Accelerating the adoption and life-cycle solutions to electric mobility in Thailand

Part I: Project Information

GEF ID
10681

Project Type
FSP

Type of Trust Fund
GET

CBIT/NGI
CBIT **No**
NGI **No**

Project Title
Accelerating the adoption and life-cycle solutions to electric mobility in Thailand

Countries
Thailand

Agency(ies)
UNIDO

Other Executing Partner(s)
Eastern Economic Corridor Office (EECO)

Executing Partner Type
Government

GEF Focal Area
Climate Change

Taxonomy
Climate Change, Focal Areas, Climate Change Mitigation, Technology Transfer, Renewable Energy, Sustainable Urban Systems and Transport, United Nations Framework Convention on Climate Change,

Nationally Determined Contribution, Paris Agreement, Sustainable Development Goals, Influencing models, Demonstrate innovative approache, Transform policy and regulatory environments, Stakeholders, Civil Society, Academia, Community Based Organization, Non-Governmental Organization, Private Sector, SMEs, Individuals/Entrepreneurs, Type of Engagement, Information Dissemination, Consultation, Participation, Partnership, Beneficiaries, Communications, Education, Awareness Raising, Gender Equality, Gender Mainstreaming, Sex-disaggregated indicators, Gender results areas, Access to benefits and services, Capacity Development, Participation and leadership, Capacity, Knowledge and Research, Innovation, Knowledge Generation, Workshop, Training

Rio Markers

Climate Change Mitigation

Climate Change Mitigation 2

Climate Change Adaptation

Climate Change Adaptation 0

Submission Date

12/10/2021

Expected Implementation Start

7/1/2022

Expected Completion Date

6/30/2027

Duration

60In Months

Agency Fee($)

276,779.00

A. FOCAL/NON-FOCAL AREA ELEMENTS

Objectives/Programs	Focal Area Outcomes	Trust Fund	GEF Amount($)	Co-Fin Amount($)
CCM-1-2		GET	2,913,465.00	17,317,718.00
		Total Project Cost($)	**2,913,465.00**	**17,317,718.00**

B. Project description summary

Project Objective

To mitigate greenhouse gas emissions from the transportation sector by addressing barriers to the adoption and scale-up of electric mobility in Thailand through enhancing policy and regulatory framework, technology demonstrations in Thailand's Eastern Economic Corridor, and capacity building and knowledge sharing.

Project Component	Financing Type	Expected Outcomes	Expected Outputs	Trust Fund	GEF Project Financing($)	Confirmed Co-Financing($)
1. Improve policy and regulatory framework for electric mobility and sustainable use of batteries	Technical Assistance	1.1 National policy and regulatory framework for electric mobility and sustainable use of batteries enhanced in a gender-responsive manner	1.1.1 Analysis, forecast and management system for GHG emissions in the public transport sector developed 1.1.2 Policy and regulatory framework for EV Ecosystem development enhanced 1.1.3 Policy and regulatory framework for charging infrastructure integrated with renewable energy systems developed 1.1.4 Policy and regulatory framework for addressing life-cycle issues for electric mobility and sustainable use of batteries enhanced	GET	690,000.00	1,361,818.00

Project Component	Financing Type	Expected Outcomes	Expected Outputs	Trust Fund	GEF Project Financing($)	Confirmed Co-Financing($)
2. Accelerate technology adoption of electric mobility and sustainable use of batteries	Investment	2.1 National business sector ecosystem for electric vehicle entrepreneurship enhanced 2.2 Investment in electric vehicles and electric vehicle supply equipment integrated with renewable energy deployment and in addressing life-cycle issues for electric vehicle batteries in the EEC	2.1.1 Entrepreneurship support program for electric mobility solutions developed 2.2.1 Electric vehicles for public transport demonstrated 2.2.2 Charging systems integrated with renewable energy systems, and battery storage demonstrated 2.2.3 Applications of data to support planning and management of charging infrastructure, electric vehicles fleets, and GHG emissions reduction demonstrated 2.2.4 The integration of circular economy principles in the life cycle of electric vehicle batteries (e.g., the application of second life batteries) demonstrated	GET	1,782,000.00	13,583,000.00

Project Component	Financing Type	Expected Outcomes	Expected Outputs	Trust Fund	GEF Project Financing($)	Confirmed Co-Financing($)
3. Capacity building, up-scaling and knowledge sharing	Technical Assistance	3.1 Capacity development and knowledge exchange on lessons learned scaled-up to national, regional and global networks	3.1.1 Existing knowledge-exchange platforms and mechanisms strengthened with key national stakeholders and women engagement based on lessons learned from the EEC 3.1.2 Linkages created with regional and global platforms on electric mobility as part of the Global Electric Mobility Program 3.1.3 Training sessions for public and private sector on EVs and sustainable use of batteries taking into account gender equality and women empowerment	GET	200,000.00	1,392,000.00

Project Component	Financing Type	Expected Outcomes	Expected Outputs	Trust Fund	GEF Project Financing($)	Confirmed Co-Financing($)
4. Monitoring and Evaluation	Technical Assistance	4.1 Adequate monitoring of all project indicators	4.1.1 Monitoring and mid-term project review 4.1.2 Project terminal evaluation	GET	102,729.00	120,000.00
				Sub Total ($)	**2,774,729.00**	**16,456,818.00**
Project Management Cost (PMC)						
				GET	138,736.00	860,900.00
				Sub Total($)	**138,736.00**	**860,900.00**
				Total Project Cost($)	**2,913,465.00**	**17,317,718.00**

C. Sources of Co-financing for the Project by name and by type

Sources of Co-financing	Name of Co-financier	Type of Co-financing	Investment Mobilized	Amount($)
GEF Agency	UNIDO	Grant	Investment mobilized	80,300.00
GEF Agency	UNIDO	In-kind	Recurrent expenditures	150,000.00
Recipient Country Government	Eastern Economic Corridor Office (EECO)	In-kind	Recurrent expenditures	895,600.00
Recipient Country Government	National Science and Technology Development Agency (NSTDA)	In-kind	Recurrent expenditures	3,400,000.00
Recipient Country Government	Thailand Greenhouse Gas Management Organization	In-kind	Recurrent expenditures	1,661,818.00
Private Sector	BH Rayong Co. Ltd	Equity	Investment mobilized	3,830,000.00
Private Sector	Sakun C Innovation Co. Ltd	Equity	Investment mobilized	5,700,000.00
Beneficiaries	Rayong-Baan Chang Cooperative	Equity	Investment mobilized	200,000.00
Private Sector	Siam Cement Group	Equity	Investment mobilized	1,000,000.00
Recipient Country Government	Digital Economy Promotion Agency	Equity	Investment mobilized	400,000.00
			Total Co-Financing($)	**17,317,718.00**

Describe how any "Investment Mobilized" was identified

Discussions with relevant government agencies and private sector (e.g., local public transportation fleet operators, local electric vehicle manufacturers, charging point operators) on co-financing and co-investments have been held during the PPG phase. Table C includes confirmed co-financing (with letters provided) although additional identified co-financing where letter was not provided in time for submission

is included in description below. Government agencies: The following co-financings and investments will be provided and mobilized from government agencies. EECO, as the project executing entity, and TGO and NSTDA which will implement Component 1, and Components 2 and 3 of the project, respectively, will provide co-financing in the form of both grants and in-kind support to the project. Rayong Municipality: With GEF support for the costs of chargers to be installed at the Old Bus Terminal, Rayong Municipality will invest in providing land area and roof area within the Old Bus Terminal and at other locations such as at the Suan Sri Muang Library for installing chargers, and PV systems, respectively. The area, managed by Rayong Municipality, will be dedicated mainly for electric songthaews, and for PV systems to be integrated with the chargers. Rayong Municipality will also co-finance the operation and maintenance of these PV systems. In addition, Rayong Muncipality will be a member of the project steering committee, the Policy working group, and the Technology working group, and will provide in-kind contributions and information support to the project. Digital Economy Promotion Agency (DEPA): With GEF contribution to developing DEPA?s program for supporting start-up enterprises to develop innovative mobile applications, DEPA will help mobilize start-up enterprises to invest in developing mobile applications to collect, analyze and use data from users and drivers/operators of local public transportation fleet demonstrated in the project, and from users and operators of chargers demonstrated in the project for planning and management of electric vehicle charging infrastructure, electric vehicles fleets, and GHG emissions reduction. Government agencies which are members of the project steering committee, the Policy working group and the technology working group established under this project (see the list of government agencies in the section Stakeholders): These government agencies will provide in-kind contribution and information support to the project through the project steering committee, the Policy working group and the Technology working group which have been established. Private sector: The following co-financing and investments will be provided and mobilized from private sector following GEF support. 1. Local public transportation fleet operators BH Rayong Co. Ltd: With GEF support for a small percentage of the costs of 2 pilot electric minibuses, this minibus operator will invest in purchasing at least a total of 15-30 more electric minibuses to replace some or all of its 50 existing diesel-run minibuses during the project period, and also invest in developing its own existing garage to be usable for maintenance of electric minibuses. The company will also co-finance the operation and maintenance of these electric minibuses. As for chargers, with GEF support for one charger and PV systems to be connected with the charger, the company will invest in purchasing and installing 9 more chargers to supply its electric minibus fleet during the project period. The company will also provide co-financing in the form of property, providing its own land area, and roof area for installing chargers, and PV systems, respectively. In addition, the company will co-finance the operation and maintenance of the chargers and PV systems. Rayong-Baanchang songthaew (modified pick-up truck) cooperative and Rayong-Paknam songthaew cooperative: The cooperatives will invest in purchasing 8 more electric songthaews through soft loans and financial support from sponsors such as large conglomerates. The cooperatives will also co-finance in the operation and maintenance of the 2 prototype electric songthaews, and 8 electric songthaews, and in providing information support to the electric vehicle manufacturer during the use of 2 prototype electric songthaews for engineering design for improved safety and comfort. This has been discussed based on GEF support for the costs of 2 prototype electric songthaews and a small percentage of the costs of 8 electric songthaews to replace diesel-run songthaews operating on the route between Rayong and

Baanchang and the route between Rayong and Paknam. 2. Local electric vehicle manufacturers Sakun C Innovation Co. Ltd: The electric vehicle manufacturer will mobilize investment in infrastructure and technicians required for developing and manufacturing 2 prototype electric songthaews and some 10-25 electric songthaews to replace diesel-run songthaews. Co-financing will be leveraged based on GEF support for the costs of research and development of new electric vehicles which can substitute existing diesel-run modified pick-up truck or ?songtheaws?, including development of one standard electric vehicle platform for multi-purpose electric vehicles and two prototype electric songthaews which will be specially-designed to substitute existing diesel-run songtheaws. Another electric vehicle manufacturer: Another electric vehicle manufacturer will be sought out during the initial implementation phase to mobilize investment required in supporting the design, development, and testing of prototypes of second life batteries and the development of a guideline for life-cycle management of electric vehicle batteries for environmental sustainability. 3. Charging point operators Provincial Electricity Authority (PEA)-Volta: PEA-Volta will invest in 2 chargers to be installed at the Terminal, and additional chargers to be installed at another location such as at the Suan Sri Muang Library. PEA will also co-finance in the operation and maintenance of all these installed chargers. This co-financing will be leveraged off GEF support for the costs of 6 chargers to be installed at the Old Bus Terminal and to be dedicated for electric songthaews. Bangchak: With GEF support for PV systems to be installed and integrated with chargers at a few Bangchak?s petrol stations in Rayong, Bangchak will invest in providing roof area for PV systems to be installed and connected with chargers at its petrol stations. Bangchak will also co-finance in the operation and maintenance of these PV systems. Moreover, Bangchak will invest in providing its land area at its petrol stations to demonstrate the use of second life batteries (retired batteries from electric vehicles) as energy storage systems (ESSs), and in the operation of these ESSs. Siam Cement Group (SCG): SCG will invest in installing solar PV systems to their chargers already installed in their factory located in an industrial estate in Rayong for their electric shuttles, and in the operation and maintenance of these PV systems. In addition, SCG will invest in developing and implementing activities/measures to support the project in promoting changing existing public transport vehicles to electric vehicles. Moreover, SCG will invest in developing the protocol required for trading carbon credits to be earned from GHG emissions reduction due to the demonstrations of electric vehicles and charging stations integrated with PV systems in the project. Other charge point operators: In addition, other operators of petrol stations and chargers will be approached during the implementation phase to mobilize investment in providing areas for PV systems and in installing more PV systems and chargers to be integrated with PV systems, as well as co-finance the operation and maintenance of these PV systems and chargers. 4. Other private sector stakeholders Other private sector stakeholders such as operators/drivers of electric mini-buses and songthaews in Rayong, and local garage operators, as well as local education institutes and local technical colleges: With GEF contribution to the capacity building and knowledge exchange on electric vehicles and sustainable use of EV batteries, relevant private sector stakeholders will be sought during the implementation phase and will invest in providing meeting/training facilities and sharing information to the project related to capacity building, up-scaling, and knowledge exchange. The potential for an additional 3.5 million USD in co-financing has been identified during PPG that could be secured from public and private partners during the project?s implementation phase but has not been included in the amount of co-financing presented in the CEO Endorsement document at this time.

D. Trust Fund Resources Requested by Agency(ies), Country(ies), Focal Area and the Programming of Funds

Agency	Trust Fund	Country	Focal Area	Programming of Funds	Amount($)	Fee($)	Total($)
UNIDO	GET	Thailand	Climate Change	CC STAR Allocation	2,913,465	276,779	3,190,244.00
			Total Grant Resources($)		**2,913,465.00**	**276,779.00**	**3,190,244.00**

E. Non Grant Instrument

NON-GRANT INSTRUMENT at CEO Endorsement

Includes Non grant instruments? **No**

Includes reflow to GEF? **No**

F. Project Preparation Grant (PPG)

PPG Required **true**

PPG Amount ($)

100,000

PPG Agency Fee ($)

9,500

Agency	Trust Fund	Country	Focal Area	Programming of Funds	Amount($)	Fee($)	Total($)
UNIDO	GET	Thailand	Climate Change	CC STAR Allocation	100,000	9,500	
				Total Project Costs($)	**100,000.00**	**9,500.00**	**109,500.00**

Core Indicators

Indicator 6 Greenhouse Gas Emissions Mitigated

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO?e (direct)	351164	1440815	0	0
Expected metric tons of CO?e (indirect)	1755820	3336936	0	0

Indicator 6.1 Carbon Sequestered or Emissions Avoided in the AFOLU (Agriculture, Forestry and Other Land Use) sector

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO?e (direct)				
Expected metric tons of CO?e (indirect)				
Anticipated start year of accounting				
Duration of accounting				

Indicator 6.2 Emissions Avoided Outside AFOLU (Agriculture, Forestry and Other Land Use) Sector

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO?e (direct)	351,164	1,440,815		
Expected metric tons of CO?e (indirect)	1,755,820	3,336,936		
Anticipated start year of accounting	2022	2022		
Duration of accounting	10	10		

Indicator 6.3 Energy Saved (Use this sub-indicator in addition to the sub-indicator 6.2 if applicable)

Total Target Benefit	Energy (MJ) (At PIF)	Energy (MJ) (At CEO Endorsement)	Energy (MJ) (Achieved at MTR)	Energy (MJ) (Achieved at TE)
Target Energy Saved (MJ)		61,572,972,965		

Indicator 6.4 Increase in Installed Renewable Energy Capacity per Technology (Use this sub-indicator in addition to the sub-indicator 6.2 if applicable)

Technology	Capacity (MW) (Expected at PIF)	Capacity (MW) (Expected at CEO Endorsement)	Capacity (MW) (Achieved at MTR)	Capacity (MW) (Achieved at TE)
Solar Photovoltaic select	2.00	1.30		

Indicator 11 Number of direct beneficiaries disaggregated by gender as co-benefit of GEF investment

	Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)
Female	18,210	16,445		
Male	17,289	16,447		
Total	35499	32892	0	0

Provide additional explanation on targets, other methodologies used, and other focal area specifics (i.e., Aichi targets in BD) including justification where core indicator targets are not provided

Part II. Project Justification

1a. Project Description

CHANGES TO PROJECT DESCRIPTION SUMMARY (TABLE B) FROM PIF

Under Component 1, in the PIF, the aim of Component 1 was to improve policy and institutional framework for electric mobility and sustainable use of batteries. In the CEO endorsement, the aim was changed to improve policy and regulatory framework for electric mobility and sustainable use of batteries to better reflect the gaps/barriers to EV adoption that the component will address and the outputs and activities under this component which are related to policy and regulatory framework, and also reflect the fact that institutional framework and arrangements for electric mobility in Thailand have been well established, including the National EV Policy Committee and its sub-committees. Thus, the names of the Component, and the outcome have been changed to ?Policy and regulatory framework?.? in the CEO Endorsement instead of ?Policy and institutional framework?? as in the PIF.

Output 1.1.1 was ?Analysis, forecast and management system for GHG emissions in transport sector developed? in the PIF. A slight change has been made in the CEO Endorsement to emphasize the focus of this output on the public transport sector as recommended by members of the Policy working group established under this project during the PPG. Thus, the name of output 1.1.1. has been changed to ? Analysis, forecast, management system for GHG emissions in the public transport sector developed in the CEO endorsement.

Output 1.1.3 was ?Financial and non-financial incentives created for uptake of electric public and private fleets? in the PIF. The name of this output has been changed to ? Policy and regulatory framework for EV Ecosystem development enhanced? in the CEO endorsement in order to expand the scope of this output to cover the manufacturers of electric vehicles and to better reflect the barriers to EV adoption that this output and its activities will address. This renamed output is also put as the output 1.1.2 in the CEO Endorsement. This change is also to make the outputs 1.1.2, 1.1.3, and 1.1.4 of Component 1 in the CEO endorsement link and align with the outputs of Component 2 , which are to demonstrate and address 1) electric vehicles (users and manufacturers), 2) charging systems, and 3) second life batteries, respectively. That is, this change is also to make this output of Component 1 in the CEO endorsement link and align with the output of Component 2 on electric vehicles (users and manufacturers).

Output 1.1.2 was ?Development of plan for charging infrastructure integrated with renewable energy systems? in the PIF. The name of this output has been changed to ?Policy and regulatory framework for charging infrastructure integrated with renewable energy systems developed? in the CEO endorsement in order to expand the scope of this output to cover policy and regulatory framework instead of plan and to better reflect the barriers to EV adoption that this output and its activities will address. This renamed output is also put as the output 1.1.3 in the CEO Endorsement. This change is also to make

this output of Component 1 in the CEO endorsement link and align with the output of Component 2 on the charging systems.

Output 1.1.4 was ?Framework for addressing life-cycle issues for electric mobility and sustainable use of batteries enhanced? in the PIF. The name of this output has been changed to ?Policy and regulatory framework for addressing life-cycle issues for electric mobility and sustainable use of batteries enhanced? in the CEO endorsement in order to be more specific about policy and regulatory framework, and to better reflect what this output and its activities will address. This change is also to make this output of Component 1 in the CEO endorsement link and align with the output of Component 2 on the second life batteries.

Under Component 2, outcome 2.2 (Investment in electric vehicles and electric vehicle supply equipment integrated with renewable energy deployment) and 2.3 (Investment in addressing life-cycle issues for electric vehicle batteries) in the PIF were merged into one (outcome 2.2), as there is some overlap of investment in outcome 2.2 and outcome 2.3 in the PIF (i.e., investment in batteries). The name of outcome 2.2 is simply changed to be ?Investment in electric vehicles and electric vehicle supply equipment integrated with renewable energy deployment and in addressing life-cycle issues for electric vehicle batteries in the EEC? in the CEO endorsement. As a result, output 2.3.1 in the PIF is reordered to be output 2.2.4 in the CEO endorsement.

Output 2.2.1 was ?Deployment of electric mobility solutions for public transport integrated with renewable energy systems, and battery storage in EEC? in the PIF. This output is now divided into two outputs (output 2.2.1 Electric vehicles for public transport demonstrated and 2.2.2 Charging systems integrated with renewable energy systems, and battery storage demonstrated) in the CEO endorsement. This is simply to better reflect the investment plan that the project prepared during the PPG, and to make each of these outputs separately link and align with the outputs 1.1.2 and 1.1.3 of Component 1, respectively.

Output 2.2.3 was ?Application of big data to plan and optimize more electric vehicle chargers? in the PIF. This output is changed to ?Applications of data to support planning and management of charging infrastructure, electric vehicles fleets, and GHG emissions reduction demonstrated? in the CEO endorsement. This is to expand the scope of the purposes of the use of data and to better reflect activities planned during the PPG for this output, and to be specific that this output does not plan to use big data.

CHANGES TO THE PROJECT BUDGET ALLOCATION

There is no change to the GEF budget allocated to Component 1, 2, 3, 4 and PMC in the CEO endorsement compared to in the PIF. However, adjustments have been made to co-financing amounts based on the amounts committed at the time of the CEO Endorsement submission. The project still anticipates an additional 3.5 million USD in co-financing to be mobilized and committed during the project?s implementation as additional stakeholders from the public and private sector become engaged with the project?s activities.

Table 1: Summary of changes to project budget

Component	PIF (in $)	CEO Endorsement (in $)
1 Improve policy and regulatory framework for electric mobility and sustainable use of batteries	1,049,000	1,361,818
2. Accelerate technology adoption of electric mobility and sustainable use of batteries	14,536,200	13,583,000
3. Capacity building, up-scaling and knowledge transfer	3,000,000	1,392,000
4. Monitoring and Evaluation	162,234	120,000
Project Management Costs	937,376	860,900
Total	**19,684,900**	**17,317,718**

a) the global environmental and/or adaptation problems, root causes and barriers that need to be addressed (systems description);

Climate change, global drivers of GHG emissions in the transportation sector, and global electric mobility

Human influence has changed and warmed the climate at a rate that is unprecedented in at least the last 2,000 years and observed warming is driven by GHG emissions from human activities, according to the 2021 Intergovernmental Panel on Climate Change (IPCC) report. Today human activities in the transport sector are responsible for nearly one-quarter of global energy-related direct CO_2 emissions and is a significant contributor to air pollution. Oil has been the predominant energy source in the transport sector, providing 92% of final energy over the past decade. Increased demand for transport for people and goods and dependence on internal combustion engines (ICE) vehicles that run on oil products have called for more oil use and led to increased carbon dioxide (CO2) emissions.

Global and local objectives and commitments to improve climate and air quality underscore that the transport sector has a critical role to play and drive rapid change. Over the last decade momentum has accelerated to deploy a range of powertrains and alternative fuels. The 2010s were ground breaking for the introduction of electric vehicles which have several benefits, including zero tailpipe emissions, better efficiency than internal combustion engine (ICE) vehicles and large potential for GHG emissions reduction when coupled with a low-carbon electricity generation sector. Provided the electricity used by an electric vehicle (EV) comes from renewable energy, electric mobility can be seen as a climate smart solution to decarbonizing the transport sector.

To date, countries have announced 100% zero-emission vehicle targets or the phase-out of internal combustion engine vehicles through 2050, or allowing new sales to be electric cars, in support of decarbonizing transportation sectors, meeting climate targets, promoting cleaner air as well as economic development. Environmental and sustainability objectives are major drivers behind countries? policy support in the development and deployment of electric powertrains for transport.

Drivers for the uptake in the adoption of electric mobility also include reductions in battery prices, evolution in battery technologies, and developments in charging methods.

Although electric vehicles increase electricity demand, they reduce oil demand and greenhouse gas emissions. In 2019, there were about 7.2 million electric cars on the world?s roads, and these electric vehicles in operation globally avoided the consumption of almost 0.6 million barrels of oil products per day. In 2019, the electricity generation to supply the global electric vehicle fleet emitted 51 Mt CO2-eq, about half the amount that would have been emitted from an equivalent fleet of internal combustion engine vehicles, corresponding to 53 Mt CO2-eq of avoided emissions. GHG emissions savings from EVs are achieved thanks to the fact that the high energy efficiency of the electric powertrain combined with the current global carbon intensity of electricity systems emit less than ICEs in most countries.

Under the International Energy Agency (IEA)?s Sustainable Development Scenario which incorporates rapid grid decarbonization and the targets of the EV30@30 Campaign to collectively reach a 30% market share for electric vehicles in all modes except two-wheelers by 2030, the global electric vehicle stock (excluding two/three-wheelers) grows by 36% annually, reaching 245 million vehicles in 2030 ? more than 30 times above today?s level. In this scenario, the global electricity demand from EVs (including two/three-wheelers) increases nearly eleven-fold relative to 2019, to almost 1,000 TWh in 2030, but the global EV fleet displaces 210 Mtoe (4.2 million barrels a day) of gasoline and diesel in 2030, leading to 440 Mt CO_2-eq of avoided GHG emissions in 2030.

The IEA?s recent Net Zero by 2050 Roadmap provides a cost-effective and economically productive pathway to reach this formidable and critical goal of net zero emissions by 2050, setting out more than 400 milestones for what needs to be done, and when, to decarbonize the global economy in just three decades. Among these milestones include the massive deployment of electric vehicles. Staying on the path to net-zero emissions requires the massive deployment of all available clean energy technologies such as renewables, electric vehicles and energy efficient building retrofits between now and 2030. Net zero means huge declines in the use of coal, oil and gas and that by 2045, new energy technologies will be widespread. This requires steps such as halting sales of new internal combustion engine passenger cars by 2035 and ensuring that the vast majority of cars on the roads will be running on electricity or fuel cells by then.

To be a zero-carbon car from a life cycle perspective, a car will also need to be manufactured with zero material carbon emissions. The World Economic Forum?s recent report on Materials Roadmap for the Zero-Carbon Car states that the system-wide change is needed to also create circularity in the automotive sector. The report shows that a large proportion of automotive material carbon emissions could be abated by 2030 at no net-cost increase using technologies and practices that could be implemented today.

Despite the current growth in EV production and adoption, significant economic, regulatory and technical barriers exist to their mass adoption:

Economic barriers:

? EVs generally have higher price tags than conventional ICE vehicles.

? EVs face high costs of acquisition with fleet operators facing high capital costs to replace ICE vehicles with EVs (although EVs have very low operating costs)

Regulatory barriers:

? The characterization of EV charging as the sale of electricity or as a service.

? Tariff issues on charging stations and the cost-prohibitive prices on electricity.

Technical barriers:

? Charger standards and protocols not being standardized in countries resulting in lack of inter-operability.

? Grid stability related issues due to normal EV charging behavior place extra load on the grid during peak hours.

? Battery performance issues with respect to safety at high temperatures and the life cycle of the battery.

Information barriers:

? General awareness among policy makers, the private sector and the public about EVs, their performance, as well as incentives and regulations in place for their use

? Range anxiety due to EVs having limited range compared to ICE cars based on the size of the battery.

Climate change and drivers of GHG emissions in Thailand

Thailand?s vulnerability to climate change impacts has been well documented and acknowledged. In the past decade, recurrent extreme weather events such as droughts, extreme precipitation events, and heat waves have taken a heavy toll on both life and property and adversely affected the country?s economic growth. Based on the Global Climate Risk Index (CRI) 2019 developed by Germanwatch, Thailand was ranked among the top ten countries which were most affected by weather-related loss events in 2017. The absolute losses in Thailand were estimated at USD 4,371 million or about 0.35 % of the country?s GDP.

According to Thailand?s Second National Communication, in 2013 total GHG emissions in Thailand were 319 $MtCO_2e$ and 74% of the total GHG emissions came from the energy sector, of which energy use in the transportation sector accounted for around 26% (whereas public electricity generation and heat production accounted for 42% and manufacturing industries and construction accounted for 20%). In other words, energy use in the transportation sector accounted for 19% of the country?s total GHG emissions. Within the transportation sector, road transport (cars, trucks, buses and two-wheelers which

are dependent on fossil fuels) contributed the most to CO_2 emissions, accounting for 97% of the total transport emissions.[1][1]

Thailand submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat on the first of October, 2015. Thailand communicated that it intends to reduce its greenhouse gas (GHG) emissions by 20% from the projected business-as-usual (BAU) level by 2030 (approximately 111 MtCO2e of projected 555 MtCO2e BAU total). The level of contribution could increase up to 25%, subject to adequate and enhanced access to technology development and transfer, financial resources and capacity building support through a balanced and ambitious global agreement under the UNFCCC. As a framework for developing an action plan of implementation to meet the GHG mitigation target in 2030, Thailand?s NDC Roadmap on Mitigation 2021-2030 (NDC Roadmap 2021-2030) was prepared. The NDC Roadmap 2021-2030 was approved by the cabinet in May 2017 and included GHG reduction measures in three sectors: the energy and transportation sector, the industrial process and product use sector, and the waste management sector. These three sectors were considered as major sectors that have the potential and the readiness to meet the GHG mitigation target in 2030.

Furthermore, in October 2021, the Thai cabinet approved the country?s Long-Term Greenhouse Gas Mitigation Strategy to achieve carbon neutrality by 2065.

Thailand?s transportation sector and barriers that need to be addressed

The NDC Roadmap on Mitigation 2021-2030 states a total mitigation target for the transportation sector of 41 $MtCO_2e$ and indicates that an improvement in the efficiency of energy use in the transportation sector could contribute to a total reduction of 31 $MtCO_2e$ and the use of biofuels in the transportation sector could contribute to a total reduction of 10 $MtCO_2e$.

Despite its potential and relative readiness to meet the GHG mitigation target in 2030, significant challenges remain to be addressed in the transportation sector. The Thai government has been implementing a Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts, which identifies and addresses 5 barriers or measures/instruments that are missing and need to be implemented including;

? Infrastructure Planning and Travel Management Instrument (P)

? Policy and Regulatory Instrument/Incentive (R),

? Economic Instrument (E)

? Information instrument (I) to increase awareness about sustainable transport and environmental cost

? Technology instrument (T) to enhance the use of low emissions vehicle technology

These 5 measures/instruments will contribute to the following: ?Avoiding travels?, ?Shifting travel/transport modes?, and ?Improving energy efficiency of transport modes/vehicle technologies?, or ?A-S-I? approach which is a common paradigm, under which sustainable transport development is presented. ?Avoiding? refers to improving the overall efficiency of the transport system through integrated land-use planning and transport demand management, thereby reducing the need to travel or length of trips. ?Shifting? involves improving trip efficiency by moving individuals towards transport options that are more environmentally friendly, such as non-motorized transport (NMT) like walking and cycling, or public transport (PT) like bus and rail. Lastly, ?Improving? speaks to the need to improve the energy efficiency of transport modes and vehicle technology.

Electric mobility as a key area of climate change mitigation action and a driver of economy of Thailand

The Thai government has considered electric mobility as a low GHG and Particulate Matter (PM) emissions transport solution, and a potential alternative to vehicles with internal combustion engines (ICE), while decarbonization of the country?s electricity grid is planned.

According to the Power Development Plan 2015-2036, the percentage of renewable energy (including hydro) in electricity generation will increase from 8% in 2015 to 15-20% in 2036, while the percentage of natural gas in electricity generation will decrease from 64% in 2015 to 30-40% in 2036, and the percentage of coal in electricity generation will stabilize around 20% during 2015-2036).

In 2015, the Thai government, led by the Ministry of Energy, proposed measures to reduce the country?s energy intensity. One measure is to reduce energy use in the transportation sector through the adoption of electric vehicles. The Ministry of Energy set the target of the adoption of plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) to be 1.2 million vehicles in 2036. The NDC Action Plan in the transportation sector approved by the cabinet in 2018 also includes existing projects and plans on an expansion of electric vehicles, a purchase/leasing of electric and hybrid public

buses, and also includes recommended projects and plans on a replacement of air-conditioned public vans with electric mini buses, a replacement of public taxis and pick-up trucks with hybrid vehicles, and a replacement of delivery motorcycles with electric motorcycles in Bangkok, and 6 regional cities including Chiangmai, Kon Khaen, Pitsanulok, Phuket, and Songkhla.

In addition to being a low GHG and PM emissions transport solution, the Thai government has considered and identified electric mobility to be a driver of the Thai economy in the future. In 2015, the Thai cabinet approved the next-generation automotive industry to be one of the 10 targeted industries that will drive the Thai economy in the future (industries with high potential as new-growth engines for Thailand). The next generation automotive industry includes electric vehicles (EVs), connected vehicles, autonomous vehicles, and shared mobility. In 2017, the cabinet also approved measures to support the production of electric vehicles to achieve the target of the total production of any electric vehicles (xEV) to be 25% of the total production in 2036. In May 2021, the Thai government set an even more ambitious production target that 30 per cent of all vehicles made in Thailand will be electric by 2030 (30/30 policy), in line with the global EV30@30 Campaign which sets a collective aspirational goal of a 30% market share for electric vehicles in the total of all vehicles sales by 2030. Additionally, under the 20-year National Strategy, measures were included and addressed to accelerate the development of Thailand?s automotive industry to be a smart electric automotive industry or an automotive industry based on alternative energy, building upon Thailand?s automotive industry hub as one of the world?s important automotive production hubs (the world?s 11th largest producer, and Asia?s 5th largest producer in 2019). The automotive industry serves as an important foundation for economic development in Thailand, where its export values accounted for 6.4% of Thailand?s GDP in 2019. The Thai government has identified the shift from a production base focused on traditional automotive manufacturing to one that focuses on modern automotive manufacturing (electric vehicles and automotive vehicles) as an opportunity for the country. Thailand has an abundance of skilled labor with over 700,000 laborers in the automotive industries that can support EV production.

Gaps and barriers to adoption and production of EVs in Thailand:

The Thai Automotive Institute (TAI), in collaboration with 3 partners including Office of National Higher Education Science Research and Innovation Policy Council (NXPO), National Science and Technology Development Agency (NSTDA), Faculty of Engineering of Chulalongkorn University, proposed in 2020 to the Office of Industrial Economics in the Ministry of Industry, policy recommendations on Thailand?s Development of the Next-Generation Automotive Industry. The recommendations emphasize that the government needs to develop and implement measures that address the following gaps and barriers to adoption and production of EVs in Thailand.

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[1] OTP (2012). The Study to Develop Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts

On the supply side:

? **New product and production standards related to EVs and testing facilities:** Up to August 2021, a total of 83 standards related to EVs have so far been issued by the Thai Industrial Standards Institute (TISI). Another 15 standards are in the process of the development and are expected to be issued within 2021, leading to a total of 97 issued standards. TISI classifies Thai standards for EVs into 9 categories: 1) Sockets and outlets, 2) Charging systems, 3) Safety for various types of EVs, 4) Performance, 5) Motors, 6) Batteries, 7) Other equipment, 8) Communication system, and 9) Others. So far, Standards under Category 1, 2 and 5 and 7 have been almost completely developed and issued. However, most of standards under Category 3, 4, 6, and 8 have not been completely developed. In the latest meeting of the Industrial Product Standards Committee chaired by TISI in August 2021, the Committee approved 33 standards including standards for electric three-wheelers (tuk-tuk), smart vehicles, and electrical appliances used within EVs. The Committee earlier approved standards for electric motorcycles, and standards for passenger cars, buses, pick-up trucks, and trucks in 2020. However, standards for electric boats have not been developed and approved. Thus, overall, lack of standards as well as facilities for testing standards is still a gap for manufacturing of EVs in Thailand.

? **Thai entrepreneurs? technical capabilities on EVs and related technologies (particularly for the design and manufacturing) and for the preparation of new skill labor for the EV industry (reskill and upskill):** A gap exists for technical expertise on EV manufacturing and related technologies. There is a need for increased professional development opportunities on EVs in education institutions. The Thai Automotive Institute (TAI), in collaboration with the Office of Industrial Economics, provides capacity building for technicians on Fundamentals of Electric Vehicles Technologies. In addition, the Department of Industry Promotion has provided a course and raised awareness about EV and autonomous vehicles, including producing manuals on next generation vehicles. However, TAI?s courses are only for technicians and only address the fundamentals of EV technologies while the Department of Industry Promotion has just started a course in 2020 as its first year for 40 participants. TAI has also identified the need for upgrading the current Thai entrepreneurs in the areas of the design and the manufacturing of EVs, and for the Office of Higher Education Commission (OHEC) under the Thai Ministry of Higher Education, Science, Research and Innovation to collaborate with technical universities and colleges to develop program or curricula particularly in the areas of the design and manufacturing of EVs and to prepare new skill labor for the EV industry. Technical universities/colleges such as Rayong Technical College have started courses on the design of EV parts such as motors, and eco and electric cars. As described earlier in the section, there is a further need for increased professional development opportunities on EVs in education institutions.

? **Ecosystem for EV entrepreneurship:** In addition to the need for technical capacity, support is necessary for enhancing an ecosystem for EV entrepreneurship. This includes targeted financial and technical support and building local SMEs and regional and global markets. While there is an existing entrepreneurship ecosystem in the EEC, there are only a few components of EV entrepreneurship ecosystem in place, such as some EV charging operators and stations, a small number of EV users, and a few manufacturers of EVs and EV batteries that are starting to be in operation or planning to be in operation soon. At this stage, the existing entrepreneurship ecosystem is not complete and needs to be enhanced. The expected target for the entrepreneurship support program is to enhance the existing entrepreneurship ecosystem to be a more complete and sustainable ecosystem and can be used as a model for replication in other regions/areas of the country.

? **Research and development activities on EVs and EV parts:** Research and development is necessary for enhancing sustainable competitiveness of the supply chain in the commercialization stage. A number of manufacturers of EVs have received Board of Investment (BOI) incentives. However, most of these manufacturers are foreign companies and manufacture certain types of electric vehicles where research and development of these types of electric vehicles is conducted elsewhere. Therefore, gaps in the research and development for manufacturing of these types of electric cars as well as other types of electric vehicles such as songthaews (modified pick-up trucks) remain in Thailand.

On the demand side:

? **Consumers? awareness and understanding of EVs and related technologies:** Most of the general public, as well as operators and drivers of public transport vehicles, are still not aware of the safety, usage and maintenance of EVs and EV batteries.

? **Use of EVs for public transportation in pilot areas such as in smart cities:** Recently, there has been adoption of different types of EVs for public transportation including public buses, taxi motorcycles, passenger river ferry, and three-wheelers (tuk-tuks), mainly in Bangkok. However, there is still limited use in other areas outside Bangkok and of several other types of EVs for public transportation. In addition, there have been very few pilot uses of RE-EV integrated charging technologies, which are necessary for derisking investments in integrating renewable sources of energy with charging infrastructure and demonstrating smart charging technologies.

? **Financial and non-financial incentives for EV consumers:** While several supply-side incentives are in place to encourage EV manufacturing, there is a need for increased financial and non-financial incentives targeting EV consumers and public and private fleets. Based on EVAT?s

evaluation of the progress of the government?s provision of financial and non-financial incentives for EV consumers, the progress with respect to creating sufficient incentives and making the prices of EVs affordable or appropriate for people to purchase has been considered relatively low. TAI has also identified the need for different stakeholders to work together to create more and stronger incentives.

? **Regulations related to EV charging business:** Related regulations that hinder the expansion of charging infrastructure and business need to be developed and addressed, including regulations related to selling electricity, and setting electricity charging rates. Based on existing regulations, only 3 electricity utilities (i.e., Metropolitan Electricity Authority (MEA), Provincial Electricity Authority (PEA), and Electricity Generating Authority of Thailand (EGAT)) can sell electricity to customers. At present, other charging operators of EV charging stations than these electricity utilities let users of EVs get electricity free of charge or else pay parking fee per hour for charging electricity at the stations. The Energy Regulatory Commission Office (ERC) is in the process of developing a regulation to allow charging station operators to be able to sell electricity to users of EVs and get electricity sale revenues. ERC is also developing a low priority charging rate to attract EV users. However, at present, other charging businesses such as exporting electricity from vehicle to grid (V2G) as well as trading of electricity between those who store energy such as owners of batteries/EVs and small buyers of electricity are still not allowed.

The proposed project is expected to contribute to existing activities of the government and private sector in addressing these gaps (see section 3).

b) the baseline scenario and any associated baseline projects,

The gaps and barriers identified above highlight the additional actions necessary for Thailand to accelerate its adoption of electric mobility nationally in addition to existing actions already being taken. This section will now provide an overview of Thailand?s existing policy, initiatives, and state of progress while the alternative scenario will outline how this project will address the aforementioned gaps and barriers.

Baseline scenario at national level

Electric vehicles

Existing policy and institutional framework (addressing both supply and demand sides)

In order to efficiently and effectively drive the development of electric vehicle industry in Thailand and to ensure an integrated and coherent plan, policy, and implementation, in February 2020, the Thai Prime Minister appointed the National Electric Vehicle Policy Committee. The Committee consists of the prime minister or deputy prime minister as the chairman, Minister of Industry, Minister of Transport, Minister of Energy, Permanent Secretary of Ministry of Transport, Permanent Secretary of Ministry of Energy, Secretary General of the Board of Investment Office, Secretary General of the National Economic and Social Development Board Office, President of the Thai Federation Industries, President of the Thai Chamber of Commerce, President of the Electric Vehicle Association of Thailand, and some experts, as committee members, as well as, Permanent Secretary of Ministry of Industry as a committee member and the secretariat, and Director General of the Office of Industrial Economics, and Director General of the Energy Policy and Planning Office, as committee members and assistants to the secretariat.

The National Electric Vehicle Policy Committee has the following duties and authorities; 1) direct and set targets of the development of electric vehicles to be consistent with the 20-year National Strategy and approvals of the cabinet; 2) consider and approve plans, action plans, projects of the government that are related to electric vehicle development to be consistent with the 20-year National Strategy; 3) ensure an integrated plan and implementation, monitor and evaluate the implementation, give advice to ensure that policies are effectively implemented; and 4) appoint working groups to support the Committee.

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The first National EV Policy Committee meeting took place in March 2020, one month after the Committee was established. During the second National EV Policy Committee meeting in March 2021, the Committee appointed the following 4 Subcommittees under the National Electric Vehicle Policy Committee: 1) Subcommittee on Promotion of Electric Vehicles and EV Parts Industry, 2) Subcommittee on Infrastructure and Battery Development to Support Electric Vehicles, 3) Subcommittee on Assessment of the Impacts on Fuels and Greenhouse Gas of Promoting Electric Vehicles and 4) Subcommittee on Promoting the Use of Electric Vehicles. The subcommittees aim collectively to promote the production and use of electric vehicles and to implement policies effectively and efficiently, pushing the country to become the world's major electric vehicle and parts manufacturing base.

While much has so far been in place on the supply side to encourage EV manufacturing in Thailand, including product standards, plan and targets, policy incentives and measures (both tax and non-tax incentives), research and development, and technical capacity building, relatively less has been in place or implemented on the demand side to encourage widespread use of EVs.

An overview of electric mobility in Thailand is now presented from the supply and demand side.

On the supply side:

Regulatory framework:

Up to August 2021, a total of 83 standards related to EVs have so far been issued by the Thai Industrial Standards Institute (TISI). Another 15 standards are in the process of the development and are expected to be issued within 2021, leading to a total of 97 issued standards. TISI classifies Thai standards for EVs into 9 categories: 1) Sockets and outlets, 2) Charging systems, 3) Safety for various types of EVs, 4) Performance, 5) Motors, 6) Batteries, 7) Other equipment, 8) Communication system, and 9) Others. So far, Standards under Category 1, 2 and 5 and 7 have been almost completely developed and issued. However, some of standards under Category 3, 4, 6, and 8 have not been developed. In the latest meeting of the Industrial Product Standards Committee chaired by TISI in August 2021, the Committee approved 33 standards including standards for electric three-wheelers (tuk-tuk), smart vehicles, and electrical appliances used within EVs. The Committee earlier approved standards for electric motorcycles, and standards for passenger cars, buses, pick-up trucks, and trucks in 2020. However, standards for electric boats have not been developed and approved.

As for charging stations, there are currently three types of standards that have been issued by TISI; 1) Standards for Sockets-Outlets, 2) Standards for Charging Cabinet (Chargers), and 3) Standards for LEV Charging such as light weight motorcycle charging. The first two standards were proposed by NSTDA, and the third standard was proposed by the Thai Automotive Institute. All the three standards were issued as voluntary standards by TISI.

The Thai Automotive Institute has opened a new laboratory for testing batteries for electric vehicles within this year at the Automotive and Tyre Testing, Research and Innovation Center (ATTRI) in Chachoengsao province, in the EEC area. The laboratory is sponsored by TISI. In 2020, the testing can be done for certain items, but in 2021, the laboratory will be fully open for ASEAN countries.

With regards to battery recycling/reuse, there is a working group chaired by Pollution Control Department and Industrial Works Department set up under the Basel Convention, and a working group on Energy Storage System chaired by the Ministry of Energy that addresses the issue of battery recycling. However, there is currently no regulation enforced specifically for disposal or recycling of End-of-life (EoL) batteries. Only policies regarding hazardous industrial waste can be applied to control the EoL batteries. However, the Waste Electric and Electronic Equipment (WEEE) directive, which can directly be applied to manage EoL batteries, is now under legislative drafting. In terms of battery packs in EVs, EV producers generally take the responsibility to handle EoL batteries. Some EV producers, such as SAIC motor-CP or Mercedes Benz, plan to develop procedures to repurpose the battery packs for second-life applications, such as energy storage system. Batteries will be recycled if they cannot be further used. There is still no main battery recycler in Thailand since the amount of domestic EoL batteries is still low. However, some domestic companies provide services to collect or separate batteries before exporting overseas to recycle. Waste Management Siam (WMS), which is a group of the DOWA eco-system, provides services to pre-treat NiMH and lithium-ion batteries in HEV and EV before exporting the parts to Japan for recycling. TES-AMM Corporation and Umicore (Thailand) provides service to collect EoL lithium-ion batteries and export to recycle overseas. Some domestic lithium-ion battery producers such as Energy Absolute (EA) and Global Power Synergy Company (GPSC) also plan to initiate a domestic recycler to recycle their own batteries. It is clearly seen that technology, policy, and management for repurposing and recycling domestic EoL batteries need further investigation and development.

Plan and targets:

The National Electric Vehicle Policy Committee, in its first meeting in March 2020, discussed a draft EV master plan which lays out the following targets: 1) Thailand becomes an industrial hub of electric vehicles production within 5 years; and 2) 30% of total car production of 2.5 million units in 2030 (i.e., 750,000 units) would be electric vehicles. A short-term plan (2020-2022) targets vehicles of the government and public buses, and electric public motorbikes of 60,000-110,000 units, while a medium-term plan (2021-2025) targets eco electric vehicles and smart city buses of 250,000 units (including 3,000 smart city buses), and a long-term plan (2026-2030) targets eco EV (zero emission and shared mobility in Bangkok and large cities) 750,000 electric vehicles, or equivalent to 30% of the total car production of 2.5 million units/year.

Furthermore, the Committee, in its second meeting in March 2021, set the following targets; the country's EV production will total 1,051,000 units in 2025, divided into 400,000 cars/pickups, 620,000 motorcycles and 31,000 buses/trucks, and will reach 50% of the country?s total production of vehicles in 2030. The Committee has a vision to increase the country?s EV production to 100% of the country?s total production of vehicles in 2035, or a total of 18,413,000 vehicles, divided into 8,625,000 cars/pickups, 9,330,000 motorcycles and 458,000 buses/trucks. However, these vision/targets were yet to be studied, and concluded in the next National EV Policy Committee meeting in May 2021.

In the third National EV Policy Committee meeting in May 2021, the Committee set a policy target that 30 per cent of all vehicles made in Thailand will be electric by 2030 (30/30 policy, in line with the global EV30@30 Campaign which sets a collective aspirational goal of a 30% market share for electric vehicles of all vehicles sales by 2030. The Committee also announced a three-phase development plan for the electric vehicle (EV) industry. Under Phase 1 (2021-2022), the government will pilot electric motorcycles and support infrastructure nationwide. Under Phase 2 (2023-2025), the EV industry will be developed to produce 225,000 cars and pick-up trucks, 360,000 motorcycles and 18,000 buses/trucks by 2025, including the production of batteries. This first milestone is designed to deliver cost advantages via economies of scale. Phase 3 (2026-2030) is driven by the ?30/30 policy? to produce 725,000 EV cars and pick-ups plus 675,000 EV motorcycles. This will account for 30 per cent of all auto production in 2030 and includes domestic manufacture of batteries. The Committee also set targets for the production of EV batteries, as well as measures and incentives for promoting EVs in order to achieve the set targets, and planned for developing financial and tax incentives, as well as safety standards, for EV and battery manufacturers.

Existing policy Incentives/measures:

Board of Investment (BOI) incentives

The BOI has the role of investment promotion and business matching. The BOI provides both tax and non-tax incentives/measures to support supplier development in the EV supply chain, including EV, EV parts, and EV charging stations. EV manufacturing is considered by the BOI as infrastructure activities for the country?s development as are activities using advanced technology to create value added or technology that is deemed to be important to the development of the country with no or very few existing investments in Thailand.

Tax incentives include:

- Exemption of import duties on machinery;

- Exemption of import duty on raw or essential materials imported for use in production for export; and

- Exemption of corporate income tax for 5 or 8 years, depending on the type of activity.

Non-tax incentives include:

- Permit for foreign nationals to enter Thailand for the purpose of studying investment opportunities;

- Permit to bring into Thailand skilled workers and experts to work in investment promoted activities;

- Permit to own land in Thailand; and

- Permit to take out or remit money abroad in foreign currency.

Thailand, which is Southeast Asia?s largest automotive production hub, has no local content requirement for auto industry, making supply chain management more convenient for manufacturers, but one condition/requirement for EV car makers to receive BOI incentives is to include battery management.

BOI is also in the process of arranging incentives for electric motorcycle producers, which will be similar to those for electric car producers and will include the exemption of corporate income tax and the reduction of excise tax. One requirement for electric motorcycle producers to receive incentives is to produce a key part of motorcycles such as motors. Companies that are ready to produce electric motorcycles in Thailand include, Harley, BMW, and Chinese/Japanese and American companies.

In September 2021, BOI announced that BOI incentives for EV industries are expanded to also cover BEV platform, including energy storage system, charging module, front and rear axle module. In addition, the exemption of corporate income tax for 3 years is now given for electric bicycles (e-bikes) manufacturers.

Special excise tax rate:

For HEVs and PHEVs, the tax is reduced to 50% of the normal tax rate till 2025, and for BEVs, the tax is 0% till 2022, and will be 2% till 2025.

In addition, the second meeting of the National EV Policy Committee in March 2021 laid out the policy of driving the electric vehicle industry with urgent stimulus measures and 1-5 year stimulus measures. Urgent EV stimulus measures aim at promoting the use of both two-wheeled, tricycle and four-wheeled electric vehicles, the establishment of electric charging stations for automobiles and motorcycles, and the establishment of a battery standard testing center and the management of battery carcasses. These

measures are still being studied in detail. The 1-5-year stimulus measures include excise tax restructuring, preparation for the management of used battery carcasses, taking safety and environment into account in accordance with international standards, as well as preparing ecosystem to promote the use of clean electric vehicles.

Current status of conventional vehicle manufacturing in Thailand:

Conventional vehicles (ICE vehicles) are categorized mainly into three types; 1) passenger cars (PC) and pick-ups (PU), 2) motorcycles, and 3) buses and trucks. According to Thai Automotive Institute, there are currently two main types of producers of conventional vehicles in Thailand; 1) Assemblers; and 2) Autopart makers/suppliers. In the first category, there are 19 car assemblers and 10 motorcycle assemblers. Out of all these companies, all are foreign companies except one Thai company. There are also a few truck assemblers such as Isuzu Motors Company (Thailand) Limited (Isuzu), Hino Motor Manufacturing (Thailand) Company Limited (Hino), and Foton CP Motor Company Limited (Foton), and a few bus assemblers such as Scania Manufacturing (Thailand) Company Limited (Scania), and Thai-Swedish Assembly Company Limited (Volvo). In the second category, there are autopart makers/suppliers, including process, body, electrical and electronics, powertrain, and suspension, are separated into two tiers: Tier 1 suppliers (i.e., direct supplier of parts to Original Equipment Manufacturer (OEM)), of which there are 523 companies (most of which are pure-foreign or foreign-majority companies); and Tier 2 suppliers (i.e., supplier of parts to Tier 1 supplier), of which there are 1,667 companies (about half of which are pure-Thai companies).

Current status of electric vehicles manufacturing in Thailand:

BOI approved EV projects

With the ongoing shift towards EV in the global, regional and domestic markets, Thailand is counting on its strong foundation in the automotive and support sectors, as well as its strategic location, and comprehensive investment incentives to attract car makers? investment in EV manufacturing. The Thai Board of Investment (BOI) has already approved 24 projects by car makers to produce in the country electric vehicles of all types, including hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), with a combined capacity of over 500,000 units per year. Two EV-bus projects (SCANINTER, and SAKUN C) have also been approved. Car makers which have been granted EV manufacturing privileges include, Toyota, Honda, Nissan, Mazda, Mercedes-Benz, BMW, SAIC Motor-CP, FOMM, Mitsubishi and Mine Mobility.

According to the BOI, the approved projects include Mitsubishi Motors (Thailand) Co., Ltd.?s 5.48 billion baht investment to upgrade the company?s existing car production line at Laem Chabang Industrial Estate to allow the annual production from 2023 of a total of 39,000 electric vehicles, consisting of some 9,500 BEVs and 29,500 HEVs. In June 2020, the BOI also approved a 5.5 billion baht investment by Sammitr Group for the production, in Phetchaburi province, of 30,000 BEVs. Both projects, like most others, will aim at the local market and exports, mainly to other ASEAN countries.

Other manufacturers of which projects have been approved include the following:

? BMW: Production of PHEVs and a partnership with the DR?XLMAIER Group for the production of high-voltage batteries and battery modules);

? FOMM: A new Japanese EV brand which name means ?First One Mile Mobility?, which has started making compact BEVs at a plant in Chon Buri province; and

? Nissan Motor: Nissan has for several years made significant investment in hybrid car production in Thailand and received approval recently for a new BEV production project.

Other car makers that have been granted BOI incentives for the production of BEVs in Thailand include, for instance, Suplaor, and Takano Auto.

Besides the 5 HEV projects, 6 PHEV projects, 13 BEV projects, and 2 bus-EV projects approved since the BOI first rolled out a comprehensive set of incentives covering all major aspects of the EV supply chain. The BOI has also approved 10 battery production projects with a total capacity of half a million units per year and 2 charging station production projects that will make more than 4,400 outlets per year.

Manufacturing of electric vehicles in operation

Of the EV manufacturers approved by BOI, quite a number of those have started to be in operation or plan to be in operation soon, with their manufacturing plants located in Rayong or the EEC, as well as in other parts of the country.

EV manufacturing in operation includes the manufacturing of both hybrid and battery electric vehicles, most of which are global-branded manufacturers such as Great Wall Motor (GWM) and MG. There are, however, plans by Thai companies for up-coming manufacturing of electric vehicles. This section below does not aim to address all EV manufacturers in Thailand but rather to give an overview of existing EV manufacturing and highlight some manufacturers which have announced information to the public.

Passenger cars:

SAIC Motor and CP (Charoen Pokphand) Groups manufacturing in Cholburi and Rayong

SAIC Motor and CP Group is a joint venture for manufacturing cars and SUVs branded MG. The first manufacturing plant in operation since 2014 is located in Eastern Seaboard Industrial Estate, Ban Pluak Daeng, Rayong. The new production plant (their second plant) is located in Hemaraj Eastern Seaboard Industrial Estate 2, Sriracha, Cholburi. MG Thailand has recently produced and launched a battery electric SUV.

Great Wall Motor (GWM)?s manufacturing in Rayong

The Chinese sport utility vehicle (SUV) manufacturer GWM plans to strengthen its presence in Thailand and expand within ASEAN by launching nine different electric vehicle (EV) models within three years to court prospective Thai motorists. GWM?s manufacturing plant was upgraded and renovated from a car production facility previously belonging to General Motors which sold it to GWM following its decision to withdraw from Thailand. Thailand is the base for GWM's first smart factory in Southeast Asia. The plant is located in Map Ta Phut District in Rayong. GWM plans to invest more than 700 million USD to produce passenger EVs with a production capacity of more than 80,000 units/year and plans to produce BEVs and batteries in the year 2023.

Trucks:
Takano Auto (Thailand) Company Limited (Takano) is among the electric truck manufacturers in Thailand

Buses:
Electric Vehicles (Thailand) Public Company Limited (EVT), Sakun C Innovation Company Limited (Sakun C), and Thai Electric Vehicle Company Limited (TEV) are among the electric bus manufacturers. Among these electric bus manufacturers, only Sakun C Innovation Company Limited can produce a completed chassis and structure of electric buses, with the largest electric bus size of 12 meters and the smallest size of 6 meters, and is trying to apply their production to the platform for battery-electric bus or truck productions promoted by the BOI.

In June 2021, GWM officially launched the "All New HAVAL H6 Hybrid SUV" in Thailand, manufactured from the Rayong plant. GWM announced that BEVs will be rolled out of the

manufacturing plant in Thailand by 2023. The company will gradually introduce the new models until 2023.

Up-coming manufacturing of electric vehicles

A number of manufacturers of EVs plan to start operation soon and their manufacturing of electric vehicles cover a wide range of vehicles. These manufacturers include the following:

NEX Point and Energy Absolute?s manufacturing in Chachoengsao

Energy Absolute Public Company Limited (EA) is expanding its business to cover passenger bus business through partnerships with NEX Point. EA has established Absolute Assembly Company Limited (AAB) to operate in the business of manufacturing buses and commercial vehicles in all categories. AAB?s manufacturing plant is located in Baan-Poh District in Chachoengsao. As of June 2021, the plant was still under construction and installation of equipment. Commercial operation of the plant is expected in the third quarter of this year with a total capacity of 3,000-5,000 units per year. The plant can manufacture various types of vehicles such as bus, truck, and van. Imported parts will be assembled with key parts that are designed and manufactured in the country. The plant is in the process of preparing a delivery of 500 electric buses by the end of 2021. The bus size is 10-12 meters and it costs approximately 6-7 million Baht/bus (0.19-0.22 million USD/bus). In 2022, the plant is expected to manufacture 1,000 electric buses.

In addition, EA and NEX Point plan to launch within this year new electric buses of 5 models including the following: 1) 20-seat minibus to replace vans for passenger transport within a city and inter-city transport. Targeted customers include public transport operators, education institutions, and hospitals; 2) Private 27-seat minibus for transport within a city. Targeted customers include tourism industries, education institutions, hospitals and government agencies; 3) Public bus with 35 seats for transport on regular routes. Targeted customers include public transport operators, Bangkok Mass Transit Authority (BMTA); 4) City bus with 35 seats for transport within a city. Targeted customers include BMTA, education institutions, government agencies and state enterprises; and 5) Public bus with 45 seats for transport within a city or inter-city transport on regular routes.

As for maintenance, EA and NEX Point have established Gold SC and Gold SC Holdings to establish and operate 10 service centers in Bangkok and metropolitan areas with high standard equipment, proficient technicians, and spare parts to accommodate post-purchase services for more than 10,000 buses. EA and NEX Point have also established Bayly Service to operate more than 10 spare part centers in Bangkok for public transport operators.

The expansion of EA's electric vehicle market will focus on passenger cars, delivery cars and corporate vehicles, and electric passenger boats. The company also plans to produce an electric pickup truck for cargo with a prototype from China to be tested.

Bangkok Sheet Metal Co., Ltd. (BM) in Samut Prakarn

BM plans to launch mini EV tuk tuks within 2021. This mini EV tuk tuk is to be used as a passenger vehicle in resorts, hotels, hospitals, and as a vehicle for selling food/ice cream. The performance of the EV tuk tuk is 1.2-1.5 kW. The company will commercially produce this mini EVV tuk tuk first. Its manufacturing plant is located in Samut Prakarn in the east of Bangkok. Steel will be used as a key material for the production. The company will design and manufacture chassis of all Mini EV tuk-tuks to reduce costs, which is a strength of the company as they will only have to purchase motors and batteries. Key targeted customers include hotels, resorts, factories, hospitals, villages and mobile food sellers. The company plans to produce around 300-400 units per year and to produce two types of personal tuk tuks; passenger tuk tuks and tuk tuks carrying goods not weighing more than 1 ton. These tuk tuks will have the power of 5 kW. In addition, the company has established a subsidiary called BM Innotech Industry (BMI) to develop automation system, particularly on designing small prefabricated production systems for SME customers, which will significantly reduce the cost of production for customers, such as making welding robots with jig and fixtures ready for customers to use. BM also supports the development of electric vehicles, manufactures electric vehicles and parts for customers.

Sakun C Innovation Co. Ltd. in Suphanburi

Sakun C Innovation Co. Ltd, a subsidiary of Choknamchai Group in Suphanburi in the central region of Thailand, is the largest car producer in Southeast Asia with an extensive domestic network of parts suppliers. It has been making cars for Honda, Toyota and Nissan for two decades. Sakun C manufactures aluminum electric buses and ferries. The company is focused on light, resilient aluminum bodies that will suit an EV platform and is less energy-consuming, rather than steel, traditionally used in Japanese car-making. Its minibuses and city buses are also road-ready.

PTT and Foxconn

PTT collaborates with Foxconn in setting up an open platform for producing EVs and key components which provide instant scale to the local EV industry in Thailand, leading the country into a new era of innovative, fast-paced growth in electric car manufacturing. Automobile players in Thailand that wish to assemble electric vehicles will be able to access the entire value chain of services offered by a newly formed joint venture being set up. The intent is to help manufacturers not only access EV-specific services but also launch new models more quickly at a competitive cost. The new platform will entail

an ecosystem combining state-of-the-art technologies across the EV value chain, including auto parts manufacturing. The production of EV platform is planned to start in 2022. The companies will also invest in the production of EV batteries including solid-state batteries and lithium ion phosphate (LPF) batteries, and invest in establishing EV charging stations.

Banpu NEXT

Banpu NEXT provides total solutions of electric vehicles (EV) and EV fleet management services that respond to the specific needs of customers with choices of package, including consulting, designing, and producing or supplying electric vehicles such as Thailand?s first marine tour e-ferry.

Siam Advanced Technology Relationships in east Bangkok and Choedchai Group

Siam Advanced Technology Relationships (ATR) is in collaboration with Choedchai Group in importing and assembling BYD (Chinese brand) e-buses (sized 9, 10 and 12 meters), and e-minivans (for 2, 5, and 7 seats). Its assembly plant is located in East Bangkok. Choedchai Corporation in Nakorn Rajsrima has also developed and manufactured other types of electric vehicles such as hybrid low-floor buses, and electric low-floor buses in collaboration with Suranaree University of Technology and Provincial Electricity Authority (PEA).

Manufacturing of electric vehicle batteries in operation

Among EV batteries projects approved by BOI, there are quite a number of manufacturers of batteries for EVs in Thailand, which have started to be in operation or plan to be in operation soon, with their manufacturing plants located in the EEC, including Global Power Synergy (GPSC), Rojana Industrial Park Plc, Energy Absolute (EA), Banpu (BP), and Bangchak Corporation Public Company Limited (BCPG). A total combined planned production capacity of all these manufacturers accounts for more than 10 GWh.

They plan to produce batteries ranging from Li-ion battery cell up to Li-ion battery pack for EVs or energy storage station/systems (ESSs). For instance, Global Power Synergy Public Company Limited (GPSC) plans to produce Li-ion batteries more than 30, 1,000, and 5,000 MWh for EVs and ESSs in 2022, 2023, and the final phase, respectively. Rojana Industrial Park Public Company Limited partnered with EVlomo plans to produce Li-ion battery more than 1,000, and 8,000 MWh for EVs in 2023, and the final phase, respectively. Energy Absolute Public Company Limited (EA) plans to produce Li-ion batteries more than 1,000, 3,000, and 50,000 MWh for EVs and ESS in 2022, 2023, and final phase respectively. Beta Energy Solution Company Limited (Beta) plans to produce the Li-ion battery more than 220, and 440 MWh for EVs and ESSs in 2022, and the final phase, respectively. Banpu NEXT Company Limited plans to produce Li-ion batteries more than 1,000, and 3,000 MWh for

EVs and ESSs in 2022, and the final phase respectively. All of these are plans which may be changed depending on the demand for EVs and ESSs.

Among these manufacturers, only EA and GPSC have constructed their manufacturing plants and started their operations. A few other manufacturers plan to start manufacturing soon.

Energy Absolute?s battery manufacturing in Cholburi

Energy Absolute (EA) co-invests with Amita Taiwan, (a Taiwanese manufacturer of lithium-ion batteries) and plans to have a total production capacity of 1 GWh in Thailand, and 400 MWh in Taiwan in the initial stage. EA's battery production plant is located also in Nong Yai District in Cholburi. Amita Technology (Thailand) Company Limited (ATT), EA?s subsidiary lithium-ion battery factory, has begun its production since mid-2021 for Phase 1, selling batteries to the electric vehicle business within its group, including electric buses and electric boats. If battery production in the first phase goes well, the company plans to increase its production capacity to 49,000 MWh in the next phase. The company also plans to produce storage batteries for renewable energy plants in the EA group.

GPSC?s battery manufacturing in Rayong

GPSC co-invests with 24M Technologies Incorporation (of the USA) and Anhui Axxiva New Energy Technology Co (AXXIVA) (of China). GPSC has constructed a 30MWh prototype battery factory using semi-solid technology of 24M Technologies Inc., an innovation in lithium-ion battery production that aims to save on production costs. GPSC's battery production plant is located in Map Ta Phut District in Rayong. GPSC just kicked off the battery factory in Rayong in July 2021. The factory is the first factory in ASEAN that manufactures semi-solid batteries called G-cell batteries. GPSC plans to expand its production capacity to 1 GWh.

In the initial stage, GPSC manufactures Lithium Ion Phosphate (LFP) batteries which have as strengths in terms of high safety, long service life, and being environmentally friendly. This type of batteries can prevent short circuit within the battery cells with a structure that has special film layers within the unit cells which can last up to 4,000 times of use and can be recycled more easily than other types of batteries. This approach can have several types of applications, including uses for the EV industry for both small and large electric vehicles such as electric buses, boats, tuk-tuk, small four-wheeled vehicles, motorcycles, and for the energy storage system industry for both electricity reserve system (UPS) and energy storage systems (ESS) with a size from 10 to 10,000 kWh or higher. This will support the development of EV industry, renewable energy and smart city.

Up-coming manufacturing of electric vehicle batteries

A few manufacturers plan to start manufacturing of EV batteries soon, including:

Evlomo Inc. and Rojana Industrial Park Plc?s battery manufacturing in Cholburi

Evlomo, a Florida-based company working on electric vehicles (EVs), has teamed up with Rojana Industrial Park Plc (an industrial park operator in Cholburi) to invest in a 8 GWh battery cell production project, the largest production in ASEAN which can supply up to 150,000 electric vehicles, in Nong Yai district in Cholburi. Under the investment plan, in 2021, the joint venture firm in the initial stage constructs the battery production plant with a production capacity of 1 GWh. Construction and production of the first lot is expected to be completed in 18-24 months, or by 2024. The batteries are for use by electric four-wheeled vehicles, buses, heavy-duty trucks and two-wheeled vehicles. The output can also be used for energy storage for sale in Thailand and abroad.

Banpu?s battery manufacturing (in China)

Banpu co-invests with Dura Power Holdings from Singapore and has expanded its production capacity in China to 380 MWh and has a total production capacity of 1 GWh.

BCPG?s battery manufacturing in the EEC

BCPG revealed its 2019-2022 business plan to invest in lithium batteries manufacturing plant in the EEC. The company plans to have a pilot production capacity of 9 MWh and plans to expand its production capacity to 1,400 MWh in the next phase.

Initiative related to EV batteries

Common battery pack and battery swapping platform development

Global Power Synergy Public Company Limited or GPSC, the innovative power flagship of PTT Group, has signed a Memorandum of Understanding (MOU) with nine electric vehicle companies to develop a prototype common battery pack and a battery swapping system using GPSC?s Semi-Solid technology or G-Cell for battery electric vehicles (BEV) such as electric motorbikes, Tuk Tuks, and cars. The technology will not only increase safety, improve heat dissipation, and reduce charging time but will also further enable battery swapping at EV charging stations in the future.

The nine companies in cooperation with GPSC on the project include 1. FOMM (Asia) Company Limited, 2. I-Motor Manufacturing Company Limited, 3. Toyotron Motor Company Limited, 4. Fommunity Company Limited, 5. Asia Technology Industry Company Limited, 6. Bangkok Pay Company Limited, 7. Strongs (Thailand) Company Limited, 8. Amnuay Fire Extinguishers Company Limited and 9. Samlor Thai Company Limited. The cooperation will be implemented in three phases.

The first phase is the study on how to develop a prototype battery and a battery swapping system, including regulations and specifications, as well as the design of battery cell components for increased efficiency in heat dissipation and safety in compliance with international standards. The implementation of the first phase will result in a three-dimensional prototype battery pack, which will be used for future commercial production. The second phase of the cooperation focuses on the development of a prototype battery pack for different types of electric vehicles. The Internet of Things will be integrated into the system of the battery pack and a battery swapping station will also be set up by Fommunity Co., Ltd. and Asia Technology Industry Co., Ltd, offering a new service platform for electric vehicle users, and a test run will be conducted before being made commercially available. The third phase is a joint feasibility study on commercial sales of the common battery packs.

Status of integration of circular economy principles into manufacturing of EV and EV parts

Circular economy principles have been integrated into the manufacturing of EV and EV parts in the aspect of designing EV to be lighter, such as using aluminum replacing steel parts, e.g., by Sakun C. Innovation Co. Ltd?s manufacturing, as described previously. Other than this, circular economy principles have been little integrated in the EV production. However, some EV producers such as SAIC motor-CP or Mercedes Benz plan to develop the procedure to repurpose EV battery packs for second-life applications such as energy storage system.

Research and development:

As those manufacturers that have received BOI incentives for EV manufacturing are mostly foreign manufacturers that make or will make mostly electric cars, gaps in the research and development for manufacturing of electric cars and other types of electric vehicles remain in Thailand.

NSTDA is a semi-government organization under Ministry of Higher Education Science, Research and Innovation (MHESI) and a key government agency in Thailand that has conducted several technical

research projects related to the development of electric vehicles (see baseline projects later in this section). NSTDA consists of five technology centers: 1) National Center for Genetic Engineering and Biotechnology (BIOTEC); 2) National Metal and Materials Technology Center (MTEC); 3) National Electronics and Computer Technology Center (NECTEC); 4) National Nanotechnology Center (NANOTEC); and 5) National Energy Technology Center (ENTEC). Three of these technology centers including ENTEC, MTEC, and NECTEC have conducted research and development on EV technology.

NSTDA?s research program on electric vehicle technology aims at conducting both basic and applied research, developing prototypes and enhancing ecosystems for the automotive industry, including enhancing those with potential for research and development on the design of EV parts to extend to develop production process and usage of the EV parts. The program also aims to pilot demonstration of EVs for public transportation following the government policy. The agency has focused upon the development of prototypes of certain types of vehicles of which Thai entrepreneurs have capability to upgrade the production, and to compete in the world markets, particularly those of high demand and potential for the production in BEV niche markets, including electric buses, electric minibuses, electric three-wheelers and motorcycles, electric boats/ferries. Also, the agency?s research has focused on the development of industrial production of key parts of electric vehicles such as motors, control units, battery packs, and chargers. Besides, NSTDA has focused on human resource development. The results of NSTDA?s research and development on electric vehicles will also be used to provide recommendations to policy makers for developing policies for supporting EVs, and for preparing comprehensive infrastructure.

Technical capacity building:

NSTDA has supported King Mongkut University of Technology North Bangkok to initiate a project that runs a contest on the development of electric vehicle prototypes (EV Cup) aiming to develop students? capability at lower than the undergraduate level in the design of electric vehicles. The Thai Automotive Institute in collaboration with the Office of Industrial Economics also provides capacity building for technicians on Fundamentals of Electric Vehicles Technologies (such as courses on Electric Vehicle and Dynamics, Drive System of Electric Vehicles, Battery Management System, Electric Vehicles Charging Stations and Impact on Power Grid, Light Weight Metals and Composite Materials for Next Generation Car). The courses aim to support the development of electric vehicles industry. In addition, the Department of Industry Promotion has provided a course and raised awareness about EV and autonomous vehicles, including producing manuals on next generation vehicles.

On the demand side:

On the demand side, plans, targets and policy incentives have so far been in place to encourage widespread use of EVs.

Plan and targets:

In 2015, the Ministry of Energy made a plan for the adoption of EVs and the provision of charging stations, including improving related regulations, support for research on batteries, support for the use of EVs for public transportation such as 3-wheelers, and preparing related infrastructure such as power grid and charging stations. The Ministry of Energy set targets of 1.2 million EVs with more than 690 charging stations nation-wide by 2036.

With regard to charging stations, in the first National EV Policy Committee meeting in March 2020, the committee had a policy that the construction of more charging stations would be managed by state enterprises including the Electricity Generating Authority of Thailand and PTT.

In the second National EV Policy Committee meeting in March 2021 chaired by Deputy Prime Minister and Minister of Energy, the Committee set and updated the following targets on the demand side; 1) to use a total of 1,055,000 electric vehicles in 2025, divided into 402,000 cars/pickups, 622,000 motorcycles and 31,000 buses/trucks., and 2) to use a total of 15,580,000 units in 2035, divided into 6,400,000 cars/pickups, 8,750,000 motorcycles and 430,000 buses/trucks.

In addition, the meeting also laid out the policy of driving the electric vehicle industry with urgent stimulus measures and 1-5 year stimulus measures. Urgent EV stimulus measures aim at promoting the use of both two-wheeled, tricycle and four-wheel electric vehicles, the establishment of electric charging stations for automobiles and motorcycles, and the establishment of a battery standard testing center and the management of battery carcasses. These measures are still being studied in detail. Meanwhile, the 1-5-year stimulus measures include excise tax restructuring, preparation for the management of used battery carcasses, taking safety and environment into account in accordance with international standards, as well as preparing ecosystem to promote the use of clean electric vehicles.

According to the three-phase development plan for the electric vehicle (EV) industry and the 30/30 policy discussed in the third National EV Policy Committee meeting in May 2021, under Phase 1

(2021-2022), the government will pilot the use of electric motorcycles and support infrastructure nationwide. The Committee also set targets in 2030 for EV charging stations to have 12,000 fast chargers nationwide for passenger cars and pick-up trucks and 1,450 battery swapping stations for taxi and delivery motorcycles.

Policy incentives and measures:

Charging station subsidy program

During 2016-2018, the Energy Conservation Promotion Fund (ENCON Fund) provided financial support for service providers (both government agency, public enterprise, and private companies) to establish charging stations. For fast charge, service providers owned by the government received 1.8 million Baht, while those owned by public enterprise received 1 million Baht, and private companies received 30% of the cost of the chargers. For normal charge, service providers owned by the government received 1.9 million Baht, while those owned by public enterprise received 1 million Baht. The Electric Vehicles Association of Thailand (EVAT) was the implementing agency of the charging station subsidy program.

Electricity tariff incentive

In March 2020, the National Energy Policy Council approved the electricity tariff for EV charging station operators to be 2.6369 Baht/kWh (constant rate throughout a day), which is equivalent to the energy payment rate of the off-peak period of the Time of Use (TOU) rate of the current electricity tariff for small businesses/entrepreneurs. The condition for EV charging station operators to get this rate is that electricity for EV charging station operators is considered low priority, which mean that electricity retailers/distributors can control, reduce, or cut off electricity for these operators when there is a constraint in the capacity of the electricity distribution system. This rate is valid for 2 years from March 2020, or until further notice of new electricity tariff structure.

As for the electricity rate for users of EVs, different operators of EV charging stations have used different rates. For instance, PEA has applied the TOU rate, i.e., 4.1663 Baht/kWh for the off-peak period, and 7.5489 Baht/kWh for the peak period for PEA charging stations. The off-peak period includes weekdays from 10 P.M to 9 A.M, and the whole weekend, while the peak period includes weekdays from 9 A.M to 10 P.M. This rate is effective from May 2021. EGAT has set the rate to be 6.5 Baht/kWh for DC chargers, and 5.5 Baht/kWh for AC chargers located at EGAT?s power plant and office areas.

Energy Absolute (EA) has set the charge rate to be per hour of parking, for instance, 50 Baht for the first hour, 80 Baht for the second hour, 110 Baht for the third hour, and 150 Baht for the fourth hour, and 100 baht/hour for the next hours.

In contrast, charging electricity at PTT EV stations and MEA EV stations is still free of charge.

In addition, the second meeting of the National EV Policy Committee in March 2021 also laid out the policy of driving the electric vehicle industry with urgent stimulus measures and 1-5 year stimulus measures. Urgent EV stimulus measures aim at promoting the use of both two-wheeled, tricycle and four-wheel electric vehicles, the establishment of electric charging stations for automobiles and motorcycles, and the establishment of a battery standard testing center and the management of battery carcasses. These measures are still being studied in detail. Meanwhile, the 1-5-year stimulus measures include excise tax restructuring, preparation for the management of used battery carcasses, taking safety and environment into account in accordance with international standards, as well as preparing ecosystem to promote the use of clean electric vehicles.

Current status of use of EVs and availability of charging stations:

Number and types of EVs in use and charging stations

In Thailand, types of electric vehicles in use include Hybrid EV (HEV), Plug-in Hybrid EV, and Battery EV (BEV). The current use of the EVs includes all range of vehicles from delivery truck, bus, three-wheelers, personal vehicle (sedan), and motorcycle. According to figures from the Department of Land Transport, Ministry of Transport, as of 30 April 2021, there were a total of 202,876 HEVs/PHEVs and 7,250 BEVs registered in Thailand. Personal car (sedan) accounts for nearly all or 96% of HEVs/PHEVs and electric motorbike accounts for 57% of the BEVs. Out of the total number of 7,350 BEVs, there were 122 BEV buses and 250 BEV three-wheelers. EV adoption has been growing continuously, with more than 17,962 new HEVs/PHEVs and more than 1,667 battery electric cars and motorcycles registered during Jan 1-April 30, 2011. However, Thailand?s present overall stock of EVs remains below 1%.

With respect to charging stations, as of June 2021, there were about 12 service providers (i.e., EA Anywhere, EVAT Charging Station, Evolt, PEA Volta, PTT EV Station, Charge Now, Elex by EGAT, Sharge, MEA EV, Pump Charge, Even, ONION A PTT Group Company), 2,224 charging outlets, 774 of which were fast chargers, and 1,450 were normal chargers, in 664 locations. Fast chargers (DC) are

available for passenger cars (and buses) at electricity utilities such as PEA, Metropolitan Electricity Authority (MEA), and Electricity Generating Authority of Thailand (EGAT) as well as at some EV station at petrol stations. In Thailand, currently there is no smart charging of V2G type, as the regulation does not yet allow exporting power to the grid. There is only a stand-alone charging station integrated with PV system at PEA Headquarter. Most of charging stations are connected to the grid.

Current investment and expansion of charging stations

Electricity utilities and private companies have invested in piloting charging stations and in establishing a number of charging stations across Thailand. These include;

Investment by electricity utilities

-Electricity Generating Authority of Thailand (EGAT) has established 22 pilot charging stations in their power plant areas and office areas

-Metropolitan Electricity Authority (MEA) has established 10 pilot charging stations in their office areas in Bangkok

-Provincial Electricity Authority (PEA) has established 11 pilot charging stations in their office areas in 9 provinces since 2018

Investment by both local and international oil and gas companies (oil retailers operating gas stations)

-PTT: Since 2017, PTT has participated in setting up pilot EV charging points in PTT gas stations in Bangkok and key tourist areas. As of April 2021, PPT has 30 PTT EV stations. PTT plans to establish a total of 100 charging stations in 2021, and 300 charging stations in 2023.0 PTT EV stations.

-Bangchak has since 2019 partnered with PEA and established 56 charging stations in Bangchak gas stations. Bangchak and PEA plan to establish a total of 62 charging stations by mid-2021 along main roads (32 PEA Volta stations established as of May 2021), and an additional 190 charging stations during 2021-2022 along sub-main roads, to have a total of 263 charging stations in 75 provinces

-Susco has installed EV chargers at 7 corporate-owned gas stations

-Shell?s subsidiary, Greenlot, has collaborated with BMW Thailand, Central Group, AP Thailand, and GLT to launch the EV charging network??ChargeNow?. They have established 16 charging stations (18 ChargeNow stations as of May 2021).

-Caltex Chevron signed an MOU in 2019 with Energy Absolute (a leading local EV charging station provider) to partner in the charging station business, and has established 30 stations (from a total of 360 Caltex stations in Thailand).

-PT partnered with EGAT to invest in charging station business. As of May 2021, PT and EGAT have established 14 Elex by EGAT stations. EGAT aims to establish 35 commercial Elex stations in 2021 plus EGAT?s demonstration stations of 13 to be 48 stations (a total of 90 million baht investment).

-Esso, however, has not actively pushed forward their EV charging projects

Investment by car companies

-MG has established 70 charging stations in their showrooms and service centers, and plans to establish a total of 500 charging stations in 2021

-Benz has partnered with dealers, and chain hotels like Marriot and Hilton, and plans to establish a total of 100 chargers (wall boxes) in 2021

-BMW plans to establish 63 chargers at dealers, shopping malls like Emportia, and hotels

Investment by energy and other companies

-CP ALL which operates seven-eleven plans to establish chargers in 100 branches

-Energy Absolute (EA) which has invested in EV assembly plants and battery plants, partnered with Seven-Eleven, Big-C, Caltex, and Susco has established 500 charging stations (as of May 2021, 417 EA Anywhere stations), and plans to establish 1000 charging stations (600 stations in Bangkok and metropolitan areas, and 400 stations in the rest of the country)

-In January 2020, Delta Electronics collaborated with MEA in installing 50 charging points in Thailand

-Sharge established charging outlets at Singha Complex, Central Chidlom, Central Embassy, and The Line condominiums. As of May 2021, 14 Sharge stations have been established.

Initiatives related to charging stations

Pilot use of battery energy storage systems in EV charging station

GPSC has joined forces with PTT Oil and Retail Public Company Limited (OR) to launch the G-Box 150kwh Battery Energy Storage System (BESS) project to further develop G-Cell products, which use semi-solid technology in the future to enhance energy management efficiency with EV stations,

piloting the installation of PTT Station at Nong Khaem branch in Bangkok, which is an energy innovation that has played an important role in increasing electricity stability, reducing energy costs, and preventing electricity from falling or going out effectively.

The 150 kWh (kWh) G-Box installed in PTT Station will reduce the peak electricity demand during daylight hours of gas stations with large demand for electricity especially from electric cars that will increasingly use the service. To help stabilize the station's electricity for the evenings and evenings, G-Box manages to supply the remaining electricity to other activities. The G-Box trial is expected to have a tangible effect on energy efficiency, which will lead to a faster expansion of installations in EV stations as demand for services increases in the future.

The development of G-Box solutions with technology and innovations produced and invented by Thai people is one of GPSC's Battery Journey strategies to drive technology that aims to bring battery innovation to commercial use with businesses. PTT OR has adopted GPSC's Battery Energy Storage system in conjunction with the charging station to make the service station as ready for the most stable electric vehicle (EV) charging service. If the trial works well, PTT OR may consider expanding in other PTT Stations, including increasing the power size of batteries in line with the use of EV stations and PTT Station.

Baseline scenario of Rayong as selected area for demonstrations in this project

Rayong city

Rayong is a city in the eastern part of Thailand and on the east coast of the Gulf of Thailand. Rayong is a province with the highest GDP per capita in the country due to several large industrial estates and several well-known tourist destinations.

The main economic base of the province is agriculture/fishing. travel and industry (chemical and auto). Rayong was named an Asia-Pacific City of the Future by the *Financial Times* in 2017. The total area of Rayong is 3,552 km2. Rayong is divided into 8 districts, and 58 sub-districts, with a total population of around 0.91 million.

Rayong is one of the three Thai provinces, together with Chonburi and Chachoengsao, at the centre of Thailand?s Eastern Economic Corridor (EEC). The three provinces are to become Thailand's hub for manufacturing, research, and services tightly coupled with its ASEAN neighbours and the world

logistically. The Eastern Economic Corridor (EEC) development lies at the heart of Thailand 4.0 scheme. Important transport projects in the EEC include high-speed train, double track railway industrial port, and motorway Bangkok-Pattaya-Rayong.

Public transport in Rayong

Public transport vehicles in Rayong are focused for demonstrations in the project and are described below.

1) Existing public transport systems in Rayong

According to the Department of Land Transport, public transport systems in a city/province are grouped into 4 Categories.; Category 1 is defined as public transport within a municipality, Category 2 is defined as public transport between Bangkok and a city/province, Category 3 is defined as public transport between a city and other cities/regions, and Category 4 is defined as public transport between districts of a city. In Rayong, all 4 categories of public transport systems are in operation.

Within Rayong City

Public transport systems which transport passengers within Rayong are of Category 1 (within Rayong Municipality) and Category 4 (between districts of Rayong) and include mainly songthaews (modified 4-wheeled diesel pick-up trucks). Other public transport vehicles include taxis, taxi motorcycles, mini-buses, buses with no regular operating routes which transport passengers in industrial estates in Rayong, and buses of government agencies. There is no public transport of passengers via rail systems within Rayong.

Songthaews are the most widely used vehicles for passenger transport within Rayong. The total number of songthaews in Rayong are around 600. Songthaews operate on 5 routes (of Category 1) and 18 regular routes (of Category 4), starting the service from the old passenger terminal (i.e., Terminal 1). These routes are operated mainly by songthaew cooperatives. According to Rayong office of the Department of Cooperatives Promotion, in 2019, there are 8 cooperatives registered in Rayong to operate songthaews. The total number of songthaew cooperative members are also around 600. The fare for songthaews of Category 1 and 4 depends on the transport distance and ranges from 8 to 20 Baht, and 2 to 34 Baht, respectively, according the Department of Land Transport.

Taxis start their service from several places in Rayong, especially, the old passenger terminal, and U-ta Pao airport. Taxi motorcycles also start their service from several places in Rayong, especially government agencies, and both the old and the new passenger terminals, and operate on short distances.

The fare for taxi motorcycles depends on the distance. For instance, the fare for taxi motorcycles starting the service from the new passenger terminal ranges from 50-80 Baht.

Between Rayong and other cities/regions

Public transport vehicles which transport passengers between Rayong and other cities/regions of the country are of Category 2 and 3. Most of these public transport vehicles of Category 2 and 3 are vans and mini-buses/buses, respectively. These public transport vehicles begin the service from the new passenger terminal (i.e., Terminal 2). There is no public transport of passengers via rail systems between Rayong and other cities/regions of the country. (There is, however, public transport of passengers via airplanes between Rayong - i.e., U-ta Pao Airport in Baan-Chang District in Rayong - and a few other cities of the country).

Public transport vehicles of Category 2 (between Bangkok and various districts of Rayong) operate on 10 routes, while public transport vehicles of Category 3 (between districts of Rayong and districts of other cities in the region (mainly Cholburi)) operate on 8 routes. 3 new routes of Category 3 which have been recently operated are between U-ta Pao Airport in Rayong and the 3 following cities (Rayong, Cholburi, and Trat). U-ta Pao airport-Rayong route has a distance of 35 kilometers, a fare of 24 Baht, and is operated by BH Rayong Company, while the other 2 routes have a distance of 100 and 220 kilometers and a fare of 64 and 130 Baht, respectively, and are operated by Suvanabhumi-Burapa Company.

2) Plan and policy on public transport in Rayong (including plan and policy on EVs for public transport)

Plans related to public transport systems in Rayong include the following:

A government plan on rail systems in the EEC; 1) high-speed trains linking 3 international airports including U-ta Pao airport in Rayong, Donmuang Airport in Bangkok, and Suvannabhumi Airport in Samut Prakarn. This plan has been being implemented by public and private partnerships (PPPs), the high-speed trains are planned to start operation by 2023; and 2) the extension of rail systems linking Bangkok and the eastern part of Thailand from Cholburi to Rayong and Trat with double tracks (DT). This plan has not been implemented yet.

A master plan on public (road) transport systems in the EEC, including Rayong, Cholburi, and Chachoengsao, developed by the Office of Transport and Traffic Policy and Planning under the Ministry of Transport. No government agency or local administration office has been assigned to implement this plan yet. How this plan will be implemented as well as the budget for implementing this

plan has not been proposed by any agency, and will need to be approved by the government. It may take some years before the master plan is implemented.

This master plan focuses on public transport in secondary routes within the EEC with the aim to support the development in the EEC, linking high-speed train stations, airports, and key areas of cities and districts within the EEC such as residential and commercial areas, government complex, schools, train stations, and terminals. This plan includes adding new public transport routes in the EEC (6 routes in Rayong, 7 routes in Cholburi, and 5 routes in Chachoengsao).

With regard to Rayong, the plan includes the following 6 routes below and proposes to operate electric vehicles for all these 6 new routes including electric tram bus (Route 1), electric minibuses (Routes 2-5), and electric VIP buses (Route 6). However, these new routes will overlap with parts of existing songthaew routes (category 1 and 4), and part of existing minibus route (category 3) as summarized below.

Route1: Mab Ta Phut industrial estate-IRPC industrial estate, 22 km, Category 1, overlap with parts of 2 existing songthaew routes (category 1)

Route 2: Lam Charoen- Tri-section terminals, 14 km, Category 1, overlap with parts of 2 existing songthaew routes (category 1)

Route 3: U-ta Pao Airport-Rayong-Baan Pae, 62 km, Category 4, overlap with parts of 4 existing songthaew routes (category 4), and part of an existing minibus route (category 3)

Route 4: Rayong-Baan Kai-EECi, 58 km, Category 4, overlap with part of 1 existing songthaew route (category 4)

Route 5: Mab Ta Phut industrial estate- Pattana industrial estate- Eastern Seaboard industrial estate, 45 km, Category 4, overlap with part of 1 existing songthaew route (category 4)

Route 6: U-ta Pao Airport-Rayong-EECi, 96 km, Category 4, overlap with part of 1 existing songthaew route (category 4) and part of an existing minibus route (category 3)

Plan of a public transport operator in Rayong: BH Rayong has got a concession to operate on inter-city routes between Rayong and a few other cities including Bangkok, Cholburi and Chantaburi and the route between Rayong and U-ta Pao Airport. The company plans to use electric minibuses to replace existing vans and minibuses run by diesel to operate on these routes. Currently, the company has 50 vans and 26 minibuses. The company plans to convert all 50 vans and 26 minibuses to electric

minibuses. However, the plan has been delayed due to the COVID situation, and fewer customers. The company does not plan to buy electric vans to replace existing vans, as vans can be used as a public transport vehicle not more than 10 years, while minibuses can be used up to 30 years, according to the government regulation.

3) Existing EV ecosystem in Rayong

An overview of existing EV ecosystem in Rayong is described below from a demand side, infrastructure, and a supply side.

3.1) Demand-side

Current use of EVs in Rayong (including personal, public, and government uses)

There is a small number of electric vehicles in use in Rayong. According to the Statistics of the Department of Land Transport, the number of registered battery electric passenger cars in Rayong per year increased from 3 in 2019 to 21 in 2020, while the number of registered battery electric motorcycles in Rayong per year increased from 0 in 2019 to 16 in 2020. In 2021 (from January to July), the number of registered electric passenger cars in Rayong is 9 for BEVs, and 12 for Plug-in Hybrid (PHEVs), while the number of registered electric motorcycles in Rayong for BEVs is 17.

Based on interviews with existing operators of EV charging stations in Rayong in July 2021, these EV stations/chargers which are in operation have low usage and few customers (less than 4 times of charge per week at each EV station/charger). Customers are mainly users of private cars (branded MG and BYD) from Bangkok, and there are fewer than 10 different electric car users in Rayong which have used the chargers, including private cars (e.g., branded MG), and one hybrid car of the Rayong Governor.

3.2) Infrastructure

Existing EV charging stations in Rayong

There are currently some EV stations/chargers in Rayong including both quick and normal chargers which are in operation. All of these existing chargers are connected to the electricity grid and none of these chargers are integrated with PV systems. These are located mainly in Muang District (Central District) and are located at various types of places in Rayong including local government?s area, gas stations, and parking space of shopping malls/hotels. Existing EV stations/chargers in Rayong as of July 2021 include:

One EV station at Provincial Energy Office (PEO) is located within the Rayong Government Complex. There is one quick charger of 100 kW and one normal charger available at PEO?s EV station. These chargers were installed by Electric Vehicle Association of Thailand (EVAT) and funded by the Energy Conservation Promotion Fund in 2018. The capacity of the quick charger is now reduced from 100 to 40 kW due to 3 out of 5 modules being out of order and lack of maintenance (lack of budget for maintenance). Customers include private cars from Bangkok (MG, BYD), and around 10 regular customers within Rayong including users of private cars (e.g., MG), and one hybrid car of the Rayong Governor.

Three EV stations at 3 PTT gas stations.

? One EV station at the PTT gas station in Nikompattana District: There in one normal charger of 7.4 kW available. Around 1-4 cars per week use the chargers at the station (mainly branded MG). The majority of these customers are from Bangkok.

? One EV station at the PTT gas station in Baan-Chang District. There are two quick chargers of 75 kW each available: There are 1- 2 charges per week. Customers are users of private cars from Bangkok and few private car users in Rayong

? One EV station at the PTT gas station at Rayong Gas Separation Plant in Muang District: there is one normal charger of 7.4 kW available.

Chargers at these PTT gas stations were arranged and installed by PTT Oil and Retail Plc (PTT OR), and maintained regularly by engineers sent by PTT OR. Evlomo is also collaborating with PTT OR to bring public ultra-fast EV chargers to PTT OR sites in the EEC.

More than 10 chargers of Energy Absolute (EA) at parking space of shopping malls and hotels, and gas stations

? Two normal chargers of 22.08 kW each at underground parking space of FN Factory Outlet in Muang District.

? Two normal chargers of 22.08 kW each at parking space of Plai Hotel in Muang District: There are around 3 customers a week. Customers include mainly users of private cars from Bangkok but also include users of private cars in Rayong

? Three normal chargers of 22.08 kW each at parking space of Star IT Rayong Shopping Complex in Muang District.

? One normal charger of 22.08 kW at Sangthong Plus Shopping Center in Muang District: It is not in operation yet.

? One quick charger of 75 kW and one normal charger of 6.9 kW at parking space of Star Hotel in Muang District: Both are not in operation yet.

? One normal charger of 22.08 kW at ECF Supermarket in Klang District.

? EV station at Shell gas station in Nikompattana District: There is one quick charger of 75 kW and one normal charger, but both are not in operation yet due to lack of charger cable.

? EV station at TIM Energy gas station in Pluakdaeng District: There is one quick charger of 75 kW and one normal charger of 22.08 kW. Both are not in operation yet.

3.3) Supply-side

Existing EV manufacturing in Rayong

As mentioned previously, existing EV manufacturing in Rayong or the EEC includes manufacturing of both hybrid and battery electric vehicles of mainly global companies, for instance, Great Wall Motor (GWM) and MG. There are, however, also plans for up-coming manufacturing of electric vehicles of Thai companies (see next section).

? SAIC Motor and CP (Charoen Pokphand) Group?s manufacturing in Cholburi and Rayong

? Great Wall Motor (GWM)?s manufacturing in Rayong

Existing EV battery manufacturing in Rayong

As mentioned previously, there are quite a number of manufacturers of batteries for EVs in Thailand, which are in operation and plan to be in operation soon, with their manufacturing plants located in Rayong or the EEC, including Global Power Synergy (GPSC), Rojana Industrial Park Plc, Energy Absolute (EA), Banpu (BP), and Bangchak Corporation Public Company Limited (BCPG). A total combined planned production capacity of all these manufacturers accounts for more than 10 GWh. However, among these manufacturers, only EA and GPSC have constructed their manufacturing plants and started their operation. The other manufacturers have plans to start manufacturing soon (see next section).

? Energy Absolute?s battery manufacturing in Cholburi

? GPSC?s battery manufacturing in Rayong

4) Plan for EV ecosystem expansion in Rayong

4.1) Demand-side

Plan for promoting increased use of EVs in Rayong

So far, no specific plan has been implemented to promote an increased use of EVs specifically in Rayong.

4.2) Infrastructure

Plan for expansion of EV charging stations in Rayong

The Thai government has a policy for its state enterprises including 3 electricity utilities (EGAT, PEA, and MEA) and PTT to install chargers on major routes across Thailand. In Rayong, PEA Volta in collaboration with Bangchak (BCPG), and PTT OR, have a plan to install chargers.

PEA Volta and BCPG

In 2020, PEA Volta and BCPG plan to offer an EV charging station for every 100-km stretch on major routes to big cities and key attractions across Thailand. As a result, in Rayong, PEA Volta and BCPG plan to open 3 EV stations in 2021 at 3 Bangchak gas stations in Rayong (Muang District, Klang District, and Wangchan District). Chargers at all these EV stations will be connected to the grid. None of these chargers will be connected to PV systems.

In 2021 and 2022, PEA Volta and BCP plan to offer an EV charging station for every 100-km stretch on secondary routes in 75 provinces across Thailand including Rayong, and expect to operate 263 EV charging stations in 75 provinces across Thailand by 2023. The number of EV charging stations of PEA Volta and BCP in Rayong is not announced in public yet, but there are currently 15-20 BCP gas stations in Rayong.

PTT OR

PTT OR plans to install more than 1,000 new fast chargers every 50 km on their charging network. In 2021, PTT OR plans to offer a total of 100 EV charging stations at PTT gas stations across Thailand, and in 2022-2023 a total of 300 EV charging stations. PTT OR has a total of 2,290 petrol stations

across Thailand. PTT OR has already operated 3 EV charging stations at 3 PTT petrol stations in Rayong, however, the number of additional EV charging stations of PTT OR in Rayong is not announced yet, but there are currently around 15 petrol stations in Rayong. Whether any of these EV charging stations will be connected to PV systems is not known to the public.

EGAT

EGAT in collaboration with PT has offered one EV charging station in the EEC area (only in Cholburi-Muang District) and does not have a plan to expand EV charging stations in Rayong.

MEA

MEA only offers EV charging stations in Bangkok and Metropolitan areas.

According to the information from the EECO on the overall EV charging station plan in the EEC, quick chargers (DC) will be mainly installed at petrol stations, and parking space of restaurants and convenient stores, while normal chargers (AC) will be mainly installed in residential areas. In 2021, on-grid chargers are planned to be installed at around 500 places in the 3 provinces in the EEC, while off-grid chargers are planned to be installed at around 30 places. In 2022, on grid chargers are planned to be added at around 500 places in public areas. The number of on-grid and off-grid chargers in Rayong is not announced yet.

4.3) Supply-side

Plan for expansion of EV manufacturing in Rayong

Up to now, there has been no plan for expansion of EV manufacturing in Rayong, but there are plans for participation in manufacturing of electric vehicles of Thai companies in other cities in the EEC, and in other parts of Thailand, as mentioned previously. These include:

? NEX Point and Energy Absolute?s manufacturing in Chachoengsao

? Bangkok Sheet Metal Co., Ltd. (BM) in Samut Prakarn

? Sakun C Innovation Co in Suphanburi

? PTT and Foxconn.

? Banpu NEXT

? Siam Advanced Technology Relationships (ATR) in East Bangkok with Choedchai Group

Plan for expansion of EV battery manufacturing in Rayong

There has been no plan for expansion of EV battery manufacturing in Rayong, but there are plans for manufacturing in the other provinces in the EEC soon, including:

? Evlomo Inc. and Rojana Industrial Park Plc ?s battery manufacturing in Cholburi

? BCPG?s battery manufacturing in the EEC

Baseline projects:

The importance of EEC and EEC projects

The project?s overall target geography is Thailand, with demonstrations in the Eastern Economic Corridor (EEC). The EEC is a region comprised of three provinces: Rayong, Chon Buri and Chachoengsao. Thailand?s aim of developing the EEC is to establish it as an example of livable, smart community development and as a leading economic area for manufacturing, trading, export and logistics in ASEAN with comprehensive logistic connections to Asian countries and the world. High performance batteries and modern transports have been made a focus industry for innovation clusters under the Eastern Economic Corridor (EEC).

The EEC covers a space of 13,285 km2 and has a population of approximately 4 millions with a projection of reaching 6 millions by 2037. Population growth is expected to place even greater pressure on infrastructure and services in the region. With respect to transport, if commuting by fossil fuel-based vehicles remains the dominant modal share car, the carbon emissions of the region are estimated to rise significantly.

The EEC will be developed to include smart cities and promoted zones such as Digital Park and medical hub in Chon Buri and Innovation Park in Rayong. Innovation Park or the Eastern Economic

Corridor of Innovation (EECi) is a comprehensive innovation ecosystem designated under the NSTDA to facilitate investment in research and innovation and human resource preparation for Thailand?s targeted industries under the cooperation between government, private sector and academia. Next-generation automotive industry is among Thailand?s 10 targeted industries, and thus EECi will be developed to have complete infrastructure of the industry with attention to a multitude of areas including battery/energy storage, vehicle system integration and smart energy living labs, and material technology to reduce vehicle weight. Autonomous vehicle ecosystem will be developed in the EECi including 1) manufacturing of vehicle structure and body (EV platform), 2) parts, components and design, 3) control, software and system integration, 4) standard and testing, 5) policy and regulation, and 6) digitial HD Map.

Projects related to electric vehicles and batteries being implemented in the EECi in Rayong include; 1) Connected and Autonomous Vehicle (CAV) Proving Ground (or EECi ARIPOLIS Autonomous driving testbed). The Proving Ground project will use international standards for autonomous vehicles for testing such as ADAS EURO NCAP 2021-2023 directive, UNECE R13, R79, R10 (PTEC) and ZOOX, and will have a connectivity with other projects in the EECi in the form of ecosystem, including Sustainable Manufacturing Center (SMC) project, and Zinc-ion battery pilot plant project, and 2) Zinc-ion battery pilot plant. The battery pilot plant project includes the following 5 activities (research and development of batteries, manufacturing and assembly of batteries, storage of renewable energy and users, standard testing, and battery recycling). In the initial stage (2022), the government will invest in the project and a production capacity of 1 MWh/year is expected. In later stages, private sector will invest in the project and an expanded production capacity of 500-1,000 MWh/year will be expected. Targeted applications include energy storage systems, power plants, oil drilling platforms, and households.

In addition to the implementation in EECi, Automotive and Tire Testing, Research and Innovation Center (ATTRIC), including battery laboratory, has been established in Chachoengsao. Next-generation automotive hub and electric vehicle learning laboratory will also be developed in Chon Buri next to EECi. A total of more than 300 EV charging stations are planned to be established in the EEC by 2022.

Moreover, as described previously, there are several investments from private sector in the manufacturing of electric vehicles and batteries in the EEC, such as a 7-million-USD investment by Great Wall Motor in the manufacturing in Rayong of xEVs by 2021 and of BEVs and batteries by 2023, with a production capacity of 80,000 units per year, a joint 2-billion-USD investment by PTT and FOXCONN in the manufacturing of EV platform by 2022, and of EV batteries (solid state and lithium ion phosphate batteries) with a production capacity of 120,000 units/year and in the establishment of EV charging stations, investments in the establishment of batteries plants by Energy Absolute and AMITA (lithium ion battery), by GPSC and 24M (semi-solid state battery), and by EVlomo and Rojana (lithium ion battery), with a total production capacity of all these battery plants of 5 GWh by 2023.

Furthermore, the government has indicated funding for several large-scale projects in the EEC including 12 billion USD for new cities and 15 billion USD for industry. A key priority for investment

and development in the EEC is the development of smart cities. 7 elements of Thailand smart city include smart living, smart people, smart environment, smart mobility, smart energy, smart economy, and smart governance. An example of new urban development includes the planned expansion of U-tapao airport within the Rayong Municipality and the development of Laemchabang in Chon Buri, a coastal city with the largest port in Thailand. Additionally, significant investment is being directed towards developing connectivity in the region through infrastructure projects, including a high-speed train, double-track rail lines, expansion of ports and U-Tapao Airport, and encouraging investment in the 10 targeted industries identified by the government.

Several ongoing and announced projects as well as completed projects of particular relevance to this project

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•The Regional Transport and Traffic Promotion Bureau (RTPB) of the Office of Transport and Traffic Policy and Planning (OTP) has recently completed a project to develop a Master Plan for the Development of Public Transportation in Chachoengsao, Chon Buri, and Rayong provinces to Support the Development of the EEC. The project aimed to i) formulate the Master Plan for the Development of Public Transportation in Chachoengsao, Chon Buri, and Rayong provinces to Support the Development of the EEC; and ii) conduct preliminary feasibility study of the public transportation system which connects and supports the development of the transport infrastructure projects in the EEC, including the expansion of U-Tapao airport project, the high-speed train connecting 3 airports project, the double-track rail lines project, and the development of ports project. Based on the Master Plan, 18 key routes within the 3 provinces were identified, and electric vehicles such as electric minibuses, electric buses, tram buses, and trams were proposed as the most appropriate means of public transportation to replace existing modes of transportation (e.g., vans, songthaew (modified pick-up trucks), and buses) within the EEC area.

The proposed project aims to build on this project and the effort of RTPB OTP through a demonstration of the use of electric vehicles for public transportation in the EEC area. OTP RTPB has also implemented other projects to develop the Master Plan for the Development of Public Transportation in other cities such as Phuket, Chiang Mai, Songkhla, Nakorn Ratchrasrima, and Kon Khaen, and will be able to take lead in disseminating and replicating experiences from the EEC to these cities and to the national level.

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•Thailand Greenhouse Gas Management Organization (TGO) has developed and implemented the ?Integrating Climate Actions into EEC: Towards the Low Carbon Industry? project. As part of this project, TGO has performed a gap analysis using a questionnaire distributed to 150 factories in the EEC, surveys and in-depth interviews with 30 factories, and a review of energy management reports of

designated factories. Based on analysis of 73% of the designated factories in the EEC, energy consumption and greenhouse gas emissions from designed factories were 25,125ktoe or equal to 94,681 $ktCO_2$. This figure also represents 37% of total emissions from designated factories in Thailand. With respect to the priority S-Curve industries, the automotive industries had the highest share of reported emissions, accounting for 44.95% of total reported emissions. Regionally, Chon Buri accounted for 52.99% of emissions, followed by Rayong (27.2%) and Chachoengsao (19.89%). TGO has proposed based on their analysis five policy recommendations to promote GHG management and reduction in the EEC: policy and organizational management; legal; technology; finance and capacity development.

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•TGO has also implemented the ?City Carbon Footprint? Project since 2014 in order to help cities calculate their footprint (based on GHG protocol calculation methodology), identify mitigation potential which will help them prepare mitigation action plans in their cities, including action on their transportation sector. As of now, there are 94 municipalities and 17 provinces which participated and calculated City Carbon Footprint (CCF). In addition, there are 214 municipalities which participated in the TGO Carbon Footprint of Organization (CFO) project to calculate and identify mitigation potential to reduce GHG in their organizations. In the next Fiscal Year, which will start in October 2020 till the end of September 2021, TGO under the EEC Integrated Budgeting Plan, will implement the ?City Carbon Footprint? Project in the EEC area (Rayong, Chachoengsao, and Chon Buri provinces).

The results of this project could be relevant to the proposed project, as they could provide baseline GHG emissions for pilot areas for demonstration of the use of EVs within the EEC area.

? NSTDA has conducted several technical research projects related to the development of electric vehicles manufacturing (see below). The agency has aimed at conducting basic research, developing prototypes and enhancing ecosystems for the automotive industry. The agency has focused upon the development of prototypes of certain types of vehicles for which Thai entrepreneurs have capability to upgrade their production, and to compete in the world markets, particularly BEV niche markets, including electric buses, electric minibuses, electric motorcycles, and electric boats/ferries. Also, the agency?s research has focused on the development of industrial production of key parts of electric vehicles such as motors, control units, battery packs, and chargers. Besides, NSTDA has focused on human resource development.

? The agency has worked with 4 partners including the Bangkok Mass Transit Authority (BMTA), Electricity Generating Authority of Thailand (EGAT), Metropolitan Electricity Authority (MEA) and Provincial Electrical Authority (PEA) to improve Thai entrepreneurs? technical and capacity potential to have their own knowledge and technology for electric buses. This project also aims to develop new knowledge of ICE to electric bus conversions as well as develop an understanding of components that could be provided by Thai manufactures in order to decrease the volume of imported electric buses.

The agency has in collaboration with several Thai universities developed 4 prototypes of electric buses from BMTA?s used buses, which can now be registered as public buses and be operated legally and safely. The potential for BEV electric buses is estimated to be 600-700 buses. An extension of the above project includes the research and development of a charging station prototype, up to IEC and SAE standard, to be used by BMTA?s electric buses, by the National Electronics and Computer Technology Center (NECTEC) under NSTDA. The charging station prototype will be also used for collecting related data and developing energy management systems.

In addition, the agency has in collaboration with a private bus producer in Nakorn Rajchasrima province and a few Thai universities developed prototypes of large electric inter-city buses based on fast charge and studied various related issues such as minimizing impact on power grid system and satisfying customers? demand, safety standards, tariffs for charging, total cost of ownership, and environment impact.

- As for electric minibuses, the agency has in collaboration with a group of private companies developed prototypes of electric minibuses with the length between 7 and 8 meters to replace public vans as supported by the government policy. The agency has also developed these electric minibuses to be lighter, with aluminum replacing steel parts. Besides, the agency is in the process of developing a prototype of induction motors for minibuses and aims to support industrial production of electric minibuses.

Also, the agency is completing research and developing a prototype of three-phase induction motors for microbuses. Induction motors are inexpensive, easy to produce and control compared to standard EV motors.

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- Regarding electric motorcycles, the agency has in collaboration with a private company developed a prototype BEV motorcycle. As for electric boats, the agency has in collaboration with private companies developed prototypes of key parts and core technologies of electric boats. The agency has also just signed an MOU with Marine Department and private sector for the development of electric ferries.

The proposed project will build on these projects of NSTDA and the knowledge developed, particularly related to developing prototypes of electric vehicles (e.g., knowledge and lessons of the conversion of ICE vehicles to electric vehicles). As a national agency, NSTDA could provide linkages with the national level through sharing knowledge developed and lessons learned as well as upscaling the

manufacturing and adoption of these electric vehicles in other parts of the country, through a demonstration of the use of electric vehicles for public transportation in the EEC area.

Related projects of development banks, bilateral organizations, and/or other partners

As mentioned earlier, OTP RTPB has also completed projects to develop the Master Plan for the Development of Public Transportation in other cities such as Chiang Mai. Experiences from the proposed project could be shared and exchanged with Chiang Mai Municipality.

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•Under the Electric Mobility Program of the United Nations Environment Program, UN Environment is supporting a large group of low- and middle-income countries with the introduction of electric mobility policies and pilots. As for the electric two and three wheelers workstream UN Environment is supporting eight countries with the introduction of electric two- and three-wheelers. These are Kenya, Uganda, Rwanda, Ethiopia, Morocco, Philippines, Vietnam and Thailand. The emphasis is on introducing policies and incentives for the introduction, removing administrative hurdles, and piloting of electric motorcycles. It is working with local operators, companies and governments, and includes financing and local production and assembly for a wider uptake of electric motorcycles.

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•Building on the aforementioned UNEP programme and a host of other global electric mobility initiatives, the GEF 7 Global Program to Support Countries with the Shift to Electric Mobility (hereafter the Global Program) will support the rapid introduction of electric mobility in GEF recipient countries. The program was submitted initially with the following 17 child projects (Antigua & Barbuda, Armenia, Burundi, Chile, Costa Rica, India, Ivory Coast, Jamaica, Madagascar, Maldives, Peru, Seychelles, Sierra Leone, St. Lucia, Togo, Ukraine, and Uzbekistan). The program was expanded at a second stage to include a second group of countries: Albania, Bangladesh, Ecuador, Grenada, Indonesia, Jordan, Philippines, South Africa, Sri Lanka, and Tunisia. It will undertake activities at the global, regional and country levels. It will also build on a solid basis of knowledge and outreach capacity developed by the leading electric mobility programme of the International Energy Agency and the United Nations Environment Program (with partners). It will be the first-ever global inter-agency electric mobility program.

The overall objective of the GEF 7 Global Program is to contribute to the implementation of the Paris Climate Agreement through contributing to reaching the levels of electric mobility necessary to achieve emission reductions from the transport sector outlined in the alternative, low-carbon scenario (B2DS) in low and middle-income countries, while minimizing adverse effects for the sustainability of

transport and energy systems. This is to be achieved by providing an integrated approach to support countries with the development of electric mobility policy frameworks and the support of electric mobility projects. This global program is designed to focus on all road transport modes - including two and three wheelers, cars, buses and trucks. It uses a programmatic approach with a ?parent? project at global and regional level and related in-country ?child? projects. The in-country child projects will support the development and implementation of enabling environments for electric mobility, the demonstration of electric mobility interventions, and frameworks for scaling-up electric mobility.

The proposed project will also create linkages with the Global Program and regional platform under the program in order to support capacity building, knowledge sharing and replication of best practices in electric mobility adoption in other countries. In particular, the proposed project will benefit from transfer on the state-of-the-art technology on electric mobility. The NSTDA as the technical focal point of the proposed project will receive transfer of technology and knowhow concerning the state-of-the-art technology on electric mobility through capacity building and knowledge sharing. Thereafter, they will provide trainings and transfer the technology and knowhow to wider-stakeholders in Thailand, through this propose project.

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•The UNIDO GEF-5 project entitled ?Greening Industry through Low Carbon Technology Application for SMEs? (GEF ID 5725) promotes and supports the adoption of energy efficient practices and technologies in selected Small and Medium Enterprises (SMEs) in Thailand for improved competitiveness and a greening of industry. To achieve this, the project aims to create demand for low-carbon technologies through policy support, awareness raising activities and capacity building of government, financial institutions, industries, technical personnel, as well as the implementation of demonstration projects to encourage the adoption of such technologies in SMEs. These interventions will create an environment conducive to increased investment in low-carbon technologies and energy efficiency improvements by SMEs in Thailand. The automotive sector is a targeted industry under this project, with UNIDO supporting the adoption of industrial energy efficiency measures and adoption of ISO 50001 standard for Energy Management Systems.

This proposed project will aim to build on these interventions, building on lessons learned to date and applying them to this project?s interventions on electric mobility.

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•German International Cooperation Agency (GIZ) has implemented the project ?Facilitating the development of ambitious transport mitigation actions (TRANSfer III)?, which supports the Thai government in the design and creation of the Thai Clean Mobility Program (TCMP). TCMP is a national program that supports city administrations in their efforts to plan and implement Sustainable

Urban Transport Projects, thereby reducing GHG emissions and air pollution stemming from transport in Thai cities. The project includes a study of a congestion charging scheme for Bangkok, support to the bus sector reform and fleet modernization in Bangkok, and setting up a national Sustainable Urban Transport (SUT) Fund to finance SUT projects in other Thai cities. Office of Transport and Traffic Policy and Planning (OTP) is the project partner. The project has been implemented since July 2017 and will end by June 2022.

The proposed project will share experiences and lessons learned with this project in order to support scale-up and replication of electric mobility in other cities in Thailand.

c) the proposed alternative scenario with a brief description of expected outcomes and components of the project;

The proposed project?s overall objective is to realize the full potential benefits of EVs for contributing to GHG emission reductions in the transportation sector in Thailand, through addressing gaps and barriers to EV adoption and production in Thailand identified in the previous sections with the support of GEF funding. While Thailand has made steps towards supporting electric mobility adoption, additional support is necessary to increase the rate of adoption and support decarbonisation of the transport sector beyond the existing baseline. The project has 3 specific objectives aimed at addressing the identified gaps and barriers:

First, the project aims to support wider adoption of EVs and sustainable use of batteries within the EEC and in Thailand, through 1) improving policy and institutional framework to address barriers on both the demand and supply sides, and to address life cycle issues of electric mobility and sustainable use of batteries; 2) pilot demonstrations of the use of EVs and charging infrastructure integrated with renewable energy systems and of sustainable use of batteries within EEC; and 3) scale-up opportunities across the EEC and Thailand.

Second, the project aims to enhance a business sector ecosystem for EV entrepreneurship within the EEC and Thailand, through 1) improving policy and regulatory framework, 2) developing an entrepreneurship support program for electric mobility solutions within the EEC, and 3) demonstration of innovative electric mobility solutions within the EEC.

Third, the project aims to support the integration of circular economy practices into the life cycle of batteries through enhancing policy and regulatory framework to address life cycle issues of batteries and demonstration of, for instance, the application of second life EV batteries within the EEC.

The project consists of 4 components of which the first 2 components address each of the 3 specific objectives above (with the first component addressing at a national level, and the second component addressing at investment and EEC levels), while the third component focuses on the up-scaling to national, regional and global networks, and the fourth component focuses on monitoring and evaluation to ensure that the project?s objectives will be met.

Component 1: **Improve policy and regulatory framework for electric mobility and sustainable use of batteries in a gender-responsive manner**

Overview of objectives and expected outputs

This component aims to assess and monitor the reduction of GHG emissions in the public transport sector due to increased electric mobility, as aimed by this project, through analyzing, forecasting, and developing GHG management system in the public transport sector (for both the EEC and in Thailand). Moreover, this component aims to address gaps and barriers to wider adoption of EVs and related life cycle issues within the EEC and in Thailand on both the demand and supply sides mentioned in the previous section, through improving policy and regulatory framework at the national level.

As mentioned earlier in the previous section, on the demand side, consumer?s awareness and understanding of EVs and related technologies, particularly in terms of safety, usage and maintenance of EVs, financial and non-financial incentives for EV consumers, and related infrastructure such as charging stations and power grid to support widespread use of EVs remain barriers to wider adoption of EVs. On the supply side, new product and production standards related to EVs and components (e.g. batteries), and an ecosystem for EV entrepreneurship, remain barriers to wider adoption of EVs.

In other words, this component develops or enhances policies and regulatory framework for implementation at the national level to address these barriers, to address life cycle issues of electric mobility and to encourage the sustainable use of batteries. This component focuses on enhancing policy and regulatory framework for 1) EV ecosystem development, 2) charging infrastructure integrated with renewable energy systems, and 3) addressing life-cycle issues for electric mobility and sustainable use of batteries. Gender dimensions will be considered under each output with the aim to foster gender equality and women?s empowerment. This includes considering gender dimensions in policy reviews and gender experts and groups that promote gender quality and the empowerment of women (GEEW) in policy development.

This component will build on the results of the policy research project related to EVs implemented by the Thai Automotive Institute and its partners, mentioned earlier, and complement what the National Electric Vehicle Policy Committee, its sub-committees and working groups are working on. Based on the information from members of the Policy working group established under this project which represent government agencies that are members of the National Electric Vehicles Policy Committee, the Committee has worked on developing policy and incentives to promote EVs with particular focus on private cars/vehicles. In order to complement the focus of the Committee and to address the issue of

a possible increase in the number of vehicles on the roads, this project component will place an emphasis on developing policy, incentives, and regulatory framework to promote EVs for public transportation and sharing EVs. This component will also be integrated with practical experiences, knowledge, and lessons to be developed and learned from Component 2.

Details of activities, initial time plan, and implementing partners are described for each output below.

1.1. 1 Analyze, forecast and develop management system for GHG emissions in the public transport sector (for both EEC area and Thailand)

Objectives:
This output aims to assess and monitor the reduction of GHG emissions in the public transport sector due to increased electric mobility, as aimed by this project, with focus on both EEC area and Thailand, and to complement and link with a focus of Component 2 of this project on electric vehicles for public transport,

Activities:
The following 3 activities are included under this output;

1.1.1.1 making an analysis/calculation of total current GHG emissions in the public transport sector

1.1.1.2 making a forecast of total GHG emissions in the public transport sector, and of total GHG emission reductions due to the increased use of electric vehicles for public transport during 2022-2030, and

1.1.1.3 developing a monitoring system or platform of public transport EVs to support the GHG reduction by a certain percentage in 2030 compared with the base year.

As for the time plan for implementing this output, the first, second and third activities will be implemented in the first year, the second and third years, and the fourth and fifth years of the project, respectively. These actives will involve field data collection, stakeholder consultations, and developing monitoring systems. To implement the first activity and second activity, TGO will conduct desk research and make field visits in Rayong and the EEC to collect field data required for making the calculations and forecasts of the GHG emissions and GHG emissions reduction. TGO will also organize stakeholder consultations and meetings with implementing partners to receive inputs and feedback for completing the calculations and forecasts. For the third activity, TGO will develop monitoring systems or platforms of public transport EVs.

Implementing partners which will contribute to this output are some of the agencies of the 2 working groups established under this project, including Rayong City Municipality, Thai Automotive Institute (TAI), Electric Vehicle Association of Thailand (EVAT), Department of Alternative Energy Development and Efficiency (DEDE), NSTDA, and Rayong Technical College.

1.1.2 Enhance policy and regulatory framework for EV ecosystem development

Objectives:

As, on the demand side, financial and non-financial incentives for EV consumers remain a key gap to wider adoption of EVs, and on the supply side, an ecosystem for EV entrepreneurship remains a key barrier to wider adoption of EVs, this output aims to address these gaps/barriers, in particular as they relate to public transportation.

Activities:

This output includes the following activity:

1.1.2.1 Enhancing financial and non-financial incentives / measures for supporting the increased use of EVs in public transportation fleets (targeting fleet operators), and in private owners (targeting private users), and developing policy, instruments and developing/amending regulations to enhance/facilitate EV manufacturers and supply chain (targeting private sector), including to facilitate EV fleets registration and production.

As for the time plan for implementing this output, the activity mentioned above is planned to be implemented from the first year through the fifth year of the project. This activity will involve surveys/interviews and stakeholder consultations. In order to implement this activity, TGO will conduct desk research and collect data and information through surveys and interviews, and will also organize stakeholder consultations and meetings with implementing partners to receive inputs and feedback for these activities. TGO will propose developed financial and non-financial incentives and policy recommendations to the Eastern Economic Corridor Board or the National Electric Vehicle Policy Committee via the Eastern Economic Corridor Office (EECO) or member agencies of the policy working group under this project which are also member agencies of the National Electric Vehicle Policy Committee, respectively, for the implementation of these incentives and recommendations at the national and EEC levels.

To ensure that the policies, regulations and instruments are gender responsive, social and gender dimensions are being considered during their development. This includes conducting gender analysis, collecting gender disaggregated data during data collection, considering gender dimensions in the surveys and interviews and involving gender experts, gender focal points and/or organizations that promote gender equality and women?s empowerment. Moreover, women?s organizations will be invited to validate the policies from a gender perspective.

Implementing partners which will contribute to this output are some of the members of the 2 working groups established under this project, including Rayong City Municipality, Fiscal Policy Office, Revenue Department, Excise Department, Thai Automotive Institute (TAI), Electric Vehicle Association of Thailand (EVAT), Department of Alternative Energy Development and Efficiency

(DEDE), Office of Transport and Traffic Policy and Planning (OTP), National Economic and Social Development Council, Energy Policy and Planning Office (EPPO), NSTDA, and Rayong Technical College. Stakeholders that promote GEEW will be identified during the project inception.

1.1.3 Develop policy and regulatory framework for charging infrastructure integrated with renewable energy systems

Objectives:
On the demand side, financial and non-financial incentives for charging infrastructure such as charging stations and power grids remain barriers to wider adoption of EVs. This output aims to address these barriers, to complement the policy work of the National Electric Vehicle Policy Committee on expanding charging stations countrywide, and to enhance the reduction of GHG emissions due to the increased use of electric vehicles.

Activities:
The following 2 activities are included under this output;

1.1.3.1 developing financial and non-financial incentives for RE-powered charging infrastructure (targeting charging point operators), and

1.1.3.2 developing a 2022-2030 roadmap for establishing RE-integrated charging infrastructure to support GHG emission reductions.

As for the time plan for implementing this output, the first activity will be implemented in the first two years, and the second activity will be implemented in the third, fourth and fifth years of the project. These activities will involve surveys and interviews and stakeholder consultations. In order to implement these activities, TGO will conduct desk research and collect data and information through surveys and interviews, and will also organize stakeholder consultations and meetings with implementing partners to receive inputs and feedback for these activities. TGO will propose developed financial and non-financial incentives and policy recommendations as well the roadmap to the Eastern Economic Corridor Board or the National Electric Vehicle Policy Committee via the Eastern Economic Corridor Office (EECO) or member agencies of the policy working group under this project which are also member agencies of the National Electric Vehicle Policy Committee, respectively, for the implementation of these incentives, roadmap and recommendations at the national and EEC levels.

To ensure that the policies, regulations and instruments are gender responsive, social and gender dimensions are being considered during their development. This includes conducting gender analysis, collecting gender disaggregated data during data collection, considering gender dimensions in the surveys and interviews and involving gender experts, gender focal points and/or organizations that promote gender equality and women?s empowerment. Moreover, women?s organizations will be invited to validate the policies from a gender perspective.

Implementing partners which will contribute to this output are some of the members of the 2 working groups established under this project, including Rayong City Municipality, Fiscal Policy Office, Revenue Department, Excise Department, Thai Automotive Institute (TAI), Electric Vehicle Association of Thailand (EVAT), Department of Alternative Energy Development and Efficiency (DEDE), Office of Transport and Traffic Policy and Planning (OTP), National Economic and Social Development Council, Energy Policy and Planning Office (EPPO), NSTDA, and Rayong Technical College. Stakeholders that promote GEEW will be identified during project inception.

1.1.4 Enhance policy and regulatory framework for addressing life-cycle issues for electric mobility and sustainable use of batteries

Objectives:

This output aims to address life-cycle issues for electric mobility and support sustainable use of EV batteries and EVs.

Activities:

The following activities are included under this output:

1.1.4.1 Developing a standard for handling and management of used EV batteries / developing a comprehensive life-cycle regulation on EV batteries (production, use, disposal and reuse) / developing a guideline for low-carbon labeling of EV batteries.

Which of these activities mentioned will be implemented will be decided based on additional inputs from relevant stakeholders during the initial stage of the project to ensure that the selected activity will complement existing related work and benefit relevant agencies which will implement this policy and regulatory framework.

As for the time plan for implementing this output, the activity is planned to be implemented from the first year through the fifth year of the project. The activity will involve surveys/interviews and stakeholder consultations. In order to implement the activity, TGO will conduct desk research and collect data and information through surveys and interviews, and will also organize stakeholders consultations and meetings with implementing partners to receive inputs and feedback for these activities. TGO will propose a standard or a regulation or a guideline for low-carbon labelling to the Eastern Economic Corridor Board or the National Electric Vehicle Policy Committee via the Eastern Economic Corridor Office (EECO) or member agencies of the policy working group under this project which are also members of the National Electric Vehicle Policy Committee, respectively, for the implementation of these incentives and recommendations at the national and EEC levels.

To ensure that the policies, regulations and instruments are gender responsive, social and gender dimensions are being considered during their development. This includes conducting gender analysis, collecting gender disaggregated data during data collection, considering gender dimensions in the surveys and interviews and involving gender experts, gender focal points and/or organizations that promote gender equality and women?s empowerment. Moreover, women?s organizations will be invited to validate the policies from a gender perspective.

Implementing partners which will contribute to this output are some of the member agencies of the 2 working groups established under this project, including Rayong City Municipality, Fiscal Policy Office, Revenue Department, Excise Department, Thai Automotive Institute (TAI), Electric Vehicle Association of Thailand (EVAT), Department of Alternative Energy Development and Efficiency (DEDE), Office of Transport and Traffic Policy and Planning (OTP), National Economic and Social Development Council, Energy Policy and Planning Office (EPPO), NSTDA, and Rayong Technical College. Stakeholders that promote GEEW will be identified during the project inception.

Summary of Component 1?s outcomes, outputs and activities:

Expected Outcomes:

1.1. Policy and regulatory framework for electric mobility and sustainable use of batteries enhanced

Expected Outputs:

1.1.1 Analysis, forecast and management system for GHG emissions in transport sector developed
1.1.2 Policy and regulatory framework for EV Ecosystem development enhanced
1.1.3 Policy and regulatory framework for charging infrastructure integrated with renewable energy systems
developed
1.1.4 Policy and regulatory framework for addressing life-cycle issues for electric mobility and sustainable use of
batteries enhanced

Expected Activities:

1.1.1.1 Complete an analysis/calculation of total current GHG emissions in the public transport sector in Thailand.
1.1.1.2 Complete a forecast of total GHG emissions in the public transport sector and total GHG emission reductions due to the increased use of electric vehicles during 2022-2030
1.1.1.3 Develop a monitoring system or platform of public transport EVs to support the GHG reduction by a certain percentage in 2030 compared with the base year
1.1.2.1 Develop financial and non-financial incentives / measures for supporting the increased use of EVs
1.1.3.1 Develop financial and non-financial incentives / measures for RE-powered charging infrastructure
1.1.3.2 Develop a 2022-2030 roadmap for establishing RE-integrated charging infrastructure to support GHG emission reductions
1.1.4.1 Develop a standard for handling used EV batteries/ a comprehensive life-cycle regulation on EV batteries / a guideline for low-carbon labelling of EV batteries

Component 2: Accelerate technology adoption of electric mobility and sustainable use of batteries

Overview of objectives and expected outputs:

This component aims to enhance a business sector ecosystem for EV entrepreneurship, identified as a barrier to wider adoption of EVs, and to accelerate technology adoption of electric mobility and sustainable use of batteries through developing a bottom-up entrepreneurship support program for electric mobility solutions, and through demonstrations of innovative electric mobility solutions.

The component supports assessing existing gaps in the EV entrepreneurship ecosystem, establishing mechanisms for identifying innovative electric mobility solutions, and developing an EV entrepreneurship support program. Moreover, this component demonstrates the use and operation of EVs for local public transportation in pilot areas/routes and addresses in particular public awareness and understanding of EVs and related technologies, particularly in terms of safety, usage and maintenance of EVs, identified as gaps and barriers to wider adoption of EVs. This component also demonstrates the use of charging infrastructure for EVs integrated with renewable energy systems and battery storage that enable the use of renewables in selected pilot areas/routes and within the EEC. In addition, the component collects and applies data to support planning and management of charging infrastructure, electric vehicles fleets, and GHG emissions reduction. Furthermore, this component addresses life cycle issues of EV batteries through demonstration of the integration of circular economy practices into the life cycle of batteries.

This component will build on the efforts of the OTP in developing the Master Plan for the Development of Public Transportation in Chachoengsao, Chon Buri, and Rayong provinces to support the development of the EEC Area, and the efforts of NSTDA in developing prototypes of electric vehicles and charging stations.

The project component will be gender responsive. This includes the involvement of gender experts and women organizations to understand the needs and priorities of women in the development of project activities including the planning and design of demonstrations, as well as ensuring that women have equal opportunities to lead, participate in and benefit from all project activities.

Details of activities, initial time plan, and implementing partners are described for each output below.

2.1.1 Developing an EV entrepreneurship support program

Objectives:

The EV entrepreneurship support program aims to provide technical and financial assistance to enhance national business ecosystems for entrepreneurs/SMEs in order to accelerate the adoption of EV for public transportation. The support program will focus on the following 4 key entrepreneurs which are identified as gaps and keys for the adoption of EVs for public transportation; 1) Manufacturers of EVs; 2) EV maintenance service centers; 3) Operators of public transport vehicles with focus on songthaews and minibuses; and 4) Operators of EV charging stations. The program?s scope will initially focus on Rayong and the EEC area.

Activities:
This output includes the following activities.

2.1.1.1 Supporting local manufacturer(s) to develop electric songthaew prototype.

This activity aims to provide technical assistance to local manufacturer(s) of EVs for developing electric songthaew prototype. This activity includes the following:

1) Design multi-purpose EV platform for electric songthaews for public transport and transfer this design to
local manufacturer(s) so that the manufacturer(s) can develop an electric songthaew prototype based on this design. This includes the following steps:

- Design a structure of the prototype based on structural data of existing songthaews
- Design drive trains/power trains based on data of the usage of existing songthaews and do sourcing of these drivetrains/powertrains from local suppliers, ensure they meet standards, and finetune these power trains
- Design electrical systems/layouts based on the first two previous steps
- Analyze strength of structure platform both at static and dynamic conditions and check with national and international standards
- Manufacture a pre-prototype (Jig fixture) (i.e., manufacture platform structure without power trains to test structure
- Provide this pre-prototype to the manufacturer(s) for manufacturing a prototype

2) Develop and provide recommendations to the manufacturer(s) on what needs to be tested in terms of
performance and safety, and to the issuer of standards (i.e., TISI) on standards that are needed and related to prototype development

This activity will be implemented in the first two years of the project period.

2.1.1.2 Supporting potential entrepreneurs to develop maintenance service centers for electric songthaews and minibuses.

This activity aims to provide technical and financial assistance to potential entrepreneurs/operators of garage (e.g., existing garage for ICE vehicles) to develop maintenance service centers in particular for electric songthaews and minibuses. This includes the following:

1) Provide electrical and communication systems diagrams, information on how to access data in the On-Board
Diagnosis (OBD) in electric songthaews and minibuses, and technical knowledge on how to analyze defects in electric songthaews and minibuses; and

2) Support potential maintenance service centers to access bank loans for developing maintenance service
centers for electric songthaews and minibuses by conducting an economic feasibility for potential service centers required for accessing bank loans.

This activity will be implemented in the 3rd, 4th and 5th years of the project period.

2.1.1.3 Supporting operators of songthaews and minibuses for public transport to adopt electric songthaews and minibuses, respectively

This activity aims to provide technical and financial assistance to operators of songthaews and minibuses that have the potential to change to use electric songthaews and minibuses instead of diesel-run songthaews and minibuses, respectively. This includes the following:

1) Develop financing mechanisms to provide benefits to users of electric songthaews so that operators of songthaew receive more passengers and more income; and

2) Conduct technical and economic feasibility analyses and technical design on EV fleet management for operators of songthaews and minibuses for routes that may be feasible technically and economically

This activity will be implemented in the3rd, 4th and 5th years of the project period.

2.1.1.4 Supporting operators of EV charging stations to integrate PV systems with their chargers.

This activity aims to provide technical and financial assistance to operators of EV charging stations to integrate PV systems with their chargers. This includes the following:

1) Survey potential charging stations that can integrate PV systems and conduct technical and economic
feasibility analyses and technical design of PV system integration for potential operators (around 20 operators); and

2) Recommend financial sources to these operators for financing integrating PV systems

This activity will be implemented across each year of the project period.

2.2.1 Demonstration of electric vehicles for public transportation

Objectives:

This output aims to provide technical and financial assistance to operators of local public transport vehicles to be able to experience and demonstrate the use of electric vehicles for public transportation, addressing the use of EVs for public transportation in pilot areas/routes and the awareness and understanding of the operators and the general public on EVs and related technologies, particularly in terms of safety, usage and maintenance of EVs, which are both identified earlier as gaps and barriers to wider adoption of EVs, on the demand side. Furthermore, this output also aims to provide technical and financial assistance to local manufacturer(s) of electric vehicles to research, develop, and manufacture electric songthaews, addressing the following issues identified earlier as barriers to wider adoption of EVs, on the supply side: 1) Thai entrepreneurs? technical capabilities on EVs and related technologies (particularly for the design and manufacturing) and for the preparation of new skill labor for the EV industry (reskill and upskill); 2) Ecosystem for EV entrepreneurship; and 3) Research and development activities on EVs and EV parts.

-Selection of demonstration areas, types of electric vehicles, and routes

Based on preliminary consultations with the Office of Transport and Traffic Policy and Planning (OTP) and the Master Plan for the Development of Public Transportation in the EEC, including Chachoengsao, Chon Buri, and Rayong provinces, Rayong has the potential and readiness for implementing electric vehicle projects for local public transportation. In addition, Rayong Municipality has expressed their interest and support in implementing the demonstrations of this project in Rayong. Thus, the project has identified and selected Rayong as areas for demonstration of the use and operation of EVs for public transportation.

As detailed earlier in the baseline section, local public transport in Rayong may be simply grouped into two main categories, i.e., within Rayong, and between Rayong and other cities (inter-city).

Within Rayong (within-Rayong routes)

According to the Department of Land Transport, public transport systems which transport passengers within Rayong are of Category 1 (within Rayong Municipality) and Category 4 (between districts of Rayong) and include mainly songthaews (modified 4-wheeled pick-up trucks). Songthaews are the most widely used vehicles for passenger transport within Rayong. The total number of songthaews in Rayong are around 600. Songthaews are operated on 5 routes (of Category 1) and 18 regular routes (of Category 4), starting the service from the old bus terminal (i.e., Terminal 1). For most of songthaew cooperatives, one cooperative operates one route, but for a few cooperatives one cooperative operates a few routes. Owners of songthaews of each cooperative offer driving service by themselves.

Between Rayong and other cities (inter-city routes)

Public transport vehicles which transport passengers between Rayong and other cities/regions of the country are of Category 2 (i.e., between Rayong and Bangkok), and Category 3 (i.e., between Rayong and other cities in the eastern region). Most of these public transport vehicles of Category 2 and 3 are vans and mini-buses, respectively. These public transport vehicles begin the service from the new bus terminal (i.e., Terminal 2).

Public transport vehicles of Category 2 (between Bangkok and various districts of Rayong) are operated on 10 routes, while public transport vehicles of Category 3 (between districts of Rayong and districts of other cities in the region (mainly Chon Buri)) are operated on 8 routes. 3 new routes of Category 3 are between U-ta Pao Airport in Rayong and the 3 following cities in the region (Rayong, Cholburi, and Trat). U-ta Pao airport-Rayong route has a distance of 35 kilometers, and is operated by BH Rayong Company, while the other 2 routes have a distance of 100 and 220 kilometers, respectively, and are operated by Suvanabhumi-Burapa Company. Unlike the songthaew cases, the companies hire employees to drive vans and minibuses owned by the companies.

The drivers and owners of local public transport vehicles within Rayong (i.e., songthaews) are considered to have relatively lower income, on average lower than 1,000 Baht (around 30 USD) a day, while the operators/owners of local public transport vehicles between Rayong and other cities (i.e., minibuses and vans) are considered to have relatively higher income.

Based on this information above, the project has identified and selected to focus on 2 types of local public transport vehicles for demonstration of the use and operation of electric vehicles, one type for within-Rayong routes (lower income group), and one type for inter-city routes (higher-income group). For the routes within Rayong, songthaews are selected and focused on, while for inter-city routes, minibuses are selected and focused on. For inter-city routes, vans are not selected because they are regulated to be used only for a total of 10 years as public transport vehicles, while minibuses are allowed to be used up to 30 years.

For each of the two types of public transport vehicles focused on, two routes are selected for demonstration of the use and operation of electric vehicles. For songthaews, the project uses the following criteria for selecting two songthaew cooperatives/routes:

1. **Technical feasibility:** The main constraint of EV is the distance per charge, especially for public vehicles that cannot waste any time while they provide service. The higher the distance per charge means the bigger, the heavier, and the higher cost of the battery. The balance between the distance per charge and the cost of EV has to be designed. The battery size that we consider appropriate for Songthaew routes is 45 kW, since the size of battery is compatible to the size of Songthaews and its cost is not cost prohibitive.
2. **Economic feasibility:** Economic feasibility of changing from diesel-run songthaews to electric songthaews comes mainly from energy cost saving. Therefore, the highest distance serviced per day leads to the shorter period of the payback or breakeven point shown in section 4.3 below).
3. **Demand on route:** Routes with a large number of passengers/high demand.
4. **Potential for co-financing and interest in the demonstration:** The songthaew cooperatives need to have the potential and readiness for co-financing and the interest in participating in the demonstration.
5. **Importance of the routes and their potential for raising wider public awareness and understanding of EVs:** Sample considerations for visibility include if the route passes through downtown/communities and if it connects several public transport modes, as well as demand for trips on the route.
6. **Possibility for installing charging stations along the routes:** Feasibility of installing necessary supporting charging infrastructure for EVs on the route.

A survey using a questionnaire has been conducted to collect the above data required for assessing the suitability of cooperatives and routes for demonstration and for selecting cooperatives/routes for demonstration using the above criteria. The data collected includes, for instance, personal data of each driver, specifications of songthaew currently used, number of round trips per day, vehicle range per round, and income and expenses. Socio-economic data such as opinion, knowledge, and awareness on EVs were also collected. A total of 115 songthaew drivers (102 men and 13 women) from 7 songthaew cooperatives which operate a total of 11 routes, about 19% of total songthaew drivers in Rayong (around 600 drivers) have been surveyed using the questionnaire.

The results of the survey show that regarding technical feasibility criteria, all routes of songthaew cooperatives interviewed can be operated with 45 kW battery, which are Khao Phra Bat route, Bankai route, Map Ta Put route, Laem Charoen route, Bangkok hospital Rayong, and Banchang route. However, for the Laem Charoen route, the Bangkok hospital-Rayong route, and the Banchang route, charging the battery more than one time per day may be necessary.

With regard to the economic feasibility criteria, the Banchang route is the one that offers the longest distance per day and the shortest payback period, followed by the Bangkok hospital-Rayong route and the Laem Charoen route respectively.

Regarding the high demand criteria, stakeholders living in Rayong indicated that the most popular/high demand routes are the Laem Charoen route and the Banchang route.

As for the potential for co-financing and interest in the demonstration, both Rayong Samakkhi Cooperative, which operate the Banchang route (and also Bangkok hospital route which is the second highest distance route), and the Pak Nam-Rayong Cooperative, which operate the Laem Charoen route, showed interest to support the project and to provide co-financing support.

With regard to the key routes and possibility for installing chargers along the routes, all the routes surveyed include several key destinations in Rayong, and there is possibility to install chargers at the old bus terminal where these routes start.

Based on all the selection criteria, the following 2 cooperatives and routes met all the selection criteria and have been selected for the demonstration;

-Rayong-Baanchang Route

This cooperative has shown interest in participating in the demonstration of some 5 new electric songthaews for public transportation and the potential and readiness for co-financing. This cooperative has approximately 138 members and songthaews and operates songthaews on 3 routes, including the route between Rayong and Baanchang. This route goes along Sukhumvit Road and passes several important places such as the old bus terminal, Rayong Hospital, government offices, schools, shopping areas and Map Ta Phut industrial estate, with a total distance of around 30 kilometers per trip. Customers of this route include the elderly and the handicapped visiting Rayong Hospital, people contacting government offices, factory workers working in the industrial estate, students, and general people visiting the shopping areas. This route offers relatively the most economically feasible route with the longest distance per day and the shortest payback period. There is also a possibility to install chargers at the old bus terminal where this route starts.

-Rayong-Paknam Route

This cooperative has also shown the potential and readiness for co-financing and an interest in participating in the demonstration of some 5 new electric songthaews for public transportation. This cooperative has approximately 100 members and songthaews and operates songthaews for local public transportation on an important route which connects the center of Rayong and Rayong?s estuary (or Paknam) with lots of passengers and with a total distance of around 7 kilometers per single trip or 14 kilometers per round trip. This route offers relatively the second most economically feasible route with

the second shortest payback period. There is also a possibility to install chargers at the old bus terminal where this route starts.

For minibuses, the project use the following criteria for selecting two routes:
1. Technical feasibility
2. Operating base/hub in Rayong
3. Operators of minimum 20 minibuses
4. Potential for co-financing and interest in the demonstration (including potential in EV and charger investment)
6. Potential in EV maintenance capability development

According to the Office of Transport and Traffic Policy and Planning report of 2020, there are 3 minibus routes being operated in Rayong, including Route: 398 (Trat? U-Tapao airport) and 400 (Chonburi-U-Tapao airport) operated by Suwarnphum Burapha Co. Ltd. Route: 399 (Rayong? U-Tapao airport) and (Rayong-Chanthaburi) operated by BH Rayong Limited Partnership.

Based on the interviews with minibus operators, route 399 (Rayong ? U-Tapao airport) and (Rayong-Chanthaburi) operated by BH Rayong Limited Partnership (BH Rayong) meets all the criteria. BH Rayong has a base terminal in Rayong operating 26 minibuses on routes in Rayong. From the survey and discussion with the target group in Rayong, BH Rayong has a plan to replace more than 10 conventional minibuses with electric minibuses but the company still lacks of confidence on technical and economic viability of electric minibuses. BH Rayong has hired 2 permanent capable technicians to do maintenance on their own, and one of them had an opportunity to attend basic electric vehicle maintenance course. For the route 398, its starting point and destination are outside Rayong. Therefore, the route 398 does not meet the second criteria.

Based on the selection criteria, the routes between Rayong and U-ta Pao Airport and between Rayong and Chanthaburi are selected for demonstration of the use and operation of electric minibuses for the inter-city routes. Both of these routes are operated by BH Rayong.

The minibus company has shown interest in participating in the demonstration of the use and operation of electric minibuses for public transportation and the potential and readiness for co-financing. The company has approximately a total of 50 vans and 26 minibuses used to operate on routes, including the route between Rayong and U-Ta-Pao Airport, and the route between Rayong and Chanthaburi. The company has interest to change all these existing vans and minibuses to electric minibuses in the future. Currently, minibuses are used for the route between Rayong-U Ta Pao Airport with a total distance of around 30 kilometers per single trip (up to 7 round trips a day), while vans are used for the route between Rayong and Chanthaburi with a total distance of 110 kilometers per single trip (up to 3 round trips a day).

-Technical design and plan for demonstration

Songthaews:

Technical data collected from the survey for these two songthaew routes have been analyzed in order to find the maximum numbers of new electric songthaews and the corresponding number of chargers required for fulfilling the current average number of round trips per day of each route.

Based on the technical data and the following assumptions (electricity consumption of 0.7 kWh/km, and charging power of 50 kW/charger), the analysis shows that the appropriate size of battery for the new electric songthaews should be at least 45 kWh (around 1 hour of quick charge).

The analysis also shows that the maximum numbers of total new electric songthaews for demonstration should be 15 for the route between Rayong and Paknam, and 10 for the route between Rayong and Baanchang. The corresponding numbers of total chargers required at one charging station are estimated to be 4 chargers for each route (i.e., a total of 8 chargers for both routes).

In order to arrange these 25 new electric songthaews for demonstration, there are two options; 1) retrofitting/converting existing diesel songthaews to electric songthaews, and 2) manufacturing new electric songthaews. Based on the collected data of songthaews of the two selected routes, the average age of Songthaews is more than 20 years. There is thus a high safety risk and an increased risk of defects or poor vehicle performance and reliability, if these old diesel-run songthaews are converted to electric songthaews, These risks could occur when new electric propulsion characteristics do not match with the characteristics of diesel-run songthaews. Moreover, the cost of conversion is still high, as the demand for conversion is still low. According to a local manufacturer of EVs, in order to affect the cost structure and lower the conversion cost, the demand needs to be more than 1,000 conversion units. The cost of converting diesel-run songthaews to electric songthaews is estimated to be around 800,000 Baht (26,000 USD), which is as high as the cost of purchasing a new electric songthaew (around 1 million Baht, or 30,000 USD). The cost of owning a retrofitted electric songthaew (including the maintenance cost) could thus be even higher than that of owning a newly manufactured electric songthaew.

Thus, in order to arrange these 25 new electric songthaews for demonstration, the project will collaborate with a local experienced manufacturer of electric vehicles (i.e., Sakun C. Innovation Group) to design and develop new electric vehicles which can substitute existing diesel-run songthaews. A new design would be created to make electric songthaews meet the safety standards (i.e., improving passenger safety) and offer more comfort and convenience to passengers. Two outputs expected from this plan would be one standard electric vehicle platform for multi-purpose electric vehicles and two electric songthaew prototypes which are specially-designed to substitute existing diesel-run songthaews

The standard EV platform would accelerate local manufacturers to develop capacity in designing and producing multi-purpose EV to serve local niche market. The two prototype electric songthaews will be offered to the selected two cooperatives so that the members of the cooperatives would have an opportunity to experience electric vehicles for public transportation and gain more knowledge and

realize the pros and cons of electric songthaews, especially with regard to the safety, usage, and maintenance of electric vehicles and batteries.

A vehicle configuration of interest for the prototypes is a songthaew with 12 or 16 seats. The main work will focus on a design and development of an integrated ?platform? for the vehicle where main EV components are combined into a chassis frame of the vehicle. Emphasis will also be on a lightweight design by using aluminum alloys as the main structural components. The chassis frame will be designed and analyzed using Finite element method. The frame models will be subjected to various loading conditions such as vertical bending, lateral and longitudinal load to determine structural strength of the frame. Furthermore, representative of critical joints in the structure will undergo actual fatigue test in a laboratory to evaluate the durability of the frame with selected joining technique. In addition, the main components of EVs such as battery, drivetrain, electronics, will be carefully selected from suppliers based on surveyed data of existing service pattern available in the area in order to obtain a tailor-made setup for the application in the area. Once the detailed design could be obtained, two prototypes, with the chosen platform frame, EV components, and an aluminum skeleton body, will be fabricated by an experienced industrial partner (i.e., Sakhun C Innovation Co. Ltd.)

The prototypes, which can be used to transport up to 12 ? 16 passengers (seated), with expected cruised speed and maximum speed of around 30 and 80 km/hour respectively, will be tested at a testing facility with full load conditions to evaluate the driving performance according to regulations from the Department of land transport. Then, the field test of prototypes will be carried out extensively in Rayong with volunteer drivers under real operating conditions as in service on the selected routes. Other important information will be collected from the field test such as, driver feedbacks, operating performance and parameters especially energy consumptions in real conditions etc.

Gender analysis will also be conducted, including consultations with women organizations to understand the needs and priorities of women in the design, planning and implementation of the prototype's development and use. This includes consideration for concerns around safety issues, access and usage of the vehicles.

Minibuses:

Based on technical data on vehicle range per one single trip and the number of trips per day of the two routes selected, the following assumptions are made for minibus fleet design, including electricity consumption of 0.7 kWh/km, average velocity of 60 km/hour, and charging power of 50 kW.

Based on the above data and assumptions, the analysis shows that the appropriate size of battery for the electric minibuses should be at least 90 kWh, as the route Rayong-Chanthaburi and the route Rayong-U Ta Pao Airport require a minimal battery energy of around 80kWh and 60kWh, respectively. In this case, one charging station should be established in Rayong and another one in Chanthaburi. In case of that no charging station can be established in Chanthaburi, the appropriate size of battery for the electric minibuses to be operated on the route Rayong-Chathaburi should be about 160 kWh. With this battery size of 160 kWh, daytime charging is not required for the route Rayong-U Ta Pao Airport.

The results of the analysis also shows that with the size of battery of 90 kWh, the Rayong-Chanthaburi route requires about 12 electric minibuses and 5 chargers at each charging station (one station in Rayong and another station in Chanthaburi). An annual electric minibus range is around 120,450-160,600 km/vehicle/year for this route.

With the size of battery of 90 kWh, the route Rayong-U Ta Pao Airport requires about 2 electric minibuses and a 1 charger at Rayong station for one overnight charge. If the size of battery is smaller than 90kWh, one daytime charge is required. An annual electric minibus range is around 65,700-131,400 km/vehicle/year for this route. Chargers at the charging station in Rayong can be shared for these two routes.

With regard to arranging these 14 electric minibuses for demonstration, as the minibus company wanted to substitute all of its minibuses and vans which are expiring with electric minibuses, but still hesitates to purchase electric minibuses now due to negative cashflow during the COVID period, and due to lack of experience and confidence with electric minibuses, the project will support the company in matching with manufacturers of electric minibuses so that the company will purchase on its own suitable electric minibuses from one of the manufacturers. The project will also support a small percentage of the costs of two pilot electric minibuses (see more detail in the financial plan and business model).

Similar to the songthaews, gender analysis will be conducted, including consultations with women organizations will also be undertaken to understand the needs and priorities of women in the design, planning and implementation of the prototypes development and use. This includes consideration for concerns around safety issues, access and usage of the vehicles.

-Financial plan for the demonstration/business model

Songthaews:

The project will support Sakun C. Innovation Co. Ltd. (a local manufacturer of electric vehicle) for parts of the costs of research and development of new electric songthaews which can substitute existing diesel-run songthaews (including development of one standard electric vehicle platform for multi-purpose electric vehicles and two electric songthaew prototypes which will be specially-designed to substitute existing diesel-run songthaews). The two electric songthaew prototypes will then be offered free of charge to the two selected songthaew cooperatives (one prototype electric songthaew for each songthaew cooperative) so that the members of the cooperatives would have an opportunity to experience electric songthaews and realize the pros and cons, especially the costs savings of using electric songthaews instead of diesel-run songthaews for public transportation during the initial period of the project implementation. During consultations with songthaew cooperatives in the PPG phase,

songthaew cooperatives asked for this offer for them to try electric songthaew prototypes. This offer is expected to help convince members of songthaew cooperatives to realize the benefits of electric songthaews and to purchase more electric songthaews to replace existing diesel-runs songthaews, after trying the prototype ones.

The price of electric songthaews to be manufactured by Sakun C. Innovation Co. Ltd for songthaew cooperatives after trying the prototype ones is estimated to be approximately 1 million Baht (30,000 USD) per vehicle. In order to support the two songthaew cooperatives to be able to purchase some 10-25 more electric songthaews to be manufactured by Sakun C. Innovation Co. Ltd. after trying the prototype ones, the project will do the following to support wider adoption:

1) Support 20% of the price of one electric songthaew (200,000 Baht or 6,000 USD);
2) Provide a soft loan of 400,000 Baht or 12,000 USD with lower interest rates than the ones provided by songthaew cooperatives; and
3) Provide financial support of a total of around 400,000 Baht or 12,000 USD from sponsors (large conglomerates including SCG) through their budget for corporate social responsibility (CSR), or for advertisements (e.g. advertising their companies on new electric songthaews), and from trading of carbon emissions reduction credit to be earned from this project in the Thai domestic voluntary emission reduction (T-VER) market, and funds that support research and development of EV or EV industry or funds that support area development.

SCG will manage to have the GHG emission reductions from the project calculated, validated, verified, and traded in the carbon market, and will allocate the revenues from the trading back to the sources of GHG emissions reduction in the project, including the demonstration of the use and operation of electric songthaews replacing diesel-run songthaews. Also, SCG and other partners will design supporting measures to support more songthaew drivers to change from diesel-run songthaews to electric songthaews.

In addition, as the breakeven point of changing diesel-run songthaews to electric songthaews could be reduced by increasing the driving distance serviced, the project will also provide opportunities for the drivers of songthaews of the two songthaew cooperatives to offer charter services to corporate customers, e.g. industrial estates or government agencies, as well as general people via mobile applications.

Digital Economy Promotion Agency (DEPA), a government agency with a mission to promote the use of digital technology and offer various promotion schemes for start-up enterprises, will assist in matching up with start-up enterprises to facilitate the design of mobile applications and the management of electric songthaew fleet. Start-up enterprises and Rayong city municipality will collaborate in operating and improving mobile applications to facilitate the management of electric songthaew fleet.

Minibuses

As briefly mentioned in the previous section, the project will support the minibus company in matching with manufacturers of electric minibuses so that the company will purchase on its own suitable electric minibuses. The project will support 10% of the price of electric minibuses (but not higher than 300,000 Baht (10,000 USD)/minibus) for the company?s purchase of 2 pilot electric minibuses for the two routes selected. The experience with these pilot electric minibuses and the cost savings due to the use of pilot electric minibuses are expected to convince the minibus company to purchase at least 14 more electric minibuses without any additional support from GEF during the project implementation.

Summary of activities under the output

Objectives

Activities under this output 2.2.1 Demonstration of the use and operation of electric vehicles for public transport aim to provide technical and financial assistance to local manufacturer(s) of EVs in order to research, develop, and manufacture electric songthaews for the demonstration and at the same time to develop capacity in designing and producing multi-purpose EVs to serve local niche market.

Activities under this output also aim to provide technical and financial support to selected operators of songthaews and minibuses in order to demonstrate and experience the use and operation of some electric songthaews and minibuses, respectively, and at the same time to increase the awareness and understanding on EVs and battery technologies especially with regard to the benefits, the safety, the use and operation, and maintenance of electric songthaews and minibuses among operators/drivers of songthaews and minibuses and the general public.

Activities

This output includes the following activities.

2.2.1.1 Research, development, and manufacturing of electric songthaews

In addition to providing technical assistance to local manufacturer(s) to develop electric songthaew prototype, as described in the output 2.1.1.1, the project will also collaborate with and provide GEF financial support to a local experienced manufacturer of EVs (e.g., Sakun C Innovation Co. Ltd) to research, develop, and manufacture electric songthaews which can substitute existing diesel-run songthaews. This research, development and manufacturing will include 1) the design and development of one standard multi-purpose EV platform for electric vehicles with focus on electric songthaews, 2) the development of manufacturing processes, 3) the selection of suppliers and development of supply chain, 4) the development and manufacturing of 2 electric songthaew prototypes for the initial demonstration, and 5) the development and manufacturing of at least 8 electric songthaews for the demonstration.

This activity will be implemented from the 1st year to the 3rd year of the project period.

2.2.1.2 Field tests and demonstration of the use and operation of electric songthaew prototypes

After the 2 electric songthaew prototypes are manufactured, the project will, as mentioned earlier, test the prototypes at a testing facility with full load conditions to evaluate the driving performance required according to regulations of the Department of land transport, and support the registration of these prototypes for public transportation with the Department of Land Transport in the first two years. The project will also conduct field tests of the prototypes extensively in Rayong with volunteer drivers under real operating conditions in the selected routes. The project will collect information and data from the field tests such as data and information on driver feedbacks, operating performance, and parameters especially energy consumptions in real conditions, etc.

Within the second year of the project implementation, the project will offer the two prototypes to the selected two cooperatives which will demonstrate the use and operation of these prototypes on the two routes selected (one prototype per one route). The project will also collect data of the operation and use of these prototypes which will be used by the local manufacturer to improve the development and manufacturing of electric songthaews for the two cooperatives to demonstrate the use and operation of electric songthaews (next activity).

2.2.1.3 Demonstration of the use and operation of electric songthaews

The project will provide financial assistance to the selected songthaew cooperatives to purchase at least 8 electric songthaews from the manufacturer in order to demonstrate the use and operation of these electric songthaews along the selected routes (at least 4 electric songthaews per one route) (these numbers are confirmed by the two songthaew cooperatives).

With regard to financial assistance, the project will support adoption as follows:

1) Support 20% of the price of one electric songthaew (i.e., 200,000 Baht or 6,000 USD);
2) Provide a soft loan of 400,000 Baht or 12,000 USD with lower interest rates than the ones provided by songthaew cooperatives to their members; and
3) Provide financial support of a total of around 400,000 Baht or 12,000 USD from sponsors (large conglomerates including SCG) through their budget for corporate social responsibility (CSR), or for advertisements (e.g., advertising their companies on new electric songthaews), and from trading of carbon emissions reduction credit to be earned from this activity in the Thai domestic voluntary emission reduction (T-VER) market.

Apart from the above financial support, the project will also provide opportunities for the drivers of the two songthaew cooperatives to offer charter services to corporate customers, e.g., industrial estates or government agencies, as well as general people via a mobile application. Moreover, the project will design supporting measures and mechanisms to encourage the general public to use electric songthaews for public transport by providing some incentives/benefits for those who use electric songthaews in order for the drivers of electric songthaews to receive more passengers and more income.

The demonstration of the use and operation of at least a total of 8 electric songthaews will start in the third year of the project implementation. During the demonstration, the project will also collect data of

the operation and use of these electric songthaews as well as the prototypes for planning and management of charging infrastructure, songthaew fleet, and GHG emission reduction.

2.2.1.4 Demonstration of the use and operation of electric minibuses

As mentioned previously, the project will support the selected minibus company in matching with local manufacturers of electric minibuses so that the company will purchase on its own suitable electric minibuses. The project will support 10% of the price of electric minibuses (but not higher than 300,000 Baht (10,000 USD)/minibus) for the company?s purchase of 2 pilot electric minibuses for the two routes selected. The experience with these pilot electric minibuses and the cost savings due to the use of pilot electric minibuses are expected to convince the minibus company to purchase at least 15 more electric minibuses without any additional support from GEF during the project implementation.

In the first year, two electric minibuses partly supported by GEF will be demonstrated on the two selected inter-city routes (one electric minibus for each route).

In the second year and in the third year, at least 7 and 8 more electric minibuses, respectively, (these two numbers are confirmed by the minibus company) will be purchased by the minibus company and demonstrated on the routes. All these electric minibuses will be demonstrated along these two routes throughout the project period.

During the demonstration, the project will also collect data of the operation and use of these electric minibuses for planning and management of charging infrastructure, songthaew fleet, and GHG emission reduction.

2.2.2 Demonstration of charging systems integrated with renewable energy systems and battery storage

Objectives

This output aims to provide technical and financial assistance to local municipality or local operators of public transport vehicles to install chargers and PV systems within their areas in order to demonstrate and experience the use and operation of charging systems integrated with PV and at the same time to provide chargers for electric songthaews and minibuses demonstrated in the project. This output also aims to provide technical and financial assistance or only technical assistance to local operators of charging stations in order to integrate PV systems into their existing/planned chargers for public use of any electric vehicles. Therefore, this output aims to address the following issues identified earlier as barriers to wider adoption of EVs;

This output will help increase the awareness and understanding of clean energy source and charging systems for electric vehicles among the general public and operators of public transport vehicles, and enhance the reduction of GHG emissions due to the demonstration of the use and operation of electric songthaews and minibuses described in the previous section, and the increasing use and operation of

other electric vehicles in Rayong and in the EEC area. Thus, this output aims to address the following issues, identified earlier as barriers to wider adoption of EVs; 1) Ecosystem for EV entrepreneurship, and 2) Consumers? awareness and understanding of EVs and related technologies.

In this project, charging systems/stations to be demonstrated are classified into two types; 1) private charging stations dedicated mainly for public transportation fleets in the initial stage and also for other EVs later (i.e., the demonstration electric songthaews and minibuses), and 2) public charging stations for any electric vehicles.

-Selection of demonstration areas

The locations of private charging stations dedicated for electric songthaews have been selected based on the two songthaew routes selected. The locations have been selected to be at the starting point of these two routes, which is at the old bus terminal, where there is available area for installing chargers and there is roof area for installing PV systems. Rayong Municipality which is responsible for managing the old bus terminal also expresses their support to use this location for the demonstration of charging systems integrated with PV systems. Rayong Municipality also suggested an additional location, if needed, to be at Suan Sri Muang Library, managed by Rayong Municipality, located around a few kilometers away from the old bus terminal.

The location of private charging stations dedicated for electric minibuses has been selected, based on the two minibus routes selected, to be at the starting point (depot) of these minibus routes, located at the minibus company, in Rayong. The minibus company suggested that a charging station for electric minibuses should be located only at the starting point or/and the destination where electric minibuses are parked for hours before passengers get onboard, and not along the routes, as the drivers of electric minibuses cannot spend time at a charging station along the routes while transporting passengers. At the depot of the minibus company, there is available area for installing chargers and there is roof area of nearby buildings for installing PV systems. The minibus company also expressed their support to use this area of the company for the demonstration of charging systems integrated with PV systems.

As for public charging stations in Rayong, the locations have been selected to be at existing and planned charging stations at Bangchak?s petrol stations under the collaboration of Provincial Electricity Authority (PEA)-Volta and Bangchak oil and gas retailer. Based on our recent survey of a few existing charging stations at Bangchak?s petrol stations, there is available roof area for installing PV systems to be integrated with chargers installed by PEA. PEA and Bangchak have also expressed their co-financing support to use these locations for the demonstration of charging systems integrated with PV systems. In addition, SCG has also expressed their co-financing support to use the location of their factory located in the industrial estate in Rayong for the demonstration.

-Technical design and plan for the demonstration

For private charging stations, based on technical data mentioned in the previous section, the total number of chargers technically required for electric songthaews for both songthaew routes is estimated to be a total of 8 chargers of 50 kW each, while a total of 5 chargers of 50 kW each is estimated to be technically required for electric minibuses for both minibus routes at a charging station in Rayong, and a total of 5 chargers at a charging station in Chantaburi. During the implementation phase, charging

systems dedicated for electric songthaews and electric minibuses will be redesigned based on additional technical data to be collected during the initial phase, and based on fleet optimization.

Based on available roof area, the sizing of PV systems is estimated to be 60 kW, 70 kW, and 80 kW, at the Old Bus Terminal, Suan Sri Muang Library, and BH Minibus station, respectively. During the implementation phase, PV systems will be redesigned according to charging station load profile, size of the areas of candidate locations, and safety regulation.

As for engineering design and installation, the project will coordinate with a local engineering procurement contractor (EPC) and local proprietor to carry out an engineering design and installation of chargers and PV systems for these private charging stations.

As for operation and maintenance, the chargers and PV systems located at the Old Bus Terminal will be operated and maintained by PEA, while those located at the minibus company will be operated and maintained by the minibus company.

For public charging stations, during the implementation phase, PV systems will be designed based on charging station load profile, size of the areas of candidate locations, and safety regulation. All actual charging profile data and PV power profile will be collected. The PV systems connected to the chargers at Bangchak and PEA Volta?s charging stations will be installed by an EPC, and will be operated and maintained by PEA.

-Financial plan for the demonstration/business model

In order to address how the integration of electric mobility with PV systems will be achieved, an economic feasibility of integrating PV systems with chargers at EV charging stations is analyzed. A sensitivity analysis of key parameters including the number of operation hours per day, and the charging electricity price is also conducted. The results show that the number of operation hours should be at least 8 hours per day, in order to make it more economically feasible to install PV systems (with some subsidy) integrated with chargers than to have no PV systems, and the charging price should be at least 4 Baht/kWh in order to get a low payback period (less than 10 years) without high charging demand (high operation hours).

Thus, in the first years, the project will select to support the costs of PV systems for chargers that are with high charging demand (high operation hours) in Rayong (i.e., chargers dedicated mainly for electric songthaews and minibuses which will be demonstrated). Based on technical data collected and technical design of the number of chargers required for electric songthaews and minibuses which will be demonstrated, chargers will be efficiently used with high charging demand (high operation hours per day). In the later years, when there are more electric vehicles in Rayong, the project will then support the cost of PV systems for public charging operators (e.g., Bangchak and PEA Volta) with high charging demand. And in the last years of the project, when there are even more electric vehicles in Rayong and even high charging demand, the project will not support the costs of PV systems for public charging operators, but expect these operators to invest in installing PV systems to be connected with their chargers on their own.

For electric songthaews, the project will support the costs of 6 quick chargers of 50 kW each and its installation at the old bus terminal (around 290,000 USD), and the costs of PV systems of 60 kW to be integrated with the chargers and their installation at the Old Bus terminal (30,000 USD), an area managed by Rayong Municipality. Rayong Municipality will invest in providing land area and roof area within the old bus terminal and another area such as at Suan Sri Muang Library for installing chargers, and PV systems, respectively.

For electric minibuses, the project will support the cost of one quick charger of 50 kW and its installation (around 50,000 USD), while the minibus company will also invest in another quick charger of 50 kW for the first year and in purchasing more chargers in the later years. In addition, the project will support the cost of PV systems and installations (50,000 USD). The minibus company will co-finance in providing land and roof areas for installing chargers and PV systems EV charging station and PV installation to 170,000 USD, and in purchasing and installing more chargers. The company will also co-finance in the operation and maintenance of chargers and PV systems.

For public charging stations, the project will support the costs of PV systems of a total of 100 kW to be installed at Bangchak-PEA charging stations, and the costs of PV systems of a total of 100 kW to be installed at charging stations of other partners such as in the industrial estate in Rayong. In addition, the project will support the costs of PV systems of 70 kW and installation at Suan Sri Muang Library (30,000 USD).

-Summary of activities under the output

Activities under this output 2.2.2 Demonstration of the use and operation of charging systems integrated with renewable energy systems aim to provide technical and financial assistance to local municipality or local operators of public transport vehicles to install chargers and PV systems within their areas in order to demonstrate and experience the use and operation of charging systems integrated with PV systems and at the same time to provide chargers for the use of mainly electric songthaews and minibuses which will be demonstrated under the previous output 2.2.1, as well as to increase the awareness and understanding of clean energy source and systems for electric vehicles among the general public and operators of public transport vehicles. This output also aims to provide technical and financial assistance or only technical assistance to local operators of charging stations (e.g., Bangchak) to integrate PV systems into their existing chargers for public use of any electric vehicles.

During the project period, a total of at least 5 charging stations with 50 kW quick chargers will be established and demonstrated with at least 17 chargers with a total 850 kW, and PV systems with a total of 510 kW.

This output includes the following activities.

2.2.2.1 Demonstration of the use and operation of charging systems integrated with PV systems for electric songthaews

This demonstration will take place at the old bus terminal. A total of 6 50-kW quick chargers (supported by the project) will be installed and integrated with PV systems of 60 kW (supported by the project) at the old bus terminal to supply electricity for at least a total of 10 electric songthaews. In the second year, 2 chargers with PV systems of 60 kW will be installed and demonstrated at the old bus terminal to supply electricity for 2 electric songthaew prototypes. In the third and fourth years, 2 chargers will be installed each year to supply electricity for at least 8 additional electric songthaews.

2.2.2.2 Demonstration of the use and operation of charging systems integrated with PV systems for electric minibuses

This demonstration will take place at the minibus company. A total of 10 chargers will be required to supply electricity for at least a total of 14 electric minibuses. In the first year, 2 chargers (one charger supported by the project and another charger supported by the company) with PV systems of 80 kW (supported by the project) will be installed and demonstrated at the minibus company. In the second and third years, 4 chargers (supported by the company) will be installed each year.

2.2.2.3 Demonstration of the use and operation of public charging systems integrated with PV systems for public use of any electric vehicles

This demonstration will take place at 1) a public place managed by Rayong Municipality such as Suan Sri Muang Library and Park, 2) Bangchak-PEA charging and petrol stations, and 3) charging and/or petrol stations of other operators such as SCG charging station located in Map Ta Phut Industrial Estate.

In the third year, PV systems of 70 kW (supported by the project) will be installed and integrated with chargers at a public place managed by Rayong Municipality such as Suan Sri Muang Library and Park.

In the third, and fourth years, PV systems of a total of 100 kW (supported by the project) will be installed and integrated with chargers at Bangchak-PEA charging stations.

In the third and fourth years, PV systems of a total of another 100 kW (supported by the project) will be installed and integrated with chargers at charging and/or petrol stations of other operators such as SCG charging station located in Map Ta Phut industrial estate.

2.2.3 Demonstration of applying data to support planning and management of charging infrastructure, fleets of electric songthaews and minibuses, charging schedules, and GHG emissions reduction

Objectives

Electric vehicles in public transportation can play a significant role in reducing GHG emissions in the transport sector. Data collection to optimize the operation and use of electric vehicles for public transport and charging infrastructure is important and will enhance the efficiency, sustainability, and adoption of electric vehicles for public transport. This output aims to provide a support program to technology start-up enterprise(s) in Thailand to develop data collection systems and mobile

applications to collect, analyze, and use data from users and drivers/operators of both diesel-run and electric songthaews and minibuses for public transport demonstrated in the project, and from users and operators of chargers demonstrated in the project to support planning and management of the following below in order to facilitate an increased operation, use, and adoption of electric vehicles such as electric songthaews and minibuses for public transport:

1) **Charging infrastructure** (i.e., electricity distribution grid and/or PV systems) required to technically and efficiently serve the demand and behaviors of users of chargers (i.e., drivers of electric songthaews and minibuses);
2) **Fleets of electric songthaews and minibuses for public transport** required to efficiently serve the demand, time, and behaviors of users of electric songthaews and minibuses ;
3) **Schedules of charging electricity at chargers and more locations of chargers** required to serve the operation of drivers of electric songthaews and minibuses; and
4) **GHG emissions reduction due to the use of electric songthaews and minibuses, and PV systems** required to achieve the GHG emissions reduction target of the project.

Activities
This output includes the following activities:

2.2.3.1 Analyzing and applying data to support planning and management of charging infrastructure, and GHG emissions reduction

Under this activity, the project will develop data collection systems (hardware and software) and install these to vehicles and charging systems. The project will collect and analyze data collected to improve Rayong?s electric vehicles public transportation logistics, e.g., to provide recommendations on locations to install more chargers to be proposed to relevant authorities for consideration and implementation. This includes collecting gender-disaggregated data to better assess use patterns and needs by gender. Moreover, the project will analyze these collected data to support policy makers in planning charging infrastructure for public transport not only in Rayong, but for future EV public transportation in other parts of the country, including planning and optimization of renewable energy integrated electric vehicle charging locations. This data will also be used to calculate, evaluate/monitor and manage GHG reductions due to the use of electric songthaews and minibuses, and PV systems.

This activity will be implemented during each year of the project.

2.2.3.2 Developing mobile applications to support planning and management of fleets of electric songthaews and minibuses and charging schedules

Under this activity, the project will collaborate with Digital Economy Promotion Agency which have supported several start-up enterprises in developing and implementing similar mobile applications. The project will provide a support program to technology start-up enterprise(s) in Thailand to design and develop mobile applications to collect, analyze, and use data from users and drivers/operators of both diesel-run and pilot electric songthaews and minibuses for public transport demonstrated in the project, and from users and operators of chargers demonstrated in the project to support planning and management of fleets of electric songthaews and minibuses, and charging schedules.

A mobile application will be developed as a tool for users and operators/drivers of electric songthaews and minibuses to facilitate riders/passengers and to facilitate matching electric songthaews with corporate customers, and promote the use of electric songthaews and minibuses for public transport in Rayong. The application would serve fleet operators/drivers, passengers, and anyone who needs transport services, and provide a platform to check location of in-service electric songthaews and minibuses and reservation of charter service. Another mobile application will be developed for operators/drivers of electric songthaews and minibuses and operators of charging systems, and would provide a platform to check locations and availability of chargers, charger reservation, charging recommendation (e.g., charging period, cost).

This activity will be implemented from the third to fifth year of the project.

2.2.4 Demonstration of the integration of circular economy principles in the life cycle of electric vehicle batteries (e.g., the application of second life batteries)

Objectives

Retired batteries from electric vehicles normally have remaining capacity around 70-80% of initial capacity. They are not applicable for electric vehicles any longer; however, they are still alive and can be repurposed as second life batteries or recycled depending on their state of health index. Second life batteries can be used in stationary applications such as power backup application, renewable energy storage application, and capacity firming. A large number of electric vehicles are expected to be used within ten years, and thus life cycle management plan for end-of-life batteries from electric vehicles is necessary for environmental sustainability.

This output aims to support potential users to experience and demonstrate the use of second life batteries (retired batteries from electric vehicles) (total size less than 150kWh) for stationary applications such as power backup application in factories, energy storage application in charging stations, energy management application in isolated micro grid with non-critical load, in order to encourage efficient and sustainable use of second life batteries. This output also aims to design, develop, and test prototypes of second life batteries from a manufacturer of electric vehicles in Thailand and then to develop a guideline for life-cycle management of electric vehicle batteries for environmental sustainability. This output thus aims to address life-cycle issues for electric mobility and demonstrate a sustainable use of EV batteries and to complement the output 1.4 of Component 1 with practical experience and lessons.

Activities

This output includes the following activities.

2.2.4.1 Demonstration of the use of second life batteries for stationary applications

Under this activity, the project will support potential users to demonstrate the use of second life batteries for 2 stationary applications at 2 sites.

As for the first application, the project will support operator(s) of charging stations in Rayong that have charging systems integrated with PV systems to integrate second life batteries into charging systems as energy storage system (ESS). As for the second application, the project will support a remote community to use second life batteries in isolated micro grid with non-critical load. For both applications, data of the operation of second life batteries with regard to technical performance and economic aspect will be collected and will be used to promote efficient and sustainable use of second life batteries.

This activity will be implemented during the first four years of the project.

2.2.4.2 Development of a guideline for life-cycle management of electric vehicle batteries

Under this activity, the project will design, develop, and test prototypes of second life batteries from a manufacturer of electric vehicles in Thailand and then to develop and propose a guideline for life-cycle management of electric vehicle batteries for environmental sustainability for policy makers and relevant stakeholders to have guidance for sustainable management of electric vehicle batteries. The amounts of expected retired electric vehicles and batteries will also be estimated.

This activity will also be implemented during the first four years of the project.

Summary of Component 2?s outcomes, outputs and activities:

Expected Outcome:
2.1 National business sector ecosystem for EV entrepreneurships enhanced
2.2 Investment in electric vehicles and electric vehicle supply equipment integrated with renewable energy deployment in the Eastern Economic Corridor and in addressing life-cycle issues for electric vehicle batteries

Expected Outputs:
2.1.1 Entrepreneurship support program for electric mobility solutions developed
2.2.1 Electric vehicles for public transport demonstrated
2.2.2 Charging systems integrated with renewable energy systems, and battery storage demonstrated
2.2.3 Applications of data to support planning and management of charging infrastructure, electric vehicles fleets, and GHG emissions reduction demonstrated
2.2.4 The integration of circular economy principles in the life cycle of electric vehicle batteries (e.g., the application of second life batteries) demonstrated

Expected Activities:

2.1.1.1 Supporting local manufacturer(s) to develop electric songthaew prototype.
2.1.1.2 Supporting potential entrepreneurs to develop maintenance service centers for electric songthaews and minibuses.
2.1.1.3 Supporting operators of songthaews and minibuses for public transport to adopt electric songthaews and minibuses, respectively

2.1.1.4 Supporting operators of EV charging stations to integrate PV systems with their chargers.

2.2.1.1 Research and development of electric songthaews
2.2.1.2 Field tests and demonstration of the use and operation of electric songthaew prototypes
2.2.1.3 Demonstration of the use and operation of electric songthaews
2.2.1.4 Demonstration of the use and operation of electric minibuses

2.2.2.1 Demonstration of the use and operation of charging systems integrated with PV systems for electric songthaews
2.2.2.2 Demonstration of the use and operation of charging systems integrated with PV systems for electric minibuses
2.2.2.3 Demonstration of the use and operation of public charging systems integrated with PV systems for public use of any electric vehicles

2.2.3.1 Analyzing and applying data to support planning and management of charging infrastructure, and GHG emissions reduction
2.2.3.2 Developing mobile applications to support planning and management of fleets of electric songthaews and minibuses and charging schedules

2.2.4.1 Demonstration of the use of second life batteries for stationary applications
2.2.4.2 Development of a guideline for life-cycle management of electric vehicle batteries

Component 3: Capacity building, up-scale and knowledge sharing

Overview of objectives and expected outputs
This component aims to contribute to the scale-up of other components of the projects within the EEC and nationally through capacity building and knowledge sharing on outputs of Component 1 and 2, in order to accelerate the adoption of EVs.

Therefore, the knowledge, experiences, and lessons learned from Component 1 and 2 will be integrated as content of Component 3 and will be shared across national, regional, and global networks through the below outputs of this component. The project will also share project deliverables such as analytical reports, policies, business models and lessons learned with the Global Program in order to support scale-up and replication of e-mobility in other countries and regions.

All capacity building activities, knowledge materials and tools will be gender responsive. This includes considering gender sensitive language, avoiding gender stereotyping, including gender dimensions into training materials, ensuring that both women and men participate in the trainings as trainees and facilitators, etc.

3.1.1 Existing knowledge-exchange platforms and mechanisms strengthened with key national stakeholders and women engagement based on lessons learned from EEC

The existing knowledge exchange platforms will be strengthened through the following activities:

3.1.1.1 Producing documents of knowledge, lessons learned, best practices, and solutions based on the EV demonstrations in Rayong and the EEC area for sharing

This activity will be implemented in year 3 and 5.

3.1.1.2 Sharing knowledge and lessons learned at national workshops/meetings

This activity includes organizing and attending national workshops/meetings, for instance, on the topic ?Lesson learned from the project implementation? with national EV promotion policy stakeholders. The lessons learned from the project will be analyzed and presented with recommendations to the related national policy bodies such as the National EV policy committee, the National Climate Change Policy Committee and National energy policy committee chaired by the prime minister. Gender responsive data will also be collected and disseminated across platforms.

This activity will also be implemented in year 3 and 5.

3.1.2 Linkages created with regional and global platforms on electric mobility as part of the Global Electric Mobility Program.

This output includes the following activity:

3.1.2.1 Sharing knowledge and lessons learned at regional/international workshops/conferences

The project will create linkages regional and global platforms on electric mobility through both organizing online seminars at least one time and attending online seminars at least two times throughout the project period. The seminar?s topics include, for example, Challenge on supporting program of EV transformation for local public transportation in developing countries?, and ?A comprehensive preparation infrastructure for EV in Southeast Asia?. This activity also includes dissemination and presentation of the lessons learned from the project in an international event. Linkages will be created with gender knowledge working groups and platforms.

This activity will also be implemented in year 3, 4 and 5**.**

3.1.3 Training sessions for public and private sector on EVs and sustainable use of batteries taking into account gender equality and women?s empowerment

3.1.3.1 Manuals and trainings developed and delivered

This activity includes local capacity building on EV maintenance manual development and training (expected participants include more than 10 garages in ECC area), rescue manual development and training, end of life of EV battery solution, and EV awareness program. This activity will create awareness on EV technology and knowledge with expected participation of 10 entrepreneurs and 100

participants in the project implementation period, with the aim of 40% of participants and entrepreneurs being women. Training will be gender-responsive and include training on unconscious bias to raise awareness on gender bias and capacity to build on how to address bias to enhance gender equality and women?s empowerment.

This activity will also be implemented in year 2, 3, 4 and 5.

Summary of Component?s expected outcome, outputs and activities

Expected Outcome:
3.1 Capacity development and knowledge exchange on lessons learned scaled-up to national, regional and global networks

Expected Outputs:
3.1.1 Existing knowledge-exchange platforms and mechanisms strengthened with key national stakeholders and women engagement based on lessons learned from the EEC
3.1.2 Linkages created with regional and global platforms on electric mobility as part of the Global Electric Mobility Program.
3.1.3 Training sessions for public and private sector on life cycle solutions for EVs and batteries with focus on women participation

Expected Activities:
3.1.1.1 Producing documents of knowledge, lessons learned, best practices, and solutions based on the EV demonstrations in Rayong and the EEC area for sharing
3.1.1.2 Sharing knowledge and lessons learned at national workshops/meetings
3.1.2.1 Sharing knowledge and lessons learned regional/international workshops/conferences
3.1.3.1 Manuals and trainings developed and delivered

Component 4: Monitoring and Evaluation

Overview of objectives and expected outputs
This Component aims for UNIDO to regularly monitor and evaluate the progress on each component to ensure the project is completed following the time plan and the budget allocated, as well as to be responsive and proactive about any potential adjustment or opportunities that arise that can further leverage the GEF grant for achieving additional GEBs.

Outputs under this component include regular monitoring and mid-term project review in the third year of the project period, and a terminal project evaluation. As per GEF and UNIDO guidelines, an independent terminal project evaluation will be conducted at the conclusion of the project to glean best practices and lessons learned for future projects.

All monitoring and evaluation tools and documents, such as the monitoring plan, progress reports, final evaluation report, and thematic evaluations (e.g. training needs assessment), will include gender dimensions, and report with respect to an established baseline for gender related targets in the gender mainstreaming action plan.

Output 4.1.1 Monitoring and mid-term project review

This output includes the following activity:

4.1.1.1 Conduct an independent mid-term project review

In addition to monitoring of the progress of the project regularly, this activity will conduct an independent mid-term project review in order to evaluate the progress of each component against project indicators, and to provide recommendations to the project both content wise, time wise, and budget wise for improvements of the project in the second half of the project period.

This activity will be conducted in the third year of the project period.

4.1.2 Terminal project evaluation

This output includes the following activity:

4.1.2.1 Conduct an independent terminal project evaluation at the end of the project
This activity will conduct an independent project evaluation at the end of the project period to evaluate the progress and success of each component of the project and the whole project, including the impact of the project at the provincial level (Rayong), the EEC level, and at the national level, and to glean lessons learned and best practices for sharing to other projects, and for future projects.

This activity will be conducted by the end of the project in the fifth year.

Summary of Component 4?s expected outcome, outputs, and activities

Expected Outcome:
4.1 Adequate monitoring of all project indicators

Expected Outputs:
4.1.1 Monitoring and mid-term project review
4.1.2 Terminal project evaluation

Expected Activities:
4.1.1.1 Conduct an independent mid-term project review
4.1.2.1 Conduct an independent terminal project evaluation at the end of the project

Theory of Change (TOC)

The project solutions in the ToC are based on the root causes lay under the unsustainable transport problem in Thailand. The project outputs are structured to target one or more root causes. Different colors and lines denote the different aspects of the project?s theory of change (root causes, assumptions, outputs, etc.). Component 4 on monitoring and evaluation, gender mainstreaming and environmental and social impact assessment are considered cross-cutting and not shown in the ToC.

The ToC shows that IF the outputs (project interventions) are conducted successfully THEN the project will reduce GHG emissions resulting from decarbonised electric mobility BECAUSE creating evidence through pilot technology demonstration, building capacity on e-mobility and sustainable battery use and enabling policies and investment conditions for private sector will accelerate the adoption of EVs in Thailand.

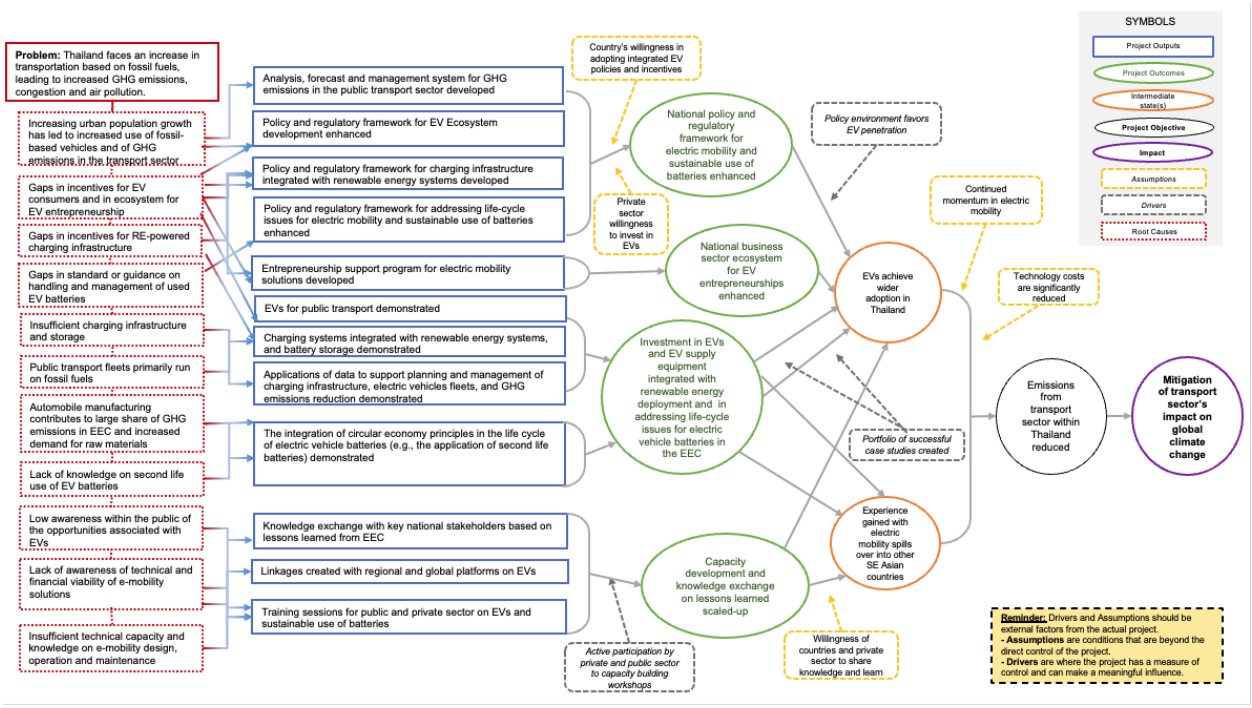


Figure 1 Theory of Change

d) alignment with GEF focal area and/or Impact Program strategies;

This project is categorized under the GEF-7 Climate Change Mitigation (CCM) focal area, specifically addressing the strategic area of CCM-2: Promote innovation and technology transfer for sustainable energy breakthroughs for electric drive technologies and electric mobility. The project supports decarbonization of Thailand?s transport sector by promoting the adoption of low-carbon electric mobility and development of innovative electric mobility solutions, contributing to direct reductions in GHG emissions and indirect reductions via scale-up within the market and the country.

e) incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, LDCF, SCCF, and co-financing;

Despite its targets for EV adoption and policies geared at EV manufacturing, Thailand?s overall stock and use of EVs remains under 1%. Thailand requires further incremental technical and financial assistance from GEF to ensure that its transportation sector decarbonizes at a rate which is more consistent with meeting the Paris Agreement. This assistance is essential to strengthen institutional capacities and policy and regulatory framework for electric mobility and to de-risk electric mobility technologies to attract stable co-financing from foreign and domestic investments in advanced technologies. With a relatively minimal GEF grant, this project will support mobilization of investment to support and accelerate the adoption of electric mobility in Thailand at a ratio of 2.02 USD per tCO2e , contributing to the program?s overall objective of reducing global greenhouse gas emissions from the transport sector.

Table 2 Incremental cost reasoning and expected outcomes

Components	**Business as usual**	**Incremental cost reasoning**	**Main outcomes expected**
1. Improve policy and regulatory framework for electric mobility and sustainable use of batteries	Limited progress in enhancing policy and regulatory framework to address gaps and barriers to the production and adoption of EVs with RE integration results in a lower rate of adoption of EV public/private fleets and RE-EV grid integration	Systematic promotion of mutually reinforcing policy and regulatory framework for EV and RE integration and EV adoption with focus on the public transport sector developed	Policy and regulatory framework for electric mobility and sustainable use of batteries enhanced

2. Accelerate technology adoption of electric mobility and sustainable use of batteries	Lack of demonstration of the uses of EVs for public transportation, innovative electric mobility solutions, addressing life cycle of EV batteries, and underdeveloped ecosystem for electric mobility entrepreneurship leads to a rate of adoption of electric mobility technologies inconsistent with meeting required targets for GHG mitigation in the transportation sector and limited management of used EV batteries	Innovative electric mobility technologies and life-cycle solutions for EV batteries are trialed in the public transport sector and programme put in place to support entrepreneurship, leading to new knowledge, experiences, and lessons about EVs to be developed and learned, and increasing public and national awareness, interest and evaluation of their uses	Investment in innovative electric mobility and battery technologies is derisked, accelerating their mainstreaming and adoption and greater support for bottom-up innovation in electric mobility from entrepreneurs
3. Capacity building, up-scaling and knowledge sharing	Knowledge and expertise on EVs, RE integrated charging infrastructure and life-cycle issues for batteries is not widely shared and up-scaled and is insufficient to lead to widespread adoption of EVs, and meeting national GHG mitigation targets	Increased national technical capacity and knowledge developed with connections through national, regional and global programs and networks	Capacity development and knowledge exchange on lessons learned scale-up to national, regional and global networks
4. Monitoring and evaluation	Lessons from implementation are not captured and project risks not meeting its objectives	Effective monitoring and evaluation of project is completed	Project achieves objectives with lessons learned for improving future projects

f) global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF); and

? **Co Direct and indirect GHG emissions and their precursors reduction**

The project will generate multiple global environmental benefits, building on a series of baseline initiatives currently being undertaken. The GHG emissions are calculated based on a top-down UNEP methodology applied across the GEF-UNEP Global Programme. This approach differs from the

bottom-up methodology that was applied during the PIF stage. The top-down methodology has been adopted in support of greater consistency across GEF electric mobility projects.

The project will provide technical assistance and facilitate investment mobilization for pilot demonstrations in Rayong. The project?s direct impact is assumed to be GHG emission reductions equivalent to the following:

? Replace at least 10 songthaews with electric substitutes and partly charged with renewable energy; and
? Replace at least 15 minibuses with electric minibuses, also partly charged with renewable energy

The breakdown of total (direct + indirect) GHG emission mitigation of 4,777,750 tCO2eq is summarized here briefly. The indirect post-project mitigation of this total corresponds to 3,336,936 tCO2eq, assumed to be realized through replication in Thailand. The total direct GHG emission mitigation of 1,440,815 tCO2eq consists of direct and secondary direct emission reductions.

The increased use of low-carbon transportation and infrastructure will directly serve 780 passengers daily, of which 51 % are assumed to be women. Other direct beneficiaries are expected in the private and public sector as recipients of trainings and knowledge exchange through connecting with regional and global platforms. Assuming that 70% of the public of the targeted areas will be permanent users, the project will indirectly benefit 381,500 people. The project will impact a wide scope of inhabitants due to cleaner air.

More details can be found in the GHG mitigation emission annex.

The assumption and sources of the input data used for the calculations are summarized below.

The vehicle stock numbers in Thailand are taken from Thailand?s National Statistical Office. The economy growth rate indicator is also used for secondary direct and indirect GHG emission calculations. The growth rate (%) of Thailand economy is expected to bounce back to the pre-COVID period, therefore, this value is estimated to average 3.3% from 2023 to 2030 and slowdown to stay 2% from 2031 to 2050 based on World Bank data. The value for electricity well-to-tank emissions (grid emission factor, kgCO2/kWh) is taken from the Institute for Global Environmental Strategies (IGES), population data is gathered from the statistics of UN Population division and GDP prospects from IFC. It is also considered that the grid emission factor of Thailand is assumed to be reduced moderately starting from 2025 in line with national policies and INDC and trends such as climate agenda, green recovery and capital investment costs for renewable energy technologies.

The estimation of number of beneficiaries is 32,922 beneficiaries. The total number consists of the following:

? Number of trainees in all technical and institutional workshops and training sessions: 1,450 (50% women)

? Number of municipal population and riders (31,400) that will use EVs as passenger/drivers etc. (50% women)
? 7 direct and 65 indirect jobs created and employment in new business: 72 people (30% women)

Therefore, the total number of beneficiaries has been calculated as such: 31400 + 1450 + 72 = 32,922; 16,445 being females and 16,477 males.

g) innovation, sustainability and potential for scaling up.

Innovation

Thailand already has a developed automotive sector with many SMEs part of a national value chain and has indicated a strong commitment to supporting the development of electric mobility in its manufacturing sector. However, in transitioning the sector towards electric mobility, increased support is needed for enhancing an ecosystem that supports entrepreneurship and innovation around EVs.

This project helps address this gap by establishing mechanisms for identifying innovative electric mobility solutions and developing an entrepreneurship support program for these innovative electric mobility solutions, as well as demonstrating the following: 1) the use and operation of EVs for local public transportation; 2) the use and operation of charging infrastructure for EVs integrated with renewable energy systems; 3) the use of data to support the planning and management of charging infrastructure, fleets of public transport vehicles, and GHG emissions reduction; and 4) the use of second life batteries.

The project has been designed to stimulate and create both technical and financial innovations especially through these demonstrations of the project. For instance, for the demonstration of the use and operation of EVs for local public transport, the project will collaborate with a local experienced manufacturer of electric vehicles (i.e., Sakun C. Innovation Group) to design and develop a new innovative electric vehicle which can substitute existing diesel-run songthaews and still meet the requirements of songthaew drivers and customers (such as space and possibility for transporting goods (fruits/seafood)) required by customers/riders). A new innovative design or technical innovation will also be created to make electric songthaews improve passenger safety and meet the safety standards and offer more comfort and convenience and safety to passengers including the handicapped, the elderly, the children, and the women, Emphasis will also be on a lightweight design by using aluminum alloys as the main structural components, which will lead to less electricity consumption. Two outputs expected from this would be one standard electric vehicle platform for multi-purpose electric vehicles and two prototype electric songthaews which are specially and innovatively-designed to substitute existing diesel-run songthaews. In addition, by providing two prototype new innovative electric songthaews for the selected songthaew cooperatives, songthaew drivers will have an opportunity to experience electric songthaews and realize the benefits especially the costs savings of using electric

songthaews instead of diesel-run songthaews for public transportation during the initial period of the project implementation, and have time to think of, plan, and/or develop innovative financial models that are suitable for songthaew drivers for investing in and financing more electric songthaews (i.e., financial innovations).

For another example, for the demonstration of the use of data to support the planning and management of charging infrastructure, fleets of public transport vehicles, and GHG emissions reduction, the project will collaborate with Digital Economy Promotion Agency and start-up enterprises to plan for collecting data through hardware and software and to develop innovative mobile applications that will support charging infrastructure planning for public transport, as well as to facilitate matching electric songthaews with corporate and public customers and enhancing the use of electric songthaews for extra service. The project will collect data and do analysis to improve Rayong logistics, e.g., recommendation on new public routes, and locations to install more chargers to be proposed to relevant authorities for consideration and implementation. All these are expected to lead to digital innovations to support the planning of charging infrastructure as well as the adoption of electric vehicles for public transport.

Sustainability

The design of each project activity and selection of counterparts is premised on ensuring long-term sustainability of the change that this GEF project will catalyze. Fundamentally, there needs to be national ownership of all interventions and their mainstreaming into the operations of the national entities to ensure that institutions will be responsible for taking actions forward beyond the project implementation period.

Long-term ownership and sustainability will be ensured through working closely with Eastern Economic Corridor, as well as other national partners and private sector. Developed tools and methodology will be universal and owned by the EECO, which will guarantee the overall sustainability of the project outcomes.

Accelerated adoption of technological solutions will be executed as public-private partnerships. The selected private sector partners will secure part of the required financing for the execution, as defined in the tendering process. As such, the private partner will have a vested interest that the technologies operate successfully for them to recover their investments. Given the commercial interest in sustaining the operations of the projects, the different proponents will also have an interest in keeping the projects running and hence sustain the global environmental benefits beyond the project lifetime.

In addition to creating public-private partnerships and investments in this project, the project will emphasize on developing innovations/models that are suitable for local needs/contexts. Specifically with regard to the demonstrations as mentioned in the Innovation section above, each demonstration will be divided into a few phases/stages. In the initial phase, the project will only demonstrate a few prototypes of electric vehicles (songthaews and minibuses), and demonstrate in a few pilot locations of chargers integrated with PV systems, and a pilot area for the second life application of used batteries.

The project will take opportunities to collect data and monitor the implementation, assess barriers and feedback from this initial phase, in order to develop technical, financial and digital innovations/models that are suitable for local needs and contexts. The project will take into account feedback, lessons learned from the initial phase and further improve technical, financial, and digital innovations for demonstrations in the later stages of the project, and also collect data and monitor the implementation closely in order to ensure that the technical, financial, and digital innovations/models suit local contexts and needs, which will contribute to ensuring the sustainability of these developed innovations after the project period.

Potential for scale-up

The project's strategy to ensure scale-up and replication is to develop the supporting policy framework, national examples and build up capacity, particularly within national and local government departments, private sector, research and academic institutions, and financial institutions since these organizations are in the best position to replicate the activities. The outputs to be generated by the Project will contribute to creating an enabling environment for integrating sustainability strategies into investment planning and management. All planned outputs are consistent with, and instrumental to, achievement of the objectives of Thailand?s key policies and legislation. Therefore, the combined efforts of technical project components are designed in such a way to ensure the scale-up of global environmental benefits beyond the life of the project. Finally, the project will share project deliverables such as analytical reports, policies, business models and lessons learnt with the Global Programme in order to support scale-up and replication of e-mobility in other countries and regions.

In addition, the project will have potential for scale-up at different levels through project partners both government agencies and private sector. The policy and regulatory framework to be developed incorporating practical experiences and lessons from the demonstrations in this project will be proposed to the Eastern Economic Corridor Board chaired by the prime minister or to the National Electric Vehicle Policy Committee chaired by a deputy prime minister, via the Eastern Economic Corridor Office, or member agencies of the project steering committee, and working groups established under this project, respectively. Thus, the policy and regulatory framework to be developed will have potential for scale-up at the national and EEC levels.

Innovative technical, financial, and digital models to be developed through the demonstrations in this project will also be proposed to the Eastern Economic Corridor Board chaired by the prime minister or to the National Electric Vehicle Policy Committee chaired by a deputy prime minister, via the Eastern Economic Corridor Office, or member agencies of the project steering committee, and working groups established under this project, and will also shared with private sector stakeholders in Rayong and the EEC, including songthaew cooperatives minibus operators, and charge point operators. Thus, innovative technical, financial and digital models to be developed will have potential for scale up at the national and EEC levels, as well as in other areas/provinces and with other private sector stakeholders.

Furthermore, through Component 3 of the project on capacity building, up-scaling, and knowledge exchange, the project will contribute to the scale-up of other components of the projects within the EEC and nationally through capacity building and knowledge sharing on outputs of Component 1 and 2. For instance, specifically with regard to the experiences of the use and operation of electric vehicles for public transportation, EECO will disseminate and experiences and especially innovative technical, financial/business, and digital models from the pilot demonstration and the selected routes to the other routes of public transportation within the EEC to ensure wider replicability. OTP will also take lead in disseminating experiences from the EEC to other cities for which OTP has developed the Master Plan for the Development of Public Transportation including Phuket, Chiang Mai, Songkhla, Nakorn Ratchasrima, and Kon Khaen, as well as other cities across the country, where songthaews/minibuses are also widely used as vehicles for local public transportation.

Knowledge, experiences, and lessons learned from Component 1 and 2 will be integrated as content of Component 3 and will be shared across national, regional, and global networks, through trainings, workshops, and conferences.

In summary, the project has been designed to provide various channels for scale-up at different levels (provincial, EEC, national, regional and global levels), including project partners that are government agencies and their relevant national committees, project partners that are private sector, other private sector stakeholders in Rayong and the EEC, and participants in trainings, workshops and conferences.

1b. Project Map and Coordinates

Please provide geo-referenced information and map where the project interventions will take place.

Coordinates: Chon Buri 13.3611? N, 100.9847? E; Rayong 12.7074? N, 101.1474? E; Chachoengsao 13.6904? N, 101.0780? E

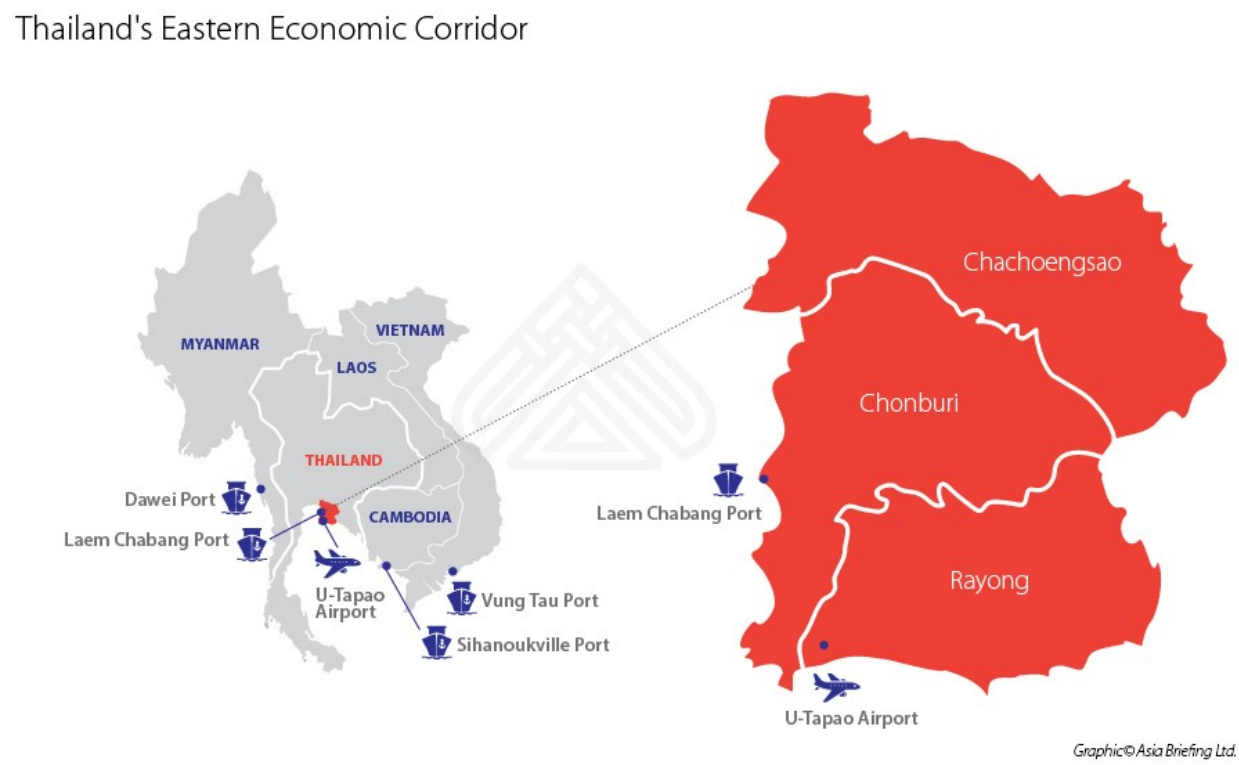


Figure 2 Project Map

1c. Child Project?

If this is a child project under a program, describe how the components contribute to the overall program impact.

The project is not under a global programme, however Output 3.1.2 and its activities are dedicated towards creating linkages with the Global Programme to Support Countries with the Shift to Electric Mobility led by UNEP.

2. Stakeholders

Select the stakeholders that have participated in consultations during the project identification phase:

Civil Society Organizations Yes

Indigenous Peoples and Local Communities

Private Sector Entities Yes

If none of the above, please explain why:

Please provide the Stakeholder Engagement Plan or equivalent assessment.

UNIDO is the GEF implementing agency of the project, and is accountable for the GEF grant. The Executing Entity is the Eastern Economic Corridor Office (EECO). The National Science and Technology Development Agency (NSTDA), and Thailand Greenhouse Gas Management Organization (TGO) will act as supporting partners, with EECO coordinating the partners execution based on each entities? technical expertise.

Stakeholders will form a comprehensive integrated structure to enhance a synergy among the project partners and serve as the knowledge source of new clean technologies, emerging entrepreneurs, knowledge network, applied research collaboration and additional team members. Furthermore, the gender mainstreaming approach will be applied in the form that early involvement of designated women entrepreneurs, associations and gender focal points will take part in all project activities. This will be in line with the GEF Policy on Stakeholder Engagement that sets out the core principles and mandatory requirements for stakeholder?s involvement.

Table 3 Project stakeholders and role in project

Function	**Stakeholder**	**Role in the project**
Implementation Agency	United Nations Industrial Development Organization (UNIDO)	UNIDO is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. **Role in the Project** UNIDO will act as the Implementation Agency for the project, oversee the project, and take a lead role in managing Component 4: Monitoring and Evaluation. This includes coordinating the Independent mid-term project review and terminal project evaluations.

Lead governmental agency, executing entity and project steering committee chair.	Eastern Economic Corridor Office (EECO)	EECO is a governmental agency that promotes investment, innovation and advanced technologies, and facilitate business operations within the EEC area. This project will build on the work being done to develop the Eastern Economic Corridor (EEC) in Thailand. The EEC is strategic development area comprised of three provinces: Chachoengsao, Chon Buri and Rayong. The aim of developing the EEC is to establish it as a strategic location for manufacturing, trading, export and logistics in ASEAN with comprehensive logistic connections to Asian countries and the world. Significant investment is being directed towards developing connectivity in the region through infrastructure projects, including a high-speed train, double-track rail lines, expansion of ports and U-Tapao Airport, and encouraging investment in the 10 major industries identified under Thailand 4.0, a government initiative to transition out of a current emphasis on heavy industry and advanced machinery and towards a ?value-based economy?. Given that this automotive industry is heavily influenced and disrupted by cutting-edge technological advances, and so as to foster continued future growth, the EEC places great importance on the production of electric vehicles (EV). **Role in the Project** EECO, the management office for the EEC, will act as chair of the project steering committee and be responsible for overall project execution and coordination of supporting partners based on their relevant expertise.

Supporting agency to the executing entity and project steering committee vice chair	National Science and Technology Development Agency (NSTDA), Ministry of Higher Education, Science, Research and Innovation	The NSTDA is a governmental agency under the Thai Ministry of Higher Education, Science, Research and Innovation, which supports research in science and technology and their application in the Thai economy. NSTDA consists of four National Research Centers, which are BIOTEC, MTEC, NANOTEC and NECTEC with a Technology Management Center (TMC). The project will strive to maximize collaboration with NSTDA as a developer of prototypes of electric vehicles for public transport and one of innovation hubs in Thailand. In addition, NSTDA can provide useful channels and networks to mobilize resources, disseminate information and best practices and further promote the adoption of electric vehicles for public transport. **Role in the Project** NSTDA will act as a supporting agency to the executing entity for component 2 and 3 of the project, and also act as a vice chair of the project steering committee, and the chair of the Technology working group.
Supporting agency to the executing entity and project steering committee vice-chair	Thailand Greenhouse Gas Management Organization (TGO), Ministry of Natural Resources and Environment (MNRE)	TGO is an autonomous governmental organization under the Ministry of Natural Resources and Environment (MNRE) responsible for promoting and encouraging stakeholders to reduce greenhouse gas emissions in Thailand. **Role in the Project** TGO will act in tandem with NSTDA as a key counterpart for the project to ensure the project aligns with Thailand?s national GHG mitigation strategies and initiatives. TGO will act as a supporting agency to the executing entity for Component 1 of the project, and also act as a project steering committee vice-chair, and the chair of the Policy working group.

Project steering committee member	Office of Transport and Traffic Policy and Planning (OTP), Ministry of Transport	OTP is a governmental agency under the Ministry of Transport that develops policy framework for national transport and traffic policy, plans, measures and standards. In other words, OTP is the national transport planning agency. 3 divisions under OTP are particularly relevant to this project. 1) Bureau of Safety Planning promotes sustainable transport, has developed the NDC Action Plan in the transportation sector and is responsible for supporting the implementation at the national level to meet the NDC mitigation target in the transportation sector. 2) Bureau of Regional Transport and Traffic System Promotion has developed the Master Plan for the Development of Public Transportation in Chachoengsao, Chon Buri, and Rayong Provinces to Support the Development of EEC Area. 3) Division of Transport and Traffic System Development provides knowledge and information related to transport and traffic technologies including electric vehicle technologies. **Role in the project** OTP will act as a member of the project steering committee to provide directions to the project and support upscaling of the project to the national level.
Project steering committee member	The Office of Industrial Economics (OIE), Ministry of Industry	OIE is a policy-making agency of the Ministry of Industry. The agency also acts as an assistant to the secretariat and a member of the National Electric Vehicle Policy Committee chaired by the prime minister. **Role in the project** OIE will act as a member of the project steering committee to provide directions to the project and ensure that the project is in line with Thailand?s policy to shift from traditional automotive production hub to electric vehicles production hub. OEI will also support upscaling of the project to the national level.

Project steering committee member	Energy Policy and Planning Office (EPPO), Ministry of Energy	Ministry of Energy has implemented initiatives and provided policy incentives on the demand side to promote electric mobility such as an incentive for installation of battery charging stations, and an electricity tariff incentive for EV charging. EPPO is an assistant to the secretariat and a member of the National EV Policy Committee, and is the chair of two Sub-committees, i.e., Subcommittee on Infrastructure and Battery Development to Support Electric Vehicles, and Subcommittee on Assessment of the Impacts on Fuels and Greenhouse Gas of Promoting Electric Vehicles **Role in the project** EPPO will act as a member of the project steering committee to provide directions to the project and support upscaling of the project to the national level.
Project steering committee member	Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy	**Role in the project** DEDE will act as a member of the project steering committee to provide directions to the project.
Project steering committee member	Office of Natural Resources Policy and Planning (ONEP), Ministry of Natural Resources and Environment	**Role in the project** ONEP will act as a member of the project steering committee to provide directions related to natural resources and environment, and NDCs to the project.
Project steering committee member	Office of Permanent Secretary, Ministry of Natural Resources and Environment (MonRE)	**Role in the project** The Office of Permanent Secretary of MonRE, as the office of the GEF operational focal point, will act as a member of the project steering committee to provide directions related to GEF operational procedures to the project.

Local administrative organization of the pilot area and Project steering committee member	Rayong City Municipality	Rayong City Municipality is a local administrative organization of Rayong City. **Role in the project** Rayong City Municipality will act as a taskforce to support and facilitate the demonstration of the use of EVs and charging stations in the selected routes in Rayong and coordinate and mobilize with local garages/technicians and operators of existing local public transportation. Rayong Municipality will also be a member of the project steering committee.
Project steering committee member	Thai Automotive Institute (TAI)	TAI was established based on the Ministry of Industry?s order and is an independent organization under the co-operation between the government and private sectors. Several divisions under TAI are relevant to this project, including Entrepreneur Development, Industrial Research, and EV battery testing units. TAI developed and proposed policy recommendations on EV development in collaboration with partners to the Office of Industrial Economics, the assistant to the secretariat of the National Electric Vehicle Policy Committee, chaired by the Prime Minister. TAI has good networks within the automotive industry. **Role in the project** TAI will act as a project steering committee member.
Project steering committee member	Provincial Electricity Authority (PEA)	PEA is the distributor and retailer of electricity to areas outside metropolitan areas (including Rayong) **Role in the project** PEA will act as a project steering committee member.

Project steering committee member	Rayong Technical College (RTC)	RTC is a technical college in Rayong that provides technical courses and trainings related to electric mobility and has a capacity to support the maintenance of electric vehicles, and related trainings under the project. **Role in the project** RTC will act as a project steering committee member and a member of the technology working group established under this project.
Project partners	Private sector stakeholders	Electric vehicle manufacturers, charging point operators, local public transportation fleet operators and drivers are all stakeholders relevant to the project?s planned interventions. **Role in the project** These private sector stakeholders will participate in the demonstrations of the project and will be key co-financiers of the project (i.e., co-financing and investing in the demonstrations)
GEEW Activities	GEEW Stakeholders	Gender experts and women centred NGOs are stakeholder relevant to the project?s gender mainstreaming approach (see Gender Plan). **Role in project** Gender focal points, gender experts, and organizations promoting GEEW will be engaged in the projects implementation.

During the PPG, the Project Steering Committee has been established. Agencies that are members of the PSC have nominated positions of their agencies to be part of the PSC as follows.

The Project Steering Committee consists of the following:

- Deputy Secretary General Chair
- Eastern Economic Corridor Office (EECO)
-
- Director of National Metal and Materials Technology Center (MTEC) Vice-chair
- National Scientific and Technological Development Agency (NSTDA)
-

•Deputy Director Vice-chair
•Thailand Greenhouse Gas Management Organization (TGO)
•
•Deputy Director General Member
•Energy Policy and Planning Office (EPPO), Ministry of Energy
•
•Director of Energy Conservation Promotion Member
•Department of Alternative Energy Development and Efficiency (DEDE)
Ministry of Energy

•Director of International Industrial Economics Member
•Office of Industrial Economics (OIE), Ministry of Industry
•
•Chief of Sustainable Transport Group Member
•Office of Transport and Traffic Policy and Planning (OTP)
Ministry of Transport

•Director of Measures and Mechanism Development Group Member
•Office of Natural Resources and Environmental Policy and Planning (ONEP)
Ministry of Natural Resource and Environment

•
•Representative Member
•Office of Permanent Secretary, Ministry of Natural Resource and Environment
•
•Assistant to the Governor, Business and Marketing Member
•Provincial Electricity Authority (PEA)
•
•Executive director Member
•Thai Automotive Institute (TAI)
•
•Municipal Clerk Member
•Rayong City Municipality
•
•Director Member
•Rayong Technical College
•
•Representative(s) Member
•United Nations Industrial Development Organization (UNIDO)
•
•Deputy Director of Investment and International Affairs Department Member and
Eastern Economic Corridor Office (EECO) Secretary

In addition, two working groups have also been established. Agencies that are members of the working groups have nominated representatives of their agencies to be part of the working groups.Working group 1 is on policy and institutional framework and chaired by TGO, and working group 2 is on technology demonstrations, capacity building, and knowledge sharing and chaired by NSTDA. Several agencies that are project steering committee members will also act as members of working groups.

Working group 1 consists of representatives from the following agencies; Thailand Greenhouse Gas Management Organization (TGO), Rayong City Municipality, National Scientific and Technological Development Agency (NSTDA), Thai Automotive Institute (TAI), Electric Vehicle Association of Thailand (EVAT), Fiscal Policy Office (FPO), Revenue Department, Excise Department, Department of Alternative Energy Development and Efficiency (DEDE), Office of Transport and Traffic Policy and Planning (OTP), National Economic and Social Development Council (NESDC), Energy Policy and Planning Office (EPPO), and Eastern Economic Corridor Office (EECO).

Working group 2 consists of representatives from the following agencies; National Scientific and Technological Development Agency (NSTDA), Rayong Technical College, Provincial Electricity Authority (PEA), Thai Automotive Institute (TAI), Thailand Greenhouse Gas Management Organization (TGO), and Rayong City Municipality.

A complete Stakeholder Engagement Plan has been attached to elaborate on the project's overall approach to stakeholder for the project's implementation and a summary of engagement activities completed during PPG.

In addition, provide a summary on how stakeholders will be consulted in project execution, the means and timing of engagement, how information will be disseminated, and an explanation of any resource requirements throughout the project/program cycle to ensure proper and meaningful stakeholder engagement

The project will engage with and communicate to various identified stakeholder groups as outlined below.

Table 4 Stakeholder groups with means of engagement and communication rules

Stakeholder group	Disaggregated group (if necessary)	Means of engagement	Rules for communication	Timing

Stakeholders to be affected, directly or indirectly, by the outcomes of the Project Implementation	Direct beneficiaries	Website, training, webinars, workshops, project reports	Communication to be done by persons authorized to communicate. Public communication can be done through national reporting rules	Continuous
	Indirect beneficiaries	Website, stakeholder consultation workshops, direct meetings, reporting	Updates provided regularly on website, reports, and public meetings on demand	Continuous
Internal stakeholders who are involved in the project implementation	Project management / PSC	Meetings, emails, phone calls, exchange of minutes, memos and official letters, website	In accordance with the rules for internal communication, meetings and the grievance mechanism for workers (employees and contract labour suppliers)	Continuous
External stakeholders who participate in the Project Implementation	Government ministries	Meetings, training, workshops, official letters, email, website, reporting,	In accordance with laid down government procedures for information exchange	Continuous
	Private sector (SMEs, associations, social enterprises)	Direct meeting, training, official letters, email, website, reporting, fora, workshops	Following project communication procedures (to be developed in first weeks of PEE appointment)	Continuous
	Finance institutions			Continuous
	International / multi and bi-lateral agencies			Continuous

Select what role civil society will play in the project:

Consulted only; Yes

Member of Advisory Body; Contractor;

Co-financier;

Member of project steering committee or equivalent decision-making body; No

Executor or co-executor;

Other (Please explain)

The project will engage with NGOs working on women and youth empowerment and local civil society through consultation meetings to assess and mitigate any emerging social and environmental risks related to the Rayong demonstration and entrepreneur support programme. Furthermore, the project will consult with the civil society representatives in relation to policy-related activities under Component 1.

3. Gender Equality and Women's Empowerment

Provide the gender analysis or equivalent socio-economic assesment.

UNIDO recognizes that gender equality and the empowerment of women have a significant positive impact on sustained economic growth and inclusive development of sustainable transport, key drivers of poverty alleviation and social progress. The UNIDO vision, as laid down in the 2019 Policy on Gender Equality and the Empowerment of Women (DGB/2019/16), is that women and men can equally lead, participate in, and benefit from inclusive and sustainable industrial development. Towards this vision, UNIDO follows a comprehensive approach to gender equality and the empowerment of women, recognizing the interests, needs and priorities of both women and men and the intersecting diversity of different groups. Moreover, UNIDO recognized the importance of involving vulnerable groups (incl. women of colour, young women) and the economy and society at large (with a special focus on groups most affected by climate-prone natural disasters).

A social and gender analysis was conducted during the PPG (see attached Gender Analysis and Gender Mainstreaming Plan). To establish a gender baseline and develop gender-based targets, basic data and qualitative information on social and gender aspects of the project was collected during PPG phase and PPG funds were allocated towards a review of the project design by a gender expert.

Research has demonstrated that women that use public transport are more susceptible to negative impacts of inadequate mobility choices as well as low public transport service levels. As a guiding principle, the project is designed to ensure that both women and men (including as staff in institutions,

as experts, and as audience, speakers and panelists at events, or where relevant in communities benefiting from the e-mobility pilots) are provided equal opportunities to lead, participate in and benefit from the project.

As a guiding principle, the project is designed to ensure both women and men are provided equal opportunities to participate and benefit from the project without compromising the technical quality of the project results. In practical terms, this will be demonstrated in a multitude of ways:

? A Gender baseline report has been prepared for this project during the project preparation grant phase. During PPG, this gender analysis and the gender mainstreaming action plan including the gender responsive targets and indicators will be validated and approved by the PSC as well as monitored during project implementation.

? Based on the General-Neutral ToRs, gender sensitive recruitment will be practiced at all levels where possible, especially in the selection of project staff, researchers and experts, as well as technical staff. Gender sensitive recruitment will be encouraged in instances where the project does not have direct influence.

? Existing staff will be trained and their awareness raised on gender issues when possible.

? Gender dimensions will be considered when data collections or assessments are conducted as part of project implementation. Examples include sex-disaggregated data collection and a gender analysis being completed during the PPG phase.

? Gender dimensions will be considered in all decision-making processes. With respect to project management, the Project Steering Committee meetings will aim to be gender balanced and extend invitations to observers that represent gender dimensions, such as organizations / associations promoting gender equality and advocating women?s empowerment. During project activity implementation, effort will be given during stakeholder consultations towards focusing on gender equality and women?s empowerment issues, in particular during policy review and formulation.

? Efforts will be made to promote participation of women in training activities, both at managerial and technical levels, as participants and trainers. This can include advertising of the events to women?s technical associations, encouraging companies to send female employees, provide childcare and safe transport, offer scholarships or reduced fees for women, adjusting TOR for selection of the trainers, etc.

? The project will pursue thorough gender responsive communication and ensure stakeholder involvement at all levels, with special regard to involving women and men, as well as civil society and non-governmental organizations promoting gender equality. This shall mitigate social and gender related risks, pro mote gender equality, create a culture of mutual acceptance, and maximize the potential contribution of the project to improving gender equality in the energy field.

The planned project outcomes will be enhanced by considering gender equality and women?s empowerment by adopting a gender lens at high-level decision-making bodies and forums, and within planning and developments relating to sustainable transport. A component-by-component short description is provided:

Component 1: The consultations for the strategy and the policy have women consultations targets. Women?s organizations will also be invited to the validation workshops. The policy and strategy will be gender-sensitive. Women's socio-economic conditions are taken into account in the strategy. At least one PMU member is assigned as the Gender Focal Point to ensure that the relevant project interventions are gender responsive. Meetings and workshops under this component have women participation targets.

Component 2: The focus of this component is the successful implementation of a demonstration-scale pilot project for e-mobility. The project will consult with the women associations and local community during the design of the pilot projects to not only integrate the needs of women and youth into project design but also provide equal opportunities for women and men to lead, benefit from and participate in the demonstration-scale pilot project.

Component 3: The training activities under this component have women participation targets and women's training needs are taken into account following consultations with local women?s organizations

During the PPG phase the gender context and relevance of the proposed project has been assessed in order to ensure the final project design fully considers its implications for women and men. This involved identification of the differentiated needs and roles of women and men as they relate to the project?s interventions. Gender responsive training material will also be developed.

Additionally, the PPG stage has been used to create relevant tools and methodologies for tracking gender issues throughout the project?s implementation. To establish a baseline and develop targets, basic relevant data and qualitative information was collected during PPG and gender markers have

been assigned at the output level in the project design. Budget will also be dedicated, as needed, during project implementation to identify and address gender issues, including collecting additional baseline data and monitoring progress towards the targets.

Does the project expect to include any gender-responsive measures to address gender gaps or promote gender equality and women empowerment?

Yes

Closing gender gaps in access to and control over natural resources;

Improving women's participation and decision making Yes

Generating socio-economic benefits or services or women Yes

Does the project?s results framework or logical framework include gender-sensitive indicators?

Yes

4. Private sector engagement

Elaborate on the private sector's engagement in the project, if any.

The private sector will be engaged through financial support for project components and in the adoption of innovative technologies and best practices within municipalities and industry. Discussions with the private sector (e.g., electric vehicle manufacturer, charging point operators, local public transportation fleet operators and drivers) have been held during the PPG phase through two field visits to Rayong; and bilateral stakeholder consultations in virtual platforms due to the pandemic conditions and in person when permitted based on national and local requirement at the time. Thus, there will be engagement with several private sector stakeholders in the project, especially, related to co-financing in the demonstration of the projects, including, but not limited to the followings:

BH Rayong Co. Ltd: With GEF support for a small percentage of the costs of 2 pilot electric minibuses, the minibus operator will invest in purchasing at least a total of 15-50 more electric minibuses to replace some or all of its 50 existing diesel-run minibuses during the project period, and also invest in developing its own existing garage to be usable for maintenance of electric minibuses. The company will also co-finance in the operation and maintenance of these electric minibuses. As for chargers, with GEF support for one charger and PV systems to be connected with the charger, the company will invest in purchasing and installing 9 more chargers to supply its electric minibus fleet during the project period. The company will also co-finance in providing its own land area, and roof area for installing chargers, and PV systems, respectively. In addition, the company will co-finance in the operation and maintenance of the chargers and PV systems.

Sakun C Innovation Co. Ltd: With GEF support for the costs of research and development of new electric vehicles which can substitute existing diesel-run songthaews (modified pick-up trucks) (including development of one standard electric vehicle platform for multi-purpose electric vehicles and two prototype electric songthaews which will be specially-designed to substitute existing diesel-run songthaews), the electric vehicle manufacturer will be mobilized to invest in infrastructure and technicians required for developing and manufacturing 2 prototype electric songthaews and some 10-25 electric songthaews to replace diesel-run songthaews.

Rayong-Baanchang songthaew cooperative and Rayong-Paknam cooperative: With GEF support for the costs of 2 prototype electric songthaews and a small percentage of the costs of 8 electric songthaews to replace diesel-run songthaews operating on the route between Rayong and Baanchang and the route between Rayong and Paknam, the two selected cooperatives will invest in purchasing 8 more electric micro-buses through soft loans and financial support from sponsors such as large conglomerates. The cooperatives will also co-finance in the operation and maintenance of the 2 prototype electric songthaews, and 8 electric songthaews, and in providing information support to the electric vehicle manufacturer during the use of 2 prototype electric songthaews for engineering design for improved safety and comfort.

Provincial Electricity Authority (PEA) - Volta: With GEF support for the costs of 6 chargers to be installed at the Old Bus Terminal to be dedicated for electric songthaews, PEA-Volta will invest in 2 more chargers to be installed at the Terminal, and chargers to be installed at another location along the Songthaew route such as at Suan Sri Muang Library. PEA will also co-finance in the operation and maintenance of all these installed chargers.

Bangchak: With GEF support for PV systems to be installed and integrated with chargers at a few Bangchak?s petrol stations in Rayong, Bangchak will invest in providing roof area for PV systems to be installed and connected with chargers at its petrol stations. Bangchak will also co-finance in the operation and maintenance of these PV systems. Moreover, Bangchak will invest in providing its land area at its petrol stations to demonstrate the second life use of used electric vehicle batteries as energy storage systems (ESSs), and in the operation of these ESSs. Other charge point operators: In addition, other operators of petrol stations and chargers will be mobilized to invest in installing more PV systems and chargers to be connected with the PV systems, as well as co-finance in the operation and maintenance of these PV systems.

Siam Cement Group (SCG): SCG will invest in installing PV systems to their chargers already installed in their factory located in an industrial estate in Rayong for their electric shuttles, and in the operation and maintenance of these PV systems. In addition, SCG will invest in developing and

implementing activities/measures to support the project in promoting changing existing public transport vehicles to electric vehicles. Moreover, SCG will invest in developing the protocol required for trading carbon credits to be earned from GHG emissions reduction due to the demonstrations of electric vehicles and charging stations integrated with PV systems in the project.

Furthermore, with GEF contribution to the capacity building and knowledge exchange on electric vehicles and sustainable use of EV batteries, **other private sector stakeholders including operators/drivers of electric mini-buses and songthaews in Rayong, local garage,** as well as local education institutes and local technical college: will invest in providing meeting/training facilities and sharing information to the project under Component 3.

5. Risks to Achieving Project Objectives

Elaborate on indicated risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and, if possible, the proposed measures that address these risks at the time of project implementation.(table format acceptable):

Please see ESMP for complete details on the baseline and mitigation plan of environmental and social risks and mitigation measures.

Table 5 Project risks, risk level and mitigation actions

Risks	**Risk Level**	**Risk description**	**Mitigation Measures**

Political and institutional risk	Low	This risk entails lack of sufficient support and engagement from the relevant ministries and institutions.	Component 1 and Component 2 of the project includes extensive engagement with the relevant institutions at national, city and local levels. The risk of leadership changes during the course of the project is a possibility against which the project cannot hold influence. Under Components 2 and 3, the project focuses significantly on private-sector engagement which would be less affected by leadership change For this reason, overall project risk is low, although political/institutional risk for Component 1 could be higher. The capacities of government and local authorities will be increased through trainings and workshops to implement policies and programs on electric mobility and sustainable battery use. The content of these workshops will include social and environmental aspects. The establishment of the Policy working group (for addressing Component 1), and of the Technology working group (for addressing Component 2 and 3) will help mitigate the risk, as each component will also steered not only through the leadership of a single agency but also through teamwork of the members of the working groups.

Operational risk	Medium	Delays in the proposed improvements to institutional and regulatory framework by public institutions.	This risk is considered medium since the scale-up of infrastructure and electric mobility investments, (e.g., Components 2 and 3) depend on a clear policy and regulatory framework that can take significant time to develop and implement due to national approval processes. The risk will be mitigated by identifying and engaging external consultants through the project to develop draft policies which can be quickly adopted by the government. Multiple experts have been identified in the pre-project design phase who have demonstrated expertise in transportation strategy and technical issues. It is expected that these experts will be engaged under Component 1 in order to help advance discussions on policy. In addition, the EECO, the executing entity and the secretariat of the EECO Board, and member agencies of the working groups, some of which are member agencies of the National Electric Vehicle Policy Committee will help address this risk, by proposing policy and regulatory framework and policy recommendations to be developed in this project to these national-level committees for consideration and implementation.

Climate change risks - Infrastructure developed is vulnerable to climate risks.	Low	Thailand is located in the southeastern part of the Asian mainland, in a tropical region with a relatively warm year-round temperature. Thailand is vulnerable to many natural and human-induced hazards, including floods, droughts, tsunamis, forest ??res and landslides (World Bank Climate Change Knowledge Portal). In particular, hydrological events and drought are common and have had fatal consequence ? notably during the 2004 Indian Ocean earthquake and tsunami which resulted in over 200,000 fatalities. Thailand?s greatest risk are floods and droughts and to a lesser extent, cyclones, specifically in the northern portion of the country. Climate change has already had an impact on the frequency and severity of hazards. In 2020, the Global Climate Risk Index ranked Thailand as the most affected country by climate change for the period of 1999 to 2008. Using the Coupled Model Intercomparison Project Phase 5 (CMIP5) models included under the IPCC?s Fifth Assessment Report (AR5), key projected climate trends for Thailand include a mean annual temperature increase of 1.4 to 1.8 C by the 2060?s and 3.0 to 3.8 C by the 2090?s. Projections for mean annual rainfall across different model?s project changes in precipitation between +28% to 74% by 2090. The Thai Office of Natural Resources and Environmental Policy and Planning estimates that sea levels will rise one meter over the next 40 to 100 years, impacting at least 3,200 km of the country?s coastal land, and affecting 17% of Thailand?s population. The rise in global temperature is anticipated to contribute to an increase in storms and in turn, flooding, in particular on coastlines along the Gulf of Thailand. Climate change is also projected to contribute to increased levels of drought, with some areas projected to have	The risks will be mitigated related to charging infrastructure by ensuring that this infrastructure meets current international standards (see Component 2) and ? where applicable ? contracting will also include a clause on resilience to climate impacts. Project planning decisions, project design, and construction methods will take into account of the on-site implications of these climate hazards. The risks associated with climate change include extreme weather conditions will be addressed by ensuring that any infrastructure investment supported by the project is climate-proofed. In addition, the project has intitially assessed climate change risks that are specific to Rayong, which is the area for demonstrations, through interviews with local stakeholders during the development of the Environmental and Social Management Plan. Climate change risks that are specific to Rayong mainly include flash floodings and storms in the rainy season. Thus, the project will take this climate change risk into account in the design of the demonstrations. For the selected routes of Songthaews and minibuses where flash floodings have occurred at a few spots in the routes and might occur in the future, the project will prepare measures to mitigate this risk, including preparing alternative routes, and taking into account this risk in the design of electric songthaews. For locations of chargers where flash floodings and storms have occurred and might occur in the future, the project will also take into account this risk in the design and establishment of charging stations.

Environmental and social risk	Low	The use of any type of electric vehicle may include environmental and social risks.	Consultation from vulnerable groups (women, refugees, the disabled, poor and elderly) will be sought when preparing policy recommendations under Component 1 and 2. Similar consultations will be held on the placement of e-chargers, and findings from the consultations will be integrated into the RFP (for example, the need for adequate lighting at the e-charging station). A complete Environmental and Social Management Plan has also been developed and included as an attachment.
Technology risk	Low	The introduction of new technologies carries a risk that they may not be suitable for the location and use intended.	The project will draw upon UNIDO?s experience and the knowledge from Global programme on the suitability of e-mobility within the context of Thailand.

Technology risk	Medium	Manufacturing of new pilot EVs not being developed on time or accepted by drivers or passengers, and the EV technologies are not sustainably used.	The project will actively engage driver and potential passengers in the design and development of the replacement the pilot EV replacement for songthaews. To help address this risk, the project will also emphasize on developing innovations/models that are suitable for local needs/contexts. Specifically with regard to the demonstrations, each demonstration will be divided into a few phases/stages. In the initial phase, the project will only demonstrate a few prototypes of electric vehicles (songthaews and minibuses), and demonstrate in a few pilot locations of chargers integrated with PV systems, and a pilot area for the second life application of used batteries. The project will take opportunities to collect data and monitor the implementation, assess barriers and feedback from this initial phase, in order to develop technical, financial and digital innovations/models that are suitable for local needs and contexts. The project will take into account feedback, lessons learned from the initial phase and further improve technical, financial, and digital innovations for demonstrations in the later stages of the project, and also collect data and monitor the implementation closely in order to ensure that the technical, financial, and digital innovations/models suit local contexts and needs, which will contribute to ensuring the sustainability of these developed innovations after the project period.

Operational risk	Low	Low interest to participate and engage project activities (from private sector, stakeholders from the government and municipalities) including political factors at the macro level	Project success depends on active participation and investment from the private sector. The project will have early engagement strategy, regular outreach with networks to keep the momentum (see Stakeholder Engagement Plan). The project team will disseminate the knowledge to ensure scalability of project beyond Rayong. Based on the demonstrated willingness of the Thai private sector to adopt and utilize e-vehicles, the risk of low participation from the private sector is considered low.
Social/Operational risk	Low	Low representation from women in positions of power and influence on the transport policy; inadequate engagement from women or missing qualified female technicians/entrepreneurs from the private sector.	This risk will be mitigated through specifically targeting women involved in the sector for participation in consultations on policy improvements under Component 1, and for safety and other considerations under Component 2. Disaggregated data on gender participation will be collected at all meetings and other events related to the project, and targeted invitations will be made for enhanced female participation as needed. To ensure gender inclusiveness of all project activities, UNIDO methodology for gender assessment and gender responsive communication showing the benefits of gender equality for both women and men will be applied. To mainstream gender dimensions and empower women, adequate and gender responsive communication strategy will be implemented, and sensitization workshops will be organized. A full gender analysis was carried out and its recommendations were incorporated into the project design.

COVID-19 Risk and Opportunities	Medium	The project faces a variety of potential risks due to the COVID-19 pandemic. First, general trends in people?s transportation preferences in response to COVID-19 could pose challenges to the project?s objectives of increasing adoption rates of electric mobility and the project?s implementation. The demonstration and awareness raising linked to the adoption of electric public transportation could be hindered due to less interest in public transportation from the public, in turn creating challenges for the viability of the business model. Reduced income from private sector and households could also impact financial decisions towards investing in new electric vehicles.	To mitigate this risk, the project will create linkages with international and national green recovery packages to build back the market towards electric mobility. To date and of relevance, Thailand has already released a suite of COVID-19 recovery measures including soft loans of THB 500 billion to SMEs through commercial banks and 6 month loan payment holidays. Opportunities to create linkages between the projects objectives and recovery measures will be monitored regularly throughout the project?s implementation. To address potential restrictions in the movement of people and goods as well as stakeholder consultations and site screening for technology demonstrations sites, the project will build into its work plan a certain amount of consideration for potential delays as well as flexibility in terms of planning the potential need to conduct capacity building and stakeholder engagement through online approaches. In addition, the project is designed to diversity this risk by not relying on one private sector stakeholder in each demonstration. For instance, for the demonstration of public transport vehicles, the project will engage both operators of songthaews (lower income group), and operators of minibuses (higher-income group). For operators of songthaews, the project also selects two routes (two songthaew cooperatives), and for operators of minibuses, the project also selects two routes. For the demonstration of charging systems integrated with PV systems, the project also engages with more than one operator of charging stations.

Table 4: COVID Opportunity analysis

Opportunity	Opportunity level	Opportunity optimization measure
New business opportunities to build back better for business continuity and economic recovery post-COVID-19	High	The project by design engages with the private sector to support the development of electric mobility, low carbon charging infrastructure and sustainable use of batteries. New business opportunities, policies and regulations will be included in entrepreneur training material so that they are fully informed of the market and policy environment trends. In addition, data of users and drivers of songthaews and minibuses and of charging station operators will be continuously collected, analyzed and used during phases of the project (especially the demonstrations of the project) not only to develop digital innovations such as mobile applications, but also to develop innovative business models and opportunities to support and facilitate the implementation of the project in the COVID era.
New business opportunities created in response to COVID-19 related restrictions and measures	High	Response to COVID-19 restrictions, such as remote working arrangements and no-contact business modalities will require solutions that can be turned into new business models. These opportunities will be analyzed at national and regional level and shared with entrepreneurs as part of market intelligence information. In addition, data of users and drivers of songthaews and minibuses and of charging station operators will be continuously collected, analyzed and used during phases of the project (especially the demonstrations of the project) not only to develop digital innovations such as mobile applications, but also to develop innovative business models and opportunities to support and facilitate the implementation of the project in the COVID era and restrictions.

6. Institutional Arrangement and Coordination

Describe the institutional arrangement for project implementation. Elaborate on the planned coordination with other relevant GEF-financed projects and other initiatives.

UNIDO will be the GEF Implementing Agency for the project and will be responsible for overseeing, monitoring, and evaluating the implementation of the project. The execution of the project will be undertaken through multiple partnership/contractual arrangements between UNIDO and selected national/international entities with relevant mandates and capacities.

The Eastern Economic Corridor Office (EECO) will act as the Project Executing Entity (PEE). UNIDO will engage with the EECO for the execution of the project. A HACT assessment was carried out by UNIDO which identified EECO as having the infrastructure including regulation and rules that would allow them to execute the project.

The National Science and Technology Development Agency (NSTDA), and Thailand Greenhouse Gas Management Organization (TGO) will act as supporting partners. NSTDA will support the EECO with delivery of Component 2 and 3 of the project, while TGO will support the EECO by delivery of Component1 of the project. The EECO will issue and manage contracts with NSTDA and TGO and coordinate with these two supporting partners to complete activities outlined for each component.

A Project Steering Committee (PSC) will be chaired by the EECO, will provide strategic and operational guidance and advice to the project and ensure its smooth execution according to the approved project document. The PSC will, among others, review and endorse project budget and work plans, and will provide necessary support to the project, and assure coordination between this project and other ongoing government activities and programs.

The Policy working group and the Technology working group which have also been established during the PPG and will be chaired by TGO and NSTDA, respectively, will provide technical input/advice to the project and provide support for specific tasks/activities assigned by the PSC.

Project Management Unit (PMU) will be established within the EECO to ensure the day-to-day management for the project and coordination with relevant baseline initiatives. The PMU will report to UNIDO and the PSC. The PMU shall be provided with an appropriate office space and will work in close coordination with the National Project Director (NPD) and the UNIDO Regional Office in Thailand.

Government support will also be required in identifying an NPD to act as main national project focal point. The NPD will also provide guidance to the PMU as far as government policies and regulations are concerned, facilitate coordination with other government entities, and facilitate approvals required from government in relation to project activities.

The project Management Framework is given in the figure below:

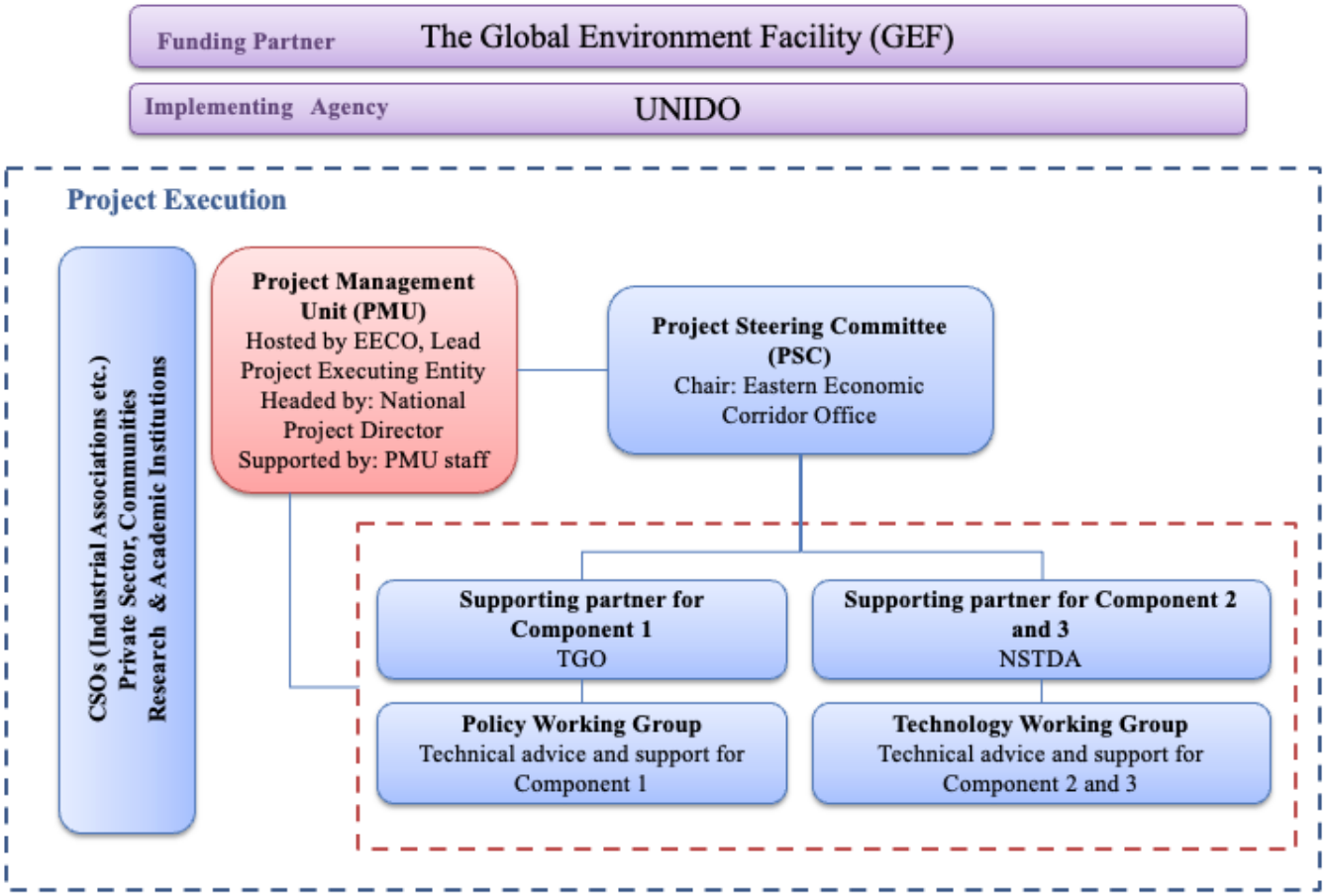


Figure 3 Project Management Framework

The project development team has endeavoured to establish and strengthen linkages with other agencies and actors that are currently planning or implementing relevant projects which will contribute to the overall outcome of the proposed GEF project. Some of such partners active in this area are local private entrepreneurs, CSOs and NGOs, academia, etc. The project development team has identified the most relevant partners during the project preparation phase. During the PPG stage, numerous stakeholders? consultation including the log frame analysis were organized to discuss related issues and concerns and prepare comprehensive structures for project implementation and management. A detailed stakeholders? involvement plan has been developed to ensure complementarity and build on best practices and lessons learned by the stakeholders. During the implementation stage, the coordination mechanism will be further established to ensure proper coordination and involvement of the baseline project proponents.

Stakeholders will form a comprehensive integrated structure to enhance a synergy among the project partners and serve as the knowledge source of electric mobility technologies, emerging entrepreneurs, knowledge network, applied research collaboration and additional team members. Furthermore, the gender mainstreaming approach will be applied in the form that early involvement of designated women entrepreneurs, associations and gender focal points will take part in all project activities. This is in line

with the GEF Policy on Stakeholder Engagement that that sets out the core principles and mandatory requirements for stakeholder?s involvement.

The project will also have linkages with the Global and Regional Programs established under GEF-7. Concretely, this will include participating in capacity building activities, contributing to knowledge platforms with lessons gained from the project and replicating best practices from countries and regions shared through the platform. A specific output (3.1.2) is dedicated to establishing these linkages and ensuring bi-lateral engagement between the project and global and regional platform to leverage synergies and support scalability and replicability of best practices developed under the project.

Legal Context:

The Kingdom of Thailand agrees to apply to the present project, mutatis mutandis, the provisions of the Revised Standard Technical Assistance Agreement concluded between the United Nations and the Specialized Agencies and the Government on 4 June 1960.

Transfer of assets and taxes:

Full or partial ownership of equipment/assets purchased under the project may be transferred to national counterparts and/or project beneficiaries during the project implementation as deemed appropriate by the government counterpart in consultation with the UNIDO Project Manager

Within the context of this project and given the type of equipment and the supply chain parameters, every effort shall be made to obtain the necessary TAX exemptions or apply claim back options in line with national regulations and rules. With regards to the assets purchased under the project, these shall be handled/transferred/owned as deemed appropriate in consultation with the Project Steering Committee.

7. Consistency with National Priorities

Describe the consistency of the project with national strategies and plans or reports and assesments under relevant conventions from below:

NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc.

Thailand submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat on the first of October, 2015. Thailand communicated that it intends to reduce its greenhouse gas (GHG) emissions by 20% from the projected business-as-usual (BAU) level in 2030 (approximately 111 MtCO2e of projected 555 MtCO2e BAU total). The level of contribution could increase up to 25% subject to adequate and enhanced access to technology development and transfer, financial resources and capacity building support through a balanced and

ambitious global agreement under the UNFCCC. As a framework for developing an action plan of implementation to meet the GHG mitigation target in 2030, Thailand?s NDC Roadmap on Mitigation 2021-2030 (NDC Roadmap 2021-2030) was prepared. The NDC Roadmap 2021-2030 was approved by the cabinet in May 2017 and included GHG reduction measures in three sectors, i.e., the energy and transportation sector, the industrial process and product use sector, and the waste management sector, as these three sectors were considered as major sectors that have the potential and the readiness to meet the GHG mitigation target in 2030.

With regard to the transportation sector, one of the key sectors for achieving the mitigation target, the NDC Roadmap on Mitigation 2021-2030 states a total mitigation target of 41 $MtCO_2e$. The Thai government has considered electric mobility as a low GHG and Particulate Matter (PM) emissions transport solution, and a potential alternative to vehicles with internal combustion engines (ICE). Therefore, in 2015, the Thai government, by the Ministry of Energy, proposed measures to reduce the country?s energy intensity, one of which is to reduce energy use in the transportation sector through the adoption of electric vehicles, and made a plan and set the target of the adoption of plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) to be 1.2 million vehicles in 2036. In addition, the NDC Action Plan in the transportation sector approved by the cabinet in 2018 thus includes projects and plans on an expansion of electric vehicles. This project's focus on low emission transport solutions will directly support reaching the target in the transportation sector of the country?s NDC Roadmap 2021-2030.

Furthermore, the proposed project complements nicely with two key strategies of a master plan for national energy reform, the strategy number 12 and 16. The master plan for national energy reform 2018 currently being considered by the cabinet aims at reforming all aspects of energy governance and fuel options (energy use in various sectors). The master plan for the national energy reform constitutes 6 elements with 17 strategies to fulfill the 6 elements. The first strategy to which the propose project contributes is the strategy number 12 under the 4th element on alternative energy promotion. The strategy number 12 is objected to achieve the 20-year- reform of energy used in transport. The strategy includes a structural change and change of ecosystem of energy used in the transport sector for national-wide adoption of alternative fuels in the transport sector. This ecosystem might include relevant regulation, and downstream production and investment of alternative fuels used in the transport sector such as biofuels. This proposed project contributes to the sectoral transform on vehicles using alternative fuels. In addition, the proposed project also fulfils the strategy 16 on electric vehicle promotion under the 6th element on innovation, technology and infrastructure. The strategy 16 focuses only on the promotion of both production and use of the electric vehicles. Therefore, the implementation of this proposed project would contribute to the country?s plan on the reform of the energy use and energy governance with specific to electric vehicles (songthaews and minibuses) both on the investment promotion as well as the promotion of usage.

8. Knowledge Management

Elaborate the "Knowledge Management Approach" for the project, including a budget, key deliverables and a timeline, and explain how it will contribute to the project's overall impact.

Knowledge management and scale-up is a key part of the project with a dedicated component to knowledge exchange and upscaling.

As for knowledge management approach, first, the project is designed to have inter-linkages and interactions between each Component of the project chiefly through the two working groups established in order to regularly and continuously exchange information and knowledge to be obtained through the implementation of each Component and to create new knowledge.

For instance, as for interactions between Component 1 and 2, information, knowledge, and lessons to be obtained through the implementation of Component 2 related to the development of EV entrepreneurship support program and the demonstration of public transport vehicles, the demonstration of charging infrastructure integrated with renewable energy systems, and the demonstration of the integration of circular economy principles in the life cycle of electric vehicle batteries (e.g., the application of second life batteries) will be shared with Component 1 for the development of policy and regulatory framework for EV ecosystem development, for charging infrastructure integrated with renewable energy systems, and for addressing life-cycle issues for EVs and sustainable use of batteries, respectively. On the other way, issues related to policy and regulatory framework including incentives to be developed through Component 1 will be shared with Component 2 for the implementation of Component 2 related to the mentioned demonstrations. In addition, knowledge and information to be obtained through the implementation of Component 2 related to the demonstration of applying data to support planning and management of charging infrastructure, electric vehicles fleets, and especially GHG emissions reduction and through the implementation of Component 1 related to the development of analysis, forecast and management system for GHG emissions in the public transport sector will be exchanged.

Furthermore, as for interactions between Component 1 and 2, and Component 3, knowledge, experiences, and lessons to be learned from Component 1 and 2 will be integrated as content of Component 3 and will be shared across national, regional, and global networks through the outputs of Component 3. On the other way, knowledge and lessons to gained from other relevant projects and initiatives and from participants in the national, regional and global platforms through the implementation of Component 3 will be shared with Component 1 and 2.

Moreover, as for interactions between Component 1, 2, and 3 and Component 4, evaluation results including lessons and best practice to be obtained through the implementation of Component 4 (mid-term review and terminal evaluation) will be shared with Component 1, 2 and 3. Feedback from Component 4 through the mid-term review, including results of the evaluation of the mid-term impact of the project will be also shared with Component 1, 2, and 3 in order to make Component 1, 2 and 3 contribute more significantly to the project?s overall impact.

Second, the project is designed to provide various channels for scale-up at different levels (provincial, EEC, national, regional and global levels), by including project partners that are government agencies with their relevant national committees, project partners that are private sector, other private sector stakeholders in Rayong and the EEC, and various participants in trainings, workshops and conferences. Third, in order to manage knowledge to be obtained, and to support the scale-up and replication in other provinces, countries, and regions, the project will also produce documents (including online documents) of

knowledge, lessons learned, best practices, and EV solutions for sharing with national stakeholders, and regional and global programs/platforms, through Component 3.

With the established internal linkages between each Component of the project, established channels for scale-up at different levels, and documents of knowledge for sharing with various stakeholders, this knowledge management approach is expected to contribute significantly to the project?s overall impact.

9. Monitoring and Evaluation

Describe the budgeted M and E plan

Project monitoring and evaluation (M&E) will be conducted in accordance with established UNIDO and GEF procedures. The overall objective of the monitoring and evaluation process is to ensure successful and quality implementation of the project by completing the following:

i) Tracking and reviewing project activities execution and actual accomplishments;

ii) Providing visibility into progress as the project proceeds so that the implementation team can take early corrective action if performance deviates significantly from original plans;

iii) Adjusting and updating project strategy and implementation plan to reflect possible changes on the ground, results achieved and corrective actions taken; and

iv) Ensuring linkages and harmonization of project activities with that of other related projects at national, regional and global levels.

According to the Monitoring and Evaluation policy of the GEF and UNIDO, follow-up studies like Country Portfolio Evaluations and Thematic Evaluations can be initiated and conducted. All project partners and contractors are obliged to (i) make available studies, reports and other documentation related to the project and (ii) facilitate interviews with staff involved in the project activities.

At the same time, M&E will comply with the rules and regulations governing the M&E of UNIDO technical cooperation projects, in particular the UNIDO Evaluation Policy and the Guidelines for Technical Cooperation, both in their respective current versions.

A detailed monitoring plan for tracking and reporting on project time-bound milestones and accomplishments will be prepared by the PEE and UNIDO at the beginning of project implementation and then periodically updated. By making reference to the impact and performance indicators defined in the Project Results Framework, the monitoring plan will track, report on and review project activities and accomplishments.

The PEE will be responsible for day-to-day execution and management of project activities and monitoring the execution, performance and the tracking of progress towards the achievement of milestones.

The PEE will be responsible for narrative reporting to the GEF, and the preparation of draft Annual Project Implementation Reviews (PIR) that will be submitted to the GEF by UNIDO. UNIDO will be responsible for oversight and tracking overall project milestones and progress towards the attainment of the set project outputs.

Mid-term project review and terminal project evaluation (TE) will be prepared by an independent evaluator as established in the M&E Plan.

One mid-term project review will be carried out and a final independent terminal project evaluation at least one month before the completion of the project. UNIDO execute independent mid-term review and terminal evaluation of the project. The UNIDO project manager will inform UNIDO Evaluation Group at least 6 months before project completion about the expected timing for the terminal project evaluation. The UNIDO Evaluation Group will then manage the terminal evaluation in close consultation with the project manager.

All monitoring and evaluation documents, such as progress reports, terminal evaluation report, and thematic evaluations (e.g., capacity needs assessment), as well as publications reporting on the project, will include gender dimensions wherever adequate. Table 8 provides the tentative budget for monitoring and the two evaluations, which has been included in Output 4.1 of Project Component 4. UNIDO as the Implementing Agency will involve the GEF Operational Focal Point and project stakeholders in order to ensure the use of the evaluation results for further planning and implementation.

The M&E plan will encompass monitoring of the Gender Analysis Report and Gender Mainstreaming action plan.

Table 6: Project?s Indicative Monitoring and Evaluation Work Plan

Type of M&E Activity	**Responsibility**	**Budget (USD)**	**Co-financing (USD) (to be distributed accordingly during execution)**	**Remarks**	**Timeframe**
Inception Workshop (IW) and inception report	PMU	Incl. in the contract arrangement with national execution partner EECO			Within first two months of project start up
M&E design and tools to collect and record data (performance indicators) including a survey to confirm baseline values for industry, manufacturers, policy makers, gender, etc.	PMU				Within first two months of project start up and mid project
Regular monitoring and analysis of performance indicators (technical, social, policy, environmental, gender)	PMU				Regularly to feed into project management and Annual Project Review
Project Implementation Reviews (PIRs) including ?lessons learned?	PMU (for data collection and drafting) and UNIDO (to final report and submission to GEF)				Annually
Annual Project Review to assess project progress and performance	PMU				Annually prior to the finalization of APR/PIR and to the definition of annual work plans

Type of M&E Activity	Responsibility	Budget (USD)	Co-financing (USD) (to be distributed accordingly during execution)	Remarks	Timeframe
Steering Committee (SC) Meetings	PMU, UNIDO Project Steering Committee			It will be part of PMU activity	Annually to coincide with the Annual Project Review and ad hoc when urgent and important decisions need approval of SC
Mid-term project review including survey to measure progress against baseline for investments, trainings and policy makers	PMU, external consultants, UNIDO PM, UNIDO Quality Monitoring Division (EVQQUA) in advising on TOR and selection of evaluators, Steering Committee and M&E specialists as required	42,729		Indicative cost	Mid of project
Final survey to measure progress against baseline for projects	UNIDO PM; PMU and M&E specialists as required	60,000		It will be part of PMU activity	At least two months prior to end of the project
Project terminal evaluation	UNIDO Independent Evaluation Division (EVQ/IEV), PMU, PM UNIDO HQ and Project Steering Committee, independent external evaluators			Indicative cost	Evaluation at least one month before the end of the project; report at the end of project implementation
Visits to field sites	PMU, UNIDO PM			It will be part of PMU activity	As required, throughout the project
Total budget:		**102,729**			

10. Benefits

Describe the socioeconomic benefits to be delivered by the project at the national and local levels, as appropriate. How do these benefits translate in supporting the achievement of global environment benefits (GEF Trust Fund) or adaptation benefits (LDCF/SCCF)?

The project will create socio-economic benefits at that national and local level by supporting Thailand's electric vehicle market continue to develop, in turn creating co-benefits in the form of new jobs along the EV value chain in Thailand, a reduction in Thailand's contribution to GHG emissions globally, and improvements in national and local air quality. Electric vehicles have emerged as a key technological solution to decarbonizing the transport sector and Thailand's decision to pursue development of their own EV automotive sector nationally creates synergies to meet climate targets while creating opportunities for people to work, develop new technological skills and improve the quality of life in local communities. The project supports this through the development of support programme for entrepreneurs and SMEs working on electric mobility, and supports inclusivity by dedicated attention to women entrepreneurs working in the space and support opportunities for women to work in the labour market in Thailand. From a gender perspective, the project also supports development of safe, clean and efficient transport for men and women, in turn supporting economic growth by reducing travel time and providing reliable modes of transport through new proposed policy and planning measures. Please see the ESMP for further details.

11. Environmental and Social Safeguard (ESS) Risks

Provide information on the identified environmental and social risks and potential impacts associated with the project/program based on your organization's ESS systems and procedures

Overall Project/Program Risk Classification*

PIF	CEO Endorsement/Approval	MTR	TE
Medium/Moderate	Medium/Moderate		

Measures to address identified risks and impacts

Elaborate on the types and risk classifications/ratings of any identified environmental and social risks and impacts (considering the GEF ESS Minimum Standards) and any measures undertaken as well as planned management measures to address these risks during implementation.

To address risks and impacts, a complete Environmental and Social Management Plan has been developed for the project (see attached). A summary of Environmental and Social Risks and mitigation measures is provided in the table below for quick reference.

Table 7. E&S risks, mitigating measures with location, frequency and responsibility

E&S risks	**Mitigating Measure**	**Location**	**Timeline, including frequency, start and end date**	**Responsibility**[ND1] [ND2]

Health risks related to Covid-19 pandemic and its impact on: *- Working arrangements* *- Restrictions on face-to-face meetings* *- National and international travel restrictions* *- Government priorities shift* *-*	*The project will fully consider the negative implications of COVID-19 and identify the most appropriate ways to conduct implementation by using safety measures and preventive precautionary procedures. Such as organizing virtual meetings and trainings where face-to-face meetings bear health risks. The project team will be in continuous consultations with the governmental project stakeholders on how COVID-19 could impact the implementation of project activities and additional challenges that may subsequently arise due to the national pandemic restrictions. That would be pinned in the project schedule to accommodate to the prolongation of activities implementation and mobilization challenges during the pandemic period. See UNIDO?s COVID-19 Response for further details.*	*Global*	Continuously during project implementation	PEE (EECO)/PMU

Generation and insufficient treatment of wastes in construction phase of pilot demonstration	Project designed to reduce waste generation Implementation of wastes collectors and evacuation of wastes to adapted treatment sites	Pilot demonstration sites	At project design Occasionally during pilot demonstration implementation, and more specifically at the end of works	PEE (EECO), NSTDA, Municipality and/or pilot demonstration partners
Air pollution (health risk) to workers and population in construction phase of pilot demonstration	- Adapted working hours, for air polluting activities - Installation of collective protection equipment, such as barriers Installation of individual protection equipment: masks	Pilot demonstration sites	Occasionally during pilot demonstration implementation,	PEE (EECO), NSTDA, Municipality and/or pilot demonstration partners
Noise pollution (health risk) to workers and population in construction phase of pilot demonstration	- adapted working hours, for noisy activities, if the noise is higher than 50dB - ear protection for workers - The noise should not be higher than 85dB	Pilot demonstration sites	Occasionally during pilot demonstration implementation	PEE (EECO), NSTDA, Municipality and/or pilot demonstration partners
Accidents in construction and operational phase of pilot demonstration	- Installation of collective protection equipment, such as barriers - Installation of individual protection equipment: helmet, safety shoes	Pilot demonstration sites	Continuously during pilot demonstration implementation	PEE (EECO), NSTDA, Municipality and/or pilot demonstration partners

Land use in Construction and operational phase of pilot demonstration	- The technical studies of pilot project will favour implementation with no or limited land use change (roofs, carports, sterile lands?)	Pilot demonstration sites	Ongoing, during pilot demonstration implementation and lifetime	Engineering office, Municipality
Disturbance to traffic and difficulties to access risks	- The design studies and specification of pilot demonstration will include mitigating measures (specific to each site). The works within municipalities will be design to avoid difficulties to access local services.	Pilot demonstration sites	Intermittently during pilot demonstration implementation and possibly lifetime	Engineering office, Municipality

Health risks from technological risks associated with EV (electroshock, fire in certain situations such as accidents?)	Even though the project will not directly procure equipment, technical assistance will be provided for the demonstration project (e.g., procurement plan, feasibility studies) and will consider equipment safety and quality certificates guided by UNIDO procurement policies and the best international experience on construction and operation as well as national regulations. The trainings on operating and maintenance of EVs will include health and safety measures (e.g., electrical safety).	Thailand	Continuously during project implementation	PEE (EECO) and TGO regarding regulation (component 1). PEE (EECO) and training organisation regarding trainings (component 3)

Climate change risks - Infrastructure developed is vulnerable to climate risks.	*The climate induced risks will be mitigated especially those related to charging infrastructure by ensuring that this infrastructure meets current international standards (see Component 2) and ? where applicable ? contracting will also include a clause on resilience to climate impacts.* *Project planning decisions, project design, and construction methods will take into account on-site implications of these climate hazards (drought, extreme heat, floods, etc. ? please see Section 6 for additional climate risks). The risks associated with climate change include extreme weather conditions, which will be addressed by ensuring that any infrastructure investment supported by the project is climate-proofed/resilient. For instance, the location of technologies (e.g., charging stations) will take into consideration flood risks.*	*Thailand*	Continuously during project implementation	PEE (EECO)/PMU

Environmental impact from disposal of EV?s batteries	*Environmental laws and regulations can mitigate the environmental effects from EV?s batteries.* *The project components address the problem of sustainability considering local ecosystems, so the realization of the project should effectively decrease the risk of environmental change.*	*Thailand*	*During and after the project?s implementation*	PEE (EECO)/PMU

Potential adverse impacts of the intervention on women, e.g. due to an inequitable access to project benefits.	This risk will be mitigated through specifically targeting women involved in the sector for participation in consultations on policy improvements under Component 1, and for safety and other considerations under Component 2. Disaggregated data on gender participation will be collected at all meetings and other events related to the project, and targeted invitations will be made for enhanced female participation as needed. The project will follow thorough gender responsive communication and ensure stakeholder involvement at all levels, with special regard to involving women and men, as well as civil society and non-governmental organizations promoting gender equality. The project team will collect and compile qualitative and quantitative gender-disaggregated data from the industries and from authorities along project implementation	Thailand	Continuously during project implementation	PEE (EECO)/PMU

Low representation/participation from women in positions of power and influence on the transport policy; inadequate engagement from women or missing qualified female technicians from the STEM sector. *See Project?s Gender Plan for Electric Mobility.*	*This risk will be mitigated through specifically targeting women involved in the sector for participation in consultations on policy improvements under Component 1, and for safety and other considerations under Component 2.* *Disaggregated data on gender participation will be collected at all meetings and other events related to the project, and targeted invitations will be made for enhanced female participation as needed. The project will follow thorough gender responsive communication and ensure stakeholder involvement at all levels, with special regard to involving women and men, as well as civil society and non-governmental organizations promoting gender equality.* *The project team will collect and compile qualitative and quantitative gender-disaggregated data from the industries and from authorities along project*	*Thailand*	Continuously during project implementation	PEE (EECO)/PMU

The project promotes the shift to e-mobility however adding new cars on the roads can have the risk of contributing to traffic congestion in cities as well as have impacts on electricity demand.	*Under Component 1, the project will support policies prioritizing public transport as well as replacing polluting fossil fuel cars with EVs*	*Thailand*	Continuously during project implementation	PEE (EECO)/PMU

Supporting Documents

Upload available ESS supporting documents.

Title	Module	Submitted
10681_ESMP_Thailand_v7_final	**CEO Endorsement ESS**	
Thailand GHG calculations	**Project PIF ESS**	
Theory of Change	**Project PIF ESS**	
UNIDO_ESSPP_Thailand_180285_signed	**Project PIF ESS**	

ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found).

Project Strategy	Objectively verifiable indicators (quantified)	Baseline	Target at End of Project	Sources of verification	Global Programme Indicator
PROJECT OBJECTIVE: To mitigate greenhouse gas emissions from the transportation sector by addressing barriers to the adoption and scale-up of electric mobility in Thailand through enhancing policy and regulatory framework, technology demonstrations in Thailand's Eastern Economic Corridor, and capacity building and knowledge sharing.	Direct GHG emissions reduced from integration of EVs with RE and from scale-up of EV use beyond business as usual, based on the project demos (tons CO2)	0	Direct: 14,083 tCO2e Direct secondary: 1,426,731 tCO2e	Demo monitoring report	
	Indirect GHG emissions reduced from integration of EVs with RE and from scale-up of EV use beyond business as usual, based on replication of the project demos (tons CO2)	0	Indirect: 3,336,936 tCO2e	Records of replication in other cities and original demo city	
	Amount of RE used to charge EVs in Thailand (both direct via project demos and indirect via replication of demos) (MW)	0	1.3 MW installed	Demo monitoring report Records of replication in other cities and original demo city	
	Energy saved in Thailand (both direct via project demos and indirect via replication of demos)	0	TBD	Demo monitoring report Records of replication in other cities and original demo city	

	Number of direct beneficiaries disaggregated by gender as co-benefits of GEF investment	0	Women: 16,445 Men: 16,447	Monitoring report	
Project Component 1: Improve policy and regulatory framework for electric mobility and sustainable use of batteries					
OUTCOME 1.1 National policy and regulatory framework for electric mobility and sustainable use of batteries enhanced in a gender-responsive manner	Number of incentive policies, amendments or roadmaps related to EV-RE integration and life cycle solutions to electric mobility (including sustainable use of batteries) approved or under current active review with high potential for approval at the ministerial level for entry into the policy pipeline	0	5	Documentation of ministerial level approval of policies or amendments for entry into the policy pipeline	
Output 1.1.1 Analysis, forecast and management system for GHG emissions in public transport sector developed	Number of management system for GHG emissions in public EV transport developed.	0	1	Documentation and demonstration of functioning management system for GHG emissions in public EV transport	
Output 1.1.2 Policy and regulatory framework for EV Ecosystem development enhanced	Number of financial/non-financial incentives approved or under current active review with high potential for approval at the ministerial level for entry into the policy pipeline	0	2	Project records on official submissions of proposed policies to government	National Electric Vehicle Policy Committee endorses a policy to promote low-carbon electric mobility

Output 1.1.3 Policy and regulatory framework for charging infrastructure integrated with renewable energy systems developed	Number of regulations and policies to enable the integrated e-mobility and renewable energy approved or under current active review with high potential for approval at the ministerial level for entry into the policy pipeline	0	1	Project records on official submissions of proposed policies to government	National Electric Vehicle Policy Committee endorses a policy to promote low-carbon electric mobility
	Number of roadmaps to enable the integrated e-mobility and renewable energy approved or under current active review with high potential for approval at the ministerial level for entry into the policy pipeline	0	1	Project records on official submissions of proposed policies to government	National Electric Vehicle Policy Committee endorses a policy to promote low-carbon electric mobility
Output 1.1.4 Policy and regulatory framework for addressing life-cycle issues for electric mobility and sustainable use of batteries enhanced	Number of regulations and policies targeting addressing life-cycle issues for electric mobility and sustainable use of batteries approved or under current active review with high potential for approval at the ministerial level for entry into the policy pipeline	0	1	Project records on official submissions of proposed policies to government	National Electric Vehicle Policy Committee endorses a policy to promote low-carbon electric mobility
Project Component 2: Accelerate technology adoption of electric mobility and sustainable use of batteries					

Outcome 2.1 National business sector ecosystem for electric vehicle entrepreneurships enhanced	Number of support programmes established to support entrepreneurs working on electric mobility	0	1	Project monitoring report on establishment of support programme	
Output 2.1.1 Entrepreneurship support program for electric mobility solutions developed	Number of entrepreneurs that receive support	0	50	Project monitoring report on establishment of support programme	
	Proportion of participants in the support program that are women	n/a	At least 40% of participants	Project monitoring report on establishment of support programme	
	# of activities targeted to foster gender equality and women?s empowerment in the e-mobility sector	0	2	Project monitoring report on establishment of support programme List of mentors for women List of women entrepreneurs/ women led companies that received support	
Outcome 2.2 Investment in electric vehicles and electric vehicle supply equipment integrated with renewable energy deployment and in addressing life-cycle issues for electric vehicle batteries in EEC	Number of electric songthaews demonstrated as alternative to diesel songthaews	0	10	Project monitoring report on demonstration of electric songthaews and scale-up aspects of project demo	Global Programme Indicator 3.2 Thailand generates evidence of the technical, financial and/or environmental benefits of low-carbon electric mobility

	Number of electric public mini buses demonstrated	0	15	Project monitoring report on demonstration of electric miniubuses and scale-up aspects of project demo	Global Programme Indicator 3.2 Thailand generates evidence of the technical, financial and/or environmental benefits of low-carbon electric mobility
Output 2.2.1 Electric vehicles for public transport demonstrated	Number of electric songthaews and mini buses for public transport demonstrated	0	25	Project monitoring report on demonstration of electric songthaews and minibuses and scale-up aspects of project demo	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project
Output 2.2.2 **Charging systems integrated with renewable energy systems and battery storage demonstrated**	Number of total RE integrated charging capacity installed (MW)	0	1.3 MW	Project monitoring reports assessing EV integration with power grid demo results and scale-up aspects of project demo	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project

Output 2.2.3 Application of data to support planning and management of charging infrastructure, electric vehicle fleets, and GHG emissions reduction demonstrated	Number of areas in which EV integration with power grid demo data and information on experience is collected, assessed, and reported with recommendations	0	1	Project monitoring reports assessing data application for charging infrastructure demo results and scale-up aspects of project demo	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project
	Number of cases of analyzing and applying data to support planning and management of charging infrastructure, and GHG emissions reduction demonstrated	0	1	Project monitoring reports assessing data application to support planning and management of charging infrastructure, and GHG emissions reduction	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project
	Number of mobile applications developed to support planning and management of public fleets of electric songthaews and minibuses and charging schedules	0	1	Project monitoring reports assessing data application to support planning and management of public fleets of electric songthaews and minibuses and charging schedules	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project

Output 2.2.4 Integration of circular economy principles in the life cycle of electric vehicle batteries (e.g., the application of second life batteries) demonstrated	Number of sites of demonstration of EV charging station with renewable energy and use of second life batteries with around 150 kWh battery system capacity for stationary applications	0	2	Project monitoring reports assessing demonstration of EV charging station with renewable energy and use of second life batteries demo results and scale-up aspects of project demo	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project
	Number of guidelines for life-cycle management of electric vehicle batteries developed	0	1	Project monitoring reports assessing demonstration of EV charging station with renewable energy and use of second life batteries demo results and scale-up aspects of project demo	Rayong takes a position on the technical, economic and environmental viability of low-carbon electric mobility based on the evidence generated through the in-country demonstration project
Component 3: Capacity building, up-scaling and knowledge sharing					
Outcome 3.1 Capacity development and knowledge exchange on lessons learned scaled-up to national, regional and global networks	# of policy makers and private sector actors trained	0	100 (At least 40% women)	? List of participants (gender disaggregated)	

	Number of documents of knowledge, lessons learned, best practices, and solutions based on the EV demonstrations in Rayong and the EEC area for sharing produced	0	5	? Documents of knowledge, lessons learned, best practices, and solutions based on the EV demonstrations in Rayong and the EEC area	
Output 3.1.1 Existing knowledge-exchange platforms and mechanisms strengthened with key national stakeholders and women engagement based on lessons learned from the EEC	# of national events organized and participated on electric mobility, sustainable battery usage and life-cycle solutions to electric mobility	0	4	? List of participants (gender disaggregated) ? Minutes of Meeting ? Event Reports	
	Proportion of attendees that are women	n/a	At least 40%	? List of participants (gender disaggregated)	
	Number of organizing online seminars, attending online seminars, and dissemination of lessons learned from the project in an international event	0	4	? List of participants (gender disaggregated) ? Event Reports	
Output 3.1.2 Linkages created with regional and global platforms on electric mobility as part of the Global Electric Mobility Program.	Annual participation in knowledge and best practice sharing through regular exchange of global, regional and national experiences through the Global Programme.	0	5	? List of participants (gender disaggregated) ? Minutes of Meeting ? Event Reports	National Electric Vehicle Policy Committee members used services and knowledge products offered by regional and global platforms
	Proportion of attendees that are women	n/a	At least 40%	? List of participants (gender disaggregated)	

Output 3.1.3 Training sessions for public and private sector on life cycle solutions for EVs and sustainable use of batteries taking into account gender equality and women empowerment	Number of manuals and trainings developed and delivered for public and private sector	0	5	? Training material ? Meeting minutes ? List of participants (gender disaggregated)	
	Proportion of attendees that are women	n/a	At least 40%	? List of participants (gender disaggregated)	
Project Component 4: Monitoring and evaluation					
OUTCOME 4.1 **Adequate monitoring of all project indicators**	Adequate monitoring of all project indicators in line with GEF, UNIDO and Government of Thailand requirements through PIRs, mid-term project review and project terminal evaluation	0	5	? Progress reports (PIRs) ? Mid-term project review ? Project terminal evaluation The data below is collected during the project for all activities: ? # and proportion (%) of women participated in capacity-building, workshops and events ? # and proportion (%) of women employed by project office at a professional level and jobs created (gender-aggregated) ? All the progress reports include the progress on the implementation of the gender mainstreaming action plan.	

Output 4.1.1 Monitoring and mid-term project review	? Annual project implementation reports (PIR) developed and submitted to the GEF including progress on gender mainstreaming and action plan	0	5	? Annual PIRs	
	? Mid-term project review conducted	0	1	? Mid-term project review (MTR) document	
Output 4.1.2 Project terminal evaluation	? Independent project terminal evaluation conducted	0	1	? Project terminal evaluation	

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF).

GEF Secretariat comment at PIF approval	UNIDO Response

United States Comments ? We are supportive of the aims of this project, but are concerned about the management strategies. There are many potential risks to the successful implementation of this proposal, and we are concerned that the level of risk mitigation does not adequately match the level of risk. ? Our domestic reviewers appreciate the acknowledgement of a potential lack of local capacity to execute the project according to the relevant UNIDO and GEF policies, and that could pose a risk to the success of the project. However, the sole recommendation of an external assessment did not seem like a sufficient response to this risk. Further development of these strategies would be welcome in the next iteration of this proposal. This project requires sufficient capacity to develop and scale renewable energy systems for charging infrastructure. These facilities and infrastructure take time to build, and the PIF does not satisfactorily address these needs and timelines.	Please provide response here An external assessment of the Project Execution Entity was completed and a Project Execution Agreement has been developed with measures in place to address any identified risks or gaps. While the external assessment has been completed in line with relevant UNIDO and GEF policies and found the risk level to be low, the project delivery partners have also been actively engaged in the project?s design with the support of national and international experts to ensure identified risks are mitigated, including local capacity. In co-developing the project, the project delivery partners have communicated what they can deliver on. The project is also building linkages with the GEF global programme which will additionally support capacity building activities from a global and regional perspective. A detailed investment plan has been developed to outline the demonstration aspects of renewable energy systems for charging infrastructure. This includes developing capacity around the demonstrations activities, particularly as they relate to renewable energy systems and charging infrastructure.

Germany Comments Germany approves the following PIF in the work program but asks that the following comments are taken into account: <u>Suggestions for improvements to be made during the drafting of the final project proposal:</u> ? The full proposal should lay out in more detail and referring to concrete suggestions how in particular the Project Outputs 1 and Outputs 2 are to be achieved. This should also be reflected in the project?s theory of change. ? More detail should be added on how the integration of electric mobility with the (renewable) energy system is to be achieved, taking into account main systemic shortcomings as well as potentials on both supply and demand side, i.e. with regard to electric vehicles (batterie and charging) state-of-the-practice technology capabilities as well as grid provision and management requirements. ? Financial and non-financial incentives created for uptake of electric public and private fleets (Output 1.1.3) should be further specified or exemplified as to the	Please provide response here How the Project Outputs 1 and 2 will be achieved have now been elaborated much more in the full proposal. (see page 34-49 of the project document) In order to address how the integration of electric mobility with renewable energy systems will be achieved, an economic feasibility of integrating PV systems with chargers at EV charging stations is analyzed. Sensitivity analysis of key parameters including the number of operation hours per day, and the charging electricity price is also conducted. The results show that the number of operation hours should be at least 8 hours per day, in order to make it more economically feasible to install PV systems (with some subsidy) integrated with chargers than to have no PV systems, and the charging price should be at least 4 Baht/kWh in order to get a low payback period (less than 10 years) without high charging demand (high operation hours). Thus, in the first years, the project will select to support the costs of PV systems for chargers that are with high charging demand (high operation hours) in Rayong (i.e., chargers dedicated mainly for electric songthaews and minibuses which will be demonstrated). Based on technical data collected and technical design of the number of chargers required for electric songthaews and minibuses which will be demonstrated, chargers will be efficiently used with high charging demand (high operation hours per day). In the later years, when there are more electric vehicles in Rayong, the project will then support the cost of PV systems for public charging operators (e.g., Bangchak and PEA Volta) with high charging demand. And in the last years of the project, when there are even more electric vehicles in Rayong and even high charging demand, the project will not support the costs of PV systems for public charging operators, but expect these operators to invest in installing PV systems to be connected with their chargers on their own. Three specific activities have been identified under this output to address different specific target group (both supply and demand sides). The first activity is to develop financial and non-financial incentives for public/private fleets (targeting fleet operators). The second activity is to develop financial and non-financial incentives for private owners (targeting private users). The third activity is to develop policy, instruments, and regulations to enhance/facilitate EV manufacturers and supply chain (targeting private sector). These different target groups will need different types of incentives, and policy design (e.g., policy incentives, or regulations amendment). Three specific activities have also been identified under this

ANNEX C: Status of Utilization of Project Preparation Grant (PPG). (Provide detailed funding amount of the PPG activities financing status in the table below:

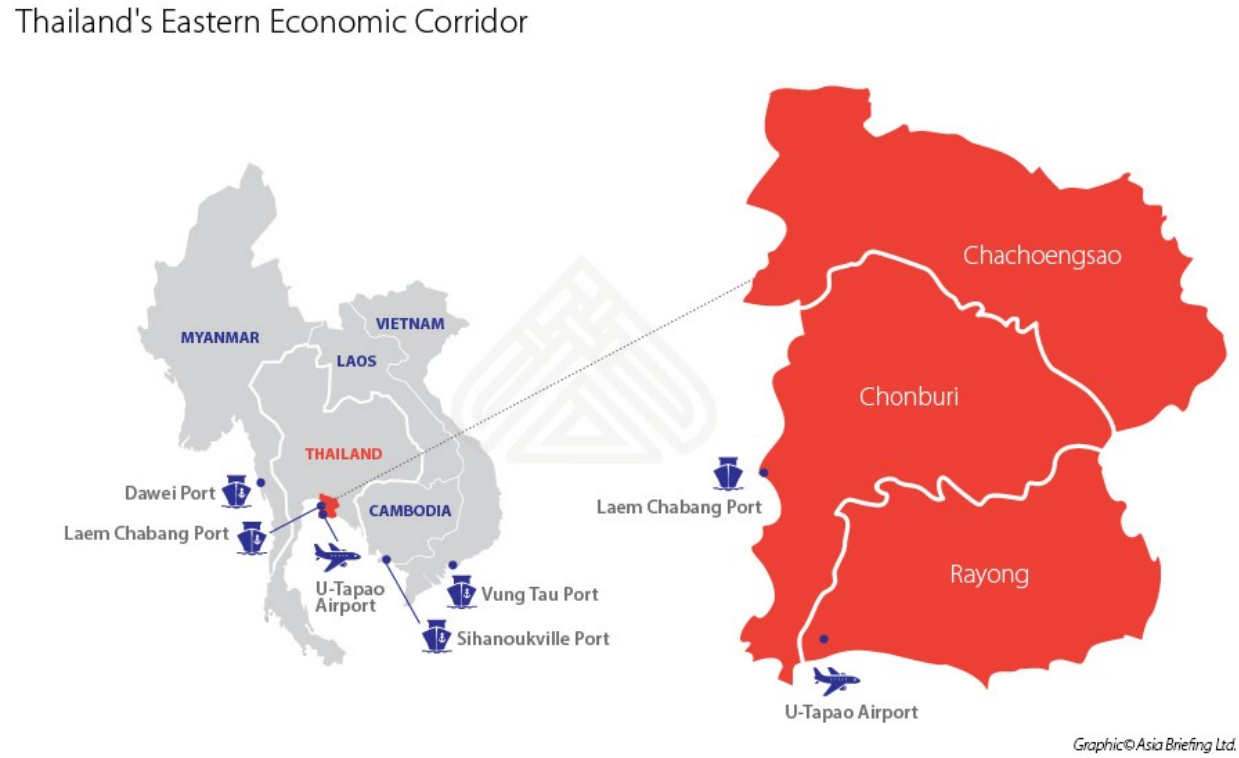
Project Preparation Activities Implemented	*GETF/LDCF/SCCF Amount ($)*		
	Budgeted Amount	*Amount Spent To date*	*Amount Committed*
International consultants	*20,000*	*5,415,04*	*14,584.96*
Local travel	17,000	1,478.26	15,521.74
National consultant	35,000	53,996.40	-18,996.40
Contractual services	15,000	10,028.72	4,971.28
International meetings	10,000	0	10,000
Other direct costs	3,000	8,677.49	-5,677.49
Total	100,000	79,595.91	20,404.09

[1] Remaining funds will support ongoing stakeholder engagement between PPG and start of project implementation.

ANNEX D: Project Map(s) and Coordinates

Please attach the geographical location of the project area, if possible.

Coordinates: Chon Buri 13.3611? N, 100.9847? E; Rayong 12.7074? N, 101.1474? E; Chachoengsao 13.6904? N, 101.0780? E



ANNEX E: Project Budget Table

Please attach a project budget table.

Activity No	Activity	Budget
Activity 1.1.1.1	Complete an analysis/calculation of total current GHG emissions in the public transport sector in Thailand.	38,639
Activity 1.1.1.2	Complete a forecast of total GHG emissions in the public transport sector and total GHG emission reductions due to the increased use of	67,968
Activity 1.1.1.3	Develop a monitoring system or platform of public EV transport to support the GHG reduction by a certain percentage in 2030	188,696
Activity 1.1.2.1	Develop financial and non-financial incentives / measures for supporting the increased use of EV	107,188
Activity 1.1.3.1	Develop financial and non-financial incentives for RE-powered charging infrastructure (charging point operators)	47,806
Activity 1.1.3.2	Develop a 2022-2030 roadmap/plan for establishing RE-integrated charging infrastructure	59,382
Activity 1.1.4.1	Develop a standard for handling used EV batteries/ a comprehensive life-cycle regulation on EV batteries / a guideline for low-carbon labelling of EV batteries	180,321
Activity 2.1.1.1	Supporting local manufacturer(s) to develop electric songthaew prototype.	250,000
Activity 2.1.1.2	Supporting potential entrepreneurs to develop maintenance service centers for electric	67,000
Activity 2.1.1.3	Supporting operators of songthaews and minibuses for public transport to adopt electric	20,000
Activity 2.1.1.4	Supporting operators of EV charging stations to integrate PV systems with their chargers.	20,000
Activity 2.2.1.1	Research and development of electric songthaews	250,000
Activity 2.2.1.2	Field tests and demonstration of the use and operation of electric songthaew prototypes	130,000
Activity 2.2.1.3	Demonstration of the use and operation of electric songthaews	53,000
Activity 2.2.1.4	Demonstration of the use and operation of electric minibuses	20,000
Activity 2.2.2.1	Demonstration of the use and operation of charging systems integrated with PV systems for	100,000
Activity 2.2.2.2	Demonstration of the use and operation of charging systems integrated with PV systems for electric minibuses	320,000
Activity 2.2.2.3	Demonstration of the use and operation of public charging systems integrated with PV systems for public use of any electric vehicles	250,000
Activity 2.2.3.1	Analyzing and applying data to support planning and management of charging infrastructure, and GHG emissions reduction	30,000
Activity 2.2.3.2	Developing mobile applications to support planning and management of fleets of electric songthaews and minibuses and charging schedules	50,000
Activity 2.2.4.1	Demonstration of the use of second life batteries for stationary applications	162,000
Activity 2.2.4.2	Development of a guideline for life-cycle management of electric vehicle batteries	60,000
Activity 3.1.1.1	Producing documents of knowledge, lessons learned, best practices, and solutions based on the EV demonstrations in Rayong and the EEC area for sharing	30,000
Activity 3.1.1.2	Sharing knowledge and lessons learned at national workshops/meetings	20,000
Activity 3.1.2.1*	Sharing knowledge and lessons learned	50,000
Activity 3.1.3.1	Manuals and trainings developed and delivered	100,000
Activity 4.1.1.1	Conduct an independent mid-term project review	42,729
Activity 4.1.2.1	Conduct an independent terminal project evaluation at the end of the project	60,000
	Sub-total	2,774,729
PMU	Project Management Unit	138,736
	Total	2,913,465

Output	Budget
1.1.1 Analysis, forecast and management system for GHG emissions in the	295,303
1.1.2 Policy and regulatory framework for EV ecosystem development	107,188
1.1.3 Policy and regulatory framework for charging infrastructure integrated	107,188
1.1.4 Policy and regulatory framework for addressing life-cycle issues for electric mobility and sustainable	180,321
2.1.1 Entrepreneurship support program for electric mobility solutions	357,000
2.2.1 Electric vehicles for public transport demonstrated	453,000
2.2.2 Charging systems integrated with renewable energy systems, and battery storage demonstrated	670,000
2.2.3 Applications of data to support planning and management of charging	80,000
2.2.4 The integration of circular economy	222,000
3.1.1 Existing knowledge-exchange platforms and	50,000
3.1.2 Linkages created with regional and global	50,000
3.1.3 Training sessions for public and private sector on life-cycle solutions for	100,000
4.1.1 Monitoring and independent mid-term	42,729
4.1.2 Independent terminal evaluation	60,000
PMC	138,736
Total	2,913,465

Component	Budget	Cofinancing
1- Policy	690,000	1,361,818
2- Demonstration /	1,782,000	13,583,000
3- Capacity building	200,000	1,392,000
4- M&E	102,729	120,000
PMC	138,736	860,900
Total	2,913,465	17,317,718

Entity	Entity	YEARS 1-5 BUDGET
EECO	Execution and monitoring	2,810,736
UNIDO	MTR and TE under Component	102,729
	Total	2,913,465

This is a summary of the budget. For the entire table, please refer to the annex uploaded to the submission.

ANNEX F: (For NGI only) Termsheet

Instructions. Please submit an finalized termsheet in this section. The NGI Program Call for Proposals provided a template in Annex A of the Call for Proposals that can be used by the Agency. Agencies can use their own termsheets but must add sections on Currency Risk, Co-financing Ratio and Financial Additionality as defined in the template provided in Annex A of the Call for proposals. Termsheets submitted at CEO endorsement stage should include final terms and conditions of the financing.

Not relevant

ANNEX G: (For NGI only) Reflows

Instructions. Please submit a reflows table as provided in Annex B of the NGI Program Call for Proposals and the Trustee excel sheet for reflows (as provided by the Secretariat

or the Trustee) in the Document Section of the CEO endorsement. The Agencys is required to quantify any expected financial return/gains/interests earned on non-grant instruments that will be transferred to the GEF Trust Fund as noted in the Guidelines on the Project and Program Cycle Policy. Partner Agencies will be required to comply with the reflows procedures established in their respective Financial Procedures Agreement with the GEF Trustee. Agencies are welcomed to provide assumptions that explain expected financial reflow schedules.

Not relevant

ANNEX H: (For NGI only) Agency Capacity to generate reflows

Instructions. The GEF Agency submitting the CEO endorsement request is required to respond to any questions raised as part of the PIF review process that required clarifications on the Agency Capacity to manage reflows. This Annex seeks to demonstrate Agencies? capacity and eligibility to administer NGI resources as established in the Guidelines on the Project and Program Cycle Policy, GEF/C.52/Inf.06/Rev.01, June 9, 2017 (Annex 5).

Not relevant