative innovation (co-innovation) projects on the development of cleaner technologies for SMEs. Promoting co-innovation between India and Japan on clean technologies for SMEs would be a valuable instrument for addressing the challenge of climate change.

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