Development of a National Hydrogen Strategy and Action Plan for Accelerating Thailand's Net-zero Target

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CTCN
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NATIONAL INSTITUTE OF GREEN TECHNOLOGY

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Chapter 1. Introduction

The Paris Agreement, adopted in 2015, emphasizes the importance of capacity building support for developing country parties. Unlike the Kyoto Protocol, which mainly focuses on reduction obligations for developed countries, the Paris Agreement underscores global efforts to address climate change. To achieve this, adequate and sufficient support should be provided to enhance the capabilities of developing countries. Accordingly, capacity building is understood as one of the means to implement the Paris Agreement, and Article 11 of the Paris Agreement stipulates provisions related to capacity building support for developing countries.

In line with the Paris Agreement, this Technical Assistance (TA) project[1,2] of the Climate Technology Centre and Network (CTCN) included providing a capacity building program for stakeholders in Thailand as one of its scope tasks. Recognizing that the ultimate goal of this TA project is not only to provide a hydrogen strategy but contribute to Thailand's greenhouse gas emission reduction, it is crucial for Thai stakeholders to acquire knowledge about hydrogen technologies, policies, and business. The knowledge of Thai stakeholders about hydrogen is essential for understanding the deliverables of this CTCN TA project, effectively utilizing these deliverables, and developing new implementation means.

This TA project planned and implemented two major programs to effectively support capacity building for hydrogen-related stakeholders in Thailand in various ways. The first program, a field trip, was designed to enhance knowledge of key considerations for the deployment of hydrogen infrastructure in Thailand by visiting hydrogen production facilities in Korea. The second program, a 2-day workshop in Thailand, aimed to strengthen the capacity for

[1] Development of a National Hydrogen Strategy and Action Plan for Accelerating Thailand's Net-zero Target

[2] Capacity building for developing countries has already been specified as one of the roles of CTCN since the establishment of the Technology Mechanism in 2010; See Para. 117 and 123 of UNFCCC (2010); UNFCCC, 2010, Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010: Addendum Part Two: Action Taken by the Conference of the Parties at its sixteenth session. https://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf (accessed on May 3, 2024)

hydrogen-related policy development and business expansion in Thailand.

This report is a summary of the results of the two capacity building programs, detailing the contents of each program. Chapter 2 covers the field trip, and Chapter 3 includes the specific presentation given at the 2-day workshop in Thailand. Finally, Chapter 4 provides a summary of the report and recommendations for future capacity building programs in Thailand.

Chapter 2. Field Trip to Hydrogen-related Facilities in Korea

Section 1. Background and Objectives

South Korea is one of the early adopters of transitioning to a hydrogen economy, having taken proactive measures such as enacting the world's first hydrogen law and establishing a hydrogen power generation bidding market. Also, in Korea, various hydrogen demonstration projects are underway, and hydrogen is already widely commercialized in the transportation sector. Thailand also shows a strong commitment to promoting the hydrogen economy through policy initiatives and institutional arrangements. However, as a latecomer, more efforts are required to secure the necessary technology and infrastructure.

Considering Thailand's abundant biomass resources for hydrogen production, this field trip aims to observe South Korea's clean hydrogen production facilities, understand the biomass and biogas-based hydrogen production processes, and seek expert advice on factors and challenges to consider when introducing similar processes in Thailand. By understanding the strengths and limitations of South Korea's case, we aim to develop policies and design hydrogen-related facilities and demonstration projects tailored to Thailand's conditions, thereby fostering a successful foundation for a hydrogen economy in Thailand.

Section 2. Outline of the Field Trip

This field trip was structured over two days (Monday, April 1, 2024, and Tuesday, April 2, 2024) according to detailed plans. It comprised Day 1, focusing on presentations by leading domestic companies on biogas-based hydrogen production technology and trends, along with expert consultations, and Day 2, aimed at understanding the operation of clean hydrogen production facilities through visits to exemplary domestic sites. Day 1 was conducted at the National Institute of Green Technology, while Day 2 involved a site visit to Korea's first clean hydrogen mother station, the Chungju Food Waste Bioenergy Center, where the program was carried out. The detailed program is as follows.

<Table 2-1> Field Trip Program

Date	Time	Visiting organizations and activities	Remarks
Day 1 Apr 1st (Mon)	15:30-15:35	Greetings and Introduction of Participants	
	15:35-15:40	Introduction of NXPO	
	15:40-15:50	NIGT-NXPO MoU Ceremony	
	15:50-16:00	Break	
	16:00-16:30	Presentation: Production, Utilization, and Business of Biogas	SK Ecoplant
	16:30-17:30	Discussion on National Digitalization Readiness Index development project	NIGT
	17:30-18:00	Q&A and discussion	
	18:00-	Closing	
Day 2 Apr 2nd (Tue)	09:00-11:30	Travel (Seoul → Chungju)	
	13:30-16:30	Visit: Chungju Biogas Hydrogen Demonstration Complex	
	16:30-19:00	Travel (Chungju → Seoul)	

Section 3. Day 1: Expert Consultation on Biogas-based Hydrogen Production

Day 1 was held in the main conference room of the National Institute of Green Technology to enhance Thailand NXPO's understanding of biomass-based clean hydrogen production technology and explore future collaboration opportunities between the two organizations. The external experts from SK Ecoplant, one of the leading companies in South Korea's hydrogen industry, attended and gave a presentation on the production, utilization, and business of biogas. Through this presentation, SK Ecoplant shared extensive knowledge about biogas-based hydrogen production technology and detailed processes tailored to local

demand in Thailand. They also comprehensively analyzed the current state and trends in global business in this field.

In the subsequent panel discussion, strong intentions to establish a hydrogen economy foundation and introduce related production facilities in Thailand were reaffirmed. Expert consultations covered detailed topics such as the feasibility of adopting clean hydrogen production technology, potential applications, and the siting of related facilities. Experts emphasized that the introduction of clean hydrogen production technology in Thailand is feasible and that government initiatives are necessary to secure initial use cases, such as hydrogen mobility, hydrogen power generation, and exploring industrial uses of hydrogen.

Additionally, the feasibility of two candidate demonstration sites (Rayong, Nakhon Ratchasima) identified during the research process was reviewed. While the physical site conditions are adequate, it was suggested that the infrastructure necessary for linking to nearby industrial complexes and residential areas, as well as facilities for hydrogen transportation, must be sufficiently established.

Regarding the National Digital Readiness Index (NDRI) project for developing countries, which is being conducted by NIGT, discussions were held about future cooperation with NXPO. This project aims to develop an index to evaluate the potential and readiness for digitalization in each country, based on the CTCN 2023-2027 Programme of Work. As Thailand is one of the main targets of this project, the collaboration with NXPO, Thailand's NDE, aims to improve efficiency in collecting relevant data and conducting research, such as meta-analysis for variable identification, index structure development, and local data collection on energy in developing countries.

Regarding this project, it was agreed to jointly promote the recruitment of local experts and the establishment of a consultative body. Additionally, to establish a close cooperative framework with NXPO, NIGT signed a Memorandum of Understanding (MOU) with NXPO, focusing on planning joint research on next-generation climate technology in key areas such as hydrogen, biomass, and waste management, sharing policy and industry-related information, and establishing a feedback system for research outcomes.

Section 4. Day 2: Biogas-based Hydrogen Production Facility Site visit

On the second day of the field visit, we visited the Chungju Food Waste Bioenergy Center and the associated hydrogen production and fueling station, which is an exemplary demonstration site in South Korea. We observed the clean hydrogen production process and facilities that utilize biogas derived from food waste. The Chungju Food Waste Bioenergy Center, an organic waste treatment facility completed in 2016, produces approximately 7,000 m^3 of methane gas daily, which is used for city gas supply and hydrogen production. The Chungju Bio Green Hydrogen Convergence Fueling Station, established in 2022, is the first hydrogen mother station in Korea based on methane gas reforming and plays a key role in hydrogen production, fueling, and distribution within Chungju City.

Chungju is pursuing various policies to promote the hydrogen economy, including operating hydrogen buses, establishing a hydrogen supply system, stabilizing hydrogen prices, and linking hydrogen production systems with organic waste treatment facilities. Notably, the city minimizes distribution processes to maintain the lowest hydrogen supply price nationwide and ensures uniform distribution costs to standardize prices across hydrogen fueling stations in Chungju.

The experts from the center, including a researcher from the Institute for Advanced Engineering, stated that the biogas-based clean hydrogen production technology employed at the Chungju site is applicable in Thailand, where abundant biomass resources could facilitate the acquisition of a wider range of resources. During the expert consultation meeting held concurrently, it was suggested that, when establishing similar demonstration sites in Thailand, the introduction of national subsidy programs for hydrogen economy infrastructure, matching funds for facility construction and operation, and the activation of hydrogen production and supply systems through public-private partnerships would be necessary.

Chapter 3. 2-Day Capacity Building Workshop in Thailand

Section 1. Background and Objectives

While Thailand expresses willingness to utilize hydrogen as a means of greenhouse gas reduction, as shown in long-term low-emission development strategies (LEDS), the establishment of hydrogen policies and business initiatives within Thailand is still in its early stages. In the Asia-Pacific region, countries such as Japan, South Korea, and Singapore, along with various developing countries, have formulated national hydrogen strategies, but Thailand has yet to officially announce its national hydrogen strategy. On the business side, various companies in the private sector are voluntarily undertaking hydrogen-related pilot or demonstration projects. However, compared to countries that have actively pursued a transition to a hydrogen economy, the scale of these initiatives in Thailand is relatively small, and there is a lack of sufficient accumulated experience in such projects.

In the aforementioned context of Thailand, support for capacity building is crucial, as well as direct support for the planning of hydrogen policies and initiatives. Even if hydrogen policies and initiatives are formulated by third parties, ultimately, the stakeholders in Thailand are the ones who will operate and be affected by these policies and initiatives. Therefore, it is necessary to enhance their understanding of policies and initiatives. Moreover, for Thailand, capacity building of Thai stakeholders is essential to plan its own hydrogen policies and initiatives in the long term. Thai stakeholders are the ones who understand the structure, strengths, weaknesses, and dynamics among stakeholders in the Thai economy and industry the best. Therefore, enhancing their capacity will ultimately contribute to the development of policies and initiatives that better suit the situation in Thailand.

This 2-day workshop was planned in response to the aforementioned need, aiming to enhance understanding of hydrogen policies, technologies, and businesses by providing key cases and information to policymakers and stakeholders from the private sector in Thailand. This workshop can help Thailand improve and upgrade existing initiatives and policies and potentially contribute to reducing Thailand's greenhouse gas emissions.

Section 2. Outline of the Workshop

The workshop was structured over a total of two days (Monday, May 20, and Tuesday, May 21, 2024) according to the target audience for capacity building. The programs of Day 1 and Day 2 were planned for policymakers and hydrogen-related business stakeholders respectively. The workshop took place at the Kamolmart Room of the Sukosol Hotel in Bangkok, Thailand.

Day 1 workshop took place on Monday, May 20, 2024, targeting policymakers. According to its target, the basic theme was set as policy, while also including essential technological and research and development content required to design policy to enrich the workshop's content. In Session 1, the National Institute of Green Technology of Korea provided an overview of Thailand's draft national hydrogen strategy prepared as part of this TA project, extensively explaining policy measures to be taken in various dimensions including hydrogen production, storage and transportation, utilization, and institutional foundation establishment. Session 2 featured a case-based presentation, introducing hydrogen policies of major countries, Korea's international cooperation strategy for hydrogen-related technology, and trends in Thailand's hydrogen technology and research and development.

Day 2 workshop took place on Tuesday, May 21, 2024, consisting of presentations related to hydrogen business in Thailand to promote capacity building in the private sector. In Session 1, the hydrogen production business model was explained referring to the successful case of Korea. In Session 2, opportunities for financing, particularly through the Green Climate Fund (GCF), were explored to facilitate hydrogen business initiatives within Thailand, in conjunction with international funds. Notably, Session 2 featured a panel discussion with representatives from the Department of Climate Change and Environment, the United Nations Development Programme (UNDP), and the Hydrogen Thailand Club, providing an opportunity to hear practical insights from Thai government agencies, international organizations, and private enterprises in Thailand regarding GCF coordination and hydrogen business-related matters.

The details of the presentation and contents covered in the workshop are explained in the following section.

Section 3. Day 1: Capacity Building for Hydrogen Policymakers of Thailand

1. Overview of the Progress of the CTCN TA Project and the Draft Hydrogen Strategy Prepared by NIGT

[Dr. Chul Ho Park, Director General, National Institute of Green Technology, Korea]

In this session, Dr. Chul Ho Park from NIGT presented the details of Thailand's national hydrogen strategy developed through this TA project. Dr. Park explained that while there are cases of voluntary hydrogen-related business activities in the private sector, the overall hydrogen business in Thailand is not yet fully activated, and the relevant technologies have not been sufficiently matured based on the analysis of Thailand's current situation. Consequently, Dr. Park emphasized that Thailand's national hydrogen strategy should be formulated with a focus on overcoming these limitations by securing hydrogen technology, promoting the distribution and development of related facilities and industries, and establishing institutional foundations.

Dr. Chul Ho Park proposed "To Reduce Greenhouse Gas Emission and Make the Transition towards a Carbon-Neutral Thailand" as the vision for Thailand's hydrogen strategy. He emphasized that the ultimate goal of expanding hydrogen production and utilization within Thailand is to achieve carbon neutrality in the country. To realize this vision, Dr. Park highlighted that the goal of the national hydrogen strategy is to establish a hydrogen economy ecosystem.

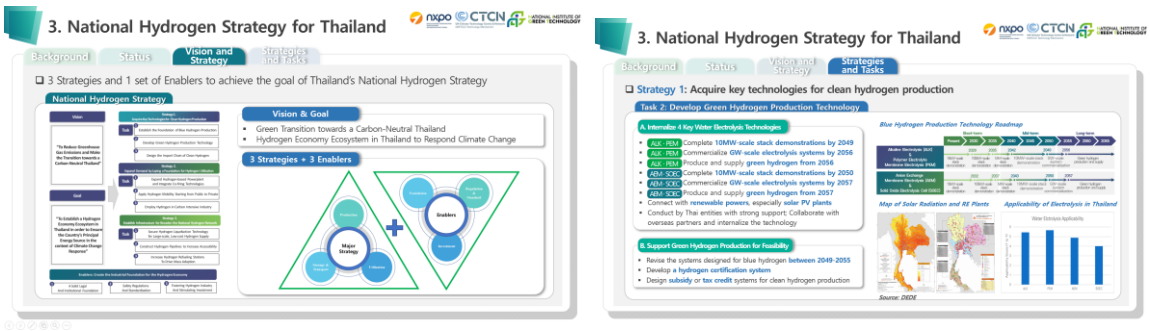
Continuing, Dr. Chul Ho Park explained three strategies and one set of enablers outlined in the drafted national hydrogen strategy. Firstly, regarding the first strategy "Acquire Key Technologies for Clean Hydrogen Production," he emphasized the importance of technology above all else and described the roadmap to secure technologies for blue and green hydrogens. He particularly highlighted that while collaboration with leading technology countries and companies is expected to be essential, the technology internalization processes to ultimately enhance Thailand's technological capabilities are highly important. Furthermore, as an ambitious goal, he mentioned that Thailand could consider importing

hydrogen developed abroad based on the hydrogen production technology of Thailand.

In the second strategy, "Expand Demand by Laying a Foundation for Hydrogen Utilization," and the third strategy, "Establish Infrastructure to Broaden the National Hydrogen Network," methods were outlined to enable hydrogen produced through the first strategy to be utilized in various locations. Dr. Park highlighted the need to consider sectors such as power and transportation for hydrogen utilization, introducing measures including expanding fuel cell power generation and transitioning public buses to hydrogen buses. Furthermore, he explained that to ensure a stable supply of hydrogen in this sector, it is necessary to introduce hydrogen liquefaction plants as foundational facilities and to sufficiently deploy hydrogen pipelines and refueling stations.

Lastly, Dr. Park also explained approaches to establish legal and regulatory frameworks, establish safety regulations and standards, and promote the hydrogen industry to enable the aforementioned three strategies. Dr. Park mentioned that without a sufficient number of such enablers, creating a hydrogen economy ecosystem would be very challenging. Also, he emphasized that enablers compatible with the target timing for hydrogen production, utilization, storage, and transportation should be introduced concurrently.

[Figure 3-1] Presentation of Dr. Chul Ho Park



Source: Park (2024)[3]

[3] Park, C. H., 2024, Development of a National Hydrogen Strategy and Action Plan for Accelerating Thailand's Net-zero Target, Capacity Building for Hydrogen Policymakers of Thailand, CTCN TA Capacity Building Workshop, May 20, 2024, Bangkok, Thailand.

2. Introduction of Hydrogen Policies of Korea and Other Countries

[Dr. Gobong Choi, Senior Researcher, National Institute of Green Technology, Korea]

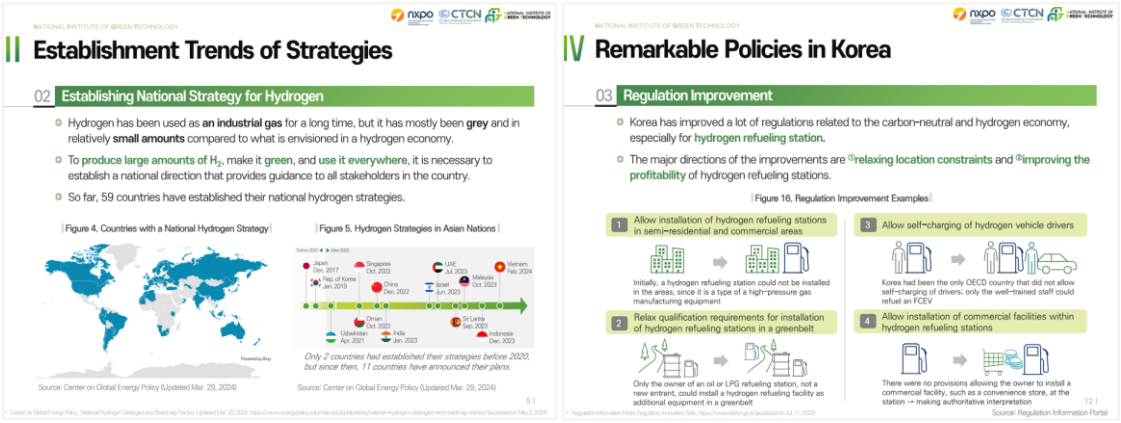
This topic was presented by Dr. Gobong Choi of NIGT, who discussed ① trends in the establishment of national hydrogen strategies, ② common characteristics in the policies of major countries, and ③ relevant key policies in Korea. Dr. Choi explained that many countries perceive hydrogen as a means to achieve carbon neutrality and are formulating national hydrogen strategies to concretize them into specific policies. According to Dr. Choi, until 2020, only Japan and Korea had established national hydrogen strategies in Asia, but since 2020, the pace of strategy formulation has accelerated.

Dr. Choi explained that alkaline and proton exchange membrane (PEM) electrolysis and steam methane reforming (SMR) integrated with carbon capture and storage (CCS) are commonly cited as key clean hydrogen production technologies in the policies of major countries. He particularly noted that to institutionalize these technologies, some leading countries have established clean hydrogen certification systems tailored to their own circumstances. Regarding the utilization of hydrogen, Dr. Choi pointed out that while major countries are considering its use in the transportation sector and explicitly mentioning the expansion of commercial vehicle deployment in their strategies, in reality, hydrogen vehicles are primarily deployed for passenger cars, excluding China.

Dr. Choi introduced noteworthy policies in Korea, including the Hydrogen Act (Hydrogen Economy Promotion and Hydrogen Safety Management Act), the Hydrogen power generation bidding market, and regulation improvement. Dr. Choi mentioned that the significance of Korea's Hydrogen Act lies in its foundation as a national law, rather than just a policy, to drive the hydrogen economy forward. He also stated that the hydrogen power generation bidding market could expand the use of hydrogen in the power sector. Regarding regulation improvement, efforts have been made to enhance regulations related to hydrogen refueling stations, aiming to alleviate site restrictions and improve the profitability of station operators.

Finally, Dr. Choi emphasized the need for Thailand to consider alkaline and PEM electrolysis, as well as SMR with CCS technology, as key technologies when formulating hydrogen policies. He further suggested the establishment of a certification system to support clean hydrogen-centered production and consumption. Additionally, he mentioned the importance of not only adopting a top-down approach but also considering a bottom-up approach to policy formulation by establishing channels to gather input from the hydrogen stakeholders of Thailand.

[Figure 3-2] Presentation of Dr. Gobong Choi



Source: Choi (2024)[4]

3. Introduction to Hydrogen Cooperation Strategies

[Dr. Hyunha Shin, Researcher, National Institute of Green Technology, Korea]

In relation to the international cooperation strategy in hydrogen, Dr. Hyunha Shin from NIGT presented ① Korea's global R&D cooperation strategy and ② import cooperation strategy research. She emphasized the need to secure national competitiveness through international cooperation in technological R&D in the hydrogen field, which is expected to make a

[4] Choi, G., 2024, Introduction of Hydrogen Policies of Korea and Other Countries, Capacity Building for Hydrogen Policymakers of Thailand, CTCN TA Capacity Building Workshop, May 20, 2024, Bangkok, Thailand.

significant contribution to achieving carbon neutrality and establish a hydrogen import strategy that takes international geopolitical issues into account as protectionism within international trade is being strengthened regarding the carbon neutrality matter. Accordingly, she described two approaches of international cooperation for hydrogen and introduced Korea's Global R&D Strategy Map (Feb 2024) and NIGT's research on identifying key partner countries for hydrogen import in Korea.

First, as part of global R&D international cooperation, Dr. Shin introduced the Strategy Map, which derives field-specific optimal cooperation strategies with key partner countries based on technological competitive advantage analysis. The map was jointly developed by the Ministry of Science and ICT, Korea, and NIGT, and was announced in February 2024. It includes international R&D cooperation strategies in a hydrogen supply sector which covers the sub-fields of hydrogen production, hydrogen storage and transportation, and overseas hydrogen storage and transportation.

In particular, the presentation was focused on the Technology Level Map which is the first step to drive specific cooperation partners and cooperation strategies for the final Strategy Map. The Technology Level Map aims to identify leading countries in hydrogen technological fields. The technological capacity of each country is evaluated by utilizing patents (triadic patents) and publications (top 10% in forward citations) data. The data, first, is extracted based on specific keywords that are relevant to each technological field, and then processed to draw technological leading countries and associated major research institutes or firms.

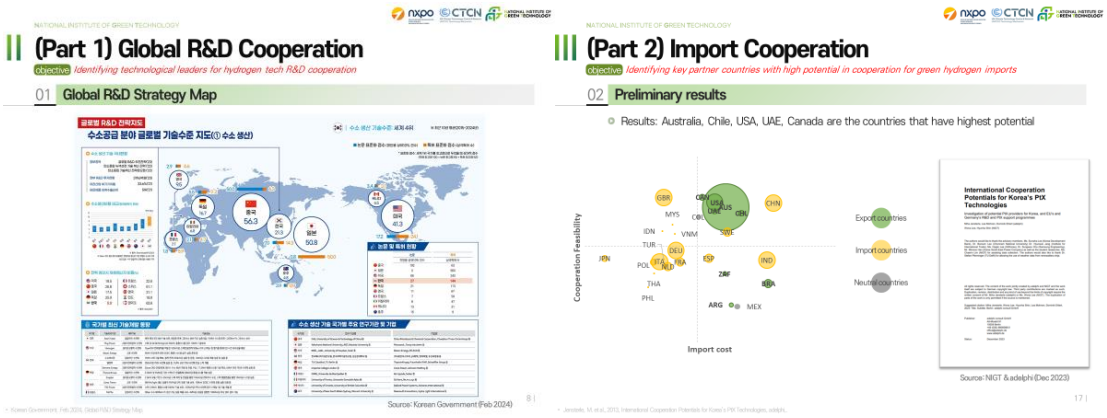
Afterward, the following steps for deriving cooperation strategies that include some additional analyses were briefly explained. In addition, examples of cooperation strategies in hydrogen technologies were provided: for AEM (anion exchange membrane) electrolyzers, where Korea has a technological disadvantage, and the technology is in its fundamental development stage, a 'securing new technology' type of cooperation by, e.g., joint technology development, exchange of professional personnel, etc., with Enapter, Germany would be favorable.

Second, an international cooperation strategy for hydrogen import was introduced. The

concept of technology diplomacy has recently emerged regarding economic security and reconstruction of the global supply chain, and likewise, there should be a strategic approach to hydrogen import to secure hydrogen supply in Korea. In Korea, it is expected that the future demand for hydrogen will be much higher than the amount of domestic production, so import cooperation for a stable supply of hydrogen is inevitable. Accordingly, NIGT conducted a study to evaluate Korea's green hydrogen import cooperation potential. The study collected and analyzed data on green hydrogen import costs (production costs + transportation costs), ease of cooperation (proportion of new and renewable energy, establishment of a national hydrogen strategy, ease of doing business, etc.), and production capabilities of target countries. The results showed countries such as Australia, Chile, UAE, the US, and Canada are likely to be the import partners with high potential. This work has been further developed by NIGT in collaboration with Adelphi, Germany, which was also briefly introduced in the presentation.

To conclude, Dr. Shin highlighted the strategic approach to international R&D cooperation, which can be used as an effective tool to strengthen technological capabilities in hydrogen and reduce technological gaps with other countries, and import cooperation for hydrogen supply, since Thailand is also one of the hydrogen import countries.

[Figure 3-3] Presentation of Dr. Hyunha Shin



Source: Shin (2024)[5]

[5] Shin, H., 2024, Introduction to Hydrogen Cooperation Strategies in Korea, CTCN TA Capacity Building

4. Introduction to Hydrogen Research in Thailand / Introduction of Hydrogen-related Technologies in Thailand

[Prof. Dr. Navadol Laosiripojana, The Joint Graduate School of Energy and Environment, KMUTT, Thailand]

The presentation was conducted by Prof. Navadol Laosiripojana, a hydrogen expert from KMUTT in Thailand. He introduced various hydrogen production technologies and the current state of hydrogen production research in Thailand. Prof. Laosiripojana categorized hydrogen production technologies into two different groups, thermochemical production methods and electrolytic methods. The thermochemical production methods include reforming, gasification, and pyrolysis, while the electrolytic methods include water electrolysis and plasma. Among these technologies, thermochemical production methods, particularly reforming, are currently widely used. He explained that water electrolysis is gaining attention as a next-generation hydrogen production technology, with active research being conducted in this area. Prof. Laosiripojana emphasized that transitioning to a hydrogen economy is essential for achieving net-zero targets, and highlighted the need to secure various potential hydrogen applications, such as power generation, mobility, industrial heat sources, and feedstock.

Next, Dr. Laosiripojana introduced key hydrogen production research projects currently underway in Thailand, providing detailed explanations of exemplary cases. He mentioned that since 2019, there have been 10 hydrogen production technology research projects in Thailand based on Scopus–Matching Documents criteria, and Chulalongkorn University and KMUTT are leading these efforts. One notable example is the hydrogen production research using thermochemical methods at Chulalongkorn University and the biogas-based reforming hydrogen production research at KMUTT.

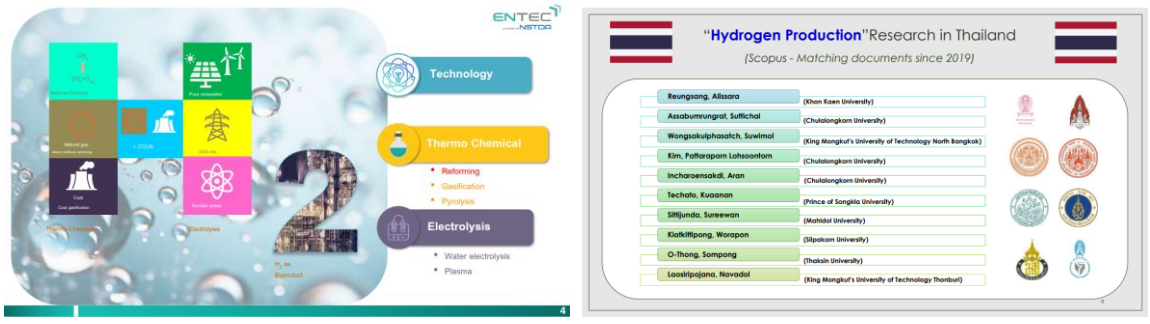
Workshop, May 20, 2024, Bangkok, Thailand.

At Chulalongkorn University, the research is focused on integrating hydrogen production processes with the palm oil industry. The goal is to produce hydrogen through biodiesel and BHD from palm oil, utilizing steam reforming technology to reform glycerol into hydrogen. This research particularly aims to enhance production efficiency by using sorption-enhanced methane reforming technology, where CO_2 sorbent is introduced around the catalyst.

The project at KMUTT involves producing biogas from organic waste and reforming it to produce clean hydrogen, employing a process similar to that used at the Chungju Food Waste Bioenergy Center in Korea. According to Dr. Laosiripojana, this project is investigating a pilot-scale process capable of producing 20 liters per minute without Pressure Swing Adsorption (PSA), collaborating with MSR-Innovations and WSG Energy Services to design an indoor reactor.

To conclude, Dr. Laosiripojana emphasized that hydrogen, being the most abundant element in nature, has significant potential to become the cheapest source for various energy applications such as mobility and industry, and stressed the need for more in-depth research to fully realize this potential.

[Figure 3-4] Presentation of Prof. Navadol Laosiripojana



Source: Laosiripojana (2024)[6]

[6] Laosiripojana, N., 2024, Introduction to hydrogen research and hydrogenrelated technologies in Thailand, CTCN TA Capacity Building Workshop, May 20, 2024, Bangkok, Thailand.

Section 4. Day 2: Capacity Building for Hydrogen-Related Business Stakeholders of Thailand

1. Hydrogen Production Business Model

[Dr. Joonho Yeo, Researcher, National Institute of Green Technology, Korea]

This session was presented by Dr. Joonho Yeo from NIGT, who focused on (1) a business model for biogas-based hydrogen production and (2) a case study of the exemplary demonstration site in Korea. In his presentation, Dr. Yeo emphasized the necessity of securing green hydrogen production technologies to address the climate crisis by transitioning existing energy resources to clean energy and meeting the growing demand for hydrogen. He noted that many countries are already accelerating their efforts to secure hydrogen technologies through strategies and policies. For instance, Europe aims to increase the share of renewable energy to 42.5% by 2050, with about 23% of this target met through green hydrogen. This has led to significant investments in hydrogen production facilities and infrastructure based on renewable energy, as well as efforts to expand hydrogen use in carbon-intensive industries. In the United States, the Biden administration has consistently supported clean hydrogen through clean energy innovation policies and announced a clean hydrogen strategy roadmap in 2023, targeting the production of 50 million tons of clean hydrogen by 2050. Similarly, South Korea has established a hydrogen economy roadmap and a basic plan for hydrogen economy implementation, aiming to produce approximately 3 million tons of clean hydrogen domestically by 2050. This plan includes goals for fuel cell utilization and hydrogen mobility throughout the entire hydrogen cycle. Dr. Yeo stressed that Thailand also needs to swiftly transition to a hydrogen economy and secure clean hydrogen production technologies to keep pace with this global trend of clean hydrogen technology development and the shift towards a hydrogen economy.

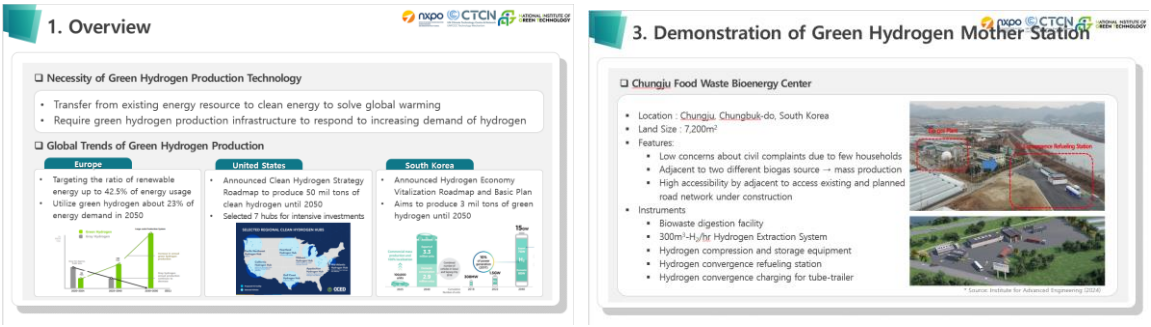
Dr. Yeo introduced the biogas-based hydrogen production process and the corresponding business model. The biogas-based hydrogen production process can be divided into biogas production and biogas utilization. Organic waste such as sewage sludge and food waste,

mainly produced in cities, can be collected and processed through anaerobic digestion to produce biogas. Dr. Yeo explained that this process has advantages such as short retention time, compact size requiring minimal land, and low production of sludge by-products, making it easy to operate and manage. The biogas, consisting of a mixture of methane and carbon dioxide, can be upgraded and purified for various uses. Particularly, it can be reformed to produce hydrogen, thereby serving as a raw material for clean hydrogen production.

Dr. Yeo presented the Chungju Food Waste Bioenergy Center and the hydrogen convergence fueling station as an exemplary case of using this technology in Korea. Located in Chungju, Chungcheongbuk-do, this center has several advantages: it faces minimal complaints from local residents, has two main sources of raw materials for large-scale production of biogas, and has good connectivity with nearby road networks, ensuring high accessibility. Dr. Yeo highlighted that the anaerobic digestion-based food waste treatment facility is located adjacent to the hydrogen production facility, allowing biogas produced from food waste to be directly transported via pipelines to the hydrogen production facility for immediate hydrogen production. This center operates hydrogen fueling stations for public hydrogen mobility and supplies other hydrogen fueling stations in Chungju through tube trailers, maintaining the lowest hydrogen supply price in Korea at 7,700 KRW/kg (approximately 200 THB). The center uses two pressure options, 200 bar, and 450 bar, for tube trailer supply. The 450 bar option utilizes the world's first mass-produced Type 4 hydrogen storage container technology for vehicles, developed in 2014, significantly reducing transportation costs. This makes it a notable example of excellent transportation practices in Korea. Dr. Yeo emphasized the need to secure hydrogen storage and transportation technologies in parallel with production technologies.

To conclude, Dr. Yeo argued that when Thailand establishes an ecosystem for hydrogen production and supply, it is essential to plan detailed production and supply processes. During this process, maximizing stability and economic efficiency will be crucial to promoting the hydrogen economy.

[Figure 3-5] Presentation of Dr. Joonho Yeo



Source: Yeo (2024)[7]

2. Introducing Hydrogen Club Thailand and its Efforts

[Dr. Thana Sornchamni, Manager, New Energy Technology Research Department, PTT Public Company Limited, Thailand]

[Mr. Satthawut Suwanthitirati, BCG Business Development Section Manager, BIG, Thailand]

In this presentation, Dr. Thana Sornchamni introduced the Hydrogen Thailand Club and its activities. The Hydrogen Thailand Club which was formed to promote the establishment of a future hydrogen energy ecosystem for Thailand's decarbonization and circular economy, aims to promote cooperation among participating members, plan a hydrogen roadmap and demonstration projects, and raise public awareness of hydrogen technology. Recently, its size has grown rapidly and thus is planning to elevate the ‘club’ to an 'association' in 2024: in 2023 alone, 34 new members joined, bringing the total to 54 members. Also, the Hydrogen Whitepaper has been published to support the development of Thailand's national hydrogen strategy, and the first demonstration project in the mobility sector was completed in 2023. In 2024, it plans to collaborate with global hydrogen-related associations such as Singapore's

[7] Yeo, J., 2024, Hydrogen Production Business Model: Case Study of Chungju Green Hydrogen Mother Station in South Korea, CTCN TA Capacity Building Workshop, May 21, 2024, Bangkok, Thailand.

Hydrogen and Fuel Cell Association.

Under the leadership of PTT, the Hydrogen Thailand Club published the Hydrogen Whitepaper as a preliminary work to support establishing the Thai government's hydrogen roadmap. The paper includes expected hydrogen demand and potential greenhouse gas reductions in power generation, industry, mobility, and other sectors. According to the paper, Thailand's hydrogen demand is expected to be 616,896 tons/year in 2040 and 2,234,126 tons/year in 2050, and it is expected to reduce greenhouse gas up to 16.3 MtCO2e through hydrogen in 2050. The club plans to propose nine subsequent projects on subsidies, safety standards, etc. to the government.

In addition, the first hydrogen fuel cell vehicle (FCEV) demonstration project was conducted in Thailand. A limousine service using FCEV was implemented at UTP Airport for one year from February 2023 to February 2024. The driving distance reached approximately 7,500 ~ 9,500 km/month covering Pattaya City, SVB Airport, Bangkok, Rayong, etc. Cumulative hydrogen use was estimated about 1,710 kg, and CO2 reduction was estimated about 35,800 kg.

Other activities include co-hosting the Hydrogen Thailand Symposium with METI, Japan in February 2023, and participating in developing the incentive system for hydrogen-related activities led by the Thailand Board of Investment (BOI).

3. Introduction to Climate Technology Finance Mechanisms: Focus on GCF

[Dr. Jihee Son, Head of Center for Global Strategy, National Institute of Green Technology, Korea]

This session, presented by Dr. Jihee Son, has been arranged to discuss follow-up measures for the CTCN TA project. The project plans to develop a concept note of the GCF as a follow-up measure. Therefore, this session explored what the GCF is, how projects are developed, and how to link the current CTCN TA project to subsequent projects.

Dr. Son explained in her presentation that climate change has fostered a global sense of crisis.

Since the Paris Agreement, both developed and developing countries have been obligated to reduce carbon emissions, underscoring the significance of technological cooperation. She emphasized that technological innovation involves several stages: research and development, demonstration, application, and diffusion, requiring the engagement of many implementers and essential interactions at each stage. She argued that during innovation, technology must be adapted to the local environment and sometimes redesigned to suit specific conditions.

Known as RD&D, the demonstration of technology, especially new technology or technology applied in a new environment, requires public funding due to the challenges associated with private investment at the unverified stage. Dr. Son highlighted that the process from development to diffusion includes research, development, demonstration, market formation, and diffusion stages. Governments typically support the initial R&D stage, while private investment increases during the market formation stage. However, she noted that a gap often exists in public investment during the technology validation stage, creating a bottleneck in the innovation process. Therefore, she advocated for the sharing of resources, risks, and values between the public and private sectors when new technology or technology needs to be applied in a new environment. Similarly, she stressed the importance of sharing resources, risks, and values between countries to address internationally common issues like climate change.

In her presentation, Dr. Son pointed out that there is a gap in the project cycle for climate technology cooperation, spanning from demand identification to project concept development, feasibility study, and project implementation. This process, she argued, requires substantial resources for project development, making funding difficult to secure. To address this, she mentioned that the UNFCCC established financial mechanisms like the GCF, with its secretariat in Songdo, Incheon, South Korea, in June 2013. For practical technical support between countries, the CTCN was established as the implementation body of the technology mechanism, with its secretariat at the UN Campus in Copenhagen, Denmark.

Dr. Son detailed that the GCF supports the Readiness Program and Project Preparation Facility (PPF), which provides up to 1.5 million USD for capacity building and feasibility studies to

prepare for funding projects. The GCF, she explained, operates larger-scale projects with complex structures, requiring official requests and letters from the NDA, the national communication channel with the GCF, for project implementation. Proposals are received through Accredited Entities (AEs), which must design projects based on the recipient country's needs and create proposals accordingly. GCF projects may include grants, loans, and investments, making the review and approval by each country's NDA critical. She noted that NDAs typically belong to the ministry responsible for national finances, with Thailand's NDA being the Ministry of Natural Resources and Environment.

In conclusion, Dr. Son outlined that this workshop session aims to identify the demand for Thailand’s hydrogen project and discuss how to expand and connect the current CTCN TA to the next stage. She called for deep consideration from all participants on transitioning the current CTCN TA to the next step. Inputs from NXPO, the body responsible for the current CTCN TA, the NDA, the Ministry of Natural Resources and Environment, and various public and private stakeholders are necessary. She stated that the scope of the CTCN TA includes reviewing the status and necessity of applying hydrogen technology in Thailand and developing policies for hydrogen technology development and application. Once the policy foundation for hydrogen technology in Thailand is established, she proposed considering specific hydrogen projects Thailand wants, possibly requiring an RD&D stage to locally apply the technology before moving directly to a GCF project.

[Figure 3-6] Presentation of Dr. Jihee Son

Source: Son (2024)[8]

[8] Son, J., 2024, Introduction of Green Climate Fund & Next Step of the Project, CTCN TA Capacity Building

4. Accredited Entities and Cases of Technology Financing

[Dr. Soeun Kim, Researcher, National Institute of Green Technology, Korea]

The presentation, delivered by Dr. Soeun Kim, explored the roles and activities of AEs within the GCF framework. It highlighted various cases of technology financing, focusing on both international and Korean entities and their contributions towards green technology and climate resilience.

According to Dr. Kim, the GCF was a critical global initiative aimed at addressing climate change by allocating resources for projects that mitigate and adapt to its impacts. By partnering with various entities, the GCF ensured effective resource allocation and the implementation of climate-related projects. The GCF employed a partnership approach, working closely with AEs to channel funds and execute projects. This collaboration was essential for the successful deployment of resources for sustainable and climate-resilient development. She further explained the importance of AEs in implementing projects using GCF funds. These entities included multilateral, regional, and national institutions with expertise in areas such as clean energy, sustainable transport, urban development, and climate resilience.

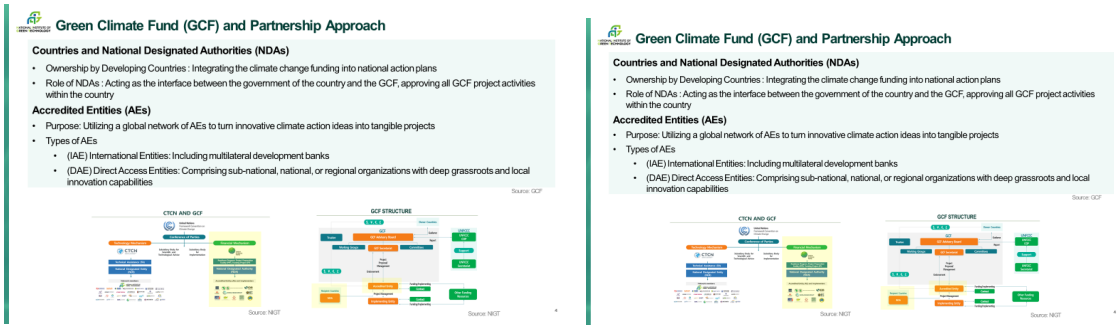
In addition, Dr. Kim introduced several international and Korean entities advancing climate resilience and green technology in Thailand. For international entities presenting in Thailand, the Asian Development Bank (ADB) focused on clean energy, sustainable transportation, urban development, and climate resilience. The International Finance Corporation (IFC) emphasized private sector development in infrastructure, manufacturing, agribusiness, services, and financial markets in over 100 developing countries. The UNDP supported low-carbon energy solutions, grid-connected renewable energy, energy-efficient buildings, and emission reduction from deforestation in developing countries. Among Korean entities, the Korea Development Bank (KDB) has experience in developing two GCF projects. The Korea

Workshop, May 21, 2024, Bangkok, Thailand.

International Cooperation Agency (KOICA) collaborated with GCF on low-emission and climate-resilient projects. SK Securities, recently accredited in October 2023, is preparing to secure project funding.

The presenter concluded that the partnership between the GCF and AEs was crucial for advancing global climate initiatives. The diverse projects and programs led by these entities underscored the multifaceted approach needed to tackle climate change effectively. By leveraging the strengths of both international and national entities, significant strides could be made towards a sustainable and climate-resilient future.

[Figure 3-7] Presentation of Dr. Soeun Kim



Source: Kim (2024)[9]

5. Panel Discussion

During the workshop, an expert panel discussion was conducted with local experts to draft a GCF concept note for the upcoming hydrogen demonstration project in Thailand as part of the CTCN TA project. The panel included three experts: Dr. Thana Sornchamni from the Thailand Hydrogen Club, Mr. Wissarut Muangpluem from the Thailand Ministry of Climate Change and Environment, and Ms. Sukanya Thongthumrong from UNDP Thailand.

[9] Kim, S., 2024, Accredited Entities & Cases of Technology Financing, CTCN TA Capacity Building Workshop, May 21, 2024, Bangkok, Thailand.

The experts emphasized that Thailand is making various efforts to address climate change and transition to a sustainable energy ecosystem. They highlighted that hydrogen technology could play a crucial role in Thailand's energy sector to reduce carbon emissions and enhance energy security. Additionally, the adoption of hydrogen technology could strengthen Thailand's response to environmental regulations such as Europe's Carbon Border Adjustment Mechanism (CBAM), create high-added value at various stages of the value chain, and provide significant benefits to Thai society through the high utilization of hydrogen-based gas turbines.

However, the experts also expressed concerns about several challenges in adopting hydrogen technology in Thailand. First, they noted that the current high costs of hydrogen production make it economically uncompetitive. Therefore, it is essential to achieve economies of scale through technological advancements and large-scale production demonstrations. Additionally, although green hydrogen is currently produced in the central and northeastern regions of Thailand, the demand is concentrated in the eastern region, highlighting the need for cost-effective transportation methods from production sites to usage sites. The experts argued that private companies need to develop technology and infrastructure to use hydrogen as an energy source. For this, the government must address legal and regulatory barriers and promote pilot projects through support and cooperation. They also emphasized the need for financial support to secure the necessary funds to commercialize hydrogen technology.

According to the experts, the Thai NDA has been collaborating with the GCF since 2015, strengthening domestic expertise through readiness support and funding proposals. This collaboration aids in drafting project concept notes, managing the approval process, and improving access to financial mechanisms. The panel revealed that Thailand is conducting secondary support projects from 2024 to 2027, prioritizing energy utilization, agriculture and waste management, security system enhancement, financial mechanism accessibility, and public awareness. While there have been no specific requests for hydrogen-related projects, they are working with experienced AEs to plan GCF projects. The UNDP expert mentioned that they are collaborating with the Ministry of Finance to list companies interested in climate

change and green initiatives and promote co-financing between similar projects and companies. Although there are currently no certified AEs in Thailand, organizations such as the Mekong River Commission, EXIM Bank, KBank, and the Environmental Fund are preparing for certification.

Finally, the experts summarized that Thailand must actively adopt hydrogen technology to address climate change and achieve sustainable energy transition. They called for collaboration between private companies and the NDA to overcome technical, legal, and financial barriers and to receive necessary support through cooperation with international organizations.

Section 5. The Results of the Satisfaction Survey

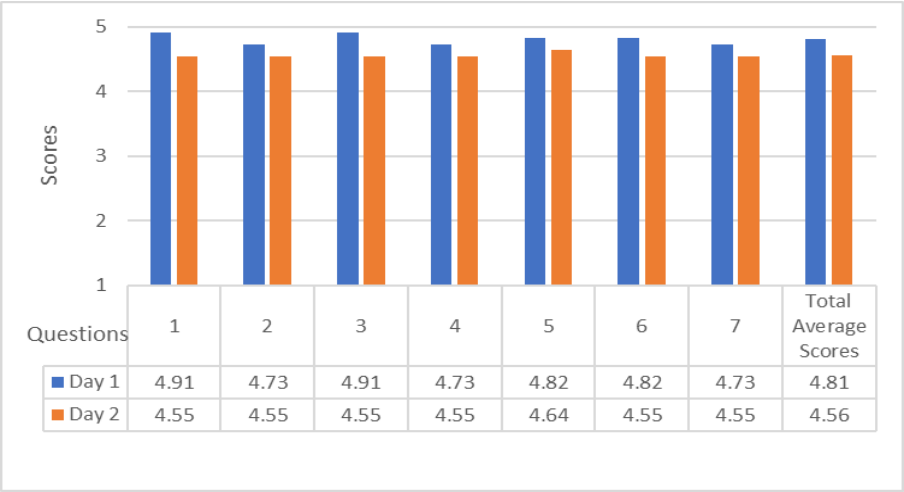
To evaluate the overall process and quality of the Capacity Building Workshop, a satisfaction survey was conducted on workshop attendees. It was conducted online using Google Forms (see Appendix 3), and a total of 26 responses were collected, including 12 attendees from the first day and 14 attendees from the second day. The questionnaire included overall satisfaction, operating procedures, content composition and quality, networking effectiveness, etc. A scale of 1 ~ 5 points was applied to each question depending on the level of satisfaction. The survey results showed a high level of satisfaction with an average of 4.81 points on Day 1 and 4.56 points on Day 2. Table 3-1 illustrates the survey results[10].

[10] There were other opinions that it would be good to have a case study that includes various examples in relation to the presentation content.

<Table 3-1> Satisfaction Survey Results

Questionnaire		Scores						
			Satisfied ← → Dissatisfied					Avg.
			5	4	3	2	1	
1	How satisfied are you with the overall experience of the workshop?	Day 1	11	1				4.91
		Day 2	9	5				4.55
2	How relevant and useful did you find the content presented in the workshop sessions?	Day 1	9	3				4.73
		Day 2	9	5				4.55
3	How would you rate the quality of the presentations given by the speakers?	Day 1	11	1				4.91
		Day 2	9	5				4.55
4	How satisfied are you with the Q&A sessions and the responses provided by the speakers?	Day 1	9	3				4.73
		Day 2	9	5				4.55
5	How would you rate the organization and logistics of the workshop?	Day 1	10	2				4.82
		Day 2	10	4				4.64
6	How satisfied are you with the networking opportunities provided during the workshop?	Day 1	10	2				4.82
		Day 2	9	5				4.55
7	Was the duration and timing of the workshop appropriate?	Day 1	9	3				4.73
		Day 2	9	5				4.55
Total Average Scores		Day 1	4.81					
		Day 2	4.56					

[Figure 3-8] Satisfaction Survey Results



Chapter 4. Conclusion and Recommendations

This CTCN TA project provided two capacity building programs on hydrogen technology, policy, and business for stakeholders in Thailand. The first program was a field trip to hydrogen production facilities in Korea and the second program was a 2-day workshop in Thailand. The field trip focused on biomethane-based hydrogen production, which has high potential in Thailand, aiming to enhance understanding of effective hydrogen infrastructure installation. The 2-day workshop in Thailand featured expert presentations on key hydrogen policies, international cooperation strategies, technologies, and businesses, along with the national hydrogen strategy developed as part of this TA project. The workshop concluded successfully with high satisfaction rates.

The capacity building programs provided through this CTCN TA project are expected to contribute to enhancing the understanding of hydrogen as a climate change mitigation tool among stakeholders in Thailand. However, it is deemed necessary that continuous capacity building programs on hydrogen be planned and provided to stakeholders through international organizations like CTCN or local hydrogen experts in the future. Capacity is typically enhanced not just through one-off programs but can improve over the long term. Especially in the case of hydrogen, while it is becoming a global focus, related technologies, and policies are relatively new compared to other energy sources, necessitating ongoing efforts for capacity building.

When planning future capacity building programs, it is also necessary to consider conducting them in a manner that provides a deeper understanding of hydrogen-related policies and businesses. This CTCN TA project planned and implemented capacity building programs in a direction aimed at providing foundational knowledge across as many areas as possible, given the limited budget and time constraints. As a follow-up to this capacity building program, conducting specific case-based capacity building workshops focusing on examples and achievements of hydrogen policies and businesses in major countries could further enhance the capacity of stakeholders in Thailand.

References

Choi, G., 2024, Introduction of Hydrogen Policies of Korea and Other Countries, Capacity Building for Hydrogen Policymakers of Thailand, CTCN TA Capacity Building Workshop, May 20, 2024, Bangkok, Thailand.

Kim, S., 2024, Accredited Entities & Cases of Technology Financing, CTCN TA Capacity Building Workshop, May 21, 2024, Bangkok, Thailand.

Park, C. H., 2024, Development of a National Hydrogen Strategy and Action Plan for Accelerating Thailand's Net-zero Target, Capacity Building for Hydrogen Policymakers of Thailand, CTCN TA Capacity Building Workshop, May 20, 2024, Bangkok, Thailand.

PTT & Hydrogen Thailand, 2024, Hydrogen Thailand Club and Its Efforts, CTCN TA Capacity Building Workshop, May 21, 2024, Bangkok, Thailand.

Shin, H., 2024, Introduction on Hydrogen Cooperation Strategies in Korea, CTCN TA Capacity Building Workshop, May 20, 2024, Bangkok, Thailand.

Son, J., 2024, Introduction of Green Climate Fund & Next Step of the Project, CTCN TA Capacity Building Workshop, May 21, 2024, Bangkok, Thailand.

Yeo, J., 2024, Hydrogen Production Business Model: Case Study of Chungju Green Hydrogen Mother Station in South Korea, CTCN TA Capacity Building Workshop, May 21, 2024, Bangkok, Thailand.

UNFCCC, 2010, Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010: Addendum Part Two: Action Taken by the Conference of the Parties at its sixteenth session. https://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf (accessed on May 3, 2024)

Appendix 1. Program of CTCN TA Capacity Building Workshop

1. Day 1: May 20, 2024

Agenda

CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen Policymakers of Thailand)

Monday 20th May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

09:30 - 10:00	Registration (Coffee and snack are provided)
10:00 - 10:10	Opening Remarks (Video, pre-filmed) ○ Dr. Sanghyup Lee (President, NIGT)
10:10 - 10:20	Welcoming Remarks ○ Dr. Kitipong Promwong (President, NXPO)
10:20 - 10:50	Introduction to CTCN, Technical Assistance, and NIGT ○ Dr. Jihee Son (Head of Center for Global Strategy, NIGT) with interpreter
10:50 - 11:10	Souvenir and Group Photo
11:10 - 12:00	[Session 1: TA project and Draft Hydrogen Strategy] • Overview on the progress of the CTCN TA Project and the draft Hydrogen Strategy prepared by NIGT ○ Dr. Chul Ho Park (Director General, NIGT) with interpreter • Q&A Session
12:00 - 13:00	Lunch
13:00 - 14:00	[Session 2-1: Hydrogen Policies and Cooperation Strategies] • Introduction of Hydrogen Policies of Korea and other countries ○ Dr. Gobong Choi (Senior Researcher, NIGT/with interpreter) • Introduction on Hydrogen Cooperation Strategies ○ Dr. Hyunha Shin (Researcher, NIGT/with interpreter)
14:00 – 14:15	Coffee Break
14:15 - 14:55	[Session 2-2: Hydrogen-related Research and Technologies of Thailand] • Introduction to Hydrogen Research in Thailand • Introduction of Hydrogen-related Technologies of Thailand ○ Prof. Dr. Navadol Laosiripojana (The Joint Graduate School of Energy and Environment, KMUTT)
14:55 - 15:15	Q&A for Sessions 2-1 & 2-2
15:15 - 15:30	Conclusion and Closing Remarks ○ Dr. Surachai Sathitkunarat (Vice president, NXPO/ Representative NDE Thailand) ○ Dr. Chul Ho Park (Director General, NIGT/with interpreter)

Note: The schedule is subject to modification without notice.

2. Day 2: May 21, 2024

Agenda

CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen-related Business Stakeholders of Thailand)

Tuesday 21st May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

09:30 - 10:00 Registration (Coffee and snack are provided)

10:00 - 10:10 Opening Remarks (Video, pre-filmed)

- Dr. Sanghyup Lee (President, NIGT)

10:10 - 10:20 Welcoming Remarks

- Dr. Kitipong Promwong (President, NXPO)

10:20 - 10:40 Souvenir and Group Photo

10:40 - 11:50 [Session 1: Hydrogen Production Business Model and Applicability to Thailand]

- Hydrogen Production Business Model
  - Dr. Junho Yeo (Researcher, NIGT) with interpreter)
- Introducing Hydrogen Club Thailand and its efforts
  - Dr. Thana Sornchamni (Manager, New Energy Technology Research Department, PTT Public Company Limited)
  - Mr. Satthawut Suwanthitirat (BCG Business Development Section Manager, BIG)
- Q&A Session

11:50 - 13:00 Lunch

13:00 - 14:00 [Session 2: Hydrogen Finance Opportunities]

- Introduction to Climate Technology Finance Mechanisms: Focus on GCF
  - Dr. Jihee Son (Head of Center for Global Strategy, NIGT) with interpreter)
- Accredited Entities and Cases of Technology Financing
  - Dr. Soeun Kim (Researcher, NIGT) with interpreter)

14:00 - 14:15 Coffee Break

14:15 - 15:30 Panel Discussions on Hydrogen-related Demonstration Projects and its Financing Opportunities / English session

- Mr.Wissarut Muangpluem (Environmentalist Professional Level, Department of Climate Change and Environment)
- Dr. Thana Sornchamni (Manager, New Energy Technology Research Department, PTT Public Company Limited)
- Ms. Sukanya Thongthumrong, United Nations Development Programme (UNDP)
- Moderate by Dr. Jihee Son (NIGT)

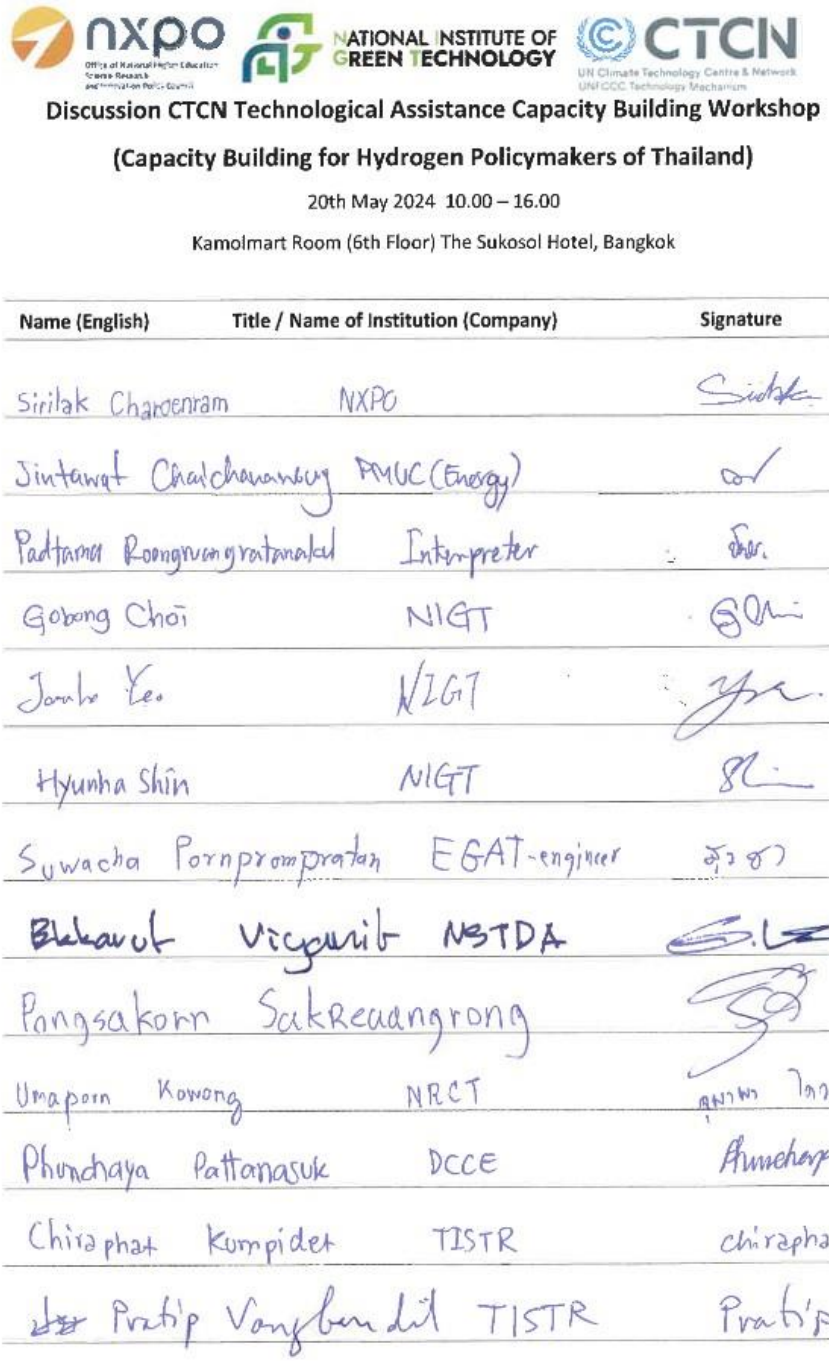
15.30 - 15.40 Conclusion and Closing Remarks

- Dr. Surachai Sathitkunarat (Vice president, NXPO/ Representative NDE Thailand)
- Dr. Chul Ho Park (Director General, NIGT/with interpreter)

Note: The schedule is subject to modification without notice.

Appendix 2. List of Workshop Participants

1. Day 1: May 20, 2024



Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen Policymakers of Thailand)

20th May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Sirilak Charoenram	NXPO	
Jintawat Chaichanawong	PMUC (Energy)	
Padtarma Roongruangratanakul	Interpreter	
Gobong Choi	NIGT	
Jaeho Yeo	NIGT	
Hyunha Shin	NIGT	
Suwacha Pornpromprataan	EGAT-engineer	
Bhakavat Vigsurib	NSTDA	
Pongsakorn Sakreuangrong		
Umaporn Kowong	NRCT	
Phunchaya Pattanasuk	DCCE	
Chiraphat Kumpidet	TISTR	
Pratip Vongbundit	TISTR	

Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen Policymakers of Thailand)

20th May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Jitsuna Darachai	Researcher / NXPO	Jitsuna
Doungkamon Phihusut	Policy developer / NXPO	
Pojana Silsmit	Administrative Officer	
Praepraphan Nakyuti	NXPO	
Chutima Suwanprasert	DCCE	
Supattra Daramas	DCCE	
Chul HO Park	NIGT	
Sararanee Singtong	NXPO	Sararanee S.
Thitiporn Pholdee	EGAT	
SIRICHAI KOONAPHAPDEEKIT	CMU	
Pongsatan Sricompa	sathorn	Sathorn
Suradej Sathitwanit	NXPO	
Pongsak MANCHAROEN	EGAT	

Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen Policymakers of Thailand)

20th May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Soeun Kim	Researcher / NIGT	[signature]
Jihee Son	Director / NIGT	[signature]
NANTHAPORN RUCHIKACHORN	Interpreter	[signature]
Apanee Luengnaruemitchai	PMUC	[signature]
Miss Ruttiyabon Ponthongkwa	PMUC	[signature]
Pariya Phuaksuk	Engineer	[signature]
Neeracha Thaiyai	NSET / Project Development	[signature]
Suwimol Wongsakulphasatch	KMUTNB	[signature]
PIJAYA NA BANGXANG	EGAT	[signature]
JITRAPORN INCHUNJIN	EGAT	[signature]
Papak Phitsuwan	[illegible]	[signature]
Visarn Lilavivat	ENTEC	[signature]
Kullachart Korpattanawong	MTEC	[signature]

Discussion CTCN Technological Assistance Capacity Building Workshop

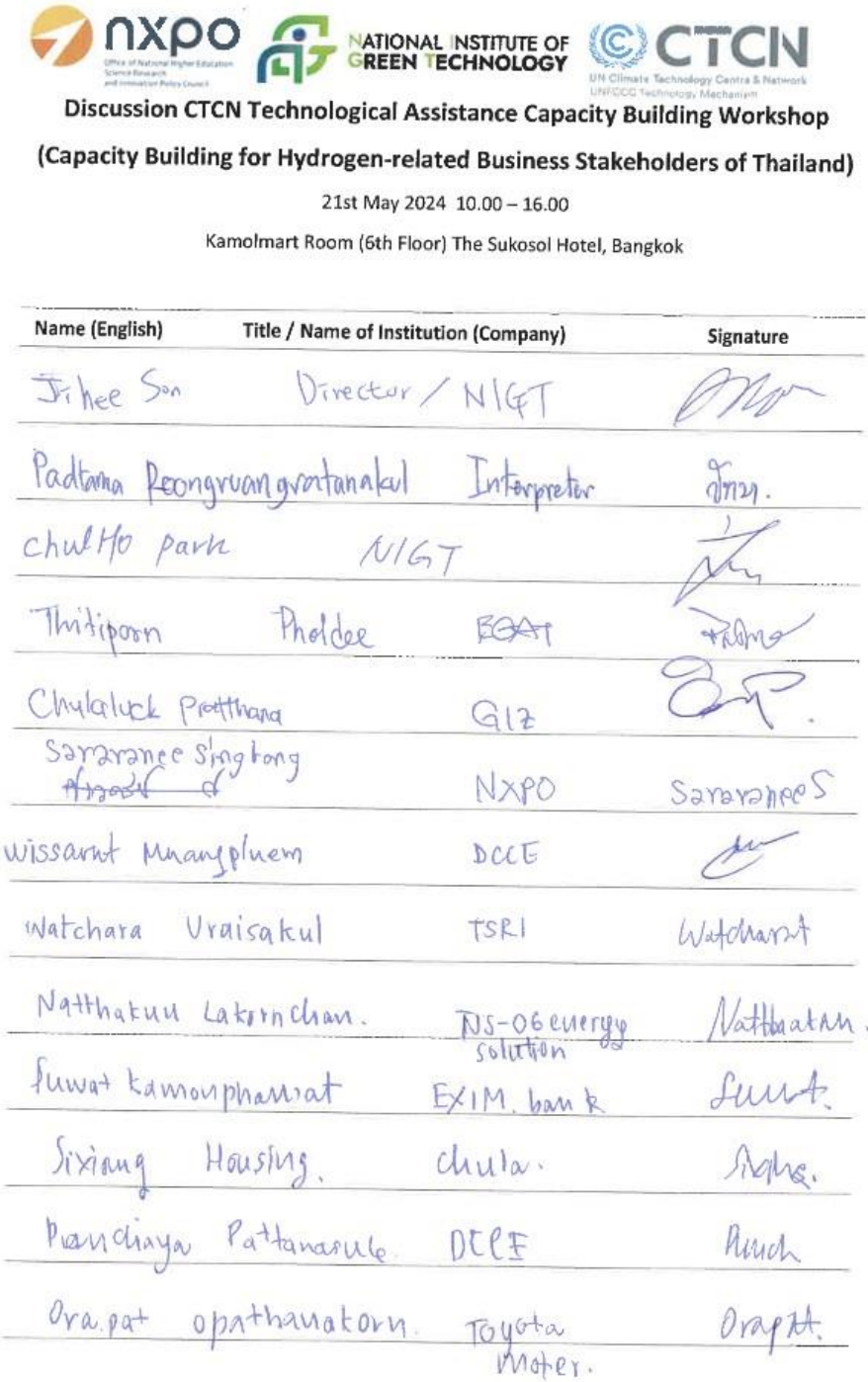
(Capacity Building for Hydrogen Policymakers of Thailand)

20th May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Natthamon Suwannaprom	NXPO	
Somrit Buddhanbut	MSTDA	
Sitti Mungkalarn	MTEC	
Nandal Laosiripojana	KMUTT	
Dr. Kittipong Promnong	NXPO president	

2. Day 2: May 21, 2024



Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen-related Business Stakeholders of Thailand)

21st May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Jihee Son	Director / NIGT	
Padtama Reongruangvantanakul	Interpreter	
chulHo park	NIGT	
Thitiporn Pholdee	EGAT	
Chulaluck Prutthana	GIZ	
Sararanee Singkong	NXPO	SararaneeS
wissarut Muangpluem	DCCE	
Watchara Uraisakul	TSRI	Watcharat
Natthakun Lakorncharn.	NS-06 energy solution	Natthakun.
Suwat Kamonpharnat	EXIM bank	Suwat.
Sixiang Housing.	chula.	Sixiang.
Pranchaya Pattanasuk	DEEP	Pranch
Orapat opathanakorn.	Toyota Motor.	Orapat.

Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen-related Business Stakeholders of Thailand)

21st May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Sirilak Charoenram	NXPO	
Soeun Kim	NIGT	
NANTHAPORN RUCHIKACHORN	Interpreter	
Doungkamon Phibusut	NXPO	
CHALERM KAKANUTAPORN	PTI	
Pariya Phuaksuk	EGAT	
Wittawat Wulyapash	UNIDO	
Natamol Thitithawida	NXPO	
Natthalucan Laoronham	NSBT	
patcharin Najui	NXPO	
Gobong Choi	NIGT	
Sunacha Pornprompatan	EGAT	
Piyawan Suwattanathum	EGEI	

Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen-related Business Stakeholders of Thailand)

21st May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
JITSUNA DARACHAI	Researcher / NXPO	Jitsuna
FOJANA SILSMIT	EGAT	Pjana
Hyunha Shin	NIGT	
(Thanarak Phongphetra)	FTI	
(saralee Phokphirom)	ETI	
Jamh Yeo	NIGT	
Phunchaya Pattanasuk	DCCE	Phunchaya
Kritiya Kaspanich	UNIDO	Kritiya
Savanit Boongasuwat	FTI	
Suwinol Wongsakulphasatch	KMUTNB	
Nitisak intisaeng	MEIDEAD	
Pongsadon Sricompa	MEIDEAD	
Pitchakorn Waengsanthia	Meidea.D	

Discussion CTCN Technological Assistance Capacity Building Workshop

(Capacity Building for Hydrogen-related Business Stakeholders of Thailand)

21st May 2024 10.00 – 16.00

Kamolmart Room (6th Floor) The Sukosol Hotel, Bangkok

Name (English)	Title / Name of Institution (Company)	Signature
Dr. Kittipong Promwong	NXPO President	[signature]
(Nirawat Narod) นิรวัฒน์ นรด.	FTI	[signature]
(Satthawut Suwanthitirat) เศรษฐวุฒิ สุวรรณฐิติรัตน์	BIG	[signature]
THANA SCRNCHAMNI	PTT	[signature]
SUCHAI BURANAVALAHOK	GGGI	[signature]
UMA WIRUTSKULSHAI	UNIDO	[signature]
Dr. Angkana Khuenpetch	TISTR	[signature]
Dr. Surachai Sathitkunarat	Vice president, NXPO	[signature]
Witsarut Duangchinda	FTI	[signature]
Chukit Qunjitti	FTI	[signature]
Sakanya Thythuras	UNDP	[signature]
Dr. Chanida Sansaard	NXPO	[signature]

Appendix 3. Satisfaction Survey Questionnaire

Satisfaction Survey for CTCN Technological Assistance Capacity Building Workshop

- **Workshop Information:**
  - **Event:** CTCN Technological Assistance Capacity Building Workshop
  - **Dates:**
    - Capacity Building for Hydrogen Policymakers of Thailand: May 20, 2024
    - Capacity Building for Hydrogen-related Business Stakeholders of Thailand: May 21, 2024
  - **Location:** Kamolmart Room (6th Floor), The Sukosol Hotel, Bangkok

* Indicates required question

CTCN Technological Assistance Capacity Building Workshop

Please indicate which date you attended. *

- [ ] Capacity Building for Hydrogen Policymakers of Thailand: May 20, 2024
- [ ] Capacity Building for Hydrogen-related Business Stakeholders of Thailand: May 21, 2024

1. Overall Satisfaction with the Workshop: *

How satisfied are you with the overall experience of the workshop?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

2. Content Relevance and Usefulness: *

How relevant and useful did you find the content presented in the workshop sessions?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

3. Quality of Presentations: *

How would you rate the quality of the presentations given by the speakers?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

4. Q&A Sessions: *

How satisfied are you with the Q&A sessions and the responses provided by the speakers?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

5. Workshop Logistics and Organization: *

How would you rate the organization and logistics of the workshop (e.g., registration process, venue, schedule)?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

6. Networking Opportunities: *

How satisfied are you with the networking opportunities provided during the workshop?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

7. Workshop Duration and Timing: *

Was the duration and timing of the workshop appropriate?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied

8. Suggestions for Improvement: (optional)

Please provide any suggestions for improving future workshops:

Your answer

9. Most Valuable Session: *

Which session did you find the most valuable? (Multiple selections possible)

- [ ] Introduction to CTCN, Technical Assistance, and NIGT
- [ ] Overview on the progress of the CTCN TA Project and the draft Hydrogen Strategy
- [ ] Hydrogen Policies and Cooperation Strategies
- [ ] Hydrogen-related Research and Technologies of Thailand
- [ ] Hydrogen Production Business Model and Applicability to Thailand
- [ ] Hydrogen Finance Opportunities: Focusing on GCF
- [ ] Panel Discussions on Hydrogen-related Demonstration Projects and its Financing Opportunities

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Appendix 4. Gallery

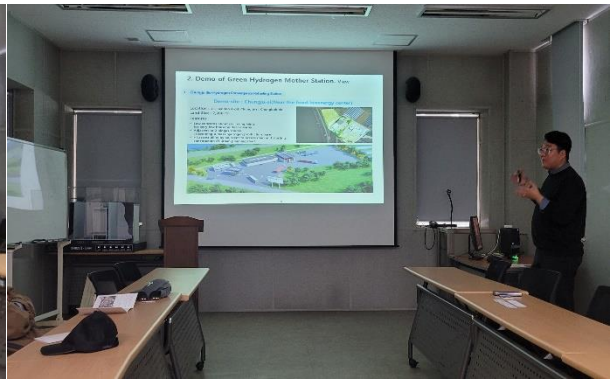
1. Field Trip to Hydrogen-related Facilities in Korea

-Day 1: April 1, 2024




-Day 2: April 2, 2024





2. 2-Day Capacity Building Workshop in Thailand

- Day 1: May 20, 2024








- Day 2: May 21, 2024



Hydrogen
Thailand
Club and
its efforts


Cases of Technology Financing


(Capac


CTCN Technological Assistance
Capacity Building Workshop