Accelerating Net-zero Goals in Asia

The Role of Joint Crediting Mechanism and Co-innovation

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Key Messages

- A radical technological transformation is needed in Asia to accelerate net zero transitions. Transferring advanced low carbon technologies can help strengthen the capacities of countries in the region to move towards net zero goals.

- While newer innovative technologies have greater emission reduction potential, policymakers should also consider the efficient use of existing technologies.

- Joint Crediting Mechanism has helped popularize low-carbon and innovative technologies in developing countries that can play a crucial role in net zero transitions.

- Co-innovation, or jointly developing and manufacturing advanced technology-based equipment and machinery, can increase the penetration of transformative technologies in developing country markets and deliver climate and environmental co-benefits

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Introduction

Technology plays an important role in reducing emissions and achieving other critical climate mitigation goals aimed at keeping global warming below 1.5 degrees. The increase in emissions from energy and industry by over 60% since the formation of UNFCCC in 1992 is a concerning signal that highlights the need for advanced technology to address growing emissions from all key sectors (IEA, 2021). A fundamental shift is necessary in the way energy is produced and consumed in the power, industry, transport, building, and residential sectors to reach net-zero goals (McLaren, et al., 2019). Decarbonization of the power sector is a crucial step towards these goals, and technologies such as low emission power generation and primary fuel consumption, carbon capture utilization and storage (CCUS), and the deployment of renewables and other cleaner technologies are important (Greig & Uden, 2021). The building sector must integrate more renewable energy and electrification, and commercial buildings must undergo a significant transition. Transportation must consider transitioning to electric vehicles and hydrogen. Innovative technology integration will also be crucial in waste management to lower emissions.

Considering the disparities in technological development across Asia, technology transfer will remain critical to facilitating the integration and use of advanced technology. The definitions and core concepts used in discussing technology transfer have varied across different disciplines. This variation notwithstanding, the term "technology transfer" refers to the transfer of knowhow from the source partner (country or corporate entity or other stakeholders) to a recipient partner. This relatively simple and straightforward definition may nonetheless obscure what can be a complex process. In the past, multinational firms have tried to minimise losses in income, trade, and employment through judicious investment and licensing in foreign facilities (Baranson, 1976). In the net-zero context, technology transfer plays a critical role in achieving the emission reduction and meeting the climate mitigation goals of countries (Pigato, et al., 2020). However, the extent of penetration of transferred technologies and their respective mitigation potential will depend on the scale of transfer among the source and recipient countries. The purpose of this paper is to explore various pathways and mechanisms for promoting technology collaboration among Asian countries to accelerate to net-zero, including co-innovation and the Joint Crediting Mechanism (JCM). The paper also discusses the potential role of these collaborations in contributing to net-zero emissions and provides a discussion of the broader implications for technology collaboration in the Asian region.

The remainder of this paper ~~chapter~~ discusses the pathways of technology transfer and the role of technology collaboration across Asia that can help accelerate transitions towards net-zero goals. The discussion will then specifically focus on two mechanisms of technology collaboration – JCM and Co-innovation. While the former is

an existing mechanism of technology collaboration that facilitates transfer of technologies from Japan to other developing countries, the latter proposes a non-conventional approach to technology collaboration.

Technology Transfer among Asian Countries

Though western economies have been the major source for advanced technologies in various sectors in Asia, today the majority of the transfer of technology and knowhow happens through intraregional trade and collaboration within Asia. With regard to the role of technology and innovation to the region's GDP as well the contribution of Asian countries has been significant. It is estimated that over the past decade, about half of Asia's GDP was due to the total factor productivity--a measure of the contribution of technology and innovation to the economy (Tonby, et al., 2020). The past years have witnessed greater collaboration among Asian economies as well in promoting technology in all key sectors. In terms of this collaboration, advanced technology flows through the trade of equipment and machinery mostly from China (Nikkei Asia, 2021; Tonby, et al., 2020). In many instances these are trade of advanced technology-based equipment than termed as technology transfer. Nevertheless, the use of advanced technology-based machinery is leading to better and efficient use of energy at a relatively cheaper cost.

This section highlights the role of four major economies in technology transfer (dissemination of technology through sale or other means) within Asia, that include China, India, Japan and Republic of Korea. While the sections below explore the collaboration of Asian as well as leading global players in promoting advanced technologies within Asia, a precise accounting of the technologies that contribute to net-zero targets is not yet available.

Box 1: Clean Technology Promotion in the region

China's role in popularising clean technology: With active support from the government, domestic industries in China have been witnessing remarkable growth in innovation and manufacturing growth over the past few decades. This has also led to significant level of domestic industry growth across all sectors. The competitive advantage (Porter, 1990) China possesses in the use and sale of equipment and machinery based on advanced technology is much higher than other leading economies in the region. Though the Chinese approach towards technology collaboration has been mostly market driven, its efforts through Belt and Road Initiative and South-South Climate Cooperation Fund has been significant. Nevertheless, there has also been concerns about China's technology collaboration as the country has been exporting coal plants (Kong & P.Gallagher, 2021). Specifically, with regard to the renewable energy sector, China remains the largest producer and exporter of solar modules and other equipment worldwide. Even for the Asian market, China remains the largest source of these equipment and machinery (Groba & Cao, 2015; Mallapaty, 2020).

India's technology collaboration: Though India has been one of the major recipients of transferred technology from other countries, it also has existing technology collaboration with the Southeast as well as South Asian neighbours. The ASEAN-India Green Fund, which aims at promoting greater collaboration between India and countries in ASEAN, has been one of the active platforms for India to share advanced technology-based machineries to Southeast Asia. The green fund has received an initial funding of $5 million (MEA, 2018) from India when it was formed in 2007. The country also has been one of the leading partners for the South Asian economies, for which the South Asian Association of Regional Cooperation remains an important platform. Collaboration on clean energy development has been one of the major areas through which India has been supporting countries in the region (MEA, 2011). However, in recent years, India has generated far less revenue through technology sales than China. While the average revenue of Indian technology incumbents was $107 billion for 2016 through 2018, for the same for the Chinese companies were estimated at $1,860 billion (Tonby, et al., 2020) from the global market. This indicates a relatively smaller scale of India's technology market access within Asia and beyond.

Japan's leadership in technology transfer in Asia: Traditionally Japan has played a key role in promoting clean energy technologies in Asian (MLIT, 2021; Asselt, et al., 2009). The Kyoto Initiative of Official Development Assistance (ODA),

The Green Aid Plan (GAP) and the Climate Technology Initiative (CTI) are examples of Japan's long running efforts to facilitate technology transfer. Specifically, with regard to energy and environmental technologies, renewable energy technologies, energy saving and energy storage, utilisation of unused resources etc have been gaining more attention in the technology transfer programmes. Noticeably, China has been one of the major recipients of Japanese technology (Lacour & Figuière, 2014), of which one third constitute clean technology transfer. Other Asian countries have benefitted from Japan's technology transfer in the past (Hayashi & Ursacki, 2021). Under several programmes promoted by the Japanese government, technology transfer to Asia has been given greater impetus in recent years. Most of these initiatives have has been towards efficiency improvement and energy conservation (JITMAP-IGES, 2015).

The Republic of Korea and technology transfer: Like China and Japan, Korea has also set a target for achieving net-zero emissions by mid-century and to steer its energy sector based on fossil fuels to one based on clean energy. The Korean government also promotes active information sharing and technology transfer within the industry, particularly between large multinational companies and small and medium-sized enterprises (SMEs), to maximize the benefits of energy efficiency and facilitate its widespread adoption (IEA, 2020c). Several governments supported as well as corporate entity driven initiatives have been driving Korea's technology transfer to Asian economies (Nicolas, 2021). One such initiative is Korea's partnership with the Association of Southeast Asian Nations (ASEAN) since 2013, which is aimed at sharing of knowhow in the transportation, energy and information and communication technologies (ICT) (Nicolas, 2021).

Pathways of Technology Collaboration

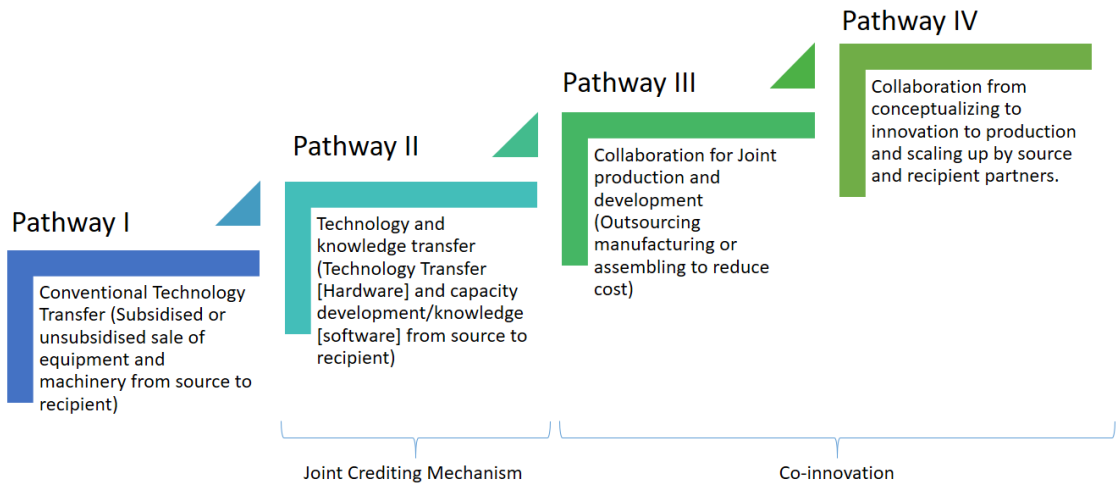
Fundamentally, technology transfer is categorised as vertical and horizontal. This happens within the entity or within the source country institutions to enable the transfer of knowledge to research and development and then to production. On the other hand, horizontal technology transfer refers to a he transfers of a developed technology from one entity to another. Among countries, horizontal technology transfer operates through multiple pathways (Gilsing, et al., 2011; Gorman, 2002). The level of political engagement among the countries, business ties between corporate players, the importance of the market in target geographies, opportunities for improving and scaling up technologies, and keeping pace with consumer demand in the market etc. have been factors that play determinant role in technology transfer (McMaster, et al., 1998). Interestingly, the term technology transfer is an overstatement in the conventional interactions between countries. While the real 'transfer' of technology happens only on limited occasions and mostly involve outdated technologies, the term technology transfer is often used for subsidised sale or purchase of advanced equipment and machinery by consumer/recipient countries.

Two elements are important in planning the advanced technology integration in all key emitting sectors in Asia. First, technology collaboration in Asia will not only need the hardware (equipment and machinery) but also the software (adequate capacity and knowledge transfer). The mere sale of equipment and machinery to developing countries in a piecemeal manner is not likely to contribute to substantial emission reductions. Japan's Joint Crediting Mechanism (JCM), which facilitates technology transfer between countries and enables sharing of carbon credits (discussed below), promotes sharing of both hardware as well as software. Second, the technology transfer also needs to consider the appropriateness of technology (Trace, 2016) as well as the host country conditions. These two considerations are critical in accelerating the adoption and use of the technology transferred.

Four different pathways are discussed here. In the first pathway of technology collaboration, what is commonly seen is the sale of equipment and machineries from the source (country) to the recipient (country). Source countries often use economic and diplomatic tools to promote the sale of advanced machinery and equipment to recipient countries. However, the most notable limitations of this type of engagement are the adaptability and affordability of the imported technologies. These factors significantly limit the scalability and replicability of technologies.

The second pathway demonstrates a more active engagement between source and recipient countries. Considering the fact that recipient countries are not only in need of hardware - equipment and machinery- but also the software - the knowhow to manage, operate and maintain the hardware, technology collaboration, the second pathway offers more fertile ground for technology collaboration in comparison to the first pathway. The capacity building and development facilitate efficient use and smooth operation of the equipment and machinery.

Figure 1: Technology Transfer: Four Pathways



Source: Authors

The third pathway involves collaboration that reflects the deeper engagement between the source and the recipient in jointly manufacturing or outsourcing the manufacturing or production facilities to capture the local knowledge and expertise that are needed in fine-tuning the technology and its applications. This also facilitates a more active market presence of the source country production facilities within the host country and thereby creates an ecosystem that involves, use of raw material from host country, labour, and knowledge sharing to facilitate auxiliary or support industries. Several instances of such collaborations happen across the world.

The fourth pathway refers to an active collaboration between source and recipient countries or entities that provides a platform to jointly conceptualise, innovation as well as contribute to production, manufacturing and scaling up. Such collaboration between source n and recipient countries have several advantages including, optimum use of locally available, opportunities for understanding the market conditions and consumer demand in the host country, development of locally adaptive technologies etc. Some of the major criticisms of technology transfer include adaptability, acceptability and affordability of manufacturing products. The discussed fourth pathway can efficiently address these concerns and make use of the locally available resources and labour. Against the backdrop of the climate mitigation initiatives, the technology collaboration among countries will gain greater relevance. As developing countries seek to industrialise its economy, more and more attention is being paid to industrial manufacturing. Support from countries with advanced technologies is important in strengthening the manufacturing sector. While from a conventional prism this type of engagement does not appear to offer much benefits to source countries, the scalability of products and replicability to more markets will ensure sustained access for source countries.

The next section discusses two vehicles that can facilitate technology transfer – the Joint Crediting Mechanism (JCM) and co-innovation. It has been playing a key role in promoting advanced technologies in Asia, and operates mostly through the second pathway. On the other hand, co-innovation—jointly innovating, manufacturing and scaling up technologies—operates through the in the third and fourth pathway. The following section aims to examine to what extent these approaches to technology collaboration contribute to countries in Asia's efforts towards net-zero goals.

Promoting Technology Collaboration in Asia: Joint Crediting Mechanism

The JCM (Joint Crediting Mechanism) supports the spread of innovative low-carbon and zero-emission technologies, products, systems, services, and infrastructure; and contributing to sustainable development in developing nations. Launched by the government of Japan, its first bilateral agreement was signed with Mongolia in 2013 (JCM, 2023a). Currently, 25 partner countries[1] from Asia Pacific, Africa, and Latin America are involved in the JCM. The mechanism uses measurement, reporting, and verification (MRV) methodologies to quantitatively evaluate the reduction of GHG (greenhouse gas) emissions from projects. These reductions are used to meet the nationally determined contributions (NDC) of both Japan and partner countries. By 2030, the cumulative expected GHG emission reductions from current JCM-supported projects is expected to exceed 20 $MtCO_2$ (MOEJ, 2023a). As of February 2023, the Ministry of Environment of Japan (MOEJ) has financed 234 projects under the JCM (MOEJ, 2023b)

Private entities from both countries must form an international consortium to apply for JCM financial support for their projects. The JCM is governed by a joint committee, consisting of representatives from both Japan and partner countries, which has the authority to make decisions related to rules, guidelines, and project registration. This equal partnership and collaboration allow for the transfer of advanced technologies crucial for the partner countries' transition to a net-zero pathway.

The role of the JCM in contributing to net-zero

The JCM is a starting point to accelerating the net-zero transition in Asia by transferring advanced low carbon and zero emission technologies such as solar PV with battery storages in rural areas. The JCM is an innovative approach to technology transfer with capacity development to developing countries with financial support as it falls in the pathway II of technology transfer stages (Figure 1). This mechanism transfers green technologies that are in the context of sustainability, which enhance climate mitigation and support sustainable development of the countries in the region. In terms of technical assistance (soft side) of technology transfer collaboration (Figure 1), the JCM supports capacity building for the private sector in partner countries by conducting training on operation of the technology and equipment during project lifetime. This enhances technical skills and knowledge in local employees of the project participants from partner countries. The table below summarizes the projects financed through the JCM in Asian countries with its annual estimated GHG emission reductions (GEC, 2023a).

[1] JCM partner countries: Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Viet Nam, Lao PDR, Indonesia, Costa Rica, Palau, Cambodia, Mexico, Saudi Arabia, Chile, Myanmar, Thailand, Philippines, Senegal, Tunisia, Azerbaijan, Moldova, Georgia, Papua New Guinea, Uzbekistan, Sri Lanka

Table 1: Summary of the JCM financed projects in Asian countries			
Country name	Number of projects	Annual estimated GHG emission reduction	Type of project
Bangladesh	5	24,238 tCO_2eq	Renewable energy, Energy efficiency
Cambodia	6	4,293 tCO_2eq	Renewable energy, Energy efficiency, Waste management - biomass utilization
Indonesia	49	454,997 tCO_2eq	Renewable energy, Energy efficiency, Waste management - biomass utilization
Lao PDR	7	31,151 tCO_2eq	Renewable energy, Energy efficiency, REDD+
Myanmar	8	38,123 tCO_2eq	Renewable energy, Energy efficiency, Waste management - biomass utilization
Mongolia	9	75,680tCO_2eq	Renewable energy, Energy efficiency
Philippines	17	371,846 tCO_2eq	Renewable energy, Energy efficiency, Waste management - biomass utilization, F-gas recovery
Thailand	51	323,827tCO_2eq	Renewable energy, Energy efficiency, Waste management - biomass utilization, F-gas recovery
Viet Nam	45	324,565 tCO_2eq	Renewable energy, Energy efficiency, Waste management - biomass utilization, F-gas recovery
Source: Global Environment Centre Foundation (GEC), 2023a			

To facilitate smooth technology transfer, the financial assistance and support provided to developing countries is significant. The JCM subsidises a portion of the investment that is needed for transferring those low carbon technologies in partner countries. This scheme can support countries and the private sector to lower the initial cost of disseminating zero emission technologies for facilitating and accelerating the net-zero transition. Furthermore, the JCM contributes to 12 of the 17 SDGs in partner countries by generating positive impacts such as reducing air pollution, supporting sustainable industry, promoting safe working environments and increasing global cooperation to mobilize public-private finance (Murun & Tsukui, 2020b). The following are the main areas in which the JCM has a critical role to play in the net-zero pathway in Asia:

Financial support: Without financial support, it would be challenging to disseminate advanced zero emission technologies in developing countries. Hence, the JCM provides three financial programmes, which are supported by the MOEJ (MOEJ, 2021a):

- JCM model project financial scheme
- F-gas recovery and destructions financial scheme
- ADB Trust Fund Japan Fund for JCM[2]

Under the JCM model project financial scheme, if the technology is transferred for the first time to the country, 50% of initial investment is covered. However, if the low-carbon technology has already been disseminated in the country, the rate of financial support would decrease. This approach enables the investment to transfer the most advanced technologies into partner countries. It was announced that the financial budget of the public and private partnership in Japan would increase to around 1 trillion JPY by 2030 (cumulative), including JCM financial support (MOEJ, 2021b). This financial flows from the private sector would increase further technology transfer through the JCM in the region, which can accelerate a transition onto a net-zero pathway.

[2] ADB Trust Fund Japan Fund for JCM, https://www.adb.org/what-we-do/funds/japan-fund-for-joint-crediting-mechanism

Technology transfer: Through the JCM, various energy saving technologies in industries, renewable energy, waste management, biomass power generation, and REDD+ activities have been financed and implemented. As on 2023 February, a total of 76 projects were registered under the JCM in all partner countries (JCM, 2023b). To further enhance climate change mitigation, large scale renewable energy projects were selected for the financial support; for instance, in the Philippines, the solar PV power generation that has expected GHG emission reductions is around 40 thousand tCO_2eq/year has been financed (MOEJ, 2021c). In combating deforestation, a new REDD+ project has been developed in Lao PDR to increase awareness of forest conservation by introducing alternative livelihoods in local community. From 2021, the JCM excludes to support transferring power generation systems using fossil fuels in partner countries in an effort to support a net-zero transition. The strategy and policy of the JCM has shifted to further accelerating de-carbonization technology transfers in the region such as deploying wind power generation, green hydrogen in the transportation sector, geothermal power generation, and REDD+ activities (MOEJ, 2021b).

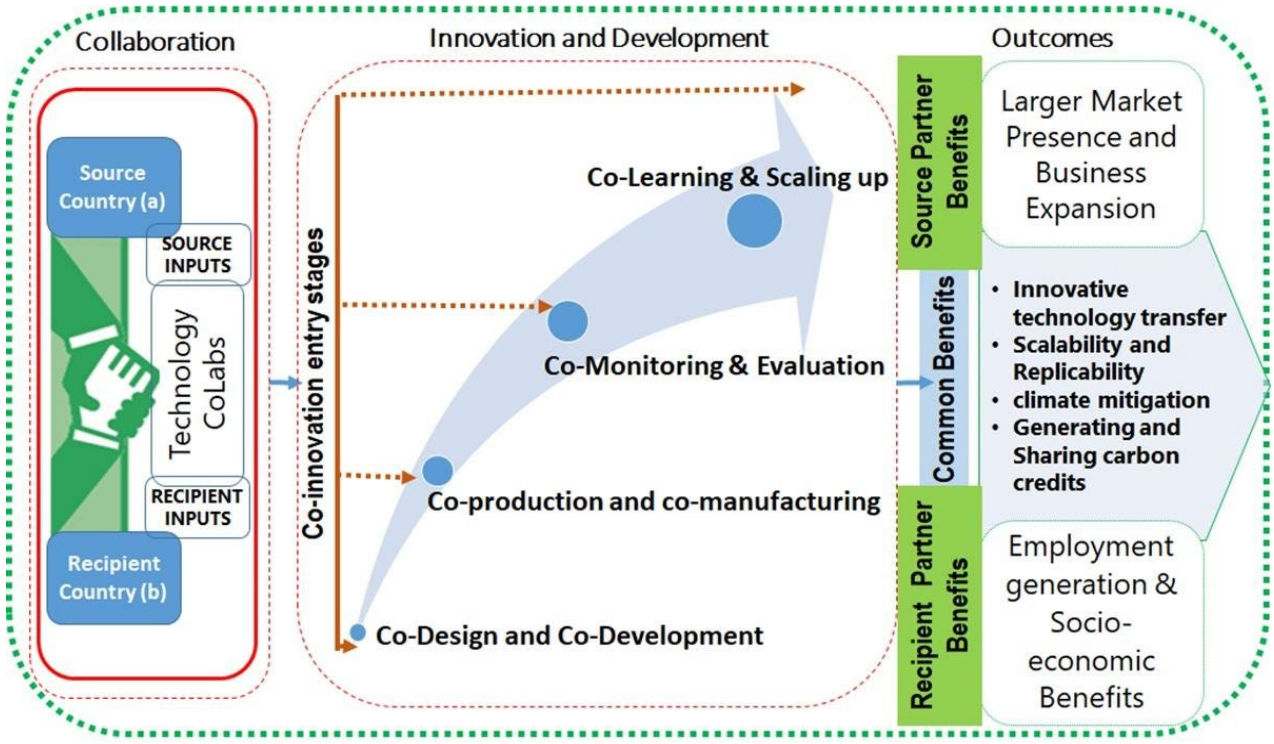
Capacity development: Developing countries also need to strengthen human resource and enhance their vocational skills to operate advanced technologies to successfully transition to a net-zero world. The area of building capacity and improving technical skills through the JCM has been implemented for all partner countries. For operation and maintenance of transferred technologies and equipment, the project partners in Japan often provide training and guidance regularly online and/or in person at the project site (Murun & Tsukui, 2020a). The support on the soft side of technology transfer, which is technical assistance, is implemented throughout the project lifetime. The length of project's operational lifetime is more than 10 years depending on the project type and technology.

Co-innovation: Collaboration beyond Conventional Technology Transfer

Co-innovation is "a collaborative and iterative approach by two or more partners for jointly innovating, manufacturing and scaling up technologies" (Janardhanan, et al., 2020; Saragih & Tan, 2018; Maniak & Midler, 2008). The experiences of technology transfer among countries in Asian reflect that collaboration has not made any substantial impact on reducing GHG emissions. The limited effects on GHGs is the result of many barriers. The barriers to technology adoption and implementation in a host country start with adapting the technology to the local context. Consumer adoption, the broader acceptability of the new technology, and the lack of capacity for operation and maintenance are major challenges. The perception and attitude of consumers towards the new technology, as well as their confidence in its reliability, can play a critical role in determining its usage and proliferation (Janardhanan, et al., 2021).

Co-innovation offers a way to overcome the previously described constraints. It not only recognises the importance of the recipient country's cheap labour but also aims to systematically integrate the technology into the local market through creating opportunities for opportunities and adaptation to relevant contexts.

Figure 2: Co-innovation Framework



Source: (Janardhanan, et al., 2021)

The flow chart titled "Co-innovation Framework" displays the steps involved in the co-innovation process, including the responsibilities of each partner and the benefits gained by each stakeholder. The framework is broken down into three phases: collaboration, co-innovation, and results. This helps to clarify the process and its various components. The first phase of the process focuses on the collaboration of both (or more than two) partners by identifying the needs and benefits of cooperation. The second phase for innovation and development highlights the levels of collaboration where the stakeholders can enter. Though the entry stages are identified as co-design and co-development (ideation, conceptualising, and fine tuning of the innovative idea), co-production and manufacturing, co-monitoring and evaluation, and co-learning and scaling up, there needs to be flexibility in deciding the actual entry stage of each of the stakeholders. Considering the fact that the real benefit of co-innovation is to pool in the intellectual, financial as well as human resources to develop a better product, there can be sufficient level of flexibility among partners about the entry stage of each stakeholders. In the third stages, namely the outcomes there are specific benefits of the stakeholders apart from common benefits to all. These include, sustainability, scalability and replicability which range from larger market access to stakeholders, employment generation, climate benefits and other socio-economic outcomes.

Table 1: Advantages of co-innovation to source and recipient partners

Area	Source Partners	Recipient Partners	Common benefits

Market opportunities (Replicability)	Access to wider market for technologies, Scaling up to new developing country markets	Scaling up jointly developed technologies in other countries	Expanding business, profit levels
Cost	Significantly lower production cost by utilizing local workforce and materials	Use local workforce, employment opportunities, market for local materials	Lowering cost of production
Scalability	Opportunities for scaling up within the host country	Knowledge of local markets and trends help in scaling up products more efficiently	Expanding business, profit levels
Sustainability	Sharing Carbon credits (possible adding up of JCM learning)	Sharing Carbon credits (possible adding up of JCM learning)	Contribute to emission reduction
Source: Authors			

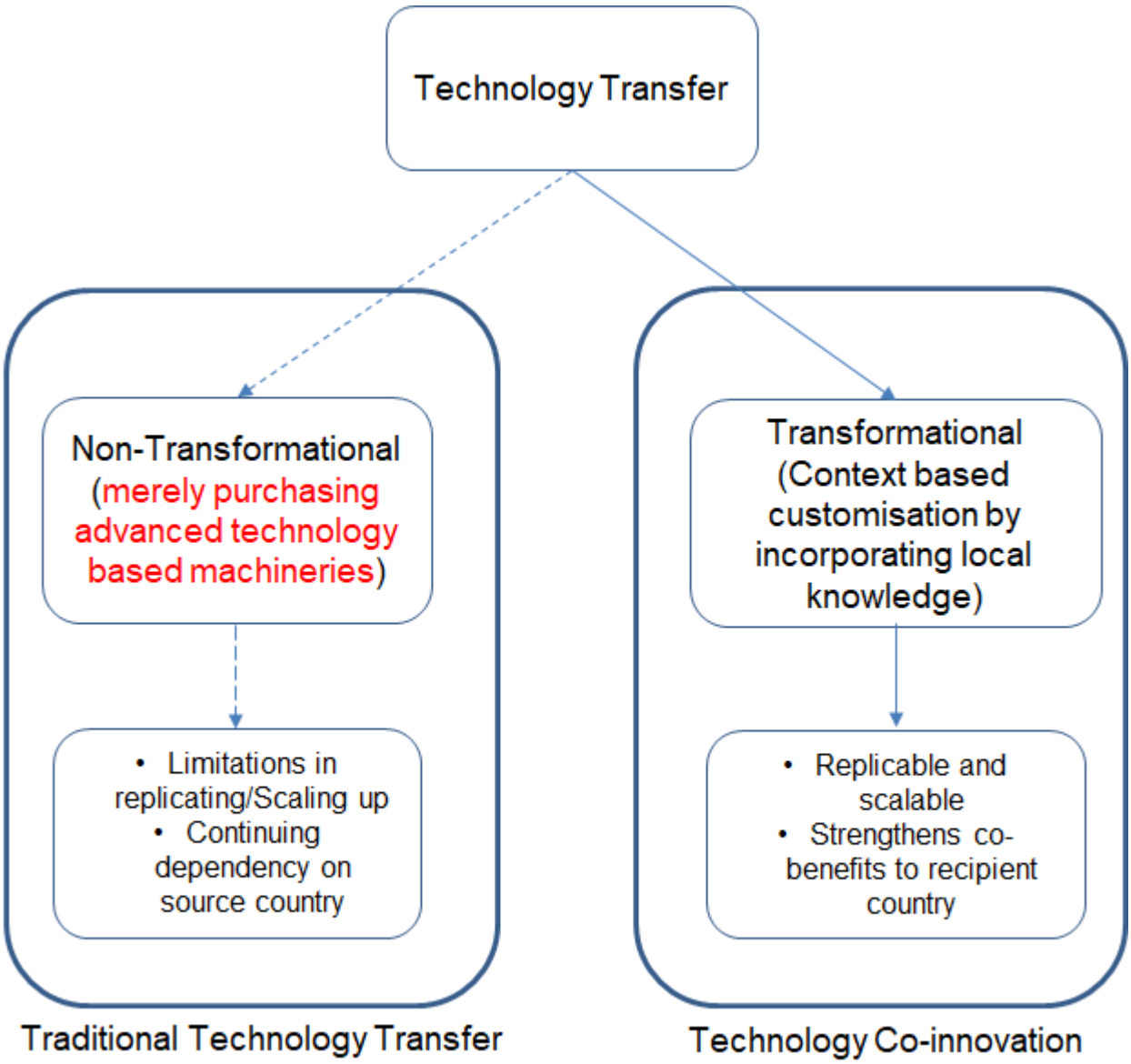
As discussed above co-innovation can operate in the technology transfer pathways III and IV which involve joint innovation and development, and joint manufacturing. While there are existing examples of co-innovation in the technology engagements of countries in Asia, there are neither institutional mechanisms nor specific guidelines or processes to implement co-innovation exiting in any country. Examples of co-innovation exist mostly on a case to case basis, depending on the business and market interest of stakeholders.

How can Co-innovation accelerate Technology Collaboration?

While traditional technology transfer is non-transformative as it does not help in scaling up or replicating the advanced technologies in recipient countries, technology co-innovation on the other hand is transformational as it helps in context-based customization by incorporating local knowledge for maximizing its impact.

Traditional technology transfer does not always consider the local context and specific needs of the recipient country. As a result, the technology may not be relevant or useful in the local context, leading to a lack of adoption and impact. Additionally, the recipient country may lack the infrastructure and resources necessary to scale up or replicate the technology effectively. This can result in a limited impact, as the technology may only be accessible to a small portion of the population.

In contrast, technology co-innovation approaches aim to address these limitations by involving the recipient country in the development process. This involves local knowledge and expertise being incorporated into the technology development process, leading to a technology that is customized to the local context. This approach not only increases the relevance of the technology, but also helps to ensure its successful implementation and impact. Furthermore, by involving local stakeholders in the development process, technology co-innovation helps to build local capacity and expertise, which is crucial for scaling up and replicating the technology in the future. This can lead to a virtuous cycle of technology transfer and co-innovation, where the recipient country is able to continuously improve its technological capabilities and make a greater impact.



Source: Authors

Implementing co-innovation will also be based on various factors such as governance and policy enablers, legal and intellectual property rights, goals and priorities of source and recipient countries and measurability of success.

Determining who owns the IP created through the co-innovation process can be a challenge. Defining the ownership of specific innovations and agreeing on IP ownership before the project begins will help in meaningful co-innovation. It may also be important for partners address the differences in perception of goals, priorities, and expectations for the collaboration, to avoid disagreements. While co-innovation helps in sharing opportunities and risks, partners will need to be open to address these elements jointly. Overall, trust and fostering transparency between partners is essential for successful co-innovation.

Discussion

Technology will play a key role in driving the net-zero goals of countries across Asia. This paper discussed various aspects of technology collaboration among Asian countries. Specifically, it explored technology transfer, pathways of technology collaboration, and the Joint Crediting Mechanism (JCM) as a means of promoting technology collaboration in Asia. The paper also delved into co-innovation as a means of collaboration beyond conventional technology transfer and how it could accelerate technology collaboration.

Unlike conventional pathway to technology transfer, JCM facilitates not only the hardware but also the software of technology transfer. On the other hand, co-innovation discussed in this paper presents a forward-looking approach that could significantly offer multiple co-benefits to both source and recipient countries. It highlights the opportunities for joint innovation, manufacturing and scaling up of technologies that have greater relevance in the sustainability context. However, as shown in Table 1, most of the JCM-financed projects were in renewable energy and energy efficiency areas due to its purpose of reducing GHG emissions from fossil fuels. This is one of the limitations of the JCM as it cannot expand projects in the agriculture and forestry sectors. In most South Asian countries, agriculture and forestry can be significant contributors to increasing GHG emissions, but at the same time, these sectors have enormous potential to reduce emissions to contribute to the net-zero transition. Another challenge to expanding the JCM projects is that it requires a Japanese company to establish an international consortium to apply for the JCM model project funded by the MOEJ. This can create difficulties for local companies in the partner countries to apply, and it can be challenging to find the right partner for both sides because the JCM projects are often being implemented for 10-15 years, requiring a strong commitment. Also, to establish the consortium and share responsibilities and risks during project development and implementation would require trust and long-term business cooperation. To facilitate the challenge of finding the right partner, business matchmaking events were organised, and an online platform was developed to initiate a discussion between private companies from both sides. (GEC, 2023b).

A significant share of transformational technologies that may have potential role in accelerating the transition of countries to net-zero pathway remains at rudimentary stage even today. CCUS, Hydrogen, Small Modular Reactors, and other such technologies that can drastically reduce emissions have limited market presence. This remains the key element that highlight the importance of transfer of technologies among countries in the Asian region. The transferability, as discussed in this section, also aims at examining the questions of what 'net-zero technologies' are ready to be transferred and whether such transfer can have a potential role in meeting net-zero emissions targets of host countries. It is important to synchronise technology transfers and integration with investment cycles, which may not be feasible in many developing economies without sufficient financial support. Therefore, one may witness transfer of technologies happening with less focus on heavy industries and mostly on energy efficiency improvement as well as renewable sector. The ease of availability through transfer/sale, adaptability of technology to host country conditions, economic feasibility etc. are driving forces that shape technology transfer. This paper highlights the importance of technology collaboration to accelerate countries towards net-zero pathway. In this regard, the points related to the transferability of technologies, approaches of technology collaboration, as well as specific mechanisms discussed above showcase important solutions.

References

Asselt, H. v., Kanie, N. & Iguchi, M., 2009. Japan's position in international climate policy: navigating between Kyoto and the APP. *International Environmental Agreements: Politics, Law and Economics,* 9(3), pp. 319-336.

Baranson, J., 1976. Technology Exports Can Hurt Us. *Foreign Policy,* 25(Winter), pp. 180-194.

GEC, 2023a. *JCM financed projesct in JCM partner countries.* [Online]
Available at: https://gec.jp/jcm/jp/wp-content/uploads/2023/02/20230210_list_jp.pdf
[Accessed February 2023].

GEC, 2023b. *JCM Global Match Making platform.* [Online]
Available at: https://jcm-gm.my.site.com/JCMGlobalMatch/s/?language=en_US
[Accessed February 2023].

Gilsing, V. et al., 2011. Differences in technology transfer between science-based and development-based industries: Transfer mechanisms and barriers. *Technovation,* 31(12), pp. 638-647.

Gorman, M. E., 2002. Types of Knowledge and Their Roles in Technology Transfer. *The Journal of Technology Transfer,* 27(3), pp. 219-231.

Greig, C. & Uden, S., 2021. The value of CCUS in transitions to net-zero emissions. *The Electricity Journal,* 34(7), p. 107004.

Groba, F. & Cao, J., 2015. Chinese Renewable Energy Technology Exports: The Role of Policy, Innovation and Markets. *Environmental and Resource Economics,* 60(2015), pp. 243-283.

Hayashi, T. & Ursacki, T., 2021. Technology Transfer in Asia in Transition: Case Studies of Japanese Companies . In: M. Nakamura, ed. *The Japanese Business and Economic System: History and Prospects for the 21st Century.* Singapore: Springer, pp. 115-138.

IEA, 2020c. *Korea 2020: Energy Policy Review,* Paris: International Energy Agency.

IEA, 2021. *Net-zero by 2050: A Roadmap for the Global Energy Sector,* Paris: IEA.

Janardhanan, N., Ikeda, E., Zusman, E. & Tamura, K., 2020. *Co-innovation for Low Carbon Technologies: The Case of Japan-India Collaboration,* Hayama: Institute for Global Environmental Strategies.

Janardhanan, N., Pham, N.-B., Hibino, K. & Akagi, J., 2021. Japan's low-carbon technology collaboration with Southeast Asia: Co-innovation and Co-benefits. In: H. Farzaneh, E. Zusman & Y. Chae, eds. *Aligning Climate Change and Sustainable Development Policies in Asia.* Singapore: Springer, pp. 10-25.

JCM, 2023a. *The Joint Crediting Mechanism.* [Online]
Available at: https://www.jcm.go.jp/about
[Accessed February 2023].

JCM, 2023b. *JCM registered project.* [Online]
Available at: https://www.jcm.go.jp/projects/registers
[Accessed February 2023].

JITMAP-IGES, 2015. *Japan-India Technology Matchmaking Platform (JITMAP).* [Online]
Available at: https://jitmap.org/Japanese-technology.php
[Accessed 16 September 2021].

Kong, B. & P.Gallagher, K., 2021. The new coal champion of the world: The political economy of Chinese overseas development finance for coal-fired power plants. *Energy Policy,* August(2021), p. 112334.

Lacour, P. & Figuière, C., 2014. Environmentally-friendly technology transfers from Japan to China: an empirical analysis using patent data. *Journal of Innovation Economics and Management,* 3(2014), pp. 145-169.

Mallapaty, S., 2020. *How China could be carbon neutral by mid-century.* [Online]
Available at: https://www.nature.com/articles/d41586-020-02927-9
[Accessed 15 September 2021].

Maniak, R. & Midler, C., 2008. Shifting from co-development to co-innovation. *International Journal of Automotive Technology and Management,* 8(4), pp. 449-468.

McLaren, D. P. et al., 2019. Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions. *Frontiers in Climate,* 8(2019), p. 1.

McMaster, T. et al., 1998. *Facilitating Technology Transfer Through Partnership.* 1 ed. New York: Springer.

MEA, 2011. *Brief on SAARC.* [Online]
Available at: https://mea.gov.in/in-focus-article.htm?18785/Brief+on+SAARC
[Accessed 12 September 2021].

MEA, 2018. *India-ASEAN Relations.* [Online]
Available at: https://mea.gov.in/aseanindia/20-years.htm
[Accessed 12 September 2021].

MLIT, 2021. *Japan's Quality Infrastructure Around the world: Compendium of Good Practices,* Tokyo: Ministry of Land, Infrastructure, Transport and Tourism, Japan.

MOEJ, 2021a. *Recent Developments of the Joint Crediting Mechanism.* [Online]
Available at: https://www.carbon-markets.go.jp/document/20210712_JCM_goj_eng.pdf
[Accessed 30 August 2021].

MOEJ, 2021b. *Initiative for Decarbonized Infrastructure.* [Online]
Available at: http://www.env.go.jp/press/files/jp/116383.pdf
[Accessed 30 August 2021].

MOEJ, 2021c. *Selected 11 projects for JCM Model Projects of Joint Crediting Mechanism (JCM) financing support programme FY 2021.* [Online]
Available at: https://www.env.go.jp/en/headline/2528.html
[Accessed 30 August 2021].

MOEJ, 2023a. *The announcement of JCM model project financed in 2023 (In Japanese).* [Online]
Available at: https://www.env.go.jp/press/press_01147.html
[Accessed February 2023].

MOEJ, 2023b. *JCM projects overview (In Japanese).* [Online]
Available at: https://www.env.go.jp/content/000110206.pdf
[Accessed February 2023].

Murun, T. & Tsukui, A., 2020a. *Joint Crediting Mechanism (JCM) contributions to Sustainable Development Goals (SDGs),* Hayama: IGES.

Murun, T. & Tsukui, A., 2020b. *Joint Crediting Mechanism and Sustainable Development Goals Linkage Guidance,* Hayama: IGES.

Nicolas, F., 2021. *The Economic Pillar of Korea's New Southern Policy: Building on Existing Assets,* Paris: Centre for Asian Studies, IFRI.

Nikkei Asia, 2021. *China tightens grip on key components of tech economy.* [Online] Available at: https://asia.nikkei.com/Business/Business-trends/China-tightens-grip-on-key-components-of-tech-economy
[Accessed 18 September 2021].

Pigato, M. A. et al., 2020. *Technology Transfer and Innovation for Low-Carbon Development,* Washington DC: World Bank.

Porter, M. E., 1990. The Competitive Advantage of Nations. *Harvard Business Review,* March-April(2), pp. 73-93.

Saragih, H. S. & Tan, J. D., 2018. Co-innovation: a review and conceptual framework. *International Journal of Business Innovation and Research,* 17(3), pp. 361-377.

Tonby, O. et al., 2020. *The future of Asia: How Asia can boost growth through technological leapfrogging.* [Online]
Available at: https://www.mckinsey.com/featured-insights/asia-pacific/how-asia-can-boost-growth-through-technological-leapfrogging#
[Accessed 18 September 2021].

Trace, S., 2016. *Rethink, Retool, Reboot: Technology as if people and planet mattered.* 1 ed. London: Practical Action Publishing.