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A Strategy for Responding to New Market Mechanisms based on the Technology Demands of Developing Countries: A Comparison of Technology Needs Assessment (TNA), Technical Assistance (TA) of the Climate Technology Center and Network (CTCN), and Clean Development Mechanism (CDM) in Six Priority Partner Countries

Choi, Ga Young[*] · Hwang, Hansu[**] · Lee, Eunmi[***] · Lee, Sue Kyoung[****†] and Jin, Tae Young[*]

[*]*Postdoctoral researcher, Division of Climate Technology Cooperation, Green Technology Center, Korea*
[**]*Postdoctoral researcher, Division of Technical Supervision, Green Technology Center, Korea*
[***]*Researcher, Division of Climate Technology Cooperation Green Technology Center, Korea / Ph.D Student, Department of Technology Policy, Yonsei University, Korea*
[****]*Senior researcher, Division of Climate Technology Cooperation, Green Technology Center, Korea*

ABSTRACT

Developing countries continue to seek technological and financial support from the international community to more effectively respond to climate change. Through the Paris Agreement, many countries pledged to develop and implement a voluntary 'Nationally Determined Contribution (NDC),' and accordingly the demand for developing and transferring climate technology in developing countries is expected to expand further. In this regard, the present study discusses policy implications associated with accomplishing a national NDC by comparing the climate technology demands of developing countries and the present status of the Clean Development Mechanism (CDM). For this, technology needs assessments (TNAs) and Climate Technology Center Network Technical Assistance (CTCN TA) data were used to understand the technology demands of developing countries and to determine the present status of the CDM regarding technology demands for developed countries. To this end, six countries among South Korea's priority partner countries were selected – Vietnam, Myanmar, Sri Lanka, Chile, Peru, and Mongolia. The results of this study can be used to establish a response strategy for new market mechanisms based on the technology demands of developing countries in the future, and can further provide implications for the development of domestic advanced climate technology companies.

Key words: *New Market Mechanism, TNA, CTCN, CDM, Technology Demands*

1. Introduction

Developing countries continue to seek technical and financial support from the international society to respond to climate change. The Clean Development Mechanism (CDM) is mechanism under the Kyoto Protocol of United Nations Framework for Convention on Climate Change (UNFCCC) that can utilize GHGs reduction activities through cooperation between developed countries (Annex I) and developing countries (non-Annex I). It aims to help achieve the GHGs reduction target as developed countries with technological and financial advantage implement reduction projects for developing countries while helping developing countries achieve sustainable development

†**Corresponding author** : sklee@gtck.re.kr (04554, Namsan sq 17floor. Teogyero173, Junggu, Seoul, Green Technology Center, Republic of Korea. Tel. +82-2-3393-3924)

ORCID Choi Ga Young 0000-0001-6979-0213 Lee Sue Kyoung 0000-0001-5716-7942
Hwang Hansu 0000-0001-6950-3309 Jin Tae Young 0000-0002-7909-6679
Lee Eunmi 000-0003-4005-476X

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through technology transfer and funding for reduction (UNFCCC, 1998). Although technology transfer is not a prerequisite for CDM implementation, previous research shows that the potential for GHGs reduction improves when technology transfer occurs (Murphy et al., 2015). Thus, the introduction of high-quality technology from developed countries to developing countries through the CDM is important in that it can positively contribute to the reduction of GHGs in both the short and long term. However, the CDM has several limitations because it was developed and implemented from the position of "contributor," contributing to technology and finance. Regarding the limitations of the CDM project, Cho and Um (2015) and Schmidt (2010) pointed out that advanced technology transfer does not occur smoothly because technology transfer is concentrated in specific projects that are relatively easy to implement for developed countries. Because the existing CDM has been driven mainly by the demands of developed countries, it does not sufficiently reflect the demands of developing countries.

In this regard, technology transfer based on the 'demands' of developing countries is expected to become more important in the upcoming new climate era following the conclusion of the Paris Agreement in 2015. In particular, since the Paris Agreement presupposes the climate technology support from developed countries in achieving the voluntary Nationally Determined Contribution (NDC) goal of developing countries, the importance of technology transfer will increase further. To respond to Articles 6.2 and 6.3 "Cooperative Approach," Article 6.4 'Sustainable Development Mechanism," and Article 6.8 "Non-market Approaches" under discussion, promising technologies for the cooperative commercialization of potential projects must be developed based on the institutional experience and foundation of the existing Kyoto mechanism, and its advancement and commercialization must be implemented.

To actively support technology development and transfer in developing countries for GHGs reduction and climate change adaptation, UNFCCC officially launched a technology mechanism consisting of the Technical Executive Committee (TEC) and Climate Technology Centre and Network (CTCN) in 2010 (FCCC/SB/2017/3, CMA.1). Under the ambiguous definition of "technology transfer", the expectations of the CTCN, which is an official organization established for "technology transfer," is rising as an alternative to overcome the limitations of technology transfer centered on developed countries as established under the Kyoto Protocol.

From this perspective, this study was conducted to derive policy implications related to the future achievement of domestic NDC target utilizing overseas GHGs reduction projects by understanding the increasing demand for climate technology in developing countries. As mentioned earlier, it is expected that the importance of sustainable development is being more highlighted in New Climate Mechanism. To promote implementation of carbon reduction projects in developing countries, the projects should be designed and implemented by ensuring that they are closely matched to local needs regardless of reduction effect. Therefore, to identify the local needs of priority partner countries will contribute to achieving NDC and Sustainable Development Goals (SDGs) by building bilateral/multilateral cooperation. To this end, five countries of South Korea's priority partner countries were selected—Vietnam, Myanmar, Sri Lanka, Chile, and Peru—in addition to Mongolia, which is considered a key partner in the future[1]. To evaluate the demand for technology in the "position of developing countries," this study employed a Technology Needs Assessment (TNA) and the CTCN technical assistance (TA). TNA is a report led by developing countries and can be a useful resource for understanding the technological demands of developing countries (UNFCCC, 2002). CTCN TA supports developing countries in enhancing the capabilities thorough network and partnership establishment, and activities that promote cooperation and strengthen information access. On the contrary, the result of CDM was regarded as technology demand in developed countries. The results of this study can be used to

1) Five countries (Vietnam, Sri Lanka, Myanmar, Chile, and Peru) that are implementing bilateral cooperation with the Korean government, and Mongolia, which has a high potential for cooperation, were selected as targets for analysis.

establish a response strategy for new market mechanisms based on technology demand in developing countries in the future and provide implications for the advancement and growth of domestic advanced climate technology companies.

2. Literature Review

2.1 Technology Transfer

IPCC (2000) defines the term technology transfer as *"....encompass[ing] the broad set of processes that cover the flows of knowledge, experience, and equipment for mitigating and adapting to climate change among different stakeholders."*

Although it is considered a process of experience and equipment/support for responding to climate change among various stakeholders, the scope is ambiguous. Accordingly, the definition of technology transfer has been defined differently by various researchers, and most researchers classify technology transfer in narrow and broad sense. The range of definition of technology transfer depends on local demands. In the narrow sense, it includes the import of equipment and knowledge, acceptance of technology from developed countries and patenting developed countries' technology. In other words, technology transfer is implemented in one way from developed to developing countries. As mentioned earlier, it is unlikely to bring about a fundamental shift in GHGs reduction in developing countries. In the broad sense, it includes the concept of local adaptation. For this reason, it includes not only the use of technology or the knowledge imported from developed countries but also the use of locally imported technology and capacity building. In other words, it refers to the localization of transferred technology. Wang (2010) suggested a stage called "know-what and know-why" in which the knowledge of developed countries spreads in developing countries in the process of technology transfer and evaluated the process of localized technology penetrating in developing countries, terming this process "technology-diffusion."

In the narrow sense, interactivity of technology transfer is also considered. Coninck and Sagar (2015) emphasized that technology development and transfer is not addressed by responsibility and leadership of either developed or developing countries but requires intercompatibility. Since the mechanism of technology transfer from developed countries to developing countries includes financing and technology as well as service transfer projects, the CDM is also included in the projects that are carried out for the purpose of technology transfer. According to Cho and Um (2015), the CDM project for wind power generation is evenly distributed over 5 project types including international trade, foreign direct investment, cooperative venture, technology licensing, and localization. Under this classification, first four factors are included in the narrow definition, and last factor is included in broad one. For example, the CDM project for wind power generation is distributed evenly among the 5 classification. However, 82% of the wind power CDM project belongs to the narrow definition, while only 18% belongs to broad one.

This implies that most of the technologies transferred from developed countries to developing countries simply end with financing and the transfer of technology, and the proportion of CDM projects aimed at localization is very small. It can be inferred that mitigation projects through market mechanisms under UNFCCC are insufficient for localization in developing countries and are inefficiently used for capacity building. Additionally, the CDM confirmed that the technology has been partially transferred in terms of GHGs "mitigation," but poor performance in terms of "adaptation" is worth noting. Previous research has found that other methods such as problem solving through technology innovation or participation expansion are required for improvement (Coninck and Sagar, 2015).

This study attempted to prove that the concept of 'technology transfer' in the new market mechanism under the Paris Agreement should go beyond the narrow sense centered on developed countries through the CDM, and include a concept in a broader sense considering local demand. Therefore, in this study, local demand in developing countries was identified through TNA and CTCN TA, and on the contrary, the previously implemented CDM was regarded as the technology

demand centered on developed countries. In conclusion, through a comparative analysis of demand from developing countries and demand from developed countries, this study aims to suggest the direction in which technology transfer should proceed through the new market mechanism under the Paris Agreement.

2.2 Technology Demands of Developing Countries

The starting point for responding to climate change can be considered understanding the technological needs of developing countries. From this perspective, considering that TNAs are country-driven activities that enable developing countries to identify and prioritize the demand for climate technologies necessary for mitigating and adapting to climate change, it can be a useful resource for understanding the technological demands of developing countries (UNFCCC, 2002). TNAs are attracting significant attention compared to other methods for evaluating climate technology demand because developing countries voluntarily identify and prioritize technology needs before implementing a project. In addition, the goal of TNAs is to strengthen the national capacity to analyze and prioritize climate technology and form the basis for implementing the UNFCCC Paris Agreement.

According to Shin and Kim (2020), TNAs require that developing countries grasp demand in principle. TNAs are prepared according to the following stages: (1) identify and prioritize technology demand for reduction/adaptation based on selected areas, (2) identify and analyze obstacles that hinder the successful supply/spread of priority technology, and (3) establish a Technical Action Plan (TAP) based on the information identified in the previous two stages (i.e., a mid- to long-term plan to support the implementation of the identified technology). The TNA is written over a period of approximately 8 to 24 months, and developing countries ascertain technology priorities based on demand and the results of strategy fields to support it. Although it is required that developing countries prepare this voluntarily, international organizations can participate in technical and financial support for creating the TNA when those in charge may not have sufficient knowledge to do so independently. Representatively, the UNEP DTU Partnership is responsible for technical support, and the Global Environment Facility is responsible for financial support. Given the status of submission, TNAs were completed and submitted by 36 countries from 2009 to 2013 and another 26 countries from 2014 to 2018. By 2019, 23 countries including the least developed countries and small island developing countries have completed and submitted TNAs. Currently, 25 developing countries in the preparation stage, and 350 TAPs requested financial support.

According to the April 2020 TNA summary report, sectors prioritized for technology demand in the mitigation area (Fig. 1) were energy supply and consumption; agriculture, forestry, and other land use; waste; and industry, in descending order of priority. Sectors prioritized in the adaptation area (Fig. 2) were agriculture, forestry, and other land use; water; infrastructure and settlements (including coastal areas); and climate observation, in descending order of priority (UNFCCC, 2020a).

The CTCN's Technical Assistance (TA) can also be used to understand the demand for climate technology in developing countries. For the development, diffusion, and transfer of climate technology to respond to climate change, the CTCN supports developing countries in enhancing the capabilities via TA, network and partnership establishment, and activities that promote cooperation and strengthen information access. Among them, TA is a representative activity of CTCNs. The Technical Request (TR) is submitted by the developing countries through the Nationally Designated Entity (NDE), CTCN consortium, or suitable organization among network members. As CTCN's core work, TA is implemented as a form of technology identification, technical assessment, technical support of policy and planning, training and capacity building, tools and methodologies, and implementation plans (CTCN, 2015; CTCN, 2018a, Bak, 2019). TA is divided into 3 types :

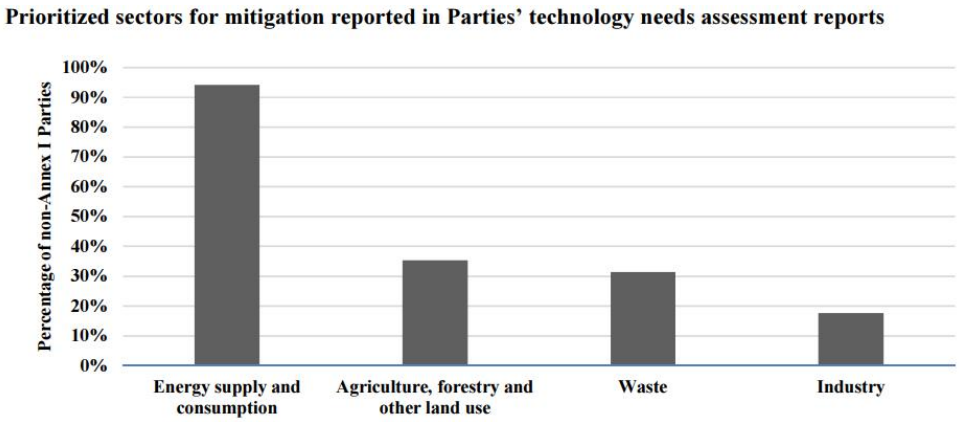


Fig. 1. Prioritized sectors for mitigation in developing countries (TNA report) (UNFCCC, 2020a)

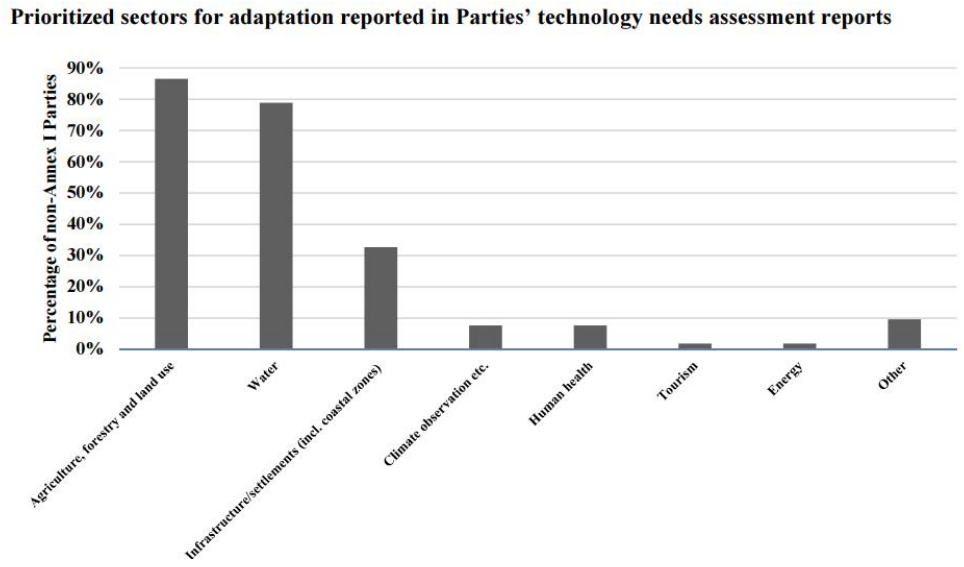


Fig. 2. Prioritized sectors for adaptation in developing countries (TNA report) (UNFCCC, 2020a)

quick response, technical support, and rapid technical support; these are employed in developing countries according to the CTCN's judgment[2]. Since the establishment during the 19th UNFCCC Conference of the Parties, 273 TA requests have been received from a total of 93 countries. Of these, 223 projects have been reviewed and approved through the CTCN Advisory Board, and 99 projects have been completed (Green

2) (1) Rapid response: Indicates that it is possible to solve in a small scale and short time via implementation by consortium organization
(2) Technical assistance: As a general technical support project, the project scale is large and cannot be solved in short period of time. Participant selected through CTCN open bidding.
(3) Rapid technical assistance: Established in 2018 to address more urgent issues rather than the existing rapid response. CTCN secretariat carries out the assistance through a contract with individual expert.

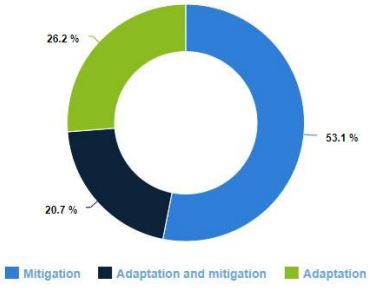
Technology Center, 2019).

As seen in Fig. 3 (a), requests for in the mitigation field comprised 53.1%, requests for projects in the adaptation field comprised 26.2%, and requests for joint mitigation and adaptation projects comprised 20.7%. Over 70% of project requests were made in the field of climate change mitigation. Energy efficiency and renewable energy sectors had the highest number of requests in the mitigation field and accounted for approximately two-thirds (66%) of all project requests in the mitigation field (Fig. 3 (b)). In the adaptation field, projects in agriculture and forestry sector and water sector accounted for approximately 50% of all projects in the adaptation field (Fig. 3 (c)).

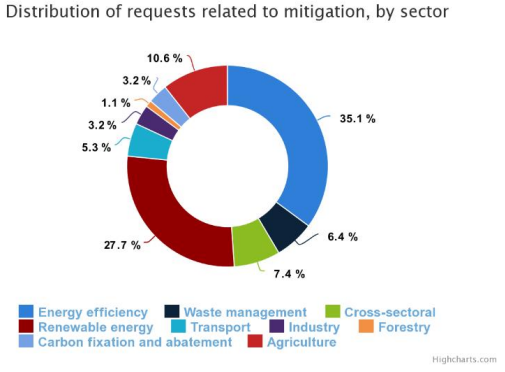
3. Materials and Methods

To investigate the technological demands of developing countries, this study explored the TNA and the CTCN TA projects conducted for Vietnam, Myanmar, Sri Lanka, Chile, Peru, and Mongolia. TNAs have been conducted by the UNFCCC since 2012 to examine the technical needs in developing countries, and the update history for each country is different from 2012 to the present. For example, Vietnam and Peru submitted TNAs in 2012, and Sri Lanka and Mongolia submitted and updated TNAs in 2013. Myanmar updated its TNA in June 2020, which is the most recent[3]). Chile has not yet submitted a TNA report. This study examined the sectors on which each developing country must focus by using the disclosed TNA reports.

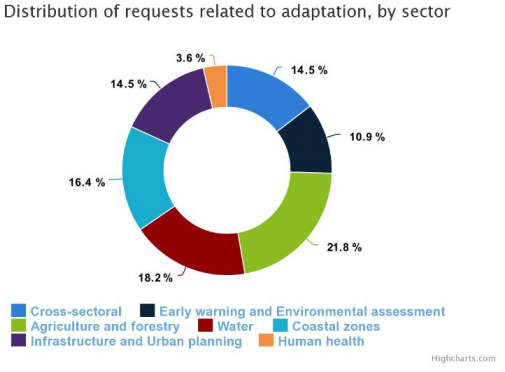
CTCN TA is TA selected through TR directly made to CTCN, which is a technology mechanism of the UNFCCC, for the purpose of responding to climate change, reducing GHGs, and strengthening capabilities since 2014. “Here, technology transfers include both GHGs mitigation and adaptation based on the needs of developing countries.” The present study analyzed TA activities in the evaluated countries by using data derived



(a) Distribution of requests by objective



(b) Distribution of requests related to mitigation, by sector



(c) Distribution of requests related to adaptation, by sector

Fig. 3. Distribution of technical requests of developing countries (CTCN, 2020)

from the CTCN website[4] and identified local technology needs.

If the TNA can identify technological demand at the national level, there is a mutual difference as the CTCN TA can grasp technological demands, such as technology classification and the type of technology project required in the demonstration stage of developing countries. Thus, this study identified technical needs of developing countries on a macroscopic and microscopic level by combining the information from TNAs and CTCN TA data.

Technology transfer through the CDM is more influenced by the willingness to commercialize technology transfer of developed countries rather than being focused on the demand of developing countries. This study investigated all CDM projects that have been promoted to date to examine the technology transferred from developed countries to developing countries. For CDM projects, all information related to the UNFCCC CDM Registry[5] are disclosed. Therefore, the status of commercialization of technology transfer and scope of technology applied were identified by referring to the CDM's Project Design Document (PDD). Moreover, this study identified whether the technology transfer was successfully "registered," whether the registration was withdrawn by participants, or whether it the registration was rejected by the UNFCCC. In this study, the evaluation period was divided into 3 sub-periods including the first period of the Kyoto system (up to 2011), the second period of the Kyoto system (2012–2015), and the period after the Paris Agreement (2016–present) based on the CDM's PDD for the 6 subject countries by focusing on the years in which a meaningful decision was made at the Conference of the Parties to the Climate Change Convention for the analysis as in the analysis of technology demand.

CDM projects can be divided into Project Activity (PA) and Program of Activity (PoA) depending on the size and type of the project. In the case of PA, one PA is classified as a single CDM, but PoA is different because it allows multiple individual components of Project Activity (CPA) to be composed of one program. This study examined the present status of technology transfer based on the number of CDM projects implemented, exploring PA and PoA together as a "project unit" is required. Accordingly, by distinguishing a "project" that constitutes PoA—that is, classifying CPA into one PA and equivalent—it re-classified CDM projects implemented by field and period and determined the number of projects implemented.

4. Research results

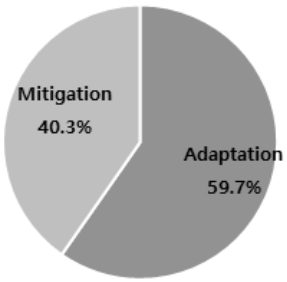
4.1 Analysis of Technology Demand in Developing Countries

4.1.1 TNA

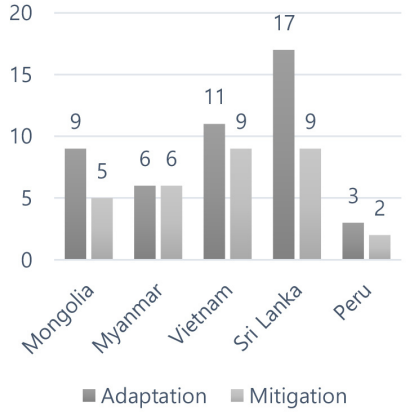
TNAs are developed according to the principle that they must proceed in a country-led manner; they are planned and promoted by the government of developing country. UNEP-DTU Partnership (UDP) and United Nations Development Programme (UNDP) are in charge of technical support to compensate for any lack of capacity in preparing TNA, and Global Environment Facility (GEF) manages financial support. The present study conducted an analysis on the technical needs of Vietnam, Sri Lanka, Myanmar, Mongolia, and Peru by using the TNA reports of developing countries based on the support of the UNFCCC and GEF. The status of each report submission is divided into 2012 submission (Vietnam, Peru), 2013 submission (Mongolia, Sri Lanka), and June 2020 submission (Myanmar). Chile is currently believed to have not submitted a TNA. Accordingly, five of the six examined countries were examined for the analysis of the TNA reports.

In the five evaluated countries, 77 technological demands were raised. Of these, 31 were cases in the mitigation field, comprising 40.3%, and 46 were cases in the adaptation field, comprising 59.7% (Fig. 4 (a)). This

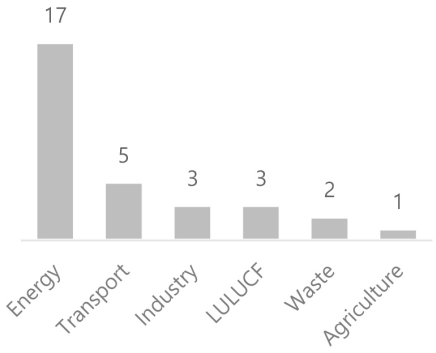
3) https://unfccc.int/ttclear/tna (UNFCCC, 2020a)
4) https://www.ctc-n.org/technical-assistance/data (CTCN, 2020)
5) https://cdm.unfcc.int (UNFCCC, 2020b)



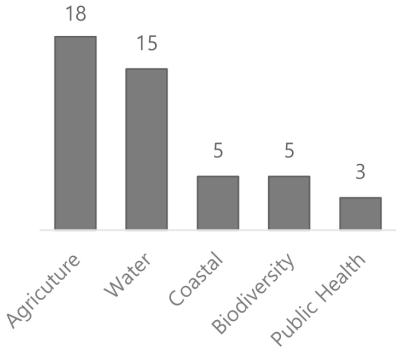
(a) Distribution of technology demands by objective in 5 countries



(b) Number of technology demand related to objective, by country



(c) Number of technology demands related to mitigation



(d) Number of technology demands related to adaptation

Fig. 4. Technology demands sector by mitigation/adaptation in 5 countries (TNA)

reflects overall trends observed in the TNA technology needs of developing countries (Green Technology Center, 2019). This finding implies that the technology demands of the five countries are more related to adaptation to climate change effects rather than GHGs mitigation technology. Mitigation technology also has a slightly higher priority for technology needs of individual countries (Fig. 4 (b)). Examining the status of each country, 17 cases of adaptation and 9 cases of mitigation were found for Sri Lanka, thereby showing a high demand for adaptation. Further, in Mongolia, Vietnam, and Peru, adaptation technology was in greater demand than mitigation technology, but Myanmar's most recent submission in 2020 shows six mitigation cases and six adaptation cases. In the field of mitigation among technological demands of all countries, the energy sector had the highest priority with 17 cases, followed by the transport sector with 5 cases (Fig. 4 (c)). The sector in the adaptation field was found to have 18 agriculture and 15 water resource management cases (Fig. 4 (d)).

As seen in Fig. 5, examining the detailed technological demand by sector in the evaluated countries, agriculture had the highest number of cases with 19 (25%), followed by energy with 17 cases (22%), and water resource management with 15 cases (19%). These sectors accounted for a very high proportion at 66% of the total.

In addition, the following technological demands were observed by sector: biodiversity (5), transportation (5), coastal management (5), LULUCF (3), public health (3), industry (3), and waste (2). Meanwhile, in the case of agriculture with the highest priority, most countries showed high demand, but there was no demand for technology in Peru (Fig. 6). Moreover, the energy sector, which has the highest priority in the area of mitigation technology, was also confirmed to have the highest priority after agriculture in countries other than Peru.

4.1.2 CTCN TA

Since the start of first project in 2014, a total of 204 projects have been implemented as of 2020; 89 projects have been completed, 36 projects are currently in the implementation stage, 48 projects are in the design stage, and 31 projects are in the review stage.

Of these, 14 projects were found to target the six evaluated countries, and the project purposes were mitigation (50%), adaptation (36%), and a combination of

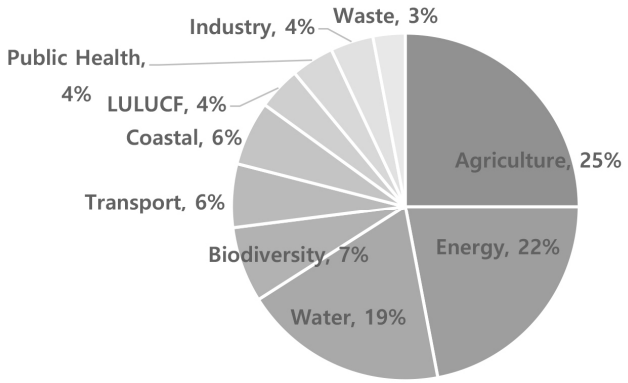


Fig. 5. Technology demands by sector (TNA)

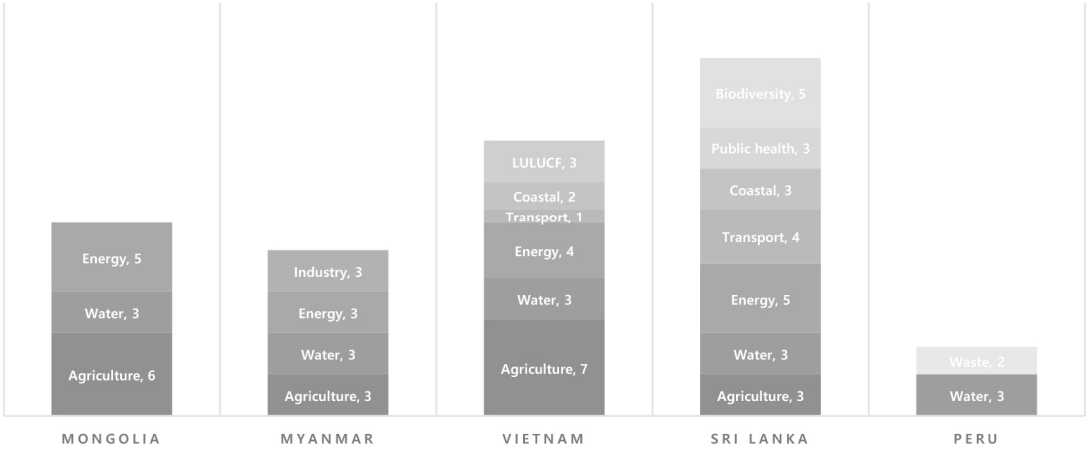


Fig. 6. Technology demands related to sector, by country (TNA)

mitigation and adaptation (14%). Regarding the number of projects by country except Mongolia, which did not request technical assistance, Chile (including 5 national and 1 multinational projects) and Vietnam (5) made the most requests for technical assistance, followed by Sri Lanka (2), Peru (1), and Myanmar (1). Looking at the projects by country in more detail, the projects for Vietnam consisted only of adaptation (5), while those for Chile promoted adaptation (2), mitigation (1), and a combination (1). There was 1 multinational project targeting Brazil, Mexico, Uruguay, and Chile, which consisted of complex technology support. Sri Lanka conducted a total of two projects, including adaptation (1) and mitigation (1). Peru and Myanmar are only pursuing one adaptation project each.

Considering the project distribution by technology field (Fig. 8), the number of cross-sector including mitigation and adaptation fields was six, comprising the largest percentage. The demand was the highest in the agriculture sector, followed by forestry (4), industry (2), infrastructure and urban planning (1), and waste management (1). Cross-sectoral projects have various complex forms, including combined energy and waste management projects and combined energy efficiency, infrastructure, urban planning, and transportation projects. As shown in Fig. 8, in the adaptation project, the proportion of agriculture and forestry and cross-sectoral projects was high. In the case of cross-sectoral projects, projects such as water resource management (flooding and drought monitoring) and strengthening ecosystem resilience monitoring (biodiversity, exotic species monitoring, soil monitoring) to respond to climate change were facilitated. In the case of adaptation, there seems to be a high demand for technology in the agriculture and forestry sector. In mitigation projects, there was a relatively high demand for cross-sectoral and industry-related projects. The cross-sectoral projects in this field mainly comprise projects that can make an immediate contribution to

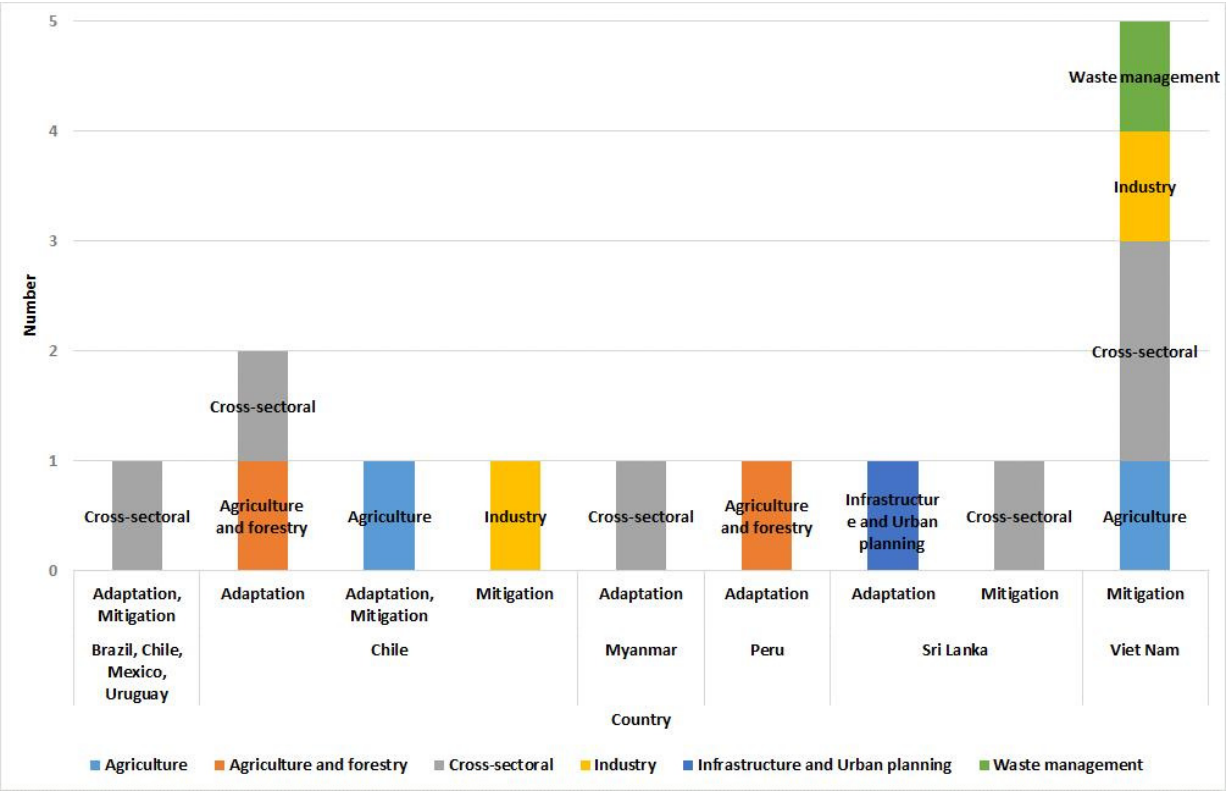


Fig. 7. Distribution of technology demands related to objective, by country (CTCN)

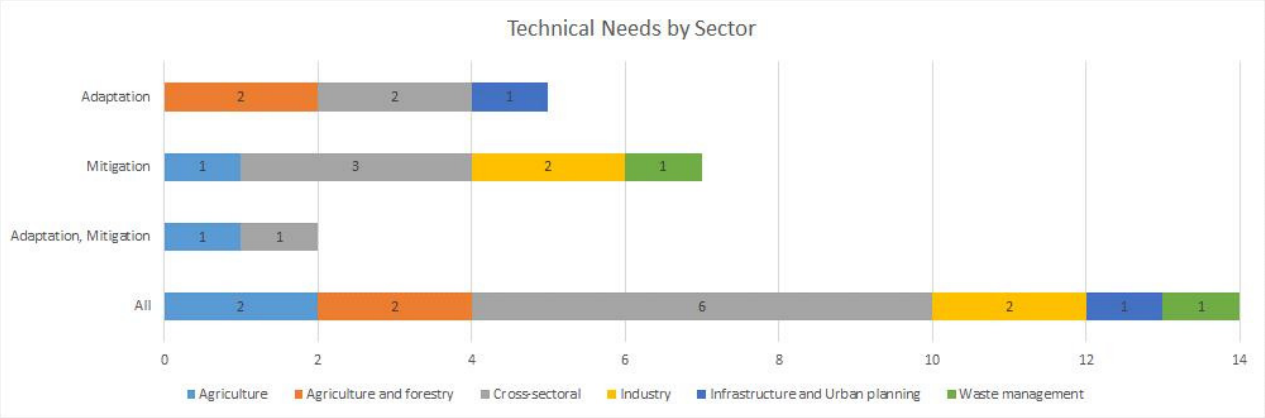


Fig. 8. Technology demands related to sector, by objective (CTCN)

achieving mitigation targets such as energy efficiency, infrastructure, and transportation.

4.2 Status of Technology Transfer Projects in Developed Countries (CDM)

The CDM is one of the mitigation mechanisms under the Kyoto Protocol. It can recognize part of the GHGs reduction project, which is implemented by Annex I Parties (developed countries among those that ratified the Kyoto Protocol) for non-Annex I Parties (developing countries), as a result of the advanced countries' carbon mitigation. Certified Emission Reduction (CER) can be secured by a relatively low cost investment through technology transfer and GHGs reduction through CDM projects, and the CDM can be utilized through a market mechanism such as ETS as a carbon mitigation effect. Simultaneously, for developing countries, capital and technology from developed countries can be transferred under the climate change response system. Accordingly, the CDM has an advantage of being able to pursue benefits of both groups (Annex I and non-Annex I) simultaneously (Cho, 2015). The CDM, which promotes technology transfer under the UNFCCC and aims to achieve GHGs reduction through technology commercialization, requires scientific monitoring of GHGs reduction performance (Ex-post) that should be performed to issue CER. Accordingly, technology transfer, and infrastructure construction of developing countries through technology transfer help to successfully approve and implement project. Further, the study by Murphy et al. (2015) found that the carbon reduction potential of the project for technology transfer is higher.

CDM project progresses according to the following steps. To issue a CER, a CDM project must be registered with the UNFCCC by developing PDD using the CDM methodology approved by the UNFCCC EB. If no suitable methodology exists, a new project methodology should be developed by the participant, and it should go through the process of obtaining approval from the UNFCCC EB. When it is not an approved methodology, CDM can be officially recognized under the UNFCCC only when the new methodology is registered and PDD is developed based on this.

Table 1. The number of deployed CDM projects for 6 priority partner countries (UNFCCC, 2020b)

Country	Sector	Kyoto 1st commitmentperiod (2003~2011)	Kyoto 2nd commitmentperiod (2012~2015)	After the Paris Agreement (2016~)	Total
Vietnam	Agriculture	3	0	0	3
	LULUCF	1	0	0	1
	Energy	268	33	10	311
	Waste	34	4	0	38
Sri Lanka	Agriculture	0	0	0	0
	LULUCF	0	0	0	0
	Energy	39	27	5	71
	Waste	5	2	0	7
Myanmar	Agriculture	0	0	0	0
	LULUCF	0	0	1	1
	Energy	1	3	56	60
	Waste	0	0	0	0
Mongolia	Agriculture	0	0	0	0
	LULUCF	0	0	0	0
	Energy	5	3	0	8
	Waste	0	0	0	0
Peru	Agriculture	1	0	0	1
	LULUCF	1	0	0	1
	Energy	63	16	1	80
	Waste	7	0	0	7
Chile	Agriculture	12	2	0	14
	LULUCF	3	0	0	3
	Energy	87	48	17	152
	Waste	26	4	0	30

Regarding the number of CDM projects that can be confirmed through the UNFCCC CDM Registry as of June 2020, 12,127[6] applications of projects were confirmed from 2003 to 2011 and 3,018 applications were confirmed from 2012 to 2015. A total of 344 applications[7] were submitted from 2016 to June 2020. Looking at the status of CDM attempts by period, they were concentrated during the first implementation period of the Kyoto Protocol (2008–2012). Given the results of Table 1, most CDM projects seem to have been developed during the first implementation period of the Kyoto Protocol. A total of 556 cases were applied from 2008 to 2011, and 142 CDM applications were submitted in the second implementation period (2013–2015). Since the Paris Agreement was signed, only 90 applications have submitted to be as CDM projects.

In general, CDM projects are mostly concentrated in the energy sector, and the same pattern is observed in six key partner countries. The country with the highest number of CDM projects performed is Vietnam. There, 311 out of 353 (88.10%) CDM projects were concentrated in the energy sector. In Chile, which has the second-most

6) The number includes every applications of CDM activities. In case of the PoA, each CPA was counted as single project activity.

7) To analyze aspects of technology transfer through the CDM, the CDM classification subjects in this study included registered, rejected, and withdrawn.

CDM attempts, 152 of 199 cases (76.38%) were classified as CDM projects in the energy sector. Sri Lanka and Peru had 71 cases (91.03%) and 80 cases (89.89%) among 78 cases and 89 cases, respectively. Like Vietnam and Chile, most were attempted in the energy sector. In Mongolia, all eight projects were intensively attempted in the energy sector. The reason CDM projects were intensively attempted in the energy sector can be inferred by looking at the composition of the methodology for development and implementation of CDM. The methodology consists of a baseline methodology and a monitoring methodology (reference); based on this, the results of GHGs reduction through CDM can be quantitatively estimated. In the CDM's energy sector baseline and monitoring methodology, the essential parameters and coefficients required for the quantification of GHGs can use those developed according to guidelines of IPCC (1995), and accordingly, it is relatively easy to promote CDM compared to fields such as agriculture and forestry. In the case of the agriculture and forestry sector, absorption and emission coefficients, which considered the regional specificity such as the attempted ecology, environment, and weather condition, must be developed and applied. Hence, implementation is difficult if the target country does not have unique information and coefficients.

Of the evaluated key partner countries, Vietnam has attempted significant technology transfer and technology commercialization, followed by Chile with 199 cases. While the number is distributed similarly for other key partner countries, the number of CDM projects in Mongolia is significantly low. During the total analysis period, only 8 attempts were made in the energy sector, and after the Paris Agreement was signed, no CDM request was applied as a GHGs reduction project. According to a previous study by Jung (2006), the attractiveness of CDM host countries can be classified according to the amount of potential reduction, institutional potential, and general degree of foreign investment. Mongolia was classified as an attractive country group; therefore, the reason for a low number of CDM attempted needs to be examined in detail (Jung, 2005). According to Shagdar (2005), Mongolia may have a low number of CDM projects owing to low total emissions. However, he implied that Mongolia can become a promising area for CDM projects in the future as there are many cases in which the efficiency of technology and equipment in Mongolia has decreased or depreciated. A CDM project feasibility study was conducted in Korea for the afforestation project and wind farm in Mongolia from the early to mid-2010s. However, LULUCF, land use that can promote land-based CDM excluding the energy sector, land-use change and forestry, or absence of CDM for agriculture sector under the UNFCCC imply that the agricultural and forestry CDM methodology developed to date is technically not suitable for application in Mongolia. Thus, while the majority of CDM projects that are applicable in the region decreased after the Paris Agreement, 56 CDM projects were attempted in the energy sector in Myanmar. The number of projects shows a different trend than other countries. However, if analyzed more in detail, 56 CDM projects attempted in Myanmar were developed as only CDM, or PoA, and the methodology applied is considerably less impactful than the number of projects attempted. That is, CDM projects targeting Myanmar were no different from other countries in terms of time-series tendency.

4.3 Conclusion

The present study was conducted to derive implications for drawing a strategy when securing overseas emission rights to achieve national INDC target in the future by comparing and analyzing the climate technology needs of developing countries and the present status of CDM projects. For this, it utilized TNA submitted by each country and CTCN's Technical Assistance program data in order to understand technical demands of six developing countries (Vietnam, Myanmar, Sri Lanka, Chile, Peru, and Mongolia) which are South Korea's key partner countries, and used CDM project status as data on technical demand in the position of the advanced countries. The analysis results are summarized as follows.

First, in the case of TNAs, five countries except Chile made a submission. Regarding the technical needs of the

countries, demand for adaptation to climate change was higher than demand for GHGs reduction. Among the overall technical demand, demand for mitigation technology was concentrated the most in the energy sector, followed by transportation. In the adaptation field, agriculture and water resource management dominated.

If TNAs could be used to demand technology at a national level, CTCN TA could be referenced as data for a more specific analysis of demand for technology transfer in the country. Only 14 cases, 6.8% of the CTCN TA cases, were observed for the evaluated countries, but meaningful results were examined. In five countries except Mongolia where CTCN TA was not promoted, there was a demand for technical support in the order of mitigation (50%), adaptation (46%), and combination of reduction and adaptation (14%). By country, the trend was similar to the aforementioned TNA. In Vietnam, all technical support was concentrated in the adaptation field, and Chile had 2 cases for adaptation, 1 for mitigation, and 1 for combination. Sri Lanka had 1 each for adaptation, and mitigation. Peru and Myanmar were pursuing one adaptation project each. Furthermore, in Brazil, Mexico, Uruguay, and Chile, 1 technical support was performed in the combination field in accordance with the TA implementation standard of CTCN which can provide technical support on a regional scale.

Lastly, the present status of technical support in developing countries could be inferred through CDM projects from the perspective of developed countries. For the CDM, the tendency toward implementation by period following the implementation of the Kyoto mechanism and the conclusion of the Paris Agreement was very clear. Regarding the number of CDM projects that can be confirmed through the UNFCCC CDM Registry as of June 2020, it is 12,127 from 2003 to 2011, and 3,018 from 2012 to 2015. A total of 344 attempts were made from 2016 to June 2020[8]. Given the status of CDM attempts by period, they were concentrated during the first implementation period (2008-2012) of the Kyoto Protocol. Even in the six subject countries, most CDM were analyzed to have been intensively attempted from 2008 to 2012, which is the first implementation period under the Kyoto Protocol. In general, CDM projects are mostly concentrated in the energy sector, and the same trend was observed in 6 key partner countries. The country with the highest number of CDM projects carried out among the six countries is Vietnam. In Vietnam, 311 of 353 (88.10%) CDM projects are concentrated in the energy sector. In Chile, 152 of 199 cases (76.38%) were classified as CDM projects in the energy sector. Sri Lanka and Peru had 71 cases (91.03%) and 80 cases (89.89%) among 78 cases and 89 cases, respectively. Like Vietnam and Chile, most were attempted in the energy sector. Even in Mongolia, all 8 projects were intensively attempted in the energy sector. These projects are likely concentrated in the energy sector because the applicability of "methodology" that can quantitatively reveal the reduction of GHGs through the results of CDM is more facile than in other fields.

5. Concluding Remarks

The study found that technical support through CDM, which is the existing representative technology transfer mechanism, has been mainly conducted in accordance with the needs of the developed countries rather than in the field of technology transfer preferred by the developing countries. In other words, developing countries' demand for technology transfer, which was reflected in TNAs and CTCN TA cases, has not been sufficiently considered. This refutes the point that reflecting the needs of developing countries in terms of sustainability of technical support is essential when implementing new market mechanism in the future. In particular, as demonstrated by current market mechanisms, the promotion of GHGs reduction activities, which considers the technological demand of developing countries, should be conducted more actively in the new market mechanism in the future while considering the

8) To analyze aspects of technology transfer through the CDM, the CDM classification subjects in this study included all registration, withdrawal, and rejection.

positive effect of GHGs reduction performance through market mechanisms on cash-flow for sustainable technical support in developing countries.

As the sectors prioritized for technology needs in the six evaluated countries were found to be agriculture and forestry or transportation, it is necessary to determine sectors requiring intervention and prepare related strategies. The CDM has performed poorly because the parameters and coefficients necessary for preparing and applying the methodology—that is, the mechanism of Measurement, Reporting, and Verification (MRV) and GHGs quantification—were not established for the target country. Thus, if capabilities are strengthened, such as improved MRV levels, technology infrastructure for applying methodology and database construction can be supported through the CTCN's technical support or ODA financing. Moreover, sustainable technical support projects will be possible under the new market mechanism.

South Korea has set a GHGs reduction goal of 37% (compared to BAU) by 2030 and is preparing a systematic implementation plan to achieve this target. Particularly, the overseas reduction target is 96 million tons, which is 11.3% of the 2030 emission forecast. To achieve this, sustainable development mechanisms, bilateral cooperation, and direct purchases of emission credits are expected to be used as reduction measures. Accordingly, it is necessary to use the Paris Agreement as an opportunity to establish an institutional foundation for GHGs reduction and to establish a new growth engine for climate change mitigation.

Under the new market mechanism, Parties can voluntarily build and operate a variety of bilateral/multilateral cooperation systems in accordance with the collaborative approaches of Articles 6.2 and 6.3 of the Paris Agreement, and "Internationally Transferred Mitigation Outcomes (ITMO)," which are the mitigation results, can be used to achieve the NDC target. There is a need for establishing a bilateral/multilateral cooperation model for key partner countries by matching technology demand with potential prospective technology. Moreover, the Sustainable Development Mechanism (SDM), which is referred to in Article 6.4, is highly likely to be operated in a direction that improves the limitations of CDM in the future as a form similar to the existing CDM. Accordingly, advancement and commercialization of promising cooperative technologies should be prepared, considering the commercialization of potential project.

The results derived from this study can be used to establish a response strategy for a new market mechanism based on future technological demand in developing countries and provide implications for the advancement and growth of domestic companies related to advanced climate technology.

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