Terminal Evaluation – Thailand LCC Project

Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand (LCC)

***a project of*:**
Royal Thai Government
United Nations Development Programme
Global Environment Facility

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Basic Project/ Terminal Evaluation Information and Acknowledgements

Basic Project Information
Official Project Title: *Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand (LCC)*
Abbreviated Project Title: *LCC* or *Thailand LCC*
Country: Thailand
Region: Asia Pacific
UNDP PIMS# 4778
GEF Project ID# 5086
Executing Agency/ Implementing Partner: Thailand Greenhouse Gas Management Organization (TGO) under Ministry of Natural Resources and Environment
Other Project Partners: City of Nakhon Ratchasima, City of Khon Kaen, City of Samui, and City of Chiang Mai

GEF Focal Area/ Strategic Program:
Focal Area: Climate Change Mitigation (CCM)
Strategic Programs*:

CCM-3: Promote investment in renewable energy technologies
CCM-4: Promote energy efficient, low-carbon transport and urban systems

*Note: These are called "focal area objectives" for GEF-5, which is the tranche of GEF funding under which this project was designed. "Strategic programs" is the designation required by our TORs.

TE timeframe:
Main consultation period: April 26, 2020 – May 7, 2021
Draft report submission: June 2, 2021
Final report submission: June 21, 2021

TE Team: Eugenia Katsigris and Walaitat Worakul

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Contents

Acronyms, Abbreviations, and Definitions

3Rs – recycle, reuse, reduce: An approach to waste management. In this document, refers to KK's 3Rs program.
AFOLU – Agriculture, forestry, and other land use: Often used as a category of GHG emissions in a carbon footprint.
ap – software application, often used on smartphone
attribution: The action of regarding something as being caused by something else. In the case of GEF CCM projects, it is important to determine which GHG ERs can actually be attributed to (be determined to be caused by) activities of the GEF project, as opposed to being caused by outside factors.
BAU – business as usual: used to refer to the scenario where no major changes from the current situation and its trajectory into the future are made
BMC – Bright Management Consulting: Implementer of *LCC*'s Samui demo package and of its CCF and LEDS work for Samui.
BOT – build-operate-transfer. Refers to the situation in which an entity builds a system and owns and operates it for some time, gaining revenues during that period, and then eventually transfers system ownership, usually to the main user or owner of the involved property.
BRT – bus rapid transit: A bus-based public transit system that is designed and expected to have better speed and reliability than typical bus systems. Often, BRTs involve special bus lanes or other features that allow the buses to avoid normal traffic.
CBO – community based organization: a local, civil-society organization
CCF – city carbon footprint
CCM – climate change mitigation
CCTV – closed circuit television: Equipment for video surveillance achieved by transmitting video signal to a certain location where the video is monitored.
CDM – Clean Development Mechanism. A previous global carbon credit trading scheme under UNFCCC, the market for which crashed in 2012 and 2013.
CDR – Combined Delivery Report. A UNDP report that tracks project expenditures.
CEO – chief executive officer (in this case refers to CEO of the GEF)
CER – CEO Endorsement Request. Along with ProDoc, a key document submitted to the GEF for approval of detailed design of a GEF project.
CM – Chiang Mai, one of the four main, mid-sized city partners of *LCC*
CMU – Chiang Mai University, implementer of *LCC*'s Chiang Mai demo package
CO – country office. In this document, refers to UNDP Country Office.
CO_2 – carbon dioxide
COLA – College of Local Administration, KKU: The unit within KKU responsible for implementing the KK demo package
Covid-19 or Covid: In this document used to refer to the disease or pandemic caused by the Cov-2 virus that spread around the world causing extensive illness, death, and economic dislocation in 2020 and 2021.
CP-ALL: private sector company that owns or oversees franchises of all 7-11 outlets in Thailand
direct GHG ERs: GHG ERs due directly to activities of the UNDP-GEF project
CSR – corporate social responsibility. Philanthropic initiatives undertaken by corporations to benefit society, often in the communities in which they work.
CU – Chulalongkhorn University, implementer of *LCC*'s NR demo package. (Note: A different unit at CU implemented the *LCC*'s curriculum and knowledge package work.)
DEDE – Department of Alternative Energy and Efficiency, under the Ministry of Energy.
DJ – disc jockey
DPC – direct project costs: Cost of work that UNDP carries out on behalf of the project and that, by agreement with the IP, is charged to the project. These costs are separate from UNDP's project oversight work as GEF IA.

DRR – Deputy Resident Representative. In a UNDP Country Office, a person one level below the Resident Representative in rank.
E4C: Private company providing fixed route public bus transport in Chiang Mai.
EA – Executing Agency
e-BRT – BRT using electric buses. In this case, refers to NR's envisioned BRT system
EE – energy efficiency
EMI – Environmental Management Institute: Unit of CU carrying out NR demo package for *LCC*.
EOP – end of project
ERI – Energy Research Institute: unit of CU carrying out curriculum and knowledge packages of *LCC*.
ERM – Environmental Resources Management: MRV consultancy for *LCC*. Also, carried out *LCC*'s CCF and LEDS work for NR, KK, and CM, and prepared the project's final report.
ESCO – energy service company: A company that finances and carries out energy efficiency improvements in client facilities and is paid back over time through the verified energy savings.
e-ticket – electronic ticket. In this document, refers to a bus ticket purchased online and shown on a mobile device upon boarding of the bus.
EV – electric vehicle
GEF – Global Environment Facility
GEF TF – GEF Trust Fund
GHG – greenhouse gas
GHG ER – greenhouse gas emission reduction. A measure of reduction in the amount of greenhouse gas emitted as compared to business as usual, which, for GEF projects, is the "no GEF project" scenario. Usually measured in tons of CO2 equivalent (t CO2eq).
HH - household
IA – Implementing Agency. In this document, refers to international agency tasked with providing oversight to the implementation of GEF projects.
IC – Individual Contractor. For UNDP projects this is a single person contractor in contrast to a contractor that is a multi-person organization.
Incrementality: Concept used is designing, implementing and assessing GEF projects. It refers to the addition, due to activities of the GEF project, of positive results to those results that would have been achieved in the "no GEF project" situation, also called the baseline scenario.
INV – investment: In the case of GEF projects, refers to funds spent directly on equipment, infrastructure, or software, as opposed to on TA.
IP – Implementing Partner: Used in this document to refer to the national government organization responsible for implementation of a UNDP-GEF project in NIM modality.
IPPU – industrial process and product use. Often used as a category of GHG emissions in a carbon footprint.
IT – information technology
kg - kilogram
KK – Khon Kaen, one of the four main, mid-sized city partners of *LCC*
KK LR or KK LRT: refers to Khon Kaen's envisioned light rail system
KKTS - Khon Kaen Transit System, owned by Khon Kaen and 5 neighboring cities, which the KK LRT will run through
KKTT – Khon Kaen Think Tank: Collaboration of private sector entrepreneurs advising the city of Khon Kaen. Now called Khon Kaen City Development Company.
KKU - Khon Kaen University, implementer of *LCC*'s KK demo package.
KK WTE: refers to Khon Kaen's waste to energy plant, run by a private sector company.
KPI – key performance indicator: a measurable and quantifiable item that helps show how well an organization is achieving one of its key objectives
kW – kilowatt, a measure of power that is 1,000 watts
L – likely: One of four rating levels used regarding sustainability of UNDP-GEF projects.
LCC – Low Carbon Cities. Abbreviated name for the project being evaluated in this document.

LED – light emitting diode. A type of light that is highly energy efficient.
LEDS – low emission development strategy: LEDS were prepared by LCC for each of the four partner cities.
LESS - Low Emission Support Scheme: A scheme developed by TGO to praise those who do well in achieving GHG ERs by issuing a Letter of Recognition (LOR). The scheme does not allow for the buying and selling of credits.
lifetime GHG ERs: GHG ERs projected to be achieved over the lifetime of the equipment installed or (in cases where equipment is not the key determiner) of the activity undertaken.
LR – light rail
LRT – light rail transit
M - million
M&E – monitoring and evaluation
ML - moderately likely: One of four rating levels used regarding sustainability of UNDP-GEF projects.
MOI – Ministry of the Interior. The Thai Ministry responsible, among other things, for local administration. The Minister of Interior appoints the provincial governors, but leadership of municipal administrations is elected locally.
MoNRE – Ministry of Natural Resources and Environment
mos – months
MOU – memorandum of understanding
MRTA – Mass Rapid Transit Authority of Thailand
MRV – monitoring, reporting, and verification. In this report, refers to the collecting of data on GHG emissions, energy savings, and waste treated, and the estimation of GHG emission reductions achieved by various actions.
MS – moderately satisfactory: one of six rating levels used for evaluation of certain aspects of UNDP-GEF projects.
MTR - Mid-Term Review. For full-sized UNDP-GEF projects, a required evaluation that takes place roughly half-way through the project. One of its major aims is to provide suggestions for course correction of the project, as needed.
MW – unit of electric power equivalent to one million watts
MWh – Megawatt hour. A unit of energy representing amount of electricity delivered over time.
NA – not available or not applicable
NCE – Nature Climate and Energy Unit: UNDP unit that provides technical and other guidance to UNDP's environment-related portfolio of projects financed by "vertical funds," such as the GEF and GCF (Green Climate Fund).
NDC – Nationally Determined Contributions: Non-binding national plan that outlines GHG ER targets and how the country aims to reach these targets to contribute to globally agreed climate targets.
NGO – non-governmental organization: a non-profit civil society organization
NIM – National Implementation Modality. A modality of implementation of UNDP-GEF projects in which government counterparts lead implementation.
NPD – National Project Director. In UNDP-GEF projects, the IP official responsible for day to day liaison and approvals with regard to the project.
NR – Nakhon Ratchasima, one of the four main, mid-sized city partners of *LCC*
OTP – Office of Transport Policy and Planning, which is under Ministry of Transport
PB – Project Board
PCA – Project Coordination Associate. Member of *LCC* Project Team
PIF – Project Information Form. A proposal to the GEF for a new project concept. Once approved, funds are set aside awaiting detailed project design and its subsequent clearance by the GEF.
PIR – Project Implementation Review. A required annual assessment of UNDP-GEF projects that takes place around July of each year.
PLC – programmable logic controller. A device used in automation of industrial systems.

PLCC Project - *Promotion of Low Carbon City across Municipalities in Celebration of His Majesty the King's 84th Birthday*, a project implemented by the National Municipal League of Thailand (NMLT) and focused on reducing GHG emissions by working with 100 cities.
PM – Project Manager: In this case, leads *LCC* Project Team.
PPG – Project Preparation Grant. Funds from the GEF for the detailed design of projects, to be carried out after PIF approval.
ProDoc – Project Document. In the case of UNDP-GEF projects, along with CER, a key document submitted to the GEF for approval of detailed design of a GEF project.
PV – photovoltaic: PV cells are used to convert sunlight to electricity.
RFP – Request for Proposals
RTA – Regional Technical Advisor. A UNDP official based in one of UNDP's regional headquarters and providing technical guidance for UNDP's various projects from environmental vertical funds, such as the GEF and GCF.
RTC – private bus company that was providing fixed route public transport in Chiang Mai, but has stopped these operations due to the Covid-19 pandemic.
RTG – Royal Thai Government
S – satisfactory: one of six rating levels used for certain aspects of UNDP-GEF projects.
songthaew: a pick-up truck converted with seats in and cover on the bed, used for short-haul bus rides as a form of public transport in many Thai cities
t - tons
TA – technical assistance. In the case of development projects, this term may be used to differentiate between technical support ("TA") on areas such as policies, plans, capacity, institutions, etc. in contrast to direct investment ("INV") into measures in the field and infrastructure.
TE – Terminal Evaluation. For UNDP-GEF projects, an evaluation that takes place around the time of project close.
TGO – Thailand Greenhouse Gas Management Organization, an entity under Thailand's Ministry of Natural Resources and Environment.
THB – Thai Baht, Thailand's national currency
TOD – transit-oriented development. Real estate and economic development focusing on the areas around transit stations.
TOR – terms of reference. A description of professional services to be provided.
T-VER – Thailand Voluntary Emission Reductions: A system developed by TGO in 2014 to provide credits for GHG ERs. These can either be kept by the company that achieves them for the purpose of their own CSR promotion or sold to other companies that wish to purchase the credits as "carbon offsets" (to offset their own carbon emissions) as a form of CSR.
UNDP – United Nations Development Program
UNDP CO – UNDP Country Office
UNDP-GEF: Refers to GEF-financed projects for which UNDP provides oversight as GEF IA.
UNFCCC – United Nations Framework Convention on Climate Change
USD – US Dollars
VSD – variable speed drive
WTE – waste to energy: Refers to a facility that converts thermal energy from waste incineration to electric power.
yr – year

Executive Summary

Project Information Table

Project Title	*Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand (LCC)*		
Project Details		Project Milestones	
UNDP Project ID (PIMS#):	4778	PIF Approval Date:	November 15, 2013
GEF Project ID:	5086	CEO Endorsement Date:	April 25, 2016
Atlas Business Unit Award #: Project ID:	86118 93514	ProDoc Signature Date (date project began):	April 26, 2017
Country:	Thailand	Date project manager hired:	May 2017
Region:	Asia Pacific	Inception Workshop date:	January 26, 2018
Focal Area:	Climate Change Mitigation (CCM)	Midterm Review completion date:	April 19, 2020
GEF Focal Area Strategic Objectives:	CCM-3: Promote investment in renewable energy technologies CCM-4: Promote energy efficient, low-carbon transport and urban systems	Planned project closing date:	April 25, 2021 (*original closing date before extension granted*)
Trust Fund:	GEF TF	If revised, proposed op. closing date:	July 31, 2021 (*with 3 month extension included*)
Executing Agency/ Implementing Partner:	Thailand Greenhouse Gas Management Organization (TGO) under Ministry of Natural Resources and Environment		
Other Execution Partners:	City of Nakhon Ratchasima, City of Khon Kaen, City of Samui, and City of Chiang Mai		
NGO/ CBO Involvement	Gold Bin		
Private Sector Involvement	CP-ALL, both as partner (plastic bag campaign) and beneficiary (solar PV systems)		
Geospatial Coordinates of Project Sites	15.013422, 102.066827 Nakhon Ratchasima Municipality 16.438928, 102.823180 Khon Kaen Municipality 18.841358, 98.971277 Chiang Mai Municipality 9.550869, 100.048871 Koh Samui Municipality		
Financial Information			
PPG	at approval (US$M)	at PPG completion (US$M)	
GEF PPG Grants for Project Preparation	0.100	0.100	
Co-Financing for Project Preparation	NA	NA	
Project	at CEO Endorsement (US$M)	at TE (US$M)	
[1] UNDP contribution	0.300000	0.414480	
[2] Government	182.001010	20.138920	
[3] Other multi/bi-laterals	0.0	0.0	
[4] Private Sector	0.0	1.968337	
[5] NGOs	0.0	0.0	
[6] Total co-financing [1] + [2] + [3] + [4] + [5]	182.30101	22.521737†	
[7] Total GEF funding	3.150	2.652790*	
[8] Total project funding [6+7]	185.45101	25.174527	

†Definition of co-financing used at CEO Endorsement stage likely included "associated co-financing," such as general spending on public transport, waterworks, and waste management, whereas the TE Team has adopted the more narrow definition utilized

by the GEF of those funds that directly support implementation of the GEF project and achievement of its objectives. In addition to implementation support, we thus included only those items truly low carbon and with some relation to project activities.
*As of April 30, 2021. It is expected virtually all of the USD3.150 M in GEF funding will be spent by financial close of project.

Project Description: The RTG-UNDP-GEF project *Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand* ("LCC") was designed as a four-year project with the overall objective of promoting low carbon urban development in mid-sized Thai cities. It pursues the dual aims of greenhouse gas (GHG) emissions reductions, economic benefits, and enhancement of the lives of local people through an improved urban environment. Emphasis is on the waste management, transport, and electricity end-use sectors. The project cooperates with the four mid-sized Thai cities of: Nakhon Ratchasima, Chiang Mai, Samui, and Khon Kaen. Project launch date was April 26, 2017 and, with three months extension, project close is July 31, 2021. During its last 1.5 years, the project has been impacted by the Covid-19 pandemic, especially transport sector work in Chiang Mai. GEF funding is USD3.15 M. *LCC* targets three outcomes for its partner cities: (1) low carbon planning, (2) demonstration of low carbon city initiatives, and (3) financing of/ increased investment in low carbon city initiatives. The low carbon planning work features, for each city, development of city carbon footprints[1] and low carbon development strategies, intended to be incorporated into mainstream planning. The demo outcome features a package of demos for each city. NR and KK demos cut across all three sectors: waste management, end use energy/ distributed solar PV, and transport, while Chiang Mai focuses fully on transport and Samui on organic waste management. The financing/ investment outcome was intended to develop financing mechanisms for low carbon development, but its design also features capacity building and awareness raising.

***LCC* Evaluation Rating Table** (*for rating scales, please see Annex 5*)

Evaluation Ratings:			
1. Monitoring and Evaluation	***Rating***	**2. IA& EA Execution**	***rating***
M&E design at entry	MS=4	Quality of UNDP Oversight (S)	S=5
M&E Plan Implementation	MS=4	Quality of Execution - Executing Agency (S)	S=5
Overall quality of M&E	MS=4	Overall quality of Implementation / Execution	S=5
3. Assessment of Outcomes	**rating**	**4. Sustainability**	**Rating**
Relevance (1.1 MS, 1.2 S, 2.1 MS)	S=5	Financial resources:	ML=3
Effectiveness (1.1 MS, 1.2 S, 2.1 MS)	S=5	Socio-political:	ML=3
Efficiency (1.1 MS, 1.2 S, 2.1 MS)	MS=4	Institutional framework and governance:	ML=3
Overall Project Outcome Rating	S=5	Environmental:	L=4
		Overall likelihood of sustainability	ML=3

Findings and Conclusions:

Background: Cooperation with mid-sized cities on CCM fills an important gap, because Thai cities make decisions on certain areas not controlled at the national level, such as waste management and local public transport, whereas the national level controls areas such as power plants. City officials are locally elected in contrast to provincial officials, who are appointed by MOI. Thailand's *NDC Roadmap* allocates targets to national agencies, but not to the local level, suggesting untapped opportunity with regard to mid-sized cities. While the population of these cities is small (typically 100,000+), their full metropolitan areas can have around 500,000 to 1 million persons (NR, KK, and CM) and/or they may have high unregistered population (e.g. estimated at 300,000 in Samui in normal times).

Planning outcome: *LCC* prepared city carbon footprints and low emission development plans for each of the four cities. The footprints are each basically an estimate of the annual GHG emissions of the respective city, broken down into five sectors. It does not appear they are that new to Thai cities as TGO

[1] Estimates of the total annual GHG emissions of a city, in this case including a breakdown into five main sectors.

has prepared 90 other city or province carbon footprints to date with other funds.[2] The plans include possible projects the respective city could implement to reduce its carbon footprint. These efforts appear to have been positive on the capacity building side, but not that impactful in terms of changing the city budgeted plans or planning process. In most cases, the city staff learned what they were already doing that could be designated low carbon. NR, though, incorporated a new "low carbon" section in its city plan.

Demo outcome overall: The demos are the true strength of *LCC*, showing a high level of responsiveness to city needs across the areas of waste management, transport, and end-use energy/ distributed solar PV and with good potential for impact in a number of areas. Their weakness is they did not pursue GHG ERs very strategically and had mostly low GHG ERs. For the demo outcome overall, only 34.4% of the roughly USD1.7 M spent is classified as INV, compared to 80% designation in the ProDoc. Findings suggest, however, that, in addition to INV, some kinds of very focused TA can directly stimulate GHG ERs (e.g. building energy audit), while more general trainings, info products, etc. do not.

NR Demos: NR Demos include a range of project types and impactful results: (i) Recommended improvements to the city's anaerobic digester resulted in increased biogas production and electricity generation, but very limited increase in GHG ERs from landfill avoidance[3]. (ii) Support of Water Supply Bureau via TA led to 1 M ton per year reduction in water loss in water supply/ distribution and thus reduced electricity use in pumping. Two *LCC*-provided pumps also improved efficiency. Based on learnings from the TA, Bureau is planning a gravity based piping system (which will save energy) and has purchased two more energy efficient pumps. (iii) Ten building energy audits conducted by *LCC* resulted in six initiatives (PV system, VSD adjustment, new chiller, LED lights) across five buildings. (iv) *LCC*'s *Low Carbon Home Guidebook* is distributed at the office providing permits for new homes. The NR city plan calls for 1,000 copies to be printed each year. (v) *LCC*'s "cost of traffic" study for NR compares BAU, light rail, and electric bus BRT and finds e-BRT the most economic. This has been used to convince the national government, which had NR slated for light rail, to consider the city's preference of e-BRT and even do studies on e-BRT for six cities. It has also resulted in a one-year USD666,000 UK grant to plan the BRT system. NR demos are the most faithful among the city demo packages in pursuing GHG ERs, with 43,200+ tons direct lifetime GHG ERs expected. While 91.3% of the USD326,667 demo package goes to TA, we find that some of this TA (energy audits, studies to make specific efficiency related recommendations) can be as impactful as INV in stimulating GHG ERs, while other types of TA would have best been relegated to other outcomes. *LCC* claimed GHG ERs for 7 initiatives in NR for which the only *LCC* support was GHG ER estimation. Typically, such "MRV only" GHG ERs are not attributable to UNDP-GEF projects.[4]

CM Demo: CM demo is comprised of a set of initiatives all focused in the area of transport, mainly public transport. A number of meaningful and interrelated steps, the first of their kind in CM, were achieved. Yet, as is often the case with transport work, there is still a long way to go; and sustainability of this work is a risk. We did not find clear evidence of GHG ERs for CM demos, though 2,592 t were claimed.[5]

[2] One source indicated that GIZ had supported CCFs for 70 Thai cities, but we were not able to confirm this.
[3] That is, there was only limited increase in reduction in methane emission from organic waste in the landfill, as the amount of organic waste entering the biogas digester did not increase that much. (It actually decrease substantially as compared to 2018 during a transition period in 2019, but did increase marginally, as compared to 2018, by 2020.)
[4] If an MRV system is developed by a UNDP-GEF project and used for the accounting of GHG ERs of a specific installation, the GHG ERs from such an installation cannot be considered as something that was brought about by the MRV system. The MRV system (development and utilization) does not, by itself, bring about the GHG ERs. At the same time, MRV has benefits, such as allowing the installation owners to understand the GHG ERs of their installation.
[5] LCC indicates Chiang Mai demo began to accrue GHG ERs in 2018 in June (MRV report) or October (Excel spreadsheet). Yet, it is explained to the TE Team that the GHG ERs are a result of the consolidated bus stops achieved by LCC. The consolidated bus stops were not approved by the province until July 2020, when Covid-19

Achievements, though, could contribute to such reductions post-Covid. Segments of this work include: (i) Updated traffic model and citizen survey (TA), with recommendations for the three fixed route bus companies to adjust their routes and consolidate their bus stops. (ii) Establishment of CM Smart Mobility Alliance by *LCC*, which, for the first time, brought together public and private sector players in transport, cutting across silos to progress public transport as evidenced by the consolidation of bus stops in the next item. (iii) Consolidation of CM's bus stops and improvement of bus routes. The bus stops were previously different for different fixed-route providers. Bus stops were reduced from 443 to 203. This had been discussed before, but was finally achieved due to *LCC*'s CM Smart Mobility Alliance bringing the companies together. (iv) Mobile transport ap. *LCC* paid for the development of this ap, whereby riders can determine bus connections and buy electronic tickets and Alliance members can collect data on them. To date, there have been just 300 to 400 downloads. (v) Electronic payment system, including, for the first time, the CM Municipal Bus Company. *LCC* had to do significant liaison and policy work to overcome regulatory barriers to this. The project paid for 18 e-ticket readers for buses, though so far e-ticket purchases have been quite small.

Samui Demos: Samui demos are impressive for addressing some of the most important needs of the island and for high level of involvement across different segments of society. With landfill space being tight, Samui must export cubes of waste to the mainland. It has also suffered many traffic accidents due to slippery road conditions from garbage truck spillage. Lifetime direct GHG ERs for Samui demos are 6,560 t, reflecting the challenge of generating GHG ERs from bottom-up waste management activities. Samui demos include: (i) Scale-up of a household composting initiative from 750 HHs to 15,000 HHs (31.4% of all households on the island), in cooperation with dynamic "DJ Noo." (ii) Initiation of composting by hotels on Samui for the first time, involving 28 hotels, though stopped due to Covid. This could have good potential post-Covid, when expansion could target some of the other 600-plus tourist accommodations on the island. (iii) Provision of equipment to scale up organic waste processing at three privately-owned stations, one producing soil conditioner and animal feed from organic waste, one producing soil conditioner and other products from coconut waste (addressing the island's vexing coconut waste problem), and one producing charcoal from organic waste. Findings suggest waste processing (even pre-Covid) is far below capacity of new equipment at all three sites. Support is needed to ensure adequate daily waste input supply. (iv) Provision of wastewater treatment equipment (10 m^3 water treated per day) for fish market. Due to the baseline situation of previously untreated wastewater flowing into the ocean and need for treatment to achieve regulatory compliance, MRV team did not assign any GHG ERs to this demo, It's possible there is some reduction from baseline due to the near shore release of the wastewater.

KK Demos: Lifetime direct GHG ERs of KK demos are estimated at just 541+ tons, though information is lacking to determine increment for a couple of the demos. Demos include: (i) 100% grant for the installation of two 12.3 kW PV systems at municipal facilities. Support included design for much larger overall systems and has stimulated discussions with private sector company for over 10 times expansion of each system via a lease/ BOT model. (ii) 100% grant for new, less labor-intensive equipment at a pre-existing organic waste learning center that expands processing capacity to 10 tons per day. Yet, station is operating at an average of 2.2 tons per day. If supply can be increased so that full capacity is reached, this may be a model for replication. (iii) Addition of 50 inorganic waste sorting stations to city's original 73 such stations and support of city's training of HHs. (iv) A two-part TA study to support KK's proposed light rail project: (1) a feeder study proposing routes for transport to LR stations; an (2) a TOD study, proposing real estate development around stations to make the full venture more economically viable. KK LR has undergone bidding and on January 6, 2020 CKKM Joint Venture preliminary won two bids: (i) that to handle construction of both the TOD real estate around the stations and the light rail itself (3 year

was already having a major negative impact on public transportation in Chiang Mai. Indeed, the consultancy for Chiang Mai demo facilitation did not begin until Sept. 2018 and the Alliance, which was instrumental in achieving the consolidated bus stops, did not first meet until Jan. 2019.

contract) and (ii) that to operate the light rail (30 year contract).[6] According to the contract, CKKM is responsible for securing financing and will have a period to do so. Prices and other conditions still need to be negotiated, so the agreements for these contracts are not yet legally binding. It does not appear the two-part TA study has yet been shared with CKKM, though the project has plans to share with the mayor and other key stakeholders in the future, having been delayed by Covid-19 impacts and mayoral elections. (v) *LCC* also provided MRV to the KK WTE plant, but did not support increased GHG ERs as envisioned in project design.[7] The KK WTE has negative overall GHG ERs due to burning (without power generation) of excess waste at the site. Yet, the *LCC* project claims attribution for positive GHG ERs of KK WTE of 408,110 tons direct lifetime, 64.1% of the total it claims across all demos.[8]

Financing outcome: The project did not pursue the development of new financing mechanisms per project design. It did support T-VER promotion, though T-VER was developed in 2014, prior to project design.[9] T-VER is a carbon credit scheme. LCC's contribution with regard to T-VER is introducing this scheme to

[6] The investors/ ownership shares in CKKM are now: (1) Cho Thavee Public Company Limited (25%, a Thai company); (2) Khon Kaen Cho Thavee (23%, a Thai Company) – Taweesaengsakulthai Group is the main shareholder of the foregoing company; (3) Ktech Building Contractors Co. (3%, a Thai Company) –Ktech Construction is the main shareholder of the foregoing company; and (4) MCC Overseas (49%, a Chinese company, which is an international engineering services company wholly owned by Metallurgical Corporation of China. It is thought that MCC may bring in Chinese investment and this fits with the trends that Chinese companies have been the biggest investors in the region for many years.

[7] The agreement between the private sector company Alliance Clean Energy and KK for the WTE was signed in August 2011, long before even the PIF of LCC. And the PPA of the WTE with PEA, the power company, occurred in Oct. 2013. Construction of the KK WTE began in 2013 or 2014, so it seems incongruous that the ProDoc indicates the LCC project during its implementation would provide incremental enhancements to the design of the WTE. Findings suggest the PPG (the design phase of LCC), occurred at earliest from July to December 2014, though the CER/ ProDoc were not submitted until Aug. 2015. Regarding attribution of the KK WTE, given the foregoing timeline, it does not seem possible that the PPG (with its earliest timescale of July to Dec. 2014) could have been the key force leading to realization of the KK WTE.

[8] Alliance Clean Energy signed a contract with the Khon Kaen City for the WTE in August 2011 and a PPA with PEA for the KK WTE in October 2013, whereas PPG design of LCC began in July 2014. Thus, the TE Team does not believe there is a possibility for LCC to claim attribution of the KK WTE. Further, because the WTE operations are integrated, our view is that GEF would require GHG ER calculation methodologies (were there a possibility of attribution) consider the inputs coming in (waste) and the results going out (energy, GHG emissions) for comparison to the baseline. Thus, the waste that is incinerated but not used in power generation would need to be included in the GHG ER calculations. Based on the MRV consultancy's TVER methodology-based estimates for the power generation portion only, we roughly estimate that for the WTE plant overall, there are negative GHG ERs both for the period considered (Nov. 2016, commissioning, to July 2021, EOP) at -99,750 tons CO2eq and for the lifetime of the installation (which is assumed to be 20 years) at -791,454 tons CO2eq. Not only did LCC choose to ignore the additional burning onsite, it selected to use a methodology that ignored the waste stream's plastic content's negative impact on GHG ERs and the positive benefit from landfill methane avoidance. This "choice" had the net effect of increasing the GHG ERs it claimed from 34,179 tons by EOP to 96,007 tons by EOP. While the latter method was used in the ProDoc, we believe it is incorrect. Further, we note that ProDoc preparation resources, at USD 100,000 and meant to cover all of design, were much, much more limited than project implementation resources or even project implementation resources dedicated to MRV. Especially with both a large MRV contract for the demos overall and a local consultancy entirely dedicated to the MRV of the KK WTE, it seems an estimate that uses more than (i) simple grid emissions factor, (ii) MW exported from site, (iii) percentage uptime, and (iv) life of installation and that takes more than two minutes to compute would have been in order.

[9] Stakeholders suggest that the project differed with the project designers and did not see the benefit of developing new financing mechanisms, finding it preferable to promote and support TVER, the existing carbon offset one. Later in this report, we discuss that there is a still a need for other types of financing mechanisms besides carbon offset ones to support low carbon efforts of cities. While it would be challenging to set up such a financing mechanism (such as a fund for feasibility studies and design, a partial grant fund or soft loan fund for installations), if successful it might have resulted in more funds available for low carbon city activities and resulted in more GHG ERs.

various stakeholders and assisting them in applying for credits. The TE Team did not find evidence that would allow attribution to LCC of GHG ERs from projects for which T-VER was the only LCC contribution.[10] Three curriculum and information package contracts are held by a single institution. TGO plans to use the developed materials to train cities. The materials are quite broad, encompassing climate change adaptation as well as mitigation. *LCC* has cooperated with CP-ALL (7-11 owner and franchiser for all of Thailand) in its "say no to plastic bag" campaign, which is believed to have had an accelerated start due to *LCC* involvement.

Additional results: A positive impact is that TGO has set up a Bureau for Low Carbon Cities and plans additional city-level outreach, though it aims to address local level through cooperation with provinces. TGO also plans to work with the responsible ministry, MOI, to develop low carbon KPIs for city and provincial staff. This was a target in the project results framework, but was not addressed by *LCC*.[11]

Our assessment of the 11 indicators in LCC's Project Results Framework (PRF) shows the majority of targets were not met. For 9 of those indicators, our assessment is substantially lower than LCC's self-assessment (see Annex 1). For example, our rough estimates of total direct GHG ERs are 12,468 t CO2eq by EOP and 59,007 t lifetime, as compared to 269,552 t by EOP and 636,594 t lifetime as self-assessed by *LCC*, with assistance from the MRV consultancy it retained (see Annex 2). These differences are due mainly to differences in attribution and baseline assessment, rather than to other differences in methodology of GHG ER computation.

As for gender, the project has promoted the woman clerk of Pha-Ngan Island in reporting achievements of household composting there. In addition, women made up a good portion of attendees at various trainings and events and were said to be among the most vocal. They are well-represented on the project team and in consulting team leadership and coordination roles as well.

Implementation: Although the project invested considerable resources in M&E via a large MRV contract to estimate or quality check GHG ERs, waste treated, and energy saved for its 24 "demos," the majority of the estimates are problematic as they do not properly assess attribution or incrementality. GHG ERs of initiatives not due to *LCC* were claimed. When there was incremental support, GHG ER calculations often had a start date before installation and did not subtract baseline values. Attribution and baseline issues also affected the project's assessment of other indicators. Putting aside attribution and incrementality for the moment, the installations with the largest LCC self-assessed GHG ER estimates appear to have other issues. The problem of excess waste burning as the source of negative GHG ERs at KK WTE was not properly communicated. Instead, very large GHG ERs, representing over 60% of those claimed overall for *LCC* were reported for that plant. The amount of waste going into the NR biogas digester as used in GHG ER estimates for that installation appears to be over three times that reported to the TE Team.

A majority of project expenditures, 67.2% of *LCC*'s USD3.15 M in GEF funds (or USD 2,117,257), were allocated to 11 relatively large contracts across 6 organizations. Based on procurement files, qualified

[10] LCC supported T-VER accreditation in two ways: It helped stakeholders in LCC partner cities apply for T-VER credit. Also, some funds from LCC were reportedly used by TGO for travel to other cities where they assisted stakeholders in getting T-VER certification and, for smaller projects, TGO's LESS certification. Other than funds for travel, LCC was not involved in these other city activities in any way, though TGO, the IP, was. One stakeholder estimated (in response to our query) that up to half of these TGO-only T-VER certification projects would not have occurred without the TGO outreach. Yet, the TE Team was not able to find evidence that either the partner cities' or other cities' "T-VER only" installations would not have happened without LCC T-VER support, nor that the TGO outreach T-VER and LESS projects similarly would not have happened without LCC support of TGO travel.

[11] Some stakeholders suggest that the LCC project has played a partial role in influencing TGO's plan to pursue the KPIs up to the ministerial level. This seems plausible to the TE Team.

competitors were in many cases absent. Also, based on experience of the TE Team with other CCM projects, ICs may offer a better value for money in some cases.

TE Recommendations for *LCC* Project

#	TE Recommendation	Responsible Entity	Timeframe
A	**Overall Way Forward on Realizing Decentralized CCM in Thailand**	---	
A1	Consider additional initiatives to address untapped GHG ERs at the local level, but do so only if able to develop sound strategy for achieving substantial GHG ERs (per Recommendations 3 and 4). Continue to partner with mid-sized cities, but consider expanding partnerships at different levels to maximize results, including city-based private sector, cities in greater metropolitan area of core city, provincial government, and line ministries for sectors with high potential GHG ERs at local level. Consider expansion of *NDC Roadmap* to include local level targets.	UNDP CO in consultation with TGO, line ministries, local governments and private sector	Next 6 months to determine viability and partnerships
A2	For future projects, emphasize private sector engagement, leveraging UNDP comparative advantage in setting up dialogue to solve problems: Building on learnings from LCC, leverage "Alliance Model" (Chiang Mai Smart Mobility Alliance) to break down silos between private and public sectors and "Khon Kaen Model" to engage the private sector in major low carbon urban development initiatives. Determine other opportunities in mid-sized cities to leverage similar models. Also emphasize private sector cooperation on demos that reduce GHG emissions and benefit bottom line of businesses.	UNDP CO in consultation with private sector leadership in various cities	Next 6 months to identify partners and propose models for specific cities
A3	Be strategic about achieving substantial GHG ERs in future CCM projects and put the bulk of CCM funds in efforts directly tied to reducing GHG ERs. Understand which types of initiatives will bring substantial GHG ERs. Focus funds on INV (such as 20% grant) or the types of TA that lead directly to GHG ERs (feasibility studies, designs, energy audits and not workshops or information packages) and minimize facilitation fees. Pursue larger projects/ installations and take a portfolio approach pursuing several if needed to avoid risk that some will not come to fruition. Strategy may be based on an optimistic view in terms of the receding of Covid-19 impacts, but include a back-up plan to focus on sectors less impacted.	UNDP CO, TGO, other UNDP IP partners in CCM related fields, designers and implementers of UNDP-GEF CCM projects	As needed, at the time of concept formulation, detailed design, and inception of CCM projects
B	**Planning and Policy for Decentralized CCM in Thailand**		
B1	Make city low carbon planning work more action-oriented and less report heavy, perhaps identifying the potential of very specific measures in specific sub-sectors and emphasizing to stakeholders the cost effectiveness. Also, make this very specific to informing the achievement of substantial GHG ERs in conjunction with cost savings/ return on investment in areas where there is room for substantial scale-up.	UNDP-GEF project designers, TGO, project implementers of planning outcomes	As needed, at the time of project concept formulation and detailed design and at the time of implementation
B2	Look for entry point to low carbon mid-sized city initiatives via ongoing smart city plan efforts in relevant cities as focus of future project. Review the smart city plans of selected cities to find synergies with low carbon work and consider work such as in Recommendation B-1 to expand strategic and cost-effective win-win low carbon content. In the	UNDP CO, partner cities	Next 6 months

	case of Chiang Mai, consider especially transport aspects of this plan. Discuss with selected cities. Consider whether a smart city plan theme would be a good way to incorporate the strategies discussed in Recommendations A-1, A-2, and B-1 (and possibly, B-2).		
B3	Consider and promote as relevant, national level policy to promote low carbon initiatives in mid-sized cities. In particular, consider promotion of KPI for city and provincial officials through liaison with MOI and relevant high-level leaders. Consider also sector-wise national policies that may facilitate low-carbon city work, such as parking fee policies (vis-à-vis promoting sustainable transport), etc.	TGO, UNDP CO leadership, implementers of future sector-based projects	Next 6 months for KPIs; as needed for sector-wise policies
C	**Financing for Decentralized CCM in Thailand**		
C1	Consider promoting financing mechanisms or other means of generating increased investment for low carbon development at the mid-sized city level in future project. Address the gap of funding mechanisms that operate at the city level and consider and address funding needs of private sector. Consider partial grant fund (e.g. 20% of costs), grants for feasibility studies and design, soft loans, ESCO-type modality for different types of low carbon initiatives, BOT, etc.	UNDP CO, TGO, financial sector	Next 6 months to determine whether of interest
D	**Improving Implementation of CCM and other GEF Projects**		
D1	Put top priority of improvement of indicator assessment aspect of M&E for GEF Projects, including bottom-up framework to allow for better spot checking. Also monitor co-financed work to ensure it is realized: Prepare a brief guidance document (e.g. maximum 5 pages) for UNDP COs outlining clearly the most important basis on which UNDP-GEF projects will be assessed, especially GHG ERs for CCM projects (or other top indicator for other types of GEF project). Emphasize concepts of attribution and incrementality. CO staff should become completely familiar with this guidance document and be responsible for asking project teams the right probing questions to ensure their projects are addressing GHG ERs (or other core indicator) with proper consideration of attribution and incrementality. Further, a bottom up accounting showing how each indicator assessment is arrived at should be prepared by the project team. CO QA personnel should use this for spot-checking to ensure the entries in the bottom up accounting can be attributed to the project and are accurate. For third party MRV/ M&E consider an international consultant or one partnered with a national consultant as an alternative to a firm. As for co-financing, enhance its monitoring and realization, putting effort into the coordination, reporting, and actual utilization of committed co-financing.	UNDP NCE (guidance document), UNDP CO, project teams, M&E/ MRV consultants	Next 6 months for launch and then as needed on project basis
D2	Emphasize beneficiary focus in M&E, including spot checks and evaluation: CO spot-checking of project progress should include consultations with multiple beneficiaries in the absence of those paid to implement the project. For future evaluations, ensure that there is strong emphasis on one-on-one consultations with a large number of beneficiaries without presence of those paid to implement the project.	UNDP CO, project teams, evaluation consultants	As needed during implementation of projects
D3	Scrutinize plans for large contracts with organizations and minimize number of large TA contracts, if any. Focus on tangible results rather than preparation of voluminous reports. Consider options to cut costs while maintaining or improving quality by use of ICs for appropriate assignments. When organizations are definitely needed ensure that there	UNDP CO procurement, program team, leadership,	As needed during project design, inception, and implementation

	are multiple qualified bids that are truly competitive by starting outreach early and not making requirements too onerous.	RTAs, project teams	
D4	Reassess repeated delays at all stages in the UNDP-GEF cycle in Thailand and look for new solutions to avoid them. Project design is likely a step that could be sped up simply by requiring a shorter timeline of consultants. For lags between ProDoc clearance and signatures, high-level discussions within Thailand on national process may be needed. Inception workshops should be held shortly after hiring of PM.	UNDP CO leadership (DRR and Team Leads), RTAs	Next 6 months for assessment and high level discussions
E	**Addressing Sustainability of Promising *LCC* Demos and Possibly Building on them with Future Sector-Wise Work in Thailand**		
E1	Transport: Consider options for ensuring sustainability of promising *LCC* transport demos/ studies and options for future projects that may continue to build on *LCC* transport sector achievements in NR, CM, and KK. (i) For all, consider low-cost measures to discourage private car use. (ii) For CM, consider supporting Smart City Plan's mobility section (e.g. software to assess CCTV camera feeds monitoring illegal parking that impedes traffic flow and smart traffic lights) if not fully funded already. Take steps to ensure sustainability of Alliance, its ap, and electronic tickets. (iii) Now that NR has received one year of UK support, consider using this period to plan follow up support thereafter to implement NR's e-BRT plan. (iv) For KK, ensure *LCC*'s feeder plan and TOD study are shared with CKKM, KKTS, etc. Assess viability of LR, and if it makes sense, consider partnership to ensure TOD buildings are low carbon.	*LCC* Team, UNDP CO, RTA (all in partnership with NR, CM, KK)	Next 2 months for *LCC* Team; next 6 months for others
E2	Waste management: Consider options for ensuring the success of promising LCC waste management initiatives and leveraging the learning from efforts in Samui, KK, and NR. And, if it makes sense in terms of potential GHG ERs, continue to build on those achievements and/or take them to other cities in future projects: (i) Ensure organic waste supply flow to *LCC* learning centers/ stations in Samui and KK allows them to maximize capacity on daily basis. If attractive, consider promoting replication. (ii) Consider promoting replication of Samui HH composting in other locales. (iii) Take steps to re-stimulate and expand Samui hotel composting post-pandemic. UNDP may promote to international chains on Samui as well. (iv) Consider support for extending biogas digesters to interested schools and hospitals in NR. (v) For WTE projects, use caution in considering close involvement due to the challenges, but continue to provide advice to NR and KK WTE initiatives based on lessons learned.	*LCC* Team, UNDP CO, RTA (all in partnership with Samui, KK, and NR)	Next 2 months for *LCC* Team; next 6 months for others
E3	Energy end use and distributed energy: Strongly consider opportunities in energy end use and distributed energy for future CCM projects, realizing that sizable GHG ER results can be achieved more quickly and with less complexity than in transport and typically, though not always, more easily than in waste management. Solar PV systems in the northeast seem an area that is just taking off that may be supported by studies/ designs showing cost savings or by providing small part of large system that can be expanded in the future. Verify impact of NR building energy audits and, assuming confirmation, consider expanding audits to achieve installations (or relevant adjustment of) of LED lights, VSDs, chillers. Consider low carbon home initiatives, such as energy efficient	Responsible Entity: *LCC* Team, UNDP CO, RTA (in partnership with NR and other cities, especially northeastern ones)	Next 2 months for LCC Team; next 6 months for others

	appliances and lighting. Consider support of water supply/ distribution, such as efficient pumps.		
F	**Improving Design of UNDP-GEF Projects**		
F1	**Improve the PPG/ project design process for GEF projects in Thailand.** Ensure strong logical framework analysis work at the beginning of design, so that there is a strong framework addressing key barriers as the basis for design. Ensure that interpretation for international consultant is detailed and strong, so ProDoc represents real situation. During design, ensure that baseline project owners are onboard and confirm that their timelines fit with that of the project being designed. Increase specificity of incremental improvements planned. Ensure that GHG ER projections are specific on whether 100% attribution is expected or only incremental attribution. Enhance the identification, mobilizing, and securing co-financing for projects during the design phase.	PPG team, UNDP CO, UNDP RTA	As needed when projects are designed

1. Introduction to the Terminal Evaluation

This section presents background on the *Thailand LCC* Terminal Evaluation (TE), such as purpose, scope, methods, and limitations. It also introduces the content of this TE Report.

Purpose of TE: The TE has two key purposes: (1) Transparency: Provide information on and assessment of the project, so that all who are interested can know how funds have been spent. This will include identification of achievements and strengths as well as challenges and weaknesses, which will in turn contribute to the second key purpose. (2) Lessons and recommendations for the future: For Royal Thai Government (RTG), involved municipalities, UNDP, and other interested parties, identify: (a) Priorities for enhancing, sustaining, replicating, and building upon project results and benefits. (b) Ways to better design and implement future projects, as UNDP continues its portfolio of development projects in Thailand and around the world, both within and beyond the climate change mitigation area.

Scope of TE: The scope of the evaluation is the *UNDP-GEF Thailand LCC Project*. The baseline environment (things that would have happened anyway without the project) is also considered in the assessment. The evaluation mainly focuses on *LCC*'s targeted goal and objective and its three targeted outcomes, rather than its easier-to-achieve targeted outputs. Achievement of outcomes depends on more than the project alone, so that UNDP-GEF projects aim to reach targeted outcomes not only via their own outputs, but also by influencing the outside environment.

As outlined in the TE TORs and UNDP's *Guidance for Conducting Terminal Evaluations of UNDP-Supported, GEF-Financed Projects* (2020), our assessment is to include a number of items across the three broad areas of design, results, and implementation. We take results as the lead priority among these three inter-related areas, as shortcomings in results often illuminate a trail leading one back to design or implementation problems. And, results are, after all, the reason GEF has provided the funds. For results, verification of claimed results is an important aspect required for UNDP-GEF terminal evaluations.

Among the many required items in the scope of UNDP-GEF evaluations, a handful stand out as particularly important concepts in the analysis of development projects. These are listed below, each followed by questions elicited by them:

- Relevance: Were the results targeted/ achieved really in need of GEF support? Would they have happened anyway without the project? If not, was what happened really useful or needed? For the last query, evaluators may look at two main channels for achieving relevance: (i) Was the measure innovative or new, introducing something with high potential that was absent before? (2) If the measure was not new, did it provide substantial scale-up or critical improvements?
- Effectiveness and impact: Were targeted results/ outcomes achieved? Was progress made towards the project objective? Did the project have a meaningful impact? In assessing results, the evaluation puts strong emphasis on attribution (were these results really due to the project?) and, relatedly, the concept of incrementality (did the project add anything to the business-as-usual situation that, in turn, resulted in substantial results beyond the things GEF funds paid for directly?).
- Cost effectiveness: Were GEF funds well spent? Were the interventions a good value for the money? Were GEF funds leveraged as intended?
- Sustainability: Will the achievements last and continue to be meaningful beyond the project? Will they continue to stimulate additional results and/or be built upon as intended?

Methodology of TE, including information collection and analysis: Our TE work includes both quantitative and qualitative methods. In particular, it integrates three key methodologies: (1) stakeholder consultations; (2) document review; and (3) special information requests and related analysis. Annex 3

includes a full list of organizations and individuals interviewed, along with timeline. Due to the Covid-19 crisis, all interviews were conducted virtually.

Among the special information requests are detailed, tailor-made requests for each of the project's four city demo facilitation consulting teams. These requests cover a range of topics and include special efforts to determine: (i) attribution of various results claimed and (ii) impact/ potential future impact of those results. Information on expenditures was also sought, both on the project overall and on the four city demo facilitation consulting contracts, which encompassed not only facilitation service fees but also the GEF contributions to the city demos themselves.

Ethics: The evaluators sign a code of conduct. In particular, they are careful not to reveal what a specific stakeholder told them during consultations. Further, the evaluators must be unbiased and not allow their assessment to be influenced by relationships with UNDP, the Project Team, the IP etc. The situation is delicate, as the UNDP CO commissions the work, but is also being evaluated. And, the Project Team typically makes arrangements for the evaluation and provides documents, but is being evaluated.

Limitations to the evaluation: This evaluation faced many challenges, which are listed and explained below. While Covid-19 impacted the ability to carry out in-person interviews and site visits, given the possibility of virtual workarounds, the pandemic is not considered the key contributor to these challenges, except for the one listed last.

- Mixing of those paid to implement with beneficiaries in the same meetings; large number of persons at meetings: Key consultations mixed those being paid by the project with beneficiaries and often included several people at once. An evaluation best practice is for beneficiaries to be interviewed separately from those paid to implement, so the former will speak more freely and the TE Team can triangulate to verify claims. Smaller meetings can be more effective, particularly when there is interpretation, and elicit more input from each stakeholder. The international consultant requested to interview each city focal point separately from the respective city consulting team and to have all consultations limited to a couple of stakeholders at most, but neither request was realized. Subsequent meetings with demo beneficiaries typically included implementers as well, except for those meetings that the international consultant was not invited to attend.
- Limited access to beneficiaries; limited opportunity to interview those available with interpretation: The majority of consultation meetings involved project implementers, especially those who had been paid by the project. While project implementers tend to have the most detailed information, evaluations should focus on beneficiaries to validate and provide perspective on claims of implementers. The TE Team emphasized the need to consult with more beneficiaries, beyond each of the four city focal points, who were each interviewed in the same meeting as the respective city demo facilitation consulting team. While some such beneficiary consultations were then added, more would have been needed to validate claimed achievements. The international consultant was anxious to be involved in beneficiary consultations and set up a means for her to be looped into each call, but was told some beneficiaries were only willing to spare 30 minutes and it would not be convenient for her to attend. The implied lack of willingness of more beneficiaries to be available for consultations or to be available for consultations involving more time/ the international consultant raises questions about the true impact of the project and in itself may be considered a form of evidence. In experience with similar multi-city projects in other countries, beneficiaries are usually quite willing to be interviewed as a sort of return favor, given the benefits they have derived from the project. Particularly notable is that for most of the demos with the highest GHG ERs claimed to be attributable to *LCC*, the TE Team was unable to verify with beneficiaries directly involved.[12]

[12] Key examples are the Khon Kaen WTE Plant (lifetime GHG ERs claimed by *LCC*: 408,110 tons CO2); the Nakhon Ratchasima Anaerobic Waste Digester to Power Plant (city focal point interviewed with city demo

- Lack of proper assessment and attribution of progress toward indicator targets and haziness of the true situation with regard to them: Because terminal evaluations have many aspects, it is difficult for terminal evaluators to correct extensive flaws in assessment of progress toward indicator targets. Some evaluators upon encountering such a situation simply state the claimed progress and offer a "cannot verify" statement, but this does not provide the transparency needed. The *LCC* TE Team found extensive problems with claimed progress towards indicators, particularly GHG ERs. And, getting down to the bottom of the situation of the relevant demo in some cases was extremely time-consuming. In the end, we had to strike a balance between offering true transparency on the achievements of the project and covering all the required areas of the evaluation.
- Lack of effective interpretation across most meetings where it was needed: Interpretation at most meetings was ad hoc. Typically long explanations in Thai were followed by very brief explanations in English. Interpretation in much shorter segments (e.g. on a roughly sentence-by-sentence basis) would allow more interactive discussion and allow the international consultant, who has main responsibility for drafting the TE Report, to gain a lot more from meetings. Responsibility for interpretation should be agreed upon in advance.
- Lack of site visits: Due to Covid-19, the mission was completely virtual. The international consultant proposed virtual tours of project sites, but was unable to achieve traction with this idea. Past experience suggests such virtual tours combined with discussion of the relevant demo can be very effective in helping the TE Team learn more about the project and validate claims by the project.

Structure of TE report: A summary of the main findings and recommendations of the TE can be found in the Executive Summary at the beginning of this document. The main text begins with two preliminary sections, this one, Section 1, being an introduction to the TE itself, and the following one, Section 2, presenting background on the project and country context. Section 3 presents assessment of project design. Sections 4 to 6 each cover results of one of the project outcomes, respectively. Content within each of these sections is divided into the main areas of work under the respective outcome. We start with Outcome 1.2, the demo outcome, covering in it Section 4, because of its leading role in the project. That section presents the demos on a city-by-city basis. These three sections together (Sections 4 to 6) consider key aspects of the results, including their relevance, efficacy and impact, cost effectiveness, and sustainability. Section 7 assesses projects results overall and reviews some miscellaneous cross-cutting results topics and concerns. It includes a cross-cutting summary of findings on sustainability, bringing together the findings presented earlier in the outcome-by-outcome results sections (Sections 4 to 6). Second 8 focuses on implementation, covering a range of topics, such adaptive management, finance and co-finance, and M&E. Section 9 provides conclusions and recommendations. A number of annexes, as listed in the table of contents, follow. Key among these are: (a) Annex 1, which compares LCC self-assessments of the project's 11 indicators with TE assessments of the same, and (b) Annex 2, which compares LCC self-assessment of GHG ERs on an installation-by-installation basis to TE rough estimates of the same.

facilitation consulting team, but we did not talk to digester management; lifetime GHG ERs claimed: 81,957 tons); Central Pattana solar PV system(s) (lifetime GHG ERs claimed: 21,730 tons, but, by TE Team assessment, could be additional 265,000 tons if additional systems influenced by project's T-VER capacity building included); and Terminal 2 (Nakhon Ratchasima) variable speed drive on water pump (claimed lifetime GHG ERs of 50,101 tons). The only beneficiary with *LCC* claimed lifetime GHG ERs in as high of a range that was interviewed directly was CP-ALL (claimed lifetime GHG ERs of 33,984 tons). CP-ALL was said to have benefited from five 100% grant rooftop PV systems from *LCC*, while the other four aforementioned beneficiaries received only TA support from *LCC*. In the end, though, it was found LCC budget did not include the USD1 million-plus needed for those claimed 100% grant CP-ALL systems.

2. Project Description and Background Context

Before moving to the TE team's assessment of the project in subsequent sections, in this section we provide background on or related to the project, including: (i) a description of the project's basic design; (ii) project implementation and management arrangements, (iii) main stakeholders, (iv) timeline, and (v) background context covering the cities and the national situation with regard to decision-making, socio-economic development, and climate change mitigation.

2.1 Project Basic Information and Project Design

Basic information: The RTG-UNDP-GEF project *Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand* ("LCC" or "Thailand LCC") was designed as a four-year project with the overall aim of promoting low carbon urban development in Thailand to achieve the aims of greenhouse gas (GHG) emissions reductions and enhancement of the lives of local people through a more healthful, pleasant, and economically beneficial mode of urban development. Emphasis is on the waste management and transport sectors, though electricity end-use is also included. The project is designed to cooperate closely with four cities: Nakhon Ratchasima, Khon Kaen, Samui, and Klaeng. At the time of implementation, the city of Klaeng dropped out and was replaced with Chiang Mai. *LCC* is reportedly built on an earlier UNDP low carbon cities project that cooperated with the same four cities as in the design. *LCC* was launched April 26, 2017. The original close date was April 25, 2021, though the project was extended about three months to July 31, 2021. The project's core funds are GEF grant financing of USD 3,150,000. The project's committed co-financing totals USD182,301,010, of which 97 percent is cash co-financing. Of the cash co-financing, 99.99%, about USD177 M, was to come from the four cities.

Barriers addressed: At the time of ProDoc submission (2016) and continuing on until today, Thailand's ongoing economic growth has been leading to both negative local environmental impacts (such as increased waste in landfills, traffic jams, and unhealthy air quality resulting from combustion of fossil fuels) and increased greenhouse gas (GHG) emissions. While there has long been an institutional framework and progress in developing a strategy to address growing GHG emissions at the national level, local level progress in cities other than Bangkok has been limited. And, at the same time, local-level challenges related to waste, air quality, and traffic jams continue to intensify. Barriers leading to limited progress on both GHG emissions reductions and these local-level problems in mid-sized cities, such as those targeted by *LCC*, include: (i) Lack of awareness of municipal officials and citizens about GHG emissions and the "win-win" co-benefits of low carbon growth. (ii) Lack of experience and capacity of municipal officials in low carbon planning, (iii) Lack of strong examples of low carbon initiatives in mid-sized municipalities in the waste, transport, and end-use electricity sectors that show both the strong GHG ERs and co-benefits in improving the bottom line, improving air quality, and making the urban environment more attractive and healthful for citizens. (iv) Lack of up-front financing for low carbon initiatives at the municipal level.

Project goal, objective, and outcomes (including "development objective and immediate objectives") – basic design: The project goal as stated in the project results framework is "Reduction of future GHG emissions from cities in Thailand." The project objective as stated in the same and in the CER's Project Framework table is: "Promotion of sustainable urban systems management in Khon Kaen (KK), Nakhon Ratchasima (NR), Samui and Klang to achieve low carbon growth." The project has three targeted outcomes. Our paraphrased interpretation of each outcome as a brief statement, followed by GEF budget allocation as in the signed ProDoc, brief description, our paraphrasing of targeted outputs as in the CER, and the official outcome statement as in the CER's Project Framework table, is given below:

Outcome 1.1 Integration of low carbon planning into the mainstream urban planning process and implemented low carbon municipal plans – GEF budget USD505,312 (all TA)*:* The aim of this outcome is to integrate low carbon planning into the municipal planning process so that low carbon initiatives are budgeted and implemented now and on an ongoing basis, with effective monitoring to support the process. The CER-indicated outputs are: (1) GHG inventory (also known as "carbon footprint") for each project city that can be used as a basis for low carbon planning. (2) Formulated low carbon urban development plan integrated into the main, budgeted urban plan and planning process. (3) Formulated and implemented monitoring frameworks for waste management activities in cities.
Outcome statement in CER: "Increased number of Thai cities that have formulated and implemented low carbon sustainable urban development plans."

Outcome 1.2 Low carbon city initiatives that demonstrate their financial and technical viability and local and global environmental benefits – GEF budget: TA USD360,323 and INV USD1,463,231: The aim of this outcome is to get sustainable urban systems in the areas of waste management, transport, and end-use energy operational to show their viability and benefits. The CER-indicated outputs are:
TA: (1) Completed planning, design and engineering plans for the low carbon urban waste management and sustainable transport systems in KK. (2) The same for NK. (3) The same for Klaeng. (4) The same for Samui. INV: (1) Operational low carbon urban waste management and sustainable transport systems in KK. (2) The same for NK. (3) The same for Klaeng. (4) The same for Samui.
Outcome statement in CER: "Increased number of Thai cities with energy efficient urban systems."

Outcome 2.1 Increased availability of financing leading to increased financial closure for and replication of low carbon city initiatives – GEF budget USD671,134 (all TA): The aim of this outcome is to increase the availability of financing for low carbon city initiatives via operationalized financing mechanisms that lead to substantial realized financing. The CER-indicated outputs are: (1) Analysis of existing and potential financial incentive schemes, both domestic and international carbon offset incentives and especially establishment of the Thai voluntary market scheme. (2) Establishment of financial incentives and institutional arrangements for replication/ scale-up of low carbon city initiatives. (3) Trained technical specialists in city governments who can access funds for climate change mitigation. (4) Operational MRV system for carbon offset incentives. (5) Implemented training course of low carbon cities. (6) Expanded and improved Low Carbon Cities Network. (7) Implemented awareness campaign on climate change and low carbon development.
Outcome statement in CER: "Increased volume of investments in energy efficient urban systems by government and private sector."

Expected results: The expected results are largely encapsulated in the goal and objective statements and the paraphrased (and underlined) outcome statements above. The goal, objective, and outcome indicators convey quantified expected results and include the areas of, at the goal and objective levels: GHG ERs, fuel savings, waste gainfully used (via recycling, composting, anaerobic digestion, or waste to energy), and green jobs. For Outcome 1.1, they include, for all four cities: an institutionalized carbon footprint process, approved and adopted low-carbon development plans, and integration of low carbon evidence-based planning with normal urban development planning. For Outcome 1.2, they include: number of low carbon demos implemented as result of the TA and INV assistance of the project and number of low carbon demos designed based on results of the project demos and the low carbon city plans. For Outcome 2.1, they include: new investment leveraged through local plans for low carbon city projects and number of policies facilitating low carbon urban city projects approved by line agencies.

Theory of change of the project: The project design adopts a theory of changed based on a multi-pronged approach to barrier removal. The project's three outcomes each address a different type of barrier, though there are expected to be synergies among the three. The first outcome builds capacity and awareness at the local level to achieve integration of low carbon planning into the city planning process to

ensure low carbon city projects get incorporated into the main city plans with budget. The second outcome focuses on the need to build experience with actual low carbon projects and demonstrate their technical and financial viability, along with their co-benefits (e.g. cost savings, improvement of local air quality, quality of life factors) via actual design and implementation of low carbon city projects, particularly in the areas of waste management and transport. The last outcome addresses the lack of financing at the city level for low carbon projects, aiming to generate availability of financing and capabilities in accessing it. It is expected that together these three prongs, city planning, demonstration, and increased ability to access financing, will create conditions to grow the number of low carbon city projects implemented in a sustainable fashion.

2.2 Project Implementation Arrangements, Stakeholders, and Timeline

Implementation and management arrangements of the project: At the national level, the project has a Project Manager (PM), Project Coordination Associate (PCA), and an Administrative and Finance Officer, all based in Bangkok. The last has been part-time during most of the project, though full-time towards project close. The project has chosen to operate mainly through large sub-contracts. It has retained sub-contracting organizations, one for each city, to facilitate demo implementation in each of the cities. It also sub-contracted to organizations the carbon footprint and low carbon city planning work (two organizations), the MRV work (one organization), and training materials and knowledge management work (one organization). A focal point in the city government for each project city was appointed and leads the project's low carbon planning group for that city. The groups consists of persons from different parts of the municipal government. The project is NIM modality, with a National Project Director (NPD) from TGO for day-to-day oversight of the project and with TGO responsible for handling procurement. There is a Project Board for oversight and approval of the annual budget. The Chair of the Board is the Director of TGO. The board has met four times or about once per year. UNDP, as the GEF IA, provides oversight and backstopping to the project and provided procurement earlier in the project, when the project had difficulty moving forward in a timely fashion via the national procurement system.

Main stakeholders: The main stakeholders and beneficiaries are the four project cities, including their city officials, those involved with city operational organizations (such as those handling waste and those handling transport), the private sector in the project cities, and the citizens of those cities. More broadly, the project has also touched upon citizens in other locales through its cooperation with key private sector stakeholder CP- ALL (owner and franchisor of Thailand's roughly 12,000 7-11s). National government organizations, such as IP TGO, or PB member DEDE, are also stakeholders potentially influenced by the project.

Timeline: *LCC*'s timeline is depicted in Exhibit 1, with longer-than-usual gaps indicated by red ellipses. The *LCC* ProDoc was signed April 21 and 26, 2017, with the second signature date serving as the official project launch date. This represents a significant lag (almost 3.5 years) from the PIF (project concept) approval date of Nov. 15, 2013 and a lag of about one year from the CER (full project design) clearance date of April 25, 2016. Nowadays, after PIF approval, detailed design submission (ProDoc and CER) is expected within 1.5 years and GEF CEO clearance, on a relatively fast timescale after that submission. In theory, signing of the ProDoc could happen immediately after CEO clearance. After signing of the ProDoc, the project again experienced a lag, this time of about nine months, until the inception workshop, which was held Jan. 26, 2018. And, there was yet another lag in that sub-contractors to serve as the local facilitators for demos in each of the four project cities and other major sub-contractors were not hired until another eight months later in September 2018, almost 1.5 years after ProDoc signature date. It is thus not surprising that the Mid-Term Review (MTR) was not held until Feb. 2020 and final MTR Report submitted in April 2020 – yet that was roughly three years into the four-year project. Due to real delays

created by the Covid-19 pandemic over the last year of the project, *LCC* applied for and received a special extension of three months, so will now close in July 2021.

Exhibit 1: Thailand LCC Project's Timeline (*designed duration of project implementation: 4 years*)
Significant Delays Indicated by red ellipses

PIF Approval	CER/ ProDoc clearanc	ProDoc last signatur	Inception Workshop	Hiring of Facilitators for 4 Cities	MTR Final Report	Original Close Date	Current Close Date
Nov. 15, 2013	Apr. 25, 2016	Apr. 26, 2017	Jan. 26, 2018	Sept. 2018	April 2020	April 2021	July 2021

2.3 Background Context

Background on the project cities: Brief background on LCC's four project cities is given below. All four suffer to varying degrees from traffic congestion and lack of good public transport, problems in waste management, and inefficiencies in electricity end-use. It is worthwhile noting that *LCC*'s local-level entity of cooperation is the municipality, which in the cases of Nakhon Ratchasima, Khon Kaen, and Chiang Mai, have a much smaller population than their respective greater metropolitan areas.

Nakhon Ratchasima (NR, "Korat"): Located in the northeast, with registered municipal population of 126,391 (2019), NR's characteristics include urban sprawl and its being a commercial center not only for the region, but also for Cambodia and Laos. Its "mega-stores" are said to account for one-third of municipal electricity consumption. NR's broader metropolitan area (including urban areas in NR District both within and without the municipal borders) has a population of around 444,000.

Khon Kaen (KK): Also in the northeast, KK is a university town, but with strong commercial and residential sectors. KK's registered population was 114,559 in 2019, though this does not include students. KK is pursuing an image of "smart city" and is designated to become a rail hub. KK's broader metropolitan area is estimated to have a population of around 500,000.

Chiang Mai (CM): Located in the north, Chiang Mai is an internationally famous tourist destination. Its registered population was 127,240 in 2019, though it has substantial urban sprawl with a broader metropolitan area population of almost 1 million.

Samui: Koh Samui is an island located in the Gulf of Thailand in the south of the country. It is an internationally famous tourist destination. The registered municipal population was 68,894 in 2018, though non-registered population (workers and average tourist population) was estimated at 300,000. Samui's tourism-based economy has been hit hard by the Covid-19 pandemic. The municipality's area covers the full 229 km2 of the island.

Background on levels of government in Thailand and locus of decision-making vis-a-vis low carbon growth: Municipalities in Thailand have their own, local government, led by locally elected municipal officials, namely the mayor (leading the executive branch) and the members of the municipal council (leading the legislative branch). They have their own plans and their own budgets, though often rely on approval of the national government for allocations for major projects. As such, there may be important exchange between the two levels on issues such as major transport infrastructure. Important areas related to low carbon growth under the control or strong influence of municipal governments include waste management, water supply, and transport within the municipality. Local governments also issue building permits and thus have interface with builders.

Aside from Bangkok, the nation's 76 other provinces have their provincial level government officials appointed by the central government, with the Governor appointed by the Minister of Interior. When it comes to low carbon growth, this national-provincial power axis has responsibility for things like power plants and transport between municipalities. As noted, the national government also allocates funds for major projects to municipalities, so in those cases, there is an interaction of local and national-provincial level decision making.

The private sector is another important domain of decision making related to low-carbon growth in Thai cities. The private sector may participate in infrastructure projects, such as waste management and transport projects, and may operate bus companies. Further, with large facilities, it may undertake energy efficiency or renewable energy measures to operate them.

Socio-economic situation: Thailand is considered a great success story in economic development over the past four decades, moving from the status of low income country to upper-middle income country (achieved in 2011).[13] The World Bank estimates, for 2019, Thailand's per capita income at USD 7,807 and per capita purchasing power parity at USD 19,277. This is significantly higher than per capita PPP of neighboring countries of Cambodia, Laos, and Myanmar, as well as nearby Vietnam. It is also higher than China, but substantially lower than per capita PPP of neighboring Malaysia. At the same time, growth in Thailand has seen rising traffic congestion and a decrease in air quality in some cities, along with a relatively high rate of traffic accidents. Rising incomes have led to increasing waste; and waste disposal is a key challenge for many cities.

National-level policy, institutions, and strategies related to climate change mitigation: At the national level, Thailand has been active in setting up an institutional structure and developing strategies to address climate change. In 2006, it established its National Climate Change Committee (NCCC). In 2007, it set up Thailand Greenhouse Gas Management Organization (TGO), which is under the Ministry of Natural Resources and Environment (MoNRE) and is the IP for the project being evaluated. TGO's function complements that of the Office of National Environmental Policy and Planning (ONEP), which is also under MoNRE and is responsible for climate change policy and planning. TGO is the supporting agency and leads on climate action and awareness raising/ promotion. Institutions responsible for key sectors related to climate change mitigation include: (i) Department of Alternative Energy and Efficiency (DEDE) under Ministry of Energy, (ii) Waste and Hazardous Substance Management Bureau, Pollution Control Department, MoNRE, and (iii) Department of Land Transport, Ministry of Transport.

Thailand has consistently been involved at the national level in developing climate change mitigation strategies and involved with the UNFCCC. In 2011, Thailand developed its *National Master Plan for Climate Change (2012-2050)*. Thailand is a non-Annex I Party to the UNFCCC and signed and ratified the Paris Agreement in 2016.[14] It has now submitted its *Third National Communication* (regarding its GHG emissions) to the UNFCCC. In 2015, Thailand submitted its first Intended Nationally Determined Contributions (INDC) to the UNFCCC, and, in 2020, submitted an updated NDC. The new NDC reiterates Thailand's earlier commitment to achieve reduced emissions that are 20 percent less than BAU by 2030 and reports a 14 percent reduction compared to BAU achieved in 2017. The new NDC highlights the strategies developed to support the commitment including: (1) *NDC Roadmap on Mitigation 2021-2030*: The Roadmap identifies key measures and allocates GHG ER targets to national agencies in the energy, transport, industry, and waste management sectors. (2) NDC sectoral action plans: These add

[13] World Bank's online "Thailand Country Overview": https://www.worldbank.org/en/country/thailand/overview#2, accessed May 23, 2021.

[14] Non-annex I parties are mainly developing countries. The Paris Agreement is in international accord that includes commitments by nations to reduce GHG emissions.

further detail on emission reduction targets and measures to achieve them in each sector. (3) *NDC Supportive Action Plan*: This identifies gaps and corresponding needs for support to achieve targets.[15]

Carbon credit market: Thailand participated in the Clean Development Mechanism (CDM) market, but got involved in the incentive scheme relatively late, so that not many projects were successfully implemented and received carbon credits. The first year that CDM projects could be registered globally for carbon credits was 2001. The market dropped from a high of USD20 per ton carbon in 2008 to USD5 in 2012 and finally to less than USD1 in 2013. Thailand got involved in the market when the price was high, but due to the time it took to develop projects, in the end not many were able to register carbon credits before the market crashed and most were not implemented, due to not being considered financially attractive without the carbon credits. Yet, suggesting one model to consider for the future, donor CDM work in Thailand, namely that by Denmark, successfully introduced systems for palm oil plant wastewater treatment that captures biogas, which is then used to generate electricity. These systems have now been replicated across the palm oil industry (without carbon credits) because they are cost-effective.

Thailand has more recently developed two domestic carbon credit schemes, T-VER and LESS that are mainly for the purpose of CSR and voluntary carbon offsetting by companies. Managed by TGO, which in 2014 developed the program and methodology to fit the Thai context, the T-VER Program issues T-VER (Thailand Voluntary Emission Reduction) credits. These can either be kept by the company that achieves them for the purpose of their own CSR promotion or sold to other companies that wish to purchase the credits as "carbon offsets" (to offset their own carbon emissions) for the purpose of the company's CSR. LESS (Low Emission Support Scheme) is not a market mechanisms as it does not allow for the buying and selling of credits. The purpose of LESS is to praise those who do well in achieving GHG ERs by issuing a Letter of Recognition (LOR). The program especially encourages small-scale GHG reduction activities, such as those of communities, temples, and schools. It also aims to raise awareness and prepare the organizations to develop in the future projects at a level that might be bought and sold.

3. Assessment of Project Design

3.1 Relevance of Design

On an overall basis, the design of the *LCC Project* ranks as highly relevant in three key dimensions:

(1) Addressing the un-addressed and important gap of climate change mitigation potential controlled or substantially influenced at the municipal level: While Thailand has shown strong commitment to climate change mitigation by national level strategies, there is little coordinated strategy or action at the mid-sized city/ municipal level, which controls or substantially influences certain important aspects of the economy relevant to reducing GHG emissions. As noted, municipal control is limited to the area within municipal borders and thus does not cover the much larger metropolitan populations often associated with a municipality's name. Yet, work that begins at the municipal level, such as in public transport, could be a starting point to expand to the greater metropolitan areas. While, reportedly, a previous UNDP low carbon

[15] Information on Thailand's second NDC from IISD, "Mongolia and Thailand Update NDCs, Pledge to Up Targets with Technological and Financial Support," Nov. 11, 2020 accessed at https://sdg.iisd.org/news/mongolia-and-thailand-update-ndcs-pledge-to-up-targets-with-technological-and-financial-support/#:~:text=Thailand's%20latest%20NDC%20reiterates%20the,resources%2C%20and%20capacity%20building%20support on May 23, 2021.

city project addressed the municipal-level climate change mitigation gap[16], additional work was clearly needed, particularly in investment and demonstration.

(2) Addressing key needs of mid-sized cities: The project focuses much effort on waste management and transport; and these are clearly priority areas of need of the mid-sized cities.

(3) Selecting major projects of cities for incremental GEF support to achieve optimal GHG ERs: By focusing much of its activity design on incremental additions to major waste management facilities and major transport projects, *LCC* design positioned the project to be highly relevant in terms of potential to generate a large amount of incremental GHG ERs. Baseline projects in the design that were to be enhanced by the *LCC* project include: KK – new WTE plant, new shuttle bus service, and new traffic data management center to support BRT. NR –improvement of city's anaerobic digester, new WTE plant, and bus rerouting and traffic data management center. Samui – new comprehensive waste management center (with anaerobic digestion, RDF, etc.) and traffic zoning. Klaeng – new waste management center and improvement of city shuttle bus service.

3.2 Quality of Project Framework and Detailed Design

Project strategy: As reflected in the design of the project objective and outcomes, the project has a sound logic in bringing together three aspects: municipal planning, demonstration, and financing to work towards achieving low carbon growth in mid-sized Thai cities. Yet, the planning aspect may be repetitive with previous work if it results in a focus on awareness raising and capacity building. As noted, it was reported to us that a previous UNDP project worked with the same four cities as referenced in *LCC*'s design and that capacity building on low carbon development and low carbon planning was the focus. Given this and the work of other donors in areas such as CCF and capacity building, the *LCC* project design might have considered focusing its GEF resources solely on demos and replication/ financing.[17] Or, if it was to maintain the planning outcome, it should have ensured *LCC* took the work to the next level per some of our later comments about achieving substantial results in budgeted projects, with identification of specific measures with strong financial benefits and scale-up potential. Interestingly, Germany, in its comments as GEF Council Member on *LCC* design, emphasized the importance of recognizing other donor work in this area. Related to this, one source indicated to us that GIZ had supported 70 city carbon footprints in Thailand. Though we were not able to confirm this, TGO's own website indicates that, in addition to LCC's four city carbon footprints, 90 other carbon footprints for cities and provinces have been prepared.

Also at the strategic level, we see some room for improvement in formulating the outcome statements more precisely to reflect what really needed to be achieved for maximum impact in the Thai context. Outcome statements, if formulated well, can be very useful for guiding the implementation team. In this case, Outcome 1.1 was formulated as "Increased number of Thai cities that have formulated and implemented low carbon sustainable urban development plans." It would have been more practical for this outcome statement to focus on integration of low carbon measures with budget allocation in the existing draft municipal plans and the existing planning process to avoid the risk that a separate "low carbon plan" sit on the shelf or has only weak influence on the actionable city plan. The original outcome statement does include the term "implemented," but it's possible this would be brushed over, with a

[16] While this earlier project was referenced via stakeholder consultation, it was not confirmed. We guess that either the information is accurate or that instead there may have been another similar project supported by another donor.
[17] As an example, the ProDoc itself mentions that Khon Kaen has a low carbon city plan prepared under the umbrella of the *PLCC Project*, which we know to have been active in 2014/2015 as the LCC project was being designed.

strong focus on delivering a low carbon plan. Outcome 1.2 was formulated as "Increased number of Thai cities with energy efficient urban systems." Use of the term "energy efficient" urban systems is not as on-target as "low carbon urban systems." Reducing methane emissions from landfill, installing solar panels, or increasing use of public transport over private cars, does not fit as well with the term "energy efficient" urban systems. The same issue is found with the Outcome 2.1 statement: "Increased volume of investments in energy efficient urban systems by government and private sector," which might have referenced "low carbon urban systems" instead.

Another point about overall project strategy comes from our review of the detailed design and indicators (as below). Based on the more detailed content, it seems the project design might have considered having a separate policy outcome and a separate knowledge management/ capacity building outcome. Content related to both areas seems to be stuffed into the financing outcome, but doesn't fit that that ideally there. Challenges with the content of the financing outcome (particularly as implemented) not matching the outcome statement were raised strongly in the MTR, but dismissed in the management response.

Project indicators, also an important part of project strategy, are discussed later in this sub-section.

Design details: Other challenges with the project as implemented might possibly have been avoided by stronger attention in the details of the design:

Demos: Given that the project was allocated USD 100,000 for its design phase, more detailed work could have been done on the specifics of the demo design and in liaising well with the cities to ensure the demos were agreed upon and the timeline for baseline activities fit with the project design. In actual implementation, it seems the demo plans were in many cases abandoned for new options; and GHG ERs suffered as a result. And, the PM and IP had to spend a lot of time re-designing the demos after project launch. Ideally, this in-depth work of designing quality demos that have the strong support and enthusiasm of cities would have been achieved during the PPG phase, with the detailed plan provided as an annex to the ProDoc. While some of the problems encountered may be due to a change in situation during the long delay of project launch, more specific and more detailed demo design during PPG work might have led to stronger demo results. Stronger commitment from the cities to the design via increased collaboration during the PPG may also have helped. As with this evaluation, interpretation for the international consultant drafting the ProDoc may not have been strong enough to ensure that document carefully reflected, in detail, what the cities wished to cooperate on. Also related to this "level of detail" issue, the ProDoc, when discussing incremental features of the demos, often mentions MRV of GHG ERs in conjunction with measures that increase GHG ERs. Yet, detail of how the GHG ERs would be increased by the incremental features supported with GEF funds is sometimes absent. This can lead to a tendency in implementation to focus on MRV, which does not add any incremental GHG ER benefit to the demos. Ideally, the project demo design should have put strongest emphasis on how exactly the project contributions would result in increased GHG ERs beyond the baseline of the supported activities. GEF funds, after all, are granted on the condition that they will lead to additional GHG ERs beyond baseline.

City Planning: As for Outcome 1.1, more depth could have been offered in the design as to how the city carbon footprint (CCF) work and the low emission development strategies (LEDS) would really add something truly meaningful and sustainable, instead of having their impact mainly limited to capacity and awareness building. The design should have stressed a means to achieve tangible results. It might have discussed how, specifically, low carbon planning would be integrated with the existing planning process. It might also have offered finer specificity in the CCF and/or LEDS to highlight the most attractive measures to pursue, both financially and scale-up potential wise. As a simple example of one such area, the work might have addressed how much of the CCF is represented by residential and commercial air conditioners, respectively. How much could promotion of certain available measures for air conditioners

reduce the carbon footprint of that segment and save on costs for end users? In general, municipal governments and their constituents need to see clearly the benefits beyond GHG ERs to take strong interest in initiatives. Thus, this planning work would have benefited from stronger emphasis on the win-win aspects of low carbon development and that could have been written as a requirement into the project design.

Financing: In terms of detailed design, Outcome 2.1 is the most problematic. The outputs and activities are spread across: financial incentive mechanisms, capacity building, MRV, and awareness. To achieve such a challenging target as increased financing, the many outputs may have focused more directly on access to financing. The implementers interpreted the two outputs that did address financing directly to be focused on carbon offset mechanisms. While this is an important area that may offer widespread opportunities in the future, to address near-term city-level financing needs, the project could have also more clearly addressed other channels, such as potential soft loans or pilot partial grant schemes (to be supported by the project). Or, it might have designated assistance to banks to understand the analysis of the financial potential of WTE and other types of low carbon city initiatives. As alluded to earlier, for greater focus, the capacity building, awareness, and MRV work might have been moved to a separate knowledge management and capacity building outcome.

Project indicators: As for project indicators, which are an important aspect of project strategy, we find the goal and objective level indicators, covering GHG ERs, fuel saved in transport, waste gainfully used, and green jobs created to be well designed. The calculation of expected GHG ERs in the relevant ProDoc annex, however, is not that clear. For example, there is no explanation in the case of the two WTE plants of whether the calculations will be for the incremental GHG ERs facilitated by the incremental activities of the project or if, instead, the designers believe the project can claim the WTE plants would not have been built without the project and thus attribute all of the GHG ERs of these plants to the project.

We see substantial room for improvement of the outcome level indicators – for making them more on-target for the kind of impact the project as designed might best make. There is also room for improving the means of verification so that the full extent of the target can truly be measured. In general it's important that each indicator statement: (1) manifests the achievement of the outcome, (2) can be verified, and, (3) preferably, is quantitative. For the planning outcome, in terms of what the work under this outcome might have achieved if it were high impact, the most interesting indicator may have been "total amount of funding budgeted or invested for low carbon city initiatives newly added to local plans of participating cities," where the "newly added" is confirmed to be a result of *LCC Project's* work rather than a repackaging of existing city initiatives. An indicator similar to this proposed one ("total amount of new investment leveraged through local plans of participating cities for low carbon projects by EOP") is placed with the financing outcome, though we suggest the planning outcome is the better fit for it. Our proposed planning outcome indicator would look at low carbon city budgeted or invested projects that are now in the municipal plans but that would not have made it there were it not for the *LCC Project*. As for means of verification of such an indicator, further work would need to be done to understand the available documents, but a comparison of previous drafts of city plans, if available, to drafts/ finalized versions after incorporation of budgeted LCC initiatives might be done. The strongest (in terms of implying sustainable results) of the planning outcome indicators in LCC as designed and implemented is "Percentage of participating cities where evidence-based low carbon planning is integrated with normal urban development planning processes by EOP." Yet the means of verification included only "Local development plans of the cities and Strategic Action Plans." With these, it is difficult to determine what is new and what is just business-as-usual. Also, a good means of determining whether evidence-based low carbon planning has been incorporated into the city planning process on an ongoing basis is also absent.

The demo outcome indicators are simply "No. of low carbon demonstration projects implemented as a result of technical and investment assistance in participating cities by EOP" and "No. of low carbon

projects designed based on or influenced by the results of the demonstration projects and the low carbon city plans by EOP." While "number of projects" is attractive in ease of counting, it gives equal credit to very simple to achieve low-cost projects and very challenging to achieve high-cost projects. While it might be more complex, the indicator could better reflect achievement by perhaps targeting number of projects in different areas (such as waste management and transport) and include some minimum factor, such as investment or annual GHG ERs. The second indicator, which is a replication indicator, may focus just on those replications stimulated by the project demos, while those influenced solely by the low carbon city plans would be counted by an improved indicator for the planning outcome, discussed above.

The finance outcome indicators include the one referenced above in the discussion of planning indicators (i.e. total investment leveraged through city plans, with the means of verification simply "project reports") and another indicator on policy: "No. of new policies facilitating low carbon investments in cities endorsed and approved by line agencies by EOP" (with the means of verification simply project reports and policy recommendations). Neither one of these indicators fully fit what the outcome seems to target, which is new channels of financing for low carbon city initiatives.[18] Thus, the indicator might have been "total funds leveraged in project cities for low carbon financing via new financing channels." Options for these new channels might have been indicated in a footnote and included a partial grant mechanism (e.g. 20 percent grant) for low carbon initiatives, soft loans or other loans facilitated by the project, an ESCO model facilitated by the project, or international sources accessed with guidance from the project. Means of verification could have been the records of the financing mechanism on the total investment for the various initiatives supported. The indicator for policies is interesting and might have been an indicator for a separate policy outcome.

3.3 Other Design Aspects

Assumptions and risks: The ProDoc identified six risks, listed in its Annex I, which (paraphrased by us) are: (1) involvement of many stakeholders could make decision-making difficult; (2) delay of co-financing could negatively impact implementation; (3) change of government staff and leadership (national and local level) could negatively impact project; (4) unmet unrealistic expectations of support from cities could negatively impact their willingness to cooperate; (5) unstable economic growth or political unrest; and (6) lack of participation of private sector and other stakeholders. It also identified suitable mitigation measures. Yet, with the benefit of hindsight, we notice some unaddressed risk areas for which mitigation might also have been helpful. In particular, (a) the delays in the LCC Project from design to start-up (i.e. delays in the design submission, signing of the ProDoc, inception workshop, and then initiation of city demo work) may have meant that the planned demos, which were meant to be incremental, were out of sync with what the cities were doing. At the same time, (b) the "out of sync" issue may have been related to a lack of understanding during design of the status of city activities, something that is seem to be true in the case of the KK WTE, where design was clearly completely before ProDoc submission, though LCC design indicated LCC implementation would add incremental features to KK WTE design. In the future, however, the risk of expected baseline projects moving faster than UNDP-GEF project design and approval may need to be mitigated by UNDP finding ways to speed up the process both of design (which should be doable) and ProDoc signatures post CEO-clearance (which may face challenges due to the national situation, but should be addressed nonetheless). And, the design process will also need to work harder to clarify the status of proposed baseline projects.

The project might also have considered risks related to specific types of low carbon city initiatives, given that waste management initiatives and transport initiatives, in particular, are some of the most challenging to make progress with. As will be discussed, in the case of KK WTE, the private owner has been accepting extra waste at the site (because payments for accepting the waste generate attractive revenues),

[18] Also, the means of verification for them is not that strong.

resulting in half of the waste being burned on site without power generation, so that the whole operation actually has negative GHG ERs. Thus, the project is faced with a result quite the opposite of what was intended. In other cases (such as in the Bangkok area), there has been the opposite sort of challenge in developing WTE plants, due to those having the waste driving a hard bargain due to its perceived value. Such issues, if anticipated in the advance, might be addressed in the PPG stage. Or, if the risk is considered too high, the project may choose to pursue other types of demos. In the realm of transport sector projects, strong political will may be needed to take controversial action discouraging use of private cars. Transport initiatives that only focus on improving public transport, without discouraging private car use, may not see the intended results. Thus, absence of needed political will is a risk.

Consideration of other relevant projects in design: The ProDoc mentions three complementary projects or programs, with which *LCC* was to leverage cooperation. The first is the *Third National Communications*, which is indicated as targeted for completion in 2016. Cooperation on data and planning was indicated. The second is an energy efficient buildings project, whose implementation period is indicated in the *LCC* ProDoc to be 2012 to 2015. For both of these two items, as with the KK WTE plant, for which construction started in 2013 or 2014, but which the *LCC* ProDoc submitted in 2015 plans to support the design of, shows that content of the ProDoc was not in good sync with the timelines of its proposed cooperation. The third complementary item is more of an ongoing program – the MoNRE Environmental Fund. This proposed cooperation is quite apt to *LCC*'s financing component as the Fund supports environmental projects, including waste management ones and requires feasibility studies. As such, it could be envisioned that *LCC* providing support for feasibility studies (such as through Outcome 1.2) and then facilitating the MoNRE Fund application process (through Outcome 2.1) could be a way for *LCC* to leverage incremental GEF funds in a waste management project. Yet, to our knowledge, *LCC Project* did not, in the end, pursue this approach.

As for incorporating lessons from other relevant projects in climate change mitigation into project design, while such lessons may have been leveraged, we did not find much indication of such in the project design documents. Yet, one consultation reported *LCC* was follow up to an earlier UNDP Thailand (non-GEF) project for promotion of the concept of low carbon cities. The earlier project is said to have worked with the same four cities as in the *LCC* design (KK, NR, Samui, and Klang). Under the previous project, city government authorities and technical personnel were provided capacity building on low carbon urban development and low carbon urban development planning. The ProDoc mentions that LCC will expand the Low Carbon City Network and that this network was initially established by the EU-supported *PLCC Project.* This appears to be a different project from the UNDP one that we heard *LCC* follows on, though *PLCC* was also focused on achieving GHG emission reductions by working with Thai cities.[19]

Planned stakeholder participation: The project gives good attention to past problems of stakeholder participation and to integrating stakeholder participation in its design. Past problems pointed out occur on two levels: (1) Communities are not involved in decisions that affect them. (2) Local level governments may not be involved in national-level funding decisions that affect their city. As for the former, the need for community involvement in the planned bus rerouting demo in NR and the traffic zoning demo in Samui are mentioned. In addition, references to the demo outcome specifically designate stakeholder consultations for both of these two demos, as well as for pedestrian walkways in Klaeng. For the other two outcomes, the design emphasizes extensive stakeholder engagement, mainly through training and coaching, including: training of local government officials in CCF and low carbon urban planning, trainings on monitoring waste management, training on climate change mitigation market mechanisms,

[19] The CER indicates that the full name of the *PLCC Project* is *Promotion of Low Carbon City across Municipalities in Celebration of His Majesty the King's 84th Birthday*. The ProDoc explains *PLCC* set up the network in 2014/2015. The project was implemented by the National Municipal League of Thailand (NMLT) and focused on reducing GHG emissions by working with 100 cities. Its financing was around USD275,000.

coaching of city staff on financing mechanisms, establishment of MRV working group in each city, training course on low carbon cities, and expansion of Low Carbon City Network through outreach program and meetings.

4. Outcome 1.2 Results: LCC Demonstration

This section reviews Outcome 1.2 results – the city demo results – for each of the four cities and then overall. The TE Team views the demos as the strongest contribution of the *LCC Project* to low carbon city development in Thailand. We are quite favorably impressed with the relevance of the demos in responding to critical needs of the cities and level of positive impact or potential future impact. The greatest weakness of the demos is that they were not pursued to strategically achieve maximal GHG ERs, so that in many cases the GHG ERs are quite low. Further, in a number of cases, the only addition of the project to the listed "demo" is MRV, which did not increase GHG ERs and which, as far as we could confirm, did not result in an installation that would otherwise not happen. We suggest that those cases of "addition of MRV only" be considered another type of activity of the project rather than "demo."

4.1 Nakhon Ratchasima Demo Results

The demo results of NR impressed the TE Team for: addressing important needs of NR in a "win-win" fashion, providing a strong mix of project types across the full range of key areas (waste management, transport, and building energy efficiency), and providing in some cases impactful, potentially replicable results and those that can continue to be built upon. The NR demo work also impressed us as being the most faithful, among the four sets of city demos, in pursuing the GEF GHG ER mandate and, as a result, the most successful in that area as well, albeit with lower than targeted achievements. The NR demo work was coordinated by a team at Chulalongkhorn University (CU), which set about its work beginning in May 2018, thought its contract was not signed until September 2018. The contract of USD 317,766 encompassed both a service fee and the cost of all demos, though the vast majority of expenditures (91.4%) was TA rather than investment. Five NR "demos" (some being sets of demos) are discussed below. It is noted that two of the items are not demos, but instead a guidebook and a technical study. Yet, these too are considered meaningful and potentially impactful. In addition to these five "demos," there is also a category of initiatives for which the main contribution of the project was MRV (including T-VER and LESS support). We believe the claimed GHG ERs of these mostly should not be attributed to the project. Instead, the work may be considered a separate area of MRV, as designated by Outcome 2.1. Yet, we briefly present these items in this sub-section. Exhibit 2 gives of summary of the five demos and this additional "MRV-only" area. The following text, after reviewing the details of the six items, closes with an aggregation of indicator results and sustainability findings, as well as a breakdown of expenditures.

Demo 1. Improvement of power generation (with increase of +160% in power generated) of the existing NR waste-to-biogas anaerobic digester: NR City's anaerobic digester was first commissioned in 2012 and recommissioned with improvements in 2016. In 2018, CU provided recommendations that resulted in increased power generation of the biogas digester from 138 MWh per year in 2018 to 362 MWh per year in 2020. The power is sold to the grid. Though the measures are said to have increased the amount of biogas available for power generation, the amount of landfill methane avoided (based directly on amount of organic waste treated) was not increased very much. The measures taken are said to improve the utilization of organic waste in the digester through selection of waste trucks on high organic content routes and through cooperating with businesses, such as restaurants, to presort organic waste. CU also made recommendations for improving the plant's conveyance system with PLCs, etc. The recommended measures were adopted via city financing. The TE Team found problems with the calculations of self-assessed GHG ERs attributed to LCC from this installation. Those calculations were made based on the full amount of "landfill methane avoided" by the digester rather than on incremental

improvements. And, the calculations consider GHG ERs beginning back in June 2016, though LCC was not launched until April 2017. The original GHG ER calculations, we are told, did not consider power generation GHG ER benefits. The TE Team estimated GHG ERs based on the incremental improvements only. These came out to -4 t CO2eq by EOP and 3,062 t CO2eq lifetime. The slightly negative value by EOP is due to a reduction in waste treated in 2019, as the plant adjusted to the recommendations, that roughly cancelled out the GHG ER benefits of increased power generation.

Exhibit 2. Nakhon Ratchasima Package of Demos and Related Work: Strong Results, though LCC Support is Predominantly TA[20]
Text after "//" indicates replication or follow up work secured in the pipeline

"**Demo/ Activity"**	**Increases** in city **anaerobic waste digester's power gen via improved feedstock, etc. based on LCC study** (*GHG ERs expected from increase in RE power gen/ replacement of grid energy*)	Improvements to city **water supply system** (reducing pipe leakage based on LCC study and improving efficiency of pumps via 2 LCC invested pumps) (*GHG ERs expected from reduced power use to pump water*)	**Large building energy audits** via LCC TA leading to EE and RE investments (including LEDs, VSDs, chillers, PV systems) (*GHG ERs expected from energy savings achieved when building owners adopt audit recommendations*)	**MRV**, T-VER, LESS TA support† (helping NR installations estimate their GHG ERs and get certified) (*no GHG ERs attributable to LCC expected*)	**Low carbon home guidebook** - LCC TA (a guidebook for those building new homes) (*possible GHG ERs via measures adopted by homeowners, but not measurable/ verifiable by project*)	**"Cost of traffic" study** – LCC TA: BAU versus light rail versus e-BRT cost/ payback analysis* (*study, so no GHG ERs, but possibly contributes to realization of some via improved transport in future)*
Comment/ Result	+224 MWh increase in annual power generation; incremental direct lifetime GHG ERs of 3,062 t CO2eq// NR schools/ hospitals now interested in biogas	1 million tons/ yr water saved. Electricity savings.// Replication: one pump. New, pump-less gravity pipe system expected as inspired by LCC piping TA.	Audit recommendations said to have been adopted: LEDs, 1 MW solar system, VSD adjustments, new chiller (good results)	Positive, but GHG ERs should typically not be claimed by project, if MRV is only support	In the city plan to print 1,000 copies per year. Strong interest, appears impactful.	High impact. National leaders now willing to consider e-BRT instead of light rail for NR and looking into e-BRT for 6 cities.//Got UK USD 666,000 grant to continue.

*Possibly highest potential impact of all demos, though long road ahead.
†NR demo facilitation team conducted basic data collection and initial GHG ER estimates under their Outcome 1.2 demo contract. MRV contract under Outcomes 1.1 and 2.1 also supported estimates/ verification.

Possible way forward: (i) NR's biogas digester might be considered as a model for other cities hoping to address significant amounts of organic waste. At the same time, based on recent figures, it appears the digester handles just around 2,000 tpy o of organic waste, so less than 6 tons per day, and has presented some technical challenges over the years. As will be discussed, Khon Kaen, under *LCC*, has set up a station that has the capacity to process 10 tons organic waste per day into soil conditioner and liquid animal feed, probably with lower capital cost. Though that station is still operating far below capacity, it is another alternative for cities to consider in treatment of their organic waste. (ii) CU Team has introduced the NR Biogas Plant improvements to local educational institutions and hospitals in NR; and

[20] In the first three cases, while LCC support is mostly TA, investment by installation owners leads to direct GHG ERs. In the last case, it is hoped that the studies (also TA supported by LCC) will contribute to future investment that leads to GHG ERs.

these are said to be considering installing biogas systems to deal with food waste on site. While these would be smaller systems, support for them may be considered. (iii) NR is planning a "Phase 2" at the digester site, which would be incineration of waste for power generation and is currently under procurement. Incremental enhancement to ensure strong GHG ERs and good efficiency, low plastic content (which, as will be discussed, *LCC* has found to substantially increase GHG ERs), as well as avoidance of incineration without power generation, as is now occurring at Khon Kaen WTE, should be promoted to NR for its upcoming WTE, building on *LCC* lessons learned.

Demo 2. Water Supply Bureau of NR – water saving and energy efficiency initiatives (*set of 2 demos and a replication*): This included two efforts: (i) The CU Team provided a study of water pressure within the municipality's area. This was used to identify water loss points for repair. The Water Supply Bureau made repairs with its own funding in July 2020, resulting in 1 million m3 of water being saved per year and thus reducing the electricity expended on pumping. [GHG ERs EOP: 749 t, lifetime: 6,869 t] (ii) *LCC* provided 100% grant for replacement of two pumps with energy efficient ones as a result of energy audit that suggested replacing four pumps. [GHG ERs EOP: 125 t, lifetime: 1,364 t.]

Replication/ potential replication: (i) The Water Supply Bureau, seeing the results of the pump replacement, has replaced one more pump with its own funds and plans to replace another.[For the one pump, GHG ERs EOP: 40 t, lifetime: 682 t.] (ii) The Water Supply Bureau expanded the CU study to the pipes coming in from one of two natural water sources 60 km away and realized they could use a gravity system instead of pumping to bring the water in from the source. This will save on electricity costs now used to operate the relevant pumps and yield GHG ERs. The project is still in the pipeline.

Total GHG ERs for Water Supply Bureau LCC efforts: EOP: 914 t; lifetime: 8,915 t

Possible way forward: These two types of energy saving projects for municipalities could be replicated across water bureaus of other cities as "win-win" measures. Yet, considering the total investment for the piping upgrades, there may be more cost effective ways to achieve GHG ERs. Thus, if GHG ERs is a key consideration, these other types of efforts may be prioritized. At the same time, the combined waster saving and energy savings aspect is attractive.

Demo 3. Measures resulting from building energy audits and other *LCC* advising to building owners (*set of 6 demos*): The NR team reported undertaking ten building energy audits and, in several cases, pre-audit informal advising to the ten entities. These ten efforts resulted in six GHG ER generating initiatives across five of the entities, as listed below. The MRV consultancy provided an estimate of GHG ERs for the first of these initiatives, the Terminal 21 VSD, but it was not incremental. What the project did was make recommendations on adjustment of an existing VSD. Upon the TE Team request, the NR demo facilitation consultancy provided a revised estimate. Based on similar initiatives, we estimate the GHG ERs of the second initiative. In recent follow up, the NR demo facilitation consultancy provided estimates for the next three initiatives, though we still lack an estimate for the last one. While the *LCC Project* financed the energy audits and advising, all equipment and installation costs were borne by the building owners. The project had an MOU signing ceremony with its building audit partners, as well as individual meetings with each. It also had a group workshop on zero waste buildings for these organizations.

3-1. Terminal 21 Variable Speed Drive (VSD) for cold water pump efficiency improvement: While the initial drive was installed without TA in January 2017, CU provided TA on operational improvements that led to 15% improved efficiency and increased GHG ERs by EOP of 714 t and lifetime of 7,031 t.
3-2. Terminal 21 999 kW solar installation: Implemented in 2019 as a result of CU *LCC* energy audit recommendations, system was 100% invested by the owner. No GHG ER estimates are available from

project, but, based on project's Central Plaza estimates for a similar-sized system and assuming July 2019 installation, we estimate direct GHG ERs of 1,738 t by EOP, 21,730 t lifetime.
3-3. Central Nakhon Ratchasima Chiller VSD adjustment: This is a result of CU *LCC* energy audit, with (no cost) adjustment undertaken in 2020. Incremental direct GHG ER estimates provided by the NR demo facilitation consultancy are 127.05 t CO2 by EOP and 1,042.99 t CO2 lifetime.
3-4. The Mall Korat chiller replacement: This is result of the CU *LCC* energy audit, with 100% owner investment, made in 2020. Incremental GHG ER estimates provided by the NR Team are 47.46 t CO2 by EOP and 1,144.06 t CO2 lifetime.
3-5. Klang Plaza LED replacement: This is the result of *LCC* energy audit, with 100% owner investment, made in 2019. Incremental GHG ER estimates provided by the NR Team are 35.36 t CO2 by EOP and 254.88 t CO2 lifetime.
3-6. Klang Villa chiller adjustment: This was implemented in 2019, but did not require investment.

Total GHG ERs estimated for energy audits and advising: EOP: 2,452 t and 28,761 lifetime, though estimates for one of the implemented items still needed.

Possible way forward: A success rate of half of auditees acting on energy audits is quite positive and, if it can be verified, suggests that energy audit work for large buildings in mid-sized cities in Thailand may be fruitful grounds for further GHG ERs.

Other demos claimed but attribution in question: *LCC* claimed GHG ERs for a number of other demos in NR, but attribution is in question. These are shown in Exhibit 3. It appears to us that most of these did not occur due to the *LCC* project, so should not be counted as demos nor should their GHG ERs be attributed to *LCC*, even if the *LCC* project provided MRV (estimates of their GHG ERs). In general, provision of MRV only is not a basis for attribution. Further, as noted, verification is an important aspect of the TE. Yet, even for potentially very large claimed attributions, requests to consult the relevant beneficiaries were not met. One of the listed projects (also a PV system) reportedly received support for efficiency improvement from LCC (NR Technical Colleges PV system), so that GHG ERs resulting from the efficiency improvements could be counted. For future GEF projects, it should be clarified to the implementation team that adding MRV alone to a project is not enough to claim the project's GHG ERs, unless the MRV service availability is what caused the project to occur in the first place. At the same time, this work and the other MRV work of the project can be considered a separate TA contribution, particularly when it introduced TGO T-VER and LESS to project owners. Such work overlaps with the MRV work of Outcome 1.1 and Outcome 2.1.

Exhibit 3: NR Demos Claimed with Questionable Attribution (*All systems invested by project owner*)
Color code: Red - not attributable; yellow - might be attributable or incrementally attributable.
Full attribution claimed based on MRV support and, in some cases, support applying for T-VER credits. TE Team view is that MRV-only support does not result in attribution of the installation's GHG ERs, etc. to the LCC project.

Demo Claimed	Installation Date	Notes on whether attributable to project
1. Maharaj Hospital LED light replacement	Oct. 25, 2018	Appears this was undertaken independently of LCC
2. Waste recycle bank at Maharaj Hospital	Feb. 1, 2017	Undertaken before *LCC Project* launch. LCC provided LESS info only.
3. Mall Korat LED light replacement	March and May 2019	Appears this was undertaken independently of LCC
4. NR Technical College rooftop PV system. Ministry of Energy involved.	Dec. 15, 2018	Efficiency improvements only should be attributed to project; not the full system which was undertaken independently of LCC. Still need GHG ER info on efficiency improvements

5. Central Plaza rooftop PV system (999.7 kW). Ministry of Energy involved. 13 replications outside NR by Central Pattana (owner of Central Plaza and the other buildings)	Dec. 15, 2018 Unknown	Appears this was undertaken independently of LCC, though LCC introduced T-VER opportunity Appears these were undertaken independently of LCC, though T-VER pursued for these replications as well.
6. LED lights of NR municipality	May 1, 2017	Did not receive assistance from project
7. Waste recycle at NRRU	Jan. 1, 2017	Project provided LESS info only.
8. Waste recycle bins at RMUTI	Jan. 1, 2018	Project provided LESS info only.

Possible way forward: Large PV rooftop systems provide strong GHG ERs (e.g. Central Plaza's 1 MW system provides lifetime GHG ERs of about 22,000 tons). They are relatively rare in the Northeast, but initial private sector adoptions (Central Plaza, Terminal 21) have begun. Future work might consider providing outreach to large building owners with information on long-term financial benefits of solar systems and T-VER benefits. It might then provide assessment and design for systems to achieve replication across the northeast.

"Demo" 4. Low Carbon Home Guidebook: Another activity carried out under the NR demo package is the preparation of *Low Carbon Home Guidebook*, along with a workshop with 72 attendees[21] on the same topic. The project provided 300 copies of the *Guidebook* in November 2019, which were distributed at the office that people in NR must visit to apply for a home building permit. Based on the *NR Municipal Development Plan 2018-2022*, the city will print 1,000 more copies each fiscal year and has included the guidebook as one of the plan's KPIs, implying the city's positive view of this contribution. It has been reported that the measures in the *Guide* that people most take action on are energy savings measures and recommendations of how to choose energy saving products (e.g. lightbulbs, air conditioners, building materials, etc.). The top recipients of the guidebook are said to be real estate entrepreneurs, home builders, and contractors, while the rest are community leaders and members. The guide is also available as an e-book. In preparing the *Guidebook*, the CU team consulted local authorities, relevant agencies, and pertinent regulations and guidelines. They also considered similar documents from other countries, such as Canada, the USA, and Japan. While DEDE has a guidebook on a similar topic, the target group is said to be the building sector, whereas the *LCC* guidebook focuses on the household sector.[22]

Possible way forward: If it is determined this guidebook is truly having a substantial impact on GHG ERs, its use, if appropriate, could be spread to other mid-sized cities.

"Demo" 5. Study on the cost of traffic in BAU and alternatives of light rail versus electric bus: As a part of the "demo package," CU prepared a transport sector study. The study has the potential for high

[21] Includes 34 participants from various organizations (e.g. local government and community leaders), as well as 38 students from the Electrical Power Department and Construction Department of NR Technical College.
[22] Topics include: (i) What's a low carbon home? (ii) Example and types of garden landscape and house plants for low carbon home. (iii) Example of material selection in details of roof, wall, color, mirror, as well as how to select energy efficient and energy saving electrical and appliances in bedroom, kitchen, bathroom (air conditioner, light bulb etc.) and water saving materials. (iv) How to implement low carbon at home (smart home, solar cell panel selection). (v) Waste management and food waste management in household. (vi) Behavior of residents in low carbon home and carbon footprint of individual. (vii) Table of comparative study and calculation in material selection for low carbon home (see also appendix). (viii) Standards and labels for eco-friendly products. (ix) Information on where to sell recyclable waste in the NR municipality.

future impact on NR, by being used as a document to convince the national government to change its plans for the future of NR public transport. The study compares the external costs of bad traffic in the BAU scenario to the costs of both a light rail option and an electric bus option. The results show both of the alternative scenarios in the long run have positive returns, but that the electric bus option has a better return on investment due to lower costs. Previously, the national government had NR slated for a light rail system, which is quite costly and difficult to realize.

Impact on decision-makers and public transport plans for NR: The study reportedly is already being quite impactful at both the local and national levels, though there is a long road ahead before the electric bus BRT (e-BRT) system is realized in NR. Prior to the project, local officials and particularly the mayor had hesitancy to pursue the light rail project proposed at the national level, wondering about its cost effectiveness and preferring the alternative of e-BRT. They realized that a careful analysis was needed to prove to the national government that e-BRT was more sustainable financially. For them, this study confirmed that e-BRT is the right option for NR's future direction, supporting the national agenda on EVs and NDC. The national level had previously seen light rail as the only option, as supported by an earlier study by the Office of Transport and Traffic Policy and Planning (OTP). NR has already made use of this study to discuss the options with OTP and Minister of Transport, Mr. Saksayam Chidchob, who has recently ordered OTP to rethink the light rail plans for NR and study the feasibility of using e-buses in six major Thai cities, including NR. Further, sources suggest that the Mass Rapid Transit Authority of Thailand (MRTA), which is responsible for the design stage of the NR Green Line (which was to be the first light rail transit route in NR) is now willing to conduct another public hearing, reconsidering the appropriateness of the whole light rail project. Thus, it can be seen that the *LCC*-supported study has had quite an impact on decision-makers.

Current situation of public transport: The main mode of public transport within NR is the "Songthaew," a pick-up truck converted with seats in and cover on the bed, used for short-haul bus rides (see Exhibit 4, left). The songthaew is considered dangerous and has relatively high GHG emissions from its inefficient diesel engine. Passengers must step up into the back of the truck and sit on parallel benches. They press a buzzer and hand fare to the driver when they want to get off. Electric buses will offer a completely new public transport system to NR - a safer, more comfortable mode of transport with much lower carbon emissions.

Details on the proposed alternatives – routes, dedicated, busways, and costs: For the *LCC* traffic study, the routes used for the light rail were those from the previous study by OTP. The electric bus routes used were those proposed by the former mayor of NR, Mr. Surawut Cherdchai. According to this e-bus route plan, which will be improved by the UK study discussed below, the purple line (see Exhibit 4, right) will be a separate, elevated, bus-only route that runs above the center lane of Mittraphap Road (the national highway running through city center). The reason for the elevated structure is that the narrowness of Mittraphap Road makes it difficult to have dedicated bus lanes. Other routes as shown in the exhibit are along relatively high capacity roads, so no special plans for bus lanes are considered at present. The traffic study considered the cost of the elevated infrastructure and other costs such as bus stops with transit information, EV charging stations, and maintenance and service for the buses. The total cost for the electric bus system is estimated in the study at 4.703 billion THB (150 million USD). The elevated part's estimated cost is 2.531 billion THB (81 million USD), representing about 53% of total cost. For all four routes, an estimated 65 e-buses are needed, proposed to be acquired in two phases: 35 buses during the first five years, 2022-2027, beginning right after the completion of infrastructure build up in 2022, and another 30 after 2027. The total cost of the buses is estimated at 780 million THB (about USD 25 million), which is 16.6% of total costs and not including battery replacement costs that are expected to be incurred every 10 years.

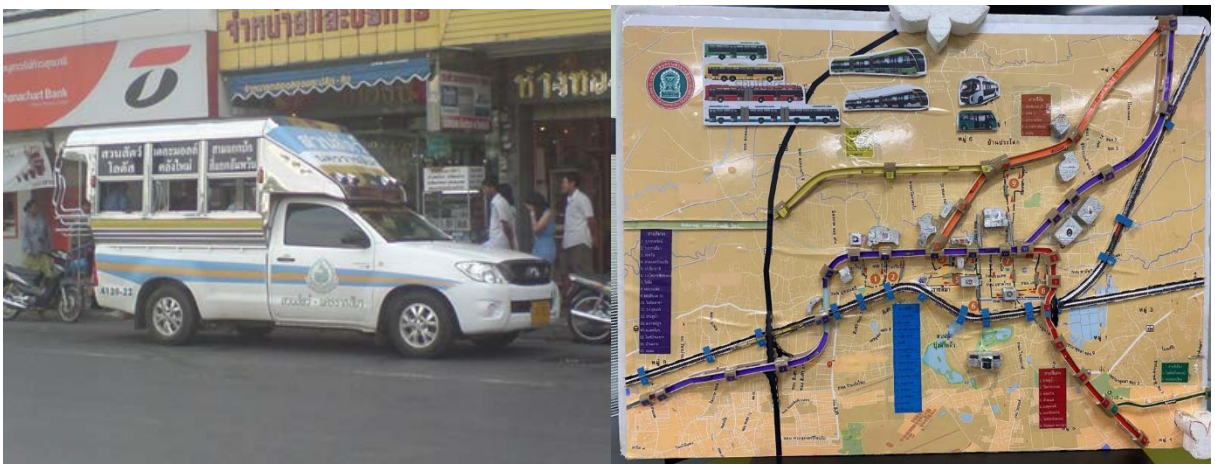

Exhibit 4. Left: "Songthaew," main mode of public transport in NK at present. Right: Preliminary Electric Bus Routes for NR as proposed by former mayor of NR. Upcoming UK-supported study will use transport engineering to determine optimal routes, though it is guessed the overall outcome will share similarities with the above model.

Air quality monitoring equipment: Air quality monitoring equipment was provided to NR as part of the traffic damage cost study. The five installation sites were selected on roads with high traffic volumes in the city. Because the equipment is expensive and requires the power supply for continuous recording and transmission of data to the server, NR decided to use the equipment only under the supervision of specialists and solely for the purpose of research. In the next phase study, to be funded by the UK, NR and CU plan to use the monitoring system to prove the impact of road traffic on carbon emissions.

Expected initial e-bus routes in city and scale-up of e-bus manufacturing: In addition to the impact on decision-making for long-term plans for the city, another impact, the benefits of which will be seen on a faster scale, is the initiation of e-bus routes in the city. Interestingly, NR is launching production of the first 100% made-in-Thailand electric bus. This work, to some extent building on discussions between the former mayor (Mr. Sarawut) and the *LCC Project*, was initially carried out concurrently with the *LCC* study, leading to prototype e-buses used at shopping malls and for sight-seeing. The bus production is a collaboration of Suranaree University of Technology and Cherdchai Industrial Factory Co., Ltd. The city is now planning to introduce these e-buses on a more regular basis by introducing new operating routes in the city. Given that the city has developed its own electric bus company, the likelihood of implementation of overall e-BRT plan is considered high.

Securing of UK funding for follow-up work: Another very positive result is that, building on the *LCC*-supported traffic study, UNDP and CU working together were able to apply for and win a very competitive grant from the UK Government. The TA grant of £470,000 (about USD666,000) will cover, over a period of 12 months (July 2021-June 2022): analysis of the transport ecosystem, design of the public transport network (compared to the version from the former mayor, this will be a carefully designed system using expertise in transportation engineering and methods such as the 4-step model or transit-oriented development), impact assessment, policy recommendations, and capacity building and awareness raising. A key strength of the proposal is said to be the strong connection with the NR Mayor's Office and the Provincial Governor's Office developed during the *LCC Project.* The project, entitled *Achieving Sustainable Low Carbon Growth in the City through Electrified Urban Transport System in Thailand* (*E-Transport in LCC*), will be managed by UNDP Thailand.

Need to institute both "push" and "pull" to increase public transport use: The TE team suggests that NR should not only prepare an attractive form of public transport, but pay good attention of how to "push" people out of their cars as well, by measures that make car use less attractive. The study assumed 20%

bus ridership, increasing annually by 3 to 5% of rides until reaching a maximum of 50% of rides by bus. The study team recognized that the figures will vary according to policy measures, such as higher parking fees and special bus lanes. The detailed study of potential measures for convincing private car users to ride public transport is within the scope of the upcoming UK-supported project. There will be a survey to calibrate accurately for the "mode-shifting parameters" using a model. And, the city is also including such "push" measures in its integrated plan for transitioning towards a smart city. The TE Team stresses the strong political will required to adopt measures that discourage private car use. We suggest the policy and awareness work of the UK-funded TA emphasize policy, consensus building, and political will building work with regard to measures such as high parking fees or limited parking spaces that discourage private car use.

Possible ways forward: (i) UNDP may wish to consider work to follow the UK-supported TA or support efforts for e-buses in the other five cities that Ministry of Transport has asked OTP to study. UNDP may facilitate a combined grant and loan for the bus purchase/ infrastructure, accompanied by appropriate TA. (ii) Next steps should put strong emphasis on how to get people to ride buses and reduce private car use.

Overall progress towards indicators targets: Based on current incremental measures and full initiatives considered with high likelihood to be due to the *LCC* project, GHG ERs for the NR demos are estimated as shown in Exhibit 5. This excludes initiatives for which the only *LCC* contribution is MRV.

Exhibit 5. Roughly Estimated GHG ERs from Demos/ Demo Increments in NR Attributed to *LCC*

Demo	Incremental or Full Demo Attributed to *LCC*?	EOP Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)	Lifetime Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)
1. City Biogas Digester increased power gen	Incremental	-4	3,062
2. Water Supply Bureau – pipe improvement	Full Demo	749	6,889
3. Water Supply Bureau – 2 new pumps	Full Demo	125	1,364
4. Water Supply Bureau – 1 pump (replication)	Full Replication	40	682
5. Terminal 21 VSD (+15% efficiency)	Incremental	714	7,031
6. Terminal 21 PV system – 999 kW	Full Demo (due to audit)	1,738	21,730
7. Central NR Chiller VSD (improvement)	Incremental (due to audit)	127.05	1,042.99
8. Mall Korat new Chiller	Full Demo (due to audit)	47.46	1,144.06
9. Klang Plaza upgrade to LED lights	Full demo (due to audit)	35.36	254.88
10. Klang Villa chiller adjustment	Incremental (due to audit)	NA	NA
11. NR Technical College PV system (improvement)	Incremental	NA	NA
Total	**--**	**3,572+ tons**	**43,200+ tons**

As noted in the review of design, the TE team finds "number of demos" and "number of replications" to be problematic as a measure of achievement in that the scale of the demos and even the way one chooses to subdivide or not subdivide demos into separate items is not reflected. Yet, based on the above, if each building in which one or more recommendations of the energy audit is adopted is counted as a separate "demos" and the Water Supply Bureau effort is counted as a single demo, then the total number of demos is 8 (or 10, if the TA guidebook and traffic study are counted); and the number of replications is 1.

Sustainability: Sustainability of the NR demos and related TA work looks quite positive. The biogas plant has developed new sources of inputs that increase power generation, so will be able to continue with those. The Water Supply Bureau is already pursuing replication in pipe improvement and EE pump installation. The energy audits have already led to installations that are likely to be sustainable. Yet, those audits or audit recommendations not yet followed up on could benefit from further interaction. And, it

would be beneficial to spread the learnings to other large buildings. The *Low Carbon Home Guide* has impressively been incorporated into the city budget for additional printings. It may be useful to ensure that it continues to be used and that it is shared with other cities if the content will transfer well. The transport TA has had impact that assures its continuation for one more year under UK funding. The work may benefit from additional support to secure grant and loan investment funding and other technical expertise beyond to ensure strong bus ridership, such as through measures to discourage private car use.

Expenditure Assessment: The overall impression is that, for the contracted amount USD317,766, the NR demo package achieved good value for money. At the same time, it should be noted that the package is heavily skewed towards TA, with 91.3% of funds spent on TA (all understood to be carried out by CU), whereas the original design of the demo outcome called for 80% of funds to be spent on investment. While TA that leads directly to GHG ERs (such as energy audits) may be an acceptable replacement for investment, the workshop, guidebook, and similar types of outreach support, while valuable, might best have been funded from the capacity building and knowledge products part of the budget, as could the T-VER/LESS support. In that way, for example, instead of USD45,000 going towards energy audits, which achieved ten audits and five GHG ER generating measures, the full USD90,000 of the "low carbon buildings" "demo" item, if going towards audits, may have provided double the GHG ER result, with workshops/ training of building owners funded out of the capacity building budget in Outcome 2.1.

Considering individual "demo" items: The highest budgeted item is the building audits, which were the strongest contributor to lifetime GHG ERs. The traffic study has not yet yielded any GHG ERs, but is considered potentially impactful for the long-run. In retrospect, a stronger emphasis on GHG ERs over MRV outreach and TA not leading directly to GHG ERs might have contributed to higher overall achievement. It is noted that the biogas plant improvement TA has no documented costs.

Exhibit 6. Breakdown of Spending of NR Demo Package
91.4% of funds went to TA, all carried out by CU.

Expenditure Area/ Item	**Amount in USD**
Technical Assistance Expenditure Areas	---
Traffic Study	46,691.92
Water Supply Study - Audit actual energy efficiency of waterworks system: $16,666.67 - Mapping waterworks contour and modelling waterworks system: $33,333.33 - Waterworks system failure and improvement analysis: $6,158.33 - Training local government authorities: $3,333.33	59,491.66
Study to Increase Efficiency of Organic Waste Biogas Power Generation Plant	0.0
Low carbon buildings initiative (Number of buildings: 10) - Energy Audits for 10 building: $45,000 (or 4,500 per building) - Solid waste management practices for 10 buildings: $15,000 workshop - Training, building a template, prepared a carbon footprint for organization for 10 buildings: $20,000 - Training GHG ER schemes for 10 buildings, and building a template and prepared a T-VER report for 3 buildings and LESS report for 3 buildings: $10,000	90,000.00
Low carbon Home - Low carbon home study: $16,000 - Training and setting up a campaign for raising awareness: $4,000	20,000.00
Facilitation of full package of demos/ service fee*	70,232.68
Subtotal for Technical Assistance (91.3% of city demo package total)	***286,416.26***
Investment Expenditure areas	---

Energy Efficient Pumps for Water Supply Bureau (2 sets)	23,183.33
Air pollution monitoring units (5 units)	3,308.08
Low Carbon Home Guidebook (1,000 copies)	100.00
Power meter for Water Supply Bureau (1 set)	658.33
Subtotal for Investment (8.7% of city demo package total)	***27,249.75***
Grand Total	**313,666**

*Estimated based on actual transaction for contract of USD313,666 (instead of planned amount of USD326,667). Other figures provided by NR Demo Package Team.

4.2 Chiang Mai Demo Results

Chiang Mai focused all of its "demo" work in the area of transport and mainly on public transport. A number of meaningful and interrelated steps, the first of their kind for Chiang Mai, were achieved towards a better public transport system. Yet, as is often the case with transport work, there is still a long way to go and the sustainability of this work is a risk, given that there is no clear follow up step or well-established follow up body to "pass the baton" to.[23] We did not find clear confirmation of claimed GHG ERs for the Chiang Mai demo, though the consolidation of bus stops and improvement of bus routes (impressive achievements) may lead to increased shifts from cars to public transport in the future. Aside from these, there were no other results that could have been expected to have a relatively immediate impact on emissions.[24] Considering that the contract with Chiang Mai University (CMU), which was a package covering facilitation of the demo and the cost of the demo itself, was not signed until September 2018, the project had only about a year and a half of active implementation of the Chiang Mai demo before Covid-19 began to impact people's use of public transport. At the same time, the project put a large portion of its funds into the Ap and electronic ticketing, which may take longer to bear fruit than had *LCC* chosen to use these funds to address items with more immediate impact. Faster impact options might have been those related to impeding illegal parking (software to analyze CCTV feed of parked cars) and extending/ improving Chiang Mai's smart street lights as in the city's Smart Mobility section of its Smart City Plan.[25] We find the CCTV plan for parking infractions as particularly attractive for improving flow, as it may support a modal shift to buses due to reduced parking availability. One reviewer has pointed out these two measures, if they improve traffic flow, may serve to encourage private cars. Yet, there are options, such as synchronizing the smart traffic lights with buses, to consider. At the same time, such options may fit less well with the focus of the Chiang Mai demo on public transport. The components of the Chiang Mai demo, which are quite inter-related and emphasize integration of providers, particularly fixed route bus companies, are summarized in Exhibit 7 and discussed one by one, followed by a review of sustainability, assessment of progress toward indicator targets at the Chiang Mai level, and expenditure analysis.

Demo component 1. Updated traffic model and citizen survey: This work included: (a) updated survey of 2,000 citizens on their transport habits and preferences and (b) update of the city traffic model. Results

[23] Agreement was reached to set up a social enterprise, but, perhaps due to Covid-19, progress has been limited.
[24] The project reported GHG emission reductions achieved by the CM demos starting in June or October 2018, but the contract with the CM demo facilitation consultancy was signed only in Sept. 2018. The Alliance, which is said to have been required for stakeholders to reach agreement on the consolidated bus stops, had its first meeting only in Jan. 2019. And, the consolidated bus stops were not approved by the province until July 2020, when Covid-19 was already having a major negative impact on Chiang Mai public transport. Thus, we guess that the GHG ER benefits of this work may be seen only after the impacts of Covid 19 recede.
[25] We received mixed information on the status of these items in the Smart Mobility section of Chiang Mai's smart city plan. One source indicated that the items had not been implemented but are budgeted. The Chiang Mai Municipality Annual Report for 2018 indicates the achievement of installation of 400 units of CCTV around the city and computerized traffic light control devices.

were used as a basis to propose improved bus routes and consolidated bus stops. The results of the survey fed into the traffic model. The work was completed in October 2018, just a month after launch of CMU's contract with *LCC*. It was explained that the research team had experience in developing and applying traffic models in Chiang Mai, having done similar work in 2012 for CM, funded under the World Bank-GEF Project *Sustainable Urban Transport*, so was able to complete the work quickly. That earlier project also focused on Chiang Mai, had GEF funding of 729,630 USD, and closed in October 2014. Persons involved in that earlier work were recruited to be involved in the update by *LCC*.

Results: Our understanding is that results, namely adoption of the bus stop consolidation and the improved routes, required the additional step of the Alliance (discussed below) so that parties could reached consensus. Thus, these results are listed as a separate component of the demo. It is reported, however, that CM would not have been able to achieve this shift in the bus routes and bus stops were it not for *LCC*'s traffic model report. Since the last work of this type closed in 2014, about seven years ago, this seems likely to be the case.

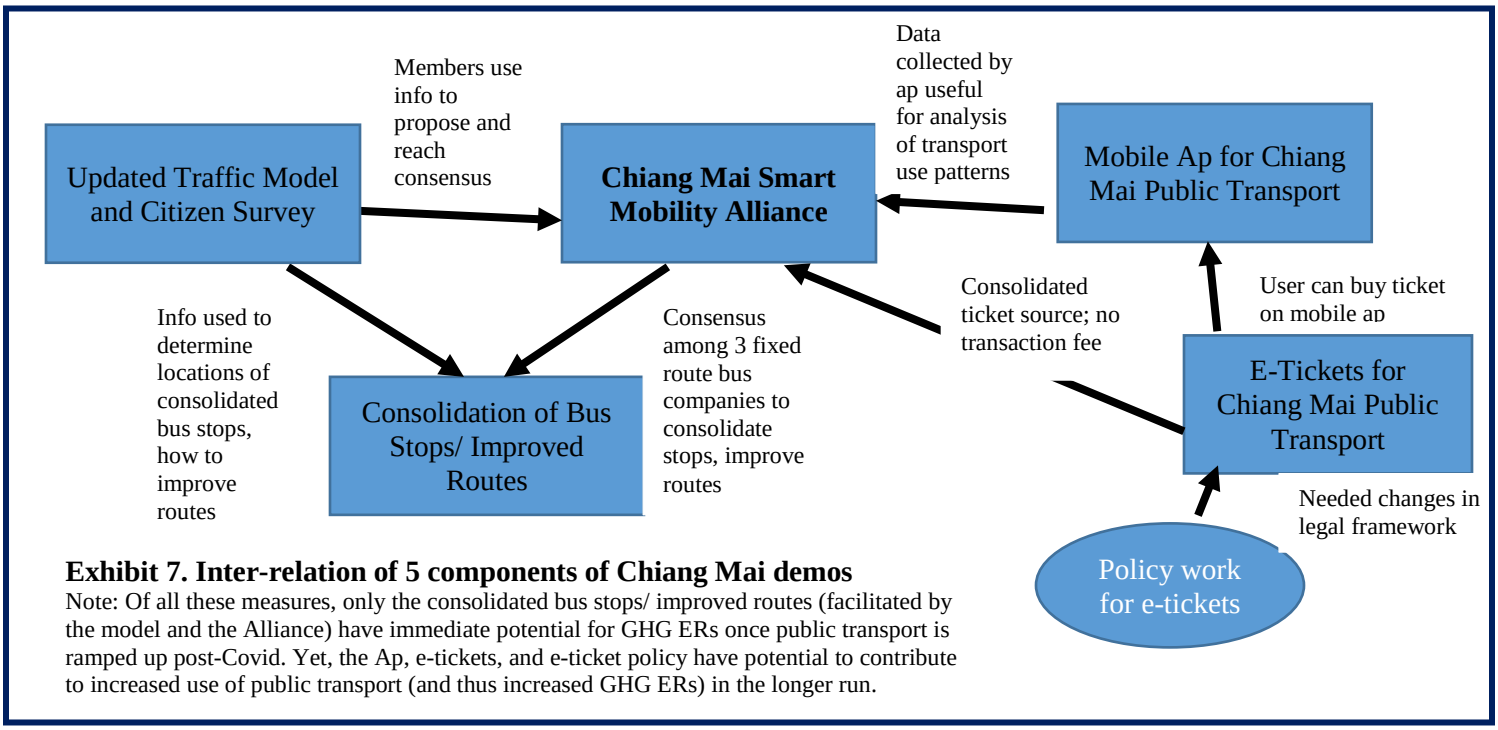

Exhibit 7. Inter-relation of 5 components of Chiang Mai demos
Note: Of all these measures, only the consolidated bus stops/ improved routes (facilitated by the model and the Alliance) have immediate potential for GHG ERs once public transport is ramped up post-Covid. Yet, the Ap, e-tickets, and e-ticket policy have potential to contribute to increased use of public transport (and thus increased GHG ERs) in the longer run.

Demo component 2. Chiang Mai Smart Mobility Alliance and Social Enterprise: The centerpiece of the Chiang Mai demo is the Chiang Mai Smart Mobility Alliance, an initiative that, for the first time, brings together different players in the transport sector to discuss issues and come to consensus on certain aspects of public transport. It is particularly notable that the government sector (e.g. Chiang Mai Municipal Bus Company) was brought together with the private sector (e.g. the two private fixed route companies). The Alliance facilitated the three bus companies agreeing to consolidate their bus stops (as described in the next component of the demo). Exhibit 8 shows the 21 members of the Alliance. While there is a broad range of members, we note that the songthaews (the converted trucks that take passengers in the back and that are a cornerstone of public transport in Chiang Mai at present) do not appear to be represented, except in an indirect way through Grab, which is a ridesharing ap. (Users can select songthaew service through the ap.) This may be because the vision represented by the Alliance does not include a strong position for the songthaews. Indeed, it is understood that, during the initial phase of the discussion, the cooperative that represents songthaews attended Alliance meetings but, but because they did not agree with the contents of the MOU and decided not to sign it, they stopped participating. The

Alliance is reported to be the first substantial effort ever in Chiang Mai to work towards integrating all the different services related to urban mobility.

Exhibit 8. Members of Chiang Mai Smart Mobility Alliance

Chiang Mai Smart Mobility Alliance *(total of 21 members)*
Fixed Route Bus Companies (*3 members*)
1. Regional Transit Corporation, Ltd. (private company, providing "RTC" bus service, though has stopped operation due to Covid; whether it will restart business in the future is unclear(2. Energy for Environment Company, Ltd. (private company, providing "E4C" bus service(- one of three members agreeing to manage the social enterprise that the Alliance will form 3. Chiang Mai Municipality Bus Company (municipality's bus company, operates "white buses")
Non-fixed Route Providers (*3 members*)
1. Kenber Supply (Thailand) Co. (service provider for Chiang Mai University Electric shuttle) 2. Chiang Mai Electric Tricycle Cooperative Limited (tuk tuk cooperative and also "electric tuk tuk" service provider) 3. Anywheel Company, Ltd.
"Infrastructure" (*9 members, including academic, taxi and rideshare, smart card, and manufacturing*)
1. Chiang Mai University School of Public Policy (CMU SPP) 2. Nakornping Energy Research and Development Institute, Chiang Mai University (ERDI) 3. Chiang Mai Transport Company Social Enterprise, Limited 4. Grab Taxi (Thailand) Co., Ltd. ("Grab") 5. Green Tree Corporation, Limited 6. PSS Group (Thailand) Company Limited (for smart parking) 7. Bangkok Smart Card System Co., Ltd. ("Rabbit Care") 8. Chiang Mai Electric Car 2018 Co., Ltd. (manufacturer) 9. PEA ENCOM International Company Limited (provider of charging stations)
"Support Service Providers" (*6 members including government and IT company*)
1. Chiang Mai Province 2. Chiang Mai Municipality 3. Chiang Mai Provincial Land Transport Office 4. Chiang Mai Provincial Traffic Police Division 5. Omm Platform Thailand, Limited (IT company that provided e-ticket reader equipment to the LCC Project and is understood to be a closely related company to Siam D Ap, which provided the Ap and follow up service) - one of three members agreeing to manage the social enterprise that the Alliance will form 6. MayDay Community Company Limited (Designs bus stop signs and bus stops, served as consultant to LCC project to design consolidated bus stop signs) – one of three members agreeing to manage the social enterprise that the Alliance will form

Exhibit 9 shows formal meetings held by the Alliance, of which there were six between Jan. 2019 and July 2020. Thus, on average, these were held once every three months over 1.5 years, though the last two meetings were held in the same month. There were no formal meetings June to Dec. 2019, as the key organizing person was on leave, but there were reportedly smaller conference call meetings to discuss direction during that time. And, generally, there were reportedly smaller meetings and discussions throughout implementation that were not officially recorded as Alliance meetings, due to the limited number of members present and due to that decisions, while discussed, were not made. The Chair of the Alliance is Dr. Poon, who was also part of the CMU team and is also the Chair of the Provincial Transport Coordination Committee advising the Provincial Land Transport Department. He has further been a consultant on transport for Chiang Mai Municipality and was also paid to provide overall direction to *LCC*'s Chiang Mai demos.

Exhibit 9. Formal Meetings of Chiang Mai Smart Mobility Alliance

Formal, Large Meetings of the Alliance (*Does not include several smaller meetings at which decisions were not made*)	**Attendees**	**Organizations represented (out of 21 members)**
First meeting 28 January 2019	30	13
Second meeting 13 March 20219	31	11
Third meeting 21 May 2019	32	11
MOU signing ceremony 30 May 2019	127	23
Fourth meeting July 2020 (virtual)	27	19
Fifth meeting July 2020 (virtual)	15	12
Total (person-times at Alliance meetings)	**262**	-----

Chiang Mai Smart City website: In addition to the ap (described below), the Alliance, and eventually the social enterprise, has one other "asset," the Chiang Mai Smart City website. This website existed prior to the project, but the domain payment had expired. While the pre-existing content of the website was relevant to low carbon cities, there was no specific info on the site on either low carbon cities or smart, sustainable mobility. Thus, *LCC* added both of these topics to the website, after renewing the domain.

Social enterprise: LCC envisions a "social enterprise" to keep the Alliance going post-project. And, LCC prepared the *Social Enterprise Business Model Report*. Based on consultations, however, the TE team finds that the social enterprise remains in concept only, with lack of a well-developed idea on who will keep it going and how. There is an idea that the social enterprise will sell its "Ap" to other cities to have revenues, but there is not a clear idea of how the social enterprise and the Ap maker (who would supposedly need to modify the Ap for each city) will split the revenues. As indicated with red font, Mayday (designs bus stop signs), E4C (has fixed route buses), and Omm Platform (designed the e-ticket system and believed to be closely affiliated with the Ap maker) have agreed to jointly manage the social enterprise. It is expected that different members would invest in the social enterprise and then receive profits according to their shares.

Possible way forward for Alliance and Chiang Mai Mobility generally: Given that there now have been at least two significant donor investments in Chiang Mai mobility, there is a need to ensure the positive results of *LCC* are taken to the next level. Some visions of the way forward for the Alliance and Chiang Mai smart mobility include the following: (i) Once the pandemic is less of a barrier to public transport, the Alliance may work together to cover more areas of the city with bus routes and increase the frequency of service, while not competing for service on the same routes. The Alliance platform could facilitate integrated planning among the fixed route providers and also other modes of transport, such as pedestrian paths, shared public bikes, taxis, etc. According to its current plan, the Alliance/ social enterprise targets that 40% of Chiang Mai people will have access to fixed route public transport in the short term, 50% in the medium term, and that, in the long term, this kind of transport will be provided to ten other cities. (ii) Other work may be done, either through the Alliance or other means, with policy makers to discourage private cars via the regulatory system. So far, most measures in Chiang Mai to improve transportation have been focused on road expansion and studies of large-scale public transport infrastructure, such as metro, light rail, and underground, but none has materialized. As noted in the NR demo review, the TE Team finds that very low-cost measures can often promote sustainable transport in medium-sized cities by discouraging private car use, so that people make the transition to public transport. Yet, political will is needed and this may be an area for further TA work. (iii) Interestingly, Chiang Mai's Smart City Plan, in its mobility component, calls for software to analyze feed from CCTV cameras to identify cars parked on the road, since parking on the road is illegal in certain cases, depending on the zone and road width. Parking on the road blocks traffic flow and causes congestion. This could have been a fruitful area for

LCC to support and could still be interesting for future support, though may already be budgeted. [26] (iv) Chiang Mai's Smart City Plan also calls for a smart sensor system to control the traffic lights. These sensors count the number cars on the road and interact with other intersections to calculate the amount of time that should be allowed for red and green lights, so that traffic will flow best and both local pollutants and GHG emissions will be reduced. This, too, could have been a fruitful area of *LCC* support that may have had an immediate impact in reducing GHG emissions from cars on the road. It might be considered for support in future initiatives, though we have gotten contradictory information as to whether this aspect of Chiang Mai's Smart Mobility Plan has been implemented and suspect it is partially implemented, but could enhanced.[27] (v) Other measures that might be considered, but that will take political will, may be dedicated bus lanes, bike lanes, or pedestrian, bus, and bike roads where cars are not allowed. Bus lanes reduce the space for cars and allow buses to reach destinations quickly, while cars may be left behind in traffic jams, thus encouraging people to use public transport. While Chiang Mai has some areas with wider roads that may more easily accommodate bus lanes, in the parts of the city with more narrow roads, political will may be needed either to make some of these one way to accommodate bus lanes or to shut them off to cars to realize increased attractiveness of public transport as compared to cars.

Demo component 3. Consolidation of bus stops and improved bus routes: Prior to the *LCC* intervention, bus stops across the city for the three different fixed route bus providers were at different locations, even if in the same general area, such as near a certain intersection. Based on the recommendations of the updated traffic model done by the *LCC Project* and the agreement of the three providers via discussions of the CM Smart Mobility Alliance, consolidation of bus stops in the city was achieved. Prior to the consolidation, there was 443 bus stops total in Chiang Mai City. Now, after the consolidation, there are 203 total stops. While the bus operators and city already knew, prior to *LCC* work, that the bus stops should be consolidated, the survey and traffic model helped to identify where there is a concentration of demand along routes, so as to determine when more and fewer stops should be placed along routes. And, the Alliance facilitated discussion among previously siloed parties, so consensus could be reached. This consolidation of bus stops is a first for Chiang Mai. The discussion platform provided by the Alliance is considered instrumental in the achievement. *LCC* paid for the signs at all the consolidated bus stops, for a total cost of 757,000 THB (25,233 USD). This appears to be a cost effective way to have substantial impact on the transport system in Chiang Mai. Indeed, it reflects the TE Team's view that often transport improvements are low cost in terms of infrastructure, but require political will and/or bringing different parties together to reach consensus. In addition to the bus stop consolidation, bus routes of the three fixed route bus companies (RTC[28] and E4C, both private, and CM Municipal Bus Company) were adjusted based on the traffic model recommendations. It is understood, but not confirmed, that this result also came out of Alliance consultations.

[26] One source indicates that Chiang Mai City and Chiang Mai Province already have budget allocations for this activity. We are unclear, however, when the activity was first proposed and why it was not supported sooner. It was also indicated LCC chose not to support activity as better traffic flow may encourage more private car use. While this may be true, a few other aspects should be considered: (i) Reducing widespread illegal parking via CCTV monitoring along the road makes parking more scarce and private cars thus less attractive. (ii) At present, there is no plan for bus lanes. As such, buses are going to get stuck in the congested traffic, too. (iii) Improving traffic flow/ reducing stop and go due to improperly parked cars will reduce GHG ERs.

[27] While some point out that such measures, by improving traffic flow, could encourage private cars and thus be contrary to low carbon, sustainable urban transport, a few aspects might be considered: (i) Smart traffic lights could be made to favor buses and BRT, particularly if bus lanes are set up. (ii) Improved traffic flow in combination with other measures to discourage private cars (such as high cost parking in city center) could lead to increased GHG ERs as compared to the "no smart traffic lights" scenario.

[28] RTC has stopped bus services in Chiang Mai due to the Covid-19 pandemic and it is not clear whether they will resume, once the pandemic is well under control.

Demo component 4. Mobile ap: *LCC* supported the development of a mobile ap that bus riders can use to determine routes and connections. Prior to the project, there was no integrated application for the three different bus operators. Before *LCC* developed the ap, there was a "via bus" ap that provided information about RTC's buses, but this did not cover the service of Chiang Mai Municipality's buses nor link with information on other transportation services, such as bike share or parking. The ap is also linked to the payment system developed by *LCC*, so that the riders can purchase electronic tickets on the ap. The ap is foreseen by the project to be able in the future to provide data on ridership, especially once most tickets are electronic. This would be useful to Alliance members in making future decisions, such as about routes. So far, the ap is said to have been downloaded just 300 to 400 times. Clearly, for a city of around 130,000 people and metropolitan area of almost one million people, the ap has not yet had much of an impact.

Demo component 5. Electronic payment system work: Prior to the *LCC Project*, the two private fixed route bus companies, RTC Bus and E4C Bus, were accepting electronic ticket payments over Omm Platform's system, which allowed smooth transfers and contactless payment. Chiang Mai Municipality buses, however, accepted cash only. They did not allow credit and debit cards, because the city, based on regulations, could not allow the delay in receiving payments to the next day or end of month, nor pay the transaction fees charged by the card companies. Electronic payment with the Omm Platform does not have any money transfer charge, because the money is paid directly to the municipality's account, which complies with regulations. In the long-run, the benefits from electronic ticketing of preventing "payment leakage" and tracking people are also envisioned. As for "payment leakage" problems, for the municipality buses, because cash has been the only payment mode: (1) non-issuance of paper/ticket on the bus (ticket seller pocketing the money) and (2) "recycling" of paper tickets after a person has left the bus have both been "payment leakage" problems. Given the Covid-19 experience, there is also an interest in potentially tracking ridership for virus tracking. Achieving the payment system for Chiang Mai Municipality buses was quite challenging and required a lot of government liaison work. The project implementers had to consult with Chiang Mai Municipality's Finance Unit as well as the relevant ministries at the national level to ensure that the electronic payments paid to the city comply with all laws and regulations that govern local government. As a pilot, *LCC* supported installation of machines for scanning electronic tickets on 18 buses, but the use of electronic tickets so far is extremely low. Some methods to promote electronic tickets, once Covid-19 has receded, that the project implementers have discussed are reduced or free ride electronic tickets (though this would be complicated as it would require a new regulation to allow it) or discounts at retail stores along the route when shoppers show they used an e-ticket.

Other transport related achievements: The *LCC Project* claims to have influenced additional transport-related results through consultations: (1) *LCC* recommended that Chiang Mai Municipality extend its B3 route beyond the city borders. The municipality agreed and the route now goes to Nakorn Ping Hospital. This could be an important step in moving Chiang Mai towards addressing public transport in its greater metropolitan area, which has almost 1 million people. (2) While Chiang Mai University has had electric buses for a while,[29] there have been no electric buses used on fixed bus routes in the city. One source notes there is a lack of charging stations outside Chiang Mai University which is an important determining factor in this situation. *LCC* has encouraged the three fixed route operators to pursue electric buses. E4C incorporated electric buses into its operations in November 2020. Now, Chiang Mai Municipality has plans to buy electric buses for part of its operations. While E4C's electric bus purchase cannot be fully attributed to *LCC*, the project played a role in helping E4C connect with PEA ENCOM and ERDI, which have charging stations around the city. Further, once seeing E4C's deployment of electric buses, the municipality was able to see the possibility of running e-buses in Chiang Mai. The

[29] News reports indicate that Chiang Mai University in January 2021 bought 40 electric buses for on-campus shuttles to replace older electric buses at a cost of over 50 million Baht.

number of e-buses the municipality will purchase will depend on budget allocations in the coming fiscal year.

Sustainability: In general, sustainable urban transport initiatives take much more time and nurturing than some other types of low carbon city efforts such as, say, a building based RE power system, to be successful. The Chiang Mai efforts are no exception to this. While some of the achievements of the Chiang Mai demo package should be sustainable, the TE Team has strong concerns about the sustainability of the overall effort, which is still far from achieving its vision and generating the large amount of GHG ERs that might be possible with strong modal shifts from private cars to public buses. The adjustments to bus routes and the consolidation of bus stops, which are results of the traffic model/ citizen survey and Alliance together, should be sustainable, as the new bus stop signs are in place and the fixed route companies have begun to use the consolidated stop locations. Yet, much more work is needed both to develop the public transport system into an attractive one and to discourage people from driving private cars and riding buses instead. And, the likelihood the Alliance continues seems at risk if no further concerted action is taken. The TE Team found no evidence to assure us the social enterprise will continue to function, aside from a plan to use the Ap for revenues by selling it to other cities. It should be noted that one of the three fixed route bus companies, RTC, has stopped operation during the pandemic. The Ap itself and the e-payment system both have achieved only limited pilot usage at this time, so their sustainability is also at risk.

Progress towards indicators: The project claimed very limited GHG ERs: 2,592 t by EOP and 11,370 t lifetime. The justification of the small increase is not clear, even after reviewing the MRV consultancy's report.[30] The report indicates a start date of June 2018 for emission reductions and the later updated spreadsheet provided indicates a start date of October 2018. Yet, the provincial approval of consolidated bus stops did not come until July 2020. And, workshops of the Alliance to discuss design of the new bus stop signs occurred in May 2020. As it was explained that the GHG ERs were achieved as a result of bus stop consolidation, the emission reductions could not then have begun to accrue as early as 2018. Given that the consolidation likely occurred at earliest in late 2020 and that Covid-19 was already having a severe negative impact on public transport in the city, it is unlikely that GHG ERs from the achievement (via people shifting from private car use to public buses in response to an improved public transport system) will be detectable prior to end of project. As such, we suggest that no GHG ERs by EOP be claimed. A generous assessment, if it determines there is evidence the bus stop consolidation and route improvements are likely to generate such modal shifts in the future, may estimate some projected lifetime GHG ERs, all occurring post-project, once the impact of Covid-19 has subsided.

As for numbers of demos and replications, as noted, the TE Team questions the usefulness of this indicator without certain minimum requirements for something to count as a demo. Yet, for completeness, based on input from stakeholders, the various aspects of Chiang Mai work are integrated into a single demo. There are no replications.

Expenditure breakdown and analysis: Exhibit 10 shows the rough breakdown of spending for the CM "demo" package. With software and IT service included in the "investment" category, these expenditures breakdown to 69.4% investment, 30.6% TA, as compared to 80% targeted to go to investment in the CER. It is worth noting that the expenditures are quite heavy on IT – with 43.7% going to software and other IT services, or a total of 58.2% (USD183,666) for IT and related, the related being the machines

[30] The MRV report states: "A questionnaire was used to calculate the amount of greenhouse gas emissions in the base case." The ERM report does not further explain how achievements from the LCC project resulted in GHG ERs as early as June 2018, the date the report indicates the emission reductions it calculates began to occur.

provided to read the electronic tickets.[31] The bulk of these IT and related expenditures go towards the routing ap and electronic ticketing, which are investments fitting with the theme of bringing the three fixed route bus players together and making public bus riding more convenient for passengers. At the same time, the question arises of whether the project might instead have focused on measures that would have provided more immediate and tangible results, such as those in CM's Smart City Plan (software to support identification of illegally parked cars that impede traffic flow from CCTV camera feeds and extended sensor/ analysis system for street lights to also improve traffic flow) or those that might have created special bus lanes, bike lanes, or pedestrian ways.[32] Earlier, the project had intended to purchase GPS for the buses to interface with the AP, but this was not needed as the existing GPS systems were sufficient. Further, there had been a plan to purchase CCTVs for the buses, as a safety and convenience service to passengers, so that bus video might be broadcast on the ap and people might watch their children on the bus or see if there is a free seat. It was determined, however, that Thailand's IT Act, which does not allow posting of photos online without consent, would not allow this.

In terms of organizations carrying out work under the "demo" package, for those items for which the organization is known, Siam D App. Co and Omm Platform (which appear to be closely related companies) carried out 57.9% of contract volume and CMU carried out 30.8%. (We did not include in the total those items for which implementing organization is not known.)

Exhibit 10. Breakdown of Spending under CMU Contract for CM "Demo Package"

Item	Amount (USD)	Provider
Technical Assistance (TA) Expenditure Areas	---	---
1. Traffic survey, traffic model, including plan for consolidated bus stops and plan for improved bus routes	51,008	CMU
2. Alliance meeting costs (4 meetings and 1 MOU signing event)	9,333	CMU
3. Communication plan	8,100	CMU
4. Social enterprise set-up (non-IT part of this work)	6,666.5	Thammasart University
5. Demo package facilitation/ service fee*	21,518	CMU
Subtotal for Technical Assistance (30.6% of city demo package total)	***96,625***	---
Investment Expenditure areas	---	---
1. Installation of New Signs to Consolidate Bus Stops	25,233	Indeed Creation Co.
2. Ap for bus riders to find routes and make digital payment $71,093 Maintenance of Ap $46,666	117,759	Siam D App Co.
3. Social Enterprise – IT aspects	13,333	Siam D App Co.
4. Website development (improvement of CM Smart City website)	6,666.5	NA
5. Bus-based units for electronic ticketing (18 units and installation)	45,907	Omm Platform†
6. Design and mock-up of bus stops for city-wide consultation	6,666.5	NA
7. T-shirts, maps and posters for corporate identity	3,333	NA
Subtotal for Investment (69.4% of city demo package total)	***218,898***	---
Grand Total	**315,523**	**---**

[31] One stakeholder has offered the input that the investment decision was made by Chiang Mai City. The City, it was explained, cannot legally invest in an IT system used by private companies that provide urban transit services in the city, so thus the need for outside funding. The stakeholder also indicates that the measures in the Smart City Plan already have budget allocations and that the "smart street lights" are already in place.

[32] As has been noted, one stakeholder indicates the Smart City Plan's mobility initiatives have budget allocations but have not been implemented.

Note: The service fee estimate was made by the TE Team based on subtraction of all other items (which were provided by CMU team) from actual amount paid for contract of USD315,523. The CMU team used an exchange rate 30THB/dollar in their estimates.
†Based on interviews, it is believed that Siam D App Co. and Omm Platform are closely related companies. Online search show similar addresses (345/15 moo 3 San Phranet San Sei, Chiang Mai for Omm Platform and 345/16 Moo 3 San Phranet San Sei, Chiang Mai for Siam D App Co.) and stakeholders referred to Omm Platform as the ap developer.

4.4 Samui Demo Results

The demo results in Samui impressed the TE Team for addressing some of the most important needs of the city and for the high level of involvement across different sectors of the community, including both households and the private sector. The six Samui demos/ initiatives are further appreciated in that they were all intended to be active demos deploying investment or at minimum stimulating direct action towards GHG emission reductions and problems faced by the city. This contrasts with some of the TA seen in the demo packages of the other cities that is mainly meant to set the stage for change in the future. In the end, three of the six demos will achieve estimable GHG ERs beyond baseline by end of project, though two of these could have much stronger GHG ERs if the waste input streams are improved. One of the other demos has good potential to achieve incremental GHG ERs post-Covid. The Samui demo work was coordinated by Bright Management Consulting (BMC), whose contract with *LCC* covered both facilitation of the demos and the cost of the demos themselves.

The Samui demos are summarized in Exhibit 11. All focus on issues related to organics in waste, five addressing organics in solid waste and the other, organics in wastewater. Specific problems of Samui that are addressed include: excess waste that must be “cubed” and sent back to the mainland, traffic accidents due liquids from organic waste spilling out of garbage trucks and making the road slippery, excess coconut shells (which smell bad, attract mosquitos, are an eyesore, and can explode if burned), and wastewater from a market flowing into the ocean, with negative impacts on the environment and on tourist perception. We are especially impressed with the scale-up of household composting efforts, with the project adding 2,500 households to a baseline of 750, and then achieving an additional 11,750 households in replication for a total of 15,000 households, or 31.4% of all households on the island reported to be participating. The efforts with hotel composting also look extremely promising for once the Covid-19 pandemic is over. This is because of the benefits noted by the 28 hotels that had initiated composting under *LCC* and the potential for replication with the over 600 hotels and other tourist accommodations on the island.

Yet, the concerning weakness of the Samui demos is that the reported GHG ERs and also the incremental GHG ERs that we calculate (noting that some of the reported items are not incremental) are not very high. The low numbers may be partly because *LCC* chose to use a bottom-up approach (household by household and hotel by hotel) to Samui’s organic waste, rather than a top down one (e.g. large biogas digester for the entire city). Further, the Covid-19 pandemic has affected at least four of the demos’ access to organic waste. Yet, it’s also important to consider that the potential GHG ERs for organic waste may not be as high as in other sectors. Based on Samui having 16,825 tons of organic waste in 2018 and assuming an emissions factor of 0.43 t CO2eq/ ton organic waste, the total potential of the sector in Samui (assuming all organic waste is composted) is limited to 7,235.75 t CO2eq/ year, compared to Samui’s total 2017 carbon footprint 820,517 t CO2eq. At the same time, in the case of the household composting, an important point should be made that the GHG ERs reported by the MRV consultancy probably do not reflect the full impact, firstly because the 11,750 additional HHs who have reportedly joined the program have not been included in their lifetime GHG ER estimates. Further, the lifetime of the initiatives is assumed to be just 5 years, since the composting bins may only last that long. Yet, the bins are inexpensive and the mindset change is the real achievement here, so that probably a ten-year

Exhibit 11. Samui Demos: All Related to Organic Waste

<table>
<tr><th colspan="2">Solid Organic Waste: For comparison, total organic waste on Samui was 16,275 tons in 2018</th></tr>
<tr><td>Household composting-> soil conditioner for self-use mainly (bins and promotion to get households to compost organic waste): Baseline 750 HHs, now 15,000 HHs on island composting (31.4% of HHs) =14,250 HHs added
Increment: 934.8 t waste/ year (5.7% Samui total)
Lifetime GHG ERs (10 years*) from reduced landfill methane emissions: 3,818.7 t CO2eq
also: replication 500 HH on Pha-Nang Island, potential additional scale-up on Samui and PN</td><td>Hotel composting->soil conditioner for self-use (waste audits and training to get hotels to compost organic waste): stalled due to Covid-19, likely to pick up after:
28 hotels (21.6 t waste/hotel/ year)
604.8 t waste/ year (3.7% Samui total)
Possible lifetime GHG ERs (10 years)* once Covid impact lifts from reduced landfill methane emissions: 2,419.2 t CO2eq
(Potential for additional scale-up high - Samui has 600+ hotel/ hotel-like accommodations)</td></tr>
<tr><td>Bophut Organics Recycling Station composting -> soil conditioner and animal feed pellets for sale (also some “effective microorganism” made from expired milk, for use in soil) (provision of equipment to expand capacity of organic waste processing): Baseline capacity 100 kg/ day. Capacity with incremental equipment is 1 ton per day. Comparing the six months post installation but pre-Covid, waste processed is 3.48 tons per month average, far below capacity of 30 tons per month. The achievement is an increment over baseline of 1.98 tons per month. The annual increment is 23.76 tons waste processed per year.
Incremental GHG ERs: 5.3 tons by EOP and 53.3 tons lifetime.
Once Covid impact lifts, there is a need to work on ensuring increased consistent supply of organic waste to the station to realize the full capacity of the equipment of 30 tons per month, as even pre-Covid with new equipment, average amount processed was just 3.48 tons per month.</td><td>Ban Ya Suan Pu Learning Center coconut shell processing->pig feed (self-use); soil conditioner, charcoal, wood vinegar (all for self-use and sale) (provincial of equipment to expand capacity of coconut waste processing). Baseline capacity was 600-700 kg/ day and is now 1 ton per hour. Post-installation of new equipment and pre-Covid, 5.87 t per month processed, still far below capacity. The achievement exceeds baseline by 2.97 tons per month or 35.6 tons per year.
Incremental GHG ERs: 13.45 t by EOP and 134.5 lifetime
Before Covid, had 1,000 visitors per year. Visitors from Chiang Mai have bought coconut processing equipment to replicate.
Once Covid impact lifts, there is a need to work on securing larger supply and consistency of supply. While 5.87 tons per month on average were processed pre-Covid, post new-equipment-installation, with 1 ton per hour capacity, assuming 4 hours operational per day, monthly capacity could be 120 tons.</td></tr>
<tr><td colspan="2">Seeds2Sustain Station: Organic waste->charcoal. (provision of equipment to expand capacity of organic waste processing) This preexisting station transformed a variety of organic waste into charcoal. LCC provided 10 additional kilns. Yet, we are unclear regarding baseline and whether any increment beyond baseline was achieved. Incremental GHG ERs (EOP and lifetime): 0 (NA) Consider working on ensuring substantial and consistent supply.</td></tr>
<tr><th colspan="2">Wastewater with organics</th></tr>
<tr><td colspan="2">Hua Thanon Fish Market small waste water treatment plant (Provision of equipment to newly treat 15 m3/day of wastewater from market near ocean). Reduces BOD from 862.5 mg/l to 19.1 mg/l. Because wastewater previously flowed into the ocean and because the equipment was required for regulatory compliance, the MRV consultancy has indicated that no GHG ERs are achieved by this demo.[33]
Incremental GHG ERs (EOP and lifetime): 0 (Note: Limited GHG ERs likely due to organic carbon and nutrients in the wastewater being eaten by shallow, near shore ocean microbes that then respire carbon that can reach the surface. Yet, the amount of GHG emissions are not easy to determine and may be small.)</td></tr>
</table>

[33] One stakeholder notes that the market was out of compliance in previously emitting its wastewater in the ocean and that TVER and CDM methodologies do not “count” GHG ERs for installations that are required to meet installations. GEF, however, to our knowledge does not have the same “can’t count the GHG ERs” rule and GEF CCM projects are required to estimate their GHG ERs.

*As explained in the text, we assume at least a ten-year lifetime of composting behavior. Evidence from replications shows provision of composting bins/ structures (with estimated 5 year lifetime) are not a limiting factor.

lifetime can be assumed, particularly given that the 11,750 replicating households managed to get their own bins.[34] Our analysis suggests the five other demos are not on track to achieve as substantial of lifetime GHG ERs as the household composting is. We believe the tourist hotel initiative, however, has the greatest potential to achieve significant direct lifetime GHG ERs post-project once the impact of Covid lifts if it can be reinitiated and expanded. For the composting station and the coconut shell processing station, the amount of waste processed per day after LCC-provided machine installation and pre-Covid is far below the new capacity of the machines. For the organics-to-charcoal station, we lack information on the baseline processing amount, but presume the situation is similar in that the waste supply is too low to realize the capacity added by LCC support.

The rest of this sub-section presents the Samui demos one by one, followed by an assessment of sustainability, progress towards relevant indicators, and expenditure analysis.

Demo 1. Household composting: An impressive success story of *LCC* is its partnership with Samui's Disc Jockey Noo ("DJ Noo") in his promotion of organic waste composting for households. DJ Noo got interested in this area, as he found that he was frequently announcing traffic accidents that he eventually learned were due to slickness on the road created by liquids seeping from garbage trucks containing organic waste. DJ Noo learned about composting to address the issue and gained a following of 750 households (HH) doing home composting, founding the organization "Gold Bin." He then partnered with *LCC* to scale up the efforts. *LCC* provided 5,000 composting bins, two for each of 2,500 households across the 7 sub-districts of the island. *LCC* also provided a manual on home composting. As one channel of distribution, the bins were sent home with school children. Through promotion, the program has now reportedly spread to an additional 11,750 households that have found their own bins (by either buying a new one or repurposing an old item). Thus, there are now said to be 15,000 HH on Samui doing this home composting. That's 31.4% of the island's 47,817 HHs. It has been reported that Samui's Department of Social Development and Welfare and the International School of Tourism's Samui Branch hope to extend the implementation of this demo to additional households on the island. Working with *LCC*, DJ Noo has expanded his work to 500 HHs on nearby Phang-An Island, with LCC providing two bins for each HH there as well. In addition, leaders of Gold Bin continue to aggressively work to expand the program on Samui, including to hospitals, hotels, restaurants, and the academic sector. One "Gold Bin" case study mentioned by a stakeholder is a hospital that, by sorting, reduced its waste from 400 kg to 100 kg per day. While Gold Bin can approach local hotels, it has been suggested UNDP may assist with approaching hotel chains that have branches on Samui.

There is such great enthusiasm for the HH composting on Samui that it is considered likely people who did receive bins from the project will continue by finding their own bin (either by buying a new one or repurposing an old item) after the original one is no longer usable. Some of the motivating factors are that people who compost: can pay less waste collection fee; make their home cleaner; have no flies, better hygiene, and no bad smell; and feel proud. Participating HHs are advised to set the first bin (which has an open bottom) near a tree. It takes about three months to fill, and during that time, some liquids may go in the soil and benefit the tree. After it is full, they begin to use the second bin, which, after being set aside for an additional three months, is ready to be used as soil conditioner. Most households use the soil conditioner themselves. Gold Bin has packaged and sold some, but the amounts are very limited.

[34] The amount of GHG ERs shown in Exhibit 11 is our estimate for the Samui household composting increment. It includes the additional 11,750 households reported and assumes 10 year lifetime of the composting behavior.

GHG ERs: As noted, the GHG ERs indicated by the MRV consultancy cover only 2,500 households and not the additional 11,750 HHs on Samui or the 500 HHs on Pha-Nang. Further, the MRV assumes only a five-year lifetime of this initiative, due to the estimated lifetime of the bins. While it is standard practice in GHG accounting to consider the lifetime of the installed equipment, in this case, experience on Samui has already shown that bin distribution is no longer the constraining factor, as 11,750 households have either bought their own bin or repurposed an old item. Given the strength of the behavior change, we would suggest it's quite reasonable to use a lifetime of ten years. With that assumption, for the increment of 14,250 households, the organic waste to landfill avoided is 934.8 t/ yr, which is 5.7% of the organic waste generated per year on the island (based on 2018 data). Adding in 500 households in Phang-An, lifetime GHG ERs (assuming the HHs keep up with the composting for 10 years) is 3,953 t CO2eq. (To keep it simple, for EOP GHG ERs we use the amount estimated by the MRV consultancy, which was just for the 2,500 HHs – 116 t CO2eq. Thus, we roughly assume the other HHs joined the movement close to EOP.)

Possible way forward: UNDP may want to consider ways to support the expansion of this exciting movement, including the suggestion of assisting in bringing hotel chains onboard or considering promoting household composting in other locations in the country. On the other hand, a large, centralized facility, such as a biogas digester with power generation may also be considered for processing of organic waste.

Demo 2. Hotel composting: *LCC* did "walk-through" waste audits for 17 Samui hotels; and 30 hotels joined *LCC*'s hotel waste management training. Of the latter, one source indicates 28 hotels began to practice composting. While some had sorted waste before, they had still been sending their organic waste to the landfill. None had done composting before the *LCC* intervention. Most of the hotels participating are of medium sizes (30-100 rooms), owned by natives from Samui or investors from outside the island who identify themselves as people of Samui, having lived there for many years. The project also prepared a manual for hotels on waste management, which is said to be user friendly and to have incorporated the suggestions of participating hotels. The project further developed a mentor program, whereby hotels that had already gained experience in composting early in the project served as mentors to others.

Though the demo was stopped due to Covid-19's impact on tourism, based on feedback, this hotel program looks quite promising for post-Covid re-launch. The hotels are said to have found the cost of setting up their own composting facilities to be lower than the cost they had to pay the municipality as collection fee. They see investing in the composting set-up as a one-time cost, whereas the waste collection fee is a regular expense. Those that have the space/ need used the compost as soil conditioner. The others were sending it to *LCC*'s Bophut demo. Those that directly use the compost saved on buying fertilizer from the mainland. Because the manual is easy to use, most hotels feel they can develop the composting facilities by themselves and through their mentors. It is anticipated that the Samui Hotel and Tourism Association will encourage additional hotels to join the effort through demonstration and mentoring. Given that Samui has over 600 hotels, resorts, homestays, and other kinds of tourist accommodation, the potential to expand the program is quite large. While not all are members of the Association, the community of hotels in Samui tends to have a lot of interlinkages so that people in the business know each other.

GHG ERs: EOP GHG ERs are zero, as there is no information on how much composting the 28 hotels did prior to Covid stopping their efforts. Assuming the average organic waste in the landfill avoided per year is 26.8 tons per hotel (based on the average estimated for the 17 hotels for which there were walk-through waste audits), then, assuming a ten-year lifetime of the effort, lifetime GHG ERs for this group of 28 hotels is 2,419.2 t CO2eq.

Possible way forward: Findings suggest the composting is very attractive to the hotels; and the hotel network could well spread the effort. Yet, getting things going again may benefit from some outside stimulus, which both the City of Samui and UNDP may want to consider. Also, as noted in the case of Gold Bin, UNDP may have a special role to play in bringing international hotel chains with Samui locations onboard to participate and promote the effort.

Demo 3. Expansion and Enhancement of Bophut Station Organic Waste Recycling: Prior to the *LCC* project, this privately-owned station produced animal feed and soil conditioner from organic waste. The prior machinery, however, was simple and relied heavily on manual operation. Further, the source of organic waste delivered to the station was quite limited, mainly from a street market and the community. It is reported that the amount of waste delivered to the station, prior to *LCC* involvement, was exceeding its capacity, though we lack figures to verify this. The *LCC* project provided machinery with 100% grant, including a new crushing machine (which has a capacity of 250 kg/hour or about 1 ton per day, compared to the earlier machine which had a capacity of only 100 kg/day) and milling, mixing, and pelletizing machines (none of which the station had before). With the new equipment, the station could potentially process more waste (higher capacity crusher) and could sell the animal feed and fertilizer in pellet form, which commands a higher market price than the non-pellet form that the station was selling earlier.[35] It is said that after *LCC* support, the station expanded its waste sources to include retail convenience stores in the Bophut Community area and waste from elsewhere delivered to the station by Samui Municipality trucks. And, through the new relationships with retail stores, the Station has acquired a source of expired milk, which it uses to make EM (Enhanced Microorganism) liquid, sold to users to enhance the productivity of their soil. Overall, given that new capital investment was not needed on the part of the operation, it is guessed that the stations' organic waste processing is profitable, though Covid in reducing waste inflow has had a negative impact on potential revenues.

Waste processed per year and GHG ERs: Data suggests the amount of waste processed by Bophut Station with the new equipment, which was commissioned August 1, 2019, averaged 3.48 tons per month over the six months preceding Covid-19 impact. This represents a 1.98 ton per month increase over the roughly estimated baseline amount of 1.5 tons per month. Clearly, as the new capacity is roughly 1 ton per day or 30 tons per month, the pre-Covid post-installation average of 3.48 tons per month is way below the potential. One source indicates a challenge in that waste is not necessarily achieved daily. During the period of Covid-19 impact, for the four months for which we have data, the amount of waste processed did not surpass the baseline. Given that a recovery is expected post-Covid and assuming a 7-year lifetime of the equipment, we use the 1.98 ton increment of waste processed for the six months pre-Covid also for 4.5 years following Covid, assuming a two-year period of impact from Covid when baseline is not exceeded. The average annual increment in waste processed in non-Covid times is 23.76 tons. Direct GHG ERs are estimated at 5.3 tons CO2eq by EOP and 53.3 tons CO2eq lifetime.

Way forward: Clearly, the amount of waste processed per day is critical to ensuring the contribution of *LCC*'s investment in equipment for the Bophut Station. If the City could ensure a steady supply of organic waste to Bophut Station, so that it could maximize its contribution at 1 tons per day and operate 95% of the time, then 347 tons of waste would be processed per year or 2.1% of the city's organic waste (based on 2018 data). Then, about 15 such stations could take care of 1/3 of the city's organic waste. A challenge, though, is that the peak organic waste stream is seasonal, so the number of stations to achieve this may be higher, e.g. 30 or more. There is at least one other privately-owned organic waste processing station on the island, "Bang Makham Model Station" in Mae Nam Sub-District, that is also making soil conditioner. The capacity is lower than 100 kg per day; and the source is households and restaurants in the area, though this station is believed not to have a strong interest in expanding. An alternative to

[35] The price for both regular type animal feed and soil conditioner is 20 THB per kg, while the price of the pelletized version of both is 40 THB per kg.

expanding Bophut's organic waste supply and replicating the model to other similar sized stations is to consider the more top-down approach of a centralized biogas power generation facility.

Demo 4. Ban Ya Suan Pu Coconut Learning Center: Ban Ya Suan Pu Coconut Learning Center is a privately-owned facility that processes both regular organic waste and coconut shell waste into soil conditioner. While the majority of coconut waste is turned into soil conditioner, the Center (now, with support of *LCC*) also produces charcoal and wood vinegar from the coconut waste. Coconut waste has been a vexing problem on the island, creating a bad smell, attracting mosquitos, and creating a negative scene for tourists.

Ban Ya Suan Pu was already processing coconut waste prior to the *LCC* intervention and had been doing so for 8 or 9 years, but *LCC* increased the capacity and facilitated the addition, beyond soil conditioner alone, of charcoal and wood vinegar products. *LCC* provided the required equipment with 100% grant, including two choppers and a blade sharpener for the coconut chopping and two kilns for the charcoal and wood vinegar production. Ban Ya Suan Pu uses most of the output of the chopping in its pig sty, where the pigs can eat some of the chopped coconut waste, with their urea assisting in turning the rest into soil conditioner, which is used on the owner's farm and also sold at 20 THB per kg. The newly produced coconut waste based charcoal and wood vinegar are also mainly for self-use, though some is sold to local farmers. The owner employs one person with the revenues from all the coconut waste related efforts to assist with the work, though it is said this aspect of his operations is a non-profit/ educational.

With the equipment the center had before, the capacity of coconut processing was 600 to 700 kg per day, while the two new coconut shell choppers combined can process 1 ton per hour. Yet, as with the Bophut Station's supply of organic waste, the amount of coconut waste supplied to Ban Ya Suan Pu varies and also did not grow as expected due to the Covid-19 pandemic. While the MRV reporting did not subtract out baseline amount of coconut processed nor consider the impacts of and potential recovery from Covid, the TE team requested additional information in this area. Based on that information, we found that, for the six pre-Covid months post-installation of UNDP-GEF project supported equipment, the center processed an average of 5.87 tons coconut waste per month. This is 2.97 tons per month more than the 2.9 tons per day roughly estimated to have been processed pre-Covid. During the Covid impact period, based on the four months of data supplied, it appears that the center is not surpassing its baseline coconut waste processing capacity. Obviously, with a capacity of 1 ton per hour, the pre-Covid post-new equipment installation average processing of 5.87 tons per month is far below what could be realized. Thus, more work post-Covid needs to be done in ensuring supply. It has been indicated, however, that the station processes 70% of the coconut waste in Bophut sub-district (which is one of seven sub-districts in Samui and the one with the greatest amount of coconut waste). This would be surprising, however, given the low pre-Covid post-installation level of utilization of the equipment. As far as the TE Team knows, Ban Ya Suan Pu is the only site on the island processing coconut waste at such large scale, though it is unclear whether the increased capacity facilitated by the *LCC* purchased equipment will be utilized as the impact of Covid-19 subsides.

Replication and potential replication: *LCC* organized an exchange on Samui between stakeholders from Chiang Mai and Samui in the area of waste management. It is reported that one of the Chiang Mai stakeholders was so impressed with Ban Ya Suan Pu's solution to coconut waste that they bought coconut processing equipment to set up such a facility in Chiang Mai. In addition, during non-Covid times, about 1,000 persons per year visit the Learning Center, so this also has the potential for stimulating replication once visits are resumed.

GHG ERs: Based on the increment of waste processing achieved, we estimate direct GHG ERs by EOP to be 13.45 t CO2eq. We further assume that after a two-year Covid impact period when the baseline of waste processing is not surpassed, the pre-Covid post-installation levels of processing are achieved over

the remaining 4.5 year lifetime of the equipment (which has a total lifetime of 7 years), yielding an increment of direct lifetime GHG ERs of 134.5 t CO2 eq.

Possible way forward: Due to the negative impact of coconut waste, this initiative is compelling. Yet, like the Bophut Station, it is important to see whether supply can be scaled up post-Covid, so that the station can go well beyond the baseline and utilize a much larger share of the increased capacity, as anticipated. Thus, the municipality may wish to first focus on ensuring supply to the station and also assessing whether the benefits of separating coconut from other waste outweigh the cost of doing so. Once a ramped up supply is demonstrated (such as perhaps 4 tons per day, given the capacity of the machines), then the city and/or UNDP may work together with the Learning Center to try and replicate the effort on Samui or at other locations in Thailand with high coconut shell waste.

Demo 5. S**eeds2Sustain Station**: This preexisting station had already been transforming a variety of organic waste into charcoal. *LCC* facilitated increased capacity, providing 10 additional kilns. Yet we are unclear regarding the baseline and whether any increment beyond baseline was achieved. As was the case with Bophut and Ban Ya Suan Pu, it is assumed that the reported GHG ERs were calculated without assessing the baseline. Without further available information, we thus assess the incremental GHG ERs (EOP and lifetime) as zero or "NA". We guess that, as for Bophut and Ban Ya Suan Pu, realization of the potential of this demo will also require that greater and more consistent waste flow to the station is achieved.

Demo 6. Hua Thanon Fish Market Wastewater Treatment Plant: *LCC* provided 100% grant to support the installation of a 15 m^3 per day wastewater treatment plant at this fish market in a tourist area. The market is located close to the sea; and the wastewater was previously allowed to flow into the sea untreated. The plant has reduced BOD from 862.5 mg/ l to 19.1 mg/l, which is within the Thai standard of 20.0 mg/l. While the proponents of this demo selected it expecting it would generate GHG ERs, the MRV consultancy has indicated that, because the baseline wastewater was discharged into the ocean, there was no or minimal GHG emissions that could have been abated. They further note that CDM and T-VER methodology do not allow GHG ERs to be counted in cases where measures are required to comply with regulations. Findings of the TE Team, after review of the literature and discussion with experts, suggest the situation with regard to wastewater discharged into shallow ocean is complex. As one expert noted: Wastewater is full of organic carbon and nutrients that ocean microbes can eat and then respire carbon that can reach the surface. (At the same time, wastewater can produce algal blooms which can either be a sink or source of carbon, depending on the ecosystem and what's in the wastewater, though such blooms are typically tied to fertilizer run-off.)

GHG ERs and the way forward: Based on the foregoing, we suggest that the GHG ERs are probable, but undetermined and likely low. Because it is difficult to determined GHG ERs when the baseline is discharge of wastewater to the ocean, this type of demo, unfortunately, is not amenable to claiming GHG ERs, even if it does create them. Thus, future projects of this type may require a deeper analysis of the baseline before a decision is made whether to embark upon them, when GHG ERs are a key funding criteria.

Sustainability: Looking at the 6 Samui demos, two are seen as strongly sustainable and four may need more effort to ensure continuation and results beyond baseline. The household composting organized by Gold Bin has really taken root; and the wastewater treatment plant is also believed to be strongly sustainable, though admittedly the TE Team was not able to look into its operation. The hotel composting has good potential, but as it was quickly cut off due to Covid, there will need to be some impetus to get it going again and then expand to additional hotels. The organic waste station, coconut learning center, and waste-to-charcoal station will be in especial need of more support in scaling up their supply of waste for

processing in order to go beyond the capacity of their pre-*LCC* machines. Should they be successful and appear to represent a viable model for scale-up, more work may be needed to stimulate replication.

Progress towards indicators: Our assessment of GHG ERs for the Samui Demos is given in Exhibit 12.

Exhibit 12. Roughly Estimated GHG ERs from Samui Demos Attributed to *LCC*

Demo	Comment	EOP Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)	Lifetime Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)
1. Gold Bin HH composting	Incremental†	116	3,953
2. Hotel composting	Full Demo	0	2,419.2⁑
3. Bophut Organic Waste Station	Incremental	5.33‡	53.25‡
4. Ban Ya Suan Pu Coconut Learning Center	Incremental	13.45‡	134.49‡
5. Seeds2Sustain (organic waste to charcoal)	Incremental	0/ NA‡‡	0/ NA‡‡
6. Hua Thanon Fish Market Wastewater Treatment	Full Demo	Probable low amount, but undetermined**	
Total	**--**	**134.8 tons**	**6,559.9 tons**

†14,250 HH in Samui and 500 HH in Pha-Nang, assuming lifetime of 10 years and that only 2,500 HHs began substantially before EOP (1.73 years prior to project close).
⁑Assumes 28 hotels involved (as 28 hotels began composting as a result of *LCC* and prior to Covid) for ten-year lifetime. The assumed average amount of organic waste composted per hotel (21.6 ton per year) is based on the average potential organic waste per hotel available, determined in the 17 walk-through waste audits *LCC* performed for the hotels.
‡The original GHG ERs provided for the Bophut and Ban Ya Suan Pu sites did not subtract the baseline, nor differentiate pre and post-Covid performance in lifetime GHG ER projections. Based on additional information provided, we subtracted a rough estimate of the baseline so that estimates are incremental. We also used monthly estimates for the six months preceding Covid to estimate post-Covid performance for the rest of the lifetime of the equipment after the impact of Covid recedes. For both sites, waste processed during Covid was recorded to be less than the baseline, so no increment is included for the Covid period. With a seven year lifetime, the first six months of the equipment are considered "pre-Covid", the next two years "Covid" (with no increment) and the last 4.5 years "post-Covid" (using the Pre-Covid increment)
‡‡No information was provided on GHG ER achievements of this demo. Also, it is unclear whether the baseline was surpassed.
**Baseline GHG emissions from wastewater discharge into shallow near-shore ocean water are difficult to determine. Yet, there are likely to be at least some limited GHG ERs as microbes in the ocean will eat the organic nutrients and carbon in the wastewater and respire carbon that will bubble to the surface.

In terms of the Outcome 1.2 indicators for demos achieved and replications achieved, as noted, we feel these indicators, without more detailed requirements on what constitutes a demo or replication, are problematic. As also noted, though, the Samui Team is to be commended in that its demos are all real demos, with tangible physical activities potentially leading to GHG ERs. While the hotel demo is currently shut down due to Covid-19, as we understand, 28 hotels initiated composting due to *LCC* and could, with the proper additional stimulus, restart post-Covid. Thus, we may conclude there are 5 operational demos, or 6 demos if the non-operational one is counted given its future potential. Because the HH composting has been expanded to Phang-An Island, that can be counted as one replication.

Expenditure breakdown: Exhibit 13 shows the breakdown of expenditures under the Samui "Demo Package" contract. In terms of value for money and considering GHG ERs and potential GHG ERs, the Gold Bin household composting and the hotel composting (given what we consider strong post-project potential) seem the most cost effective. The wastewater treatment plant, with a combined investment and TA cost of USD86,000, which is 26 percent of total "demo package" costs, in some regards seems least effective, as no GHG ERs can be claimed. At the same time, the equipment is certainly serving a positive

purpose and, as noted, limited GHG ERs are probably being achieved, but are just very difficult to confirm. Given that, without Covid-19, the other three demos may have together achieved significant increase in organic landfill waste avoided, their cost effectiveness may also have been positive. Yet, pre-Covid data on the waste two of them processed suggest much work is still needed in increasing waste supply and assuring its consistency before the increased capacities will be truly cost effective. Overall, the breakdown of investment and TA expenditures is 46.8% TA and 53.2% investment, though some of the investment figures (particularly that for household composting) actually included TA mixed in. The breakdown compares with a CER breakdown of 80% of Outcome 1.2 allocation intended to go towards investment. BMC's service / management fee of USD120,000 accounted for 36.7% of the total demo package.

Exhibit 13. Breakdown of Spending under BMC Contract for Samui "Demo Package"

Item	Amount (USD)**	Provider*
Technical Assistance (TA) Expenditure Areas	---	---
1. Wastewater treatment plant site assessment and consultations	6,000	BMC/ Green World
2. Bophut Organics Recycling Station site assessment and consultations	5,250	BMC/ Progress Eng'g
3. Hotels: Walk through audit for 17 hotels, training, guidebook, consultations	15,000	BMC/ Samui Tourism Assn/ HR Club
4. Gold Bin household composting: site assessment and consultations	3,497	BMC*
5. Seed2Sustain Station: site assessment and consultations	3,000	BMC*
6. Service/ management fee for facilitation of demos, including MRV data collection‡	120,000	BMC
Subtotal for Technical Assistance (46.8% of city demo package total)	**152,747**	
Investment Expenditure areas	---	---
1. Wastewater treatment equipment ($15m^3$/day) for fish market⁑	80,200	Green World Solution
2. Bophut Organics Recycling Station equipment⁑ (one of each of crushing, milling, mixing, and pellet making machines)	16,576.80	Process Engineering Co
3. Ban Ya Suan Pu Coconut Learning Center equipment⁑ (2 coconut shredding machines, blade sharpener, and two kilns)	32,922.80	Nimut Engineering; Fiber Resource Energy
4. GoldBin: 5,000 bins for composting by 2,500 households along with TA	39,540†	Big C, etc.
5. Seeds2Sustain: 10 kilns for making charcoal from organics⁑	4,680	Local Shop
Subtotal for Investment (53.2% of city demo package total)	***173,920***	---
Grand Total	**326,667**	**---**

**Figures in this table use 1 USD=30 THB. Contract size based on actual exchange rate was USD312,788, though USD326,667, the planned amount, is what is reflected in this table.

*Provider information was given to the TE Team on a per demo basis (without breaking down the providers by TA and investment for the demo). BMC was usually listed along with equipment providers when equipment purchase was accompanied by TA. We have done our best to dissect who did what, assuming that BMC in most cases did the TA and the equipment provider simply provided the equipment. For more complex equipment, however, especially the wastewater treatment equipment, the provider may have assisted with site assessment and is also listed under TA.

‡Includes site assessments of other potential demos that, in the end, were not adopted: organic waste management at Bang Makarm, Bangkok Airways, Lamai School.

⁑Includes equipment training and two years operation and maintenance service

†Includes compost training for households and raising awareness through radio broadcasting. (Strictly speaking this should have been included in TA, as the "equipment training" was not provided by the equipment seller, and awareness raising is a TA activity.)

4.4 Khon Kaen Demo Results

The demo initiatives of KK have the strength of presenting a mix across three sectors of work highly relevant to the municipality. Exhibit 14 shows the KK demos organized by sector, with comments on

Exhibit 14. Summary of Khon Kaen Demo Work

<table>
<tr><th>Solar PV systems</th><th colspan="2">Waste Management</th><th>Transport</th></tr>
<tr><td rowspan="2">2. Fresh market rooftop PV – 12.3 kW
3. Wastewater plant ground-based PV – 12.3 kW
(provision of PV systems and design for expansion. GHG ERs achieved by replacement of grid electricity)
Both 100% grant. Very few such systems in city. These are the first owned by city. Potential for expansion of over 10x of first system through BOT with private sector company. Need going forward is to promote replication via more commercial models like this.</td><td>4. Organic waste learning center - expansion to 10 ton per day capacity (provision of equipment to treat more organic waste per day; GHG ERs achieved by increased organic waste treatment compared to baseline): New, less labor intensive equipment, operating at average 2.2 ton per day, though baseline unclear. Need to achieve steady, expanded 10 ton per day waste supply.</td><td>5. Non-organic waste sorting centers added and HH training expanded (provision of bins and training to increase size of existing city program; GHG ERs via decreased energy use in industry expected from greater reuse and recycling): Added 50 waste sorting centers at government offices (73 already existed). HH training expanded. Both part of city's larger 3R program. Incremental impact unclear.</td><td rowspan="2">1. Study package to support light rail (LR) (No immediate GHG ERs expected, but may contribute to future GHG ERs from improved public transport)
<u>5a. Feeder study</u> – for trams or songthaew to feed into proposed LR.
<u>5b. TOD study</u> – as mandated at national level: real estate/ business development (stores, etc.) around LR stations to achieve economic viability of LR.
<u>Status and need</u>: KK held bidding for its LR and in Jan. 2020 selected CKKM Joint Venture (with Thai and Chinese investment) to construct rail and TOD real estate, was well as operate rail. CKKM is now working to secure funding for project. LCC needs to ensure studies are in the hands of CKKM and decision-makers.</td></tr>
<tr><td colspan="2">6. KK WTE MRV – not a demo (no GHG ERs achieved, this work is focused on estimating the GHG ERs of the existing WTE plant) as did not aim for increased GHG ERs; should be considered part of LCC MRV work instead. WTE has negative GHG ERs due to substantial waste burning not linked to power generation. Yet, good learning on role of plastic in WTE GHG ERs and the revealed negative GHG ERs. Both can be used to educate KK and other cities on the ins and outs of WTE projects. There may be room to influence city policy in these areas as well.</td></tr>
</table>

meaningfulness, concerns, and/ or follow up needs. The two solar PV demos are notable because the city has few such solar installations. Full 100% grant, such as used to finance these, is not preferred, given the need to stimulate economically viable models. Yet, it looks like this initial experience may lead to BOT expansion of the PV systems by many times as next steps. Work in the waste sector is difficult to assess, due to lack of baseline information and, in the case of inorganic waste, lack of differentiation from the larger city program into which it is integrated. As for the learning center, which received equipment from LCC to expand its capacity for processing organic waste, more work is needed to ensure a larger daily waste input stream. Expanding its roughly 2.2 tons per day stream of organic waste input to utilize the full 10 tons capacity facilitated by *LCC* would yield attractive results. Claims of the KK WTE as a project demo seem ill-founded, as the *LCC* did not support increased GHG ERs at the plant and was not involved in its initial development. The private sector signed an agreement with the city in August 2011 to build the WTE and signed a power purchase agreement (PPA) in October 2013 with PEA. It turns out the plant started having negative GHG ERs in 2019. This is because it is now accepting waste from other cities and, with waste now far beyond the capacity of the generators, is burning half of its waste without linked power generation. Lack of transparency both on attribution of the KK WTE plant and on the negative GHG ERs of the plant are quite concerning. The project claims attribution for positive GHG ERs from KK WTE of 96,007 tons by EOP (66.6% of total EOP ERs claimed by project across all demos) and 408,110 tons lifetime (64.1% of total lifetime direct ERs claimed by project across all demos). Yet, the experience provides important lessons, both on the challenges of WTEs that can be shared with KK and other cities and on the need to ensure project implementers understand attribution and attach high priority to transparency. Finally, a two-part study related to KK's planned light rail (LR) could make good

contributions to this high profile initiative of the city. It should be ensured the study is in the right hands and properly followed up upon to maximize the potential that it will be used. And, work should be done to ensure the TOD buildings are low carbon. The Khon Kaen demo work was facilitated by Khon Kaen University, which held a subcontract covering both facilitation and the cost of all the demos in the city.

Demo 1. Feeder Study and TOD Study for Khon Kaen Light Rail:

Background: *LCC* provided a two-part study package to advance the progress of the Khon Kaen Light Rail (LR) Project, a major initiative of the city. The KK LR Phase I is envisioned to be a 22.6 km system with 16 stations, expanding by 3.5 km and 5 stations in Phase II. Originally, in 2012, the national government proposed a BRT system for Khon Kaen, but in 2015, the municipal government proposed converting this into a light rail, as part of its Smart City Plan. The LR plan was also justified by Khon Kaen's potential future as an international rail hub for the region with train links to China, Laos, Vietnam, and Myanmar. The KK LR concept was approved in 2016 by the national government, which also provided funds for a feasibility study, completed in early 2018. In 2017, Khon Kaen set up the company Khon Kaen Transit System (KKTS, owned by Khon Kaen and 5 neighboring cities, which the LRT will run through) to be the LR project proponent. In 2019, Ministry of Transport announced that Khon Kaen would be one of three pilot cities for transit oriented development (TOD), which is the development of real estate (shops, offices etc.), near to transit stations. More recently, in January 2020, the winning bidder for the construction of the LR and TOD real estate was selected. The winning bidder is CKKM Joint Venture, which includes both Thai and Chinese investors, and is now working to secure financing. CKKM won both the construction package, which covers the construction of the light rail and TOD real estate development (to be carried out over 3 years) and operation of the light rail. The agreement with CKKM, however, is not yet binding and still pending negotiations on payments to the bidder. It is reported that profit from the development of the area around the station (TOD) will be used to support the LR and fund other infrastructure projects in the city.

By setting up a company (KKTS) and working to fund the LR through the private sector, KK has developed a model called the "Khon Kaen" model, whereby the municipality bypasses the central government, finding funding in other ways. KK has been advised in this process by Khon Kaen Think Tank (KKTT, now Khon Kaen City Development Co.), a nonprofit group of concerned business persons advising the City. The cost of the rail line alone (not including developing of surrounding real estate as envisioned by TOD), is 22 billion THB, or about USD700 million.

Feeder study: The first of the two-part study package supported by *LCC* is a feeder study that assesses and makes recommendations on public transport lines feeding into the LR. According to one source, the feeder study builds on the original BRT routes proposed in the 2014 national-level work, converting the six BRT routes into tram routes that instead feed the light rail. Another source, in contrast, indicates the feeder study focuses on using the songthaew (pick-up trucks converted to short haul mini-bus type transport) for the feeder routes, partly to achieve buy-in from and protect the livelihoods of the songthaew owners. We guess that perhaps both trams and songthaews, or a combination of the two, are being considered. Relatedly, KKTT is working with KKU and KK Technical College on developing EV trams for this feeder system, starting with an electric tram donated by Japanese sister city, Hiroshima. Input suggests the feeder study developed by the LCC project is "helpful."

TOD study: The second part of the two-part study package supported by LCC is a transit-oriented development (TOD) study for the KK LR. The purpose of the TOD study is to look at how real estate development around rail stations can occur both to increase the vibrancy of these areas and generate revenues to support the rail system. The TOD approach is considered an important part of making the light rail effort economically viable. LCC's *TOD* study collected data about the areas around the future LR stations and proposed how the areas could be developed to attract more ridership. It has been

suggested to the TE Team that LCC's *TOD* study for the LR project in an important component to achieving the "KK model," in which such a major project is potentially funded without central government support. The *TOD* study also included an assessment of potential GHG ERs associated with the rail project. According to feedback from one source, the TOD study is not yet in the hands of the winning construction bidder, CKKM Joint Venture. If true, this seems odd, as the bid is said to include both the rail lines and the surrounding real estate development. The project reportedly has plans to submit this study and the feeder study to KK City, but this has not happened yet.

Possible way forward: It's not clear at this point whether the winning bidder will be able to secure funding and a successful deal will be negotiated between the city and them. In past years, the project was also looking towards funding from China, but those plans fell through. Yet, closely involved sources seem optimistic and state that the project has been progressing steadily forward to more and more advanced stages, never before having reached the bidding stage. To ensure that the TOD work and feeder work are put to good use, *LCC* should assure that the two reports are in the hands of the winning bidder. Further support by UNDP, should the LR project go forward, might focus on policy to encourage ridership and discourage private cars, continued enhancement of feeder network, and emphasis on ensuring that the TOD real estate investments adopt low carbon building design and installation. At the same time, UNDP may want to have some discussions with experts and investors or commission a study to better understand the viability of the project and its potential to be realized before getting involved in a big way.

Demos 2-3. Solar PV Systems at Fresh Market and at Wastewater Treatment Plant: *LCC*'s solar PV system work in KK is considered especially meaningful, because previously there were reportedly only one or two systems in the private sector in KK and none in the public sector. And the two small projects, while both funded with 100% grant from *LCC*, have stimulated serious discussions between the city and a potential "BOT" PV leasing partner for expansion of the systems by many times.

Each of the two solar systems, one on the roof of the Fresh Market and one ground-based installation at a wastewater treatment plant, is comprised of 40 panels and is 12.3 kW, for a total of 24.6 kW for the two systems. The *LCC*-provided feasibility studies for these projects include not only the 40 panel scope of each, but also design for potential expansion to become much larger systems. The city has found a potential private sector partner for expansion of the Fresh Market system by 15 times the scale of the installation supported by *LCC*. The addition would include 600 more panels for an added total of 186 kW. The city and the potential private sector partner have discussed a deal whereby the company will install the system, paying up-front costs and supplying electricity, which the city will pay for over five or so years, depending on what period is negotiated. After that, the system would be transferred to city ownership. Sources suggest this potential deal with the company is a direct result of *LCC*'s contribution, as the initial solar system helped the city understand power generated and costs of such systems. The city and the company are discussing a similar deal for expansion of the *LCC*-funded solar system at the wastewater plant. At present, the vendors in the Fresh Market still pay the full price of electricity they use, though there has been some discussion of whether, with a larger system, savings might be passed on to users. For now, benefits of this 100% grant solar PV system accrue to the city.

GHG ERs: For these completely new systems, the MRV consultancy estimates annual direct GHG ERs of 11 t CO2eq for each, EOP ERs of 23 t (fish market) and 22 t (wastewater plant), and lifetime GHG ERs of 277 t and 264 t, respectively.

Possible way forward: Considering that distributed solar PV systems are reportedly very new to KK, but now reaching costs low enough to make them economically competitive, the city and UNDP can promote additional replication by promoting the cost analysis of such systems, along with basic technical information. "BOT" models, such as the city is considering with the private sector company, could also

be promoted. Lastly, "solar audits," simple feasibility studies, and design support could be provided to stimulate owners of large buildings to move forward investing in such systems.

Demo 4. Incremental support for organic waste management by city at its Self-Sufficiency Organic Waste Management Learning Center: *LCC* supported the renovation and equipping of KK's pre-existing Self-Sufficiency Organic Waste Management Learning Center, the only one such site receiving waste from all over the city. Prior to this support, it is said that KK was treating 5-6 tons organic waste per day, with labor intensive processes, and distributed among communities, households, schools, and temples, as well as farmer sites to which sorted organic wastes from restaurants and fresh markets was sent. Most of this waste, via composting, was converted to soil conditioner. The project provided the Learning Center with a wood chipper, tractor, and compost turner, which would allow the center to process 10 tons of separated organic waste per day. In addition, 23 containers for making bio-fermented liquid were given to the Center by *LCC* and 27 more were distributed to communities involved in the city's organic waste management program. MRV for this demo indicates an installation date of Jan. 1, 2018, which is nine months prior to *LCC*'s city demo contracts being issued and unlikely to correspond to when the new equipment was installed at the learning center. It further indicates average annual waste treatment of 798 tons, which is about 2.2 tons daily. A challenge is that baseline values of waste treated at the site are unavailable, so whether an increment above baseline was achieved at the site is unclear. Certainly, the site is far from utilizing its newly acquired 10 tons per day capacity. This may be partly due to Covid, but it could also be due to challenges in ramping up organic waste supply. The demo's strength is reducing the degree of human labor required. For example, the wood chipper crushes tree branches into small particles, instead of requiring that they be broken into piece by hand before being deposited in the compost bin. The center now makes both soil conditioner and bio-fermented liquid, the latter which can be used as animal feed. Project reporting indicates that 32 businesses, shops, and markets have formed a network and expressed their interest in submitting sorted organic waste to the center. Yet, the TE Team does not have information on the volume of organic waste expected to be submitted daily by this network. Lastly, it is worth noting that the Learning Center is structured to have guests and teach others about organic waste management.

GHG ERs: The MRV Consultancy includes the full 2.2 tons per day treated at the Learning Center in its GHG ER estimates, assuming Jan. 1, 2018 as the starting date. Thus, no baseline is subtracted out. Without further information on the baseline and whether it was surpassed, we suggest the incremental GHG ERs, both EOP and lifetime be assessed as zero or NA. If there is information on the baseline, the date the new equipment was installed, and information on a ramp-up after installation and pre-Covid, that information may help generate better EOP incremental estimates and a better estimate of lifetime emissions assuming a post-Covid recovery to post-equipment installation, but pre-Covid levels.

Possible way forward: As the Center is now just processing 2.2 tons a day and the equipment installed should allow 10 tons per day, it is important that steps be taken by the city to increase the waste supply as the impact of the Covid pandemic recedes. This may build on the network of 32 potential suppliers that have expressed interested in providing their waste to the Center. Further, it should be ensured that the Learning Center is indeed utilized for learning and has a steady stream of guests that may cooperate with it or start their own efforts. The city should further determine how much of its estimated total of 150 tons of waste per day is organic waste and, based on the experience of the Center, plan accordingly as to whether more such centers with significant capacity (e.g. 10 tons per day) should be set up or if a central biogas digester would make more sense.

Demo 5. Incremental support for inorganic waste management by city and joint training with city on waste management for households: The *LCC* project helped build on the city's pre-existing program for sorting inorganic waste. It did this by increasing the number of inorganic waste sorting stations and also by training citizens in waste sorting. Prior to *LCC* intervention, the city had 73 points within

government organizations at which waste could be separated into hazardous waste or general waste by the provision of two bins at each site. The *LCC* project added 50 points also within government organizations and of the same scale, though each had three bins, one for each of recyclable items, hazardous waste, and general (non-recyclable and non-hazardous) waste. The 50 stations set up by the *LCC* project began operation in June 2019. The 73+50=123 stations are a part of the city's broader 3R Program ("reduce, reuse, recycle"). The program is comprised of "waste cooperative, waste charity, public campaign, and trainings." As a part of this, *LCC* and the city provided training to 2,000 households on composting, recycling, and how to minimize waste. Sources note that, while there were 633 tons of waste recycled through the 3R Program in 2018-2020, or an average of 211 tons/ year, there was an upward trend, so that 302 tons of recycled waste are expected in 2021. Also, membership of the 3R program was about 1,000 households in 2019 and expanded to 2,000 households in 2021.

GHG ERs: Unfortunately, the GHG ER calculations provided by the MRV consultancy do not separate increment from baseline and begin calculations from Jan. 2018, though the waste separation sites supported by *LCC* were installed in June 2019. Further, if we understand correctly, the calculations are for the city's entire 3R program, not just the parts in which *LCC* was involved. With the information available, it is impossible to make even a rough calculation of the incremental contribution of the project to GHG ERs associated with the KK 3R Program. Thus, while it is likely that some increment in GHG ERs was achieved by *LCC* contributions, we must conclude it is indeterminable.

KK Existing and Future WTE Plant – GHG ER MRV and Advising: As a part of the KK "demo package," KKU provided services towards GHG ER estimates for the existing KK WTE plant. This is a 6 MW plant, providing 4.5 MW to the grid and 1.5 MW for self-use. The power plant's combustion capacity is 219,000 tons of waste per year. For this work, KKU interviewed the WTE plant about processes, including waste input, electricity generation, and equipment. And, KKU together with the MRV consultancy, reportedly provided a tracking system via which KKU performed monthly analysis. KKU noticed in its calculations that high plastic content in the WTE waste stream was initially leading to much lower GHG ERs than would be obtained with a lower share of plastics in the waste stream. They found that, by T-VER methodology, for example, based on the tonnage of waste into the plant between Oct. 2016 and Dec. 2018, a composition of 23.4% plastic would yield 12,206 t per year GHG ERs, while a slightly lower plastic content of 20.34% (which was eventually achieved in 2020) would yield GHG ERS of 28,248 t per year. Thus, the KK Team advised the city of the GHG ER benefits of reducing share of plastic in the WTE plant's waste stream. The situation is challenging, as the plant might benefit from higher plastic share in terms of heat and therefore electricity generated. In the end, both because of the 3R Program and trends in the waste stream, KK achieved the indicated reduction in share of plastic in the waste stream.

Yet, starting in 2019, another problem arose in terms of GHG ERs. The plant began to accept waste from other cities, as it could get paid to accept this waste. Then, as the waste was roughly double the waste that could be accommodated by its power generators, the plant burned half the waste without using it to generate power. The effect on GHG ERs is that they became negative. Given the situation with the PPA, it reportedly does not seem that an easy fix is increasing power generation. The city has been planning a second WTE at another site where a PPA for more power would be more suitable. In this regard, KKU and the project team have educated the city about the negative GHG ER problem and urged them to ensure waste at the new site is not burned without power generation. It is believed that the city's awareness has been raised by this experience, though it may take several years before the next WTE plant comes online. And, the second plant, like the first one, is likely to be contracted out to a private party, over which the city may not have much control. Nevertheless, the TA's identifying the negative GHG ERs of the first KK WTE plant and educating the city about this problem vis-à-vis recommendations for the second plant is considered an important contribution of *LCC*.

GHG ERs and attribution: There has been significant exchange between the TE Team and the *LCC Project* regarding GHG ERs associated with the KK WTE plant. The most significant in terms of "bottom line" is that the KK WTE simply cannot be attributed to the LCC project, nor did the LCC project provide any support that resulted in additional, incremental GHG ERs. Thus, LCC really should not be claiming GHG ERs associated with the KK WTE. And, the KK WTE's GHG ERs are negative anyway, so LCC should probably not want to claim those GHG ERs.

At present, the project is reporting a start date for its claimed GHG ERs from KK WTE plant of Nov. 1, 2016, which is some months before the *LCC Project* was launched in April 2017, its inception workshop in Jan. 2018, or the signing of contracts with the KK demo team in Sept. 2018. Annual GHG ERs of 20,405 t CO2eq are reported for the plant, 96,007 t by EOP, and 408,110 t lifetime. These are all large shares of the totals across all demos claimed by the LCC. For example, the lifetime GHG ERs claimed for the KK WTE plant are 64.1% of total lifetime GHG ERs claimed. There are a few very important issues here that are quite concerning and the basis for lessons learned:

1. Negative GHG ERs not transparently reported in MRV or LCC's project reporting – instead, KK WTE is reported as largest single demo in terms of GHG ERs, accounting for 64% of total direct lifetime GHG ERs claimed by LCC: As noted, the KK WTE has had negative GHG ERs since 2019 due to burning of waste at the site that is not used in power generation. We estimate that this change in situation leads to an estimated -99,750 t CO2eq by EOP and -791,454 t CO2eq lifetime GHG ERs, quite the opposite of the low carbon aim of LCC. The problem of negative GHG ERs is recognized by the team most closely involved with the plant, as within the KK demo package, a local USD33,000 consultancy to look at MRV of the plant and advise the government accordingly was commissioned. Yet, this information of negative GHG ERs is not reflected in the GHG ERs reported by the overall MRV consultancy, nor is it reported in the PIRs and it was also not reported to the RTA, who, evidence shows, took a strong interest in the project's claimed GHG ERs. One argument that might be made for not reporting the negative GHG ERs is that the power generation should be treated as one system and the burned waste not used in power generation be treated as another. Yet, since this facility represents one investment, that approach does not seem valid when claiming full attribution. Indeed, GEF guidelines require that the full facility as in a project's logframe be considered in calculating GHG ERs. Another argument raised in discussions to defend the ignoring of the extra waste burning is that the project was told to switch to GEF methodology to "compare apples to apples;" and GEF methodology results in positive emission reductions. Thinking logically, if one methodology is yielding over +408,000 tons lifetime GHG ERs and another is yielding negative GHG ERs of -791,000 t, something is deeply wrong. In fact, it seems that the argument that GEF methodology would not require reporting of the additional waste being burned on site simply because a specific case like this is not mentioned in GEF's EE and RE GHG ER methodology manual appears disingenuous. The manual referred to in defending this approach does not once mention WTE installations at all. As the *LCC* Project hired a specialized MRV consultancy with a contract size of USD290,804 to oversee the MRV of just 24 projects and provide MRV training, it seems that greater care would have been taken with the single largest claimed source of GHG ERs and that this would have been dealt with in an independent third party fashion with a high level of transparency. It seems that more than one important lesson is encompassed in this experience and these may be among the most important lessons of the project.

2. Project claimed the full WTE plant as achievement of the *LCC* project although it appears clear the plant would have been built (and built the same as it was built) had there been no GEF project: Originally, the *LCC* project in its design had planned to support enhancements to the design of the WTE project that would provide incremental GHG ERs. Yet, this was never done, since the WTE plant was commissioned prior to *LCC* project launch. Actually, evidence suggests the design of the WTE was even completed before LCC's ProDoc was submitted to the GEF. Further, it is not just

incremental GHG ERs that are being claimed by LCC, but the entire GHG ERs for the plant (though as above, these were not properly reported either, as they did not include the negative GHG ERs from 2019, 2020, and 2021 or the negative GHG ERs overall by EOP and lifetime). Thus, the TE Team looked into the question of whether the WTE plant would exist in the "no GEF project' scenario, which is a very basic test to determine attribution for GEF projects. The evidence clearly shows that the WTE plan would have existed in the absence of the GEF project. As noted, the agreement between KK and Alliance Clean Energy, the private sector operator, for this WTE was signed in August 2011. This is stated in the 2020 Annual Report of the publicly listed company Absolute Clean Energy, which owns Alliance Clean Energy. Also stated in that Annual Report is that Alliance Clean Energy signed a Power Purchase Agreement with PEA in October of 2013 for the power generated by the KK WTE. PPG Design of the LCC project did not begin until July 2014.

3. Possible incremental GHG ERs due to plastic reduction difficult to attribute to project as plastics reduction attributed to a number of efforts, only some due to project: One idea raised by the TE Team is that if the project was the main reason that the share of plastics had reduced in the waste stream of the plant, that incremental GHG ER benefit might be attributed to the project. In the end, however, it was learned that there are many factors leading to a reduction of plastics in the waste stream of the plant, so it would be hard to attribute the majority of the improvement to the *LCC* project. A good portion of the impact is evolution of trends in product use and disposal, while the city's 3 R program (which has eight components) is also believed to play some role. LCC supported one of these components by expanding the number of inorganic waste disposal and recycling bin stations. Yet, plastics reduction from the whole 3R program (not just the incremental portion) probably just represents less than 1 percent of the plastics waste entering the KK WTE grounds. Further, were this approach to be taken, efforts would need to be made to avoid double counting of the benefit of recycling and the benefit of avoiding plastic in the combustion stream.

Sustainability: The KK demos have different levels of sustainability alluded to above and summarized here. In most cases, as noted, there are potential follow up actions to ensure the impact of the interventions. Due to the low level of effort required to maintain them, the two solar PV installations are potentially the most sustainable. Yet, in terms of broader impact, these installations were 100% grant and what is needed for replication is to ensure more commercial initiatives, such as the city is in discussion with the private sector about, take off. Sustainability of the two waste management initiatives may require more work. In particular, work is needed to ensure the processed waste at the organic station is increased from its current level of 2.2 tons per day to its new capacity of 10 tons per day by securing a steady organic waste stream. After success with this station, the city may consider developing additional ones of the same scale, while at the same time comparing the option to a central biogas digester. The WTE efforts, because they were focused only on MRV, are not considered a true demo and may have best come under Outcome 1.1. Yet, the findings of negative GHG emission reductions and the key role of plastic composition in GHG ERs for WTE plants are important and should be disseminated. KK should be encouraged in its aims to be a smart city to strongly discourage burning of waste that does not go to power generation at WTE sites. This may be incorporated into city policy and the permitting process and might be promoted to other cities as well. Thus, a weakness may be turned to a future advantage. Finally, the sustainability of the feeder study and TOD study for KK light rail may depend on greater promotion of these studies. At present, it appears that CKKM, the winning bidder for construction of the KK LR, whose mandate is said to include surrounding real estate, may not have seen the TOD study. Further, if the LR project does come to fruition, low carbon development of the surrounding real estate in building design and installation should be a priority to complement the low carbon nature of the light rail itself.

Progress toward indicator targets: Our rough estimates of GHG ERs attributed to the project for Khon Kaen demos is included in Exhibit 15. The KK WTE plant is not included, as the main contribution of *LCC* to the plant was MRV and this is not a measure that incrementally increased the GHG ERs.

Exhibit 15. Roughly Estimated GHG ERs from Khon Kaen Demos Attributed to *LCC*

Demo	Comment	EOP Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)	Lifetime Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)
1. Fresh market rooftop PV system (12.3 kW)	Full Demo	23	277
2. Wastewater plant ground-based PV system (12.3 kW)	Full Demo	22	264
3. City Organic Waste Management Learning Center	Incremental	0/ NA‡	0/ NA‡
4. Inorganic waste sorting stations and HH training	Incremental	unknown‡	unknown‡
5. Light Rail Feeder and TOD studies*	Incremental	0	0
Total	**--**	**55 tons**	**541 tons**

‡Lack of evidence that baseline was surpassed. If there were evidence of surpassing baseline in the months of operation post-installation and prior to Covid, this increment could contribute to EOP GHG ERs and also be used to estimate lifetime emissions avoided, with contributions post-Covid. For Learning Center, average organic waste processed since Jan. 1, 2018, is said to be 2.2 tons per day, whereas LCC has assisted in capacity expansion to 10 tons per day. For inorganics, the GHG ERs due to recycled plastic at the additional 50 stations supported by LCC and an estimate of other increase in recycled plastic due directly to project activities should be estimated and disaggregated from overall results of the city's 3R program, which existed before *LCC* was launched.
*Construction of light rail not yet confirmed. Winning bidder, CKKM, is looking for investment.

In terms of number of demos, KK is assessed to have achieved 4 physically operational demos and 5 demos in total. While there are no replications, over 10 times expansion of the fresh market and wastewater plant PV systems seems likely.

Expenditure breakdown: The breakdown of expenditures for KKU's contract for the KK "demo package" is shown in Exhibit 16. The reported expenditures are 45.9% TA and 54.1% investment, whereas the CER breakdown for the demo outcome calls for 80% spending to be investment. We note that the work for the WTE plant is pure MRV and thus should probably have come under Outcome 1.1 or Outcome 2.1. The largest non-project management item is the equipment for the organic waste learning center which, at USD81,500, accounts for 24.9% of costs. Thus, it seems particularly important to ensure that newly realized capacity of 10 tons per day is better leveraged beyond the current level of 2.2 tons per day processing by further attention to supply of organic waste to the center. KKU's service/ facilitation fee, at USD83,333, accounted for 25.5% of the total "demo package" expenditures.

Exhibit 16. Breakdown of Spending under KKU Contract for KK "Demo Package"

Item	Amount (USD)**	Provider*
Technical Assistance (TA) Expenditure Areas	---	---
1. Feeder study for light rail and 7. TOD study for light rail	33,333	SIRDC (Eng'g), KKU
2 GHG MRV for Waste-to-Energy Power Plant	33,333	Prof. Kitirote (Eng'g), KKU
3. Project management by KKU	83,333	COLA, KKU
Subtotal for Technical Assistance (45.9% of city demo package total)	***149,999***	
Investment Expenditure areas	---	---
1. Fresh market solar PV rooftop system (100% grant)	32,310	New Energy Plus, Ltd.
2. Ground-based plant solar system for wastewater plant (100% grant)	33,333	New Energy Plus, Ltd.
3. Equipment for household composting	13,691	Purchase order by KKU
4. Equipment for learning center composting	81,500	Purchase order by KKU
5. Equipment for inorganic waste sorting	15,833	Purchase order by KKU
Subtotal for Investment (54.1% of city demo package total)	***176,667***	---
Grand Total	**326,666**	**---**

**Figures in this table use 1 USD=30 THB. Contract size based on actual exchange rate was USD312,788, though USD326,667, the planned amount, is what is roughly reflected in this table.

4.5 City Demo Results Overall

Relevance: Considering the four city demo packages overall, the team is highly impressed with Outcome 1.2's relevance in that the demo design in many cases fits closely with the needs and interests of the cities and with areas that need outside stimulus in order to reach potential. The main weakness with regard to relevance is that the initiatives typically have low GHG ERs, whereas GEF CCM projects have as a main criteria of approval, potential for the generation of substantial GHG ERs. Still, based on the city needs, the relevance of Outcome 1.2 is rated as satisfactory.

Effectiveness: As for effectiveness, the TE Team is quite challenged in making this rating, as for a low-carbon project, the demos as a set did not strategically pursue GHG ERs and in many cases resulting ERs are low. (Exhibit 17 shows our estimates for GHG ERs across the four sets of city demos.) Yet, at the same time, the project did an outstanding job in achieving mindset change and stimulating meaningful activity across the range of low carbon areas over which cities and their private sector businesses have the most control: waste management, transport, and buildings. Some of these areas, particularly transport, do not yield direct GHG ERs in the early stages of work, but such work is an investment in potentially large amounts of GHG ERs in the future. In general, more than one stakeholder familiar with the Thai situation commented to us that the level of engagement and enthusiasm seen at the city level for *LCC* activities is rarely seen with such development projects. Further, it must be noted that Covid-19 inhibited full achievement of GHG ERs during the last year and a half of the project. Some initiatives, if they are picked up after Covid-19 is no longer having such a major impact, may be able to generate higher lifetime GHG ERs than currently estimated. While, as noted, we do have concerns about the "number of demos" and "number of replications" indicators for Outcome 1.2 as lacking minimum criteria for an acceptable demo, we find that assessing the first of these indicators reflects a strength of Outcome 1.2 -- the diversity and number of different initiatives pursued. Exhibit 18 summarizes results for these two indicators. Based on the various aforementioned strengths of the demos and consideration of Covid-19 impact together outweighing the lack of strategic pursuit of GHG ERs, we rate effectiveness of the outcome as "satisfactory."

Exhibit 17. Roughly Estimated Direct GHG ERs Attributed to *LCC* Demos (Outcome 1.2)

Demo	Comment	EOP Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)	Lifetime Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)
1. Nakhon Ratchasima Demos	GHG ERs for one energy audit generated demo and a PV system improvement need to be added.	3,572+	43,200+
2. Chiang Mai Demo Package	Basis for claimed GHG ERs not clear	0.0	0.0
3. Samui Demo Package	Might be increased if baseline and pre-Covid results of three waste management stations better understood	135 tons	6,560 tons
4. Khon Kaen Demo Package	Might be increased if baseline and pre-Covid results of two waste management demos understood better	55+ tons	541+ tons
Total	**--**	**3,762+**	**50,301+**

Exhibit 18. HERE Outcome 1.2 Indicator Assessment: Number of Demos and Demo Replications
(Based only on Outcome 1.2 demo activities. One additional demo achieved in Outcome 2.1)

City	Number of Demos with Active, Physical Aspect (used in Project Results Framework Assessment)	Number of Other Demos	Total Number of Demos	Replications
1. Nakon Ratchasima	8 ((i) biogas digester enhancement; (ii) water supply pipes enhancement and new pumps for water supply; (iii) implemented building energy audit or other TA recommendations at 6 different buildings – actions include VSD adjustments, new chiller or chiller adjustment, LED lights, PV system or PV system adjustments)	2 (cost of traffic study comparing LR to BRT, and low carbon home guidebook)	10	1 (energy efficient pump for water supply system). Also, likely adoption of gravity based piping system based on learnings from related demo. Possibly, biogas digester adoption and additional VSD work.
2. Chiang Mai	1 (integrated public transport demonstration with consolidation of bus stops and improvement of bus routes; also contributing now or in future are traffic model survey, Smart Mobility Alliance, transport ap, digital payment system)	0	1	0
3. Samui	5 ((i) HH composting; and expansions of: (ii) coconut waste processing center, (iii) organic waste processing station, (iv) organic waste to charcoal station; (v) wastewater plant at fish market)	1 (hotel composting)	6	1 (500 HHs composting on Pha-Ngan Island)
4. Khon Kaen	4 ((i) Fresh market PV, (ii) wastewater plant PV, (iii) organic waste learning center, (iv) inorganic waste sorting stations)	1 (transport study package: feeder study and TOD study)	5	0, but good potential for over 10x expansion of fresh market PV station and wastewater plant PV station with private sector
Total	**18**	**4**	**22**	**2**

Efficiency: A rough breakdown of Outcome 1.2 expenditures is given in Exhibit 18. We rate cost effectiveness of Outcome 1.2 as "satisfactory," given the range of initiatives and progress in meaningful areas. If one considers total expenditures of USD1.7 M, then the average cost of this outcome is USD425,000 per city. Thinking about what a USD425,000 mini-project might achieve in each city (focusing only on the demo packages), the cost seems reasonable. At the same time, we note some concerns and think more physical tangible results (and GHG ERs) might have been achieved with more strategic focus of the USD1.7 million expended on true demonstration: We recommend that future projects of this type ensure the demos have a higher component going into either investment or into TA that directly stimulates investment (such as energy audits, waste audits, RE system design, or system feasibility study). TA costs for workshops, for MRV not associated with real project demos, etc. should not generally be included in the demo component. Further, looking at Outcome 1.2 expenditures overall (see Exhibit 18), in addition to the four demo packages that were in the range of USD315,000 each, for a total of about USD 1.26 M, there was also USD 414,000 attributed to "travels, workshops, project personnel on technical support, supplies, ISS fee, exchange gain/loss." This adds about 33% in TA to the

cost of the demo packages and seems high, considering that the demo outcome was meant to spend 80% of funds on investment. Considering the demo breakdowns between TA and investment and additional TA investment for Outcome 1.2, overall share of TA in the outcome, as shown in Exhibit 18, is 65.6%, whereas the target was to keep TA at 20%.

Exhibit 18. Outcome 1.2 Expenditures by Major Activity Area and Broken down by TA versus Investment

Note 1: INV includes equipment and software; TA includes studies, workshops, knowledge products, etc.
Note 2: TE Team has found that some specific types of TA, such as energy audits, walk through waste audits, feasibility studies, and system design may be even stronger than INV in leveraging GEF funds to stimulate GHG ERs, but workshops, studies, and knowledge product TA, while useful in the long-run, are typically much weaker in this regard. The exception in *LCC* may be the composting training and handbooks for hotels and households in Samui, which appear to have played a role in generating strong physical results.

Item	TA (USD)	INV (USD)	Total (USD)	% INV
1. Nakhon Ratchasima Demo Package	286,416	27,250	***313,666***	8.7%
2. Chiang Mai Demo Package	96,625	218,898	***315,523***	69.4%
3. Samui Demo Package	146,257	166,531*	***312,788***	53.2%
4. Khon Kaen Demo Package	145,815	171,179	***317,553***	54.1%
5. Travels, Workshops, Project personnel on technical support, Supplies, ISS fee, Exchange gain/loss	414,711	---	***414,711***	0%
6. Standard Operating Procedures Preparation	7,627	---	***7,627***	0%
7. Project Assistant	17,076	---	***17,076***	0%
Total (overall)	**1,114,527**	**583,858**	**1,698,944**	**34.4%**

*Samui INV actually includes some TA in it, particularly the household composting reported INV also includes promotion and capacity building.

Sustainability: Rating sustainability is challenging, as the range of demo projects have different levels of potential sustainability. Ideally, the cities and UNDP, if it continues to be involved, can put strong attention on follow up related to sustainability of *LCC*'s various measures to ensure potential impacts are realized. Much of the work is poised to provide greatest benefit post-project if followed up upon. This is particularly true of transport-oriented work, which has not yet generated GHG ERs and in most cases has a long, politically difficult path to follow before substantial achievements are possible. The energy related work (energy efficiency adjustments and installations and renewable energy systems) appears to have the strongest sustainability as only limited follow up work is required and financial benefits are clear. The sustainability of the waste management demos is intermediary between that of transport and energy demos. Many of the small-scale waste demos did not achieve their potential during the project and require follow up attention to securing a sufficient input waste stream. At the same time, equipment is installed and ready to go. Considering the range of demos, sustainability of Outcome 1.2 is rated as Moderately Likely.

5. Outcome 1.1 Results: Planning and MRV

This section reviews Outcome 1.1 results. Outcome 1.1 is the "planning outcome," aiming for the cities to both formulate and implement low carbon plans. The outcome also addresses MRV. The project has one large MRV contract, part of which is allocated to Outcome 1.1 and part allocated to Outcome 2.1. As the majority is allocated to Outcome 1.1, we choose to cover that contract here. The section first reviews the main aspects of the outcome's work: (1) carbon footprints for each city; (2) low emission development strategies ("LEDS") for each city along with targeted incorporation of those LEDS into general city plans

and their subsequent implementation; and (3) MRV focused on GHG ERs of the project demos. Overall for this outcome, the project had three major contracts. One with ERM combining the carbon footprint and LEDS work for three cities: NR, CM, and KK; one with BMC to do the same work for Samui only; and another contract with ERM for MRV, mainly of the project demos. Each contract includes a capacity building aspect, whereby the contractors conduct training on carbon footprint/ LEDS or MRV, respectively, in the relevant city(ies).

5.1 City Carbon Footprint (CCF) Work

As planned, complete city carbon footprints were prepared for each of the four cities by ERM (3 cities) and BMC (Samui only). The TE Team heard that other donors had supported carbon footprint efforts in Thai cities before. In particular, it was reported that GIZ had supported city carbon footprints for 70 cities, so that LCC's work in support of just 4 more was not that innovative, nor did it represent scale-up. While we were not able to verify this GIZ support, TGO's own website indicates that it has prepared a total of 94 full city or province carbon footprints (4 of which are LCC's). (TGO's website indicates that an additional 214 organizational carbon footprints were done, distinct from these full city or full province ones.) In general, GEF projects should target something either more innovative or representing significant scale-up from the baseline. Another question to consider is the unit cost of the LCC carbon footprints as compared to the 90 others done. Given the large number of the other 90 footprints, it is guessed that the cost per city may be relatively low, though this was not verified. As for LCC, it is difficult to disaggregate the cost per footprint, though the consultancy contracts (which covered city carbon footprint, low emission development strategy, and capacity building) ranged in cost from roughly USD64,000 to USD73,000 per city, suggesting a relatively high cost per city. As for previous experience of the specific LCC cities, we understand that for Samui, in 2013, a GHG inventory was developed under the APEC Low-Carbon Model Town (LCMT) Phase 2, though it did not use the same GPC standard[36] that *LCC* does, which is specific to cities/ communities. We were not able to verify any previous support for complete city carbon footprints for the other three LCC cities, though we learned that TGO had previously supported Khon Kaen in developing an "organizational carbon footprint" for the municipal government. In general, we note that donor TA initiatives related to climate change mitigation in Thailand have been around for well over a decade now and have included work with *LCC*'s partner cities. For this reason, the TE Team suggests that future CCM TA supported by UNDP projects be quite specific towards tangible climate change mitigation results, rather than continuing to emphasize general climate change capacity building.

While LCC's city carbon footprint reports follow GPC standards, we wonder if there would be a way to make such work either more actionable or less costly in the future. As it is, it seems the main benefit of these footprints is for cities to understand the size of their total carbon footprint and its breakdown into certain sectors. Based on this info, they might potentially set emission reduction targets and, if they make future progress on emissions reductions, they can see what portion of the total footprint is reduced. More actionable carbon footprints, in contrast, might guide cities to specific measures vis-à-vis total potential reduction in footprint represented by each specific measure combined with an assessment of which measures have win-win benefits of saving the cities money, etc. The LEDS in the case of LCC provides some such suggestions (via its short-term, medium-term, and long-term measures), but not integrated in the same report as the city carbon footprint. And, as for the win-win benefits for cities, with estimates on cost savings and/or return on investment, the carbon abatement cost curves of the LEDS are useful, though may benefit from more specificity (as discussed later in this section).

The LCC city carbon footprint reports break the carbon footprint down into five sectors: energy use, transportation, waste management, industrial process and product use (IPPU), and AFOLU. And, we are

[36] Global Protocol for Community-Scale Greenhouse Gas Emission Inventories

glad to see that these reports break those five sectors down into sub-sectors, to give the cities more insights on their footprints, though think that there may be a way to break the sectors down further or differently into more actionable sub-segments. In the case of KK, for example, the report breaks the footprints down as follows: (1) Stationary energy: residential energy use; energy use in commercial, business and government buildings; energy use in manufacturing and at construction sites; off-grid power generation; grid-connected power generation; energy use in agricultural, forestry and fishery sectors; GHG leakages from the mining, natural gas, and fuel processing; and transportation. (2) Transportation energy uses: land road transport; water; air; and off-road land transport. (3) Waste: landfill in city area; landfill outside city area; bio-composting and bio-digesting in city area; incineration in city area; incineration outside city area; waste water management in city area; waste water management outside city area. (4) IPPU: industrial manufacturing process; consumption of industrial products. (5) AFOLU: livestock; land use and land use change; other emission sources from the ground. In the case of cities, the building energy use, for example, may be interesting to break down further into areas like air conditioning and lighting, whereas the power generation would be of less interest, as it is not controlled at the city level. Or, for reaching out to the private sector in the vicinity of a particular, the manufacturing GHG emissions may be broken down by industrial sector.

Our impression is that the footprint process is not institutionalized in most of the cities and therefore may not be continued without additional donor support. This institutionalization was a target in LCC's Project Results Framework, though we recognize it may be considered a stretch to expect mid-sized cities to develop and finance such capacity on an ongoing basis. What would probably have been more practical and more cost effective would be to target the capability to estimate emission reductions rather than the ability to prepare data-intensive full city carbon footprints. Some cities, namely NR and Samui, seem to have an interest in continuing the CCF or at least the GHG ER estimation work, though it's not clear if that interest will translate into independent action. KK seems the most advanced, being said to have set up a specific team to monitor GHG ERs. In the case of Samui, we understand that a CCF working group was assembled from relevant entities and organizations and that LCC provided CCF training and a workshop to build their technical capacity. Still, it's not clear whether the training in Samui or other cities will result in independent updating of the CCFs by each city, respectively, as intended.

5.2 Low Emission Development Strategies and Incorporation into Mainstream City Plans

With regard to the Low Emission Development Strategies (LEDS), there is also a question of whether previous work had supported the cities in the low carbon planning area. One stakeholder indicated that UNDP had had a previous project with the same four cities as *LCC* was designed to partner with (NR, Samui, KK, and Klaeng) and that, through that project, the city government authorities and technical personnel were provided capacity building on low carbon urban development and low carbon urban development planning. We were not, however, able to confirm this earlier UNDP project and wonder whether what this stakeholder was referring to was indeed a UNDP project or one supported by another donor.

Stakeholder feedback was generally positive about the LEDS process, which involved initial preparation by the consultants and then exchange with city personnel for ranking of measures and revision. We understand that the four cities adopted their LEDS, but the level of incorporation into the general city plans, in which items are budgeted, varied from city to city. In general, while some of the "short-term" items from the LEDS plans may have made it into the general city plans, these items may not have been that innovative or different than what would have been in the plans without the UNDP-GEF project. Specific feedback gathered from stakeholders and our own findings on incorporation of LEDS initiatives into the budgeted city plans are provided below, on a city-by-city basis. These findings mostly confirm

our impression that Outcome 1.2 work did not result in that many new initiatives being incorporated into city plans. Instead, it was more of a capacity building activity that helped city staff understand which of their preexisting planned initiatives are considered low carbon. In the case of NR, however, the impact seems potentially somewhat more significant, given the addition of a new section to the plan.

- NR: Some initial short-term LCC activities were confirmed to be adopted into the 2018-2022 municipal plan. These are a small portion of the total budgeted items in the plan, but they were allocated to a special, new "low carbon city" section of the plan, showing some impact of the project that would perhaps carry over to the planning process in the future, given the newly named section. And, a stakeholder confirmed that at least one item, "solar moat," was newly added to the plan as a result of the LCC LEDS process.
- CM: It is said that integration of LEDS initiatives will need to go through an internal approval process for budgeting and planning. The LEDS work is said to help municipal officials understand what activities are considered low carbon. The officials may need to adjust the name of these activities to be in line with their preexisting planning process
- KK: Feedback suggests it would not be fair to say that the LEDS process got low carbon initiatives newly incorporated into the plan. Instead, it is said LEDS helped the city to prioritize and confirm they were working on low carbon areas including: (a) expansion of transport network, (b) alternative energy, and (c) cluster waste management. These areas had already been adopted in KK's *Smart City Plan*.
- Samui: Samui's LEDS had 16 low carbon measures (LEDS). Feedback indicates Samui Municipality adopted the LEDS and already integrated some low carbon measures within their City Development Plan for 2018-2022 and specifically into the 2021-2022 plan. Yet, that feedback also indicates there are no new LEDS initiatives that were not in the plan before, but that instead the city came to understand how low carbon initiatives were included among measures they were already planning.

The TE Team was impressed and glad to see "marginal cost abatement curves" in the LEDS reports. These curves show, for different types of measures, the total amount of CO2 emissions that might be abated in the city and the cost per ton abatement of the various measures. We believe these curves could be very useful to cities if they are able to understand then well, though in some cases need to incorporate greater specificity among the measures. Indeed, these curves are along the lines of what we are recommending above in the discussion of the city carbon footprints vis-à-vis helping cities understand how much CO2 emission reductions potential are embodied in various measures and the cost savings/ return on investment of various measures. Ideally, a city would be able to look at such a curve and see what both the GHG ER and the financial benefits would be to implementing a specific measure city-wide. As an example of the measures included in the LCC LEDS reports, the KK marginal cost abatement curve in its report includes the following measures (ranked from most cost effective to least): "Measures to increase energy efficiency in electrical equipment, changing to energy-saving lamps, compact tube power, modify indoor LED bulbs, waste sorting by 3Rs principle, walking and cycling, establish a waste sorting center and production of soil conditioners, household organic waste composting, biodiesel production, increasing green space, use gasohol for vehicles, use private trains, use biodiesel for vehicles, electric pole with solar panel lamp, build an electric public transport system, generating electricity from solar energy, establish a public transport system." As an example of how to increase specificity, the first item (which is indicated to be the most cost effective) might highlight measures more specifically such as air conditioners versus other electrical equipment. And for air conditioners, central air conditioners versus room units might be differentiated, as might be various measures (chillers versus VDS) for large building units.

5.3 GHG ER MRV Consultancy

We see both pros and cons of the MRV consultancy, which focused on assessment of GHG ERs of the claimed project demos and also provided GHG ER training. On the one hand, by hiring expert input on the MRV of the 24 claimed demo projects, new insights were gained on those demos for which the MRV was more difficult. While solar PV systems, for example, have relatively easy GHG ER MRV, "say no to plastic bags" GHG ER MRV is more challenging. And, the professional MRV also created a situation in which data was collected periodically from the demos raising confidence that the GHG ERs reflected the real situation and were not just theoretical estimates that might have missed operational problems substantially reducing the true GHG ERs.

At the same time, the project's GHG ER MRV was in many ways extremely weak, which is surprising given that there was a specialized consultancy with a contract of USD290,804 to carry out the MRV and provide capacity building in the area. The main problem with the MRV of the demos is that the two key GEF concepts of attribution of GHG ERs and incrementality of GHG ERs were not applied. Attribution is a key GEF concept and answers the question of whether the intervention and GHG ER achievement would have occurred in the "no project" situation. If the intervention would have occurred in the "no project" situation with no differences, the GHG ERs are not counted towards the project's achievement. Incrementality is also a key GEF concept and asks, for those initiatives that were already in existence prior to the project or otherwise would have occurred anyway in the "no project" situation, whether the GEF project has resulted in increased GHG ERs for the initiative, as compared to the "no project" situation. If so, the GHG ERs attributed to the GEF project would be the "incremental" GHG ERs, calculated by subtracting the baseline (no GEF project) GHG ERs from the total GHG ERs. These GEF concepts of attribution and incrementality are critical to ensuring that GEF project work to achieve real results with donor funds. In their absence, a project could claim credit for things that would have happened without the project, allowing donor funds to be spent without really achieving anything and obfuscating responsibility for this situation.

We consider the shortcomings of the GHG ER MRV work quite serious. It is worth asking why they happened and how they can be prevented in the future. The contractor may have lacked understanding of GEF practices, though the RFP did reference a requirement to get familiar with them.[37] Or, the consultancy may have been assuming it could take direction from the project team as to how to handle attribution and incrementality (and even methodology), and thus did not provide an unbiased third party opinion on these topics that would have been so valuable to the M&E of the project. Finally, other explanations are that language barriers can be a problem or that GEF practices seem illusive and confusing. We do believe that GEF practices can be explained simply, as we have tried to do above with our explanation of "attribution" and "incrementality" with regard to GHG ERs. Yet, it might be useful for UNDP to prepare a brief document (e.g. 5 pages) for team members and MRV consultants that lays out in a clear agreed upon way some of the priorities and approaches for UNDP-GEF CCM projects, particularly with regard to GHG ER attribution and incrementality issues.

As a result of problems with attribution or incrementality, the TE team finds that about 15 of the 24 demo GHG ER assessments cannot be used as provided. And, in the cases with the two largest reported GHG ERs, there are additional problems. (These additional problems are eliminated if one handles attribution properly, but their occurrence is still concerning.) Already, the major example of the Khon Kaen WTE plant has been raised. This plant, with negative GHG ERs is somehow listed as the top contributor to the project's GHG ERs, despite the negative GHG ERs and the fact that the plant cannot be attributed to the project. The additional waste incineration (without power generation) on site was not brought to light in

[37] One of the requirements of the assignment as noted in the RFP is: "Understand project's monitoring and evaluation process and requirements, as per GEF and UNDP protocols."

project reporting, although it began to occur early in 2019. For many other demos, full GHG ERs are listed (often from a date before the project made any contribution) rather than incremental GHG ERs. For example, the GHG ERs from NR's anaerobic digester are computed in full starting from June 2016, whereas the project began April 2017 and did not provide advice to the digester (resulting in some much smaller incremental GHG ERs) until sometime in 2018. And, we also have concern that the MRV consultancy used an annual waste reduction of 13,192 tons per year at the digester, whereas data provided to us on waste going into the digester (and confirmed) is less than 4,000 tons per year. (In the end, this gap is not relevant as the full digester GHG ERs are not attributable to the project, but the major gap and impact on the MRV consultancy computed GHG ERs is concerning in terms of quality control beyond the attribution/ incrementality issues.) The GHG ERs for the three organic waste related stations in Samui, which all had baseline activity before *LCC* provided enhancements, are all reported in full, rather than on an incremental basis. The organic waste station in Khon Kaen, as well as inorganic waste activity there is also reported in full rather than looking at the incremental contributions added by *LCC* to pre-existing entities or programs. For the Chiang Mai transport demo, GHG ERs are claimed to have begun accumulating in October 2018, though the ERs are said to be due to Alliance work in consolidating bus stops and that consolidation was not approved by the province until July 2020, when Covid-19 was already having a major impact on public transport, so that it is unlikely GHG ERs from that time forward were verified. The project also claims attribution/ credit for GHG ERs initiatives to which it only provided MRV, even though those initiatives would have happened without the MRV. (KK WTE is the most prominent example, though there are several others.)

The consultancy has prepared a roughly 700 page document on the GHG ERs. While we did not review in full, we found that for certain demos we had questions about (such as the claimed GHG ERs for Chiang Mai), the document did not provide a clear, simple explanation of its approach to justify the GHG ERs claimed and thus answer our questions about attribution and incrementality. Instead, it seems to cut and paste a lot of background information, but not always explain key points. Also, the contents mostly does not offer page numbers, so the user has to search through the document to find the desired entry. As the point of this expensive MRV is partly to build capacity, a document in which the rationale for attribution/ incrementality and an explanation of methodology for each estimate is clearly laid out and justified in simple language could have been worthwhile.

The consultancy reviewed and checked the work of the demo teams that were also responsible for collecting data. These costs were taken out of the demo budgets rather than the team members being paid by the MRV consultancy budget. As noted, in the case of the KK WTE, a specific local consultancy was commissioned (and taken out of the demo budget).

5.4 Planning/ MRV Outcome Overall

Relevance: We do not find the planning/MRV outcome to have the same striking level of relevance as the project demo outcome does. Indeed, as implied, findings suggest a need to shift to greater specificity and action-orientation (versus report on paper orientation) in CCM-related TA support to achieve relevance. We further suggest that for low carbon planning work (and for all low carbon work, for that matter) to be more relevant, such work should make it a standard practice to emphasize and quantify co-benefits. That is, if the low carbon measures will also save the cities money, this should be emphasized and quantified in the planning work in a way that is clearly understandable to the cities. (The marginal cost abatement curves are a first step, but more user-friendly and measures-specific information in this area of bottom-line co-benefits to cities is needed.) As one stakeholder pointed out, it is difficult to expect cities to adopt low carbon measures simply because they are low carbon. While cities realize that co-benefits are what will make such measures attractive, planning work that delineates and quantifies the co-benefits would add real value to the planning and prioritization process. MRV work is also relevant and

needed, though to be truly relevant it should come with clear, easily followed explanations. Given shortcomings we rate Outcome 1.1's relevance as moderately satisfactory, because it is useful for cities to know the magnitude of their total carbon footprint, understand which of their pre-existing initiatives may be considered low-carbon, and be exposed to their marginal cost abatement curve. And, the GHG ER MRV simply needed to be done.

Effectiveness: In some ways, aside from the attribution and incrementality issues of the MRV, it can be said that all three aspects of this outcome did much of what they set out to do. The carbon footprints were done according to guidelines and provided each city with the benefit of knowing the number associated with their annual carbon emissions, broken down into five sectors and into finer subsectors, and projected into the future. The LEDS plans were developed with consultation and identified short-term, medium-term, and long-term measures.

Exhibit 19. Assessment of Indicators Associated with Outcome 1.1

Outcome 1.1 Indicator*	Target and EOP Assessed Value	Comments
No. of cities that have approved and adopted low carbon development plans by ~~2017~~ EOP	Target: 4 Assessed value: 4	While it was indicated that all four cities had approved their LEDS plans, the meaningfulness of adoption is not clear, as LEDS are not required to be implemented
Percentage of participating cities where evidence-based low carbon planning is integrated with normal urban development planning processes by EOP	Target: 100% Assessed value: perhaps 25% (i.e. 1 out of 4 cities)	We did not find clear evidence the LEDS process had been integrated into the normal planning process. We did find that NR had incorporated some LEDS measures into its general plan with a new "low carbon city" section of the plan that may achieve cross-over to future year plans. Feedback gathered on the other cities indicated that the LEDS process helped them see how their pre-existing planned initiatives qualified as low carbon. A key point is that cities do not have a requirement in the future to incorporate LEDS work into their general planning process.
No. of cities which have completed carbon footprints in selected sectors and have institutionalized the process by ~~2018~~ EOP	Target: 4 Assessed value: 1 perhaps	While all four cities have completed carbon footprints prepared by the consultants, it seems unlikely that most of the cities will prepare these on their own in the future. Khon Kaen, however, has set up a specific team to measure GHG ERs. Also, we find a more reasonable target would indeed be for these mid-sized cities to have the capability to assess GHG ERs rather than to prepare full-blown city carbon footprints.

*We've slighting modified two indicators due to delayed start of the project as indicated by strikethrough and red font.

Yet, these initiatives could have been more impactful in terms of stimulating action and follow up to the information and analysis provided. In particular, in the case of some identified areas (such as building equipment), more specific measures could have been assessed for their maximum GHG ER potential and costs of abatement to assist cities in selecting measures. The planning work could have emphasized and provided analysis on the co-benefits of various measures to facilitate planners doing what they must do anyway – weigh the economic and other local benefits of any proposed low carbon measures. And activities could have addressed the city planning process, in addition to the plans themselves. Exhibit 19 shows our rough assessment of the indicators associated with Outcome 1.1. It can be seen that the targets are partially met. The second indicator is challenging to assess as the "integration with normal planning"

may be defined in different ways. We interpret it to mean the planning process has been modified so that future years will also result in evidence-based low carbon planning impacting the general plan rather than a one-time infusion of short-term low carbon measures (that may be similar to what is already in the plan). Thus, we assess the associated indicator target not to have been achieved. Based on all of the foregoing in this paragraph, we rate effectiveness of Outcome 1.2 as moderately satisfactory.

Efficiency: Exhibit 20 shows the expenditures associated with Outcome 1.2. It is noted that the full MRV consultancy amount is split between Outcomes 1.2 and 2.1. We find that the MRV (total expenses around USD 300,000) is quite expensive given that the results are not satisfactory in terms of attribution, transparency, and incrementality required for assessment of GHG ERs of GEF projects. Extensive additional work, some of which has been carried out by the TE Team, would be needed to provide transparent results that truly reflect the contributions of the project. Carbon footprint and LEDS (total cost USD276,086 or about USD69,000 per city) also seem quite expensive as the main result is capacity building on carbon footprint and planning rather than long-term change in the planning process or substantial new, low carbon projects being implemented. If one looks at the overall expenditures of this outcome to date, USD531,316, and adds in the USD85,907 of the MRV consultancy expenditures allocated to Outcome 2.1, it can be seen that total costs for the footprint, LEDS, and GHG ER MRV work are USD617,223. It seems like this is not a strong value for money, considering the main results are that: (i) cities know their total GHG emissions and emissions in each of five broad sectors and their sub-sectors; (ii) city staff have more awareness about CCM and which of their measures can be considered low carbon; (iii) GHG ERs for LCC were estimated, but major work must be done due to the attribution and incrementality errors. We thus rate cost effectiveness of this outcome as only moderately satisfactory.

Exhibit 20. Outcome 1.1 Expenditures by Major Area

Note: Total MRV expenditures (aside from those included in Demo Outcome, Outcome 1.2) are USD304,091, as part of ERM MRV contract is included in Outcome 2.1.

Item	Expenditure
Samui Carbon Footprint and LEDS with capacity building (Bright Consulting Contract)	69,196
Carbon Footprint and LEDS, with capacity building for CM, KK, and NR (ERM contract)	183,348
Stakeholder Engagement to support integration of LEDS in the 4 cities (IC contract)	23,541
CCF and LEDS subtotal	***276,086***
MRV framework, assuring GHG ERs achieved in partner cities, MRV training (ERM contract) – total ERM contract for MRV is USD290,804, actual expenditures to date are USE254,557	168,650
International Technical Advisor (MRV focus; IC contract)	24,767
MRV subtotal (including Outcome 2.1 part of ERM contract it would be USD304,091 instead)	***193,417***
Re-assessment of partner city needs (National Institute of Development Administration contract)	27,705
Local technical support in Chiang Mai	5,637
Travels, Workshops, Supplies, ISS fee, Exchange gain/loss	28,471
Other subtotal	***61,813***
Total Expenditures for Outcome 1.2	**531,316**
Additional expenditures on ERM GHG ER MRV consultancy allocated to Outcome 2.1	85,907
Total Expenditures for CCF, LEDS, and MRV including all Outcome 1.1 expenses and the above line item from Outcome 2.1	**617,223**

Sustainability: We rate sustainability of Outcome 1.1 as moderately unlikely. Evidence suggests most of the cities will probably not continue to prepare carbon footprints, nor are they likely to continue to prepare low carbon plans (though NR might continue to include a low carbon section in future plans). As for MRV, the skills to assess GHG ERs do not appear to have been transferred at a significant level to most of the cities, though Khon Kaen may be the exception with its setting up of a team for the purpose of GHG ER estimation. The problems with attribution and incrementality suggest these basic skills to guide development projects to real results have not been gained by the implementers.

6. Outcome 2.1 Results: Financing/ Investment and Capacity Building

This section reviews Outcome 2.1 results. Based on the component title and outcome statement, Outcome 2.1 is the "financing/ investment outcome," aiming to develop financing mechanisms/ channels and stimulate increased investments in low carbon city initiatives. Yet, a review of the outputs as designed and detailed activity descriptions in the design shows that significant capacity building and awareness work is also considered a part of this outcome, perhaps with the intention that they be ingredients to mobilize investment. This section first reviews the main aspects of the outcome's work: (1) financing mechanism and mobilization of investment; (2) capacity building and knowledge products; and (3) awareness. Overall for this outcome, the project had three major contracts, all with Chulalongkorn University, in the area of curriculum and knowledge products. It also has a significant planned expenditure for the final project conference and the final project report, which may be considered awareness building activities.

6.1 Financing Mechanism and Mobilization of Investment

The TE Team finds that the project in implementation decided not to follow up on key aspects of the design of Outcome 2.1. The original design proposes an analysis of existing and forthcoming financing mechanisms, especially carbon offset ones and particularly the establishment of a Thai Voluntary Scheme (though such a scheme was already established at the time of ProDoc submission). It further calls for the development of financial incentives and institutional arrangements to replicate low-carbon development. The project implementers suggest these targets (which were outputs in the design) had already been met by the establishment of T-VER and LESS and thus were unnecessary. What's strange is that T-VER had been developed in 2014, so it seems that ProDoc designers would have been aware of this, which was achieved prior to ProDoc submission, and therefore we might guess they still felt it would be useful to assess incentive mechanisms and work on their establishment of new ones. (On the other hand, this could be a case, as with the KK WTE, where not enough diligence was done in design to understand the real situation on the ground.) Based on consultations, the TE Team found that lack of funding for low carbon initiatives at the city level is indeed still a problem. Stakeholders suggest that access to low interest loans, for example, could be useful to private companies in the public transport sector that currently lack access to such loans. It was also noted by a stakeholder that grants or loans from funds set up at the national level tend not to make their way down to the city level in an effective way and that it would thus be best to set up low carbon funds at the municipal level. There are a number of ideas that *LCC* might have pursued in this regard, despite the limited GEF funds available. It may have set aside some funds for a competition to fund feasibility and/or detailed design of low carbon projects or to provide an incentive grant to them (e.g. 10 to 20% of total cost of the respective low carbon project). The TE Team suggests that focusing only on carbon offset schemes / carbon credits to stimulate low carbon investment is risky and does not leverage the full realm of possibility. At present, there is not a unified international market for carbon and has not been since the days when the carbon price under CDM hit bottom. Instead, the price varies from one national system to another, because most of the domestic carbon markets are not connected with one another, though Thailand has made some progress in connection with schemes in two other countries.

In the end, what the project did instead of developing new schemes or enhancing existing ones was work in promoting TGO's existing T-VER and LESS schemes to potential implementers of low carbon projects. LCC helped project demos and other initiatives register for T-VER credits. This appears to have been mostly facilitated by the city demo teams, with support from the MRV consultancy to verify estimates of expected GHG ERs. The most notable example is Central Plaza in NR, which has installed an almost 1 MW rooftop PV system with expected lifetime GHG ERs of 21,730 tons. The project was

initiated by the department store and Ministry of Energy. Central Pattana, the owner of the building, has since invested in 13 additional rooftop systems at other of its properties. These have an aggregate capacity of over 12.1 MW. Central Pattana registered these with T-VER as well, building on help it got from the project in NR. The TE team received mixed information on attribution of these. Some claimed that the 13 systems could be attributed to the UNDP project, maintaining that Central Pattana decided to install them mainly for the purpose of getting T-VER credits after being trained in T-VER by *LCC*. Yet, our assessment based on what is available to us, is that *LCC*'s contribution was not the determining factor, though may have been a contributor. Another example of T-VER support provided by the project is that to CP-ALL, which invested in PV systems on five of its distribution centers and then moved to leasing arrangements to get PV systems put on its 13 other distribution centers, which have similar design to the first five buildings.

The TE Team was also told that *LCC* supported travel of TGO to various provinces to help develop T-VER and LESS projects in the waste and energy areas, for which 115,422 t (T-VER) and 6,233 t (LESS) of GHG ERs by EOP were reported and attributed (in the project's self-assessment of indicators) to *LCC*. Interestingly, the majority of these projects are in the waste management area and may reflect some learnings from *LCC*. Yet, the TE Team suggests that MRV work/ T-VER registration alone is usually not enough to attribute these GHG ERs to the project. While TGO is said to have been successful in many of these cases in introducing measures that would not have happened otherwise, the TE Team does not have information or access to verify this and notes that if *LCC* was simply paying travel expenses for TGO, the link to the project for attribution purposes is somewhat tenuous.

6.2 Capacity Building and Knowledge Products

For capacity building and knowledge products, the project retained the Energy Research Institute (ERI) of Chulalongkorn University, with which it has signed three contracts, valued in total at around USD206,000. The ERI team is made up of engineers. While they do not have a background in training, they are interested in human aspects of engineering issues and have picked up good knowledge of capacity building approaches, such as the importance of active learning. Their work has included: preparation of an information package (*Low Carbon City and Resilient City Management for Local Government Organizations*) that initially included four modules covering the importance of climate issues, the estimating of GHG emissions, methods to reduce GHG emissions, and implementation of climate change mitigation plans. They further developed a *Low Carbon City Handbook*, carried out training, trained the trainers on climate policy and climate change adaptation, and expanded the information package to include case studies and lessons from *LCC*'s four partner cities. They are now developing a game and video as a part of their work for the project. TGO has expressed its plans to make use of these materials.

6.3 Awareness

The project has gotten involved in a partnership between UNDP CO and CP-ALL, which owns or franchises all the 7-11 stores in Thailand. CP-ALL had previously conducted a limited "say no to plastic bags campaign" and had the idea to do a bigger campaign, but no specific plan. After discussions with UNDP and the project, CP-ALL decided to go ahead with its nationwide "say no to plastic bags" campaign, which has been carried out at all 17,000+ 7-11s in the country. The campaign, begun in January 2019, is said to have continued to the present. Sources suggest the discussions with UNDP sped up initiation of the campaign by one year, so that one year of GHG ERs as estimated by the project at 8,706 tons CO2eq are attributed to the project.

6.4 Financing/ Investment and Capacity Building Outcome Overall

Relevance: While the need for financing as reflected in the design is highly relevant, the project ignored this mandate to assess and develop financing mechanisms, thus reducing the outcome's relevance. Yet, its promotion of existing schemes, T-VER and LESS, is quite relevant for the future. And, its private sector cooperation with CP-ALL is also relevant in leveraging the private sector channel for promotion of CCM. As noted in our discussion of Outcome 1.1, we suggest that capacity building on CCM, if it is to be continued after so much has been done in the past, be highly tailored to achieving low carbon cities initiatives and investments in them. It appears that the capacity building materials the project undertook to prepare were instead fairly general. Indeed, for the training of trainers, it appears the focus was on climate change adaptation, which is not within the scope of this project's objective. Based on the foregoing, we rate Outcome 2.1's relevance as moderately satisfactory.

Efficacy: Because the project did not really assess existing financing channels nor aim to generate new ones for low carbon initiatives, results in that area are lacking. Yet, there are positive results in expanding T-VER and LESS to more organizations, the development of more capacity building materials (albeit general ones) that will be used by TGO, and engagement of the private sector. We thus rate Outcome 2.1's efficacy as moderately satisfactory. Review of indicator results for this outcome, as shown in Exhibit 21 and explained further below suggest a similar rating.

Exhibit 21. Assessment of Outcome 2.1 Indicators

Outcome 1.1 Indicator*	Target and EOP Assessed Value	Comments
Total amount of new investment leveraged through local plans of participating cities or other activities stimulated by the project (other than the project demos themselves, which are achievements of Outcome 1.2)* for low carbon projects by EOP	Target: USD16 million Assessed value: USD71,169 up to USD34,962,502 (*11,592 spent to date, the rest is budgeted*)	See Exhibit 21a for breakdown and types of projects. One project, the gravity water supply pipeline system for NR, accounts for the majority of possibly included investment in the upper end (USD35 M) case. While the TE Team heard from one source plans for this initiative are due to the project, with such a large budget, we guess that *LCC* has perhaps influenced some aspects of plans for this system that will make it more low carbon (not requiring pumps) but has not really stimulated the whole investment. Thus, the lower end of the range for this indicator (USD71,000) excludes this water supply piping project.
No. of new policies facilitating low carbon investments in cities endorsed and approved by line agencies by EOP†	Target: 2 Assessed value: 0	*LCC* appears to have achieved some policy wins at the local level, but did not pursue national level policies to promote low carbon cities. Interestingly, TGO has indicated plans to promote low-carbon related KPIs for city staff, which is one of the two possible policy targets listed in the relevant footnote for the indicator. According to project design, policies targeted as a part of Outcome 2.1 are national level policies. Local level policies and programs are targeted as a part of Outcome 1.2, the demo outcome.

*Font added in red gives more detail on how we interpreted the indicator.
†The ProDoc offers the following footnote, which implies the indicator references national-level policy: "Policy recommendations are envisaged in the following two areas: 1) inclusion of low carbon investment in the performance evaluations (KPIs) of city staff (cooperation with Ministry of Interior), 2) legal revisions in order that cities are able to receive revenues from carbon credit sales (cooperation with Ministry of Interior)."

Exhibit 21a. Amount of Additional Investment in Low Carbon Initiatives (beyond the Demos) Stimulated Directly by *LCC (in USD)*

Notes: We use a fairly strict attribution criteria to assess which expenditures or budgeted expenditures are due to *LCC*. While the new pipe system with such a large budget is unlikely to be due to LCC, changes to make the system more low carbon are believed to be due to LCC. We thus show this entry in grey, as it is unlikely to have been stimulated by LCC

Low Carbon Initiative	Spent (USD)	Expected with certainty (USD)	Explanation and Totals (USD)
NR Gravity pipe system	---	34,891,333	Inspired by CU study on pipe pressures and elevations: Though item was probably already in budget, *LCC* work is believed to have inspired modification of design plans to go "pumpless" and use gravity-only based on learnings from that work.
NR Water Supply: EE pumps	11,592	---	Inspired by 2 pumps supplied by *LCC*
NR subtotals	***11,592***	***34,902,925***	***Full sub-total for NR: 11,592 - 34,914,517***
CM Coconut waste processing equipment	---	47,985	Inspired by *LCC* exchange in Samui
CM subtotals	***---***	***47,985***	***Full sub-total for CM: 47,985***
Grand Total	**11,592**	**59,577 - 34,950,910**	**Full Total: 71,169 - 34,962,502**

Efficiency: Exhibit 22 shows Outcome 2.2 expenditures by contract or major category. At the bottom of the table we subtract out the portion of the ERM MRV contract budgeted under Outcome 2.1, given that we have assessed MRV in the cost effectiveness analysis for Outcome 1.1. That leaves us with expenditures and expected expenditures of USD457,791 remaining for the outcome. Given that the main achievements are knowledge management, curriculum development, and T-VER and LESS promotion, but that not much progress was made in leveraging new channels of financing for low carbon projects, we believe that this expenditure level is somewhat high and rate cost effectiveness as moderately satisfactory.

Exhibit 22. Outcome 2.2 Expenditures by Major Area as of April 30, 2021

Item	Expenditure
GHG ER MRV (part of same ERM contract as in Outcome 1.1)	85,907
Demo Replication – HH composting on Pha-Ngan Island (contract with BMC) (12,000 expected)	0.0
Training materials and training (3 contracts with Chulalongkorn University)	192,106
Study on private sector engagement in low carbon city (individual consultant)	28,773
Project Final Report (contract with ERM) (46,667 expected)	0
Project Management: contracts for admin and finance consulting staff	7,860
Travels, Workshops, Supplies, Petty cash, ISS fee, Exchange gain/loss	3,052
Total spent roughly to April 30, 2021	***317,698***
Communications – promotional materials and publications	36,000
TGO's sustainable and livable cities (project closing event with 600 persons, June 2021)	130,000
Committed contracts under TGO (replication 12,000, KM, final report 46,667, and others)	160,000
Additional expenditures expected by EOP	***226,000***
Total Expenditures for Outcome 1.2	**543,698**
Subtracting out amount for ERM GHG ER MRV consultancy as it was assessed with Outcome 1.1	-85,907
Total Expenditures for financing mechanism/ investment, capacity building, and awareness after subtracting out the portion of the MRV contract in the line above	**457,791**

Sustainability: Sustainability of what has been achieved under Outcome 2.1 looks positive. The main achievements are in the knowledge product and curriculum area; and TGO has agreed to adopt the materials prepared and use them in its own ongoing training. TGO has also set up a bureau related to cities, which could also play a positive role in sustainability of the training materials. We thus rate sustainability of Outcome 2.1 as Likely.

7. Cross-Cutting Aspects of Results and Miscellaneous Results Topics

This section addresses some cross-cutting aspects related to results and other miscellaneous results topics. It begins by looking at the assessment of the results overall. In this, it brings together the outcome-by-outcome assessments, as well as some impacts that cut across outcomes, and provides overall project ratings, including those on sustainability. It then addresses some miscellaneous cross-cutting topics related to results, including main concerns, GEF additionality, country ownership, and gender.

7.1 Assessment of Results Overall, including Sustainability

Relevance: Based particularly on our findings with regard to the project demos, the TE Team finds *LCC* as implemented relevant. The level of engagement and positivity about the project by city stakeholders is quite high and surpasses that typically found in such projects in Thailand. This is because the demo work focused on those areas that are priorities to the cities. It also took a sector-wise approach in cities rather than a site-by-site approach. And, it supported cooperation between different segments, breaking down silos, such as in the Chiang Mai Smart Mobility Alliance, which brings together private sector and government companies. Relevance of the other outcomes independently in less strong in our view. We would suggest this is because their efforts are somewhat general and thus less differentiated from previous efforts. They might have been more effective by being more focused on how to stimulate specific low carbon initiatives, whether it be through planning, investment, or capacity building. Yet, overall, the project has good relevance and engagement from cities. Thus, the overall relevance rating is satisfactory.

Effectiveness:

Progress towards impacts: At the national level, the greatest impact of *LCC* so far is on TGO, the IP. This is reflected both in actions taken by TGO and plans it has articulated. Through these, it's clear that TGO has become aware of the importance of adding a decentralized approach to achieve GHG ERs to ongoing national-level efforts. Depending on how successful TGO is in following up, that impact on TGO may be leveraged for broader impact both on national policy and on other cities. TGO is planning to encourage MoI to require low carbon KPIs for cities and require low carbon aspects in provincial plans. While this may not be fully attributable to the project, it is likely that the project has had some influence. TGO, for its decentralized work, expects to focus on provincial planning going forward. This may be a good approach, given that metropolitan areas with large populations of up to nearly a million extend beyond the boundaries of the mid-sized cities (with populations of 100,000-plus) the project addresses. Yet, a dual focus on both the provinces and the municipalities, given that certain aspects of the economy are under the latter's purview, is recommended. Possibly influenced by *LCC*, TGO has set up within its organizational structure a Bureau for Low Carbon Cities. And, TGO plans to use the training materials of *LCC* via its TGO Academy (which focuses on training) to carry out training of more cities.

Another cross-cutting impact of LCC is the mindset change and enthusiasm for win-win low carbon growth achieved in the cities. We noted high levels of stakeholder engagement, awareness, and sense of ownership. Clearly the cities learned what carbon footprints and low carbon initiatives really are. Many seem excited to be involved and see the win-win benefits of the demo initiatives, about which they are particularly enthusiastic.

We also see progress towards potential major impacts in some of the demo work that has been done, though in some cases, if realized, this may be a long time in coming. The transport efforts across three of the cities could play a role in future dramatic change if these efforts are followed up upon. In the waste sector, scaling up of initiatives could similarly have a major impact, particularly in the area of organic waste management.

Catalytic/ replication effect: There is evidence among project results of catalytic and replication effects. So far, the most impressive replication effect stimulated by the project has been the household composting in Samui. There, the project added 2,500 households to the existing 750 households that were composting. Eventually, replication reportedly led to an additional 11,750 more households joining in. Now, the total number of households involved in Samui is said to be 15,000. The effort, with project help, was further replicated on nearby Pha-Ngan Island with 500 households. Initiatives in NR also seem to have had some catalytic effects, such as the Water Supply Bureau deciding to pursue a gravity-based pipe system in bringing the water supply into the city from one source, rather than using a pump-based system. Also, the Bureau is buying energy efficient pumps to replicate those the *LCC* project provided to it for pumping in another area. In the transport sector, the "cost of traffic" study for NR appears already to be having a potentially catalytic impact in convincing decision-makers at the national level to move discussions on the BRT versus light rail issue forward not only for NR, but for other cities previously slated for light rail development. And, Chiang Mai's Smart Mobility Alliance brought fixed route bus companies together for the first time and got them to agree to consolidate bus routes – an idea that has been raised before but was never realized until now.

Progress towards objective: The project objective, again, is "Promotion of sustainable urban systems management in Khon Kaen (KK), Nakhon Ratchasima (NR), Samui and Klaeng to achieve low carbon growth," though Klaeng is now replaced with Chiang Mai. Particularly based on demo results, we can say progress has been made towards this objective, with work cutting across the areas of waste management transport, building energy efficiency and renewable energy, and water supply energy and water efficiency. Exhibit 23 shows GHG ERs generated by *LCC* across all outcomes, along with estimated cost of abatement, considering the USD3.15 M investment by GEF and potential replication of two times. Strictly speaking, in the case of *LCC*, GEF ERs were designated as a goal-level indicator. Yet, they are often considered an objective-level indicator for GEF CCM projects in general. And, regardless, they are considered a key indicator of success of GEF CCM projects overall. As noted in the assessment of the demos, GHG ERs are a big weakness of the project, being less than those expected of a project with this level of GEF investment. The project did not seem to strategically aim to stimulate a significant level of GHG ERs through its own activities, but instead sought to claim the GHG ERs of other initiatives that we do not think can be attributed to the project. Our estimate of the level of GHG ERs achieved for the project overall is far less than the values self-assessed by the project. The project claims 269,552 tons CO2eq by EOP, while we estimate an achievement level of just 12,468 tons CO2eq by EOP. The project claims 636,594 tons CO2eq lifetime, whereas we estimate just 59,007 tons CO2eq lifetime. Nevertheless, as shown in Exhibit 23, if it is assumed the project can create an indirect emissions reduction two times its projected direct emissions reduction, the cost of CO2eq per ton to GEF falls a bit below USD20, which, during the CDM era was roughly the peak price reached (2008).

The objective-level indicators for *LCC* include an indicator on each of fuel savings, waste gainfully used, and green jobs created. As with the GHG ER indicator assessment, our findings on these indicators are

much lower than the self-assessed value of the project, due mainly to attribution /incrementality issues (see Annex 1 for summary of indicator assessment comparisons and explanation of gaps). For energy saved due to LCC, our assessment is 18,862 GJ by EOP, whereas the project's self-assessment is 751,167 GJ by EOP, much closer to the target of 788,093 GJ by EOP. As for the indicator on waste gainfully used per year, we estimate 1,372 tpy newly gainfully used, while the project estimates 145,497 tpy, though we are not sure if this latter number includes the baseline of 46,272 tpy. Whether or not it does, the self-assessed achievement is obviously far beyond the TE assessment. At the same time, this indicator statement does not clearly state the waste gainfully used should be attributed to the project, though we wonder how meaningful this indicator would be if it did not require such attribution. As for green jobs, the project claims those generated by the KK WTE plant and EV Tuk in Chiang Mai, for a total of 88 jobs. As noted, the TE Team has determined the WTE plant is not attributable to *LCC*. We also did not have any findings to suggest EV Tuk in Chiang Mai is attributable to LCC. Based on consultations, we were not able to find the instance of a single job confirmed to be attributed to LCC, though discussions suggest there may be some benefits in the future, such as in some of the public transport initiatives, if they come to fruition, particularly the KK LR, given the TOD plans. At the same time, it should be noted that modernized public transport may result in some dislocation for Songthaew drivers, perhaps one reason KK is considering maintaining opportunities for them in its proposed LR feeder routes. Like the waste gainfully used indicator, the green jobs indicator does not stipulate the jobs must be attributed to LCC. Yet, we don't see the usefulness of this indicator if attribution is not required.

Exhibit 23. *LCC* GHG ERs across all Outcomes, along with Cost of Abatement

Demo	Comment	EOP Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)	Lifetime Direct GHG ERs (rough estimates in some cases) (in tons CO2eq)
1. Nakhon Ratchasima Demos	GHG ERs for one energy audit generated demo and a PV system adjustment need to be added in.	3,572+	43,200+
2. Chiang Mai Demo Package	Basis for claimed GHG ERs not clear, though GHG ERs from bus stop consolidation may occur post-project.	0.0	0.0
3. Samui Demo Package	Still lack baseline info on Seeds2Sustain organic waste to charcoal demo, so have not included incremental amount, if any.	135 tons	6,560 tons
4. Khon Kaen Demo Package	Might be increased if baseline and pre-Covid results of two waste management demos understood better	55+ tons	541+ tons
CP-ALL: 7-11 Say No to Bags Campaign	It is said that while CP-ALL would have done this initiative anyway on its own that the *LCC* project got them to start about 1 year earlier	8,706 tons	8,706 tons
Total	**--**	**12,468+**	**59,007+**
Total project costs: USD3.15 M; Cost per ton of lifetime direct GHG ERs = USD53.38 per ton CO2eq			
If we assume 2x replication factor for bottom up indirect GHG ERs and consider both direct and indirect GHG ERs (which would total 177,021 t CO2eq), then cost per ton CO2eq is USD17.79			

Effectiveness rating: Considering the strong and interesting diversity of initiatives in the project's demo outcome, the impacts already achieved, and the potential stimulus to greater change in the long-term in areas like transport, it can be seen that the project has a lot of strengths. Further, the impact of Covid-19 pandemic should be considered along with the possibility that some progress that has been stymied by Covid may again come to life once the pandemic's impact recedes. As one stakeholder told the TE Team, the greatest "harvesting" of project results in the case of *LCC* will come after project close. Thus, despite

the low GHG ERs, and because of the strength of the demo outcome and consideration of the Covid impact combined, we rate the effectiveness of the project overall as satisfactory.

Efficiency: Overall, had greater care been taken and funds more strategically spent, we believe *LCC* could have leveraged its USD3.15 M USD to achieve greater GHG ERs without sacrificing other aspects of its results. In particular, the project demo outcome allocated budget, which is USD1,823,554 in the CER, about 80% of which was to be INV, would best have been wholly focused on demonstration. As it is, the outcome has a lot of activities that might be termed capacity building and even information products. These could have been moved to Outcome 2.1 to make its capacity building more tailored to stimulate low carbon initiatives than the general approach that was taken in the end. If the full USD1,823,554 was allocated to the demos, that would have amounted to USD455,888 per city. If the management fee for those contacts could have been reduced to a lower level, that may have further conserved funds. We note that our findings suggest that demo funds do not necessary need to be focused on equipment only to achieve GHG ERs. In fact, certain kinds of TA, such as energy audits (as seen in the case of the NR demos) may be more successful per dollar in generating GHG ERs than direct purchase of equipment. Other types of TA support that may directly stimulate demonstration include feasibility studies and design of demos. In some GEF projects, competitions have been held where interested applicants apply for support on feasibility studies, design, or perhaps 20 to 25% grant for their projects. Where equipment is supported directly, a way to leverage funds better is indeed to offer only partial support (25% or less) and require the project proponent to fund the rest. As noted, we rated cost effectiveness of the demo outcome as satisfactory, but that of the planning outcome as moderately satisfactory and that of the financing and capacity building outcome as moderately satisfactory as well. Moving the capacity building and information product type TA from the demos to these two outcomes and further enhancing the remaining TA to be more specific and actionable so that it stimulates specific low carbon initiatives would further enhance cost effectiveness.

Another issue related to cost effectiveness is that the project chose to allocate much of the funds to large contracts with organizations. Exhibit 24 below shows the total volume contracted to *LCC*'s top contracting organizations. In total, this value accounts for 67.2% of *LCC*'s total GEF funds. While large contracts with organizations are sometimes warranted, smaller contracts with individuals can often be a lot more cost effective. It should be noted that the contracts for the city demos, each at a value of USD326,667 included not only the contractor's facilitation fee (roughly a quarter of the total), but also the cost of all the demos. Some stakeholders mentioned that it was easier to use this "demo package contractor" model for each city rather than for the project to pay for each of the demos one by one. In some cases, however, much of these "demo" funds went to the contractor or its affiliates, too, as they implemented the demos themselves via TA. (For NR, the proportion of "demo funds" going to the main contractor for services and facilitation combined was 91.3%.)

An additional point on cost effectiveness with regard to these key contractors should be raised. As will be discussed later, it appears that not a lot of attention was put on optimizing competitive bidding for the majority of the eleven contracts covered below. For at least nine of the eleven contracts, there is evidence that the winner faced no other qualified competing bidders, so that these were either "single bid" procurements (six contracts) or "no bid" procurements (the three contracts with ERI, as they were procured by TGO via "government-to-government" mode, which does not require competition). And it is guessed that the other two contracts may have had some elements of "preselection," though at least one is known to have undergone competitive bidding with qualified competitors in a third round. This lack of competition could be related to lack of outreach or a problem that the requirements for qualification are set excessively high or perhaps that potential competitors know there is a "preselection" mentality and don't waste their time on a bid they know they cannot win. Thus, both utilization of qualified ICs when possible to lower cost and enhanced competition in bidding through greater outreach to potential bidders and not making the qualification requirements too onerous may yield greater cost effectiveness in the

future. Some stakeholders mention that all contracts except for the capacity building ones with Chulalongkorn's Energy Research Institute (ERI) were advertised and are officially considered competitive bidding (presumably even if most had only one qualified bidder).[38] Given this situation, greater outreach may indeed by the best way to address the lack of bidders.

Exhibit 24. Total Contract Volume of Top Five Contractors to the Project
(in total, accounts for 67.2% of GEF Funds)

Firm and Contract	Value of contract (USD)	Total Value of Contracts to Vendor (USD)
ERM: MRV (contract with UNDP)	290,804	---
ERM: CCF and LEDS for 3 cities (contract with UNDP)	193,333	---
ERM: Project Final Report (contract with TGO)	46,667	---
ERM TOTAL (3 contracts)	---	**530,804**
BMC: Samui City Demo Package (contract with UNDP)	326,667	---
BMC:CCF and LEDS for Samui (contract with UNDP)	73,333	---
BMC TOTAL (2 contracts)	----	**400,000**
Khon Kaen University: KK Demo Package (contract with UNDP)	326,667	**326,667**
Chiang Mai University: CM Demo Package (contract with UNDP	326,667	**326,667**
CU EMU: NR Demo Package (contract with UNDP)	326,667	**326,667**
CU ERI: Curriculum on low carbon city planning and training 4 cities	58,065	---
CU ERI: Further develop curriculum and train Mae Hong Sorn City	48,387	---
CU ERI: Knowledge Management Package	100,000	---
CU ERI TOTAL (3 contracts)	----	**206,452**
GRAND TOTAL of CONTRACTS to TOP 6 CONTRACTORS	**2,117,257**	**2,117,257**

Due to the overall challenges with cost effectiveness across all three outcomes and the room for improvement, we rate the cost effectiveness of the project overall as moderately satisfactory.

Sustainability: Previous sections have discussed the sustainability of each of the city demo packages and of each of the three outcomes overall. The sustainability ratings on an outcome basis were: Outcomes 1.1 - moderately unlikely; Outcome 1.2 - moderately likely; and Outcome 2.1 - likely. The city-by-city demo package discussions focus in particular on what can be done to achieve sustainability, whereas the full outcome discussions offer assessment of the EOP situation with regard to sustainability. Here we also offer assessment of the EOP situation with regard to sustainability, though in this case for the project overall. We also offer brief comments on specific sub-areas of sustainability, as required.

Financial: Moderately likely: Funding for city-level low-carbon measures is a big challenge. Outcome 2.1 was intended to focus largely on developing financing mechanisms, but this was not addressed. The rationale of the project is that the T-VER mechanism already existed, though as noted, the TE Team suggests other types of financing mechanisms are needed. Still, it should be pointed out that T-VER has developed some connections in the international market (with two organization) and trading is also occurring in the domestic market (with 63 organizations having made purchases of T-VER credits to date) at an average price (in the domestic market) of USD0.83 per ton CO2. So far, 691,261 tCO2eq have been sold on the domestic T-VER market, presumably since the system was set up in 2014.

[38] The ERI contracts did not have competitive bidding and apparently this is allowed in certain Government-to-Government contract situations in Thailand.

At the same time that further financing mechanisms may be needed, when cities can see the win-win nature of some low-carbon initiatives, they are likely to adopt them. And, the private sector will also adopt win-win measures. We therefore suggest future efforts put more emphasis on assessing the win-win benefits for cities and the private sector. In the meantime, it is expected the win-win aspects of the LCC demos achieved to date, in terms of saving money or achieving quality of life objectives, will benefit the project sustainability-wise, as replication occurs to reap these win-win features. Sustainability through such replication potential may occur in NR-adopted building efficiency measures and solar PV systems that have been shown to save the owners money or hotel composting in Samui, which also presents savings potential.

Socio-political: Moderately likely: Among the cities, the TE Team found that Samui is the one where the greatest participation was achieved from citizens and other non-government segments of society. For other cities, there is a need to achieve more outreach with citizens, though the KK demos also included some citizen training. In terms of city governments, the project has done a good job of reaching officials and educating them. Yet, there is a challenge in that city leadership can change and with them, priorities.

Institutional framework and governance: Moderately likely: The project has some weakness in terms of institutional framework and governance. It did not achieve a lasting change to the city planning process in any of the four cities that will ensure low carbon measures continue to enter the general plans. And, it did not achieve any regulations at the national level as targeted, such as KPIs related to low carbon development for city and provincial officials. Yet, it did educate city officials and it clearly had an impact on TGO and its plans going forward, as discussed earlier.

Environmental: Likely*:* Overall, the project's measures are pro-environment, so that environmental sustainability is strong. Yet, with the KK WTE, it was discovered the plant has negative GHG ERs due to burning some waste that is not used in power generation. The project fortunately has identified this problem and aimed to educate city leaders so that future WTEs will not be used in this way. There is some risk, though, that the advising will not be paid attention to. Still, this advising was a smart part of the overall project and, as noted, the KK WTE is likely not attributable to *LCC*.

Overall likelihood: Moderately likely: Considering the above sub-ratings in addition to the sustainability needs of the various project demos, we see that there is some risk to sustainability. We will give good attention to the sustainability needs of the demos in our recommendations. In this way, the national and local governments as well as UNDP may follow up where possible to ensure sustainability of the many quality initiatives that have been initiated or built upon. Indeed, we understand LCC is planning a closing workshop where sustainability issues with regard to the demos are to be a key area of focus.

7.2 Miscellaneous Cross-Cutting Results Topics

Main cross-cutting issues/ concerns: In terms of results, some of the main concerns have been raised before so are just summarized here. One of the greatest issue with project results and how they are pursued is that the project did not strategically pursue GHG ERs, even though "low carbon" is a part of both the name and objective of the project. Had the project been more strategic, it almost surely could have come to understand what type of activities would generate more GHG ERs and how to pursue them. Another related issue is that attribution and incrementality were not well understood. Thus, it seems that the project put effort into pursuing already existing efforts that it thought it could claim by providing MRV, when it should have put more time into efforts that would have generated GHG ERs that could be attributed to the project. Another issue is that the demo expenditures were not as directly focused on stimulating demos as they could have been, instead encompassing capacity building and knowledge projects.

GEF additionality: As noted in the discussion above of concerns, a lack of good understanding of GEF additionality caused problems both in MRV for GHG ERs and other indicators and in ensuring *LCC* pursued efforts that would have been most worthwhile in generating real results. Yet, after much hard work by the TE Team, which was well supported by the city teams and project team, we were able to unwind what was actually additional about the project. And, good and highly relevant additionality was found across the demos and across the four cities. In some cases, the work involved new demos or completely new efforts, but often there were found to be expansions or additions to existing efforts.

Country ownership: Country ownership of *LCC* is very strong. As noted in the background section (Section 2) of this report, Thailand has put strong priority on climate change initiatives at the national level. TGO's response to *LCC* and the city responses to it all show strong ownership of moving forward to address CCM opportunities at the local level.

Gender equality and women's empowerment: We found that the project did not appear to have a special, comprehensive strategy for gender, but achieved good success in promoting women nevertheless. One specific action the project is taking is to promote the role of the municipal clerk of Pha-Ngan in bringing replication of Samui household composting to Pha-Ngan. The project in its promotion has featured this municipal clerk as an outstanding woman leader promoting low carbon city development on her island. In addition to this, stakeholders mention that women were well-represented at the various project workshops and were often the most active and vocal of the attendees. Lastly, we found women to be well-represented among the core project team in Bangkok (with all three persons being women) and among the various consultancies, with women often taking the lead role or being the lead coordinator. Of the four city focal points, however, only one was a women, so that is an area that might be improved in the future.

8. Implementation

8.1 Key Implementation Topics: Adaptive Management, Actual Stakeholder Participation and Partnership Arrangements, and Risk Management

Adaptive management: The project carried out good adaptive management in its demo work. At project launch, the demos as designed may have no longer made sense or not had enough detail. The PM and TGO carried out extensive consultations in the cities and came up with demo plans that were meaningful for the cities. The city facilitation teams then picked up this work to continue to find opportunities for *LCC* to leverage its funds in areas meaningful to the cities. As noted, one concern is that this adaptive management did not give enough consideration to potential to generate GHG ERs in selecting demos. Also, for the planning outcome and the financing outcome, more adaptive management could have been taken up to make these more effective in stimulating low carbon initiatives. As noted, greater specificity and greater analysis on win-win aspects in the footprint and planning work could have made them more effective. For the financing outcome, greater adaptive management was needed to identify what the project could do to stimulate financing for low carbon city-level initiatives. Ideas include a pilot competitive grant fund for feasibility studies or partial grants for solar PV rooftop installations, etc. Instead, the project assumed the target had already been achieved in that T-VER (which was developed before the ProDoc) is operational. Yet, the need for financing of low carbon initiatives at the municipal level continues.

Actual stakeholder participation and partnership arrangements: One of *LCC*'s great strengths is its partnership with the cities and various stakeholders. As noted, in Samui, the project was particularly

strong at working with communities and the private sector, expanding composting from 750 households at baseline to 15,000 and getting 28 hotels to begin composting. (The latter have stopped composting, only temporarily we hope, due to the impact of Covid-19.) In Chiang Mai, *LCC* brought together 21 organizations to form the Chiang Mai Smart Mobility Alliance. In NR, the project worked with various private sector organizations on building audits and provided support to communities via its *Low Carbon Home Guide* and associated workshop. Across cities, the TE Team found that the project held numerous workshops, bringing different types of stakeholders together and including government staff, the private sector, educational institutions, and households among those reached.

In terms of partnership arrangements, the project took a good strategic approach in establishing low carbon city committees in each of the four partner cities. The *LCC* focal point in the municipal government headed the respective committee and provided strong support for the project's achievements in demos related to municipally owned facilities. There was some good engagement of civil society partners, though this may be increased in the future. In Samui, the project formally partnered with the NGO Gold Bin to achieve the aforementioned dramatic results with household composting. In Chiang Mai, there was some cooperation between the Chiang Mai Smart Mobility Alliance and the Breathe Council, which works on local air pollution issues.

Risk management: The main method the project used to lower risk was its strong consultation with city partners. In this way, it ensured that it chose initiatives that were valuable to the cities and would be supported by them. The city focal points, as noted, were important to the process and may also be considered an institutional type of risk mitigation measure.

Risks in general for UNDP-GEF projects that may have negatively impacted *LCC* early on are lack of true coordination with key purported baseline projects and delays. *LCC* experienced delays in project launch, delays in inception, and delays in contracting. A key illustration with regard to lack of true coordination with purported baseline projects is that *LCC* initially planned to provide incremental design support to the KK WTE plant that would have increased the plant's GHG ERs as compared to the "no project" scenario. The plant was commissioned before *LCC* was launched. From review of the KK WTE's timeline, it seems obvious that its design was completed well before the LCC ProDoc was submitted. This would mean that, even had project launch come more quickly after ProDoc submission, it would have been impossible for the project to support KK WTE's design. For future projects, UNDP may wish to develop better mitigation measures via better coordination with baseline projects and steps to avoid excessive delays in the design, approval, and implementation process.

KK WTE's negative GHG ERs also represent a different kind of risk that needs to be considered for future UNDP-GEF projects. On the one hand, if UNDP-GEF projects can provide support leading to incremental GHG ERs in such large projects, the incremental benefits may also be large. On the other hand, it may be difficult for the UNDP-GEF project to influence behavior that negates the GHG ERs or even puts them into negative territory. Thus, it will be important for UNDP-GEF projects to develop strong relationships with baseline project owners pre-launch and also weigh the risk of developments such as what happened at KK WTE in designing risk strategies and determining which baseline projects to partner with.

In pursuing GHG ERs generally, a different risk management strategy might be pursued than the one adopted. In the end, it seemed *LCC* managed risk of demo failure by pursuing, in many cases, "small" initiatives with very low investment, but also with very low GHG ERs. In order to generate greater GHG ERs, future UNDP CCM projects may need to take more risk by pursuing larger initiatives, the outcome over which the project may have less control. Yet, risk mitigation can be achieved by diversifying across a number of organizations and project types in a "portfolio approach." For example, future projects like

LCC can support feasibility studies or design support for initiatives with large GHG ERs. While not all may come to fruition, some may.

Another risk area identified with regard to *LCC* is cost effectiveness and procurement risk. More work may be needed in this area on future projects. Outreach to more potential bidders, use of ICs rather than organizations when possible, and ensuring that bid qualifications are not overly onerous can all reduce the risk of low cost effectiveness. The aim would be to ensure quality providers at best cost.

8.2 Project Finance and Co-Finance

Expenditures: Exhibit 25 shows *LCC*'s expenditures of GEF funds by outcome and year, based on UNDP CDRs, to April 30, 2021. The total shows that about USD500,000 remained with three months left to project close. Exhibit 26 compares expenditures by outcome to CER budgeted amounts and finds that none of the outcomes to date have substantially exceeded their CER allocations. Outcome 2.2, the financing outcome, is the most underspent, percentagewise.

Exhibit 25. LCC's Expenditures of GEF Funds by Outcome and Year (to April 30, 2021) (in USD)
About USD500,000 of total GEF Budget of USD 3.15 M remained 3 months before project close.

Outcome	2017	2018	2019	2020	2021 (to April 30)	Grand Total
Gains/ losses	(1,424.63)	(611.07)	(1,092.01)	(2,638.10)	64.84	(5,700.97)
Outcome 1.1	25,602.55	77,917.90	323,823.92	98,116.05	5,338.45	530,798.87
Outcome 1.2	26,669.88	179,477.85	753,030.65	543,007.32	197,161.40	1,699,347.10
Outcome 2.1	3,030.49	18,074.77	82,601.29	169,301.69	44,688.91	317,697.15
Project Management	42,633.99	15,066.40	5,540.79	41,159.14	6,247.96	110,648.28
Grand Total	**96,512.28**	**289,925.85**	**1,163,904.64**	**848,946.10**	**253,501.56**	**2,652,790.43**

Source: UNDP CDRs

Exhibit 26. LCC's Expenditures of GEF Funds as Compared to CER Allocation

Outcome	Realized to April 30, 2021	CER Allocation	% CER allocation spent	Amount beyond CER allocation if any	% of total budget beyond CER allocation if any
Gains/ losses	(5,700.97)	---	---	(5,700.97)	---
Outcome 1.1	530,798.87	505,312	105.0%	25,486.87	0.8%
Outcome 1.2	1,699,347.10	1,823,554	93.2%	---	----
Outcome 2.2	317,697.15	671,134	47.3%	---	----
Project Management	110,648.28	150,000	73.8%	---	----
Total	**2,652,790.43**	**3,150,000**	**84.2%**	----	----

Source: UNDP CDRs

Exhibit 27. LCC Expenditures of GEF Funds Allocated to Project Management (in USD)

Item	Expenditure
Mid-Term Review (contracts for the two ICs)	28,175
Project personnel, Travels, Petty cash, Audit cost, Translation, ISS fee, Exchange gain/loss	82,474
Total	**110,648**

There are a number of other expenditure analysis tables presented earlier in this document and considered in our assessment of *LCC*'s cost effectiveness, which was discussed earlier. This includes outcome-by-outcome expenditure tables (Exhibits 18, 20, and 22) and city-by-city demo package expenditure breakdown tables (Exhibits 6, 10, 13 and 13). There is also a table showing contract volumes held by the

project's six major contractors (Exhibit 24). Together, these contracts total USD 2,117,257 and account for 67.2% of the USD3.15 M in GEF funding. To complete the view given by the outcome-by-outcome expenditure tables, we include a rough breakdown of the project management component in Exhibit 27.

Co-Financing: Given that so many items can be related to low carbon cities, many items were submitted to the TE Team as co-financing of the *LCC Project*. This includes what appear to be some standard, ongoing expenses for waste management and public transportation and some planned expenditures that have not yet been realized or even confirmed (e.g. roughly USD710 million for KK LR). It also included some financing not directly related to LCC initiatives, which might be considered "associated financing" rather than co-financing. In order to narrow down the co-financing, the TE team aimed to identify those items that were specifically related to being low carbon and those that were carried out during the lifetime of the project and related at least in some sense to project activities. We did not include any pipeline expected expenditures in co-financing. Overall, we find that the definition of co-financing for UNDP-GEF projects could use more definitive direction for evaluators. The UNDP's 2020 *Guidance for Conducting Terminal Evaluations of UNDP-Supported GEF Financed Projects*, however, implies that the funds should be those spent during the lifetime of the project. This is an aspect we adopt. We do not require the co-financing to have been stimulated by LCC, however, just that the co-financing has interacted with LCC activities.

"The TE team should request assistance from the Project Team and Commissioning Unit to complete the co-financing tables and follow up through interviews to substantiate the co-financing figures. The TE report must briefly describe the resources the project has leveraged since inception and indicate how these resources contributed to the project's ultimate objective." (page 44)

Exhibit 28 below lists the realized co-financing by co-financing organization or city, under our somewhat stricter definition of co-financing, breaking the co-financing down by area of expenditure. Exhibit 29 compares the realized co-financing to co-financing committed at the time of project design. Realized co-financing under our more narrow definition is USD22,531,737. This is over seven times GEF financing of USD 3,150,000, so is considered quite substantial. While the CER indicates much higher co-financing of USD 182,301,010 and does not designate how this co-financing will be spent, it is guessed the original co-financing may have included very large projects such as the KK WTE, which was commissioned prior to project start. Overall, the performance of co-financing seems acceptable.

Exhibit 28. Co-Financing to *LCC Project*

Criteria for inclusion: Specifically related to low carbon work, carried out during lifetime of project, and at least in some sense related to project activities.

Source	Use	Amount (USD)	Type
1. CP-ALL (private sector)	-Solar PV panels for distribution centers -Plastic bag campaign	*1,790,000* *133,337* 1,923,337	Cash Cash
2. ERM Foundation	-Study on response to Covid's plastic waste impact	45,000	In-kind
3. UNDP	-Staff time -Office space -Ending Plastic Pollution Challenge: Allocation from UNDP Vietnam project ("TA from other project") -DPC, NIM facilitation, contribution to research	*288,845* *16,290* *70,915* *38,430* 414,480	In-kind In-kind Cash Cash
4. TGO	-Professional and technical services -Other staffing -Office costs and software -Travel	*781,833* *370,928* *96,547* *28,737* 1,278,045	In-kind In-kind In-kind In-kind

5. Nakhon Ratchasima Projects	-Upgrade anaerobic digester per *LCC* recs -Central Patanna 14 PV system (*LCC* did MRV) -Water supply pipe upgrades per *LCC* recs -Water supply EE pump (replication) -NR Tech College PV (*LCC* made recs afterwards) -Mall Korat change to LED (*LCC* did MRV) -Municipality change to LED (*LCC* did MRV) -Solar PV installation in moat (due to *LCC* LEDS)	*215,384* *12,833,160* *611,600* *108,436* *174,080* *130,400* *227,337* *38,184* 14,338,531	Cash Cash Cash Cash Cash Cash Cash Cash
6. Khon Kaen Projects	-Waste management under 3Rs	3,516,989	Cash
7. Chiang Mai Projects	-Coconut waste processing equip (replication) -GPS on buses to work with ap -Bus station improvement -Bus stop improvement	*48,077* *1,423* *801,282* *9,721* 860,503	Cash Cash Cash Cash
8. Samui Projects	-Travelling cost for municipal staff -Second hand mini-truck to deliver composting bins to households and monitor demo project -municipal staff time to coordinate with consultant -waste transportation service from sources to Bophut and Bann Ya Suan Pu – Fuel expense -2 municipality staff: garbage truck driver and loader -power for wastewater treatment plant -Bophut co-financing of demo -Gold Bin co-financing of demo -Ban Yan Suan Pu co-financing of demo	*26,666* *13,333* *24,000* *6,400* *19,200* *13,333* *12,000* *6,720* *23,200* 144,852	In-kind Cash In-kind In-kind In-kind In-kind Cash Cash Cash
Total	**Cash: 20,803,958; in-kind: 1,717,789**	**22,531,737**	---

Exhibit 29. Comparison of Committed Co-Financing to Realized Co-Financing

Note: For realized co-financing we use a stricter definition than might have been used for committed co-financing. We require the co-financing to be specifically related to low carbon work, carried out during lifetime of project, and at least in some sense related to project activities.

Party	Type of Co-Financing	Amount Committed	Amount Realized
UNDP (GEF Agency)	Cash	30,000	109,345
UNDP (GEF Agency)	In-Kind	270,000	305,135
TGO (National Government)	In-Kind	400,000	1,278,045
Samui (Local Government)†	Cash	26,780,654	55,253
Samui (Local Government)	In-Kind	1,255,202	89,599
Nakhon Ratchasima (Local Gov't)	Cash	102,162,752	14,338,531
Nakhon Ratchasima (Local Gov't)	In-Kind	1,521,410	0.0
Khon Kaen (Local Government)	Cash	42,512,056	3,516,989
Khon Kaen (Local Government)	In-Kind	1,292,308	0.0
Klaeng (Local Government)	Cash	5,266,816	0.0
Klaeng	In-Kind	809,812	0.0
Chiang Mai	Cash	0.0	860,503
CP-ALL	Cash	0.0	1,923,337
ERM	In-Kind	0.0	45,000
Total	---	**182,301,010**	**22,521,737**

8.3 Monitoring and Evaluation

M&E Design: The project M&E plan as designed is rational. The CER includes a budgeted M&E plan that is quite standard, though it leaves planning for assessment of project indicators to inception. With the benefit of hindsight, we would suggest that the ProDoc could have been clearer about how GHG ERs and other indicators, both at the objective and outcome level, are to be estimated. While the ProDoc shows parts of its GHG ER estimation methodology, more text to explain the incrementality concept and the attribution status in the case of each demo for which there are calculations would be useful. Taking the controversial issue of attribution of the KK WTE plant as an example, while the ProDoc's design section talks about incremental measures that *LCC* will assist in adding to the WTE design, the GHG ER explanations do not discuss whether the GHG ERs should be only incremental or credited in full to the project. Given the challenges in this and other projects with GHG ER M&E, future projects may want to explain more clearly when only incremental GHG ERs are expected and explain clearly why full attribution is given for an installation in other cases. These issues carry over to the objective level indicators related to energy, waste, and jobs. As for design of the project indicators, there is discussion of this in Section 3, where room for improvement is noted. Overall, based on the foregoing, we rate M&E design as moderately satisfactory.

M&E Implementation: In general, the submission of all required M&E reports and the carrying out of required M&E activities was quite strong. Yet, the quality of those reports was significantly weakened by over-assessment of indicators. We found that of the 11 PRF indicators, 6 appear to have problems of over-assessment due to issues of attribution and/or baseline. And an additional 3 also appear to be over-assessed for other reasons. Thus, a total of 9 of 11 indicators may be over-assessed. In the cases of the four goal and objective indicators, the overassessment is quite extreme.

Wrong assessment of indicators can have negative impacts across a range of the rating criteria for M&E Implementation listed in UNDP's 2020 *Guidance for Conducting Terminal Evaluations of UNDP-Supported GEF Financed Projects*. In the case of LCC, we find that this wrong assessment impacts five of the listed criteria as follows: (i) Collection of data should have included proper baseline data, but did not. (ii) Quality of M&E reports were negatively impacted, because indicator assessment was off. (iii) Value and effectiveness of M&E was negatively impacted due to indicator assessment being off. (iv) Similarly to item iii, monitoring reports couldn't properly be used to improve performance since the indicator assessments are off. That is, had it been realized the GHG ER and other targets were not going to be hit and that achieved GHG ERs and other indicator achievements were very small, there may have been some discussion of how to pursue activities with greater GHG ER (and other) achievement potential. (v) PIR findings are not fully consistent with MTR and TE findings (and thus not as effective as they could have been) due to problems with indicator assessment. As mentioned, the MTR noted attribution and baseline problems, but did not highlight this. One of the PIRs noted concerns about attribution (2019), but by 2020, this issue seems to have been dropped.

Already, we have noted how the GHG ER M&E was quite costly and provided poor results, clouded in confusion about attribution and incrementality. As noted, around 15 of the 24 demo projects (confirmation of GHG ERs of which were the main responsibility of the GHG ER MRV consultancy) appear to have problems in attribution and/ or incrementality. The basic and well-known concept of improvements over the baseline seems to be ignored, with GHG ER calculations in several cases starting either before LCC launch or at least before the project intervention was added to an existing installation. In several cases, GHG ERs were calculated and added to *LCC*'s claimed total even though the only contribution of *LCC* was MRV. In some cases, there were claims that the MRV was the reason the installation occurred, but we were not able to verify those, with the project owners typically being unavailable for consultations. In essence, the simple mental tool of comparing the "with project" situation

to the "no project" situation seems to have been ignored. Lastly, there were problems with transparency of M&E. The case of the KK WTE plant, beyond attribution issues, is the most serious, though there are also questions with the approach for the Chiang Mai demos (where a start date of GHG ER accumulation of Oct. 2018 is used whereas bus stop consolidation, the purported key source of LCC-related GHG ERs, was not approved until July 2020) and the data used for amount of waste treated in the NR anaerobic digester (with a value used that was over 3 times the amount we confirmed with sources that was going into the digester annually). During the TE it was learned that the negative GHG ERs at the KK WTE site were negative due to the burning of excess waste that was not used in power generation. Yet, through the life of *LCC*, the main message that got across was that there were some problems with plastic content being too high at one point and thus causing negative GHG ERs. As noted, the attribution of the KK WTE and the correct GHG ERs (particularly when the issue is whether they are negative or in fact hugely positive) is important because the GHG ERs claimed by *LCC* for the KK WTE at 408,110 tons (direct lifetime) were 64% of the total of 636,534 tons (direct lifetime) claimed for *LCC* as a whole.

It should be noted that, despite problems, a lot of work was put into the MRV and some lessons were learned. Still, the results arrived at do not give a clear view of the achievements of the project and this is concerning, particularly as there was a roughly USD 290,000 MRV contract with main responsibility to assess the GHG ERs of the 24 demos, though there was also some responsibility for capacity building in this contract. The contract did not include costs for local personnel who assisted and gathered data. Their expenses were included in the city demo package contracts.

Based on the above challenges, we initially rated M&E implementation as unsatisfactory. UNDP stakeholders involved in implementation strongly disagreed with this rating, asserting either that the M&E implementation rating is not the place to reflect the problems described above or that the items to consider in the M&E implementation rating are not the same as what we have described above. After consulting third parties and again reviewing UNDP's 2020 *Guidance for Conducting Terminal Evaluations of UNDP-Supported GEF Financed Projects* and the rating scale definitions, we still feel that it's pretty clear that the project has major shortcomings in M&E in indicator assessment and that these problems cut across many of the recommended rating criteria for M&E implementation, so that the project would be at best rated moderately unsatisfactory and also might reasonably be related unsatisfactory. (The rating scales are: Moderately Unsatisfactory (MU): somewhat below expectations and/or significant shortcomings; Unsatisfactory (U): substantially below expectations and/or major shortcomings.) Yet, we also found in our follow up that problems with wrongly assessing indicators (and inflating assessed indicator values) is not uncommon across UNDP-GEF projects. Yet, the majority of UNDP-GEF climate change projects receive a rating of S on M&E implementation. Probably, there is some inflation of ratings and it may also be an issue that most TE teams are not able to follow up and determine actual assessment of indicators to compare to self-assessment. Thus, based on this relatively low level of the bar and the need to provide a level playing field, we rate LCC's M&E implementation as moderately satisfactory. At the same time, we think it is imperative for UNDP to highlight the M&E implementation problems with LCC and take action to ensure they are not repeated in future projects and that project self-assessment of indicators is properly carried out.

Overall M&E: Based on the above, overall M&E is rated as moderately satisfactory. It is suggested that UNDP put strong attention on the problems encountered with indicator self-assessment in *LCC* towards improving the situation in future projects. UNDP CO staff should be familiar with GEF concepts of attribution and incrementality. They should push projects to apply these concepts correctly in their M&E by asking them probing questions. Potentially, projects should prepare bottom up accounting of their claimed indicator achievements and UNDP CO QA staff in their spot checking should check specific claims in the bottom up accounting.

8.4 UNDP Implementation and Oversight, IP Execution, and Implementation and Oversight Overall

UNDP implementation/ oversight: Findings suggest that UNDP provided adequate support to the project in implementation and oversight. Further, UNDP went beyond this in supporting the project with connections to CP-ALL, which became an important project partner, and the UNDP Vietnam plastic waste project, which provided some co-financing. UNDP CO leadership was visible at major events and the Energy and Environment Team provided strategic support. UNDP's input in reporting, such as the PIRs, provided important insights. Despite best efforts of the RTA at getting down to the bottom of the M&E issues, without strong CO support, these were never really resolved until the TE Team had the opportunity to dig quite deep into what was going on. In the future, it is suggest that the CO should gain a good understanding of basic GEF M&E concepts, especially attribution and incrementality, and assure that their GEF projects are applying these both in their strategy and in their M&E. Overall, we rate UNDP's implementation/oversight as satisfactory, with the caveat that concerted action should be taken so that the M&E problems of this project are not repeated with future projects.

IP execution: As noted, the TE Team is impressed with the adaptive management and stakeholder participation achieved with regard to the city demo packages. This is due to the pro-activeness of the project team and their partnership with the IP, TGO. The project not only fulfilled its plan, but actively sought out and pursued new opportunities for cooperation at the local and national level. Documentation, reports, and finance records are all especially impressive as compared to other projects we have reviewed. Also, we are particularly impressed that, despite a lot of delays in the beginning, the project was able to move quickly once contracts were signed in September 2018. By the time Covid began to have an impact, most of the demos had already become operational and studies completed. Overall, we rate execution by the IP as satisfactory, with the caveat that there may need to be more scrutiny of procurement processes in the future. While contractors appear to be high quality organizations, the project put the majority of its money into large contract packages and put more into TA and less into INV than planned. Future projects may want to pay more attention to the TA and INV breakdown, though, as noted, some TA that directly stimulates investment (such as feasibility studies, designs, etc.) may be an acceptable substitute for INV. Future projects may also want to utilize ICs, as a more cost effective option in some cases. And, when there are large bid packages, competition should be ensured by proper outreach to qualified parties and qualification requirements that are not overly onerous. We rate IP execution as satisfactory, with the caveat that attention should be given in the future to: (i) the cost effectiveness of large contracts, including considering the possibility that ICs may be more cost effective than organizations and that such large contracts may not be necessary; (ii) the balance of TA and INV (or of TA that leads directly to investment versus other kinds of TA); and (iii) generating more real competition in large procurements to ensure high value for money.

Implementation and oversight overall: Considering the work of UNDP, the IP, the project team, and the "extended project team" (city demo facilitator consultancies), we rate overall implementation and oversight as satisfactory. To add to the above, from our consultations, we found that the city demo facilitators were quite active in their cities and an important ingredient to the success of the project.

9. Conclusions and Recommendations

9.1. Conclusions

TE

- TE methodology combines consultations, document review, and special information requests.
- TE received very strong support from project team and city demo facilitation consulting teams.
- TE spent much time trying to unwind attribution, incrementality, and true situation with regard to claimed GHG ERs. Results suggest small fraction of GHG ERs claimed attributable to project.
- TEs need to put strong emphasis on beneficiary consultations and triangulate to confirm achievements. Yet, access to beneficiaries was limited. Most interviews included persons that had been paid to implement portions of the project. Interpretation was often not comprehensive and could be improved. Weak interpretation may also have negatively impacted project design.

Background and General Findings

- A four-year project with GEF funding of USD3.15 M, *LCC* cooperates with four mid-sized Thai cities. Of its three outcomes (LCC demos, LCC planning, and LCC financing), the demos are the greatest strength, showing a high level of responsiveness to city needs across the areas of waste management, transport and building energy. Their weakness is they did not pursue GHG ERs very strategically and had mostly low GHG ERs. In several cases, *LCC*'s only addition to initiatives for which it claimed GHG ERs was MRV. As MRV does not typically lead to GHG ERs, we suggest those items should have been relegated to a different, non-demo part of the project.
- *LCC* experienced serious delays throughout the project cycle (1 year between CEO clearance and project launch, 9 mos between project launch and inception, and another 9 mos between inception and signing of major contracts). The project ended up being out of sync timewise with major baseline projects it was meant to cooperate with, perhaps due to these delays, but more likely due to weaknesses in securing true partnerships with baseline projects during design and understanding their status.
- Cooperation with mid-sized cities on CCM fills an important gap, because Thai cities make decisions on certain areas not controlled at the national level, such as waste management and local public transport, whereas the national level controls areas such as power plants. The private sectors in such cities are also important partners for building energy efforts. City officials are locally elected in contrast to provincial officials, who are appointed by MOI. A comprehensive strategy for local CCM initiatives might include efforts at both the city and provincial levels, as well as partnerships with the private sector and outreach to communities.
  - Thailand's *NDC Roadmap* allocates targets to national agencies, but not to the local level, suggesting untapped opportunity with regard to mid-sized cities.
- While the population of these cities is small (typically 100,000+), their full metropolitan areas can have around 500,000 to 1 million persons (NR, KK, and CM) and/or they may have high unregistered population (e.g. estimated at 300,000 in Samui in normal times).
- With an implementation period from April 2017-July 2021, roughly the last 1.5 years of LCC was seriously impacted by Covid-19. Fortunately, the project moved quickly once major contracts were signed in Sept. 2018 and was able to complete most installations before Covid impacts began.
- Thailand entered the CDM carbon credit market late and not many successful projects were registered before the carbon market crashed in 2012/2013. Yet, one GHG ER-generating model of that period to learn from is introduction of biogas-to-power wastewater treatment systems at palm oil plants, now adopted widely in the industry because of their cost-effectiveness.
- While there are now carbon credit markets in some countries, these are mostly not linked internationally. In 2014, Thailand introduced its T-VER scheme, mainly for the purpose of CSR and voluntary carbon offsetting by companies. A company may keep its own verified credits for CSR or sell

to others who, for CSR, wish to "offset" their carbon footprint. Thailand has developed links with two international organizations in the area of carbon credit trading. Domestically, 63 organizations have purchased T-VER credits for an average of USD0.83 per ton CO2eq, with a total of 691,261 tons CO2 purchased on the domestic market since T-VER initiation in 2014.

***LCC* Design**

- Project demo outcome design is considered highly relevant for addressing CCM potential controlled or substantially influenced at the municipal level, addressing the key needs of mid-sized cities, and focusing on major waste management and transport projects, with the potential for high GHG ERs.
- More specificity on how the demos would achieve incremental GHG ERs in baseline projects *LCC* was to partner with might have prevented confusion in implementation.
- Project planning and financing outcomes' heavy emphasis on general capacity building may be repetitive with prior donor efforts, such as, reportedly, prior UNDP project focused on *LCC* planning.
- Design of financing outcome could have more strongly focused on financing rather than mix of items.
  - Policy shows up in the indicators for this outcome, but might better have been its own outcome. Capacity building and knowledge management might have been a separate outcome as well.
  - It would have been useful in the design to specify other types of financing mechanisms in addition to offset schemes, such as schemes to support feasibility studies, partial grant schemes (e.g. 20% of total costs), soft loans, etc.
- Indicators might have been more carefully designed to reflect true achievement. "Number of demo projects," without further qualification, seems not to set the bar high enough.

Outcome 1.2 – Demo Packages

- Each demo package was subcontracted in full to an institution for USD 326,667, meant to cover service fee of the institution (about 25%) and all demos. For the demo outcome overall, only 34.4% of the roughly USD1.7 M spent is classified as INV, compared to 80% designation in the ProDoc. Findings suggest that, in addition to INV, some kinds of very focused TA can directly stimulate GHG ERs, while more general trainings, info products, etc. do not. Given the range of potentially impactful results, at an average overall outcome cost of USD425,000 per city, cost effectiveness is still considered satisfactory.

<u>Nakhon Ratchasima Demo Package</u>

- NR demos are impressive for addressing important needs, providing a strong mix of project types across a range of key areas (waste management, transport, and building energy use), and in some cases providing impactful, potentially replicable results. NR demos are the most faithful among the city demo packages in pursuing GHG ERs, with 43,200+ tons direct lifetime GHG ERs expected. While it's concerning that the expenditures are 91.3% TA (the CER had targeted 80% INV for the outcome), all going to CU (contractor) entities, we find that some of this TA (energy audits, studies to make specific efficiency related recommendations) can be as impactful as INV in stimulating GHG ERs. Yet, other kinds of TA (training, knowledge products, etc.) might have best been shifted to the budgets of the other outcomes, so that more funds could have been left for true demo-like activities.
- Demo 1: Improvements to city's anaerobic digester (*LCC* provided recommendations only) resulted in increase in biogas generation and 160% increase in power generation sold to grid (in turn leading to GHG ERs in the long run), though organic waste treated is said not to have substantially increased. Schools and hospitals in NR said to be interested in developing their own biogas digesters for food waste. NR's digester might be a model for other cities, but it has also required substantial renovation since commissioning. A new WTE (incineration to power generation) is in the works for the same site, presenting both potential and risks.
- Demos 2 – Water Supply Bureau: (i) Improvements to city's water supply piping system (*LCC* provided recommendations only) led to savings of 1 M t water/year and electricity savings (and thus generated GHG ERs). Based on learnings, city now planning a gravity only system for piping water in

from distant site, which will save on energy costs (and thus generate GHG ERs). (ii) Replacement of two pumps (*LCC* provided new pumps) also led to electricity savings (and GHG ERs). Based on the experience, the city has purchased two more pumps.
  - Such work with water supply bureaus in other cities might be considered, though GHG ERs may not be as good a "value for the money" as in some other areas, such as building energy audits.
- Demos 4 to 8 – building energy audits: *LCC* provided 10 energy audits resulting in building owners carrying out 6 improvements or installations (LEDs, VSD adjustment, solar PV system, new chiller, etc.) across 5 buildings. These provided good GHG ER results as a group. A success rate of half of auditees acting on energy audits is quite positive and, if verified, suggests energy audit work for large buildings in mid-sized Thai cities may be fruitful grounds for further GHG ERs.
- "Demo 9": *Low Carbon Home Guidebook* prepared by *LC*C is provided to those visiting permit office for new homes. NR has incorporated in its plan the printing of 1,000 copies per year. This appears impactful and might be shared with other cities. Yet, to provide more funds for demos, it could have been shifted to a non-demo outcome.
- "Demo 10": Cost of traffic study (TA) provided by *LCC* compares: BAU, light rail, and BRT, showing BRT the most cost-effective among the options. This is believed to already have had high impact, as national leaders now willing to consider e-BRT for NR, whereas previously they had NR slated for light rail, and are now looking into e-BRT for 6 cities. Based on *LCC* success, NR, which prefers BRT, got UK grant of USD666,000 to continue. NR has developed the first e-buses in Thailand and will be setting up some e-bus routes soon. This has highest potential impact of all NR demos, though has a long road ahead. Currently, NR's main mode of public transport is the *songthaew*. Total cost for e-bus system with 4 routes is USD150 M, of which about USD 81 M is for elevated roadway in one area. Plan calls for 65 buses, including 35 in Phase I (2022-2027). TE Team sees need to combine improved public transport with measures to discourage private cars, such as high parking fees and bus lanes.
- MRV-only efforts: *LCC* claimed GHG ERs for 7 initiatives in NR for which the only *LCC* support was GHG ER estimation. (In some cases, T-VER or LESS registration was provided). It was not possible for the TE team to talk to any of the project owners, but typically such GHG ERs are not attributable to the project providing MRV only. Yet, some of these efforts inform the way forward in that large PV rooftop systems provide strong GHG ERs, such as Central Plaza's 1 MW system with lifetime GHG ERs of 22,000 t. These are relatively rare in the Northeast, but private sector adoptions have begun.

<u>Chiang Mai Demo Package</u>

- CM demo is a group of integrated efforts all focused in the area of transport, mainly public transport. A number of meaningful and interrelated steps, the first of their kind in CM, were achieved. Yet, as is often the case with transport work, there is still a long way to go; and sustainability of this work is a risk. We did not find clear evidence of GHG ERs for CM demos, though 2,592 t were claimed. Spending is 69.4% INV, 30.6% TA, though most of the INV is software and digital ticket readers. Siam D App. Co and Omm Platform (closely related companies) carried these out with 57.9% of contract volume, while CMU entities carried out 30.8% via TA.
- Component 1. Updated traffic model and citizen survey (TA). These, along with Alliance (Component 2), resulted in the three fixed route bus companies adjusting their routes and consolidating bus stops (Component 3). The last work of this type for CM occurred in 2014 under a World Bank project.
- Component 2. Chiang Mai Smart Mobility Alliance. This has for the first time brought together public and private sector players in transport, cutting across silos to progress public transport as evidenced by the consolidation of bus stops (Component 3). There are 21 members. The ap (see below) is a key asset of the Alliance. Although *LCC* was to set up a social enterprise to ensure sustainability of the Alliance, the TE Team did not find strong evidence that this has been set up.
  - Post-pandemic, if the Alliance can be continued, it may work on greater coverage of the city with bus routes and greater frequency of buses and on discouraging private car use. Impactful transport measures can be low cost but require political will.

  - The mobility component of *CM Smart City Plan* calls for software for CCTV camera feeds to identify cars parked on the road illegally, impeding traffic flow. The Plan also calls for sensors to control traffic lights and optimize traffic flow. Both could have been fruitful areas for *LCC* to support and are worthwhile for future support, though are said to have budget allocations already. Another area of support might be dedicated bus lanes and one-way roads or bus only roads to accommodate bus lanes in parts of CM with narrow roads.
- Component 3. Consolidation of CM's bus stops and improvement of bus routes. Bus stop consolidation had been discussed before, but was finally achieved due to *LCC*'s CM Smart Mobility Alliance bringing together the 3 fixed route bus companies. Previously bus stops of different providers even if in the same general area, such as near a certain intersection, were separate. Prior to consolidation, there were 443 bus stops; and now there are 203.
- Component 4. Mobile transport ap. The ap shows users how to get to destinations on public transport. It can also be used for e-tickets (see next demo) and to provide data to Alliance members for decision-making. The ap has been downloaded just 300 to 400 times.
- Component 5. Electronic payment system work. While private providers already had this, there were some policy hurdles to achieve e-tickets for CM Municipal Bus Company. In addition to overcoming these, *LCC* supported purchase of e-ticket reading machines on 18 buses, though use of e-tickets is extremely limited to date.
- Other achievements: *LCC* claims to have convinced CM to extend its B3 bus route beyond city borders. It also claims to have contributed partially to decision of E4C, a private fixed route bus company, to purchase electric buses (Nov. 2020) for CM routes and to Chiang Mai Municipality's plans to do the same in the future. *LCC* facilitated E4C's decision by connecting it with charging station providers.

<u>Samui Demo Package</u>

- Samui demos are impressive for addressing some of the most important needs of the island and for high level of involvement across different segments of society. The 6 Samui demos are further appreciated in that they were all intended to be active demos, generating GHG ERs right away. All focus on issues related to organics in waste, five addressing solid waste, the other wastewater. We are most impressed with the household composting demo and see great potential for the hotel composting demo, though it is stalled due to Covid. Lifetime direct GHG ERs for Samui demos are 6,560 t, all from avoidance of methane emissions from organic waste in landfills via composting or processing of waste. The Samui case shows the challenge of achieving large GHG ERs from bottom-up waste management activities. Expenditures of the USD326,667 demo package were 46.8% TA, 53.2% investment. The hotel and household TAs (together USD 18,500 of USD153,000 total TA) seem important in achieving GHG ER results.
  - With landfill space limited, Samui cubes waste to send to the mainland.
  - Slippery drippings from garbage trucks' organic waste had been causing a lot of accidents in Samui.
- Demo 1: Partnering with Gold Bin (which is led by "DJ Noo"), *LCC* reportedly scaled up household composting from baseline of 750 HHs to 15,000 HHs, 31.4% of all households on island and addressing 5.7% of Samui's organic waste. Project provided bins to 2,500 HHs. The rest of the increment (11,750 HHs) got their own bins or repurposed other items. City organizations have an interest in continuing to upscale the initiative. Demo is being replicated with project support on nearby Pha-Ngan Island in 500 HHs.
- Demo 2: While some hotels had been sorting waste, *LCC* waste audits and training resulted in 28 mid-sized hotels newly composting and appreciating the cost savings and other benefits. Efforts stopped due to Covid. We see high potential in the future given Samuis 600-plus hotel or other tourist accommodation facilities. Stimulus may be needed for restarting; and help is needed to approach non-local/ big chain entities.

- Demos 3-5: *LCC* provided equipment to increase capacity (and, in some cases, extend product line) of three pre-existing, private waste processing stations. There is great need to achieve increased and consistent daily supply of waste to these stations to realize their new capacities:
  - Bophut Organic Recycling Station: With *LCC* supplied equipment, composting capacity increased from 100 kg per day to 1 t per day. Yet, waste is not received daily and post-installation pre-Covid data suggests just 3.48 t/ mo processed (a 1.98 t/mo increment over baseline). Main products: soil conditioner and animal feed (now pelletized, with *LCC* support). If waste processing were maximized to 1 t per day 95% of the time, 2.1% of Samui's organic waste would be processed.
  - Ban Ya Suan Pu Learning Center: Coconut waste, a vexing problem on Samui that attracts mosquitos, smells, and is an eyesore, is processed and turned into pig feed and soil conditioner. With *LCC* support, capacity was increased to 1 ton per hour and new products (charcoal and wood vinegar) introduced. Yet, capacity utilized after installation and pre-Covid was 5.87 t per mo, a 2.97 t per mo increment of baseline, but far short of what could be achieved with the 1 t/ hr capacity. In non-Covid times there are 1,000 visitors/year. Chiang Mai visitors have replicated in CM.
  - Seed2Sustain Station: This preexisting station transforms a variety of organic waste into charcoal. *LCC* provided 10 additional kilns. It's unclear whether any increment beyond baseline was achieved.
- Demo 6: *LCC* provided wastewater treatment equipment (10 m^3/day) to fish market that had been releasing wastewater into ocean. MRV consultancy ascribed no GHG ERs due to baseline of ocean release. Given release is into shallow, near-shore water, there may actually be some GHG ER benefit.

KK Demo Package

- The KK demos present a mix across three sectors highly relevant to KK. Highlights are the solar PV installations, which have potential for over 10x expansion, and the light rail studies, which support a major initiative pursued by the city. The waste management efforts mainly build on pre-existing efforts of the city, though expansion of an organic waste station's capacity, if it could be fully utilized, may provide a good model for scale-up at additional stations. Lifetime direct GHG ERs are just 541 tons. Expenditures of the USD326,667 demo package are 45.9% TA and 54.1% investment.
- Demos 1-2: *LCC* provided 100% grant for the installation of two 12.3 kW PV systems, one on fresh market roof and one ground-based at wastewater treatment plant. Support included design for much larger overall systems and has stimulated discussions with a private sector party for over 10x expansion of each system via a lease/ BOT model.
- Demo 3: *LCC* provided 100% grant for new less labor-intensive equipment at a pre-existing organic waste learning center that expands processing capacity to 10 tons per day, but station is operating at an average of 2.2 tons per day. If capacity can be reached by better waste supply stream and the station replicated, significant impact on KK's total overall organic waste might be achieved.
- Demo 4: *LCC* supported equipping of additional non-organic waste sorting centers and expansion of HH training under KK's 3R Program, which also has other aspects. City had 73 sorting centers in government facilities to which *LCC* added 50. GHG ERs supplied by MRV consultancy encompass entire program, rather than incremental contribution.
- KK WTE MRV: *LCC* provided MRV only to this plant. We do not count it as a demo, as *LCC* did not support increased GHG ERs an originally envisioned. The plant actually has negative GHG ERs, as it is now accepting waste from other cities, so that its total waste stream exceeds capacity and half the waste is simply being burned with no power generation. Lack of transparency, both on the attribution of the KK WTE plant and on its negative GHG ERs are quite concerning. *LCC* claims attribution for positive GHG ERs of KK WTE of 408,110 tons direct lifetime, 64.1% of the total claimed across all demos. This experience provides important lessons for UNDP COs implementing GEF projects. KK may be planning a second WTE plant, though it is years down the road. *LCC* has advised city to ensure waste is used only for power generation and plastic proportion is kept low to ensure high GHG ERs.
- Demo 5: LCC provided two-part TA study for KK's proposed LR Project. One part is a feeder study proposing routes for transport to the LR stations. The other is a TOD study, proposing real estate

development around stations to make the full venture more economically viable. Sources report a bid on the station and TOD won by a Thai-Chinese joint venture company, which is currently working to secure funding and needs to negotiate terms with KK before the agreement is binding. While potentially meaningful, it appears the LCC studies have not yet been provided to the winning bidder.

Outcome 1.1. Planning (MRV also included)

- While positive awareness and capacity building were achieved via the carbon footprint and low carbon planning work of this outcome, there may have been ways to make this work more actionable and impactful in terms of stimulating future GHG ERs. TGO has had 90 other carbon footprints prepared for cities and provinces in addition to LCC's four city carbon footprints. Previous projects appear to have provided good support for general capacity building. The majority of the MRV consultancy costs are allocated this outcome. Bringing the full costs of that consultancy to this outcome (to facilitate assessment) brings total expenditures for the outcome to USD 617,223. Based on results, we do not find this outcome to be a strong value for the money and rated cost effectiveness as moderately satisfactory.
- Carbon footprints and low emission development strategies: Consultancies were hired to provide a carbon footprint and LEDS for each city. While it is useful for reference for the cities to know their total carbon footprint, work could have been more impactful by focusing less on report preparation and more on stimulating investments and ensuring the LEDS process was incorporated into general city planning process for the long-run. Possibilities may have included a stronger focus on identifying actionable sub-sectors and very specific measures. Also, an emphasis on assessing financial and other co-benefits of such measures may have been helpful to promote them. For example, building air conditioner use could have been sub-footprint for which measures vis-à-vis their potential impact and cost-effectiveness could have been assessed. Cities need to understand the co-benefits clearly in order to be convinced to invest in low carbon initiatives. For most cities, it seemed any LEDS measures included in the general city plan and budget were not new, so that the exercise mainly helped the city staff understand which of their pre-existing measures are considered "low carbon." In the case of NR, however, a new "low carbon" section was added to the general city plan.
- MRV consultancy: This USD 290,904 contract covered MRV of GHG ERs for the 24 project "demos" and associated capacity building. The cost of personnel who supported this work at the local level was not charged to this contract, but instead covered by the city demo packages. This large contract is quite problematic in terms of supporting project M&E, as it did not properly assess attribution nor incrementality. GHG ERs of initiatives not due to *LCC* were claimed. When there was incremental support, GHG ER calculations often had a start date before installation and did not subtract baseline values. Lastly, the problem of excess waste burning as the source of negative GHG ERs at KK WTE was not properly communicated. Instead, very large GHG ERs, representing over 60% of those claimed overall for *LCC* were reported for that plant. We found about 15 of 24 reported GHG ERs problematic in these various regards.

Outcome 2.1: Financing

- While Outcome 2.1's statement implies investment is to be the focus, work for this outcome (and its more detailed design) is spread across additional areas, especially capacity building and awareness raising. As with Outcome 1.2, we find that general awareness raising is not as needed as would be more specific, actionable work. Subtracting out the portion of the MRV consultancy contract allocated to this outcome, total expenditures (realized and expected) are USD457,791. We don't find strong value for money in terms of what was achieved and rate cost effectiveness as moderately satisfactory.
- Financing: *LCC* indicates its main financing related work is to support the promotion and carrying out of T-VER credits and LESS certifications. T-VER, developed in 2014, pre-dated project design. Thus, when project design called for development of financing mechanisms, it either likely referred to additional work on mechanisms, which was not conducted under the project, or was unaware of the

advanced status of T-VER. Consultations suggest that financing at the municipal level for low carbon projects indeed remains a barrier.

- Capacity building/ knowledge products: This work is all carried out by a single contractor with total contracts of USD206,452. As before, we would suggest a more specific and actionable program. The work done included significant attention to climate change adaptation as a major area of training, though adaptation is not within the scope of GEF CCM projects. TGO plans to adopt the training packages prepared for future work to be carried out by TGO Academy in training cities.
- Awareness - CP-All cooperation: *LCC* cooperated with Thailand's overall 7-11 owner and franchisor on the latter's "say no to plastic bags" campaign. CP-All had already had an idea to do this campaign, expansion of a small-scale initiative it did earlier, but its relationship with UNDP is said to have led to earlier implementation than expected, with 8,706 tons direct GHG ERs in one year.

Additional Points on Results Overall

- A positive impact is that TGO has set up a Bureau for Low Carbon Cities and plans additional city-level outreach, though it aims to impact the local level through cooperation with provinces. TGO also plans to work with the responsible ministry, MOI, to develop low carbon KPIs for city and provincial staff. This was a target in the project results framework, but was not addressed by *LCC*.
- Our rough estimates of total direct GHG ERs are 12,468+ t by EOP and 59,007+ t lifetime, as compared to 269,552 t by EOP and 636,594 lifetime as self-assessed by LCC. The large gap between our figures and those of LCC's self-assessment are explained by issues of attribution and incrementality.[39] For a few demos, we were actually more generous than the MRV consultancy, expecting a 10 year lifetime (instead of 5) for household composting and expecting a resumption of hotel composting post-Covid. Our aim is to focus on the true accomplishments of the project and the potential for those to flourish, rather than focus efforts on the GHG ERs of large initiatives not attributable to *LCC*.
- A majority of project expenditures, 67.2% of *LCC*'s USD3.15 M in GEF funds (or USD 2,117,257), were allocated to 11 relatively large contracts across 6 organizations. It appears many of these large contracts may not have been very competitive, with evidence of either single qualified bidder of non-competition in 9 of the 11 cases. In some cases, ICs may provide a better value. And, truly competitive bidding, with pre-bidding outreach and qualification requirements that are not overly onerous, may result in better value for money when circumstances call for organizations over ICs.
- As for gender, the project has promoted the woman clerk of Pha-Ngan Island in reporting achievements of household composting there. In addition, women made up a good portion of attendees at various trainings and events and were said to be among the most vocal. They are well-represented on the project team and in consulting team leadership and coordination roles as well.

Additional Points on Implementation

- *LCC*'s reporting, finance, and admin work is extremely professional, well beyond the average level seen globally with comparable UNDP-GEF projects.
- In terms of break-down of expenditures between outcomes, there was not significant shifting of ProDoc allocations.
- As for co-financing, given the broad range of items that may be related to low carbon cities, many were reported to the TE Teams as co-financing, including general operational expenses for waste management and public transport and including investments not yet made, such as about USD700 M for the KK LR. We took a narrower approach, limited "co-financing" to investments already made during the life of LCC that are clearly low carbon and that have at least something to do with *LCC* activities. As such, we still came up with a relatively high level of co-financing, which, at USD 22,531,732, is over 7 times GEF funding of USD3.15 M. Yet, it's much less than committed co-financing of

[39] We do not attribute the KK WTE to the project, but if we did, we believe the GHG ERs would be negative instead of hugely positive as reported by the MRV consultancy.

USD182,301,010, which we believe used a broader definition of co-financing and also included major projects, such as the KK WTE.

9.2. Recommendations

A. Overall Way Forward on Realizing Decentralized CCM

1. Consider additional initiatives to address untapped GHG ERs at the local level, but do so only if able to develop sound strategy for achieving substantial GHG ERs (per Recommendations 3 and 4). Consider expanding partnerships at different levels to maximize results. Consider continuing to work outside the national government level, especially with mid-sized cities (i.e. populations of 100,000-plus), but also with their greater metropolitan areas (which can have populations of 500,000 to 1 million) and thus neighboring cities and provinces, as a good fit for UNDP comparative advantage. For partnerships, consider the local private sector as especially promising. And, for initiatives in various sectors, such as waste management, transport, and buildings, partner with responsible national-level entities, to ensure the greatest emphasis is not on measuring the GHG ERs, but on achieving them. Working with both TGO and these line ministries, consider expanding *NDC Road Map* from its solely national level targets to include local level and private sector ones. New efforts should put the most emphasis on demonstrations and scale-up to achieve GHG ERs. Funds for other type of activities should be very specific, so as to assist in stimulating more GHG ERs in the near term.

Entity responsible: UNDP CO leadership (especially DRR and Energy and Environment Team Lead) in consultation with TGO, line ministries, local governments (city and provincial), and private sector.
Timeframe: Next six months to determine viability and partnerships.

2. For future projects, emphasize private sector engagement, leveraging UNDP comparative advantage in setting up dialogue to solve problems: Building on learnings from *LCC*, leverage "Alliance Model" (Chiang Mai Smart Mobility Alliance) to break down silos between private and public sectors and "Khon Kaen Model" to engage the private sector in major low carbon urban development initiatives. Determine other opportunities in mid-sized cities to leverage similar models. Also emphasize private sector cooperation on demos that reduce GHG emissions and benefit bottom line of businesses.

Entity responsible: UNDP CO leadership (especially DRR and Energy and Environment Team Lead), private sector leadership in various mid-sized cities.
Timeframe: Next six months

3. Be strategic about achieving substantial GHG ERs in future projects and put the bulk of CCM funds in efforts directly tied to reducing GHG ERs: Build on your *LCC* success of good relationships with local partners, but do the analysis in advance and understand which initiatives will bring substantial GHG ERs for the money, or have very good potential for scale-up, so that future projects do not face *LCC*'s challenge of small GHG ERs. (See Recommendation 4 for a possible planning approach for identifying options.) Show partners analysis of the co-benefits, such as money they will save by choosing low carbon option. Pursue larger installations or extensive replications that can be attributed to your project. If it seems risky to pursue large projects, take a portfolio approach to spread out your risks among many such potential large projects. In use of donor funds allocated to "demo" outcomes, ensure funds are spent either on INV or on TA known to directly stimulate GHG ERs. The latter may include feasibility studies, design, and energy audits, but not workshops and information packages, and may even leverage funds better than INV. The former may include partial grants (such as 20% of project costs). Competitions may be used to attract strong applicants from mid-sized cities. Minimize facilitation fees to ensure maximum amount of demo outcome funds are used for INV or types of TA that directly stimulate

GHG ERs. Further, future CCM projects should put bulk of funds into their demo outcome (or financing mechanism). Strategy may be based on an optimistic view in terms of the receding of Covid-19 impacts, but include a back-up plan to focus on sectors less impacted by Covid-19.

Entity responsible: UNDP Thailand CO, TGO, other UNDP IP partners in CCM related fields, designers and implementers of UNDP-GEF CCM projects in Thailand.
Timeframe: As needed, at the time of concept formulation, detailed design, and inception of CCM projects.

B. Planning and Policy for Decentralized CCM

4. Make city low carbon planning work more action-oriented and less report heavy, perhaps identifying the potential of very specific measures in specific sub-sectors and emphasizing to stakeholders the cost effectiveness. Also, make this very specific to informing the achievement of substantial GHG ERs in conjunction with cost savings/ return on investment in areas where there is room for substantial scale-up: A comprehensive analytic approach would involve identifying low carbon opportunities that both have the potential for high impact, when scaled up, on the city's overall carbon emissions and that are also highly attractive to the city or other proponent due to cost savings/ return on investment or other benefit. This approach may be used either in donor project design or in additional low carbon city planning if pursued. The win-win benefits for cities or other local partners must be emphasized and assessed. Cities need to understand the benefits in order to be convinced to pursue low carbon initiatives. The process may also call for comparison of the options. How much will the various measures save the cities in the long-run? What other co-benefits are there? Upon doing the analysis, it may be found for example, that there are more GHG ER opportunities in rooftop PV systems than in water supply re-piping.

Responsible Entity: UNDP-GEF project designers, TGO, project implementers of planning outcomes
Timeframe: As needed, at the time of project concept formulation and detailed design and at the time of implementation if low carbon city planning outcome is included.

5. Look for entry point to low carbon mid-sized city initiatives via existing smart city plan efforts in relevant cities as focus of future project. Review the smart city plans of selected cities to find synergies with low carbon work and consider work such as in Recommendation 4 to expand strategic and cost-effective win-win low carbon content. In the case of Chiang Mai, consider especially transport aspects of this plan if still in need of support. Discuss with selected cities. Consider whether a smart city plan theme would be a good way to incorporate the strategies discussed in Recommendations 1, 2, and 3 (and possibly, 4).

Responsible Entity: UNDP CO, partner cities
Timeframe: Next 6 months

6. Consider and promote as relevant, national level policy to promote low carbon initiatives in mid-sized cities. In particular, consider promotion of KPI for city and provincial officials through liaison with MOI and relevant high-level leaders. Consider also sector-wise national policies that may facilitate low-carbon city work, such as parking fee policies (vis-à-vis promoting sustainable transport), etc.

Responsible Entity: TGO, UNDP CO leadership, implementers of future projects relevant to sector-wise policies
Timeframe: Next 6 months for KPIs; as needed for sector-wise policies

C. Financing for Decentralized CCM

7. Consider promoting financing mechanisms or other means of generating increased investment for low carbon development at the mid-sized city level in future project. Address the gap of funding mechanisms that operate at the city rather than national level and consider how to get funding to the city-level private sector. Mechanisms that might be piloted include partial grant fund (e.g. 20% of costs), grants for feasibility studies and design, soft loans, ESCO-type modality for different types of low carbon initiatives, BOT, etc. As for carbon offset work, consider work to link Thai system to other markets. Consider engagement of financial institutions for training on economic viability of certain low carbon measures.

Responsible Entity: UNDP CO, TGO, financial sector
Timeframe: Next 6 months

D. Improving Implementation of CCM and other GEF Projects

8. Put top priority on improvement of indicator self-assessment aspects of M&E of GEF projects with special attention and use bottom-up accounting to spot check claimed achievements. Also monitor co-financing and work to ensure it is realized: Prepare a brief guidance document (e.g. maximum 5 pages) for UNDP COs outlining clearly the most important basis on which UNDP-GEF projects will be assessed, especially GHG ERs for CCM projects (or other top indicator for other types of GEF project). Emphasize concepts of attribution and incrementality and clarify that simply carrying out MRV for an installation does imply the installation's existence is due to the MRV provider. CO staff should become completely familiar with this guidance document and be responsible for asking project teams the right probing questions to ensure their projects are addressing GHG ERs (or other core indicator) with proper consideration of attribution and incrementality. In addition, the project team should prepare a bottom up indicator accounting template, which shows how various individual initiatives contribute to indicator achievement. CO staff responsible for QA should spot check individual initiatives for attribution and accuracy of claimed achievements to date. For third party MRV/ M&E consider an international consultant or one partnered with a national consultant as an alternative to a firm. MRV for demos of UNDP-GEF projects should not typically run in the multiple hundreds of thousands of US dollars. Ensure that the consultants are required to provide clear explanations for their GHG ER or other calculations. Also ensure that they are familiar with the GEF requirements of attribution and incrementality in assessing the indicators. As for co-financing, enhance its monitoring and realization, putting effort into the coordination, reporting, and actual utilization of committed co-financing.

Responsible Entity: UNDP-NCE (guidance document), UNDP CO, project teams, M&E/ MRV consultants
Timeframe: Next 6 months for launch and then as needed on project basis

9. Emphasize beneficiary focus in M&E, including spot checks and evaluation: For future evaluations ensure that there is strong emphasis on one-on-one consultations with a large number of beneficiaries without presence of those paid to implement the project. Similarly, CO spot-checking of project progress should include such consultations with beneficiaries in the absence of those paid to implement the project.

Responsible Entity: UNDP CO, project teams, evaluation consultants
Timeframe: As needed during implementation of projects

10. Scrutinize plans for large contracts with organizations and minimize number of large TA contracts, if any. Consider options to cut costs while maintaining or improving quality by use of ICs for appropriate assignments. When organizations are definitely needed ensure that there are multiple

qualified bids that are truly competitive by starting outreach early and not making requirements too onerous.

Responsible Entity: UNDP CO procurement, program officers, and leadership, RTAs, project teams
Timeframe: As needed during project design, inception, and implementation

11. Reassess repeated delays at all stages in the UNDP-GEF cycle in Thailand and look for new solutions to avoid them. Project design is likely a step that could be sped up simply by requiring a shorter timeline of consultants. For lags between ProDoc clearance and signatures, high-level discussions within Thailand on national process may be needed. Inception workshops should be held shortly after hiring of PM.

Responsible Entity: UNDP CO leadership (DRR and Team Leads), RTAs
Timeframe: Next 6 months for assessment and high level discussions

E. Addressing Sustainability of Promising *LCC* Demos and Possibly Building on them with Future Sector-Wise Work

12. Transport: Consider options for ensuring sustainability of promising *LCC* transport demos and options for future projects that may continue to build on *LCC* transport sector achievements in NR, CM, and KK. (i) For all three cities consider the importance of adding measures to discourage private car use, complementing the improvement of public transport. This may include higher parking fees in city center (and require national level action) and special lanes/ roads for buses. Realize that measures to improve transport can be very low cost but require political will, thus well suited to UNDP comparative advantage. (ii) For Chiang Mai, consider support for CM Smart City Plan's smart mobility items if support is still needed – software to use CCTV camera feed to identify cars parked on road illegally impeding traffic flow and sensors to control traffic lights so that traffic flow is optimized. Consider means to ensure Alliance is sustained and continues to make progress on extending bus routes and frequency. Promote ap and electronic tickets. (iii) Now that NR has received one year of UK support, consider using this period to plan follow up support thereafter to implement its e-BRT plan. (iv) For KK, ensure that *LCC*'s feeder plan and TOD study are shared with the relevant organizations, including the winning bidder for construction of the LR (CKKM). CO may wish to discuss with experts the viability, long-term cost effectiveness, and likelihood of funding of the LR plan and, if it makes sense, consider partnership to ensure TOD development is low carbon.

Responsible Entity: *LCC* Team, UNDP CO, RTA (all in partnership with NR, CM, KK)
Timeframe: Next 2 months for *LCC* Team; next 6 months for others

13. Waste management: Consider options for ensuring the success of promising *LCC* waste management initiatives in Samui and KK and, if it makes sense in terms of potential GHG ERs, continuing to build on those achievements and/or taking them to other cities in new projects: (i) For the three privately owned learning centers or stations that manage organic waste in Samui and the one public one in Khon Kaen, ensure that their waste supply flow is increased and received daily to the level that new equipment capacity is at maximal use. If these prove to be viable means to address total city organic waste at significant levels, consider promoting replication. (ii) For Samui household composting, consider promoting replication in other locales. (iii) For Samui hotel compositing, consider means to stimulate the re-initiation of composting post-pandemic among the hotels and to expand to more of Samui's 600+ tourist accommodations. UNDP may consider promoting the program to international hotel chains with branches on Samui. (iv) Consider supporting additional biogas digesters in NR at schools and hospitals according to interest expressed, as well as possibly municipal waste digesters in other cities if practical per expert advice. (v) For WTE projects, consider involvement carefully as these present special

challenges. Consider providing continued advice to cities and private sector owners especially in the case of NR (which is launching procurement for a WTE now) and also KK (which has the negative GHG ER WTE and is planning its next WTE, though that one should be several years down the line). Advice may consider reducing plastic content and insuring waste is not burned without power generation.

Responsible Entity: *LCC* Team, UNDP CO, RTA (all in partnership with Samui, KK, NR)
Timeframe: Next 2 months for *LCC* Team; next 6 months for others

14. Energy end use: Strongly consider opportunities in energy end use for future CCM projects, realizing that sizable GHG ER results can be achieved more quickly and with less complexity than in transport and typically, though not always, more easily than in waste management. Solar PV systems in the northeast seem an area that is just taking off. Private sector initiatives may be stimulated by brief studies and designs showing cost savings. For the public sector, designs of large systems with installation of a small portion as carried out by *LCC* may be a good model. Cooperation with PV system leasing/ BOT companies may be considered. For building initiatives in general, it may be useful to closely examine the track record of the NR energy audits and determine how many of the actions taken were actually due to the audits. If findings are positive, building energy audits on a larger scale in mid-sized cities might be pursued. Lastly, consider opportunities in promoting low carbon homes, building on the NR *Low Carbon Home Guide*. Ideas might include programs to promote energy efficient appliances or lighting across certain cities.

Responsible Entity: *LCC* Team, UNDP CO, RTA (in partnership with NR and other mid-sized cities, especially northeastern ones)
Timeframe: Next 2 months for *LCC* Team; next 6 months for others

F. Improving Design of UNDP-GEF Projects

15. Improve the PPG/ project design process for GEF projects in Thailand. Ensure strong logical framework analysis work at the beginning of design, so that there is a strong framework addressing key barriers as the basis for design. Ensure that interpretation for international consultant is detailed and strong, so that ProDoc reflects the real situation. During design, ensure that baseline project owners are onboard. Develop a relationship with them and confirm that their timelines fit with the project's. Increase specificity of incremental improvements planned and ensure that GHG ER projections are specific on whether 100% attribution is expected or only incremental attribution. For finance outcomes, ensure the options are well elaborated. Consider separate outcomes for policy work and capacity building if these are included, unless they are very closely related to finance. Enhance the identification, mobilizing and securing co-financing for projects during the design phase.

Responsible Entity: PPG team, UNDP CO, UNDP RTA
Timeframe: As needed when projects are designed

Annex 1. Comparison of LCC Indicator Self-Assessment and TE Assessments, with Explanation of Gaps

LCC Project Results Framework, Comparing LCC Self-Assessment to TE Assessment

Note: TE clarifying additions to indicator statements provided in red.

Strategy	Indicator	Baseline	EOP Target	Achieved (TE Assessment)	Claimed (Project Team) (*Document of Claim*)	Reason for the Difference/ Comments on Quality of Indicator or Target
Project Goal: Reduction of future GHG emissions from cities in Thailand	Cumulative direct GHG emission Reductions (ERs) resulting from the technical assistance and investments by end-of-project (tCO2 eq.)	0	177,708 t	12,468 t Lifetime: 59,007 t	269,552 t (*presentation of LCC to TE Team*) Lifetime 636,594 t (*ERM MRV spreadsheet*)	-LCC claimed credit for installations not due to the LCC ("wrong attribution") *In one case, project claimed very large positive ERs for an installation that actually had negative ERs (and was not attributable to project) *In another case, claim of waste treated was over 3x level indicated by local consultants (and was not attributable to project anyway) -In cases where LCC only added incremental improvement, LCC still claimed credit for full installations (and sometimes used start date for claimed ERs before incremental benefit was added)
Project objective: Promotion of sustainable urban systems management in KhonKaen, Nakorn Ratchasima, Samui and Klaeng to achieve low carbon growth	Cumulative direct fuel savings resulting from the technical assistance and investments in the transport and electricity sector in the 4 participating cities by EOP (GJ)	0	788,093 GJ	18,862 GJ	751,167 GJ	Some of the same problems as with GHG ER indicator above: (i) project claimed installations that were not due to project, (ii) project claimed credit for full installations even though project sometimes added only incremental benefit (and sometimes started claiming credit before incremental benefit was added)
	Annual amount of waste gainfully used (recycled, composted, Anaerobically digested or for waste-to-energy) in the 4	46,272 tpy	389,352 tpy (*or 343,080 tpy beyond baseline)*	1,372 tpy *attributed to LCC (does not include baseline amount); (result will be more if attribution to*	145,497 tpy *(not sure if it includes baseline amount)*	Some of the same problems as with the GHG ER indicator above: (i) project claimed installations not due to project, (ii) project claimed credit for full installations, even though project sometimes added only incremental benefit.

	participating cities by EOP (tonnes/year)			*LCC Project not required)*		
	Total number of green jobs created in the waste management sector and sustainable transport sector in the cities by EOP	0	40	0 *(result will be more if attribution to project is not required.)*	88	-The project claims 20 jobs at the new EV Tuk in Chiang Mai: The TE Team sees no evidence this is linked to the LCC project -The project claims 20 jobs at the KK WTE. The TE Team does not believe these can be attributed to project. -Indicator statement does not clearly require attribution, but the low level of the target implies attribution is assumed.
Outcome 1.1: Increased number of Thai cities that have formulated and implemented low carbon sustainable urban development plans	No. of cities that have approved and adopted low carbon development plans by ~~2017~~ EOP	0	4	4	4	----
	Percentage of participating cities where evidence-based low carbon planning is integrated with normal urban development planning processes by EOP	0	100%	25% at most	100%	-This indicator is understood to mean that low carbon planning has been integrated on an ongoing basis into the planning process, not just a one-time affair. NR's plan now has a "low carbon section," so it's a good possibility that will be carried over to future plans. For the other cities, consultations indicate that nothing that new was included in the current plans as a result of the LCC activities. Instead, it was said that city stakeholders mainly learned which of the activities they were already planning could be called "low carbon."
	No. of cities which have completed carbon footprints in selected sectors and have institutionalized the process by 2018	0	4	1 at most (*all 4 have carbon footprints but at most one is close to institutionalizing the process*)	4	-No clear evidence was obtained that any city plans to update its CCF on its own in future -Yet, findings suggest that Khon Kaen is the most advanced in having staff that know how to calculate GHG ERs -Expectation for mid-sized cities to prepare their own carbon footprints seems very high
Outcome 1.2: Increased number of Thai cities with energy efficient urban systems	No. of low carbon demonstration Projects implemented as a result of technical and investment	0	19	18 *(includes only demos that are physically manifested and not studies, etc.)*	24	-The difference is probably due to LCC counting MRV-only projects as demos, which the TE believes are not attributable to the project versus the TE Team counting more of

	assistance in participating cities by EOP					the NR energy efficiency building upgrades as "demos." -A comment on the quality of the indicator is that it does not offer a clear assessment of progress as demos may be accounted for in different ways (e.g. is an energy audit program one demo, or several; and, if a building adopts two measures is that two demos or one?) and demos of vastly different size are each counted the same, as one demo..
	No. of low carbon projects designed based on or influenced by the results of the demonstration projects and the low carbon city plans by EOP	0	8	2	19	-The difference is probably explained in that two projects that had multiple replications by the project owner were not in the view of the TE Team attributable to LCC. The original projects (that were replicated) received only MRV support from LCC.
Outcome 2.1: Increased volume of investments in energy efficient urban systems by government and private sector	Total amount of new investment leveraged through local plans of participating cities for low carbon projects by EOP		USD16 million	USD71,169 (11,592 spent to date, the rest is budgeted). The value may be as high as USD34,962,502 if gravity piping system project included, though full attribution to project not clear. More if attribution to project not required.	882 million USD	-A comment on quality of the indicator is that, while this is the "financing" outcome, the indicator is quite closely related to plans, such as in the "planning indicator." While the meaning of the indicator is not entirely clear we assume a more general interpretation: Financing actually confirmed due to project activities. -A second comment: It's not clear whether attribution to the project is required. -The amount indicated by LCC includes USD709.67 million for the KK Light Rail. It is our understanding, however, that a search for financing of the KK LR is still underway. -A second amount included by LCC is USD 68.65 million for a new WTE in NR. While we understand that procurement is underway, we do not think this can be attributed to *LCC*.
	No. of new policies facilitating low carbon investments in cities endorsed	0	2	0	6	-Based on the ProDoc text and footnote to this indicator, we interpret the indicator to target national-level policies, none of which were pursued or achieved by *LCC*. Interestingly,

	and approved by line agencies by EOP. [Prodoc foonote: Policy recommendations are envisaged in the following two areas: 1) inclusion of low carbon investment in the performance evaluations (KPIs) of city staff (cooperation with Ministry of Interior), 2) legal revisions in order that cities are able to receive revenues from carbon credit sales (cooperation with Ministry of Interior).]					TGO is still considering the idea of promoting KPIs for local-level officials as in the note, but we did not detect that the project did any work on this. The project assesses this indicator to have achieved 6 policies, based on local activities in partner cities. Most of these "policies" sound more like "initiatives" or "investment decisions." For example, one is "expansion of Chiang Mai City's travel network." We understand this to correspond to the city's agreement to extend a certain bus route beyond the city borders. Another is "investment in the development of electric public transport system" in NR, which is related to its plans to develop e-BRT. The ProDoc includes such city "policy" work as a part of Outcome 1.2, the demo outcome, whereas it targets national policies that would have a broader impact on promoting low carbon city investments for this outcome.

Annex 2. Comparison of LCC Self-Assessed GHG ERs and TE Rough Estimates, with Explanation of Gaps

Dates for reference:
Start date of LCC Project: April 2017
LCC inception workshop: Jan 2018
Contracts signed by LCC city demo facilitators (out of which funds for all LCC city demos came): Sept. 2018.

Comparison of LCC Self-Assessed GHG ERs and TE Team Rough Estimates

Installation	LCC Self-Assessed GHG ERs (t CO2eq) by EOP / Lifetime	TE Team Rough Estimates of GHG ERs (t CO2eq) by EOP / Lifetime	Explanation of Gaps
I. DEMOS			
Nakhon Ratchasima			
1. City Biogas Digester increased power gen	18,783 / 81,957	-4[40] / 3,062	Should count only incremental GHG ERs: LCC claims full GHG ERs of installation since June 2016 for landfill methane avoided, but biogas digester clearly would have existed in "no GEF project" scenario, having been installed in 2012 and refurbished in 2016 (the latter with GIZ guidance). TE counts only incremental GHG ERs from increased power generation due to LCC TA, not baseline GHG ERs from landfill methane avoided. (Note: Power is sold to grid.) Possible 3-4x inflation of waste data: Also, MRV consultancy reports 13,192 tons of waste treated per year, whereas local data collection team reports less than 4,000 tons of waste per year going into digester, about half of which, or 2,000 tons per year, is organic. While the avoided methane emissions cannot be attributed to the project, it would still be worthwhile to understand if the

[40] Based on ERM's 2020 MRV report and estimates, the GHG ERs in tCO2 eq are about 0.53 times the organic waste tonnage. TA was conducted in late 2018 leading to adjustments in 2019 that led to substantial increase in electricity generation by 2020, with about the same amount of waste treated in 2020 as in 2018. Organic waste treated in 2018 before the change was 1,871 t. It went down in 2019 to 1,173 t due to an adjustment period, but rose back up to 2,015 t in 2020. Electricity generation was 136 MWh in 2018, roughly estimated at 211 MWh in 2019, and up to 362 MWh in 2020. Despite the increase in renewable electricity generation, according to TE Team estimates the reduction in organic waste treated in 2019 led to a slightly negative increment of GHG ERs by EOP. For lifetime, there is strong recovery from the dip (assuming constant results based on 2020 operation), with lifetime incremental GHG ERs estimated at 3,062 tons by TE Team.

			waste data was somehow wrongly inflated by 3.3 x and thus the GHG ER estimates were similarly inflated and how this happened.
2. Water Supply Bureau – pipe improvement	749 / 6,869	749 / 6,869	----- *(no difference/ full attribution to LCC, as LCC TA allowed this to happen)*---
3. Water Supply Bureau – 2 new pumps	125 / 1,364	125 / 1,364	----- *(no difference/ full attribution to LCC, which provided INV)*---
4. Water Supply Bureau – 1 pump (replication)	----	40 / 682	TE Team counted replication towards GHG ERs, LCC did not
5. Terminal 21 VSD (+15% efficiency)	9,126/ 50,101	714 / 7,013	Should only count incremental GHG ERs: LCC TA helped building that already had VSD with VSD adjustments that improved efficiency by 15%. LCC counted full GHG ERs of VSD since installation Jan. 1, 2017. TE Team counted only incremental GHG ERs since time of adjustment.
6. Maharaj Hospital LED light replacement	2,578 / 5,268	0 / 0	Wrong attribution – LCC provided MRV only: Installed Oct. 25, 2018 independent of advice from LCC
7. Waste recycle bank at Maharaj Hospital	890 / 989	0 / 0	Wrong attribution – LCC provided MRV only: Installed Feb. 1, 2017, before LCC launch. LCC provided LESS information only.
8. Mall Korat LED light replacement	611 / 1,285	0 / 0	Wrong attribution – LCC provided MRV only: Installed March and May 2019, but appears was undertaken independent of advice from LCC.
9. NR Technical College rooftop PV system. Ministry of Energy involved.	170 / 3,000	NA / NA	Should count incremental GHG ERs only: Installed Dec. 15, 2018 and undertaken independent of advice from LCC. LCC, however, provided advice for adjustment of the system which increased efficiency and GHG ERs, but we lack information of by how much.
10. Central Plaza rooftop PV system (999.7 kW). Ministry of Energy involved.	2,283 / 21,730	0 / 0	Wrong attribution – LCC provided MRV only: Installed Dec. 15, 2018 and undertaken independent of advice from LCC. LCC provided TVER information only. There were also 13 replications by the owner at its other sites, but TE Team could not verify these could be attributed to LCC.
11. LED lights of NR municipality	707 / 1,661	0 / 0	Wrong attribution – LCC provided MRV only: Installed May 1, 2017, well in advance of LCC inception workshop, and independent to LCC.
12. Waste recycle at NRRU	102 / 143	0 / 0	Wrong attribution – LCC provided MRV only: Installed Jan. 1, 2018, same month as LCC Inception Workshop. LCC provided LESS info only.
13. Waste recycle bank RMUTI	172/ 240	0 / 0	Wrong attribution – LCC provided MRV only: Installed Jan. 1, 2018, same month as LCC Inception Workshop. LCC provided LESS info only.
13. Terminal 21 PV system – 999 kW	NA / NA	1,738 /21,730	Result of LCC Energy Audits in NR. For some reason, not counted by LCC.
14. Central NR Chiller VSD (improvement)	NA / NA	127/1,043	Result of LCC Energy Audits in NR. For some reason, not counted by LCC.
14. Mall Korat new Chiller	NA / NA	47.46/1,144	Result of LCC Energy Audits in NR. For some reason not counted by LCC.
15. Klang Plaza upgrade to LED lights	NA / NA	35.36/255	Result of LCC Energy Audits in NR. For some reason not counted by LCC.
16. Klang Villa chiller adjustment	NA / NA	NA / NA	Result of LCC Energy Audits in NR. For some reason not counted by LCC.
NR subtotal	***36,296/174,609***	***3,572/43,200***	---
Chiang Mai			

1. Consolidated bus stops and improved bus routes (said to result in shifts from private cars to public buses)	2,592 / 11,370	NA / NA	Reported achievement calculated based on start date that is long before implementation of measures that are supposed to have led to it. Calculation based on survey done around the time of that erroneous start date: LCC calculates GHG ERs starting from Oct. 1, 2018. Province did not approve consolidated bus stops until July 2020. GHG ER estimates are based on survey in Sept. 2018, rather than on assessment of real results possibly achieved in late 2020. It is likely that due to gradual ramp up and due to impact of Covid-19 crisis by early 2021, not many GHG ERs were achieved by EOP. Yet, there is potential for lifetime GHG ERs once Covid impact recedes if, indeed, consolidated bus stops and improved bus routes are verified to have resulted in shift from private car use to public bus riding.
Chiang Mai subtotal	***2,592 / 11,370***	***NA / NA***	---
Khon Kaen			
Khon Kaen WTE	96,007/ 408,110	0 / 0	Wrong attribution – KK WTE not attributable to LCC and LCC provided only MRV to KK WTE: Alliance Clean Energy signed agreement with city of KK for WTE in Aug. 2011. It signed PPA with PEA in Oct. 2013. LCC PPG did not start until July 2014. Even if it were attributable, GHG ERs would be negative due to excess waste burned on site without power generation: Our estimate is that GHG ERs from Nov 2016 (the date LCC starts counting KK WTE's GHG ERs) to EOP, the GHG ERs are -99,750 t CO2eq. Lifetime GHG ERs are -791,454 t CO2eq. GEF methodology calls for including all emissions at demo site. Nowhere does manual for GEF RE GHG ER methodology say that extra burning at site of WTE does not have to be counted. That manual does not even mention WTE. Further, ProDoc GHG ER calculations do not anticipate this extra burning on site, so cannot be used as justification. Even for power generation portion alone, if it were attributable and if ignoring the excess waste burning were allowed, the estimate is inflated by wrong methodology: The methodology used assumes the incineration in the power generation can be counted as zero. This would be true if only sustainable biomass were burned, but substantial plastic is burned. It is true that this wrong methodology (which takes about 2 minutes to compute) was used in the ProDoc, but it is not true that GEF guidelines for estimating GHG ERs of renewable energy projects indicate that this approach should be used. Those guidelines do not mention WTE plants. LCC implementation's resources for estimating GHG ERs of the KK WTE far exceeded ProDoc resources for doing so. There was a USD290,000 MRV contract for GHG ER calculation and training (and this was the installation with the largest GHG ERs among the 24 for which GHG ERs were calculated) and there was a USD33,333

			contract for a local consultant that was fully dedicated to GHG ER calculation of the KK WTE.
Solar rooftop PV at fresh market	23 / 277	23/ 277	----- *(no difference/ full attribution to LCC, which provided INV)*---
Solar rooftop PV at wastewater plant	22/ / 264	22 / 264	----- *(no difference/ full attribution to LCC, which provided INV)*---
Expansion of organic waste station	1,739 / 6,301	NA / NA	Should only count incremental GHG ERs: This "demo" provided larger capacity equipment to an existing station. LCC is calculating the full GHG ERs of the station from a start date of Jan 1. 2018, nine months before the city demo facilitation consultancies had their contracts signed.
Additions to inorganic waste stations	667 / 931	NA/ NA	Should only count incremental GHG ERs: LCC added incrementally to an existing city "3R" program. LCC is calculating the full GHG ERs of the program from a start date of Jan 1. 2018, nine months before the city demo facilitation consultancies had their contracts signed.
Khon Kaen subtotal	***98,548/415,883***	***55+/541+***	-----
Samui			
1. Gold Bin HH composting	116 / 333	116 / 3,953	Increment pre-EOP (2,500 households) the same; TE computes greater lifetime results. TE Team includes additional increment of 11,750 HHs in going beyond EOP, though ideally this will be verified. LCC method does not include the additional 11,750 HHs. TE Team also assumes lifetime of behavior is 10 years, as evidence shows bins are not the limiting factor.
2. Hotel composting	0 / 0	0 / 2,419	TE Team included potential for restart of hotel composting post-Covid impact
3. Bophut Organic Waste Station	25/ 88	5.33 / 53	Should only count incremental GHG ERs: Station was already processing organic waste prior to LCC support. Thus, rough baseline needs to be subtracted out. TE Team differentiates pre-/post-Covid and Covid volumes.
4. Ban Ya Suan Pu Coconut Learning Center	80 / 280	13.45 / 135	Should only count incremental GHG ERs: Center was already processing coconut waste prior to LCC support. Thus, the baseline needs to be subtracted out. TE Team differentiates pre-/post-Covid and Covid volumes.
5. Seeds2Sustain (organic waste to charcoal)	20/ 46	NA/ NA	Should only count incremental GHG ERs: This station was already processing coconut waste into charcoal prior to LCC support. Thus, the rough baseline needs to be subtracted out.
6. Hua Thanon Fish Market Wastewater Treatment	0/ 0	NA / NA	*GHG ERs may be very small and not easy to calculate: Fish market previously discharged wastewater into the ocean. LCC does not count GHG ERs based on installation being needed to comply with regulations.*
Samui subtotal	***242 / 748***	***134.8 / 6,560***	
CP All			
1. Say no to plastic bag campaign	8,706/ 8,706	8,706/ 8,706	*LCC believed to have sped up campaign: CP All did a previous "say no to plastic bags" campaign of smaller scale. They had intended to do a larger campaign before LCC interaction, but it is claimed that the LCC interaction led to a speed up of one year in the campaign.*

2. Five rooftop PV systems at distribution centers	1,601/ 25,278	0 / 0	Wrong attribution: TE Team did not find there to be strong evidence of attribution. One source indicated that the systems were paid for by the LCC project, but this would have cost over USD1 million, which is not evidence in the GEF budget.
CP All subtotal	***10,307/ 33,984***	***8,706/ 8,706***	---
DEMOS TOTAL EOP/ Lifetime	**147,897/636,594**	**12,468/59,007**	**Self-assessed amounts are over 10x TE team rough estimates**
II. TGO ADDITIONAL WORK			
1. TGO TVER and LESS certification work	121,655/ NA	0 / 0	Wrong attribution: This work was MRV only, namely T-VER and LESS certification carried out by TGO, with some support from LCC for travel. One source indicates the outreach resulted in some projects that wouldn't have happened otherwise, but this is hard to verify and likely can still not be attributed to LCC. Typically MRV only work does not lead to attribution for GHG ERs.
TGO TVER and LESS work subtotal	***121,655/ NA***	***0 / 0***	----
GRAND TOTAL EOP only	**269,552**	**12,468**	**Self-assessed amount is over 20x TE team rough estimate**

Annex 3. Terminal Evaluation Interviews – Realized Schedule and Persons Consulted

This annex shows the interview schedule for the virtual TE mission, as well as the persons consulted in each interview meeting. Due to the Covid-19 pandemic, all interviews were conducted remotely, mostly by video call, though some by telephone call. When the call was by telephone rather than video, it is noted. Most interview meetings were attended jointly by the International Consultant and National Consultant. When only one attended an interview, it is noted.

April 20, 2021 (Tuesday))
1. UNDP and LCC Project: TE Launch meeting with UNDP Thailand CO, UNDP-NCE RTA, and LCC Project Team (≈1 hour)
April 23, 2021 (Friday)
2. LCC Project Team: Discussion of TE Mission: Dr. Amornwan Resanond (Mai), Project Manager; Ms. Kwanjai Satchatham, Project Coordinating Associate (≈1.5 hours)
April 26, 2021 (Monday)
3. UNDP NCE Unit, BRH: Mr. Manuel Soriano, NCE Unit Senior Regional Technical Advisor (≈1 hour) 4. Thailand Greenhouse Gas Management Organization (TGO): Dr. Natarika Wayuparb Nitiphon, Deputy Executive Director, TGO, and former NPD to LCC Project 5. PM of LCC Project: Dr. Amornwan Resanond (Mai) (≈2 hours)
April 27, 2021 (Tuesday)
6. Contractor Facilitating Khon Kaen Demo Package (Khon Kaen University) and Khon Kaen Municipality LCC Focal Point: Dr. Supawattanakorn Wongtanawasu and Dr. Pattanapong Toparkngam, both of COLA, KKU; Mr. Tassanai Prachuabmorn, Director of Public Health and Environment Division, KK Municipality (≈3 hours) 7. LCC Project Coordinating Associate: Ms. Kwanjai Satchatham (≈2 hours)
April 28, 2021 (Wednesday)
8. UNDP Thailand CO Energy and Environment Team Leader: Mr. Saengroj Srisawaskraisorn (≈1.5 hours) 9. Contractor for Curriculum and Knowledge Packages (Environmental Research Institute, Chulalongkorn University): Dr. Jakapong Pongthanaisawan and colleagues (≈2 hours)
April 29, 2021 (Thursday)
10. Contractor Facilitating Nakhon Ratchasima Demo Package (Environmental Management Institute, Chulalongkhorn University) and Nakhon Ratchasima Municipality LCC Focal Point: Dr. Orathai Chavalparit, Dr. Nantamol Limphitakphong, and other colleagues from CU; and Mr. Netiwit Reungsukpipattana, Director of Technical Sanitary Division, NR Municipality (≈3 hours) 11. Contractor Facilitating Samui Demo Package and Leading Samui CCF and LEDS (Bright Management Consulting) and Samui Municipality LCC Focal Point: Mr. Padungsak Unontakarn and Mr. Griddipong Boontarik, Bright Management Consulting, and Ms. Supinya Srithongkul, Advisor to the Mayor, Samui Municipality (≈3 hours)
April 30, 2021 (Friday)
12. Contractor Facilitating Chiang Mai Demo Package (Chiang Mai University) and Chiang Mai LCC Focal Point: Pongtip Tiengburanatham, Chiang Mai University and Mr. Trinnawat Suwanprik, Transport Department, Chiang Mai Municipality (≈3 hours) 13. Third Party MRV Consultancy, Consultancy for CCF and LEDS for KK, NR, and CM, and Consultancy for Project Final Report (ERM Siam): Dr. Chacharee Therapong and team (≈2.5 hours)
May 3, 2021 (Monday)

14. TGO Executive Director: Mr. Kiatchai Maitriwong (≈1 hour) 15. Organization involved in implementation of Samui hotel composting demo (Tourism and Hotel Association of Koh Samui), Ms. Krissana Promkoh (≈1/2 hour *telephone call, National Consultant only*)
May 5, 2021 (Wednesday)
16. Chiang Mai Smart Mobility Alliance Network: Dr. Poon Thiengburanathum, Founder of Alliance, Consultant to LCC, and Chair of Land Transport Committee advising Chiang Mai Province; Mr. Natee Theppote, Om Platform (company providing e-ticket reading equipment and closely associated with company providing ap to Alliance); and Ms. Pongtip Tiengburanatham, Chiang Mai University (facilitating the discussion) (≈1.5 hours *International Consultant only*)
May 6, 2021 (Thursday)
17. Organization supporting implementation of LCC household composting scale-up in Samui (Gold Bin): Mr. Trinnaphob Lertsinsathaporn (DJ Noo), facilitated by Bright Management Consulting (Mr. Padungsak Unontakarn and Mr. Griddipong Boontarik) (≈1.25 hours) 18. Local consultant responsible for MRV of Khon Kaen Waste to Energy and Organization Facilitating KK Demo Package: Dr. Kitiroj Wantala, MRV Consultant and Associate Professor, Faculty of Chemical Engineering; Dr. Pattanapong Toparkngam, COLA, KKU (Facilitator of KK Demos, who presented information on history of KK WTE) (≈1.25 hours *International Consultant only*) 19. Khon Kaen Think Tank: Mr.Kungwan Laovirojjanakul Co-Founder (≈1/2 hour *telephone call, National Consultant only*)
May 7, 2021 (Friday)
20. Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy: Dr. Sukamon Prakobchat, also LCC Project Board Member (≈1/2 hour *telephone call, National Consultant only*) 21. CP-All: Mr. Varapol Klahan (≈1/2 hour *telephone call, National Consultant only*) 22. Baan Ya Suan Pu Learning Center: Mr. Kanit Somwong, Owner (≈1/2 hour t*elephone call, National Consultant only*)
May 14, 2021 (Friday)
23. Former International Technical Advisor on MRV to LCC: Mr. Karsten Holm (≈ 1 hour *International Consultant only*)

Annex 4. Master Interview Guide

Below is the Master Interview Guide, used as reference for interviews. For many interviewees, only certain parts of this guide were relevant. In general, the TE Team took some time before each interview to tailor its interview structure and content to the interview.

Master Interview Guide – *LCC* TE

1. Project Overall: Relevance, Outstanding Results, Main Challenges
We'll go into each outcome and specific activities in detail later, but for now would like to get your overall view on the following (*Note: In some cases, especially shorter interviews, we might skip over this "project overall" section, but integrate main concepts into the outcome-by-outcome questions.)*

Relevance
1. Need and attribution: Is project needed? Would the things it has done, such the LCC demos, have happened anyway without the project? What's the evidence that these things would not have happened without the project? Can what has occurred really be attributed to the project?
2. Innovativeness: Is the project innovative? Have the things it has done, such as the LCC demos, the LCC plans, and LCC financial incentive mechanisms, already been done before? If certain aspects are innovative, which ones?
3. Scale-up: For aspects that are not innovative/ brand new, is the project achieving substantial scale-up? How does the scale-up achieved compare to what was on the ground before?
4. Replication: Has the project stimulated replication or pipeline plans for such replications that are likely to be realized? What is the evidence of this? Who is replicating? Where are they getting the funds to do so? Is this across the board for all measures or just select ones?

Top achievements/ top impacts:
5. Top achievements: In your view, what are the most outstanding achievements of the project? What are you most proud of? Why?
6. Lasting change: What kind of lasting change or long-lasting achievements has the project resulted in? That is, what impacts of the project will continue in the future and continue to have positive effects?
7. Overall degree of impact: Do you feel that the impact of the project on your city (or on the four cities) is a substantial one that has changed the way the city does planning or does projects in certain sectors? Or do you see the impact as much more minor?
8. Evidence of progress towards objective: What evidence are we seeing that progress has been made towards the project objective? ("*Promotion of sustainable urban systems management in Khon Kaen (KK), Nakorn Ratchasima (NR), Samui and Chiang Mai to achieve low carbon growth*") As above, has much change been made in the way the cities are managed or in the way they manage their waste, transport, or other sectors?
9. Recommendations related to successes: Based on the most outstanding results of this project, do you have recommendations of how other UNDP projects or the RGoT or individual cities or other stakeholders can draw from methods used or build on results?

Main concerns/ shortcomings and problems*:*
10. Main concerns/shortcomings: What are your main concerns about this project? What are its main shortcomings? What could it have done better? What should it have addressed that it didn't?
11. Special challenges: Were there special challenges (expected or unexpected) that the project faced that impeded progress/ results? Could something have been done that wasn't to overcome these?

12. Recommendations related to challenges: Based on the problems, do you have recommendations for future projects or future RGoT or individual city activities to overcome such challenges?

2. Outcome 1.1 Results: Low Carbon City Planning Achieved and Institutionalized

1. Carbon City Footprints: Did the project do this for your city? Is it being used? How?
2. Low Carbon Development Plans: Were all four LCC plans done by the project? Are these useful? Are they being used? What was the role of the project in the smart city plans?
3. Influence on mainstream municipal plans: How exactly is the LCC planning integrated into the main city planning or plans? How meaningful is this in terms of future impact? Is it attributable to the project?
4. Activities not reflected in outcome level targets: Were there other activities under Outcome 1.1 (which is about planning and carbon footprints) that are not reflected in the outcome-level targets? Are there activities (under Outcome 1.1), the results of which the project/ you are particularly proud of, so that the TE team should take note?

3. Outcome 1.2 results: Demonstration of low carbon urban initiatives shows financial and technical viability

1. Summary of demo related initiatives: Please list the demos, pipeline projects, and replications LCC has supported in your city and then we'll ask questions about each below.
2. Demos: Real (or potential) impact of each demonstration and technical and financial viability: Tell us more about each demo: For each demonstration, what was achieved? Is this demonstration having or likely to have a catalytic effect to stimulate other demonstrations like it? Was this something new for your city? How are the GHG ER results? How was the cost effectiveness? Were any technical problems overcome?
3. Attribution of demos completed pre-project: For demonstrations completed before the project launch, what arguments can be made for influence of LCC's design process on realization of the demo? Would the demo have been done anyway as soon as it was done without the design process of LCC?
4. Attribution of demos completed during the project: For demonstrations completed during the project, what was the specific role of the LCC project? Would the demo have been done anyway in the absence of the LCC project?
5. Pipeline demos: likelihood of implementation, potential impact, and role of the project: Are there pipeline LCC initiatives? If so, how did the project influence them? Was the project instrumental in their coming to be? What is the probability of implementation and the meaningfulness/ impact if implemented? What are the potential GHG ERs?
6. Replications: impact, technical and financial viability, role of project/ path to stimulating the replication*:* Are there replications? What is the meaningfulness and impact of the replication? Does it show technical and financial viability? What are the potential GHG ERs and are these included in the project's direct GHG ER estimates? For replications, what is the role of the project demos or other project activities in stimulating replications? That is, how did the project's activities come to stimulate the replication? Would the replication have happened anyway on the same timescale?
7. Other activities not reflected in outcome targets or above: Were there other activities under Outcome 1.2 that are not reflected in the outcome-level targets? Are there activities the results of which the project is particularly proud of, so that the TE team should take note?

4. Outcome 2.1 Results: Substantially increased investments in LCC projects:

1. General impact of LCC projects on investments in LCC-type projects: Have you noticed that the project has increased investment in LCC projects beyond the project demos? What has been the level of investing and who is doing most of the investing? Are these the same as the replication or pipeline projects or are these additional projects you are talking about when you mention increased investment in LCC initiatives?

2. Assessing increase in investments – how the indicator is computed and what to include/ exclude*:* Does the indicator computation include the investments in the project demos? What would this indicator look like if we excluded the project demos? What if we included the pipeline projects that are considered likely only on account of the LCC Project (and multiplied them by a probability factor)? Which pipeline projects would it be fair to include if requiring it was due to the influence of the LCC project? As above, does this include all the replications? Does it include any projects beyond the replications?
3. Work on financial incentive schemes – analysis and its impact: Did the project analyze financial incentive schemes for GHG ERs? Which schemes were assessed? What was the impact of the analysis? ///Do you know about this work? How as it used? (*Which questions are asked will depend on the interviewee*.)
4. Implementation of financial incentive schemes: attribution and results: What work did the project do with regard to implementing financial incentive schemes? Which schemes were implemented? Can this be attributed to the project or would they have been implemented anyway on the same timescale without the project? What was the result – the successes and challenges?// Do you know of any financial incentive schemes that are used to encourage projects with GHG reductions? Have these schemes actually resulted in new projects? Or do people take them up only with projects they were going to do anyway? Do you know if the LCC project was involved in setting up these schemes?
5. T-VER and LESS Projects: What kind of projects in this area were done, especially if in waste management or transportation? Do you know if the LCC project played any role in stimulating these projects to happen? Or did only TGO play a role? What role did they play to stimulate the projects or were these projects going to happen anyway? What is the benefit of the projects? Their cost effectiveness and technical viability? Their impact?
6. Technical specialists that can access financial incentives for GHG ERs – impact and sustainability: Did the work the project did in this area result in technical specialists that are actively pursuing GHG ER related financial incentives on their own (without additional support)? Is this sustainable- that is, are there signs they will continue to pursue such incentives through additional projects?
7. GHG ER MRV system – impact and sustainability: Is this being used to pursue financial incentives for GHG ERs? Will this system only be used for the project, or is there evidence it continue to be used post-project? If the latter, what is the evidence? Is it easy to use or are experts needed?
8. LCC training course – trainees and impact: What type of persons were trained and what was the impact?
9. LCC network – impact of project/ sustainability and benefits: What was the status of the network before the project got involved in it? What was the impact of the project on this network? What is the benefit of this network? What are the signs that the network will continue post-project and continue to have benefits then?
10. Awareness campaign – target audience, content, and impact: Who did this campaign target? What was the content of the campaign and media used? Is there a measurable/ noticeable impact?
11. Financial and private sector participation: Since the purpose of this outcome is to increase investment in LCC projects, was there any outreach to financial institutions to convince them to support such projects? We understand there was work with the private sector. Can you tell us more about it?
12. Policy achievements: What are the policy achievements of the project? Are these policies being implemented? What did the project do to make them happen? What is the result/ impact of the policy? Will it be sustainable?
13. Other activities not reflected in outcome targets or above: Were there other activities under Outcome 2.1 that are not reflected in the outcome-level targets? Are there activities the results of which the project is particularly proud of, so that the TE team should take note?

5. Sustainability

1. Sustainability post-project of parts of the project you know about: If not discussed already, can you discuss whether the activities/ demos/ etc. of the project are likely to continue after the project?
-Plans

-Demos/ Replications/ Pipeline projects (actual physical and financial longevity expected?)
-Financial incentive mechanisms for GHG ERs
-Policies
-Capacity building and/or awareness
2. Recommendations to achieve sustainability (for RGoT, the city, UNDP, other players): What needs to be done to make these results sustainable?

6. Design (if not discussed above)
1. Strengths: Do you have comments on the strength of project design?
2. Weaknesses: The weaknesses of project design? In this regard, please talk about the planning, the demos (both waste management and transport), the financial incentive work and aim to increase investments, etc.
3. Indicators: How do you feel about the design of the project indicators?

7. Management Arrangements and Implementation (if not already discussed)
1. Impact of delays, whether such delays and impacts are common across other UNDP projects, and, if so, major measures that may be taken in the future by UNDP/RGoT: How seriously did delays at four stages - CEO Clearance, ProDoc signing, hiring of project team, and hiring of local facilitators in multi-city projects – affect the project. If these had been shortened to ideal levels for each transition, how might the project's performance have been different? Are such long delays at these four stages common across UNDP projects? If so, what are the options to try and eliminate the delays? What level of persons need to get involved in making the needed changes? Would it be CO leadership? What would be involved?
2. Impact of Covid-19 and lessons: How much has Covid-19 slowed down the project over the last year? Which kind of activities were affected? Are there lessons or ideas for measures to overcome barriers to implementation presented by Covid-19?
3. Structure of project team and support at city level by consultancies: How well did the structure work? Would it have made more sense to have dedicated staff persons at the city level rather than consultancies handling facilitation? Or was the approach of a very lean team, supported by consultancies, effective? What are the roles of team members and the facilitators? How active are they with regard to the on-the-ground implementation work and monitoring/ indicator work? Any comments on composition of project team? Do you need other types of team members?
4. Municipal partners: How are the municipal partners – the focal point and local working groups? How active have they been? What have they done? What were the challenges? Lessons for next time?
5. Project board: Has PB played an active role?
6. UNDP: Has UNDP played an active role? How has UNDP benefitted/ supported the project? Were there weaknesses of the project that UNDP might have addressed better? Anything else UNDP could have done to improve the project?

8. Adaptive Management
1. Good examples of adaptive management from this project's implementation?
2. Examples of when adaptive management was needed by not used well:
3. Specific issues related to adaptive management: How did the project adaptively manage to the situation that the WTE had already been implemented pre-project?

9. Cost effectiveness and co-financing
1. Cost effectiveness and proposed USD 1.8 million allocation across 7 consultancies? Why did the project choose not to hire a project team member for each city and instead recruit consultancies? Was this USD 1.8 million allocation across 7 consultancies realized? Can we discuss the contract size and cost effectiveness of each assignment and compare to the cost and effectiveness that would have been achieved using individual consultants?

2. Co-financing – level, use, and principles for what to include*:* Do you have data for realized co-financing? Are there breakdowns as to what the co-financing funds were used for? Is it justified for these funds to be counted as co-financing? Were all of these funds spent during the project? If not, which funds were spent before the project and what is the justification for inclusion as realized co-financing?
3. Cost effective aspects: What parts of the project do you think were most cost-effective – the best value for money?
4. Less cost effective aspects: What parts of the project in retrospect do you think were least cost-effective – not a good value for the money?

10. Stakeholder Mobilization/ Communications
1. Mobilization of local governments*:* How well were local governments mobilized to be active in this project? What is the evidence? Did the local focal point play an active role? What about the local working groups? Are there lessons for the future of how to mobilize local governments?
2. Mobilization of private sector: How did the project mobilize the private sector? Are there successes (as compared to other similar projects) and methods that should be noted? Challenges that should be noted?
3. Communities: How did the project mobilize communities? Are there successes (as compared to other similar projects) and methods that should be noted? Challenges that should be noted?

11. Gender
1. Gender: real impact on gender mainstreaming: What did the project actually do to try and promote gender mainstreaming? What were the results? Any lessons for future projects?
2. Gender indicators: Did you have these?

12. Recommendations
1. Do you have any recommendations that did not come out from our discussion so far?
a. What should Thailand do in the future to promote LCC? What aspects of this project proved to be effective that should be continued or built upon? Which aspects of LCC have proved ineffective that should not be done again as lessons learned or adjusted as lessons learned?
b. What should UNDP or other donors do in the future for LCC?
c. What do you recommend to the individual cities?
d. What do you recommend to the cities or nation in the policy area? Capacity building? Institutional?
g. Recommendations specific to waste management in cities?
h. Recommendations specific to sustainable transport in cities?
i. Recommendations specific to energy efficiency in cities?
j. Recommendations on project organization and management?

13. M&E and reporting
1. How did you carry out M&E? Who was responsible for determining indicator values? For CCM tracking tool?
2. What reporting did you have to do?

Annex 5. Rating Scales

(Based on Guidance for TE of UNDP-GEF Projects)

Ratings for Outcomes, Effectiveness, Efficiency, M&E, Implementation/Oversight, Execution, Relevance
6: Highly Satisfactory (HS): The project had no shortcomings in the achievement of its objectives in terms of relevance, effectiveness, or efficiency
5: Satisfactory (S): There were only minor shortcomings
4: Moderately Satisfactory (MS): There were moderate shortcomings
3. Moderately Unsatisfactory (MU): The project had significant shortcomings
2. Unsatisfactory (U): There were major shortcomings in the achievement of project objectives in terms of relevance, effectiveness, or efficiency
1. Highly Unsatisfactory (HU): The project had severe shortcomings

Sustainability
4. Likely (L): negligible risks to sustainability
3. Moderately Likely (ML): moderate risks
2. Moderately Unlikely (MU): significant risks
1. Unlikely (U): severe risks

Annex 6. Documents Reviewed

1. Thailand LCC CER
2. Thailand LCC ProDoc
3. Thailand LCC Mid-Term Review Report
4. Thailand LCC PIRs from 2018, 2019, and 2020
5. Audit Reports
6. Annual Budgets and Work Plans
7. Mission Reports
8. PIF and PIP and GEF Review Comments (the last obtained from GEF website)
9. Project Board Minutes
10. Project Reports: Final report from each city, Project Final Report (draft), Training Workbook, Stakeholder Engagement Final Report, Reports on CCF and LEDs, Covid-19 Policy Recommendations (ERM), ERM MRV Report, ERM MRV spreadsheet, Inception Report, Performance Management Report, CCM Tracking Tool (EOP)
11. Quarterly Progress Report
12. UNDP Thailand Country Program Document
13. Various co-financing computations and explanations
14. UNDP CDRs of expenditures by outcome
15. Presentations from the TE mission (PM presentation, presentations by each of the four demo facilitation teams, presentation by ERM, presentation by ERI, presentation on KK WTE)
16. Detailed responses of the city demo package facilitation teams for each of NR, CM, Samui and KK to extensive follow up questions from TE Team
17. Contract information covering both contracts with organizations and contracts with individuals, as provided by Project Team in response to TE Team request
18. Expenditure information by major activity area provided by Project Team in response to TE Team request

Annex 7. Evaluation Consultant Agreement Form

UNEG Code of Conduct for Evaluators/ Midterm Review Consultants

Evaluators/Consultants:

1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded.
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
3. Should protect the anonymity and confidentiality of individual informants. They should provide maximum notice, minimize demands on time, and respect people's right not to engage. Evaluators must respect people's right to provide information in confidence, and must ensure that sensitive information cannot be traced to its source. Evaluators are not expected to evaluate individuals, and must balance an evaluation of management functions with this general principle.
4. Sometimes uncover evidence of wrongdoing while conducting evaluations. Such cases must be reported discreetly to the appropriate investigative body. Evaluators should consult with other relevant oversight entities when there is any doubt about if and how issues should be reported.
5. Should be sensitive to beliefs, manners and customs and act with integrity and honesty in their relations with all stakeholders. In line with the UN Universal Declaration of Human Rights, evaluators must be sensitive to and address issues of discrimination and gender equality. They should avoid offending the dignity and self-respect of those persons with whom they come in contact in the course of the evaluation. Knowing that evaluation might negatively affect the interests of some stakeholders, evaluators should conduct the evaluation and communicate its purpose and results in a way that clearly respects the stakeholders' dignity and self-worth.
6. Are responsible for their performance and their product(s). They are responsible for the clear, accurate and fair written and/or oral presentation of study limitations, findings and recommendations.
7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

International Terminal Evaluation Consultant Agreement Form

Agreement to abide by the Code of Conduct for Evaluation in the UN System:
Name of Consultant: Eugenia Katsigris
I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.
Signed at Dallas, Texas, USA *(Place)* on May 31, 2021 *(Date)*
Signature: Eugenia Katsigris (*electronic signature*)

National Terminal Evaluation Consultant Agreement Form

Agreement to abide by the Code of Conduct for Evaluation in the UN System:
Name of Consultant: Walaitat Worakul
I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.
Signed at Chiang Mai, Thailand *(Place)* on June 21, 2021 (*Date)*

Signature: Walaitat Worakul (*electronic signature)*

Annex 8. TE Report Clearance Form

Terminal Evaluation Report for *(Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand (LCC), UNDP PIMS ID 4778*)

Reviewed and Cleared By:

Commissioning Unit (M&E Focal Point)
Name: Napaporn Yuberk
Signature: _____ Date: 28 June 2021

Regional Technical Advisor (Nature, Climate and Energy)
Name: Manuel Soriano
Signature: M.L Soriano Date: 28 June 2021

Annex 9. Terms of Reference for *LCC* TE Assignment

Terminal Evaluation Terms of Reference (ToR) for UNDP-supported GEF-financed projects

Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand

BASIC CONTRACT INFORMATION

Location: Bangkok, Khon Kaen, Nakorn Ratchasima, Samui and Chiang Mai provinces in Thailand
Application Deadline: 19 March 2021
Type of Contract: International Terminal Evaluation (TE) Consultant (Individual Consultant)
Assignment Type: Short-term
Languages Required: English
Starting Date: 15 April 2021
Duration of Initial Contract: 33 working days
Expected Duration of Assignment: 15 April 2021 – 25 June 2021

BACKGROUND

1. Introduction

UNDP Thailand Country Office is looking for an International Consultant who will work together with a national consultant in conducting the Terminal Evaluation (thereafter referred to as the "Evaluation Team").
In accordance with UNDP and GEF M&E policies and procedures, all full- and medium-sized UNDP-supported GEF-financed projects are required to undergo a Terminal Evaluation (TE) at the end of the project. This Terms of Reference (ToR) sets out the expectations for the TE of the full-sized project titled Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand (PIMS 4778) implemented through the Thailand Greenhouse Gas Management Organization (TGO). The project started on the 26 April 2017 and is in its final year of implementation. The TE process must follow the guidance outlined in the document 'Guidance For Conducting Terminal Evaluations of UNDP-Supported, GEF-Financed Projects' (Guidance for Conducting Terminal Evaluation of UNDP-Supported, GEF-Financed Projects).

2. Project Description

Thailand's 12th National Economic and Social Development Plan (2017-2021) sets a vision in moving Thailand towards a low carbon and climate resilient society and promotes sustainable economic and social growth that is environmentally friendly. Important steps have been taken to pave the way for low carbon and climate resilient society, but local authorities especially municipalities are faced with a range of challenges on low carbon urban development. Rapid economic development, urbanization and climate change pose a threat to the management of municipalities/cities in a sustainable way. In support of the Royal Thai Government and the local administration, UNDP Thailand designed a country-led intervention on strengthening the capacities and processes at local level for bottom-up integrated low carbon development planning and the sustainable management of low carbon development projects.

The Achieving Low Carbon Growth in Cities through sustainable Urban Systems Management in Thailand (LCC) Project aims to strengthen the capacities and processes at local level for bottom-up integrated low carbon development planning and the implementation and sustainable management of low carbon development projects.

The 4-year project (2016-2220) focuses on low carbon urban systems, in particular waste management and sustainable transport, in 4 cities, while experiences will be shared with other cities to learn from.

The project objective is to "promote sustainable urban systems management in selected cities to achieve low carbon growth." The objective will be achieved by removing barriers to adoption of low carbon development in cities in Thailand through the following components:

a) Low carbon sustainable urban development planning in 4 cities, which will enable them to formulate and implement low carbon sustainable urban development plans
b) Low carbon investments in 4 cities leading to more energy efficient urban systems
c) Financial incentives and institutional arrangements to increase volume of investments in energy efficient urban systems by government and private sector

The project is financially supported by the Global Environment Facility (GEF), with the Thailand Greenhouse Gas Management Organization (TGO) Public Organization, as the Implementing Partner. The total GEF-supported funding is US$ 3,150,000.

Project Implementation Period Extension

Due to the peak of the Covid-19 outbreak in Thailand during March-May 2020, strict social distancing measures were applied, and the emergency decree has been enforced nationwide since April 2020. Several measures to respond to the coronavirus infections outbreak has been enforced such as social distancing, work-from-home, restricted travel across the provinces and borders. The project team including UNDP, the implementing partners, consultants and the partner cities cannot perform their tasks efficiently during the lock-down. In June, the restriction on traveling and social distancing were gradually released.

All parties have tried their best to resume activities under given conditions. However, the key pending activities are still behind the original plan, particularly those involved with in person meetings and workshops in Outcome 2.1-- capacity building and raise awareness and the technical wrap up.

In addition, the Ministry of Natural Resources and Environment is scheduled to organize the Thailand Climate Action Conference (i.e., Thailand COP) in June 2021 where the project's low carbon cities activities will be featured as part of the conference. TGO is leading the preparation of these activities and has requested UNDP support for that.

A 3-month project implementation period extension was granted to enable the project to continue working on targeted activities to ensure the achievement of its project objective and respective outcomes as well as the sustainability of impact. The extension period from 27 April 2021 to 31 July 2021 will compensate for the delayed activities during the Covid-19 outbreak. The extension was endorsed by the project board at its recent meeting on 23 September 2020.

3. TE Purpose

The TE report will assess the achievement of project results against what was expected to be achieved and draw lessons that can both improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming. The TE report promotes accountability and transparency, and assesses the extent of project accomplishments.

The project is entering to the final phase of implementation. The project end date is on 31 July 2021. The Implementing Partner (TGO), Project Board members, and UNDP Thailand Country Office will use the project's evaluation results to ensure effectiveness of exit strategy during the 3-month project extension and take away key recommendations to embed into Thailand Greenhouse Gas Management Organization's operational strategy which supports implementation of Thailand climate action.

Further to this, the objectives of the evaluation will be to:

- assess the achievement of project results supported by evidence (i.e. progress of project's outcome targets)
- assess the contribution and alignment of the project to relevant environmental management plans and integrated low carbon development planning
- assess the contribution of the project results towards the relevant outcome and output of the Country Programme Document for Thailand (2017-2021) and recommendations on the way forwards
- assess any cross cutting and gender issues
- assess impact of the project in terms of its contribution to, or enabled progress toward reduced environmental stress
- examination on the use of funds [both GEF and non-GEF (co-financing) financial resources of the project] and value for money and to draw lessons that can both improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming

The TE will be conducted according to the guidance, rules and procedures established by UNDP and GEF as reflected in the UNDP Evaluation Guidance for GEF Financed Projects.

DUTIES AND RESPONSIBILITIES

4. TE Approach & Methodology

The TE must provide evidence-based information that is credible, reliable and useful.

The TE team will review all relevant sources of information including documents prepared during the preparation phase (i.e. PIF, UNDP Initiation Plan, UNDP Social and Environmental Screening Procedure/SESP) the Project Document, project reports including annual PIRs, project budget revisions, lesson learned reports, national strategic and legal documents, and any other materials that the team considers useful for this evidence-based evaluation. The TE team will review the baseline and midterm GEF focal area Core Indicators/Tracking Tools submitted to the GEF at the CEO endorsement and midterm stages and the terminal Core Indicators/Tracking Tools that must be completed before the TE field mission begins.

The TE team is expected to follow a participatory and consultative approach ensuring close engagement with the Project Team, government counterparts (the GEF Operational Focal Point), Implementing Partners, the UNDP Country Office(s), the Regional Technical Advisors, direct beneficiaries and other stakeholders.

Engagement of stakeholders is vital to a successful TE. Stakeholder involvement should include interviews with stakeholders who have project responsibilities, including but not limited to; executing agencies, senior officials and task team/component leaders, key experts and consultants in the subject area, Project Board, project beneficiaries, academia, local government and CSOs, etc. Additionally, the national TE consultant may require conducting field missions to: Bangkok, Khon Kaen, Nakorn Ratchasima, Samui and Chiang Mai provinces in Thailand subject to travel restriction on COVID-19.

Interviews will be held with the following organizations and individuals at a minimum:

List of Stakeholders

Bangkok:

1) Thailand Greenhouse Gas Management Organization (TGO) Public Organization

2) United Nations Development Programme Thailand
3) Bright Management Consulting
4) Chulalongkorn University
5) UNDP Thailand and UNDP-NCE Energy Team

Project Site:

6) Koh Samui Municipality
7) Chiangmai Municipality
8) School of Public Policy, Chiang Mai University
9) Khon Kaen Municipality
10) College of Local Administration, Khon Kaen University
11) Nakorn Ratchasima Municipality
12) Other project consultants and local counterparts as appropriate

The specific design and methodology for the TE should emerge from consultations between the TE team and the above-mentioned parties regarding what is appropriate and feasible for meeting the TE purpose and objectives and answering the evaluation questions, given limitations of budget, time and data. The TE team must, however, use gender-responsive methodologies and tools and ensure that gender equality and women's empowerment, as well as other cross-cutting issues and SDGs are incorporated into the TE report.

The final methodological approach including interview schedule, field visits and data to be used in the evaluation should be clearly outlined in the inception report and be fully discussed and agreed between UNDP, stakeholders and the TE team.

The final TE report should describe the full TE approach taken and the rationale for the approach making explicit the underlying assumptions, challenges, strengths and weaknesses about the methods and approach of the evaluation.

In case the International TE consultant is not able to enter Thailand due to the COVID-19 VISA protocol, the TE team should develop a methodology for carrying out the tasks remotely. This could include virtual interviews and extended desk reviews, data analysis, email or web-based surveys and evaluation questionnaires. This should be detailed in the TE Inception Report and agreed with the Commissioning Unit.

If all or part of the TE work will be carried out virtually then consideration should be taken for stakeholder availability, ability, or willingness to be interviewed remotely. In addition, their accessibility to the internet/computer may be an issue as many governments and national and pilot site counterparts may be working from home. These limitations must be reflected in the final TE report.

5. Detailed Scope of the TE

The TE will assess project performance against expectations set out in the project's Logical Framework/Results Framework (see TOR Annex A). The TE will assess results according to the criteria outlined in the Guidance for TEs of UNDP-supported GEF-financed Projects (Guidance for Conducting Terminal Evaluation of UNDP-Supported, GEF-Financed Projects).

The Findings section of the TE report will cover the topics listed below.
A full outline of the TE report's content is provided in ToR Annex C.
The asterisk "(*)" indicates criteria for which a rating is required.

Findings

i. Project Design/Formulation

- National priorities and country driven
- Theory of Change

- Gender equality and women's empowerment
- Social and Environmental Safeguards
- Analysis of Results Framework: project logic and strategy, indicators
- Assumptions and Risks
- Lessons from other relevant projects (e.g. same focal area) incorporated into project design
- Planned stakeholder participation
- Linkages between project and other interventions within the sector
- Management arrangements

ii. Project Implementation

- Adaptive management (changes to the project design and project outputs during implementation)
- Actual stakeholder participation and partnership arrangements
- Project Finance and Co-finance
- Monitoring & Evaluation: design at entry (*), implementation (*), and overall assessment of M&E (*)
- Implementing Agency (UNDP) (*) and Executing Agency (*), overall project oversight/implementation and execution (*)
- Risk Management, including Social and Environmental Standards

iii. Project Results

- Assess the achievement of outcomes against indicators by reporting on the level of progress for each objective and outcome indicator at the time of the TE and noting final achievements
- Relevance (*), Effectiveness (*), Efficiency (*) and overall project outcome (*)
- Sustainability: financial (*), socio-political (*), institutional framework and governance (*), environmental (*), overall likelihood of sustainability (*)
- Country ownership
- Gender equality and women's empowerment
- Cross-cutting issues (poverty alleviation, improved governance, climate change mitigation and adaptation, disaster prevention and recovery, human rights, capacity development, South-South cooperation, knowledge management, volunteerism, etc., as relevant)
- GEF Additionality
- Catalytic Role / Replication Effect
- Progress to impact

iv. Main Findings, Conclusions, Recommendations and Lessons Learned

- The TE team shall present the review findings of the TE in the TE report. Findings should be presented as statements of fact and described based on actual data or the result of the analysis of actual data.
- The section on conclusions shall be included based on the findings. Conclusions should be described comprehensively based on well substantiated by evidence and logically connected to the TE findings. These should highlight the strengths, weaknesses and results of the project, respond to key evaluation questions and provide insights into the identification of and/or solutions to important problems or issues pertinent to project beneficiaries, UNDP and the GEF, including issues in relation to gender equality and women's empowerment.
- Recommendations should provide concrete, practical, feasible and targeted recommendations directed to the intended users of the evaluation about what actions to take and decisions to make. The recommendations should be addressing the review findings and conclusions.
- The TE report should also include lessons learned from the project implementation, as well as best and worst practices in addressing issues relating to relevance, performance and success. These are lessons learned from project management, decision making, and implementation at different situations and circumstances (e.g.,

strategies and methods used, partnerships, financial leveraging, etc.) that can be applicable in the implementation of other GEF and UNDP interventions. When possible, the TE team should include examples of good practices in project design and implementation.

- It is important for the conclusions, recommendations and lessons learned of the TE report to include findings in the project design and implementation related to gender equality and empowerment of women.

The TE report will include an Evaluation Ratings Table, as shown below (or see Annex F).

ToR Table 2: Evaluation Ratings Table for "Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand" Project

Monitoring & Evaluation (M&E)	Rating[41]
M&E design at entry	
M&E Plan Implementation	
Overall Quality of M&E	
Implementation & Execution	Rating
Quality of UNDP Implementation/Oversight	
Quality of Implementing Partner Execution	
Overall quality of Implementation/Execution	
Assessment of Outcomes	Rating
Relevance	
Effectiveness	
Efficiency	
Overall Project Outcome Rating	
Sustainability	Rating
Financial resources	
Socio-political/economic	
Institutional framework and governance	
Environmental	
Overall Likelihood of Sustainability	

6. Expected Outputs and Deliverables

The TE *consultant/team* shall prepare and submit:

#	Deliverable	Description	Timing	Responsibilities
1	TE Inception Report	TE team clarifies objectives, methodology and timing of the TE	No later than 2 weeks before the TE mission: *by 22 April*	TE team submits Inception Report to Commissioning Unit and project management
2	Presentation	Initial Findings	End of TE mission: *by 3 May*	TE team presents to Commissioning Unit and project management
3	Draft TE Report	Full draft report *(using guidelines on report content in ToR Annex C)* with annexes	Within 3 weeks of end of TE mission: *by 19 May*	TE team submits to Commissioning Unit; reviewed by BPPS-GEF RTA, Project Coordinating Unit, GEF OFP

[41] Outcomes, Effectiveness, Efficiency, M&E, I&E Execution, Relevance are rated on a 6-point rating scale: 6 = Highly Satisfactory (HS), 5 = Satisfactory (S), 4 = Moderately Satisfactory (MS), 3 = Moderately Unsatisfactory (MU), 2 = Unsatisfactory (U), 1 = Highly Unsatisfactory (HU). Sustainability is rated on a 4-point scale: 4 = Likely (L), 3 = Moderately Likely (ML), 2 = Moderately Unlikely (MU), 1 = Unlikely (U)

5	Final TE Report* + Audit Trail	Revised final report and TE Audit trail in which the TE details how all received comments have (and have not) been addressed in the final TE report *(See template in ToR Annex H)*	Within 1 week of receiving comments on draft report: *by 14 June*	TE team submits both documents to the Commissioning Unit

*The final TE report must be in English. If applicable, the Commissioning Unit may choose to arrange for a translation of the report into a language more widely shared by national stakeholders.

All final TE reports will be quality assessed by the UNDP Independent Evaluation Office (IEO). Details of the IEO's quality assessment of decentralized evaluations can be found in Section 6 of the UNDP Evaluation Guidelines.[42]

7. TE Arrangements

The principal responsibility for managing the TE resides with the Commissioning Unit. The Commissioning Unit for this project's TE is the UNDP Thailand Country Office. The Commissioning Unit will contract the consultants and ensure the timely provision of per diems and travel arrangements within the country for the TE team, if the travel is permitted. The Project Team will be responsible for liaising with the TE team to provide all relevant documents, set up stakeholder interviews, and arrange field visits.
The UNDP Thailand Country Office and Project Team will provide logistic support in the implementation of remote/ virtual meetings if travel to project site is restricted. An updated stakeholder list with contact details (phone and email) will be provided by the UNDP Thailand Country Office to the TE team. The TE offer shall be all inclusive of cost of travelling.

8. Duration of the Work

The total duration of the TE will be approximately 33 working days over a time period starting *15 April 2021* and shall not exceed five months from when the TE team is hired. The tentative TE timeframe is as follows:

Timeframe	Activity
19 March 2021 (1 day)	Application closes
29 March-14 April 2021	Selection of TE team
15-16 April 2021 (2 days)	Preparation period for TE team (handover of documentation)
15-21 April 2021 (5 days)	Document review and preparation of TE Inception Report
22 April 2021 (1 day)	Finalization and Validation of TE Inception Report; latest start of TE mission
23-30 April 2021 (6 days)	TE mission: stakeholder meetings, interviews, field visits, etc.
3 May 2021 (1 day)	Mission wrap-up meeting & presentation of initial findings; earliest end of TE mission
4-19 May 2021 (12 days)	Preparation of draft TE report
20-25 May 2021 (4 days)	Circulation of draft TE report for comments
26 May-4 June 2021 (6 days)	Incorporation of comments on draft TE report into Audit Trail & finalization of TE report
9 June 2021 (1 day)	Preparation and Issuance of Management Response
10 June 2021 (1 day)	Concluding Stakeholder Workshop (optional)
14 June 2021 (1 day)	Expected date of full TE completion

[42] Access at: http://web.undp.org/evaluation/guideline/section-6.shtml

Options for site visits should be provided in the TE Inception Report. The expected date start date of contract is 15 April – 25 June 2021.

9. Duty Station

The International Consultant (Team Lead) can provide option to work remotely if there are constraints in obtaining VISA to enter Thailand. If so, the international consultant can work from home. The international consultant will coordinate with the appointed national consultant in the gathering of field data. The team's travel plan shall be adjusted based on travel restrictions of the government and UNDP, subject to the approval of the UNDP Thailand Resident Representative.

Travel:

- The BSAFE course must be successfully completed prior to commencement of travel;
- Individual Consultants are responsible for ensuring they have vaccinations/inoculations when travelling to certain countries, as designated by the UN Medical Director.
- Consultants are required to comply with the UN security directives set forth under: https://dss.un.org/dssweb/

REQUIRED SKILLS AND EXPERIENCE

10. TE Team Composition and Required Qualifications

A team of *two independent evaluators* will conduct the TE – *one international team leader (with experience and exposure to projects and evaluations in other regions) and one national expert from Thailand*. The international consultant will be designated as the team leader and will be responsible for the overall design and writing of the TE report. The national consultant will assess emerging trends with respect to regulatory frameworks, budget allocations, capacity building, work with the Project Team in developing the TE itinerary, etc.
The national consultant will work closely with the International Consultant in supporting any work that needs to be undertaken as laid out in this ToR, and other tasks, as required. The National Consultant will also act as a focal point for coordinating and working with relevant stakeholders in Thailand. In the case of international travel restriction and the mission is not possible, the TE team will use alternative means of interviewing stakeholders and data collection (i.e. Skype interview, mobile questionnaires, etc.) including the field visit by the National Consultant under the International Consultant's guidance.
The evaluator(s) cannot have participated in the project preparation, formulation and/or implementation (including the writing of the project document), must not have conducted this project's Mid-Term Review and should not have a conflict of interest with the project's related activities.
The selection of international consultant will be aimed at maximizing the overall "team" qualities in the following areas:

Education

- Master's degree in environment, engineering, technology, climate change, environmental science, economics, sustainable development or related fields;

Experience

- Minimum 10 years at the national or international level, related to environmental and/or energy planning, climate change, transport and waste management, low carbon development, and carbon footprint development;
- Minimum of 5 years of project evaluation and/or implementation experience in the result-based management framework, adaptive management and UNDP or GEF Monitoring and Evaluation Policy. Some experience working with GEF or GEF evaluation is an advantage.;

- Very good report writing and communication skills in English;
- Familiarity with the issues concerning the evaluated project in Thailand or in Asia Region is an advantage;
- Demonstrated understanding of issues related to gender, youth, and interlinkages with the Sustainable Development Goals;
- Good in data analytic and visualization techniques;
- Relevant experience with results-based management evaluation methodologies;
- Experience applying SMART indicators and reconstructing or validating baseline scenarios;
- Competence in adaptive management, as applied to *Climate Change Mitigation;*
- Experience in evaluating projects;
- Experience working in *Thailand;*
- Experience in relevant technical areas for at least *10 years;*
- Demonstrated understanding of issues related to gender and *Climate Change Mitigation;* experience in gender responsive evaluation and analysis;
- Excellent communication skills;
- Demonstrable analytical skills;
- Project evaluation/review experience within United Nations system will be considered an asset;
- Experience with implementing evaluations remotely will be considered an asset.

Language

- Fluency in written and spoken English.

Responsibility

- Documentation review
- Leading the TE Team in planning, conducting and reporting on the evaluation
- Deciding on division of labour within the Team and ensuring timeliness of reports
- Use of best practice evaluation methodologies in conducting the evaluation
- Leading the drafting and finalization of the Inception Report for the Terminal Evaluation
- Leading presentation of the draft evaluation findings and recommendations in-country
- Conducting the de-briefing for the UNDP Country Office in Thailand and Core Project Management Team
- Leading the drafting and finalization of the Terminal Evaluation Report

11. Evaluator Ethics

The TE team will be held to the highest ethical standards and is required to sign a code of conduct upon acceptance of the assignment. This evaluation will be conducted in accordance with the principles outlined in the UNEG 'Ethical Guidelines for Evaluation'. The evaluator must safeguard the rights and confidentiality of information providers, interviewees and stakeholders through measures to ensure compliance with legal and other relevant codes governing collection of data and reporting on data. The evaluator must also ensure security of collected information before and after the evaluation and protocols to ensure anonymity and confidentiality of sources of information where that is expected. The information knowledge and data gathered in the evaluation process must also be solely used for the evaluation and not for other uses without the express authorization of UNDP and partners.

12. Payment Schedule

- 20% payment upon satisfactory delivery of the final TE Inception Report and approval by the Commissioning Unit
- 40% payment upon satisfactory delivery of the draft TE report to the Commissioning Unit

- 40% payment upon satisfactory delivery of the final TE report and approval by the Commissioning Unit and RTA (via signatures on the TE Report Clearance Form) and delivery of completed TE Audit Trail

  Criteria for issuing the final payment of 40%
  - The final TE report includes all requirements outlined in the TE TOR and is in accordance with the TE guidance.
  - The final TE report is clearly written, logically organized, and is specific for this project (i.e. text has not been cut & pasted from other MTR reports).
  - The Audit Trail includes responses to and justification for each comment listed.

In line with the UNDP's financial regulations, when determined by the Commissioning Unit and/or the consultant that a deliverable or service cannot be satisfactorily completed due to the impact of COVID-19 and limitations to the TE, that deliverable or service will not be paid.

Due to the current COVID-19 situation and its implications, a partial payment may be considered if the consultant invested time towards the deliverable but was unable to complete to circumstances beyond his/her control.

APPLICATION PROCESS

13. Scope of Price Proposal and Schedule of Payments

Financial Proposal:

- Financial proposals must be "all inclusive" and expressed in a lump-sum for the total duration of the contract. The term "all inclusive" implies all cost [professional fees, travel costs (Bangkok to Project Sites, land transport/trip, number of accommodation per night), living allowances etc.];
- For duty travels, the UN's Daily Subsistence Allowance (DSA) rates are Khon Kaen, Nakorn Ratchasima, Samui and Chiang Mai, which should provide indication of the cost of living in a duty station/destination *(Note: Individuals on this contract are not UN staff and are therefore not entitled to DSAs. All living allowances required to perform the demands of the ToR must be incorporated in the financial proposal, whether the fees are expressed as daily fees or lump sum amount.)*
- The lump sum is fixed regardless of changes in the cost components.

14. Recommended Presentation of Proposal

a) **Letter of Confirmation of Interest and Availability** using the template provided by UNDP;
b) **CV** and a **Personal History Form** (P11 form);
c) **Brief description of approach to work/technical proposal** of why the individual considers him/herself as the most suitable for the assignment, a proposed methodology on how they will approach and complete the assignment, and comments and/or suggestions regarding the scope of work in the TOR to make the evaluation more robust, comprehensive, and useful; (max 1 page)
d) **Financial Proposal** that indicates the all-inclusive fixed total contract price and all other travel related costs (such as flight ticket, per diem, etc.), supported by a breakdown of costs, as per template attached to the Letter of Confirmation of Interest template. If an applicant is employed by an organization/company/institution, and he/she expects his/her employer to charge a management fee in the process of releasing him/her to UNDP under Reimbursable Loan Agreement (RLA), the applicant must indicate at this point, and ensure that all such costs are duly incorporated in the financial proposal submitted to UNDP.

All application materials should be submitted to the UNDP Jobs site by ***19 March 2021, 12:00 PM (Bangkok Time)***. Incomplete applications will be excluded from further consideration.

15. Criteria for Selection of the Best Offer

Only those applications which are responsive and compliant will be evaluated. Offers will be evaluated according to the Combined Scoring method – where the educational background and experience on similar assignments will be weighted at 70% and the price proposal will weigh as 30% of the total scoring. The applicant receiving the Highest Combined Score that has also accepted UNDP's General Terms and Conditions will be awarded the contract.

Technical Evaluation Criteria for National Candidates (Maximum 70 points):

- Criteria-01: Master's degree in environment, engineering, technology, climate change, environmental science, economics, sustainable development or related fields - **Max Point 5;**
- Criteria-02: Minimum 10 years at the national or international level, related to environmental and/or energy planning, climate change, transport and waste management, low carbon development, and carbon footprint development - **Max Point 25;**
- Criteria-03: Previous experiences in project evaluation and/or implementation experience in the result-based management framework, adaptive management and UNDP or GEF Monitoring and Evaluation Policy. Some experience working with GEF or GEF evaluation is an advantage **- Max Point 25;**
- Criteria-04: Good in data analytic and visualization techniques - **Max Point 10**;
- Criteria-05: Competency in Brief description of approach to work/technical proposal – **Max Point 5**

Financial Evaluation (Total 30 marks)

All technical qualified proposals will be scored out 30 based on the formula provided below.
The maximum points (30) will be assigned to the lowest financial proposal. All other proposals received points according to the following formula:
p = y (μ/
Where:

- p = points for the financial proposal being evaluated;
- y = maximum number of points for the financial proposal;
- μ = price of the lowest priced proposal;
- z = price of the proposal being evaluated.

16. Annexes to the TE ToR

- ToR Annex A: Project Logical/Results Framework
- ToR Annex B: Project Information Package to be reviewed by TE team
- ToR Annex C: Content of the TE report
- ToR Annex D: Evaluation Criteria Matrix template
- ToR Annex E: UNEG Code of Conduct for Evaluators
- ToR Annex F: TE Rating Scales and TE Ratings Table
- ToR Annex G: TE Report Clearance Form
- ToR Annex H: TE Audit Trail template
- Annex in a separate file: Relevant TE tracking tools
- Annexed in a separate file: GEF Co-financing template (categorizing co-financing amounts by source as 'investment mobilized' or 'recurrent expenditure')

Approved by Lovita Ramguttee

Lovita Ramguttee, Deputy Resident Representative, UNDP Thailand

Date: 10 March 2021