



Provision of Services Related to Enabling Readiness for Up Scaling Investments in Building Energy Efficiency for Achieving NDC Goals in Thailand

Contract No.: UNEP/2020/252 (4700019197)

PROGRESS REPORT 3: REPORT ON DELIVERABLES RESULTS OF TASK 2 (April to August 2021)

Prepared for

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By

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EXECUTIVE SUMMARY

This report summarizes progress of the Contract No: UNEP/2020/252 (4700019197) for the provision of Services Related to Enabling Readiness for Up Scaling Investments in Building Energy Efficiency for Achieving NDC Goals in Thailand. The progress report specifically summarizes the completed project activities in the third reporting period of the project (April to August 2021).

This progress report shows the completed deliverable result of Task 2 (activity 2.1 and 2.2), which is continued from the previous reporting period. The deliverable outputs of activities 2.1 and 2.2 are splitting into two separated reports, attached documents come along with this progress report 3.

Key outcomes from the implementation of the project activities 2.1 and 2.2 during the reporting period are as follows.

Activity 2.1: Assessment of relevant technologies with BEC compliance

This activities 2.1 result provides the overview of the BEC compliance requirements and parameters that are relevant to technology in building design. The evaluates of relevant technologies with BEC compliance based on the energy efficiency performance criteria of the building construction design given on component 1 to 6. Subsequently technologies and their relevance to building energy performance in each BEC components are listed, including the analysis of the BEC assessment database reveals materials commonly used in building design and how they affect to the BEC compliance. Possible improvement alternatives are evaluated.

The listing of applicable technologies for six BEC components is summarized. Best practice technologies in materials and building systems, uncommon implemented but applicable for Thai building design, are introduced for possible enhancement of building energy efficiency performance.

Activity 2.2: Prioritizing of relevant technologies with BEC compliance

Following the assessment on activities 2.1, a comprehensive prioritizing of relevant technologies is conducted. The assessment criteria are set for assessment of identified technologies on seven aspects including:

- (1) Applicability to BEC buildings – how the technology is applicable to BEC buildings.
- (2) Complexity in implementation – The difficulty of technology implementation and its impact to the building design and functions.
- (3) Technology availability – availability of technology suppliers for implementation.
- (4) Impact on energy savings – how much the technology can save building energy consumption.
- (5) Return on investment – how quickly the technology can achieve the saving and give the return on the investment premium.
- (6) Impact on BEC compliance – how the technology can improve the number of buildings to comply with BEC.
- (7) Potential growth from the existing status – implementation maturity and potential growth from the current status.

Three levels scoring on the scale of 1 to 3 will be given for each technology on every aspect. Assessment scoring are based on information gathered from local and international sources including technology suppliers, and related publications together with the results of BEC database analysis in task 1.

Table in the following page summarizes the list of technology for BEC and their overall score from technology assessment. The score result helps prioritize the technologies into three groups.

Group A: High priority technologies

Technologies in this group receive high scores on most assessment aspects. These technologies are considered as top priority for BEC implementation. All identified technologies for component 1 building envelope are in this group as they help the BEC buildings comply with the stringent OTTV and RTTV criteria. The energy efficient air



conditioning systems in component 3 are also in this group. All technologies in this group can greatly improve building energy performance with high return on investment or long-term life cycle savings.

Group B: Medium priority technologies

Technologies in Group B are also potentially good for BEC buildings. Despite lower impact on improving BEC compliance, they are still worth considering as most technologies in this group have high energy savings and good return on investment.

Group C: Low priority technologies

Technologies in this group have the lowest overall potential compared to the ones in group A and B. Nevertheless, they could still help improve energy performance of some specific BEC building types and applications.

The list of prioritized technologies in this task 2.1 and 2.2 technical assessment result will be used in financial assessment of task 3 to simulate the energy performance and analyze their return on investment of the technologies on five types of BEC buildings under this project scope.

Continued from the previous progress report the project is still facing the challenges from the widespread of COVID-19 pandemic. With the definite project completion deadline of 31 December 2021, the alternative work plans were put in place with the consultation to key project stakeholders (DEDE, KMUTT, NDE and NDA). The summary of mitigation recovery action and proposed work plan are as follows:

- The listed technologies from the task 2 will be further analysed for their potential savings and investment return in the subsequent task 3.
- Combining two workshops on outcomes of Task 2 (Technology Assessment) and Task 3 (Financial Assessment) into one workshop for stakeholder input on the priority list of BEC technology. The stakeholder workshop is expected to be held through an online virtual conference in September 2021.
- Rearrangement of business operation to replace the local staff infected by COVID-19 by arranging an additional temporary staff to support on energy performance simulation for speeding up the process- e.g., the freelancer-outsourced experiences-BEC assessor.
- Development of energy audit and data gathering forms for remote interview.
- Using alternative source of information gathering from DEDE and network BEC assessors to fulfil missing data.
- Mobilizing the stakeholder engagement process, the stakeholder meetings will be conducted through teleconference applications, e.g., Zoom meeting.

The project team is taking best effort to complete the tasks this revised work plan. Nevertheless, CTCN and all stakeholders will be continually notified on any update and progress results.



Summary of Technology assessment scores on potential technologies for six BEC components

Item	Technology	Baseline Technology	Applicability	Availability	Complexity	Saving impact	Investment return	Compliance impact	Potential growth	Total Score	% Total Score	Group
Component 1: Building Envelope												
	<u>Opaque Wall</u>											
1-1	Low mass wall materials	Concrete, concrete block or brick.	3	3	3	3	3	3	2	20	95%	A
1-2	Wall insulation	No insulation wall.	3	3	2	3	2	3	3	19	90%	A
1-3	Composite insulated panels	No insulation wall.	2	2	2	3	2	3	3	17	81%	A
	<u>Transparent Wall and Window</u>											
1-4	Energy efficient coated glass	Clear float or laminated glass.	3	3	2	3	2	3	2	18	86%	A
1-5	Insulating glass	Clear float or laminated glass.	3	3	2	3	2	3	3	19	90%	A
1-6	Window shading	Clear float or laminated glass.	3	3	1	3	2	3	3	18	86%	A
	<u>Roof</u>											
1-7	Roof insulation	Concrete or metal sheet roof without insulation.	3	3	3	2	3	3	2	19	90%	A
1-8	High solar reflective roof coating	Normal roof material.	3	3	3	2	3	3	2	19	90%	A
Component 2: Lighting System												
2-1	High efficiency LED lamps	Fluorescent lamps, normal LED lamps with efficiency < 150 lumen/Watt.	3	1	3	2	3	1	3	16	76%	B
2-2	Energy efficient luminaires	Normal luminaire with low efficiency reflector.	3	3	2	1	3	1	2	15	71%	B
2-3	Lighting controls	Basic light on-off switches.	3	3	2	1	3	1	2	15	71%	B
2-4	Daylighting	Artificial lighting and natural lighting from windows and openings.	3	1	1	1	1	1	2	10	48%	C



Item	Technology	Baseline Technology	Applicability	Availability	Complexity	Saving impact	Investment return	Compliance impact	Potential growth	Total Score	% Total Score	Group
Component 3: Air Conditioning System												
3-1	High efficiency Inverter split-type air conditioners	Normal or standard inverter split-type air conditioners.	2	3	3	3	3	1	2	17	81%	A
3-2	VRF/VRV air conditioning system	Split-type or packaged unit air conditioner.	2	3	2	3	3	1	2	16	76%	B
3-3	Oil-free magnetic bearing chiller	Standard electric chillers.	2	3	3	3	3	1	2	17	81%	A
3-4	Absorption chiller	Electric chillers.	1	1	1	3	2	1	3	12	57%	C
3-5	Energy Recovery Ventilation (ERV)	Central air conditioning system or packaged unit.	1	1	2	2	2	1	3	12	57%	C
Component 4: Hot Water Generation												
4-1	Heat pump hot water generation	Electric or fuel hot water boiler.	1	3	3	3	3	1	2	16	76%	B
Component 5: Renewable Energy Utilization												
5-1	Solar power generation	100% use of on-grid electricity.	3	3	2	1	3	1	2	15	71%	B
5-2	Solar hot water generation	Electric or fuel hot water boiler.	1	3	2	2	3	1	2	14	67%	C
Component 6: Whole Building Energy Performance												
6-1	Building Energy Management Systems (BEMS)	No BEMS.	2	2	1	3	2	1	2	13	62%	C
6-2	Combined Heat and Power (CHP)	Separate supply of electricity from on-grid system and generation of heat from boiler.	1	2	1	3	2	1	2	12	57%	C



1 SUMMARY OF ACTIVITIES

This report summarizes the project's progress from April to August 2021 and deliverables under Task 2 (activity 2.1 and 2.2). The activities undertaken by the IIEC project team during this reporting period are summarized as follows.

- Continuing from the list of identified technologies from the result of activity 2.1 in the previous progress report, the IIEC project team conducts the assessment of the potential technologies for improving energy performance of the BEC buildings in six components.
- Each technologies are assessed on seven aspects with the set scoring criteria. Information from local and international sources including technology suppliers, and related publications are used for assessment on technology applicability, implementation complexity, technology availability, energy saving and return on investment. Outcomes from the BEC database analysis of task 1 are applied in assessment of BEC compliance impact and potential growth.
- The results of all technology assessment are subsequently consolidated for overall score comparison. The assessment scores classify technologies into priority groups of top, medium and low priority.
- Technical details of the technologies are provided for reference in the two separate reports, attached documents come along with this progress report 3.
- The list of prioritized technologies will be further analyzed for their potential savings and investment return in the task 3: Financial Assessment for New Buildings within the BEC Framework.

The progress results of activity 2.1 and 2.2 are presented in a separate attached reports.



2 WORK IN PROGRESS BY TASK

Following the completed work on Task 2 (activities 2.1 and 2.2), the current status and work plan of ongoing activities of Task 2 (activities 2.3), Task 3, and Task 4 are as follows:

2.1 SUMMARY OF CURRENT STATUS AND PROPOSED WORK PLAN

2.1.1 TASK 2: Technology Assessment of Five Building Types

Current Status:

- Completion of technology assessment with priority listing of technologies for BEC (Output 2.1 & 2.2) - A long list of relevance technologies related to building energy performance in each BEC components are listed.
- A short list was developed based on criteria on technically assessed for their applicability, impacts to building energy performance, impacts to BEC compliance and their growth potential.
- The listed technologies from the task 2 will be further analysed for their potential savings and investment return in the subsequent task 3.

On-going work plan for activities 2.3:

A workshop for dissemination of results will be organized to disseminate technology assessment results on priority technologies to relevant stakeholders. A combining of two workshops on outcomes of Task 2 (Technology Assessment) and Task 3 (Financial Assessment) into one workshop for stakeholder input on the priority list of BEC technology was proposed, and agreed by NDE and NDA. The stakeholder workshop is expected to be held through an online virtual conference and held in September 2021.

Main cause of delay of Task 2:

- Delay in information gathering due to slow response from information sources and vendors due to pandemic.
- Delay in verification and debugging on the incorrect calculation of the clone web-based BEC program for simulation.
- Rearrangement of business operation: Local staff infected by COVID-19.

2.1.2 TASK 3: FINANCIAL ASSESSMENT OF FIVE BUILDING TYPES WITHIN THE BEC FRAMEWORK

Work plan for activities task 3:

- Activity 3.1: Conduct Energy Performance Simulation for Five Building Types

The priority technologies identified under Task 2 will be utilized as the key parameters to simulate the energy performance of the five selected building types under different adoption scenarios of the five technology groups for building energy component (i.e., building envelope, lighting system, air conditioning system, hot water generation system, renewable energy utilization).

- Activity 3.2: Assessment of Financial Aspects of Technology

Based on the energy performance of different technologies, investment costs for each adoption scenario will be estimated and included. The project team will conduct financial and



economic assessments of the priority technologies and recommend possible technology options that can be promoted to achieve the targets set in BEC.

- **Activity 3.3: Workshop on Recommended Technology Options**

The project team will prepare a program outline, and, in consultation with CTCN, NDE and other agencies, identify target stakeholders. It is envisaged that the building practitioners (e.g., engineers and architects), and EE technologies suppliers/manufacturers, including relevant policy makers and government organizations will be the main target audience for this dissemination workshop. Following the workshop, the project team will prepare a report summarizing discussions and conclusions from the workshop, including the workshop evaluation results and participant lists for submission to CTCN and NDE.

The stakeholder workshop is expected to be held through an online virtual conference and held in September 2021.

Current Status:

- Complete modification of the web-based BEC program for energy performance simulation.
- 25% development of building prototype on the BEC program for energy performance simulation.
- Started inputting technology to the simulation model.
- 75% on technology cost data for inputting to the simulation model.

Main cause of delay of Task 3:

- Rearrangement of business operation: Local staff infected by COVID-19.
- Delay in verification and debugging on the incorrect calculation of the clone web-based BEC program.

Mitigation recovery action and proposed work plan:

- Arranging of additional temporary staff to support on energy performance simulation for speeding up the process- e.g., the freelancer-outsource of experiences-BEC assessor.

Target delivery of task 3 outputs: The report is planned to deliver by mid of October 2021.

2.1.3 TASK 4: CONDUCT ENERGY AUDITS ON THE FIVE BUILDING TYPES

Work plan for activities task 4:

The project team will carry out detailed energy audits of five building types with data parameters in the existing BEC compliance database. The energy audits will also collect data and findings as input for designing the MRV framework (Task 5). The preparation of site visit for energy audit was done in May 2021, and the 10 representative audit sites will be selected in consultation with key stakeholders DEDE.

Current Status:

- 4 out of 10 energy audits to BEC buildings was completed in June 2021.
- The site visit could not be continued since then due to the severe resurgence of the COVID-19 infection widespread around the country.
- Open-ended schedule on remaining 6 energy audits due to COVID-19 situation.

Main cause of delay of Task 4:

- No allowance to enter target BEC buildings for energy audits due to pandemic close-out.

Mitigation recovery action and proposed work plan:

- Development of energy audit and data gathering forms for remote interview.



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- Proposed of revised methodology of energy audit through data gathering forms and remote audit interview.
 - Using alternative source of information gathering from DEDE and network BEC assessors to fulfil missing data.

Target delivery of task 4 outputs:

- The audit result will be integrated as part of Task 5 deliverables output as initially work plan.
- It is expected to deliver by November 2021 with Task 5.



3 LESSONS LEARNT AND IMPLEMENTATION CHALLENGES

Most of the works in this progress report 3 involve information collection and analysis of technology details for project task 2 and 3. The main challenges faced in this progress are the slowdown of activities from the widespread of COVID-19 pandemic. These challenges are summarized below.

1. Delay in information gathering due to slow response from information sources and vendors due to pandemic.

The carry out of task 2 and 3 needs technical and cost-related information on a number of BEC technologies both locally and internationally. And thus requires a lot of information gathering and consultation with relevant suppliers, vendors and technology experts.

The start of this activity was affected by the emergence of COVID 19 pandemic at the beginning of March 2021 and continuing through August 2021. It led to the delays in information gathering from slow responses of the information sources and vendors. Delaying in the data gathering causes the delay of task 2 and BEC energy performance simulation of task 3.

2. Unexpected multiple verification and correction of the web-based BEC cloning program

For parametric simulation of the BEC energy performance in task 3, the project team decided to utilize the web-based BEC evaluation program. With the support from DEDE working group and KMITL BEC Team, the web-based BEC program is specially cloned for the project use.

However at the initial run the project team found the differences on the calculation results between the clone and the original BEC programs. Therefore there were a series of back and forth communications between the project team and the BEC program development team for test runs, verification and coding correction. And again the pandemic slowed down the communication and correction process.

3. Uncontrollable of delay in contact and site visit for energy audit activities (Task 4)

The preparation of site visit for energy audit was done in May 2021, and energy audits of four BEC building sites were conducted in June 2021. However, the site visit could not be continued since then due to the severe resurgence of the COVID-19 infection widespread around the country. The scheduled audits of the remaining sites were cancelled and open-endedly postponed.

To cope with the situation, revised energy audit methodology was proposed using data collection forms for remote audit interview to mitigate the operational delays, together with alternative sources of information from DEDE and network BEC assessors to fulfil missing survey data.

4. Uncontrollable of delay in business operation due to local staff infected by COVID-19

The COVID-19 pandemic has also affected to the internal project team. In fact one of the local staff caught the virus in June causing the quarantine and rearrangement of the business operation.

Mitigation recovery action and proposed work plan:

With the project completion deadline of 31 December 2021, an effort to complete all the activities has been considered to avoid any potential risk that might be added. The following alternative plans was put in place, and consultation meeting with the key project stakeholders (DEDE, KMUTT, NDE and NDA) were conducted via video conference from August 4 to August 9, 2021. The meeting schedule and participants were summarized in Annex-1.



The summary of mitigation recovery action and proposed work plan are as follows:

- The listed technologies from the task 2 will be further analyzed for their potential savings and investment return in the subsequent task 3.
- Combining two workshops on outcomes of Task 2 (Technology Assessment) and Task 3 (Financial Assessment) into one workshop for stakeholder input on the priority list of BEC technology. The stakeholder workshop is expected to be held through an online virtual conference in September 2021.
- Rearrangement of business operation to replace the local staff infected by COVID-19 by arranging an additional temporary staff to support on energy performance simulation for speeding up the process- e.g., the freelancer-outsourced experiences-BEC assessor.
- Development of energy audit and data gathering forms for remote interview.
- Using alternative source of information gathering from DEDE and network BEC assessors to fulfil missing data.
- Mobilizing the stakeholder engagement process, the stakeholder meetings will be conducted through teleconference applications, e.g., zoom meeting.

CTCN will be notified if there is any change to the proposed revision work plan.



4 ANNEX-1: CONSULTATION MEETING

4.1 LIST OF PARTICIPANTS

The list of participants in each meeting are listed in table below.

4.1.1 Meeting with KMUTT

Date	4 August 2021	Time	01.30 pm	Location	Video Conference
Attendance	Name	Title		Organization	
	Dr. Apichit Therdyothin	Director, Energy Conservation Laboratory		KMUTT	
	Mr. Warut Chiwamawin	Deputy Managing Director, Energy Conservation Laboratory		KMUTT	
	Mr. Damrong Bouyom	Senior Project Manager		KMUTT	
	Ms. Sopin Wachirapuwadon	Senior project manager		IIEC	
	Mr. Sran Sribhibhadh	Senior consultant, M&E Expert		IIEC	
	Mr. Preecha Preedavichit	Senior consultant, Building EE Expert,		IIEC	

4.1.2 Meeting with DEDE and 2e-Building Consultant

Date	5 August 2021	Time	01.30 pm	Location	Video Conference
Attendance	Name	Title		Organization	
	Mr. Prakob Eamsa-Ard	Head of Building standard regulation and enforcement group		DEDE	
	Ms. Chalermeluk Jitrumpueng	Senior Professional Engineer		DEDE	
	Mr. Supakiat Thongtub	Senior Project Manager, 2e-Building Canter Consultant		DEDE	
	Ms. Parnleykha Promta	Engineer, 2e-Building Canter Consultant		DEDE	
	Ms. Sopin Wachirapuwadon	Senior project manager		IIEC	
	Mr. Sran Sribhibhadh	Senior consultant, M&E Expert		IIEC	



4.1.3 Meeting with NDA and NDE

Date	9 August 2021	Time	11.00 am (CEST)	Location		Video Conference	
Attendance	Name	Title		Organization			
	Dr. Jarunee Nugranad	Environmentalist (Senior Professional level), Climate Change Management and Coordination Division		ONEP			
	Ms. Punvadee Arayawongwan	Environmentalist - Climate Change Management and Coordination Division		ONEP			
	Ms. Oranuch Ratana	Policy specialist		NXPO			
	Ms. Sirinporn Daengphuang	Policy analyst		NXPO			
	Mr. Sommai Phon-Amnuaisuk	Director, Asia-Pacific,		IIEC			
	Ms. Sopin Wachirapuwadon	Senior project manager		IIEC			
	Mr. Sran Sribhibhadh	Senior consultant, M&E Expert		IIEC			

