Technical Assistance Closure Report Template

Objective of the technical assistance (TA) Closure Report:

- To communicate publicly in one document a summary of progress made and lessons learned during the TA towards the anticipated impact (sections 1-4).
- To document qualitative and quantitative data collected during TA, for use in donor and UN reporting (Annex 1).

Steps for completing the TA closure report:

1. The lead TA implementer submits the closure report at the end of the technical assistance as a final deliverable. The TA closure report will capture outputs, outcomes and impacts of all activities conducted under the TA. Please copy and summarise relevant material from previous TA outputs/deliverables and the Response Plan, as relevant.
2. A CTCN Manager will review and revise the closure report before final approval by the CTCN Deputy Director.

Important note on public and internal use of the closure report:
Once approved by the CTCN Deputy Director, the TA closure report will be a public document available on the CTCN website www.ctc-n.org. Selected content will be used for targeted communication activities. Annex 2 is for internal use only and will not be publicly available.

Closure Report for CTCN Technical Assistance

1. Basic information

Title of response plan	Development of a national hydrogen strategy and action plan for accelerating Thailand's net-zero target
Technical assistance reference number	CTCN 22-013
Country / countries	Thailand
NDE organisation	The Office of National Higher Education Science Research and Innovation Policy Council (NXPO)
NDE focal point	Dr. Surachai Sathitkunarat
NDE contact information	surachai@nxpo.or.th
Proponent focal point and organisation	Dr. Surachai Sathitkunarat, The Office of National Higher Education Science Research and Innovation Policy Council (NXPO), surachai@nxpo.or.th
Designer of the response plan	Dr. Chul Ho Park, National Institute of Green Technology (NIGT), park5085@nigt.re.kr
Implementer(s) of technical assistance	National Institute of Green Technology (NIGT)
Beneficiaries	The Office of National Higher Education Science Research and Innovation Policy Council (NXPO)
Sector(s) addressed	Agriculture, Industry, Renewable Energy, Transport
Technologies supported	Establishing national strategy
Implementation start date	01/10/2022
Implementation end date	30/06/2024

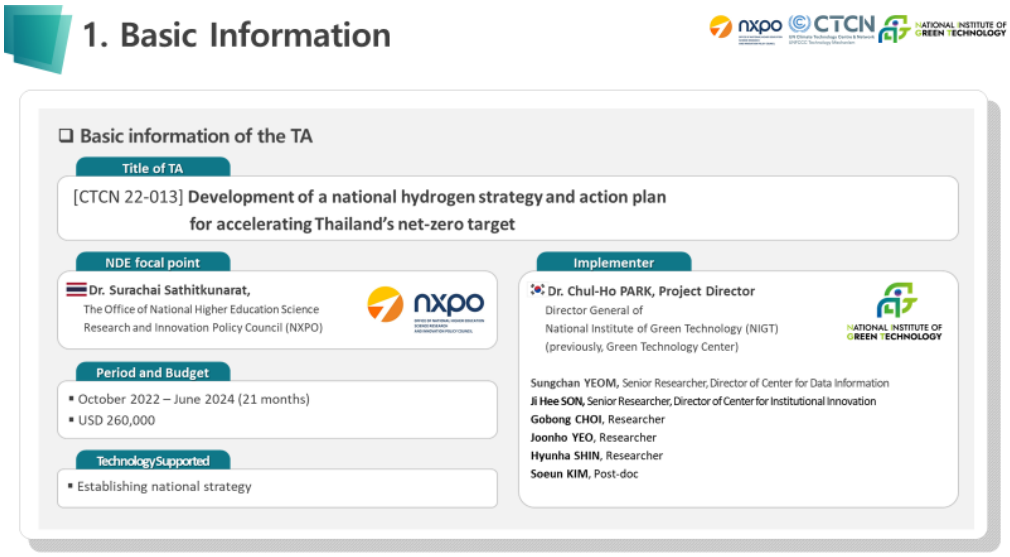
Total budget for implementation	USD 260,000
Description of delivered outputs and products as well as the activities undertaken to achieve them. In doing so, review the log frame of the original response plan and refer to it as appropriate	The followings were successfully performed and delivered: • Detailed implementation plan (Deliverable 1). • Consolidated assessment report on the potential use of hydrogen in three key economic sub-sectors in Thailand (Deliverable 2). • Comprehensive report on hydrogen production: resources, technologies, and cost analysis (Deliverable 3). • National hydrogen strategy and action plan for Thailand (Deliverable 4.1). • Draft of the GCF Concept Note (Deliverable 4.2). • Capacity building workshop and workshop report (Deliverable 5).
Methodologies applied to produce outputs and products	The following methodologies were adopted: • Estimation of climate benefits. • Surveys and semi-structured interviews with Thai hydrogen experts. • Case studies.
Reference to knowledge resources	NA
Deviations	NA
Anticipated follow-up activities and next steps	The following are some possible next steps: • Submission of a draft strategy developed by the NDE to the Thai government. • Follow-up discussions on the funding proposal drafted with support from the CTCN/GCF. • Implementation of an RD&D project designed with the following cooperation.

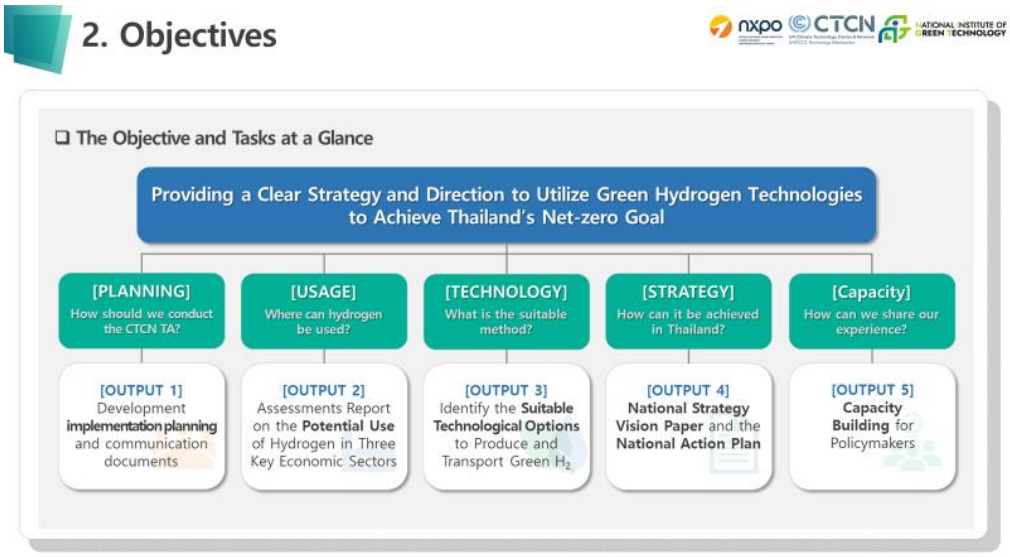
2. Lessons learned

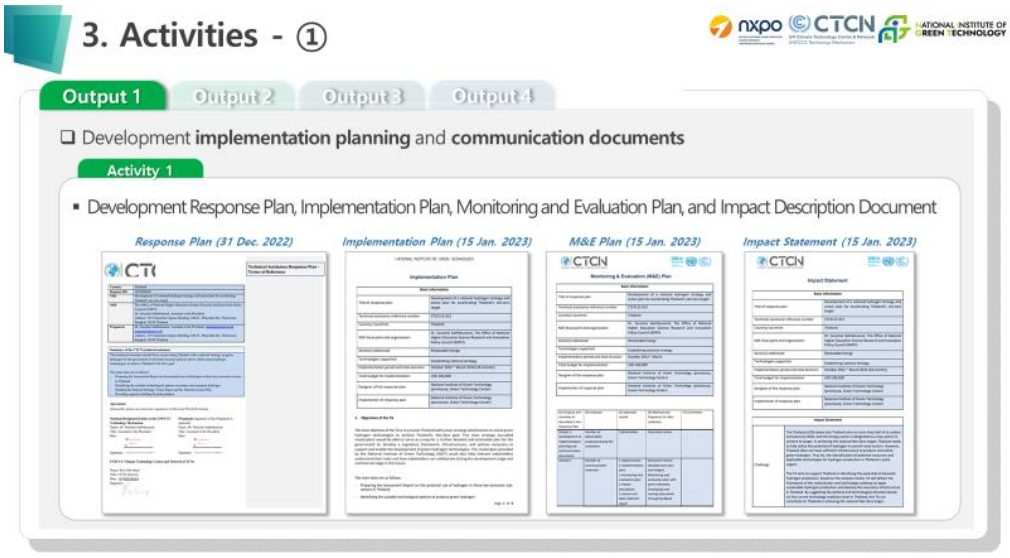
	Lessons learned	**Recommendations**
Lessons learned from the CTCN TA process	Communication with a CTCN official was effective, allowing for smooth discussions regarding the contents of deliverables, deadlines, and project extensions. However, there were difficulties due to insufficient guidelines for preparing the interim expenditure report. NDE's proactiveness toward the CTCN TA project is very important. We were able to effectively improve the quality of various outputs because the Thailand NDE was actively interested in the TA and gave a lot of feedback.	The following are recommendations: • Provision of more detailed guidelines for documentation and reports. • Active participation from CTCN in workshops and related events. • Establishing measures to facilitate interaction or enable close cooperation between the NDE and implementer(s) by CTCN. • Provision of various policy information at the TA request stage by NDEs and strengthening the policy analysis function when

	When carrying out a CTCN TA project, it is very important to obtain government data and materials in local languages. Since the results of the CTCN TA project must be in line with the policies of Thailand to a certain extent, it was necessary to obtain information about the policies that the government had been pursuing or planned to promote. Additionally, the range of materials translated into English was limited.	carrying out a TA project by proponents
Lessons learned related to climate technology transfer	The Thailand NDE showed a high level of interest in clean hydrogen technologies and provided significant assistance in engaging hydrogen-related stakeholders and various experts. There was considerable interest in producing green hydrogen using biomass. However, relevant technologies (i.e. renewable energy, hydrogen storage and transportation, hydrogen refuelling stations, etc.) to implement clean hydrogen production and utilization are considered limited, and this may act as a barrier to hydrogen production technology being established in Thailand. Additionally, there is a need to improve laws and systems for transferring climate technology. In the case of hydrogen, there are environmentally friendly aspects, but there are also dangerous aspects. Therefore, before full-scale development, introduction, and use of hydrogen technology, it is essential to check whether the relevant national systems are well established.	The following is a recommendation: • Leverage the interest in biomass-based green hydrogen production to explore and develop further collaboration opportunities. • Approaching from a systematic perspective rather than focusing on an individual climate technology at the TA project planning stage. • Checking the legal and institutional environment and providing support to safely introduce and utilize climate technology before its transfer.

3. Illustration of the TA and photos





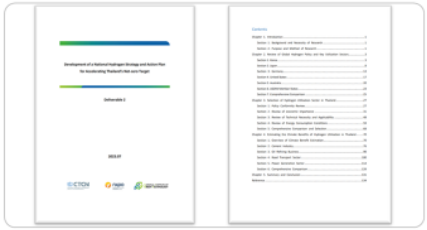


3. Activities - ②

Output 1 | **Output 2** | **Output 3** | Output 4 | Output 5

Deliverable 2

Report on the Potential Use of Hydrogen in Key Economic Sub-sectors



Deliverable 3

Report on the Suitable Technological Options to Produce Green H_2

3. Activities - ③

Output 1 | Output 2 | Output 3 | **Output 4** | Output 5

❑ **National Strategy Vision Paper** and **National Action Plan**

Activity 4

▪ Drafted a national strategy and action plan (Act. 4.1) and GCF concept note (Act. 4.2)

(Act. 4.1) National Strategy

▪ Submitted a **national action plan** including
(1) A vision of national Hydrogen strategy
(2) Tech. roadmaps

▪ **Collected opinions** from Thai experts and stakeholders

Vision and Strategies

* Source: Deliverable 4.1

(Act. 4.2) GCF concept note

▪ Drafted a **GCF concept note** on **the pilot demonstration project**

* Source: Deliverable 4.2

3. Activities - ④

Output 1 | Output 2 | Output 3 | Output 4 | **Output 5**

❑ **Capacity Building** for Policymakers

Activity 5

Workshop in Thailand

▪ Organized a **2-day workshop** in Thailand for senior policymakers from various Ministries and Offices

Workshop Agenda

Field Trip in Korea

▪ Make arrangements for a **field-trip program in Korea** to observe Korea's hydrogen-related facilities

Field-trip Program

4. Activity Photos – ①

❑ Opening Event and Kick-off Meeting






4. Activity Photos – ②

❑ Experts Interviews and Meetings / Thai Hydrogen Site Visit






4. Activity Photos – ③

❑ Field-trip to Korea and Capacity Building Workshop






4. Impact Statement

The information in the table below will be used to communicate results and anticipated impacts of this technical assistance publicly. Please copy information from impact statement developed in the M&E Plan and update as relevant.

Challenge	The Thailand LEDS states that Thailand aims to more than half of its carbon emissions by 2050, and the energy sector is designated as a key sector to achieve to target. In achieving the national Net-Zero target, Thailand needs to fully utilize the potential of hydrogen in overall social sectors. The TA successfully supported to design the blueprint of hydrogen economy development in Thailand by identifying the potential of domestic hydrogen production and delivering the framework of the national plan and technology roadmap to develop the relevant infrastructure. The next challenge would be the optimization of draft national plan and design the detailed strategy for each sector.
CTCN Assistance	This TA successfully supported hydrogen production in Thailand with following activities: ·Techno-economic assessment of hydrogen production technologies considering potential resources, technologies, geographical areas, and so on ·Establishment of a national action plan for the implementation of the best suitable application area and technologies ·Development of hydrogen technology roadmaps to efficiently adopt the hydrogen production value chain
Anticipated impact	·Enhancement of infrastructure resilience by suggesting an effective national hydrogen production plan with the following technology roadmaps ·Contribution to achieving the national Net-Zero emission target by 2065 ·Institutional capacity and coordination mechanisms in place to coordinate climate action relevant to NDE and STI policy units
Co-benefits: Achieved or anticipated co-benefits from the TA	·The TA can evoke economic development in overall sectors by stimulating the expansion of hydrogen-related industries. ·By suggesting well-organized guidelines to materialize the hydrogen economy, it contributed to Just Transition in Thailand.
Gender aspects of the TA	·The TA designed the framework of capacity building for hydrogen engineers, scientists, and policymakers and promote participation

	from women engineers, scientists, and policymakers. ·The TA offered 2-day workshop for Thailand policymakers and private stakeholders to emphasize the importance of fostering women scientists and researchers.
Anticipated contribution to NDC	·Establishment of the national plan and following technology roadmaps for developing hydrogen-related infrastructure ·Priority listing of potential hydrogen production technologies including applicable resource(s) and geographical area(s)
The narrative story	Hydrogen production and application have become one of the global trends. The importance of hydrogen and its role as a key component for reducing carbon emissions has been emphasized in all of the international agreements and national Net-Zero plans over the globe. Thailand also announced its strong ambition in achieving a Net-Zero emission target by 2065 and included hydrogen application as one of the major assignments in their national plan. For example, in New Energy Power Policy, Thailand states hydrogen is one of the seven major components to achieve carbon neutrality. Also, in Innovation Roadmap for Industrial Decarbonization, the Thailand government emphasizes the importance of hydrogen production and application and aims to apply green hydrogen on a full scale by 2050-2065. Despite its great willingness, currently, Thailand still has not formulated its national strategies for hydrogen development and has not developed related infrastructure enough. As Thailand is in the extremely early stage of hydrogen application, it is urgent to assess relevant potential resources and identify applicable technologies. In this project, we identified applicable resources for hydrogen production in Thailand and the following technologies which have high efficiency considering local conditions. Based on the result, the project suggested the draft national action plan to stimulate hydrogen application in Thailand and technology roadmaps for identified hydrogen production technologies.
Contribution to SDGs A complete list of SDGs and their targets is available here:	This CTCN TA directly contributed to the UN Sustainable Development Goal (SDG) 7: Ensure access to affordable, reliable, sustainable, and modern energy for all. This

https://sustainabledevelopment.un.org/partnership/register/	TA assessed the potential hydrogen production technologies for Thailand and promoted them to establish the relevant infrastructure for hydrogen technology development and its application by designing a proper national action plan and technology roadmaps. This TA also contributed to SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. By suggesting the framework of hydrogen application in Thailand, this TA contributed to enhance the resiliency of relevant infrastructure in Thailand and stimulate sustainable economic development in overall social sectors. Last but not least, this TA supported Thailand in terms of SDG 13: Take urgent action to combat climate change and its impacts. As hydrogen is one of the most important components to achieve the Net-Zero target, it is necessary to identify applicable technology and resource options and design a national political framework to apply them. As this TA successfully covered all the aforementioned activities, it can promote urgent action in Thailand to cope with the climate crisis.

Annex 1 Technical assistance data collection

Please add quantitative and qualitative values for the indicators selected in the M&E plan and monitored throughout the technical assistance in the tables below. Indicators which have been monitored in addition to the proposed indicators below may be added at the end of table A. Non-relevant indicators should be left blank.

A. Output and outcome indicators

Indicator Please note indicators below highlighted as **anticipated**	**Quantitative value** *Numerals only; disaggregates must sum to the total*	**Qualitative description** *List the various elements corresponding to the quantitative value as well as timelines and responsible institutions*
Total number of events organized by proponents and implementing partners	*3*	*1 Kick-off meeting* *2 Seminar on green hydrogen* *3 2-day capacity building workshop*
Number of participants in events organized by proponents and implementing partners	*317*	*1 16 participants* *2 200 participants (online+offline)* *3 101 participants*
a) Number of men	*70+*	*NA in event 2*
b) Number of women	*47+*	*NA in event 2*
Number of climate technology RD&D related events	*1*	*"Panel Discussions on Hydrogen-related Demonstration Projects and its Financing Opportunities" during 2-day Capacity Building Workshop*
Number of participants in climate technology RD&D events	*51*	
a) Number of men	*31*	
b) Number of women	*20*	
Number of training organized by proponents and implementing partners	*1*	*2-day Capacity Building Workshop*
Number of participants in trainings organized by proponents and implementing partners	*101*	
a) Number of men	*61*	
b) Number of women	*40*	
Total number of institutions trained	*25*	*(undefined: 5)*
a) Governmental (national or subnational)	*8*	DCCE, EGAT, NRCT, NSTDA, NXPO, PMUC, TISTR, TSRI, etc.
b) Private sector (bank, corporation, etc.)	*5*	*BIG, EXIM Bank, NS-OG Energy Solutions, PTT, Toyota Motors, etc.*
c) Nongovernmental (NGO, University, etc.)	*7*	*Chiang Mai University, FTI, GGGI, GIZ, King Mongkut's University of Technology North Bangkok, UNDP, UNIDO, etc.*

Percentage of participants reporting satisfaction with CTCN training (from CTCN training feedback form)	*100%*	*Satisfied= 4+ on 5-pt scale*
Percentage of participants reporting increased knowledge, capacity and/or understanding as a result of CTCN training (from CTCN training feedback form)	*100%*	*Increased knowledge, capacity and/or understanding= 4+ on 5-pt scale*
a) Percentage of men	*NA*	
b) Percentage of women	*NA*	
Total number of deliverables produced during the assistance (excluding mission, progress and internal reports)	*5*	*Excluding Implementation Plan, M&E Plan, Impact Description, and Closure Report*
a) Number of communication materials, including news releases, newsletters, articles, presentations, social media postings, etc.		
b) Number of tools and technical documents strengthened, revised or developed		
c) Number of other information materials strengthened, revised or created (For example training and workshop reports, Power Points, exercise docs etc.)	*5*	*Deliverable 2 (identifying three key sectors for hydrogen use), Deliverable 3 (hydrogen technological options), Deliverable 4.1 (national hydrogen strategy), Deliverable 4.2 (GCF concept note), Deliverable 5 (workshop report)*
Total number of policies, strategies, plans, laws, agreements or regulations supported by the assistance	*1*	
a) Adaptation related	*1*	*National Hydrogen Strategy and Action Plan*
b) Mitigation related		
c) Both adaptation- and mitigation related		
Anticipated number of policies, strategies, plans, laws, agreements or regulations proposed, adopted or implemented as a result of the TA	*1*	
a) Adaptation related	*1*	*National Hydrogen Strategy and Action Plan*
b) Mitigation related		
c) Both adaptation- and mitigation related		
Anticipated number of technologies transferred or deployed as a result of CTCN support		
Anticipated number of collaborations facilitated or enabled as a result of technical assistance	*2*	
a) Number of South-South collaborations	*1*	*NIGT (Korea), NXPO (Thailand)*
b) Number of RD&D collaborations	*1*	*NXPO, GCF, Chiang Mai University*
c) Number of private sector collaborations		
Number of countries with strengthened National System of Innovation as a result of CTCN support	*1*	*Thailand*
Insert any additional indicators here		

B. Core impact indicators

Please fill in the tables for anticipated impacts of the CTCN assistance. Every technical assistance should contribute to at least one of the indicators below. For guidance on how to report on core indicators see the '[M&E Guidance Document for TA Implementers']'.

Core indicator 1	**Anticipated metric tons of CO_2 equivalent (CO_2e) emissions reduced or avoided as a result of CTCN TA** *Please add your calculations in word or excel format as an Annex to this Closure Report, where applicable.*	
	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **on annual basis**	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **in total**
Quantitative value *(emissions reductions)*	42.79 million tCO_2e	556.31 million tCO_2e
Unit	tCO_2e	tCO_2e
GHG assessment boundary (project emissions) Identify expected post-TA activities, associated effects and assess boundary for quantification of GHG emission reductions	Applying Kaya Identity, this project estimated the GHG emissions in four carbon intensive industries identified as key industry sectors for the adoption of hydrogen as new resource in the draft hydrogen national plan, including power generation, oil refinery, road transportation, and cement. These four industry sectors were prioritized and selected based on a comprehensive analysis considering policy coherence, economic importance, technological assessment, and energy consumption. In this analysis, we considered the specification of hydrogen utilization in major policies of Thailand, value-added ratio, technological readiness with initiatives, and the share of fossil fuel usage in energy consumption.	
Baseline emissions Describe baseline scenario, baseline candidates, emission factors and emissions calculated	The Kaya Identity equation applied in this study is stated as follows: $$C = \frac{C}{E} \times \frac{E}{G} \times \frac{G}{P} \times P$$ where C indicates GHG emissions, E indicates energy consumption, G indicates GDP, and P indicates population. Therefore, according to Kaya Identity, GHG emissions (C) can be expressed as the product of GHG intensity (C/E), defined as the number of GHGs emitted per unit of energy consumed, and the energy intensity of a country's economy (E/G), GDP per capita (G/P), and population (P), and as the right-hand side of the equation shows, when all of these factors are multiplied together, only GHG emissions (C) remain, so the equation always holds. Projecting GHG emissions using Kaya Identity boils down to forecasting each factor of Kaya Identity, and then multiplying the projections for each factor to estimate future GHG emissions. If we assume that GHG intensity (C/E) is the GHG coefficient that is a fixed value over the long term, other three factors need to be projected. Furthermore, when using the projections of GDP per capita (G/P) and population (P) already projected in various national plans, an energy intensity (E/G) projection is needed. In the case of energy intensity, it is possible to estimate macroeconomic models using econometric techniques by utilizing energy intensity data from the past to the present.	
Methodology Explain the method or process of verifying the	Considering the data availability and the feasibility of analysis, modification, and supplementation, this project applied Kaya Identity for projection, a mathematical framework for estimating GHG emissions utilizing four factors including GHG emissions, energy consumption, GDP, and population. Since the GHG emissions of	

indicator and how data was gathered	the economic sector depend on the type and proportion of fuel used, this study considers GHG emissions by fuel and the level of consumption by fuel. As the power generation sector is included in this study, only direct emissions from fuel consumption were considered in estimating the GHG emissions of each economic sector. However, for the cement industry, which emits carbon dioxide from the raw materials, emissions from industrial processes and product use (IPPU) were also considered. The summation of the GHG reduction amounts among four industries shows the total amount of anticipated GHG reduction expected from the use of hydrogen.
Assumptions Describe assumptions made during calculation and quantification of GHG reductions	Based on the scenario analysis, we applied the scenario which assumes that 40% of the existing energy resources would be replaced with hydrogen. The target year is set as 2050, aligned with the target of Thailand government to achieve carbon neutrality. In addition, this project mainly considered four target industries to apply hydrogen, including cement, oil refinery, road transportation, and power generation. Moreover, as Thailand has already established and announced the Ministry of Energy's power development plan until 2037, the point to start replacing the existing source with hydrogen is assumed as 2038.

Core indicator 2	**Anticipated increased economic, health, well-being, infrastructure and built environment, and ecosystems resilience to climate change impacts as a result of technical assistance** *Please provide a **qualitative** description of the anticipated impacts on the categories below*
Infrastructure and built environment Anticipated increased infrastructure resilience (avoided/mitigated climate induced damages and strengthened physical assets)	The national strategy developed by this project fosters the development of the infrastructure and regulations required to establish a hydrogen economy. A hydrogen economy can significantly contribute to diversifying energy sources, mitigating climate risks by reducing fossil fuel usage. Also, this diversification ensures a continuous energy supply regardless of natural disasters or seasonal effects, reducing the likelihood of blackouts and associated infrastructural stress. In the transportation sector, the introduction of hydrogen vehicles can also reduce potential climate risks. Developing a network of hydrogen refueling stations not only stimulates the expansion of hydrogen application but also creates a decentralized and resilient refueling infrastructure which can promote sustainable energy supply chains.
Ecosystems and biodiversity Anticipated increased ecosystem resilience (areas with increased resistance to climate-induced disturbances and with improved recovery rates)	By transitioning to green hydrogen, the reliance on fossil fuels can be reduced, which allows to lower greenhouse gas emissions and mitigate climate change impacts that threaten ecosystems. This shift not only reduces the carbon footprint but also minimizes air and water pollution, leading to healthier ecosystems with improved resistance to climate-induced disturbances.
Economic Anticipated increased economic resilience (e.g. less reliance on vulnerable economic sectors or diversification of livelihood)	The development of hydrogen economy can contribute to reducing carbon emissions in the industry sector by stimulating the transformation of existing carbon-intensive industries, which promotes the shift to a sustainable economic framework based on renewable energy resource. Also, a draft national strategy emphasizes continuous innovation and technological development in the green hydrogen sector. By

	fostering a culture of research and innovation, the economy can benefit from technological advancements that improve efficiency, reduce costs, and create new business opportunities. This can lead to the emergence of new industries and services, further diversifying the economic base. In addition, the development of hydrogen economy creates a wide range of jobs, from research and development to manufacturing, infrastructure development, and maintenance. This not only provides new employment opportunities but also necessitates the development of a skilled workforce. Investment in education and training programs related to green hydrogen technologies leads to a more adaptable and skilled labor market, better equipped to meet future economic challenges.
Health and wellbeing Anticipated increased health and wellbeing of target group (e.g. improved basic health, water and food security)	By stimulating the expansion of hydrogen usage in the transportation and industry sectors, the development of a hydrogen economy can contribute to reducing overall carbon emission in Thailand, resulting in improved air quality. Burning fossil fuels releases harmful pollutants such as particulate matter, nitrogen oxides, and sulfur dioxide, which contribute to respiratory and cardiovascular diseases. The transition from existing fossil fuel economy to a hydrogen economy enables the improvement of air quality and the reduction of health issues like asthma, bronchitis, and heart disease. This cleaner air environment promotes better overall health and reduces healthcare costs associated with treating pollution-related illnesses.

Core indicator 3	**Anticipated number of direct and indirect beneficiaries as a result of the TA**	
	Quantitative value	**Means of verification**
Total beneficiaries	*150*	
Number of adaptation beneficiaries	*150*	*Number of participants in the capacity building workshop + number of co-workers of the participants*
Number of mitigation beneficiaries		
Number of adaptation-and mitigation beneficiaries		

Core indicator 4	**Anticipated amount of funding/investment leveraged (USD) as a result of TA (disaggregated by public, private, national, and international sources, as well as between anticipated/confirmed funding)**			
	Quantitative value confirmed *in USD*	**Quantitative value anticipated** *in USD*	**Qualitative description** *List the institutions, timelines, and description or title of the investment*	**Methods** *Describe methods used for quantificatio*

				n of funds leveraged
Total funding		*28,500,000*	*GCF Grant, "Waste to Energy Promotion in Campuses and Small Cities", 4 years of estimated project duration*	*Proposed organic waste-to-biogas project requires significant initial investments in facilities, technologies, etc.*
Anticipated amount of public funding mobilised from national/domestic sources				
Anticipated amount of public funding mobilised from international/ regional sources		*28,500,000*	*GCF Grant, "Waste to Energy Promotion in Campuses and Small Cities", 4 years of estimated project duration*	*Proposed organic waste-to-biogas project requires significant initial investments in facilities, technologies, etc.*
Anticipated amount of private funding mobilised from national/domestic sources				
Anticipated amount of private funds mobilised from international/regional sources				

Annex 2 (for internal use – to be filled in by the CTCN)

CTCN evaluation

This section will be completed by the relevant CTCN Technology Manager.

- Evaluation of the timeliness of the TA implementation as measured against the timeline included in the response plan;
- Evaluation of TA quality as defined in the response plan;

- Overall performance of the Implementers;
- Overall engagement of the NDE and Proponent;
- Lessons learned on the CTCN process and steps taken by the CTCN to improve.