THAILAND'S

LONG-TERM LOW GREENHOUSE GAS EMISSION DEVELOPMENT STRATEGY

(REVISED VERSION)

November 2022

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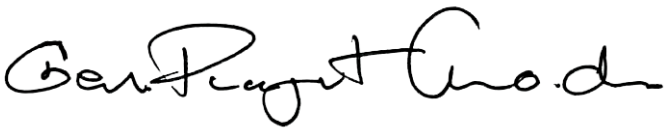
FOREWORD

More and more, Thailand has been experiencing the devastating impacts of climate change through prolonged droughts, unprecedented storms, and floods. In addition, many of our cities situated along the coastline are at risk from sea-level rise, while Bangkok is a sinking megacity. Given this, Thailand has been taking action to avoid the worst impacts of climate change, particularly by fulfilling a voluntary Nationally Appropriate Mitigation Action (NAMA) pledge; strategically implementing a Nationally Determined Contribution (NDC) Roadmap; and continuously building resilience in all sectors of society. The Royal Thai Government has also been collaborating with businesses, city administrations, along with local and international communities to undertake concrete measures to advance climate actions.

At COP 26, Thailand committed to reach carbon neutrality by 2050 and net zero GHG emissions by 2065. Thailand also pledged to enhance the NDC to reduce GHG emissions by 30-40% in 2030 from the previous target of 20-25%, in order to attain carbon neutrality and net zero goals. This revised Long-term low greenhouse gas emissions development strategy (LT-LEDS) lays out climate policies, priorities, and measures that will navigate Thailand towards low GHG emissions and climate-resilient development.

Making an efficient and equitable transition to a net zero economy is a necessary challenge for Thailand, and the Royal Thai Government will work closely with businesses and the international community to accelerate the decarbonization of the Thai economy. It is also a priority to ensure that reaching net zero emissions is fair, and is not counterproductive to balanced economic growth and the security of people's livelihoods. At the same time, this will be an opportunity for Thailand to improve our environment and public health system, and build a better and greener economy through the creation of high-quality jobs.

Thailand is fully committed to systematically making progress through a carbon neutral and net zero path, and looks forward to enhancing international collaboration with all countries and agencies to increase the capabilities of our own institutions. This will come with the development of cost-effective technologies, along with ensuring adequate and accessible financial support for investments in clean businesses and industries. Combatting climate change and reaching net zero emissions is the way forward for a safer, healthier, greener, fairer, and more prosperous future, and I am confident that Thailand's commitment, dedication and collaboration with the international community will make this possible.



H.E. General Prayut Chan-o-cha (Ret.)
Prime Minister of the Kingdom of Thailand

PREFACE

Climate change is an inevitable global challenge that is becoming more dominant in the world today. It has multiple interrelated consequences of both direct and indirect impacts on human health, ecosystem and economic and social systems. With a current population of approximately 70 million, Thailand is highly vulnerable to climate change impact and extreme weather such as floods and droughts that have intensified in scope and scale over time. International solidarity and global collaboration are critical and the only way of responding to this common concern.

Thailand always has prioritized its actions to be part of the solution to fight this climate crisis. We swiftly became a Party to the Paris Agreement as well as submitting our Nationally Determined Contributions. We have submitted our Long-term low emissions development strategy (LT-LEDS) to UNFCCC in 2021. At COP 26, our Prime Minister, General Prayut Chan-O-cha, put forth Thailand's carbon neutrality and net zero visions, including a mission to raise our NDC ambition. Such action not only has put Thailand among the forefront in countries fighting to keep the world below 1.5 degree Celsius, but also has gained enormous support back home where the whole of society offers bold commitments to be part of Thailand's carbon neutrality and net zero emission targets. Subsequently, this has led to the preparation of this revised LT-LEDS in order to put words into a clear plan of action.

This revised LT-LEDS outlines key mitigation actions that Thailand will undertake in striving toward such goals, which represent our continued and enhanced mitigation efforts in various sectors. Making a transition to carbon neutrality and net zero emissions is not easy. Government needs to ensure a transition of both economy and society with a holistic and full integration of all actors and a balanced consideration of economic, social and environmental issues. Adequate and equitable financial, technological and capacity-building support remain key drivers to ensure there is no trade-off between a net zero future, and economic growth and people's sustainable livelihoods. Collaboration and partnership at national, regional and international levels are crucial to help Thailand deliver these targets. We believe that the implementation of this LT-LEDS will catalyze Thailand to grow differently, sustainably and inclusively.

H.E. Mr. Varawut Silpa-archa
Minister of Natural Resources and Environment

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GLOSSARY OF ABBREVIATIONS

AIM	Asia-Pacific Integrated Assessment Model
AIM/CGE	Asia-Pacific Integrated Model/Computable General Equilibrium
ASEAN	The Association of Southeast Asian Nations
BAU	Business-as-usual
BCG	Bio-Circular-Green Economy
BEC	Building energy codes
BECCS	Bio-energy with carbon capture and storage
BEV	Battery electric vehicle
BHD	Bio-hydrogenated diesel
CCS	Carbon capture and storage
CCUS	Carbon capture utilization and storage
CDM	Clean Development Mechanism
CGE	Computable General Equilibrium
CH_4	Methane
CO	Carbon Monoxide
EEC	The Eastern Economic Corridor
EES	Energy storage system
ESCOs	Energy service companies
ESG	Environmental, social, and governance
EV	Electric vehicle
FCEV	Fuel cell electric vehicle
GDP	Gross domestic product
$GgCO_2eq$	Gigagrams of carbon dioxide equivalent
GHG	Greenhouse gas
GW	Gigawatts
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
Ktoe	Kilotonne of oil equivalent
LPG	Liquefied petroleum gas
LT-LEDS	Long-term Low Greenhouse Gas Development Strategy
LULUCF	Land Use, Land-Use Change and Forestry
MSW	Municipal solid waste
$MtCO_2eq$	Million tonnes of carbon dioxide equivalent
MW	Megawatts
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NCCC	National committee on climate change policy
NDC	Nationally Determined Contribution
NEP	National Energy Plan
NESDC	Office of the National Economic and Social Development Council
N_2O	Nitrous Oxide
ONEP	Office of Natural Resources and Environmental Policy and Planning
PV	Photovoltaic
QoQ sa	Quarter on quarter seasonally adjusted
R&D	Research and development
RCP	Representative Concentration Pathways
RDF	Refuse Derived Fuel
REDD+	Reducing Emission from Deforestation and Forest Degradation and role of conservation, sustainable management of forest and enhancement of forest carbon stock
SDGs	Sustainable development goals
Sqm.	Square meter
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
YoY	Year-over-year
ZEV	Zero-emission vehicle

Chapter 1:

INTRODUCTION

Climate change is a global challenge that requires international cooperation and actions. The United Nations Framework Convention on Climate Change (UNFCCC) is a fundamental and most important international framework to address this common concern. As a responsible member of the global community, Thailand became a Party to the UNFCCC in 1994, and subsequently ratified the Kyoto Protocol in 2002 and Paris Agreement in 2016.

The Paris Agreement sets out a long-term temperature goal and underscores the urgency for Parties to play their part to enable global GHG emissions to peak and decline as soon as possible. In accordance with Article 4, paragraph 19, of the Paris Agreement, all Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2, considering their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. The COP, by its decision 1/CP.21, paragraph 35, invited Parties to communicate, by 2020, to the secretariat mid-century, long-term low greenhouse gas emission development strategies in accordance with Article 4, paragraph 19, of the Agreement, and in the lead to COP 26, Thailand submitted its first mid-century, long-term low greenhouse gas emission development strategy. At COP 26, the Glasgow Climate Pact requested that countries "revisit and strengthen" their climate pledges by the end of 2022. To endorse the urgency in intensifying global cooperation to address climate change, Thailand has taken leadership at COP 26 to strengthen its climate pledge and announced the country's ambition to achieve carbon neutrality by 2050 and net zero GHG emission by 2065.

To be in line with Thailand's increased ambition, the country's mid-century, long-term greenhouse gas emission development strategy has been revised in accordance with Thailand's national circumstances (Chapter 2) and through an updated technical analysis (Chapter 3). Stakeholder consultations are carried out domestically to lay out long-term climate mitigation actions in key sectors (Chapter 4). A climate-resilient development pathway is integrated into Thailand's long-term vision (Chapter 5). To achieve the country's long-term vision of climate-resilient and low greenhouse gas development, enabling conditions and partnership building are foreseen as crucial catalysts for transformative actions to result in such a paradigm shift (Chapter 6).

The preparation and approval process of this revised Long-Term Low Greenhouse Gas Emission Development Pathways (LT-LEDS) includes a domestic consultative process among various interministerial working groups and relevant stakeholders with the objective to identify a set of long-term mitigation actions in the energy, transport, IPPU (Industrial Processes and Product Use), waste, agriculture and LULUCF (Land Use, Land Use Change and Forestry) sectors. A national consultation was organized for feedback and discussions on the outcome of the technical study, followed by consideration and approval from the interministerial working group, the subcommittee, the national committee and the cabinet, before submission to the UNFCCC. A similar approval process was undertaken for the preparation of the NAP, which provides a basis for Thailand's Climate-Resilient Development Pathway. This domestic approval process is laid out in Figure 1-1.

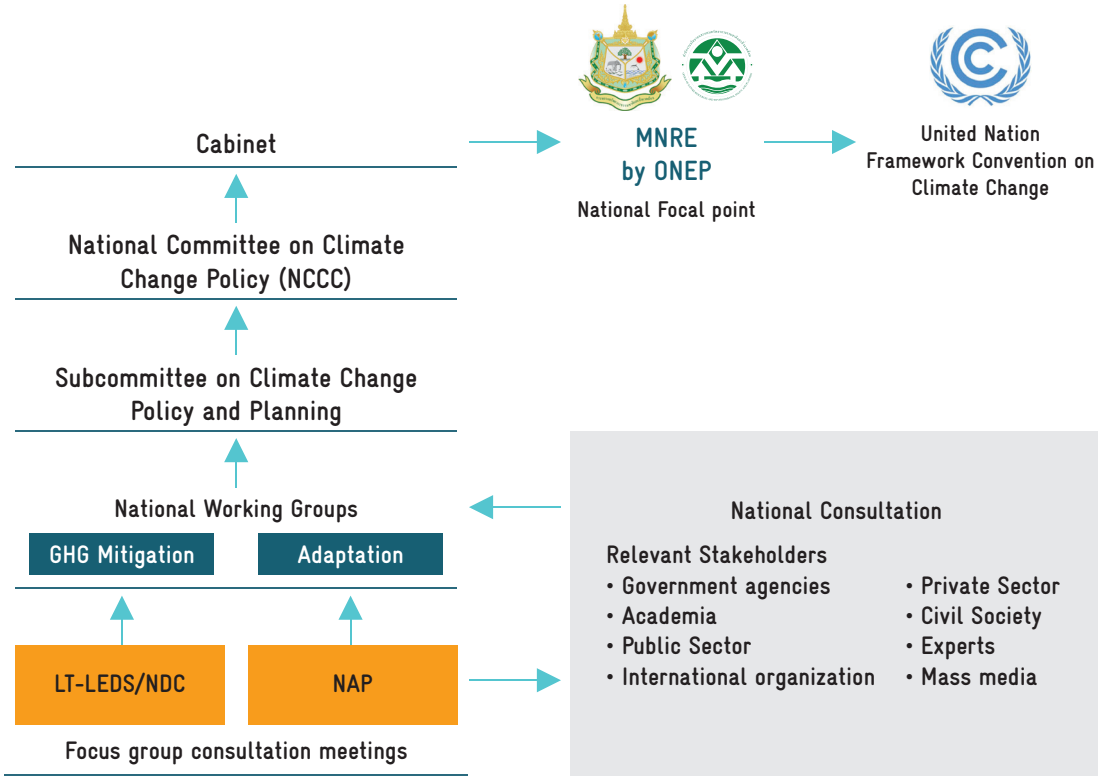


Figure 1-1 Preparation and approval process of Thailand's LT-LEDS/NDC/NAP

The Subcommittee on Climate Change Policy and Planning Integration is responsible for providing input and recommendations on the development and integration of climate change policy, strategy and plan, in relation to both mitigation and adaptation; for providing suggestions on mechanisms and measures, such as legal regulations, and financial measures; and for proposing an integrated budget allocation system on climate change. In the development of Thailand's LT-LEDS, this subcommittee considers and provides suggestions on the draft LT-LEDS document tabled by the Working Group on National GHG Emission Reduction. The other four subcommittees will be informed of the progress of Thailand's LT-LEDS formulation through a consultation process and when it is submitted to the National Committee on Climate Change Policy (NCCC) for consideration.

The NCCC has been established since 2007 as the main decision-making body for climate change management in Thailand. The NCCC is chaired by the Prime Minister and consists of members from relevant government agencies, private sectors, experts, and relevant stakeholders. The NCCC is responsible for consideration and adoption of national climate policies, guidelines and mechanisms for international cooperation, and approval of several internationally funded climate projects and activities.

Chapter 2:

NATIONAL CIRCUMSTANCES

- COUNTRY PROFILE
- GREENHOUSE GAS EMISSION PROFILE

COUNTRY PROFILE

Thailand is located in a tropical area between latitudes N 5°37' to N 20°27' and longitudes E 7°22' to E 105°37', with a total area of 513,115 km^2, or approximately 200,000 mi^2. Thailand has extensive coastline of approximately 3,100 km. Geographically, Thailand can be divided into six regions. The northern region is characterized by hilly and mountainous highland. The north-eastern region is naturally high plain while the central region is a large low-level plain. The eastern region is mostly plains and valleys with some small hills. The southern region is a peninsula with the Andaman Sea on the West and the South China Sea on the East. Lastly, the western region is mainly hilly and mountainous areas.

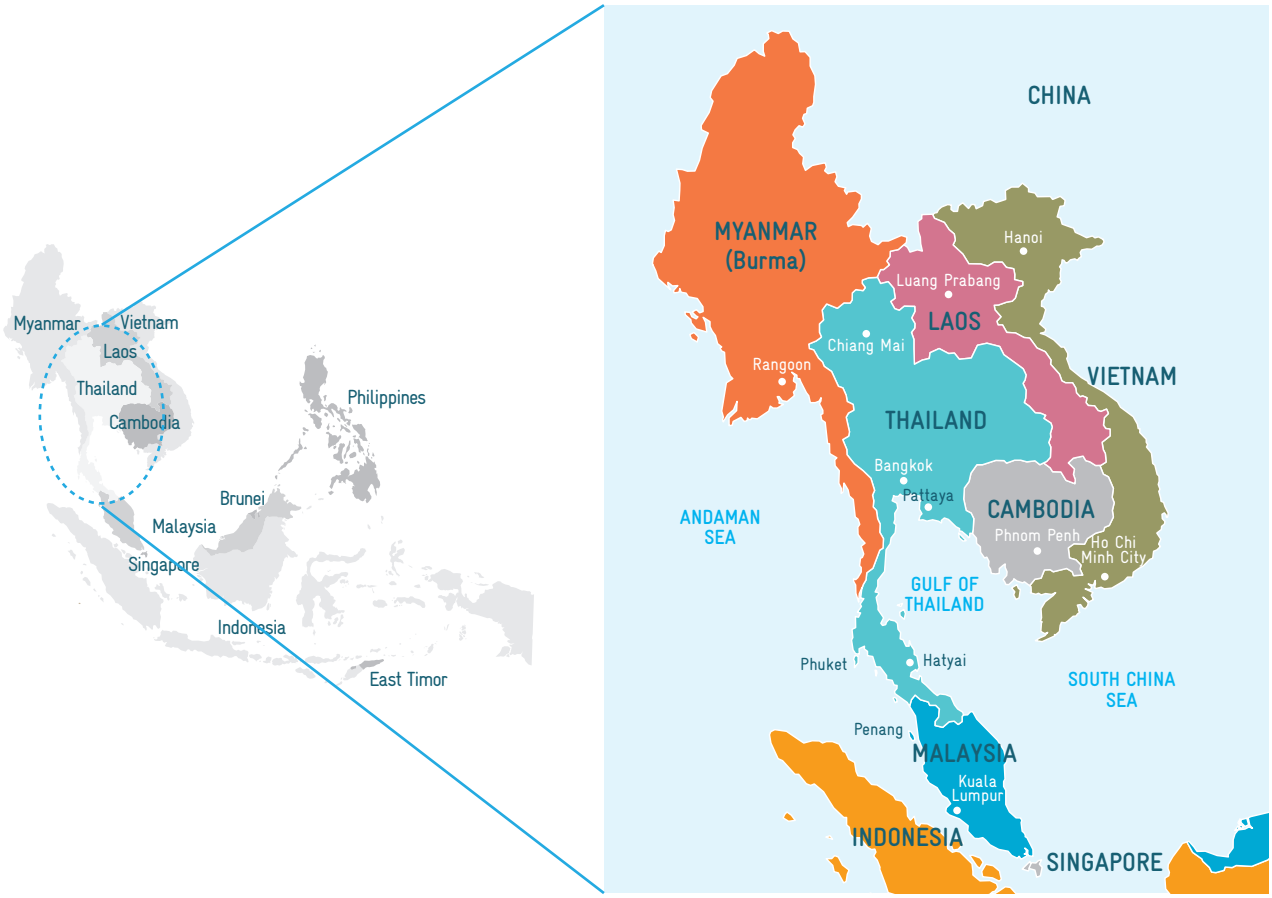


Figure 2-1 Map of Thailand

CLIMATE

Thailand's climate is influenced by two main seasonal monsoon winds, namely the southwest and northeast monsoons. The southwest monsoon begins in May and brings a stream of warm and moist air from the Indian Ocean towards Thailand, causing abundant rainfall over the mainland, especially on the windward side of the mountains. The northeast monsoon begins in October and brings cold and dry air from the anticyclone in the Chinese mainland over major parts of Thailand, particularly in the north and northeast regions. Thailand's climate can be broadly divided into three seasons of (1) rainy, or the southwest monsoon season, from mid-May to mid-October, (2) winter, or the northeast monsoon season, from mid-October to mid-February and (3) summer, from mid-February to mid-May. Figure 2-2 shows the annual mean of maximum temperatures in Thailand, which indicates a trend of increasing temperatures that is likely to continue.

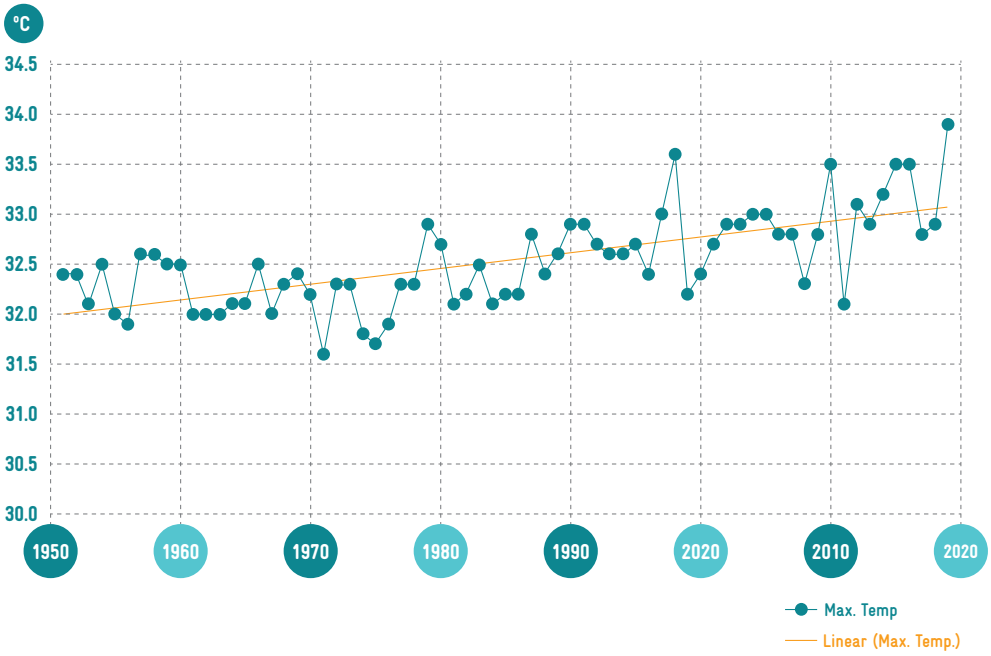


Figure 2-2 Annual mean maximum temperatures in Thailand

POPULATION

Thailand's population is projected to gradually increase and peak around 2030, before starting to decline. Its projected population figures for 2025, 2030 and 2040 are 67.09, 67.14 and 65.37 million, respectively. A decline in birth rate with a concurrent increase in life expectancy has shaped Thailand's population structure into an 'aging society'. By 2040, the aging population will be more than double that of the youth population. This transition is directly linked to the need for care and support of aging members of society while the labor force is shrinking.

ECONOMY

Gross domestic product in 2021 was valued at 16,178,719 million baht (506 billion US dollars), which comprised 8.5% of agriculture, 32.1% of industry, and 59.4% services sector. The value represents an expansion rate of 1.5 percent from 2020 — which was a 6.2 percent decline from 2019 (Information as of August 15th, 2022) — due to the relaxation of COVID-19 containment measures and the release of economic stimulus measures. Consequently, various economic activities have improved from 2020, both in terms of production of goods and services and that of expenditure. Expenditure on GDP covers exports of goods and services, imports of goods and services, gross fixed capital formation, government final consumption expenditure and private final consumption expenditure which have increased by 10.4 percent, 17.9 percent, 3.4 percent, 3.2 percent and 0.3 percent, respectively. As for the production side, the agricultural sector expanded by 1.0 percent. The non-agricultural sector expanded by 1.6 per cent, which was the consequence of the industrial sector expanding by 3.4 percent and the service category expanding by 0.7 percent. Thailand's economy in the second quarter of 2022 expanded by 2.5 percent (%YoY), from a 2.3-percent growth in the previous quarter. Seasonally adjusted, the economy increased by 0.7 percent from the first quarter of 2021(%QoQ sa). In the first half of 2022, the economy grew by 2.4 percent. On the production side, the accommodation and food service activities sector, the wholesale and retail trades sector, and the transportation and storage sector accelerated. On the contrary, the agricultural sector and the electricity, gas, stream, and air conditioning supply sector decelerated while the manufacturing sector and the construction sector decreased. On the expenditure side, private consumption expenditure and export of services increased. Export of goods, government consumption expenditure, and private investment slowed down, while public investment declined[1].

LAND RESOURCES

As of 2018, 46.54% of the total land area (or 238,791 km^2) was categorized as agricultural land. Forest land and non-agricultural land accounted for 31.96% and 21.50% of the total land area, respectively. Nearly half the agricultural land or around 109,949 km^2 (21.43% of total land area), is categorized as paddy land. Protection and conservation of forest is vital to Thailand's socio-economic development, as people and communities in rural and urban areas depend on forest goods and services for the direct provision of food, fuel, building materials, medicines and other resources. Forests are important for the people whose income and livelihood depend on forest products and services, particularly, those living in adjacent areas.

[1] Source: NESDC ECONOMIC REPORT, Thai Economic Performance in Q1 and Outlook for 2022, Office of the National Economic and Social Development Council

ALTERNATIVE ENERGY RESOURCES[2]

SOLAR ENERGY

Thailand has abundant solar energy resources across the country, with high irradiance in the northeast and central parts of the country, or approximately 1/4 of the total land area. The peak density of solar radiation in these areas is in the range of 1,200-1,400 kWh per m^2 per year, with the seasonal peak in April and the low point in December. The expansion of utility-scale solar farms can, however, cause land use conflicts and sometimes displace agricultural areas such as those used for rice, cassava, and sugarcane cultivation. As a response to this challenge, solar floating technologies have been introduced and promoted, while promotion of rooftop solar systems can also increase the solar energy share in urbanized and rapidly urbanizing areas.

BIOENERGY

Thailand has traditionally been an agricultural economy, and agriculture remains important to this day as a large number of registered farmers still live in poor conditions. The government has strong incentives to create opportunities for farmers to diversify their incomes and generate new revenue sources to protect themselves against global food price volatility. Electricity generation and biofuels, i.e., biodiesel and bioethanol production, from biomass, particularly residue or energy crops, is therefore a priority in Thailand. However, the production of electricity and biofuels from dedicated energy crops and its development requires a thorough assessment of the potential risks involved in the competition for land and water resources, which can put pressure on other uses like food crops, livestock farming and forestry, whereas concerns over the guaranteed long-term demand for feedstock must be addressed to sustain the supply. In this light, development of biogas energy is more mature, as major sources of biogas feedstock for biogas production in Thailand are traditionally from agro-industrial waste and wastewater, animal manure, farm waste and municipal solid waste. Future generations of biofuels, such as pyrolysis oil and other advanced liquid biofuels, could have the potential to increase supply without exerting further pressure on land and water use.

WASTE-TO-ENERGY

Municipal solid waste (MSW) management is a national priority. The volume of MSW has been increasing, along with the growing population, improved living standards and expanding tourism industry in Thailand. According to the Pollution Control Department, about 73,560 tons of MSW were generated per day in 2015, representing nearly a 9% increase from 2012, putting pressure on the country's waste management capacities. Waste-to-Energy from MSW will therefore remain a contributing component of Thailand's alternative energy resources, due to its significant environmental co-benefits.

WIND

Thailand has wind potential with an average wind speed of 6 meters per second (m/s) at a height of 90 meters, while technical potential can reach 13 GW in 21 areas across the country. However, the greatest wind potential is geographically located in the northeast, western and southern regions of Thailand, which are generally far away from the loads. Offshore wind potential along the coast of the Gulf of Thailand is estimated at 7 GW, nearly half of which is in the northernmost part of the Gulf of Thailand.

GEOTHERMAL ENERGY

Thailand has very modest geothermal potential in northern Thailand, with a temperature range of 40-60°C, with some spots reaching about 80°C.

[2] IRENA (2017), Renewable Energy Outlook: Thailand, International Renewable Energy Agency, Abu Dhabi.

GREENHOUSE GAS EMISSION PROFILE

OVERVIEW OF HISTORICAL EMISSIONS

Figure 2-3 illustrates the trend of GHG emissions in Thailand. Total GHG emissions (excluding LULUCF) increased from 245,899.56 $GgCO_2eq$ in 2000 to 372,648.77 $GgCO_2eq$ in 2018, with an average annual increase of 2.34%. The net removal of CO_2 increased from 45,443.60 $GgCO_2eq$ in 2000 to 85,968.30 $GgCO_2eq$ in 2018. Therefore, overall net GHG emissions increased from 200,455.96 $GgCO_2eq$ in 2000 to 286,680.47 $GgCO_2eq$ in 2018, with an average annual increase of 2.01%.

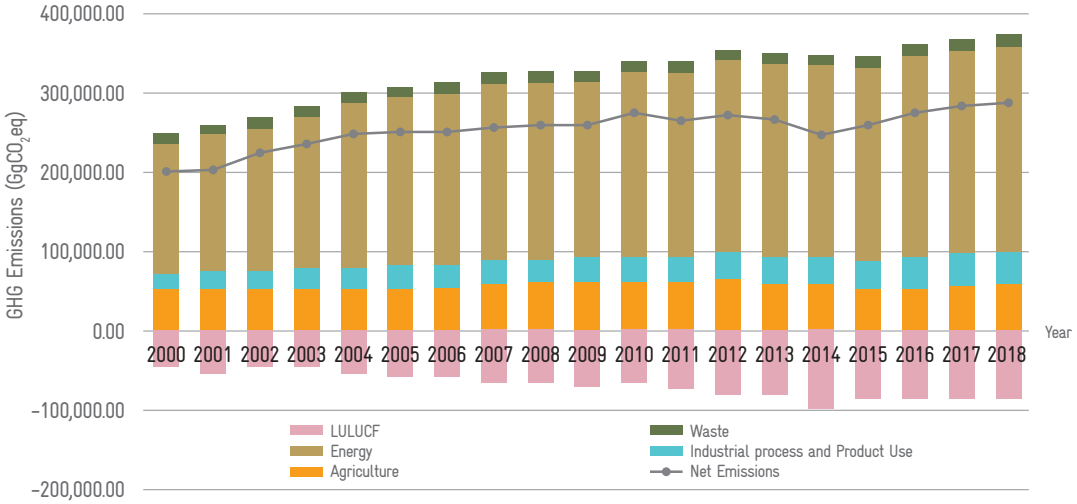


Figure 2-3 Thailand's GHG Emission Trend

Source: Thailand's Fourth National Communication, UNFCCC 2022.

During 2000-2018, the main source of GHG emissions was the energy sector, which saw an increase of 55.88% from 165,092.40 $GgCO_2eq$ in 2000 to 257,340.89 $GgCO_2eq$ in 2018. The energy sector accounted for 67.14% of total emission sources in 2000, which increased to 69.06% in 2018. In the same period, the share of emissions from the agriculture sector decreased from 19.95% in 2000 to 15.69% in 2018, while the share of emissions from the IPPU and waste sectors slightly increased from 4.26% in 2000 to 4.48% in 2018. (See Figure 2-4).

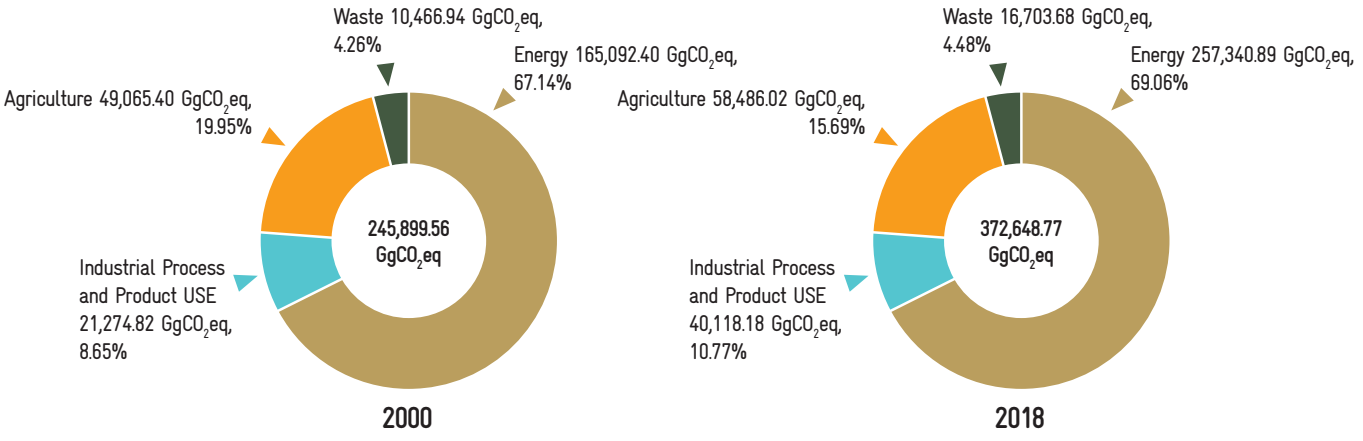


Figure 2-4 Total GHG Emissions by Sector (excluding LULUCF) 2000 and 2018

Source: Thailand's Fourth National Communication, UNFCCC 2022.

2018 EMISSION PROFILE

Total GHG emissions in 2018 (excluding LULUCF) were 372,648.77 $GgCO_2eq$ and net GHG emissions were 286,680.47 $GgCO_2eq$ (including LULUCF). In 2018, the energy sector was the largest contributor to Thailand's GHG emissions, accounting for 69.06% of total GHG emissions, while emissions from the agriculture, IPPU and waste sectors accounted for 15.69%, 10.77% and 4.48%, respectively. The LULUCF sector contributed to a net removal of 85,968.30 $GgCO_2eq$, indicating a trend of increased net removals as total removals exceeded total emissions. In a global perspective, Thailand's GHG emissions represented less than 1% of global emissions and are lower than the world average.

ENERGY

Total direct GHG emissions from the energy sector in 2018 were 257,340.89 $GgCO_2eq$, of which the majority came from fuel combustion, consisting mostly of energy industries at around 103,055.20 $GgCO_2eq$ (40.05%). GHG emissions from transport, manufacturing industries and construction, and other sectors were 75,029.65 $GgCO_2eq$ (29.16%), 52,078.20 $GgCO_2eq$ (20.24%) and 16,884.56 $GgCO_2eq$ (6.56%), respectively. Fugitive emissions from fuel contributed only 10,293.28 $GgCO_2eq$ or just over 4.00% of total GHG emissions in this sector.

INDUSTRIAL PROCESSES AND PRODUCT USE

Total direct GHG emissions from the IPPU sector in 2018 were 40,118.18 $GgCO_2eq$. The majority of GHG emissions in this sector came from mineral production, which accounted for approximately 20,574.46 $GgCO_2eq$ (51.28%), mainly consisting of cement production at 19,361.06 $GgCO_2eq$. GHG emissions from the chemical industry and product uses as substitutes for ozone depleting substances accounted for 13,307.30 $GgCO_2eq$ (33.17%) and 5,347.09 $GgCO_2eq$ (13.33%), respectively. GHG emissions from metal production and non-energy products from fuels, and other product manufacture and use accounted for 2% of total GHG emissions from this sector.

AGRICULTURE

Total GHG emissions from the agriculture sector in 2018 were 58,486.02 $GgCO_2eq$. Livestock contributed 13,115.64 $GgCO_2eq$ (22.43%), comprising 10,052.24 $GgCO_2eq$ from enteric fermentation, and 2,494.12 from direct and 569.27 $GgCO_2eq$ from indirect manure management. Crop-related GHG emissions accounted for 45,370.38 $GgCO_2eq$ (77.57%), of which rice cultivation was the main GHG contributor in Thailand's agriculture sector of approximately 29,990.25 $GgCO_2eq$ (51.28%). Agricultural soils produced approximately 11,974.34 $GgCO_2eq$ (20.47%), with 8,715.01 $GgCO_2eq$ direct and 3,259.34 $GgCO_2eq$ indirect emissions, respectively. Field burning of agricultural residues and urea fertilizer produced 1,706.82 $GgCO_2eq$ and 1,671.38 $GgCO_2eq$ (2.92% and 2.86%), respectively. Liming accounted for 27.59 $GgCO_2eq$ (0.05%).

LAND USE, LAND-USE CHANGE AND FORESTRY

GHG emissions and sinks from LULUCF sector were estimated using the 2006 IPCC Guidelines for three land categories, namely, forest land, cropland and other land. Total CO_2 emissions/removals from carbon (C) stock changes for each land use category was calculated based on the sum of each subcategory, considering three carbon pools of (1) above ground biomass, (2) below ground biomass and (3) dead organic matter (deadwood and litter). LULUCF sector contributed to a net removal of 85,968.30 $GgCO_2eq$, an increase of approximately 47% compared with the year 2000. The net removal estimated for cropland remaining cropland was 68,806.14 $GgCO_2eq$, accounting for almost 80% of the overall net removals of the LULUCF sector.

WASTE

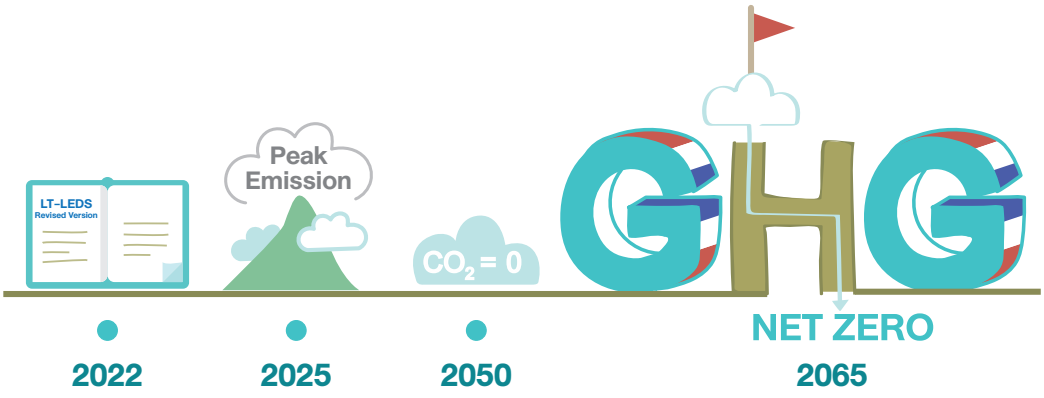
Total direct GHG emissions from the waste sector in 2018 were 16,703.68 $GgCO_2eq$. GHG emissions in this sector mainly came from solid waste disposal of around 8,774.67 $GgCO_2eq$ (52.53%) and wastewater treatment and discharge, at 7,635.72 $GgCO_2eq$ (45.71%). Incineration of waste accounted for 180.54 $GgCO_2eq$ (1.08%) and biological treatment of solid waste contributed 77.72 $GgCO_2eq$ (0.46%).

Considering Thailand's GHG emission profile, the use of energy from fuel combustion and industrial electricity use, including at the household level, is a major source of GHG emissions. In addition, the energy and transport sectors form a basis for low carbon development, such as low-carbon manufacturing industries and services, environmentally and climate-friendly economic structures and sustainable low-carbon cities. Therefore, it is imperative to re-structure energy and transport sectors to be low-carbon and environmentally friendly in order to speed up the carbon neutrality and net zero GHG emission transition. Long-term plans, with clear public benefits such as improved energy security, public health and public transport system are given priority.

Chapter 3:

THAILAND'S CARBON NEUTRALITY AND NET ZERO GREENHOUSE GAS EMISSION PATHWAY

- METHODOLOGY
- THAILAND'S CARBON NEUTRALITY PATHWAY
- THAILAND'S NET ZERO GHG EMISSION PATHWAY
- MACROECONOMIC IMPACT ASSESSMENT



METHODOLOGY

Thailand's carbon neutrality and net zero GHG emission pathway has been developed based on the country's aspiration to contribute to the global efforts to achieve mid-century carbon neutrality and net zero GHG emission, in line with science and the Paris Agreement, and presents a revised pathway incorporating the most up-to-date input data from the current national circumstances and policy directions provided by related ministerial agencies through comprehensive stakeholder consultation process as described in Chapter 1. In terms of methodology, the Asia-Pacific Integrated Model (AIM)/EndUse model is used to quantify climate change assessment and relevant policies to mitigate GHG emissions. To assess the macroeconomic impacts of Thailand's carbon neutrality and net zero GHG scenarios, a multi-sector, dynamic recursive AIM/Computable General Equilibrium (AIM/CGE) model is used. Figure 3-1 represents the framework for this updated Long-Term Low GHG Emission Development Strategy.

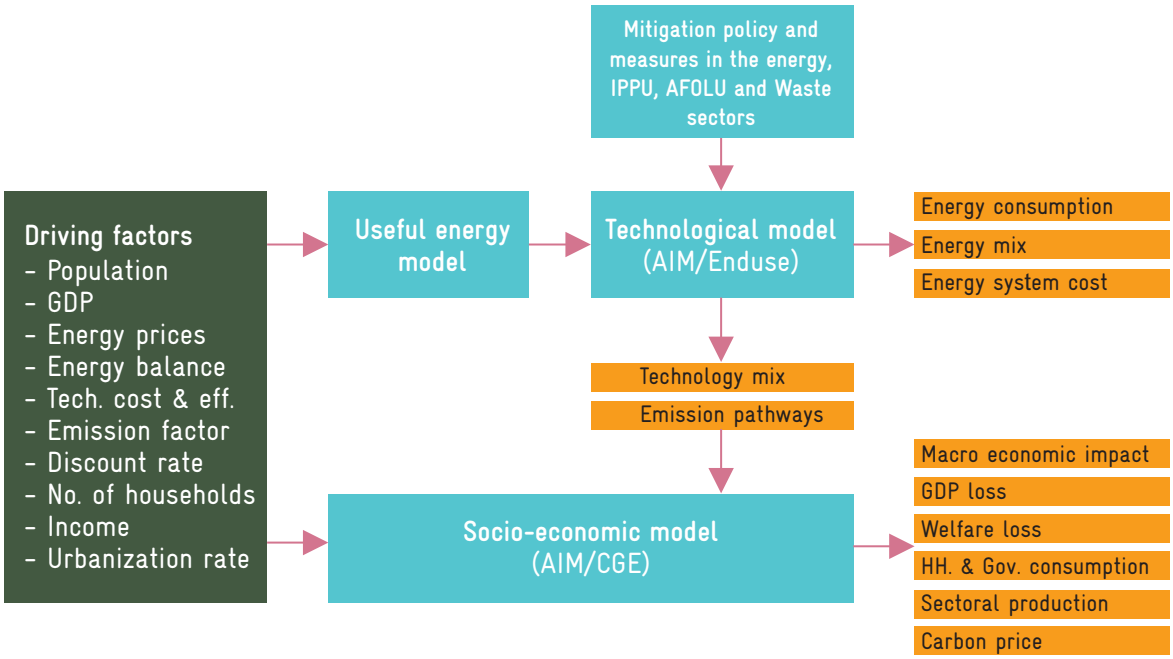


Figure 3-1 Framework of Thailand's LT-LEDS

Thailand's LT-LEDS is modeled in a bottom-up approach with detailed-technology information. The technological selection is based on an optimization framework which minimizes the total system cost subject to various constraints, e.g., the potential of solar, wind and bioenergy used in power generation to satisfy the end-user demand among the economic sectors. In the model, CH_4 and N_2O are converted into CO_2-equivalent emissions by applying the Global Warming Potential (GWP) provided by the IPCC. The CGE model is adopted to assess the economic and environmental impacts of climate policies at the national, and sub-national levels. It is noted that in Thailand's LT-LEDS, CO_2 emissions, CH_4 and N_2O are treated as GHG emissions in the model. The CGE model used for the development of Thailand's LT-LEDS uses the input-output table obtained from the Office of the National Economic and Social Development Council (NESDC) to calibrate the model. The model considered in the analysis is disaggregated into detailed production sub-sectors.

THAILAND'S CARBON NEUTRALITY PATHWAY

To achieve its carbon neutrality in 2050, Thailand has focused its attention on reducing CO_2 emission in the energy sector, which is the largest contributor of GHG emissions. Thailand has formulated a draft National Energy Plan 2022 (NEP 2022) as a policy framework to guide related agencies towards a transformational change to clean energy systems and plan to achieve the goal of becoming a carbon neutral country by 2050. In this scenario, the share of renewable energy for new power generation capacity will be at least 50% by 2050 and new vehicles in the market will be electric vehicles, including Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) with the share of 69% by 2035. CO_2 emissions from the IPPU, waste and agriculture sectors will follow the 1.5-degree pathway, where most of CO_2 emission will be from the IPPU sector, particularly the cement industry, and where carbon capture (usage) and storage can contribute to further carbon removal in the sector. Contribution from the LULUCF sector in carbon removal is expected to increase to 120 $MtCO_2$ by 2037. The 2050 carbon neutrality pathway is presented in Figure 3-2. The net nationwide CO_2 emission is expected to be 137.3 $MtCO_2$ in 2030 and 63.1 $MtCO_2$ in 2040, respectively

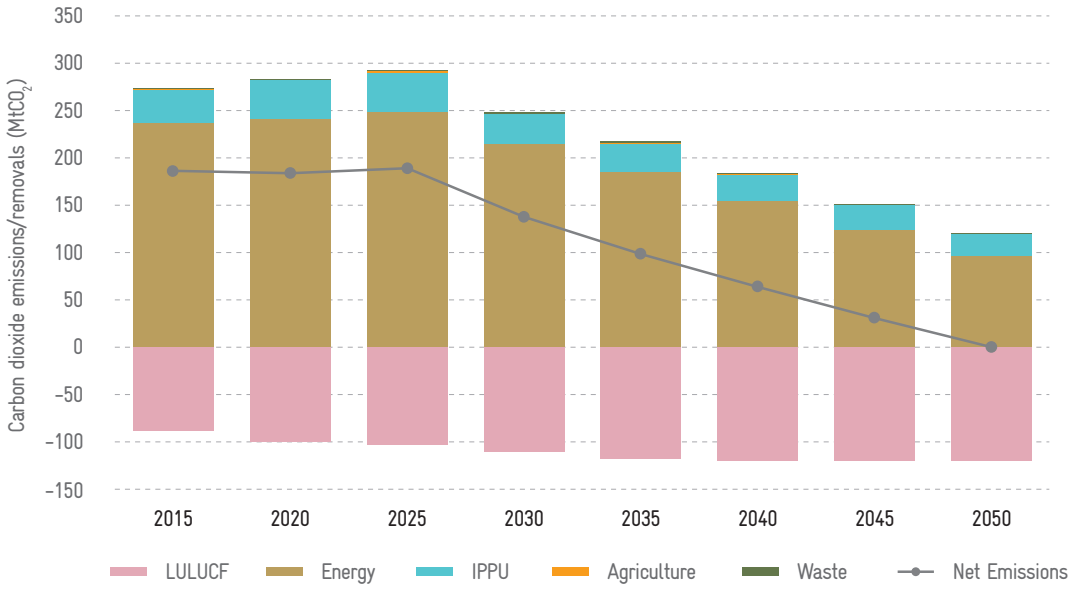


Figure 3-2 Thailand's 2050 Carbon Neutrality Pathway

THAILAND'S NET ZERO GHG EMISSION PATHWAY

To achieve net zero GHG emission in 2065, contribution from the LULUCF sector at 120 $MtCO_2$ is expected to stabilize from 2037 through the end of this century. This projection is based on forest and green area targets identified in the National Strategy (2018-2037) that aims to increase forest and green areas up to 55% of Thailand's total land area. From the 2065 net zero GHG emission scenario, it is expected that Thailand will achieve the net GHG emission of 64.1 $MtCO_2eq$ in 2050 (See Figure 3-3). GHG emissions from sources are expected to reach the peak level of 388 $MtCO_2eq$ by 2025, and the energy sector will play a key role in mitigating GHG emission after 2025. The post-2050 emissions follow the IPCC 1.5-degree pathway, under which Thailand is expected to achieve a balance between GHG emissions by sources and removals by sinks in 2065. Coal phase-out and negative emission technologies in the energy sector, e.g., Bioenergy with CCS (BECCS) or direct air capture and storage, will be necessary in Thailand's net zero GHG emission pathway.

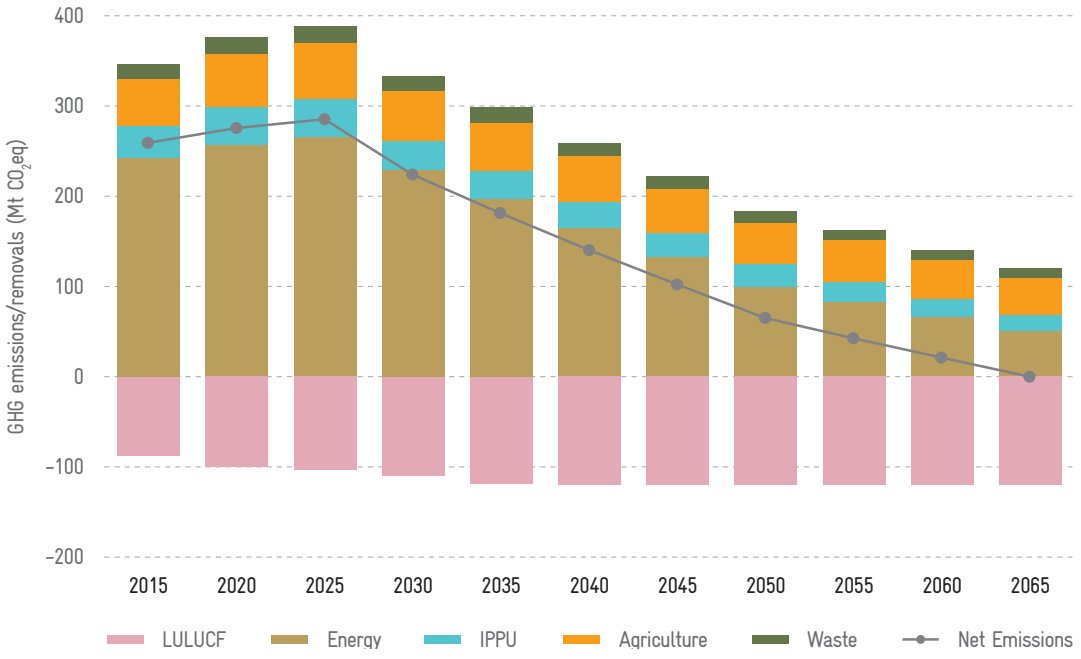


Figure 3-3 Thailand's 2065 Net Zero GHG Emission Pathway

MACROECONOMIC IMPACT ASSESSMENT

The development of national policies, including in relation to climate change, should carefully consider the direction and pattern of local and global development. A country's development pattern is greatly influenced by its public health policy, energy security, transport and urban infrastructure and capital investment, particularly investment in the manufacturing and service sectors, which are key drivers of the country's economy. To achieve carbon neutrality by 2050 and net zero GHG emissions by 2065 as laid out in the above long-term pathway, it is imperative to understand the economic impacts as a result of the adoption and implementation of such a policy scenario. In the development of Thailand's revised LT-LEDS, the macroeconomic impacts are considered mainly in terms of GDP and welfare. In addition, carbon prices are estimated. The impacts of Thailand's revised LT-LEDS, specifically the 2050 carbon neutrality and the 2065 net zero GHG emission targets, are analyzed relative to the 2-degree pathway.

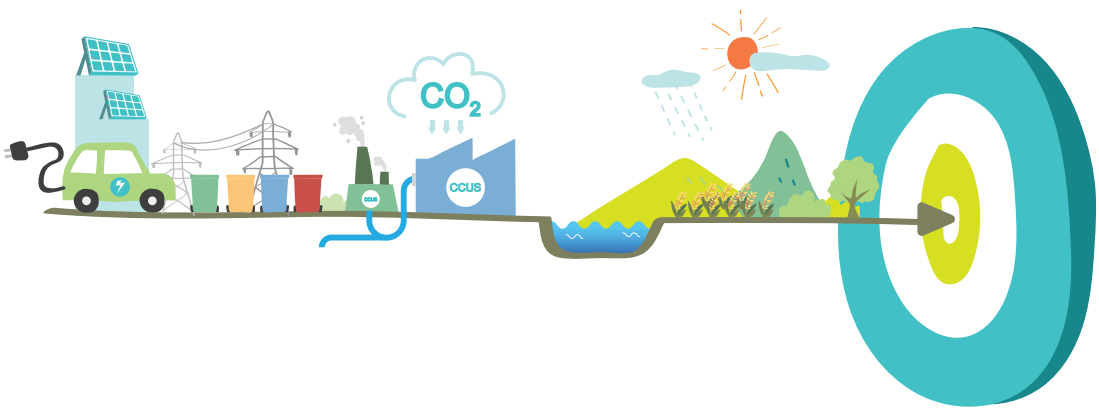
The assessment concludes that measures identified in the revised LT-LEDS will lead to a small decline in the GDP compared to the 2-degree pathway. GDP loss in 2050 is estimated to be 1.31%, while stringent nationwide GHG mitigation measures after 2050 will result in higher GDP losses of 2.6% in 2065. Lower productivity from petroleum refineries, coal and lignite mining industries, manufacturing industries, and agriculture and transport sectors are contributing factors to the GDP losses. However, the achievement of carbon neutrality by 2050 and net zero GHG emission by 2065 would lead to positive GDP gains in forestry, electricity, industries such as paper and printing, textile, chemical, non-metallic minerals, fabricated metal products, construction, trade, and services sectors. In order to avoid GDP losses, Thailand will need to prepare a transitional plan for its transformation in the energy and transport sectors to create opportunities and increase the value of investment in low-emission and environmentally friendly businesses. This domestic preparation, together with the expected lower future costs of advanced GHG mitigation technologies, will mitigate such economic impacts and result in a better and green economy in a long run. Consideration of multi-benefits, including increase in productivity, green jobs creation, enhanced ecosystem conservation and improved public health and environment as a result of low-carbon development and direct investments, would further minimize the incurred GDP losses. Government and household consumption form the major components in the national GDP. Thailand's 2050 carbon neutrality pathway will result in a significant increase in the government consumption. While the average welfare loss is estimated at 3.7% during 2020-2050, Thailand may increase government expenditures to boost economic activities. The implementation of emission reduction measures under Thailand's LT-LEDS will increase government spending on welfare benefits, education, research and training, manufacturing industries, power generation, transportation, infrastructure investments, etc.

Thailand's aspiration to adopt a long-term low GHG emission development pathway as described above will provide a long-term framework to guide the country's current and successive Nationally Determined Contributions (NDCs). Together with the 2050 carbon neutrality and 2065 net zero GHG emission pathway, Thailand has updated its NDC target (2021-2030) to 30-40% relative to the country's projected BAU in 2030. Specific information is shared through Thailand's updated NDC.

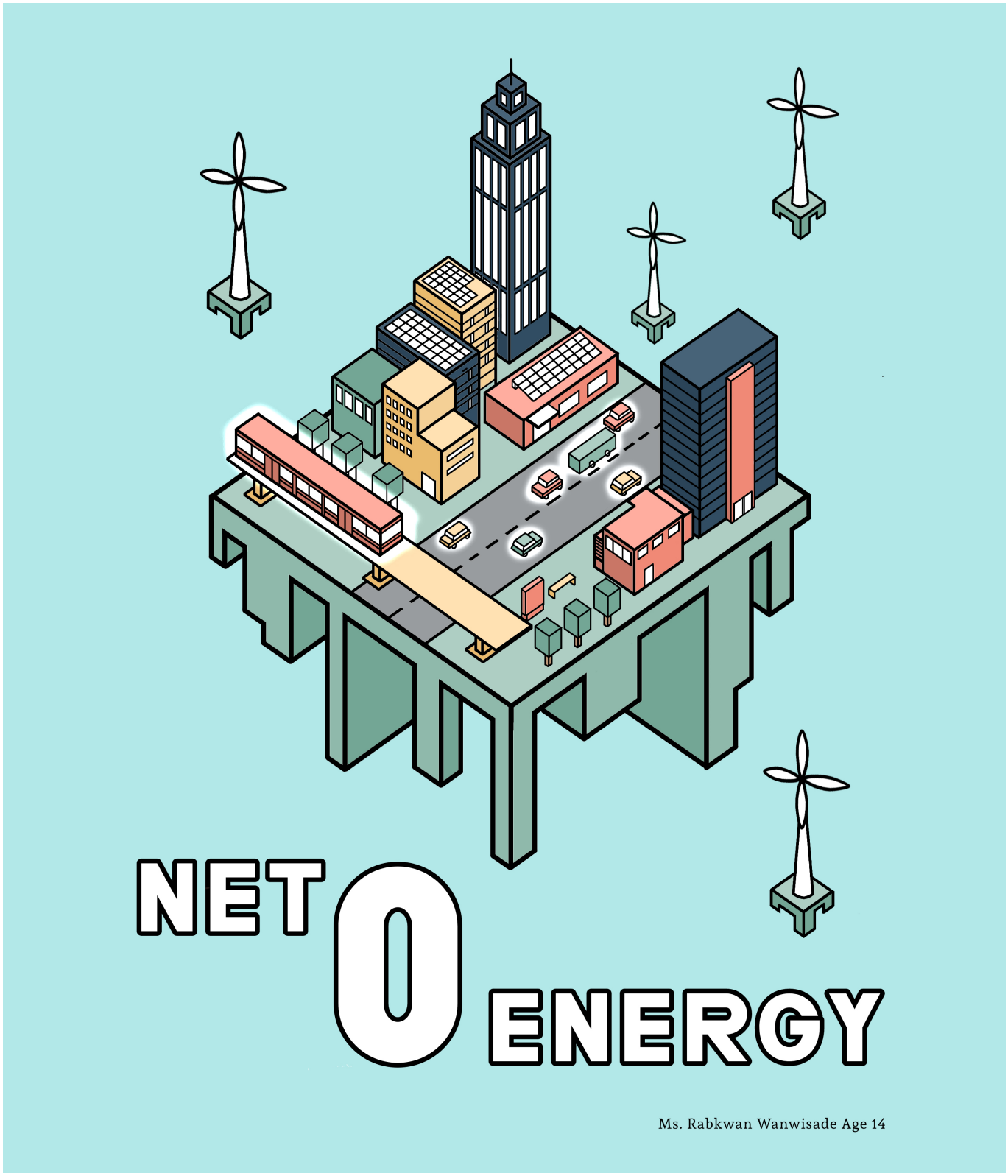
Chapter 4:

LONG-TERM MITIGATION ACTIONS IN KEY SECTORS

- ENERGY
- INDUSTRIAL PROCESSES AND PRODUCT USE
- WASTE
- AGRICULTURE
- FORESTRY



ENERGY



CURRENT LANDSCAPE

In 2020, most of the energy consumption in Thailand was for commercial use, amounting to 66,821 ktoe (86.40% of total). Among the energy sources, petroleum products accounted for the largest proportion of consumption (48.00%), followed by electricity (21.67%), natural gas (6.40%), and coal and coal products (10.32%), (see Figure 4-1).

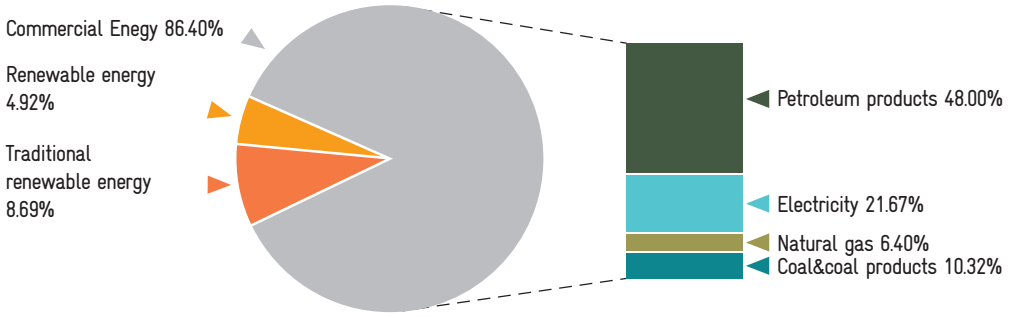


Figure 4-1 Final energy consumption by fuel type, 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

The transport sector contributed the largest share of final energy consumption, at around 38.40% of the final energy consumption, followed by the manufacturing, residential, commercial, agriculture, and construction and mining sectors, respectively (see Figure 4-2).

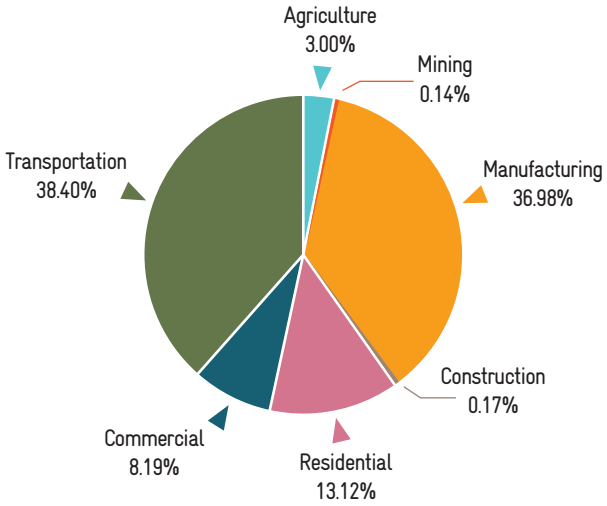


Figure 4-2 Share of final energy consumption by economic sector, 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

Energy production in 2020 was 65,821 ktoe, representing an 11.76% decrease from the previous year (Table 4-1). The commercial energy contributed the largest share of energy production at 41,871 ktoe (63.61% of the total), followed by renewable energy at 16,020 ktoe (24.34%), traditional renewable energy at 5,179 ktoe (7.87%), biofuel at 2,343 ktoe (3.56%), and, finally, other energy sources produced 408 ktoe (0.62%).

Table 4-1 Energy production by fuel type, 2018-2020

Energy Production	Quantity (ktoe)			Growth (%)	
	2018	2019	2020	2019	2020
Total energy production	72,609	74,592	65,821	2.73%	-11.76%
Commercial energy	45,828	46,188	41,871	0.79%	-9.35%
• Crude oil	6,453	6,178	5,860	-4.26%	-5.15%
• Lignite	3,756	3,532	3,282	-5.96%	-7.08%
• Natural gas	31,122	31,871	28,865	2.41%	-9.43%
• Condensate	4,497	4,607	3,864	2.45%	-16.13%
Renewable energy*	17,156	18,670	16,020	8.82%	-14.19%
Traditional renewable energy**	7,012	6,842	5,179	-2.42%	-24.31%
Biofuel	2,113	2,422	2,343	14.62%	-3.26%
Other energy***	500	470	408	-6.00%	-13.19%

* solar, wind, hydro, geothermal, fuel wood, paddy husk, bagasse, agricultural waste, MSW and biogas
** fuel wood, charcoal, paddy husk and agricultural waste
*** black liquor and residual gas

In 2020, the total amount of energy imports was 77,064 ktoe, with crude oil accounting for the largest share of 54.88%. The amount of energy exported was 10,812 ktoe, of which approximately 97.43% were petroleum products[3].

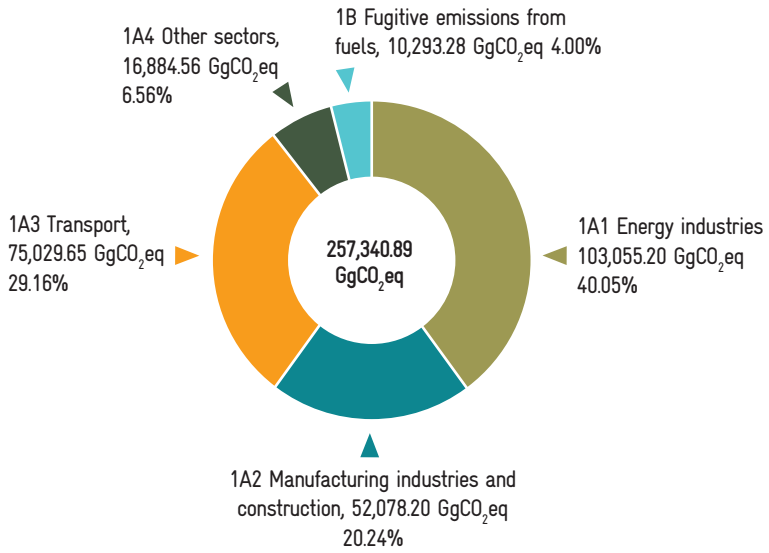


Figure 4-3 GHG emissions from the energy sector by source, 2018

Total direct GHG emissions from the energy sector in 2018 was estimated at 257,340.89 $GgCO_2eq$, accounting for 69.06% of the country's total GHG emissions. The majority of GHG emissions in the energy sector were generated by fuel combustion, consisting mostly of energy industries at around 103,055.20 $GgCO_2eq$ (40.05%). GHG emissions from the transport, manufacturing industries and construction, and other sectors were 75,029.65 $GgCO_2eq$ (29.16%), 52,078.20 $GgCO_2eq$ (20.24%), and 16,884.56 $GgCO_2eq$ (6.56%), respectively. Fugitive emissions from fuel contributed 10,293.28 $GgCO_2eq$ or about 4.00% of total GHG emission from the energy sector. Figure 4-3 presents GHG emissions from the energy sector in 2018 by source.

[3] Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

KEY MITIGATION ACTIONS

The energy sector is a main component of Thailand's transition towards carbon neutrality and net zero GHG emission. A new National Energy Plan that integrates five key energy plans, including the Power Development Plan, the Alternative Energy Development Plan, the Energy Efficiency Plan, and the Gas Plan and Oil Plan, and that incorporates decarbonization targets of the energy sector will be launched in 2023. Its decarbonization framework includes further increases of renewable energy share in power generation, by ensuring the installation of renewable based power generation at rapid rates, with at least a 50% share of renewable energy from new power plants by 2050. Solar and wind combined would account for 65% of total electricity generation by 2060. This needs to be coupled with grid modernization and micro-grid development to support distributed energy resources, deregulation of the electricity market to accommodate an increasing share of prosumers, and digitalization of the renewable energy control center platform for both on-grid and off-grid areas. In addition, provision of incentives to support renewable energy investment and markets, renewable energy technology development, including bio-economy research and development of hydrogen and bio-jet, further enhancement of energy efficiency improvement in all relevant sectors, as well as promotion of electric vehicles will be important. Following this framework, key GHG mitigation measures to transition Thailand's energy system towards a decarbonization pathway will continue to include renewable energy development and energy efficiency improvement/technology switching. In addition, carbon capture and storage (CCS) and carbon capture, usage and storage (CCUS) are identified as potential negative emission technologies to support decarbonization efforts in the energy sector. These transformative measures are further elaborated below for the relevant sub-sectors.

POWER GENERATION

Renewable energy-based technologies such as solar PV, wind turbines, biomass cogeneration plants and biogas turbines are already in use; however, their share in the total power generation is still low. To achieve carbon neutrality in 2050, the share of renewable electricity is estimated to be 68% of total electricity generation in 2040, and 74% in 2050. In addition, bioenergy with CCS technologies (BECCS) power plants will be needed to achieve the net zero CO_2 emission target by 2050.

Along with the existing technologies, additional mitigation technologies such as solar PV with battery storage, fossil- and biomass-based power plants equipped with CCS/CCUS technologies, fuel-cell power plants, gas turbines using a natural gas/hydrogen blend and 100% green hydrogen are also considered for achieving net zero GHG emissions by 2065. Figure 4-4 presents the timeline for transformation of the power generation system to achieve net zero GHG emission.

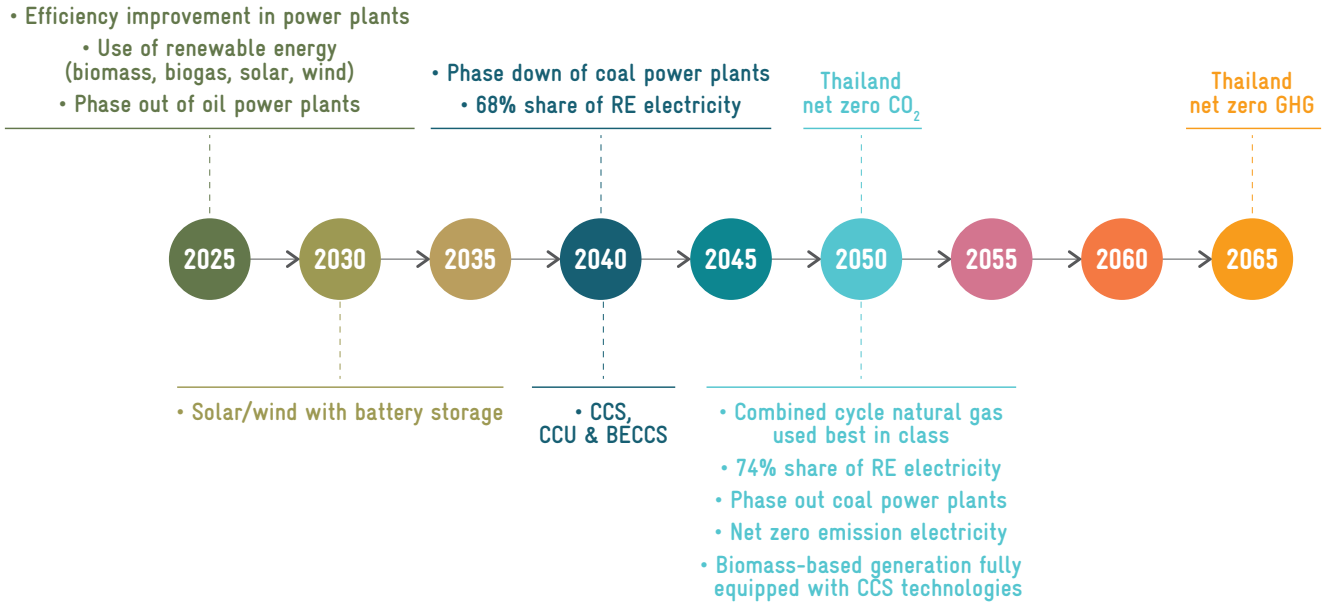


Figure 4-4 Net zero GHG emission timeline for Thailand's power generation

SHOWCASE:

HYDRO-FLOATING SOLAR HYBRID PROJECT

The 24 MW hydro-floating solar hybrid project at Ubol Ratana Dam in Khon Kaen province will be developed after the success of Sirindhorn Dam Hydro-Floating Solar Hybrid Project in Ubon Ratchathani province to support the government's goal of carbon neutrality. This project will generate electricity by the combination of solar power and hydropower from the dam. Moreover, it will be equipped with a battery energy storage system (BESS) to enhance efficiency and continuity of power generation. Prior to this ongoing project development, a report regarding the operation of the first hydro-floating solar hybrid project at Sirindhorn Dam shows that the project gained its achievement as planned.

The 45 MW Hydro-Floating Solar Hybrid Project at Sirindhorn Dam which began commercial operation in 2021 can enhance the power system stability and reduce intermittency of renewable energy. From environmental impact monitoring, it has been found that the floating pontoons installed in the reservoir do not affect inland freshwater ecosystems and environments, while the project is estimated to reduce greenhouse gas emissions of 47,000 tCO_2eq per year. All of these findings will benefit the development of future hydro-floating solar hybrid projects as specified in Thailand Power Development Plan 2018-2037, Revision 1.

Source: www.egat.co.th

Box 4-1 Hydro-Floating Solar Projects in Ubon Ratchathani, Northeastern Thailand

MANUFACTURING INDUSTRIES

Energy efficiency, fuel-switching and electrification of end-use technologies are key to decarbonization of the industrial sector. Electrification of end-use technologies in the industrial sector includes replacing non-electricity-based by electricity-based technologies. The potential to replace fossil-fuels partially or completely by renewables, such as biomass and solar in heating applications also exists in the manufacturing industries. Green hydrogen produced using renewable-based electricity will also play an important role in decarbonization of hard-to-abate sectors that cannot be electrified easily, such as iron and steel, aluminum, and cement. Hydrogen burners could be used in conjunction with electric heating to generate the high temperatures required in many heavy industrial processes, to replace fossil fuel burning. Figure 4-5 presents the timeline for key GHG mitigation measures in manufacturing industries to reach net zero emissions.

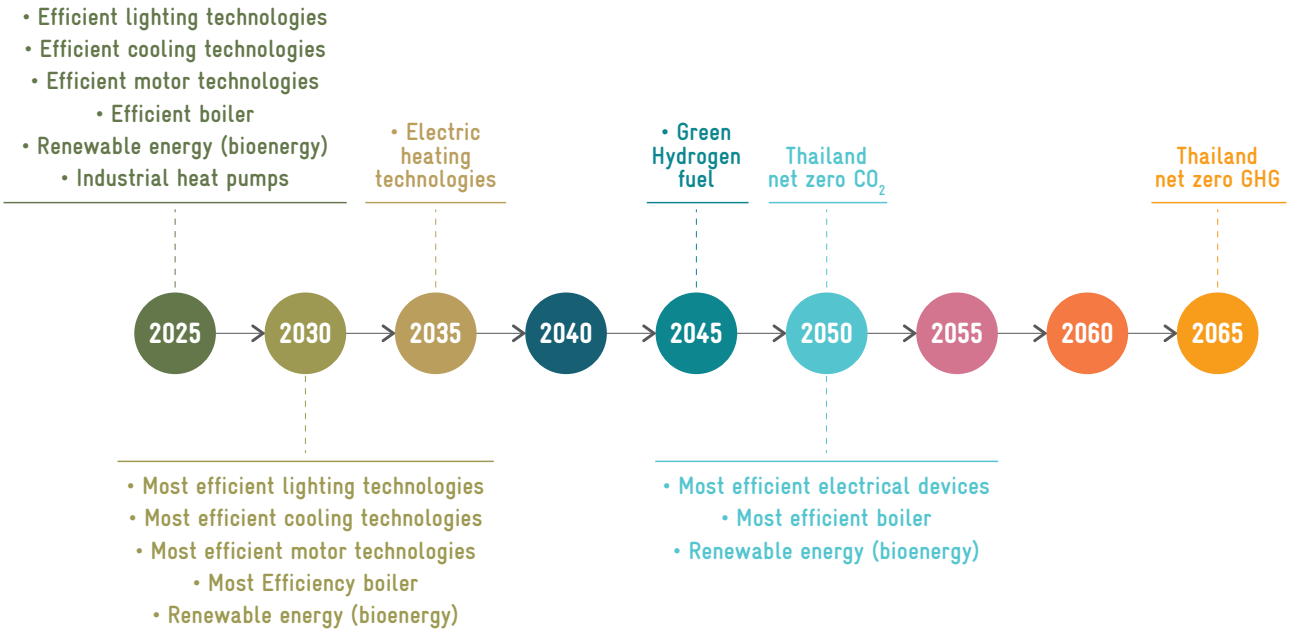


Figure 4-5: Net zero GHG emission timeline for manufacturing industries

RESIDENTIAL SECTOR

Energy uses in the residential sector mainly depend on electricity, LPG (Liquefied Petroleum Gas), and biomass. Most of the decarbonization opportunities include improving energy efficiency of end-use technologies in the residential sector. Efficiency improvement of cooling technologies such as air-conditioners and refrigeration, cooking technologies, electrical devices, and lighting technologies will have a major decarbonization role in this sector. Electrification of end-use technologies, for instance, shifting from LPG cooking to electric cooking would also contribute to the decarbonization efforts. Solar energy for water heating is also considered. The timeline of GHG mitigation measures in the residential sector to reach net zero emission is presented in Figure 4-6.

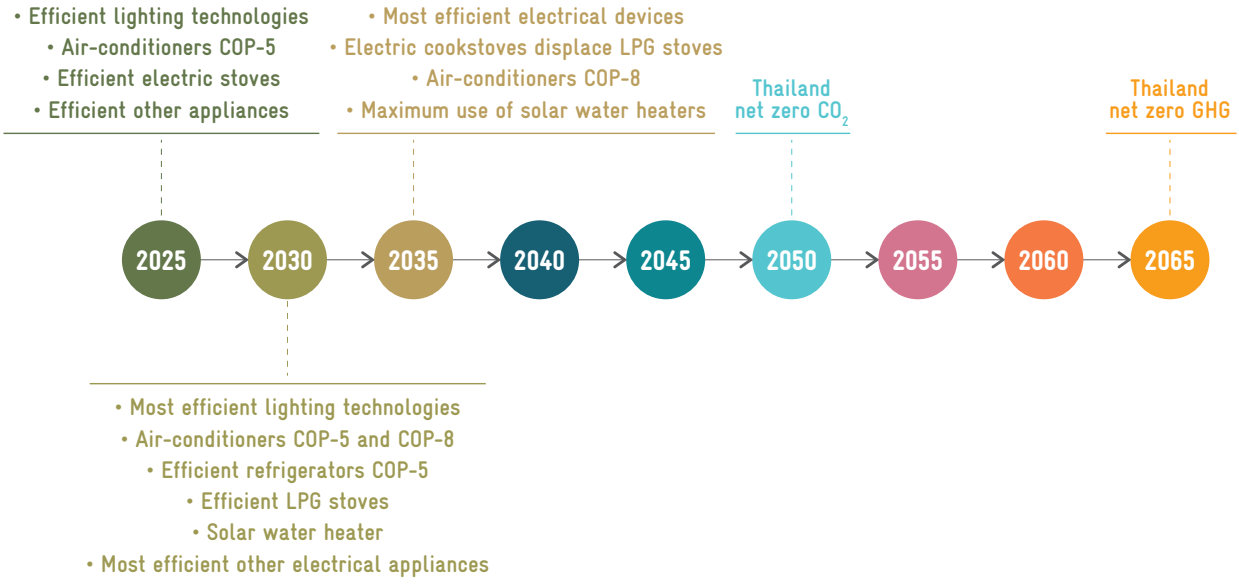


Figure 4-6 Net zero GHG emission timeline for the residential sector

COMMERCIAL BUILDINGS

The commercial sector in Thailand is mainly dependent on electricity and LPG for energy. Similar to the residential sector, most of the opportunities for decarbonization in the commercial sector lie in improving the energy efficiency of end-use technologies. Efficiency improvement of cooling technologies such as air-conditioners and refrigeration will have major role in this sector. Electrification of end-use technologies, for instance, shifting from LPG to electricity-based technologies would also contribute to decarbonization efforts. Solar water heating systems are also considered as an option for water heating in commercial buildings, particularly hotels, condominiums, and hospitals. Figure 4-7 presents a timeline for key GHG mitigation measures in the commercial building sector to reach net zero emission.

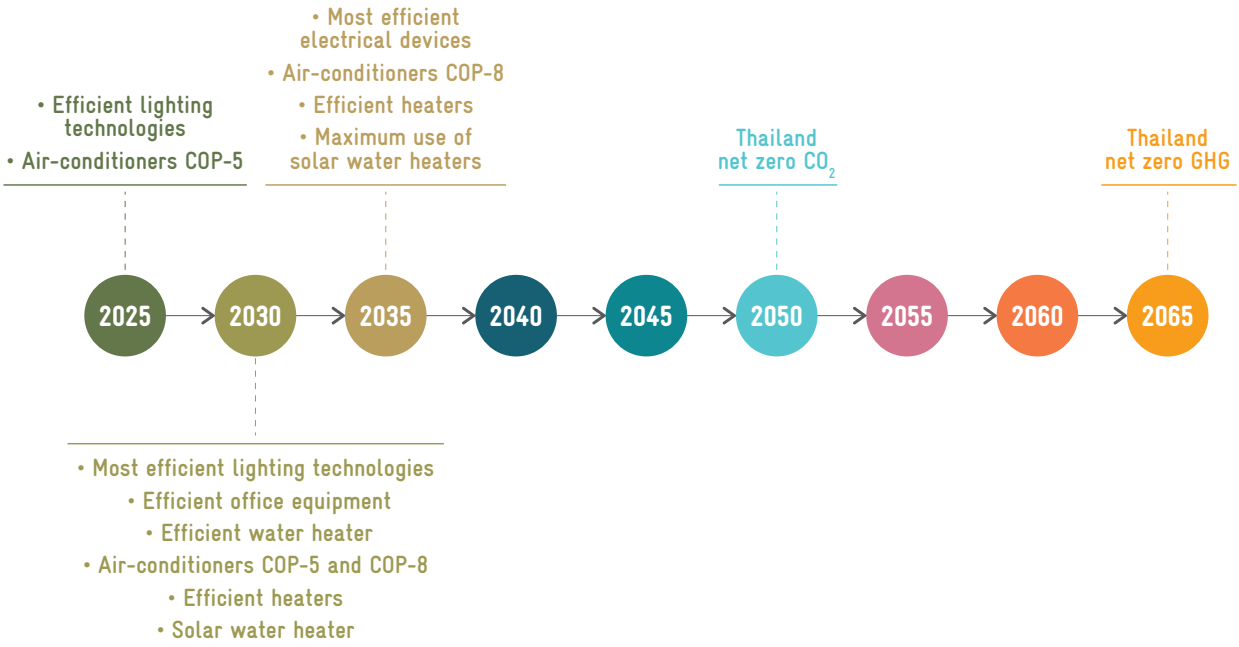


Figure 4-7 Net zero GHG emission timeline for the commercial building sector

SHOWCASE:

THAILAND'S BUILDING ENERGY CODE (BEC)

Building Energy Code (BEC) in Thailand is enforced and applies to new buildings with a gross floor area of more than 10,000 sqm. This requirement will be tightened in the future by reducing the floor area to 5,000 sqm. in 2021 and 2,000 sqm in 2023 onward and hence increasing the number of concerned buildings.

Source: https://bec.dede.go.th

Box 4-2 Thailand's Building Energy Code (BEC)

TRANSPORT

The transport sector in Thailand depends mainly on fossil fuel, such as gasoline, diesel, CNG (Compressed Natural Gas), fuel oil, and LPG. Biofuels blended with gasoline and diesel are mandatory in Thailand. Decarbonization opportunities in the transport sector include cleaner and more efficient technologies such as hybrid, plug-in hybrid, electric and fuel cell electric vehicles (FCEVs), with fuel-cell technology as a more attractive option for long-haul truck segments. It should also be noted that electrification of the transport sector would first require decarbonization of the power sector. The well-to-wheel GHG emissions of internal combustion engine (ICE) vehicles are independent of the power sector whereas well-to-wheel GHG emissions of electric vehicles (EVs) depend completely on the power sector's GHG emissions. The electrification of the transport sector without increasing the share of cleaner and renewable technologies in the power sector might lead to insignificant GHG reduction or even higher GHG emissions.

The shift to cleaner technologies such as EVs is still a challenge in the transport sector; however, with the declining cost of batteries in recent years, the costs of EVs are expected to drop significantly by 2030. Similarly, the cost of hydrogen powered FCEVs is also expected to lower in the near future. In 2030, the share of new battery EVs and Plug-in Hybrid Electric Vehicles (PHEVs) in the market is estimated to be at least 30% while ICE vehicles will be phased down after 2035 (see Figure 4-8). Efficiency improvements for ICE vehicles include shifting to EURO5 and EURO6 standards, promoting liquid biofuels and removing petroleum subsidies. In addition, energy efficiency improvement in the transport sector can be achieved by behavioral changes, road surface improvement and engine performance improvement.

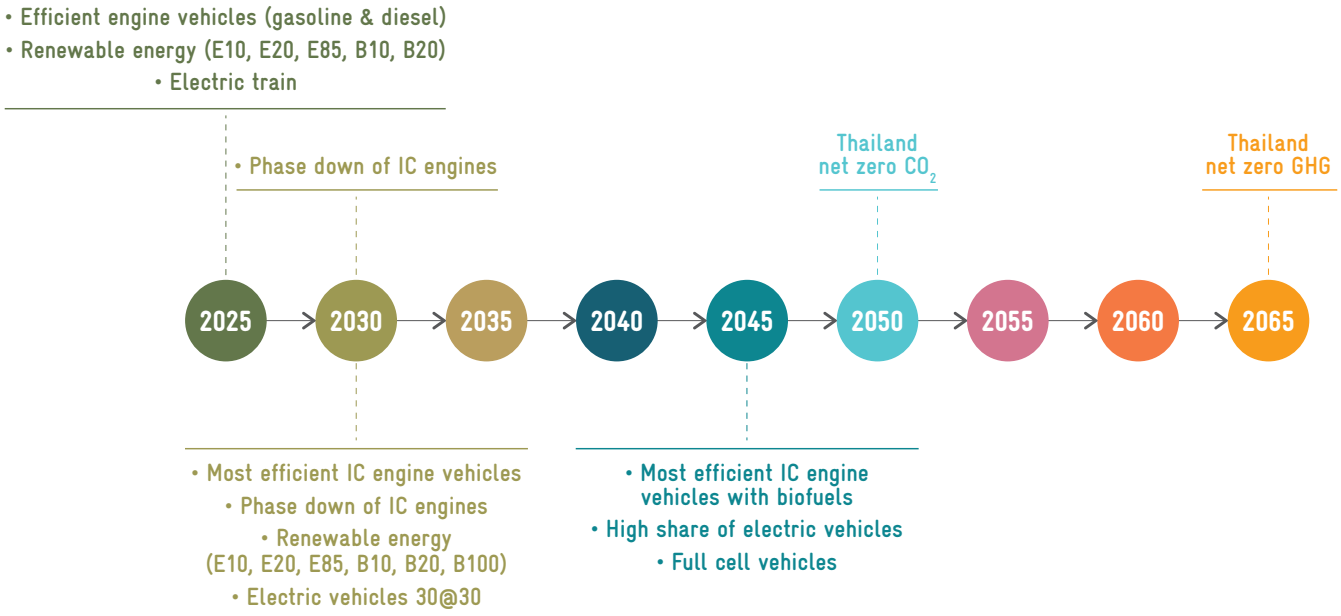


Figure 4-8 Net zero GHG emission timeline for the transport sector

Further potential mitigation measures in the transport sector from relevant plans include Travel Demand Management (TDM), Transit-Oriented Development (TOD), expansion of the railway network into double track, expansion of mass-rapid transit, high-speed trains, Single Rail Transfer Operation (SRTO) at Laem Chabang Port, improved river logistics efficiency, a ferry to connect East-West from Pattaya to Hua-Hin, adjustment of excise and annual vehicle tax collection rates according to the amount of CO_2 emission and promotion of electric and hybrid intercity and public buses, and minibus and delivery motorcycle fleet upgrades.

SHOWCASE:
DRIVING FORWARD EV POLICY 30@30

The Electric Vehicle (EV) Board recently approved the 30@30 Policy Plan, which establishes a target for zero-emission vehicles (ZEVs) to account for at least 30% of total automotive production by 2030, according to a three-phase development plan for the EV industry.

Phase 1 (2021-2022): the government will promote electric motorcycles and support infrastructure nationwide.
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% of all auto production in 2030 and includes domestic manufacture of batteries.

Financial and tax incentives, and safety standards have been set by the committee to promote investments for Thailand to become a hub of EV manufacturing in ASEAN, in order to accelerate the transition to a low-carbon society.

Box 4-3 Thailand's 30@30 Electric Vehicle Policy

AGRICUTURE

Energy use in agriculture relies on diesel, gasoline, and electricity. The end-use activities are classified broadly into pumping, threshing, and tilling. Existing technologies for pumping and threshing use fossil fuels and electricity, whereas tilling technologies depend mainly on fossil fuels (gasoline and diesel). The use of efficient devices, electrification of end-use technologies such as tractor, threshing, pumping and motors, and solar powered pumping are some of the mitigation measures in the agriculture sector (see Figure 4-9). By 2050, GHG emission from energy use in agriculture is estimated to be 2.8 $MtCO_2eq$.

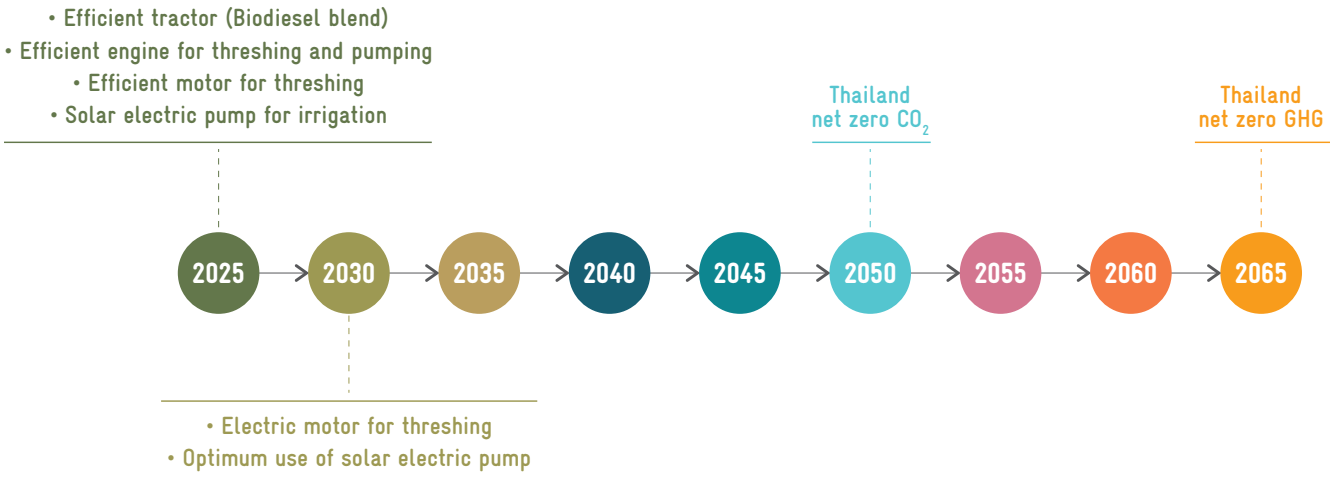
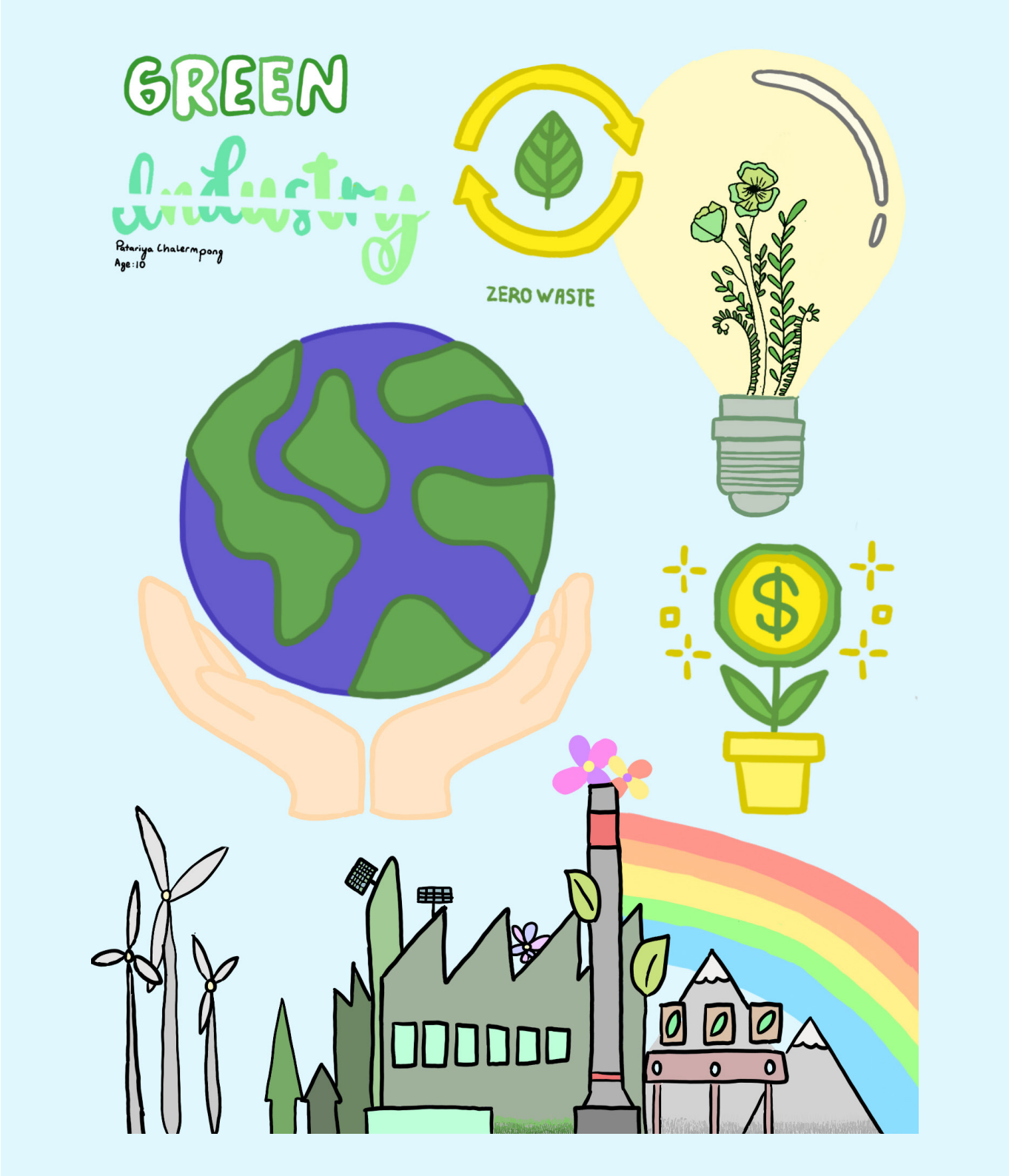


Figure 4-9 Net zero GHG emission timeline for energy use in the agriculture sector

INDUSTRIAL PROCESSES AND PRODUCT USE



CURRENT LANDSCAPE

The Industrial Processes and Product Use (IPPU) sector accounted for 8.65% and 10.77% of Thailand's total GHG emissions in 2000 and 2018 respectively. Cement industry is the major source of GHG emissions in the sector, accounting for 51.28%. GHG emissions from the chemical industry and product uses such as substitutes for ozone depleting substances were estimated at 33.17% and 13.33 %, respectively (see Figure 4-10). GHG emissions from metal production, non-energy products from fuels, and other product manufacture and use accounted for 2% of total GHG emissions from this sector.

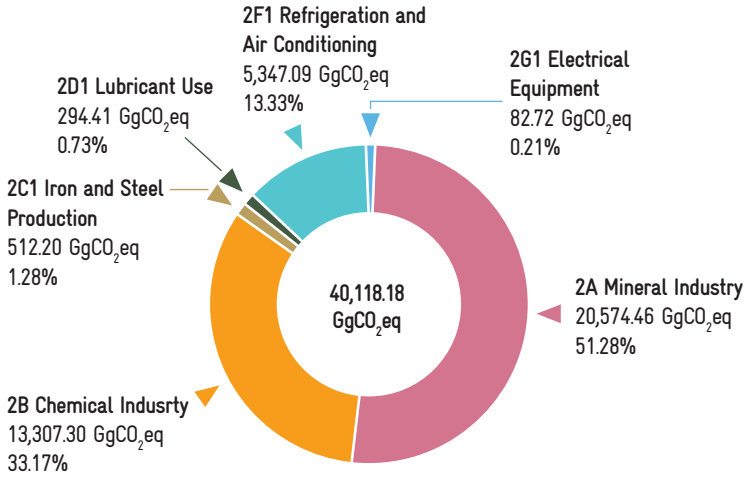


Figure 4-10 GHG Emission from the IPPU Sector, 2018

KEY MITIGATION ACTIONS

As major GHG emissions from the IPPU sector were from the cement, chemical, and refrigeration and air conditioning industries, respectively; key mitigation measures in the IPPU sector focus mainly on clinker substitution and substitution of high GWP refrigerants. Both mitigation measures were included in the National Action Plan for the GHG Mitigation from the IPPU Sector and Industrial Wastewater Measure (2021-2030) prepared by the Department of Industrial Works, Ministry of Industry, and are currently being implemented. The refrigerant substitution measure will also be implemented in conjunction with the HFCs phase-down activities in preparation for the Kigali Amendment to the Montreal Protocol.

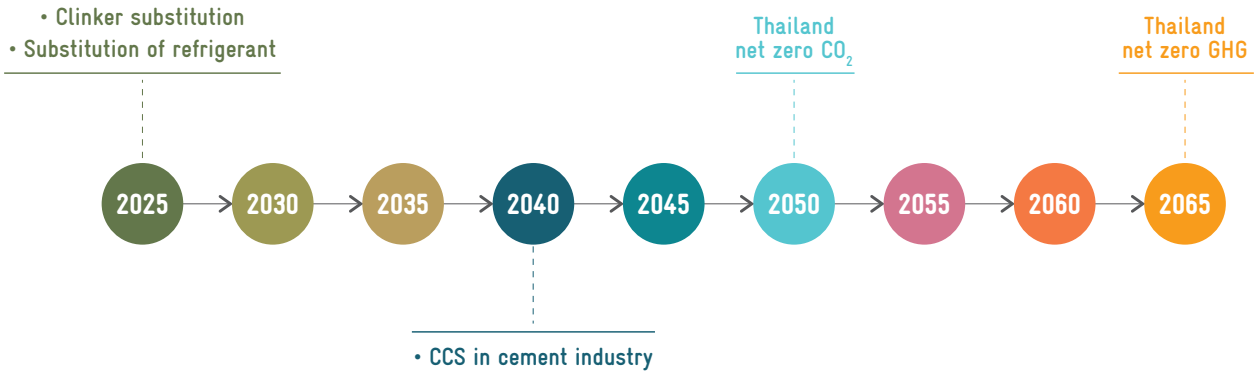


Figure 4-11 Net zero GHG emission timeline for IPPU sector

In striving for carbon neutrality and net zero emission, the Ministry of Industry, is currently implementing the Bio, Circular and Green (BCG) economic model to drive sustainable growth of Thai industries with the ability to produce value-added products and increase competitiveness. As part of the BCG policy, the Department of Industrial Works is driving the green economy by promoting business transition into Green Industry. Support is provided to increase social responsibility and environmentally friendly operations within the industrial sector by the use of technologies and innovations to maximize resource efficiency and transition to eco-friendly manufacturing. The target is to bring all industrial plants into Green Industry by 2025, which will have co-benefits in contributing to GHG emission reduction in the long term.

BIO, CIRCULAR AND GREEN (BCG) ECONOMY

The Industrial Estate Authority of Thailand (IEAT) is determined to use the Bio, Circular and Green (BCG) economic model to direct industrial investments and operations in a move to help Thailand achieve a net-zero goal.

BCG, which encourages manufacturers to use production techniques to add value to products with minimal or no impact on the environment, is viewed as a key measure to support carbon dioxide reduction campaigns.

The IEAT is promoting environmentally friendly industrial operations in the Eastern Economic Corridor, which will turn parts of Chon Buri, Rayong and Chachoengsao into a high-tech industrial hub. EEC will host 12 targeted S-curve industries: cars; smart electronics; affluent, medical and wellness tourism; agriculture and biotechnology; food; robotics for industry; logistics and aviation; biofuels and biochemicals; digital; medical services; defence; and education development.

The Smart Park project in Rayong will not only be developed to serve S-curve industries but also to promote use of zero-emission vehicles as well as modern technologies for better energy management. The new industrial park, to be located in Rayong, is expected to help boost the economy, contributing 52.9 billion baht to GDP and creating 7,459 jobs.

Source: https://www.bangkokpost.com/business/2231359/ieat-looks-to-bcg-to-meet-net-zero-goal

Box 4-4 Bio, Circular and Green (BCG) Economy

In addition, the Department of Industrial Works, in cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and with financial support from the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, is currently implementing the Climate Action Programme for the Chemical Industry (CAPCI), aiming to build the capacity of the Thai chemical industry to identify and tap mitigation potential in chemicals production and associated value chains. To achieve net zero emission, further technologies are necessary to transition to more climate-friendly industrial processes, such as reduction of nitrous oxide emission from nitric acid, caprolactam and other relevant industries. Negative emission technologies, including CCS/CCUS will be required to achieve up to 90% GHG emission reduction from the cement industry.

SHOWCASE:
COLLABORATION IN THE THAI CEMENT INDUSTRY

The Thai cement industry intends to mitigate greenhouse gas by continually working together with ambition towards carbon neutrality on clinker replacement measure by stimulating hydraulic cement consumption to mitigate greenhouse gas in accordance with the national plan.

The Thai Cement Manufacturers Association (TCMA) in collaboration with the Council of Engineers of Thailand, the Engineering Institute of Thailand under the Patronage of His Majesty the King, and the Thai Concrete Association, with the support of the Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment joined forces with 31 alliances from public, professional, industry and academic sectors to push forward carbon neutrality efforts by launching "MISSION 2023" to mitigate 1,000,000 tCO_2 within the year 2023 by encouraging all sectors to use environmentally friendly cement called 'Hydraulic Cement' in all types of construction projects in Thailand. Such collaboration is further enhanced by construction standard and production standard improvement, capacity building and product research and development.

Box 4-5 Driving Thai Cement Industry towards Carbon Neutrality

WASTE

Ms. Rabkwan Wanwisade Age 14

CURRENT LANDSCAPE

The rate of waste generation in Thailand is approximately 1.03 kg/person/day or 24.98 million tons/years in 2021. Of this amount, around 11.93 million tons are recycled, 11.19 million tons are correctly disposed and 4.23 million tons (about 16.7%) are incorrectly managed. Waste composition consists of 38.76% food waste, 28.13% plastic waste, 6.27% paper waste and 1.19% wood waste[4]. The waste sector represented around 4.48% of total greenhouse emissions in 2018. A large share of GHG emissions from the waste sector comes from solid waste disposal (52.53%) and wastewater treatment and discharge (45.71%).

KEY MITIGATION ACTIONS

Thailand has attempted to address its waste management challenge by developing national frameworks for waste management such as the National Solid Waste Management Master Plan (2016-2021) and the Roadmap on Plastic Waste Management (2018-2030). At the provincial level, municipal waste management action plans have been adopted. Various measures and approaches have implemented, including life cycle approach, 3R principle, public-private partnership, circular economy promotion, eco-friendly and responsible production and consumption. Around 27% of wastewater in Thailand is treated by central wastewater treatment plants operated by local municipalities and the Wastewater Management Authority, and 73% is treated by onsite wastewater treatment plants. Thailand will continue to manage its waste and wastewater and reduce GHG emissions from this sector through the implementation of the above-mentioned principles and approaches, particularly by reducing the amount of waste generation, increasing recycling and waste utilization, increasing biogas production from industrial wastewater through re-utilization of methane and improving efficiency in industrial and municipal wastewater management.

The Mechanical Biological Treatment site (MBT) at Phitsanulok province is a good example of a comprehensive waste management site. The MBT reduces around 50% of waste disposal to landfill and reduces greenhouse gas emission to 161 $kgCO_2eq/ton$, representing a reduction of 64% from open dumping and 83% from sanitary landfill, respectively. Waste processing at MBT includes unloading, homogenization, pilling, aeration, sieving and separation of compost-like materials and high-energy fractions before final disposal. The recyclable waste is separated at first stage and organic waste is composted to make soil replacement or fertilizer, while high calorific value waste is used as fuel/RDF.

Box 4-6 Mechanical Biological Treatment in Phitsanulok

The semi-aerobic landfill at Nakhon Ratchasima province is an example of a waste disposal facility using the aerobic technique. Such a technique increases waste decomposition rate and reduces greenhouse gas emission by more than 40%. The semi-aerobic landfill is easy to construct and operate, in which a pipe with a diameter 0.60 meters is installed at the bottom of the landfill and connected to a vertical pipe. This pipe provides airflow circulation in the landfill and drainage of wastewater. Such airflow will provide oxygen leading to an increased rate of waste decomposition.

Box 4-7 Semi-Aerobic Landfill in Nakhon Ratchasima

[4] Source: Municipal Solid Waste Composition Study 2021, Pollution Control Department

Thailand has set a goal to reduce food waste by 50% in 2030 by implementing actions in all stages of food production from raw material processing, transport, production, household consumption, and disposal. To reduce its plastic waste, Thailand banned the use of bottles' cap seal, OXO-degradable plastic and plastic microbeads in 2019. In addition, the use of thin plastic bags with less than 36-micron thickness, styrofoam food boxes, plastic straws and single-use plastic cups are to be banned by 2022. Under the Roadmap on Plastic Waste Management 2018-2030, and with a shift towards sustainable plastic waste management under the circular economy model, Thailand aims to have 100% of its plastic waste recycled/reused by 2027. In January 2020, the "Everyday Say No to Plastic Bags" campaign was launched, resulting in a halt to free plastic bag giveaways at department stores, supermarkets, and convenience stores. The Zero Industry Waste to Landfill policy and the "Green Industry Mark" for green processes were adopted to reduce industrial waste generation. Thailand also plays a key role in addressing marine debris at a regional level through the adoption of Bangkok Declaration on Combating Marine Debris in the ASEAN Region and the ASEAN Framework of Action on Marine Debris at the 34th ASEAN Summit in June 2019 which led to the preparation of ASEAN Regional Action Plan for Combating Marine Debris (2021-2025). In addition to reducing solid and wastewater generation, suitable waste disposal technologies, such as mechanical biological treatment and semi-aerobic technologies that have been proven effective to reduce GHG emissions from landfill, will be further explored by Thai local authorities, taking examples from already successful sites.

In sum, priorities for mitigation actions in the waste sector include community solid waste management, community wastewater management, waste reduction, landfill gas, waste to energy, semi aerobic landfill, composting, anaerobic digestion and mechanical biological treatment, and industrial wastewater management, including increasing biogas production from industrial wastewater by recycling methane gas (see Figure 4-12).

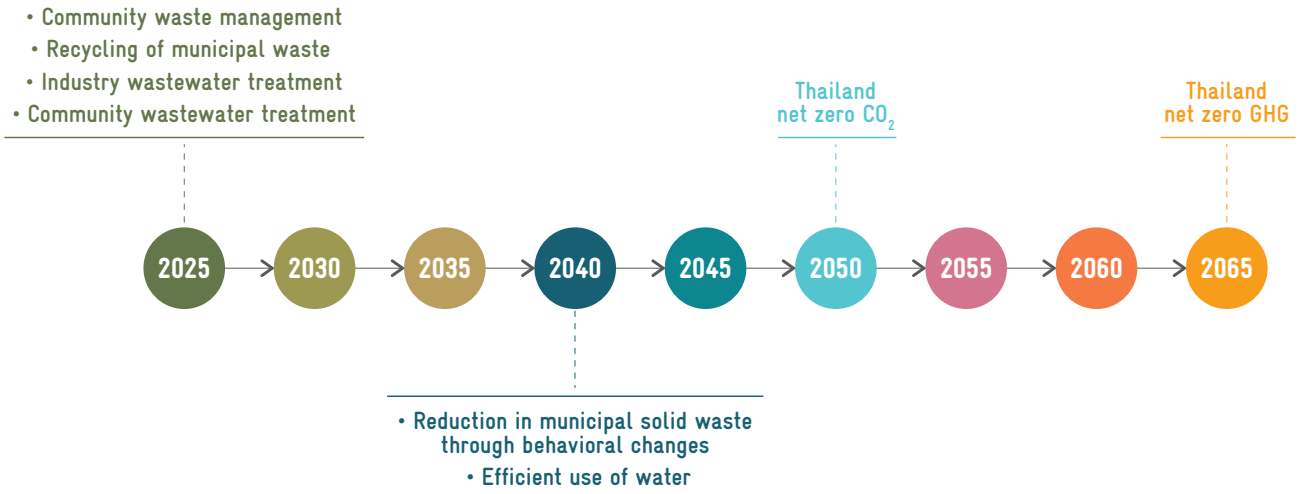
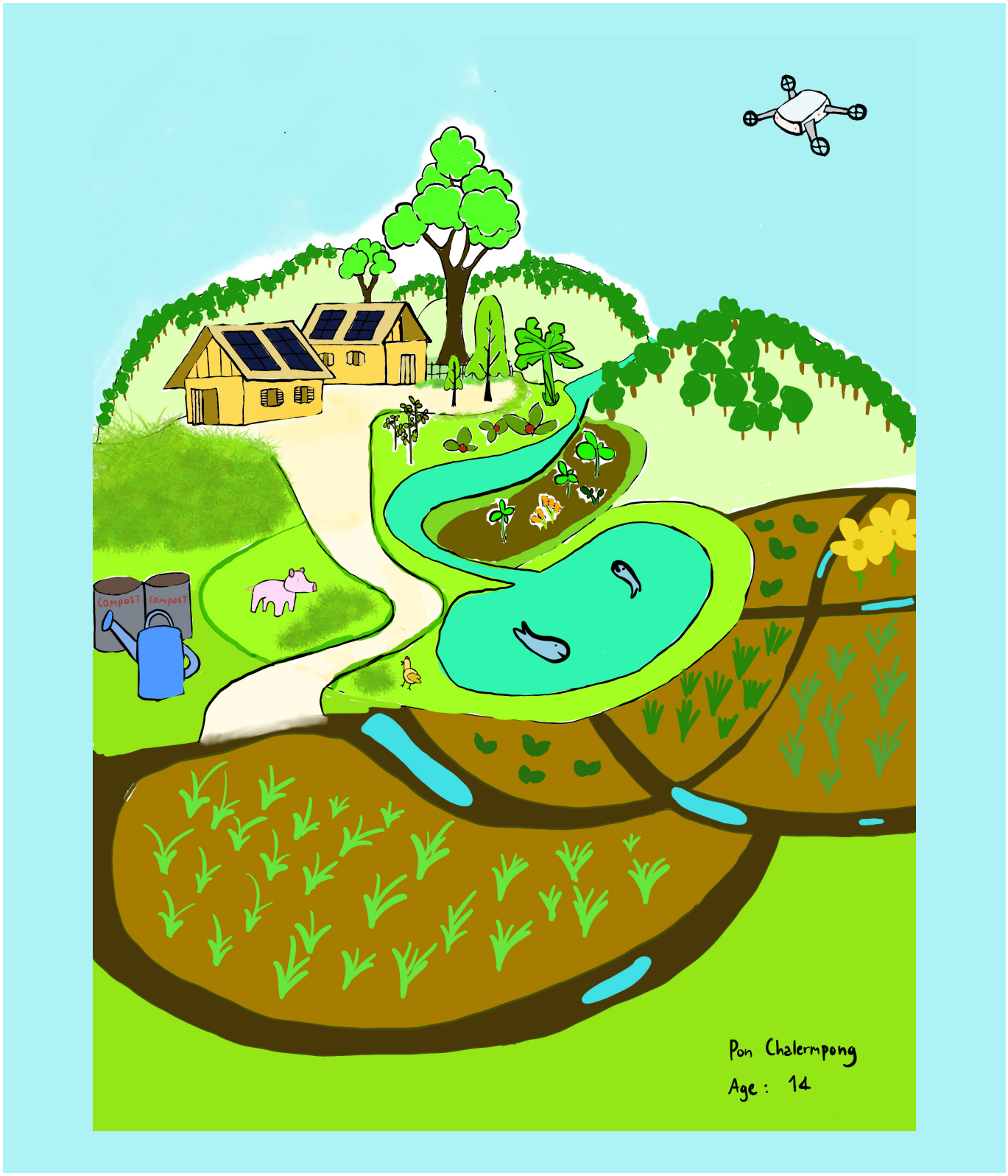


Figure 4-12 Net zero GHG emission timeline for the waste sector

AGRICULTURE



CURRENT LANDSCAPE

The agricultural sector plays a vital role in Thailand's economy as a major source of employment and generation of domestic food supply and exports. Major agricultural exports include rubber, rice, fruits, fish, chicken meat, cassava, sugar, shrimp and vegetables. Thailand's agricultural land area is approximately 149.3 million Rai (0.239 million km^2) or around 46% of total land area and the population of livestock is around 474 million, contributing approximately 58,486.02 $GgCO_2eq$ or 15.69% of total GHG emission. Agriculture generates the highest amount of CH_4 and N_2O or around 74% and 22% of total emissions, respectively. Sub-sectors that contribute the most emissions are rice cultivation, enteric fermentation, and direct and indirect N_2O emissions from managed soils, respectively.

KEY MITIGATION ACTIONS

The 20-year Agricultural Development Plan (2017-2036) was adopted to lay a foundation for long-term and systematic growth of this sector. This plan aims to improve farmers' livelihoods, increase productivity and quality standards of agricultural commodities, enhance the sector's competitiveness through technology and innovation under "Agriculture 4.0" model, promote a balanced and sustainable management of agricultural resources and the environment, and enhance capacity of public administration system. In relation to climate change, Thailand places high priority on addressing impacts and vulnerabilities of the sector through adaptation measures, as climate impacts, including shifting temperatures, more unpredictable rainfalls and extreme floods and drought have been widely experienced in the country, affecting the yields of major crops, such as rice, maize and sugarcane. In addition, measures to enhance competitiveness and promote balanced and sustainable agricultural systems are also important. Mitigation actions in the agricultural sector will likely focus on those with multi-benefits of increasing climate resilience, resource efficiency and productivity. These include better manure management, improved agriculture waste management, improved rice cultivation and practices, increased efficiency in water resource management, smart farming, high efficiency plant cultivation and livestock, promotion of organic fertilizers, increased renewable energy uses (solar, biofuels and electrification), and energy efficiency in water pumping, threshing and tilling (see Figure 4-13).

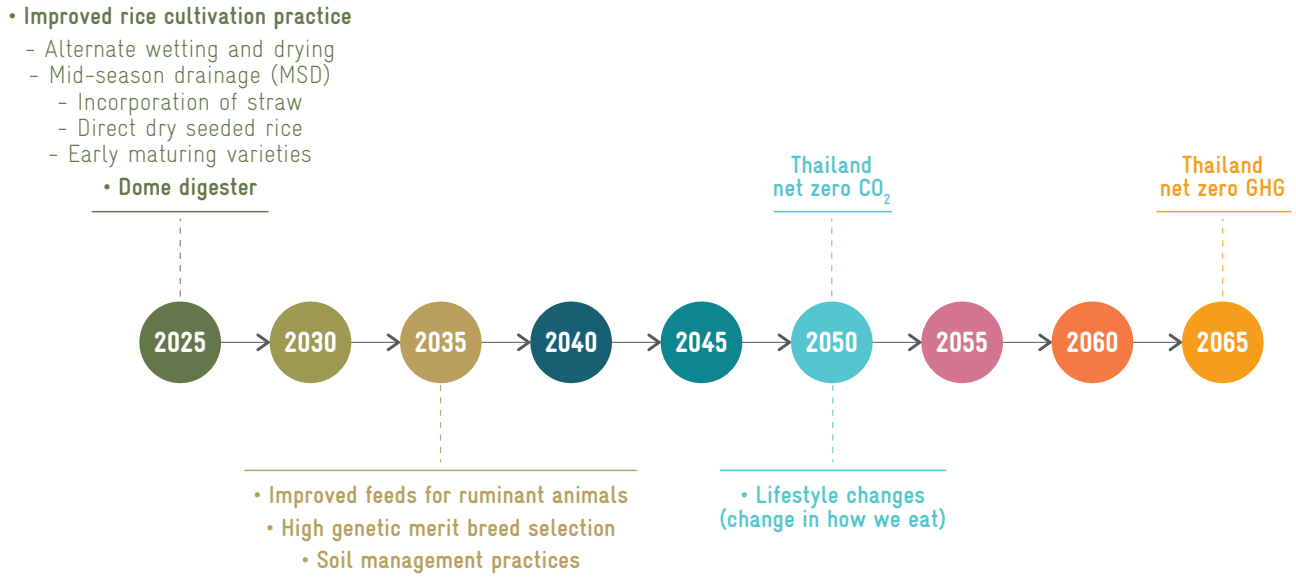


Figure 4-13 Net zero GHG emission timeline for the agriculture sector

SHOWCASE:
THAI RICE NAMA PROJECT, FUNDED BY THE NAMA FACILITY

Thai Rice NAMA is a pilot mitigation project in the agricultural sector that facilitates effective transformation of the Thai rice sector to low methane emission rice production, as rice production accounts for nearly 55% greenhouse gas emissions in this sector. The pilot area spans 6 provinces in the central region, covering a harvested rice area of 0.91 million ha. Mitigation measures using 4 mitigation technologies are being implemented, namely (1) land laser levelling technology, (2) alternative wetting and drying (AWD), (3) site specific soil and nutrient management, and (4) straw and stubble management. The mitigation potential of this pilot project is estimated to be approximately 1.7 million tCO_2eq over a 5-year period (2018-2023). In 2021, the emission decreased by 160,000 tCO_2eq, but due to the COVID-19 pandemic, drought, and floods, the implementation has been delayed. This pilot project, implemented through collaboration between the Rice Department, the Office of Natural Resources and Environmental Policy and Planning and GIZ, will be completed in 2023 and Thailand is in the process of submitting a proposal to seek funding support from the Green Climate Fund to scale-up this Rice NAMA concept to other rice production areas nation-wide.

Source: Thailand's Fourth National Communication

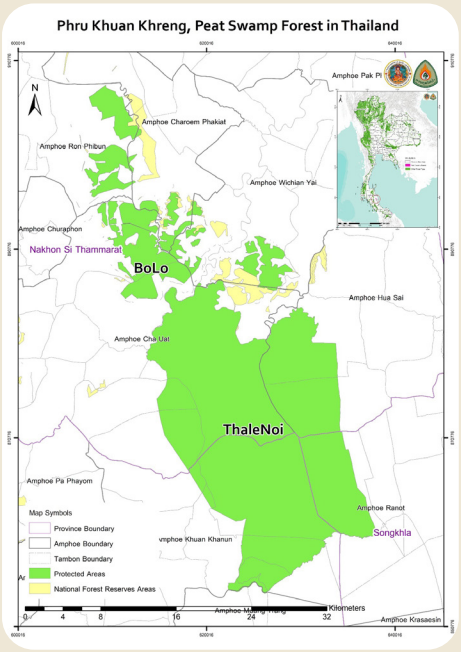
Box 4-8 Thai Rice NAMA Project to kick start low-methane rice production in Thailand

FORESTRY

CURRENT LANDSCAPE

Thailand has a total natural forest area of 31.96% of the total land area, covering approximately 164,000 km^2 in 2017. The evergreen and deciduous forest are the two predominate types of forest, which serve as a national green carbon sink. Forest is not only important for its role in promoting biodiversity and supporting economic growth, but also plays a key role in maintaining the livelihoods of many local communities by providing recreational spaces, ecosystem services and climate-related benefits.

SHOWCASE:
SUSTAINABLE USE OF PEATLAND IN ASEAN (SUPA) PROJECT



Khuan Khreng peat swamp forest is the second biggest peatland in Thailand with a total area of 187.2 km^2. It is situated in the area of 3 provinces including Nakhon Sri Thammarat, Phatthalung, and Songkhla Provinces and considered a significant peatland to the 3 provinces as it is a watershed forest to Pak Phanang and Thaley Noi rivers which are parts of Songkhla lake. Due to its unique and fragile ecosystem, this area is affected and degraded by human activities.

This project will collaborate with the Department of National Parks, Wildlife and Plant Conservation (DNP) with an objective to enhance the efficiency of Thailand's efforts to address the major threats causing degradation of Thailand's peat swamps especially in the Khuan Khreng area. It will focus on forest fire prevention and management aspects, while also promoting awareness, dialogues and knowledge on sustainable peatland management among relevant stakeholders, including existing local community networks and mechanisms.

Source: http://www.dnp.go.th

Box 4-9 Sustainable Use of Peatland in ASEAN – Thailand's component

KEY MITIGATION ACTIONS

The protection and conservation of forests in Thailand is clearly reflected in the 20-year National Strategy and the 12th and 13th National Economic and Social Development Plans. The National Forest Policy was adopted to ensure sustainable management of forest in Thailand. To safeguard forests and enhance carbon sink, a target to increase green area cover to 55% (282,216 km^2) of the total land area in 2037 has been adopted by the government, comprising 35% natural forest, 15% economic forest, and 5% urban and suburban green areas. To achieve such an aspirational target, various measures and activities will be implemented to promote afforestation and reforestation, increase green areas and prevent deforestation. Thailand aims to increase its green areas by 9% and plans to plant more trees in natural forests, economic forests and urban areas.

To achieve 35% natural forest, free plant seeds and seedlings suitable for each area are provided to interested parties for forest plantation in the reserved and buffer areas, including degraded forest land, mangrove forest and coastal areas. To complement plantation measures, restoration, reservation, and safeguard measures are also implemented in all types of existing forest areas to support this goal. The collaboration between government agencies and local communities, including for forest restoration, forest patrolling and forest fire management, is highly considered as the core mechanism of these measures. To strengthen these collaborative actions, technological instruments, including Smart Patrol System, advanced monitoring and spatial technologies, are integrated to monitor and detect forest change and fire hotspots to prevent forest encroachment and forest fires in high-risk areas and thus to ensure efficiency, effectiveness and sustainability of implementation.

To achieve 15% economic forest, the Thai government has developed a web-based program to provide information and recommendations on planting high-value economic trees. To incentivize planting of high-value economic trees and minimize the practice of mono-cropping, the Thai government revokes a restriction on the plantation and utilization of restricted trees (e.g. Siamese Rosewood, Burma Blackwood and Teak) in private land and rolls out the regulation to allow the use of 58 species of economically valuable trees as business collateral for loans.

To achieve 5% urban and suburban green space, engagement with local authorities and communities to increase green areas and encourage their use for recreational purposes, health and social benefits is promoted.

To improve the management of forest areas among different agencies, a "One Map" project is currently underway to verify reserve forest boundaries using a more detailed scale map ratio of 1:4,000 that will result in clear and agreed upon boundaries among agencies and resolve any overlaps and conflicts from existing maps. This will provide key information to prevent forest land encroachment and improve national reserve forest management in the long run.

The involvement of local communities and private sectors is highlighted as a key strategy to protect Thai forest and enhance natural carbon sink. The Community Forest Act B.E. 2562 was adopted to empower local communities living in approximately 14,000 community forest areas to work with the government to manage and utilize natural resources in a sustainable way. To promote private sector participation in forest plantation, a voluntary carbon market for this sector known as Thailand Voluntary Emission Reduction Program (T-VER) for forestry and green space has been developed. This program will allow private entities who are interested in selling and buying carbon credits from afforestation and reforestation of land, restoration of degraded mangrove habitats, planting of economic fast-growing tree and sustainable forestation projects to participate. Forest plantation can also be implemented jointly with the Department of National Park, Wildlife and Plant Conservation, the Royal Forestry Department and the Department of Marine and Coastal Resources in the area under their jurisdiction. To ensure the environmental integrity of the forest plantation, it is important to consider other integral environmental and social benefits that forests have provided, and safeguard measures including in particular biodiversity safeguard measures need to be in place when promoting forest plantation as natural carbon sinks.

SHOWCASE:

"YOU CARE FOR FORESTS, WE CARE FOR YOU"

A good example of successful pilot projects is the "You Care for Forests, We Care for You" project, jointly initiated by Mae Fah Luang Foundation under the Royal Patronage and the Securities and Exchange Commission, aiming to produce carbon credits for sale to the business sector from 16 community forest areas in Chiang Rai, Chiang Mai, Mae Hong Son and Phayao provinces. This pilot project utilizes the carbon offsetting mechanisms in the forestry sector to merge community development with forest conservation, greenhouse gas emissions reduction and sustainable development efforts. It is expected that a total of 392,220 tons of CO_2eq will be produced over the 20-year period and selling of such carbon credits from forest conservation will contribute to improving the well-being and quality of life of local communities.

Source: https://www.maefahluang.org/

Box 4-10 You Care for Forests, We Care for You

Pursuing mitigation actions in these sectors is not without challenges. Some key challenges that Thailand needs to overcome to ensure a tangible transition towards sustainable climate-friendly growth can be described as follows:

1. Setting clear policy directions and increasing regulatory efficiency, including clear national, sectoral and industry targets; adoption of standards, such as product standards and GHG benchmarking; and clear regulatory framework and procedures (e.g., for CCS/CCUS and other new technologies).
2. Designing effective incentives to promote investments, including tax incentives, access to soft loans, e.g., through sustainable finance schemes and carbon pricing mechanisms, including a carbon market, and increased market access for green, climate-friendly products.
3. Investing in supporting infrastructure, including the renewable energy power supply, EV charging stations, integrated multimodal transport infrastructure, data infrastructure, etc.
4. Providing R&D, technological development, training and capacity building support, including enhancing skilled labor relevant to climate-friendly technologies, R&D, capacity building and technical and technological support, particularly for SMEs.
5. Ensuring a just and inclusive transition through establishment of mechanisms and/or instruments to promote equitable benefit sharing and secure economic, social and environmental viability of particularly vulnerable groups.

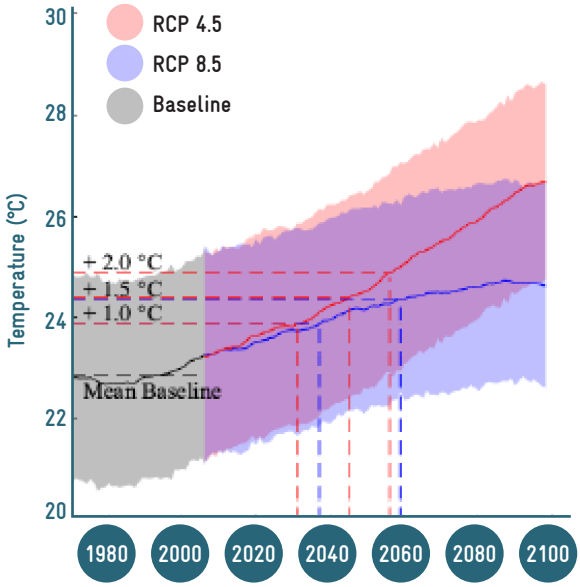
Chapter 5:

THAILAND'S CLIMATE-RESILIENT DEVELOPMENT PATHWAY

- THAILAND'S CLIMATE-RESILIENT FRAMEWORK
- KEY ADAPTATION ACTIONS

Thailand is considered a developing country highly vulnerable to the impacts of climate change, in line with Article 4.8 of the UNFCCC. During the past decades, Thailand has been experiencing more severe and intensified impacts nationwide. In 2021, Thailand was ranked the 9th most affected country – both in terms of human impacts and direct economic losses from weather related loss events during 2000-2019[5].

The ensembled result of 3-model study in 2021, namely, MPI-ESM-MR, EC-Earth, and HadGEM2-ES, demonstrated a projected temperature increase in Thailand under both RCP 4.5 and RCP 8.5. In addition, RCP 4.5 suggested a decrease in total precipitation, indicating a potential of drought. On the other hand, a maximum 1-day precipitation is projected to increase, reflecting a tendency of flash floods from heavy precipitation[6]. Thailand's coastlines are also likely to face erosion, especially in the low-lying areas. The projection of beach loss against sea level rise under the CMIP5 model in 2081-2100 resulted in beach loss of 55% for RCP 4.5 and 71.8% for RCP 8.5[7].



Box 5-1 Projected temperature increase in Thailand[6]

THAILAND'S CLIMATE-RESILIENT FRAMEWORK

To effectively and coherently build adaptive capacity and resilience among all sectors and stakeholders to address and respond to the adverse effect of climate change, the Working Group on Integration of Adaptation under the Subcommittee on Climate Change Policy and Planning Integration was appointed in 2018. This working group is tasked to provide recommendations on the development of the National Adaptation Plan (NAP) and the mainstreaming of adaptation into sectoral implementation.

Thailand's NAP was prepared in 2015, in which the first nation-wide climate risk assessment was conducted and a database of adaptation best practices was later developed. The NAP was approved by the NCCC in 2018 to serve as a policy guidance for national and sectoral implementation, including guiding the development of the National Adaptation Plan in the Health sector (H-NAP) and the Agriculture Climate Change Strategy. Thailand's NAP elaborates climate impacts and risks and key adaptation measures in six priority sectors, namely, water resource management, agriculture and food security, tourism, public health, natural resource management, and human settlements and security.

Thailand is systematically developing its national climate information and database to provide information and data services for policymakers at all levels – government, local communities, businesses, and individuals. Various agencies are coordinating in the development of this database. The Office of Natural Resources and Environmental Policy and Planning (ONEP) and the Thai Metrological Department (TMD) signed a Memorandum of Understanding in 2021 to collaborate on the development of this National Framework for Climate Service (NFCS).

[5] Source: Germanwatch 2021
[6] Source: RU-CORE 2020
[7] Source: Ritphring et al. 2018

KEY ADAPTATION ACTIONS

WATER RESOURCE MANAGEMENT

It is anticipated that Thailand's yearly average rainfall will increase while the number of rainy days remains unchanged. The amount of rain is predicted to increase while rainfall distribution is likely to decrease. In this regard, Thailand will be experiencing more drought-risk areas and facing challenges in flood management in rainy season. Geographically, Bangkok and the northeastern region are likely to face relatively higher risk in water management than other regions.

In response, Thailand developed the Water Resources Master Plan in 2019, with a focus on river basin management by introducing both structural and non-structural adaptation measures in upstream, midstream, and downstream areas. In the upstream area, the emphasis is on the retention of flood water and severe runoff prevention. This includes measures to conserve and restore watershed area as well as to promote the use of economic instruments such as Payment for Ecosystem Service (PES) to enhance conservation efforts. In midstream to downstream areas, integrated water management, and water gate and water drainage management are key to minimize loss and damage from floods. Measures include the development of infrastructure to enhance ecosystem-based adaptation, increased capacity of drainage systems, and implementation of urban flood protection systems. Certain areas are designated as flood detention areas, such as Bang Rakam district in Phitsanulok province or Bang Ban district in Ayutthaya province. These flood retention areas are conceived as agricultural areas which are intentionally inundated for a short period to protect downstream areas from flooding. Farmers in the areas are advised to shift their crop calendars and receive in-kind or in-cash compensation. For midstream to downstream drought management, increased capacities of water retention areas and water reservation systems are essential. Additional measures include the development of water footprint, water demand and supply information, water usage allowance for each economic sector considering river basin water supply, and enhancement of water retention and reservation capacity in risk areas. These measures have led to the establishment of over a thousand water management networks in local communities, such as Baan Lim Thong in Buriram province and Baan Sala Din in Pathum Thani province, to exchange knowledge on water management at a community scale. It also has facilitated a shift towards low-water requirement crop planting during dry season.

AGRICULTURE AND FOOD SECURITY

Agriculture is a key priority sector in Thailand as it accounts for 46% of total land area and approximately 30% of the labor force. Changes in the amount of rainfall and rainfall distribution, particularly during planting season and seasonal shift, directly affect agricultural yields. Extreme weather events such as drought, heavy rainfalls, and floods, lead to widespread damage. Higher temperature results in heat stress and increased outbreaks in livestock, while changes in temperature and salinity affect mortality and sex determination in the aquaculture sector. The northeastern region is likely to face higher risk of heat, drought, and floods, compared to the rest of Thailand.

To reduce climate impacts on the agriculture sector, the 20-year Agricultural Development Plan (2017-2036) was adopted to provide systematic long-term guidance of agriculture development. Key actions are identified in crops, livestock and fisheries, aimed at maintaining production capacity and national food security. Adjusting plantation management, including changing crop calendars, changing fertilizer use, shifting to large-scale farming approach and improving agricultural techniques and infrastructure are key adaptation measures for crop management. In addition, relevant governmental agencies are conducting research and experiments in crop varieties that are pest-resistant, flood-resistant or drought-tolerant to increase yield and reduce production costs. Among many success cases, the Thai Rice NAMA project has been able to reduce water consumption in rice cultivation through the laser and land levelling and alternative wetting and drying (AWD) techniques in response to water shortage during dry seasons. For livestock, promotion of closed system farming for cattle, buffaloes, and pigs to improve the management of pastures, feeding, and manure, as well as to prevent heat exposure, has been identified as a key adaptation measure. In parallel, Thailand also continues research on heat-resistant livestock and on maintaining productivity in longer and warmer summers. Similar to livestock, shifting the method of fish rearing from rivers and canals to cages or closed systems to minimize impacts from floods and drought is a key adaptation action for aquaculture practices. In addition, for coastal fishing, emphasis is placed on the management of physical environment and water quality to maintain productivity.

TOURISM

Tourism is among the major drivers of Thailand's economy, contributing around 18% of the national GDP in 2019. During 2015-2019, tourism revenue was growing on average 2.3% annually[8]. Climate change affects the quality of climate- and nature-dependent tourism destinations, water availability and biodiversity loss. Increased frequency and magnitude of extreme weather events affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, higher operating costs and business disruptions. According to a risk map of the tourism destinations, it is suggested that under RCP 4.5 and RCP 8.5 scenarios, Chiangmai, Surat Thani and Trat provinces will face the highest flood risk, while Bangkok, Khon Kaen and Nakhorn Ratchasrima provinces face the highest drought risk[9].

To build adaptive capacity in this sector, various measures of technical, research and managerial aspects are proposed for both natural and man-made tourism destinations. For natural tourism destinations, attention is given to improving infrastructure and developing location-based disaster preparedness plans and early warning systems for extreme weather events by taking into account their carrying capacity. In addition, managerial adaptation measures, such as storing a sufficient water supply for tourism activities, closing some sites during high-risk periods, shifting the tourism calendar to correspond to changes in seasonal patterns and using weather forecasts to plan different tourist activities such as gastronomy, health and wellness, and cultural related activities, have been put in place. Examples include a closure of island destinations such as Maya Bay and Loh Samah Bay of Hat Noppharat Thara in Phi Phi Islands National Park during the monsoon season from August to September to reduce risks from storm surges, and a closure of waterfalls and caves in the north and northeast during rainy seasons to reduce risks from flash floods and landslides. This adaptation measure has proven to also benefit conservation efforts as it allows nature to recover during the closing period. Similar to natural destinations, key adaptation actions for man-made destination management include building resilient infrastructure, particularly flood prevention infrastructure for historical and cultural parks, as well as adopting additional conservation measures to prevent the decay of architectural structures from temperature change, humidity, floods, and increasing atmospheric CO_2 levels.

PUBLIC HEALTH

Adverse impacts of climate change have threatened to exacerbate public health in Thailand. By 2080, the World Health Organization (WHO) estimates that heat-related mortality among Thai elderly will increase to 58 deaths per 100,000 population. This will add pressure to the health system, both on personnel and facilities, particularly those located in flood-prone or drought-prone areas as Thailand is projected to become a "super-aged society" by 2035. Additionally, under RCP 4.5 and RCP 8.5 scenarios, the northeastern region will face the highest risk in heat, drought, and floods compared to other regions in Thailand.

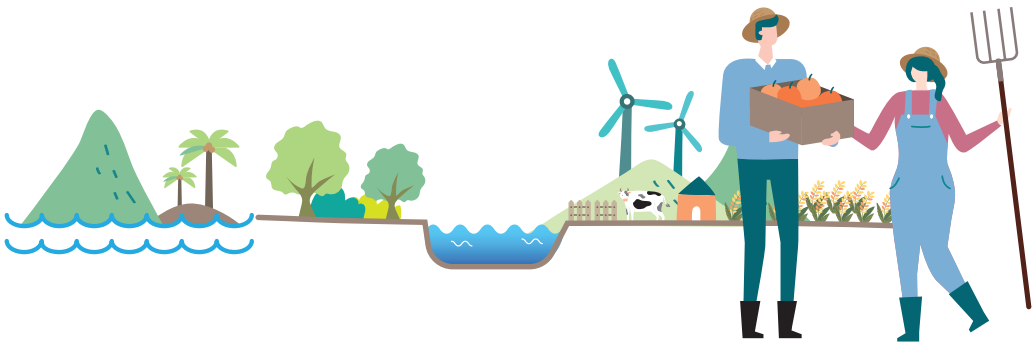
Adaptation in the public health sector is considered on two levels, namely an individual level with a focus on educating people about climate change and health impacts, and a systemic level with a focus on adaptation measures for health surveillance systems. At the individual level, adaptation measures focus on enhancing knowledge and capacity of the general public, health personnel, and healthcare networks to prevent and provide healthcare for health-risk groups such as the elderly, children, pregnant women, patients with chronic conditions and outdoor workers. Training is provided to health personnel for effective emergency responses in accordance with emergency response standards during extreme weather events. At the systemic level, efforts have been placed on the development of a health-climate database and warning criteria, development and implementation of warning systems and networks, as well as improvement of health surveillance systems and standards. Heat and extreme weather warning and alert systems at the community level are being piloted in some areas and the government will continue expanding and scaling-up successful models to other areas. In preparation for more frequent extreme weather events, resources are allocated to improve resilient health infrastructures and facilities. Examples of these adaptive actions include a collaboration between the Department of Health (DOH) and the Thai Meteorological Department (TMD) to develop a critical threshold of temperature that will trigger heat warning systems and the development of a heat surveillance and warning manual by DOH that is disseminated to relevant local authorities and communities.

[9] Source: NESDB 2022

NATURAL RESOURCE MANAGEMENT

Rich and abundant natural resources in Thailand are threatened by temperature fluctuations, changes in precipitation, and extreme weather events, including floods, droughts and storm surges, as well as sea level rise and warming of ocean temperatures, affecting both terrestrial, marine and coastal ecosystems.

To address climate risks, Thailand continues to monitor biodiversity and natural resources in terrestrial, wetland, coastal and marine ecosystems, including through developing biological indicators and Thailand's Red List Index, and to enhance the Payment for Ecosystem Service (PES) as a sustainable management mechanism. For terrestrial ecosystems, emphasis is on the enhancement of reforestation, afforestation, and conservation measures, particularly in upstream forest areas, taking into account ecological corridors and ecosystem-based approaches, in order to increase efficiency in preserving ecosystem and biodiversity integrity and conserving water supplies. To cope with forest fires during the dry season, attention is given to the expansion of forest-fire prevention networks with enhanced community participation in building ditches along protected forest areas and installing check-dams in watershed areas. On wetlands, management plans of internationally, nationally, and locally significant wetland areas are developed and implemented, focusing on habitation of water banks to prevent or slow down flooding. For fragile ecosystem areas outside protected areas, Thailand plans to expedite the designation of the Environmentally Protected Areas (EPAs) to maintain their ecological balance. In addition, for marine and coastal ecosystems, the government has been working to enhance capacity of local communities to cope and respond to climate change impacts, by installing surge barriers, planting mangrove forests and developing evacuation plan for storm surges. Among many good examples, in July 2022, the Department of Marine and Coastal Resources (DMCR) designated Trang province as the first Marine Protected Area due to its significance as a home of dugongs and seagrass. Specific conservation and prevention measures are being enforced to ensure sustainable management of the site, including measures to cope with climate change impacts.



HUMAN SETTLEMENTS AND SECURITY

Many urban and peri-urban areas in Thailand are located in low-lying areas as well as along the coastline. According to the 13th National Economic and Social Development Plan, in 2020 the urban population in Thailand was 34.5% and is projected to increase. Impacts from heavy rainfalls, temperature changes, and sea level rise have become apparent in urban and peri-urban communities. RCP 4.5 and RCP 8.5 scenarios indicated that the top four provinces with the highest risk in human settlements and security are Bangkok, Nakhon Ratchasima, Samut Prakan and Khon Kaen.

Adaptation measures for human settlements and security in Thailand are divided into two main levels, namely a metropolis and city level, and a town and community level. Supporting measures are also identified, including the development and integration of climate resilient criteria for urban planning and building code standards, and the enhancement of adaptive architecture and design at housing and building level. Key adaptation measures at the metropolis and city level include increasing resilience in critical infrastructure development to ensure continuity and accessibility for public services such as power and water supply and public transport during extreme weather events; applying additional town planning and building code regulations in high-risk areas; and encouraging mixed-use urban development and expansion of public green areas. At the town and community level, Thailand continues to integrate adaptation into land use planning and development. This includes introduction of additional analysis tools for town and land use planning, with consideration of climate risks from heavy rainfalls, drought and heat. For coastal communities, emphasis is on strengthening the coping capacity of communities in the prevention and surveillance of sea level rise and storm surges. A good adaptation example is the design of Chulalongkorn University Centenary Park, located in the center of Bangkok, as a multi-functional urban forest to serve as green space for communities to reconnect with nature. The park includes a constructed wetland, with a rain garden, a retention pond and an underground water drainage system to demonstrate the role of public parks in helping the city to reduce urban floods, urban heat islands and climate-related impacts.

As a highly vulnerable developing country, achieving climate resilience is an integral part of Thailand's climate efforts to achieve the objectives of the UNFCCC and its Paris Agreement. While Thailand has contributed less than 1% of global GHG emissions (ranking 81st in terms of per capita GHG emissions), impacts from climate change have exacerbated over the past decades and, as a result, Thailand is among the top ten most affected countries in terms of human impacts and direct economic losses. It is estimated in a recent study that the cost to implement enabling environment measures to allow Thailand for full adaptation implementation would be 3,600 million THB or 98 million USD during the NAP implementation period of 2018-2037[10]. In order to realize Thailand's vision of long-term low GHG emission and climate-resilient development pathway, global partnership and international cooperation and support on adaptation, loss and damage, and on building climate resilience, particularly in terms of technical and technological support and capacity building, will be an important integral aspect to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of national circumstances, in the implementation of the UNFCCC and its Paris Agreement.

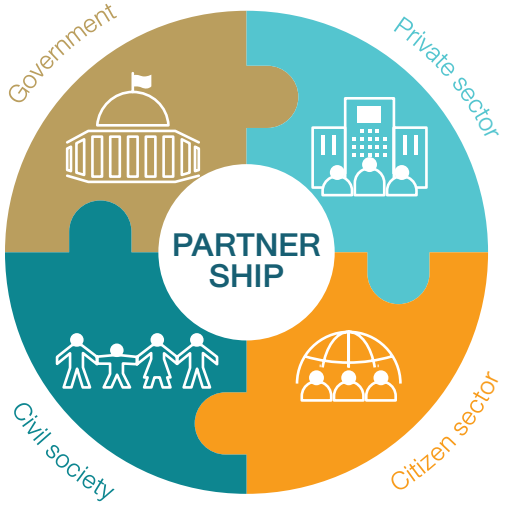
[9] Source: Creagy Co., Ltd. 2021

Chapter 6:

ENABLING CONDITIONS AND PARTNERSHIP BUILDING

ENABLING CONDITIONS

To make the transition to a climate-resilient and low greenhouse gas development pathway, specific enabling conditions will be required. In recent years, the Thai government has worked and continues to address key enabling conditions, including national regulations and incentives, as well as providing market infrastructure to create the right conditions for investment in a sustainable and green transition to low-carbon development.



REGULATORY FRAMEWORK

The National Strategic Plan on Climate Change (2008-2013) was first developed to provide a detailed and specific plan to facilitate the integration of climate change into policies and plans of relevant agencies. At the moment, the Climate Change Master Plan (2015-2050) is the most comprehensive national framework to provide a long-term direction and key strategies in mitigation, adaptation and cross-cutting issues in driving Thailand towards a low carbon emission and climate-resilient society. As a Party to the Paris Agreement, Thailand submitted its first Nationally Determined Contribution (NDC) with a mitigation target to reduce greenhouse gas emission by 20-25% from BAU level in 2030. Subsequently, the NDC Roadmap on Mitigation 2021-2030 and the NDC sectoral action plans in energy, transport, industry and waste were developed to provide a clear outline of measures and responsible implementing agencies. Thailand's first updated NDC confirms the above-mentioned target with additional elaboration on mitigation measures and adaptation actions. To be in line with this LT-LEDS, Thailand has revised its updated 2030 NDC by enhancing its greenhouse gas emission reduction target to 40% from the BAU level in 2030, with adequate and enhanced international support on finance, technology and capacity-building. Building adaptive capacity and resilience is a top priority for Thailand to reduce the adverse impacts of climate change on its economy, society and environment. The National Adaptation Plan (NAP) was developed in 2018, outlining key strategies and measures to minimize risks and strengthen capacity of institutions, systems and actors to deal with and respond to the impact of climate change. It provides a framework for guiding adaptation efforts in priority sectors, namely, water management, agriculture, natural resources management, tourism, public health and human settlement.

To effectively tackle the threat of climate change to Thailand's economy and society and to implement relevant provisions under the UNFCCC and its Paris Agreement, Thailand has integrated climate change into its national development policies, strategies and plans across sectors such as the 20-year National Strategy (2018-2037), the Master Plan Under the National Strategy, the National Reform Plan, the 13th National Economic and Social Development Plan and the National Energy Plan Framework to coherently drive Thailand towards a goal of carbon neutrality by 2050 and net zero emissions by 2065. Many sectoral policies and plans have already mainstreamed or plan to mainstream climate change into its key strategies and will play a key role in pursuing Thailand's carbon neutrality and net zero targets. Examples of these policies and plans are the National Energy Plan (2022), the Electric Vehicle for Public Transport Development Plan, the Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts (2013-2030), the National Industrial Development Master Plan (2012-2031), the National Solid Waste Management Master Plan (2016 – 2021), the Plastic Waste Management Roadmap (2018-2030) and the Municipal Wastewater Management Plan. Climate change is also a key component in the Bio-Circular-Green Economy Model (BCG) that Thailand is actively implementing as a pathway to achieve the country's sustainable development goals. Thailand's BCG strategic plan has been developed with the focus to promote waste reduction throughout economic value chains, as well as resource efficiency, green energy, and low carbon technologies. The plan focuses on four priority areas, namely, food and agriculture; medical and wellness; energy, material, and biochemicals; and tourism and creative economy.

In March 2021, the National Committee on Climate Change Policy approved a draft of Thailand's first climate legislation, the Climate Change Act, for submission to the Cabinet. The Act specifies the rights of citizens to be informed by the government about climate change information. The government has obligations to evaluate and assess the effect of climate change, and to provide information and warnings to the public, to sponsor research and development of technology and innovation that will help with adaptation to cope with climate change, and to develop and adopt climate-sensitive policies, including NDCs and NAPs. The Act mandates the Thai Meteorological Department to work with the Office of Natural Resources and Environmental Policy and Planning on the development of a national climate data center that provides information regarding changes in weather patterns, temperature and precipitation levels, and the impact of those changes on key sectors. The Act also establishes the Thai Environmental Fund as the first domestic climate financing mechanism, with resource allocation to support climate mitigation and adaptation projects, research and activities. The Act mandates key agencies, including the private sector, to report data on activities that lead to GHG emission, and efforts are under way to incorporate carbon pricing mechanisms, including carbon tax and/or carbon market, as part of the draft Act, which will soon be tabled for cabinet and parliamentary approval as next steps.

INCENTIVES FOR LOW CARBON INVESTMENT

A majority of Thailand's decarbonization efforts require investments in technology switching and development. Successful mobilization of private sector investments to shift towards climate-friendly technologies plays a key contributing role in Thailand's carbon neutrality and net zero emission pathway. The Thai private sector also recognizes that several opportunities can arise, in terms of value adding to the industries, increased efficiency and cost-saving potential as a result of the transition towards a low-carbon economy. These opportunities include, for instance, increasing efficiency in the shift to value added S-curve industries in the BCG model, cost-saving from waste recovery, energy efficiency and green logistics, new market access for sustainable, climate-friendly products, etc. The Thai government therefore plans to work in close partnership with the private sector in designing clear policies and incentives that support turning the private sector's financial and investment challenges into low-carbon opportunities.

In 2021, the Thailand Board of Investment (BOI) introduced several tax exemption schemes to promote domestic and foreign investments in low-carbon technologies, covering all mitigation sectors – energy, transport, industrial processes, waste, and agriculture. The schemes include, for example, tax exemption for energy service companies (ESCOs), carbon capture (Utilization) and storage (CCS/CCUS) technologies for the petrochemical and natural gas separation plants, the use of natural refrigerants in the cooling and cold storage industry, electric vehicle and battery platform investment, machinery replacement for energy efficiency and renewable energy, and waste recycling companies. The BOI also introduced schemes to motivate community enterprises, local authorities, and cooperatives to invest in low-methane rice cultivation, low-carbon and smart agriculture technologies.

The Ministry of Finance, the Bank of Thailand, the Securities Exchange Commission, the Office of Insurance Commission, and Thailand's Stock Exchange formed a joint Working Group on Sustainable Finance. The Working Group released Thailand's Sustainable Financing Initiatives in 2021 which include the development of a green finance taxonomy, improvement of environmental, social, and governance (ESG) data including disclosure of GHG emission for listed companies. Table 6-1 lists the five key strategic initiatives of Thailand's Sustainable Financing Initiatives.

Table 6-1 Thailand's Sustainable Financing Initiatives

Source: The Bank of Thailand

KEY STRATEGIC INITIATIVES	DESCRIPTION
KSI 1: Developing a Practical Taxonomy	Developing a practical national sustainable finance taxonomy will promote inward investment flows across Thailand's financial subsectors from domestic and international investors. A well-defined and structured taxonomy also supports better-informed and more efficient decision-making and responses to investment opportunities that contribute to achieving national sustainable development objectives.
KSI 2: Improving the Data Environment	Developing a rich data environment encourages the flourishing of new products and markets which meet the sustainability criteria of a wider and more diverse range of investor. The quality, depth, immediacy, and price of sustainable finance data will be a key competitive advantage as Thailand positions itself against other sustainable finance centers.
KSI 3: Implementing Effective Incentives	Implementing effective incentives facilitates and promotes policies and mechanisms that incentivize financial flows towards sustainable development. These incentives can include fiscal and prudential policies in the main, but non-financial approaches should also be considered where viable.
KSI 4: Creating Demand-led Products and Services	Creating demand-led products and services is essential for a thriving sustainable finance sector which requires reinvestment in continual improvement. To reach this state, there must be real underlying demand for sustainable products and services, and a genuine interest in the different aspects of sustainability.
KSI 5: Building Human Capital	The transformation to a sustainable financial sector will be driven by the day-to-day interactions among relevant stakeholders. The quality of those interactions will depend upon their skills, competences, values, and behaviors of the management and staff of the financial sector.

The Bank of Thailand also played a key role in supporting the Thai Bankers' Association (TBA) in the development of a Memorandum of Understanding (MoU) on Sustainable Banking Guidelines for Responsible Lending. The MoU was signed by all TBA members in October 2019 and by the Association of International Banks (AIB) members in February 2020. The MoU focuses on promoting responsible lending, encouraging banks to incorporate ESG risks into their lending strategies, and translating them into implementation. Following these initiatives, commercial banks have initiated green and blue bonds aiming to support businesses in accessing capital for combating climate change, particularly in the energy and electric vehicle development, as well as promoting sustainable blue economy development.

B. GRIMM'S GREEN BOND

In June 2018, B. Grimm Power Public Company, one of the largest private power producers in Thailand, was the first real-sector corporation to issue certified green bonds worth USD 155 million with Asian Development Bank (ADB) purchasing all the debentures. This has earmarked 9 operational solar power plants with a capacity of 67.7 megawatts (MW), 7 solar plants under construction with a capacity of 30.8 MW and will support Thailand in achieving a low-carbon pathway.

Source: www.bgrimmpower.com

Box 6-1 Example of green bond for solar power plants

TMB THANACHART BANK'S BLUE BOND

In May 2022, TMB Thanachart Bank, with support from the International Finance Cooperation (IFC), was the first commercial bank in Thailand issuing the Blue Bond to support the businesses in accessing capital for blue economy and climate change including reducing marine debris, marine ecosystem restoration, sustainable shipping, and offshore renewable energy. IFC has subscribed up to USD 50 million in the first Blue Bond issued by TMB Thanachart Bank.

Box 6-2 Example of blue bond to support blue economy

MARKET INFRASTRUCTURE

Thailand has established a voluntary domestic market for GHG emission reduction, called the Thailand Voluntary Emission Reduction Program (T-VER), operated by the Thailand Greenhouse Gas Management Organization (TGO). All sectors can voluntarily participate in the program to sell the carbon units within Thailand's jurisdiction. Rules and procedures for project development, GHG emission reduction methodologies, verification and certification of emission reduction credits have been developed by TGO, taking into account CDM methodologies, in light of the national context and circumstances. Since 2015, 11,860,059 tCO_2eq have been certified, the majority of which are from alternative and renewable energy projects.

The Ministry of Natural Resources and Environment through the Office of Natural Resources and Environmental Policy and Planning (ONEP) is now in the process of establishing a domestic (mandatory) cap-and-trade system for GHG emission reduction in Thailand, which will enhance the existing T-VER program. In March 2022, the National Committee on Climate Change Policy (NCCC) approved an initial guideline for domestic and international carbon trading, classified into "over the counter" trading (direct transition between buyer and seller of carbon credits) and "trading through carbon trading center". The guideline also establishes rules and procedures and designates TGO as a main responsible agency for registering and certifying carbon trading transactions and credits. Subsequent regulations are under development by ONEP to clarify priority sectors for mandatory carbon trading scheme for Thailand, which will be incorporated as part of the draft Climate Change Act.

In addition, TGO initiated several carbon labeling schemes for organizations and products to raise awareness and promote market incentives for low-carbon products.

Carbon footprint for Organization (CFO):
CFO is a tool to quantify and report GHG emissions and removals from an organization's activities which can be categorized into three scopes, which are Scope 1: Direct GHG emissions/removal; Scope 2: Energy indirect GHG emissions; and Scope 3: other indirect GHG emissions. More than 995 organizations have been approved under this scheme.

Carbon Footprint for Products (CFP):
CFP is a tool to quantify GHG emissions of products through their life cycle stages aiming to raise consumer awareness of the products' GHG emissions. More than 5,930 products have been approved under this scheme.

Carbon Footprint of Circular Economy Product (CE-CFP):
CE-CFP is a tool to quantify GHG emissions, especially for circular economy products through their life cycle. More than 38 products have been approved under this scheme.

Carbon Footprint Reduction Label (CFR):
CFR is a label that shows the carbon footprint of the product and its emission reduction based on TGO's emission reduction criteria. More than 908 products have been approved under this scheme.

DRIVING FORWARD CARBON SEQUESTRATION

Natural carbon sequestration and negative GHG emission technologies will be an important part in Thailand's carbon neutrality and net zero GHG emission efforts. In December 2021, a subcommittee on natural carbon sequestration measures was established under the NCCC, with mandates to provide policy recommendations on green area expansion, identify profit-sharing mechanism among different stakeholders and promote partnerships between public and private sectors, as well as civil society. Following the subcommittee's recommendation, a T-VER program is being promoted for the private sector and civil society to increase Thailand's green area through afforestation and reforestation in both public and private lands.

The Ministry of Energy and the Ministry of Natural Resources and Environment are also working together to prepare for CCS/CCUS technology implementation towards carbon neutrality by 2050. A Subcommittee on Enhancing GHG Mitigation Implementation from Applying CCUS Technology has been established and is chaired by the Minister of Energy. The subcommittee has a mandate to prepare for potential implementation of CCS/CCUS technologies by considering relevant necessary regulations and safeguard measures, as well as determining feasible investment options for CCS/CCUS implementation.

DOMESTIC PARTNERSHIP

The Office of Natural Resources and Environmental Policy and Planning (ONEP), as the national climate focal point, has signed several MoUs with key agencies in Thailand to collaborate on climate mitigation and adaptation mainstreaming and actions. These include MoUs with:

Department of Public Works and Town & Country Planning (DPT), with the objective to support adaptive spatial planning development in response to climate change to increase the resilience of the cities and communities.

Thai Meteorological Department (TMD), with the objective to develop the country's climate information that will be used to formulate climate policies and measures and to support achieving national strategies and the Sustainable Development Goals.

The Securities and Exchange Commission (SEC), with the objective to promote enterprise environmental performance in Thai capital market to build knowledge and awareness in doing business with good governance and responsibility to society and environment.

Department of Tourism (DOT) and Thailand Greenhouse Gas Management Organization (TGO), with the objective to enhance personnel capacity and potential of climate change implementation in the tourism sector.

Office of the National Water Resources (ONWR), with the objective to mainstream climate change adaptation into the water sector by using scientific climate and risk information as well as data sharing between government agencies.

In addition, partnerships within the private sector and civil society will be a key factor to ensure concrete implementation towards a sustainable transition. Some examples of private sector partnerships include:

THAILAND BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT (TBCSD)

The Thailand Business Council for Sustainable Development was established in November 1993 by Mr. Anand Panyarachun, former Prime Minster of Thailand, with current membership of 36 high profile business leaders from 36 companies. The objective of the TBCSD is to promote environmental awareness within the business sector under the concept of "sustainable development". The Thailand Environment Institute provides the Secretariat support. TBCSD focuses on three main programs to ensure sustainability: (1) Policy development in Thailand, (2) Capacity building on business competitiveness and good practices, and (3) Raising public awareness of cultural and environmental issues.

GLOBAL COMPACT NETWORK THAILAND (GCNT)

The Global Compact Network Thailand (GCNT) was launched in November 2016, by 15 companies as the founding members. GCNT supports companies to do business responsibly by aligning companies' strategies and operations to advance broader societal goals, including the Sustainable Development Goals (SDGs). On 11 October 2021, GCNT, together with the UN, organized the GCNT Forum 2021: Thailand's Climate Leadership Summit 2021 on the theme of "A New Era of Accelerated Actions.", where member organizations made a commitment to "prevent and solve problems of climate change" with the goal of achieving Net Zero by 2050 or at the latest by 2070. This was the first time in Thailand that the GCNT member organizations and businesses of all sizes joined hands to address the critical and urgent global sustainability issues, including the global warming crisis, which are a part of the SDGs.

THAILAND CARBON NEUTRAL NETWORK (TCNN)

TGO in collaboration with the Thai private sector have jointly established the Thailand Carbon Neutral Network (TCNN) to promote collaboration between the government, private sector, and local communities to enhance Thailand's climate actions towards carbon neutrality and net zero GHG emission targets. TCNN serves as a platform for exchanges and capacity building to inspire ambitious climate pledges from its members, supporting enhancement of Thailand's domestic carbon market. In addition, TGO and the Federation of Thai Industries have jointly supported the establishment of the Thailand Carbon Credit Exchange Platform, using a blockchain technology for carbon credit exchange for T-VER projects, in order to increase cost efficiency and create added value from T-VER carbon credits through fast, convenient, transparent and reliable carbon trading transactions, with clear reference prices reflecting real-time costs.

RENEWABLE ENERGY AND CARBON CREDIT EXCHANGE PLATFORM

The Federation of Thai Industries and the network of partners have also developed a Renewable Energy and Carbon Credit Exchange Platform (RE & CC Exchange Platform), which is an electronic platform to further facilitate exchanges of renewable energy certificates and carbon credits. Certificates and credits can be traded in four standards: T-VER, VERRA, Gold Standard and I-REC. The platform also aims to support compliance with the EU's CBAM (Carbon Border Adjustment Mechanism) for Thai exporters.

THAILAND'S SUPPORT NEEDS AND INTERNATIONAL PARTNERSHIP

International partnership is crucial as means of implementation for the achievement of Thailand's climate ambition. In particular, Thailand's support needs, in terms of technical assistance, technological transfer and development, capacity building, seed funding, capital investment support and pilot implementation, can be identified concretely (see Table 6-2).

Table 6-2 Thailand's Support Needs, including technical assistance, technological transfer and development, capacity building, seed funding and capital investment support, and pilot implementation

SECTOR	CARBON NEUTRALITY / NET ZERO GHG EMISSION PATHWAY, INCLUDING CO-BENEFITS / MULTI-BENEFITS	CLIMATE-RESILIENT PATHWAY
Energy	• Renewable energy technologies (such as solar, wind) and approaches in advanced energy storage system (EES) and demand-side management • Grid modernization and micro-grid development • Smart energy management and digitalization of renewable energy control center platform • Electricity market reform approaches and incentive schemes to promote renewable energy investments and markets • Bioenergy with CCS, green ammonia / green hydrogen R&D • Carbon capture and storage (CCS) or carbon capture, utilization and storage (CCUS) in power plants	• Climate-resilient energy infrastructure
Transport	• Electric vehicle battery and infrastructures • Bio-hydrogenated diesel (BHD) / Bio-jet fuel development • Travel demand management and transit-oriented development	• Climate-resilient transport infrastructure
Industry	• Energy efficiency improvement and low-carbon transition in iron and steel, aluminum, cement, chemical and other industries • Enhanced uses of renewables in industrial value chain • Smart energy management in the industrial sector • Carbon capture and storage (CCS) or carbon capture, utilization and storage (CCUS) in industries • Scaling up of cooling and refrigeration substitution and HFC phaseout (including HFC disposal) • Scaling up and mainstreaming of climate objectives in the Extended Producer Responsibility (EPR) framework • Policy framework for N_2O phaseout from nitric acid and caprolactam industries	

SECTOR	CARBON NEUTRALITY / NET ZERO GHG EMISSION PATHWAY, INCLUDING CO-BENEFITS / MULTI-BENEFITS	CLIMATE-RESILIENT PATHWAY
Waste	• Circular Economy development • Waste-to-energy technologies • Improved electronic and industrial waste (including HFC) disposal • Improved efficiency in industrial and municipal wastewater management • CH_4 recycling from industrial wastewater	• Climate-resilient waste infrastructure
Agriculture	• Sustainable agriculture practices, including urban agriculture, scaling up of sustainable palm oil production, etc., to support sustainable and regenerative sourcing, sustainable value chain management and BCG economy • Climate-smart agriculture technologies and techniques, including smart farming, precision farming, digitalization, drought-resistant / flood-resistant crop varieties, heat-resistant livestock, low-methane rice cultivation, improved livestock feed and manure management, sustainable soil management practices, etc. • Energy and resource efficiency improvement in agricultural practices and technologies • Climate insurance • Early warning / detection systems for plantation management adjustment (e.g. changing crop calendars, water management strategies, etc.)	
Forestry / Natural Resources	• REDD+ pilot and implementation phase, including development and improvement of forest reference level for Thailand • Smart Patrol System, advanced monitoring and spatial technologies for forest fire management • Climate and biodiversity synergy in conservation planning tools and measures, including development of biodiversity safeguards for carbon sink projects • Nature-based designs for natural carbon sinks • Sustainable community forest management / sustainable forest management practices • Sustainable management of blue carbon ecosystem services	
Water Resources		• Scaling up ecosystem-based adaptation, nature-based solutions and green infra-structure approaches for climate-resilient water resource management • Water efficiency improvement in agriculture, industry, household and commercial sectors
Public Health	• Energy efficiency improvement in health facilities	• Climate-related health surveillance and early warning system • Climate-resilient health infrastructure • Capacity building of emergency response standards

SECTOR	CARBON NEUTRALITY / NET ZERO GHG EMISSION PATHWAY, INCLUDING CO-BENEFITS / MULTI-BENEFITS	CLIMATE-RESILIENT PATHWAY
Tourism	• Sustainable eco-tourism and sustainable tourism practices	• Early warning system for extreme weather events and location-based disaster preparedness plan and capacity development • Climate-resilient tourism infrastructure, including preservation of cultural heritage sites • Seasonal closing and tourism calendar adjustment due to climate risks and carrying capacity • Alternative, less climate-dependent tourism activities
Human Settlements and Security / Urban Development	• Energy efficiency improvement in buildings • Multi-purposed, nature-based urban green space (e.g., for urban flood prevention, urban biodiversity protection, carbon sink and recreational purposes)	• Climate-resilient urban infrastructure, including urban planning and building code standards, critical urban infrastructure • Surveillance and emergency response systems and capacity development for cities, municipalities and communities • Urban ecosystem-based adaptation
Enabling Policies and Conditions	• Legal frameworks and modalities to support Thailand's LT-LEDS, NDC and NAP implementation • Design of financial instruments, incentives, mechanisms and approaches to engage the private sector in the shift to climate-friendly, climate-resilient and green investments, including carbon pricing, green taxonomy, sustainable lending instruments, for instance • Capacity building on climate-proofing tools and analyses for infrastructure / investments • Capacity building for the public and private sectors to integrate mitigation and adaptation action into their respective plans or enterprises • Skilled labor development to support climate-friendly transition • Climate awareness raising among relevant stakeholders and the general public at national and subnational levels, including through education, campaigns, media, public disclosure of climate-related environmental performance data, etc. • Just transition and benefit-sharing approaches towards low-carbon development, particularly for vulnerable population groups	

In essence, the fight against climate change requires strengthened global partnership, as no one country alone can deal with the extent and urgency of the climate challenges. As a developing country highly vulnerable to climate impacts, and a Party to the UNFCCC, the Kyoto Protocol and the Paris Agreement, Thailand has partnered with several countries in the initiatives that are in line with these multilateral agreements. Boxes 6-3 to 6-5 illustrate some of these partnerships.

THAILAND JOINED THE GLASGOW LEADERS' DECLARATION ON FORESTS AND LAND USE

In April 2022, the Thai cabinet approved for Thailand to join the Glasgow Leaders' Declaration on Forests and Land Use, which aims to underscore the importance of sustainable management of forests, biodiversity, and land use, and to affirm commitment to reduce deforestation and land degradation by 2030. Key issues under the Declaration are: (1) conserving forests and terrestrial ecosystems; (2) endorsing trade and development policies that are related to sustainable production and consumption; (3) enhancing local community immunity; (4) implementing or revising sustainable agriculture and food security policies; (5) financially supporting sustainable agriculture and forest management; and (6) facilitating the flowing of working capital in line with the goal on reforestation and areas and land restoration. The Declaration has now been joined by 144 countries worldwide.

Box 6-3 Thailand joined the Glasgow Leaders' Declaration on Forests and Land Use

CLIMATE PARTNERSHIP WITH GERMANY THROUGH THE INTERNATIONAL CLIMATE INITIATIVE (IKI) AND THE NITRIC ACID CLIMATE ACTION GROUP (NACAG)

Thailand is among the 15 priority countries of the International Climate Initiative and has been in close collaboration with the Federal Ministries of Germany on climate policy and implementation since 2008. Recently, Thailand and Germany have pushed forward concrete efforts toward mitigation action in the IPPU sector, by joining the NACAG declaration in December 2019, and are now jointly working towards nitrous oxide (N_2O) reduction in the Thai caprolactam industry. The NACAG initiative supports countries on both financial and technical aspects. The financial support incentivizes N_2O abatement technology installation and the technical support gives advice on technological, regulatory and policy options related to the industry's N_2O abatement and phaseout.

Box 6-4 Thai-German Climate Partnership

SHIFT PROGRAM ACTIVITY "OPERATION OF E-BUSES ON PRIVATELY OWNED, SCHEDULED PUBLIC BUS ROUTES IN THE BANGKOK METROPOLITAN AREA BY ENERGY ABSOLUTE"

To explore potential cooperation under Article 6.2 of the Paris Agreement, Thailand and Switzerland develop the SHIFT Program Activity "Operation of E-buses on privately owned, scheduled public bus routes in the Bangkok Metropolitan area". It will accelerate the introduction of privately owned and operated electric buses into Thailand's public transport infrastructure by introducing 500 air-conditioned electric passenger buses to replace 500 open-air diesel-fueled internal combustion engine buses in Bangkok Metropolitan Region. The result of this program will be the emission reduction of 100 tCO_2eq per e-bus per year for fuel switch and if modal shift is taken into account, the program can lead up to a potential emission reduction of 500,000 tCO_2eq over the project duration until 2030.

Box 6–5 SHIFT Program Activity: A pilot cooperation under the Paris Agreement Article 6.2

It is important to emphasize that these and future international partnerships can contribute significantly to the achievement of Thailand's climate ambition and are essential in the achievement of Thailand's 2050 carbon neutrality, 2065 net zero GHG emission and long-term climate-resilient pathway, and Thailand will continue to build international partnerships in order to strengthen global cooperation, as well as domestic actions to address climate change, including in particular those identified as Thailand's support needs and in line with the UNFCCC and the Paris Agreement.

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