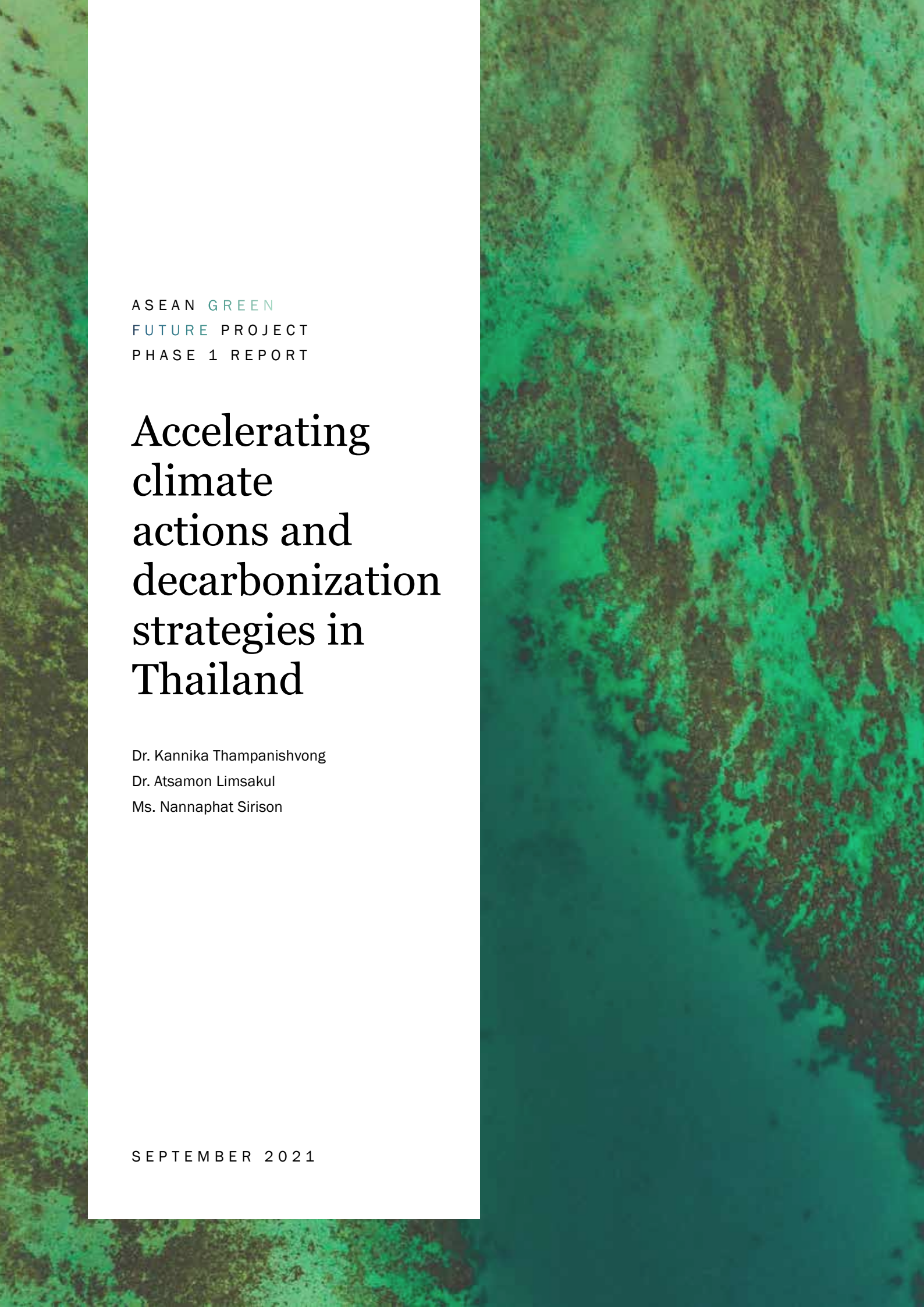

ASEAN GREEN
FUTURE PROJECT
PHASE 1 REPORT

# Accelerating climate actions and decarbonization strategies in Thailand

Dr. Kannika Thampanishvong
Dr. Atsamon Limsakul
Ms. Nannaphat Sirison

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DISCLAIMER

This ASEAN Green Future report was written by a group of independent experts acting in their personal capacities. Any views expressed in this report do not necessarily reflect the views of any government or organization, agency, or programme of the United Nations.


**Authors**

Dr. Kannika Thampanishvong

Senior Research Fellow
Thailand Development Research Institute

Dr. Atsamon Limsakul
Senior Environmental Officer

Environmental Research and Training Center
Department of Environmental Quality Promotion

Ms. Nannaphat Sirison

Duke University


**About ASEAN Green Future**

The ASEAN Green Future project is a collaboration between the Sustainable Development Solutions Network, ClimateWorks Australia, the Jeffrey Sachs Center on Sustainable Development at Sunway University, and research groups from across Southeast Asia (Cambodia, Indonesia, Laos, Malaysia, and Thailand, with potential participation by Brunei, Myanmar, the Philippines, Singapore, and Viet Nam in the future).

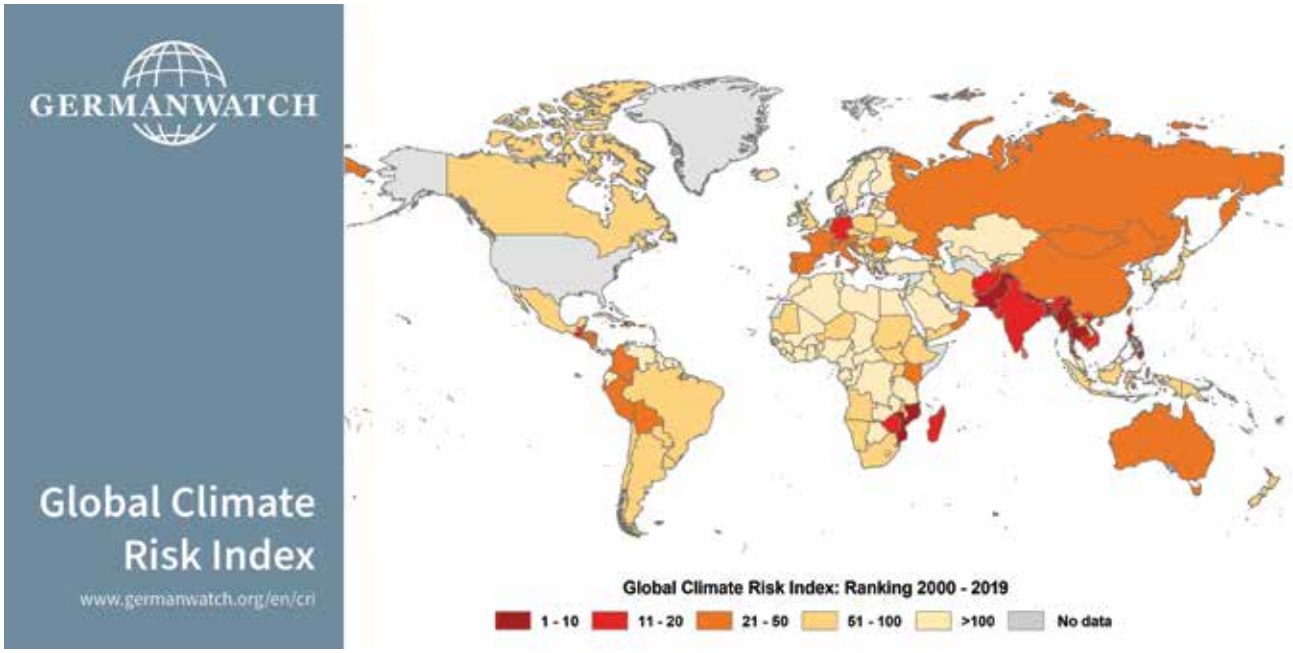
The Phase 1 report of each country team presents priorities and actions to date, and key technology and policy opportunities to further advance domestic climate action. The Phase 1 regional report situates the region's path to low-carbon transition within a global context using the country reports and other studies. This series of reports, produced through a synthesis of existing research and knowledge, builds the case for advancing the region's climate agenda. Phase 2 of the ASEAN Green Future project will undertake quantitative assessments of the different options for decarbonizing the ASEAN countries.

# Contents

# 1. Impacts of climate change on Thailand

Climate change is a global issue that impacts every country worldwide. Climate patterns are changing, sea levels are rising, and weather events are becoming more extreme. According to the United Nations (2019), 2010–2019 was the warmest decade ever recorded, bringing with it massive wildfires, hurricanes, droughts, floods and other climate-related disasters which have disrupted national economies, and affected lives and livelihoods, especially for the most vulnerable. Thailand is one of the countries most vulnerable to the impacts of climate change including rising sea levels, and increased frequency and severity of weather-related disasters. Already, Thailand is witnessing how climate change can exacerbate storms and disasters, threatening food and water supply which can lead to conflict. Figure 1 shows the Climate Risk Index (CRI) developed by German Watch. Thailand is ranked 9th in terms of countries most affected from climate change over the period 2000 to 2019 (annual average).

FIGURE 1: CLIMATE RISK INDEX MAP DURING 2000-2019



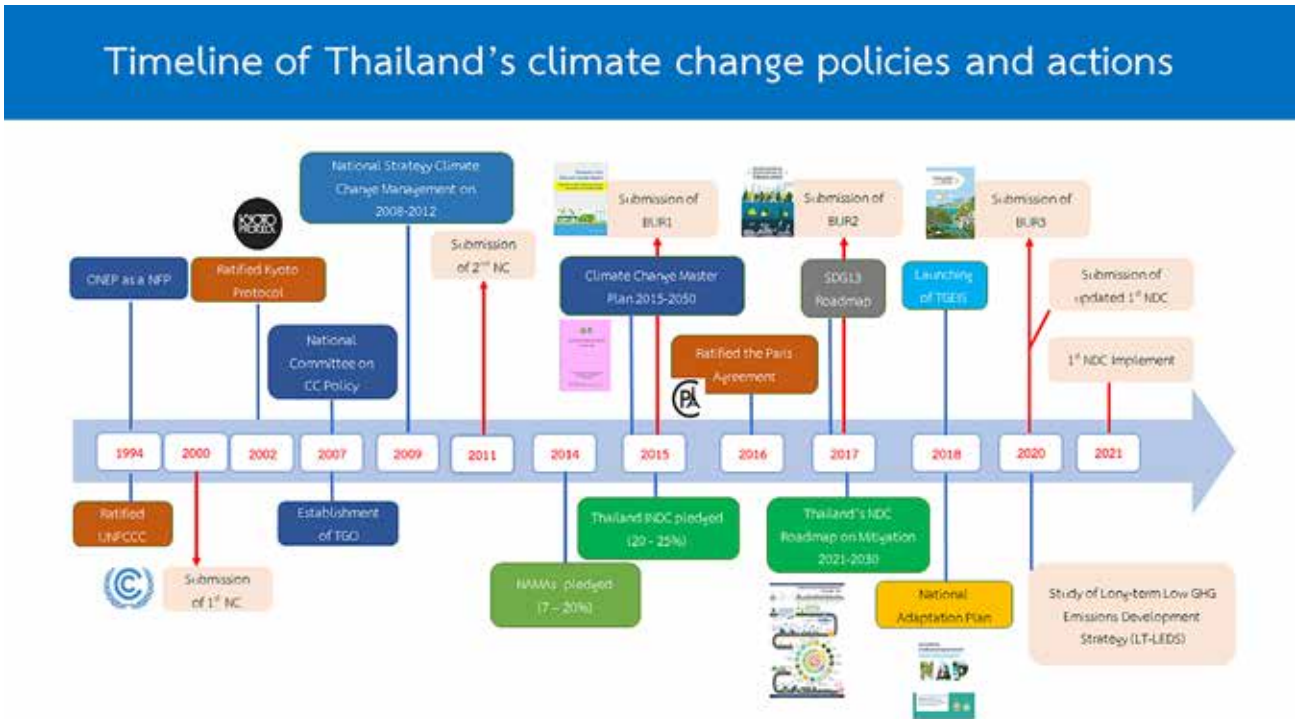

Source: German Watch 2021

Further warming will result in increased frequency and severity of extreme weather events and cumulative impacts associated with slow onset events such as sea level rise. The nation's six most vulnerable sectors to climate change impacts are: water resource and management, agriculture and food security, tourism, human settlement and security, public health and natural resource management. Increased frequency and severity of extreme weather events, especially floods and droughts, have already caused severe economic impacts and these impacts will continue to intensify unless transformative and holistic adaptation is put in place. At the same time, the country is a growing contributor to global climate change, as emissions in 2016 increased by about 43 percent compared to the 2000 level (Thailand's Third Biennial Update Report, 2020).

# 2. Thailand's state of play in terms of climate action

Thailand has shown its commitment to climate actions as the nation ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, became a member of the Kyoto Protocol as a non-annex party in 2002 and made a recent commitment under the Paris Agreement in 2016 (Figure 2). The Ministry of Natural Resources and Environment in the Office of Natural Resources and Environmental Policy and Planning (ONEP) serves as the national focal point for the UNFCCC. As a non-annex party to the UNFCCC and the Kyoto Protocol, Thailand has voluntarily implemented its mitigation actions under UNFCCC Nationally Appropriate Mitigation Actions (NAMA) with a primary focus on the energy and transport sectors. As a party to the Paris Agreement, Thailand has submitted its Nationally Determined Contribution (NDC), which sets forth goals to reduce greenhouse gas (GHG) emissions by 20 percent from the projected business as usual (BAU) levels by the year 2030, with potential for reduction by up to 25 percent, conditional on capacity building, financial and technological development support provision. At COP26, Thailand has announced that the NDC target will be revised to cutting GHG emissions by 40 percent relative to BAU conditional on capacity, building, finance and technological support. In enhancing ambition from the NAMA, Thailand's NDC also prioritizes the nation's mitigation measures in the energy and transport sectors, especially in renewable energy and energy efficiency. Thailand has not yet set a 2050 goal to reduce greenhouse gas emissions.

FIGURE 2: TIMELINE OF THAILAND'S CLIMATE POLICIES AND ACTIONS




Source: Limsakul (2021)

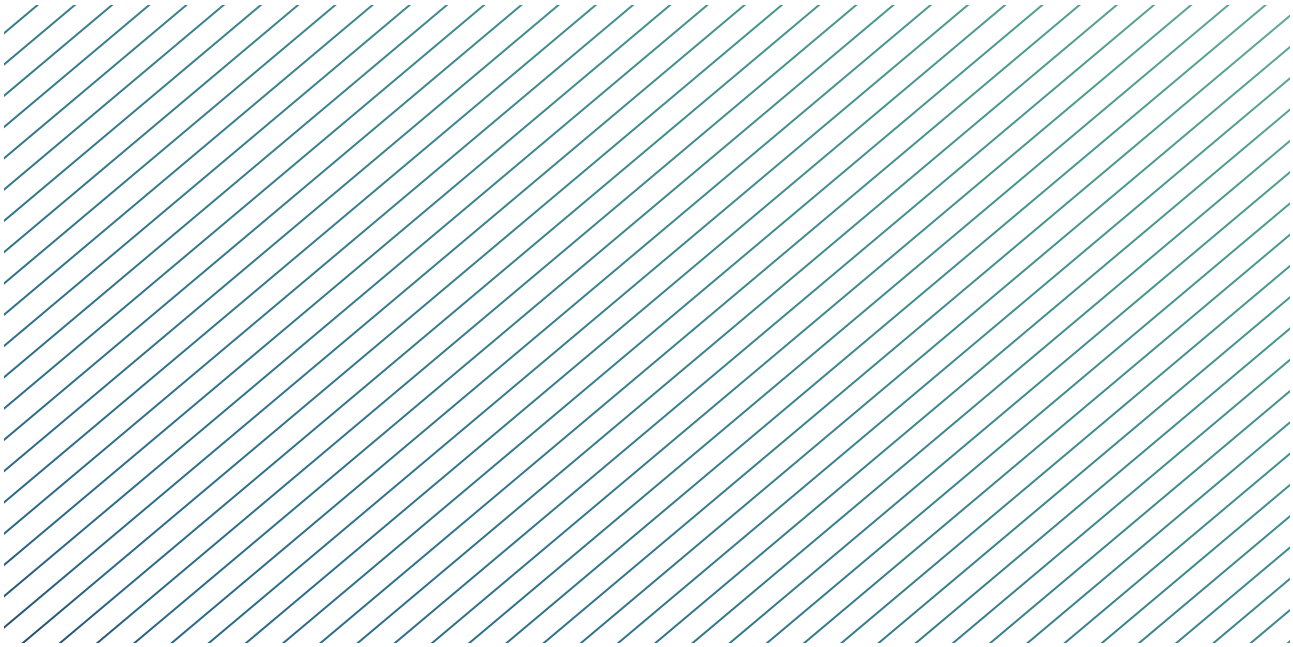
In compliance with reporting commitments as a non-annex party to the UNFCCC, ONEP regularly prepares and presents the nation's climate action efforts via a National Communication (NC) and Biennial Update Report (BUR). Most recently Thailand has submitted its Third National Communication (TNC) and Third BUR. Thailand's TNC presents the nations efforts to reduce GHG emissions and improve climate resilience, and Third BUR

provides updated information on the national GHGs inventory and progress of GHG emissions reduction under NAMA, along with constraints, challenges, gaps and needs in climate mitigation and adaptation implementations. In addition, ONEP conducts assessments on Thailand's climate change impacts and vulnerabilities, and highlights opportunities for adaptation as a part of the National Adaptation Plan (NAP). Thailand's NAP considers adaptation to climate change impacts at both national and local levels, prioritizing the six most vulnerable sectors, namely water resource and management, agriculture and food security, tourism, human settlement and security, public health and natural resource management.

Thailand submitted its Long -Term Low Greenhouse Gas Emissions Development Strategy to the UNFCCC at the end of October 2021 to accelerate and fulfill its commitment to climate-resilient and low-carbon development and to enhance its subsequent NDCs.

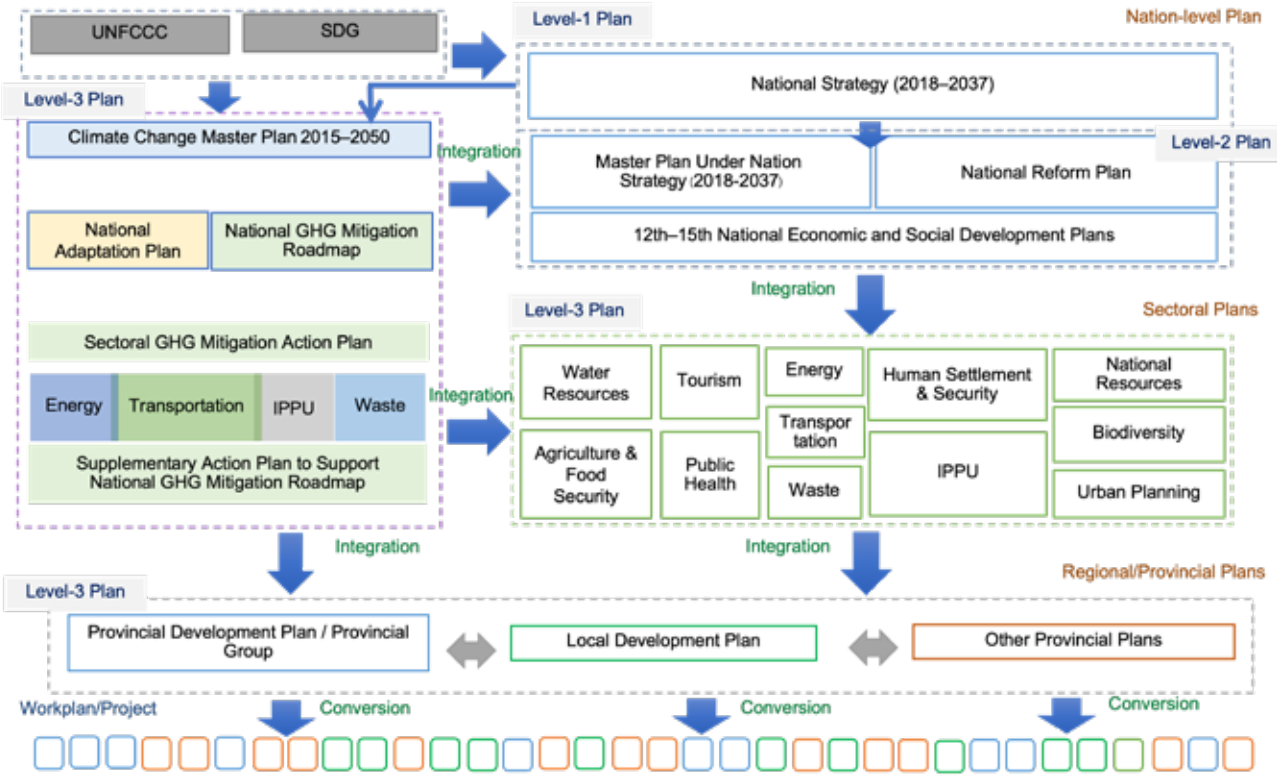
Domestically, various policies and action plans have been developed to provide concrete frameworks within which implementation for sustainable low-carbon development can progress aligned with the national priorities (Figure 3). Thailand's 20-year National Strategy Plan (2017–2036) outlines six national strategies[1]. Strategy 2, which focuses on enhancing national competitiveness, acknowledges the large potential that exists at the nexus of agricultural waste and energy production. Moreover, supported by technological innovation, Thailand aims to increase energy independence and promote a transition towards renewable energy through smart infrastructure and energy storage systems. Such a transition will help promote energy growth in an inclusive and fair manner. Strategy 5, putting emphasis on building and improving quality of life through environmentally friendly growth, sets forth plans to decarbonize the power industry and improve energy efficiency economy-wide. Strategy 4, in accordance with the 12th National Economic and Social Development Plan (NESDP), emphasizes environmentally friendly economic growth, particularly through waste management, renewable energy transition, GHG emissions reduction, and global partnerships.

The Climate Change Master Plan (CCMP) aims to increase low-carbon, climate-resilient national development through integrating measures at all levels, and enhancing awareness and capacity to implement climate change related policies, plans, and development. The CCMP outlines GHG mitigation measures, adaptation measures and capacity building measures that supplement the key strategies under the 20-year National Strategy Plan and NESDP, especially the eco-friendly development and growth. Besides the national plans and policies that support environmental friendly growth and transition to low-carbon society, plans and policies at the sectoral level are also geared towards the same future direction. Policies targeting the energy and transport sectors are further detailed in the national Power Development Plan (PDP), Alternative Energy Development Plan (AEDP), Energy Efficiency Development Plan (EEDP), and the Environmentally Sustainable Transport System Plan.



1 The six Key National Strategies are security, competitive enhancement, developing and strengthening human capital, social cohesion and equity, eco-friendly development and growth, and public sector rebalancing and development (National Strategy 2018–2037)

FIGURE 3: THAILAND'S CLIMATE CHANGE RELATED POLICIES AND PLANS

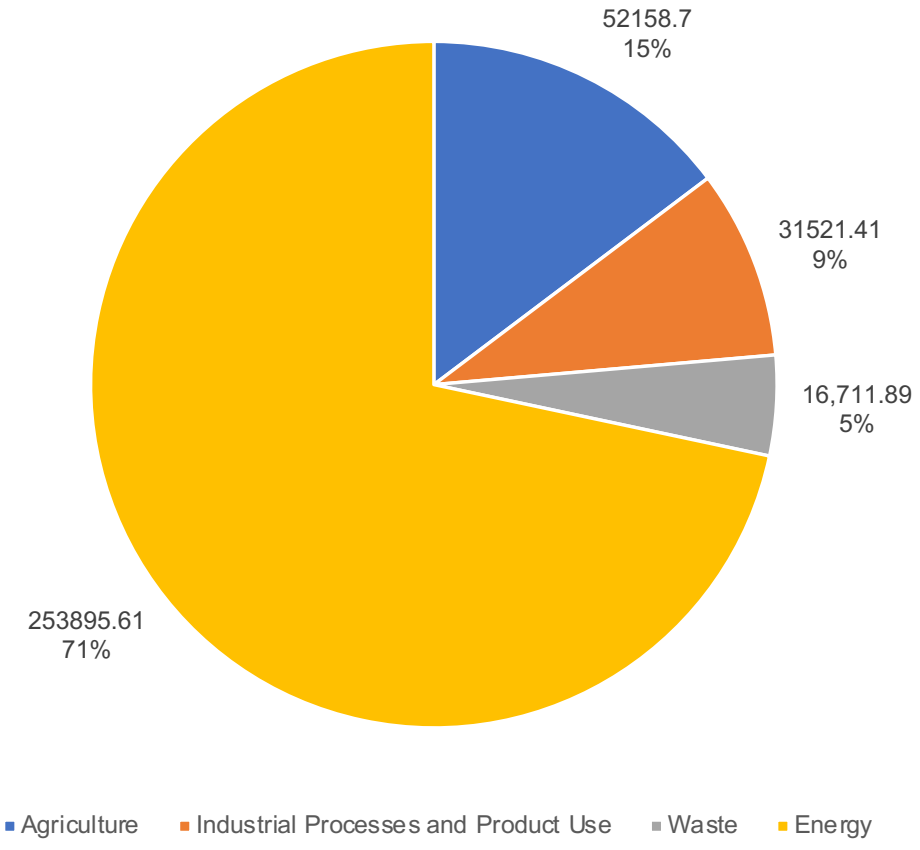



Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)

# 3. Thailand's NDC commitment and decarbonization strategies

As presented in the Third BUR in 2016, Thailand's total direct GHG emissions (excluding those from land use and land use change and forestry, see Table 1) were 354,357.61 $GgCO_2eq$ while the net removal of $CO_2$ was 91,134.15 $GgCO_2eq$, resulting in net GHG emissions were 263,223.46 $GgCO_2eq$. Figure 4 shows the breakdown of direct emissions by sector, with the energy sector accounting for 71.65 percent of emissions in 2016. Sector emissions are: energy 253,895.61 $GgCO_2eq$, industrial processes and product use sector 31,531.41 $GgCO_2eq$, agricultural sector 52,158.70 $GgCO_2eq$ and waste sector 16,771.89 $GgCO_2eq$. The GHG emissions from the energy sector accounted for 71.65 percent of total emissions in 2016 (Figure 4).

FIGURE 4: TOTAL GHG EMISSIONS BY SECTOR IN 2016 (EXCLUDING LULUCF) UNIT: $GGCO_2EQ$




Source: Thailand Third Biennial Update Report

## TABLE 1:GHG EMISSIONS FROM THE LAND USE AND LAND USE CHANGE AND FORESTRY SECTOR IN 2016

| GHG emissions from various sources relatve to total GHG emissons in the LULUCF sector 2016 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ emission | $CO_2$ reduction | $CH_4$ | | $N_2O$ | | $NF_3$ | CO | NMVOCs | $SO_2$ | HFCs | PFCs | $SF_4$ | Total |
| Greenhouse gas source and sink categories | GgCO2Eq | | Gg | GgCO2Eq | Gg | GgCO2Eq | | | Gg | | | GgCO2Eq | | |
| Land Use, Lnd-Use Change and Forestry | 52015.55 | -143427.1 | 7.15 | 178.74 | 0.21 | 62.67 | 1.69 | 109 | NO | NO | NO | NO | NO | -91,134.15 |
| Forest Land Remaining Forest Land | 16467.91 | 101841.53 | NO | | NO | | NO | NO | NO | NO | NO | NO | NO | -25117.65 |
| Cropland Remaining Cropland | 28383.57 | NO | NO | | NO | | NO | NO | NO | NO | NO | NO | NO | -73457.96 |
| Land Converted to Cropland | 7100.54 | NO | NO | | NO | | NO | NO | NO | NO | NO | NO | NO | 7100.54 |
| Land Converted to Other Land | 99.53 | NO | NO | | NO | | NO | NO | NO | NO | NO | NO | NO | 99.53 |
| Biomass Burning | NO | NO | 7.15 | 178.74 | 0.21 | 62.67 | 1.69 | 109 | NO | NO | NO | NO | NO | 241.4 |
| Biomass Burning (Forest Land) | NO | NO | 0.88 | 22.01 | 0.03 | 7.72 | 0.21 | 13.5 | NO | NO | NO | NO | NO | 29.72 |
| Biomass Burning (Cropland) | NO | NO | 6.2 | 154.94 | 0.18 | 54.32 | 1.46 | 94.8 | NO | NO | NO | NO | NO | 209.27 |
| Biomass Burning (Other Land) | NO | NO | 0.07 | 1.79 | 0 | 0.63 | 0.02 | 1.09 | NO | NO | NO | NO | NO | 2.41 |

*Note: NO= Not Occuring*

Source: Thailand Third Biennial Update Report

Thailand submitted its NAMA pledge to reduce GHG emissions by seven to 20 percent from the BAU levels, by 2020. Efforts to reduce GHG emissions under NAMA were concentrated in the energy and transport sectors. Thailand was able to achieve GHG emissions reductions of about 57.84 $MtCo_2eq$ or approximately 15.76 percent below BAU levels by 2018 (Thailand Third Biennial Update Report)

Under Thailand's NDC commitment of 20–25 percent GHG emissions reduction from the projected BAU level by 2030, efforts to reduce GHG emissions are concentrated in three sectors, namely energy and transportation, industrial processes and product use (IPPU) and waste.

Thailand's NDC estimates that total GHG emissions will increase from 273 $MtCO_2e$ in 2005 to 555 $MtCO_2e$ by 2030 under the BAU scenario (BAU-NDC). The total GHG emissions in 2030 are estimated to be approximately 440 $MtCO_2e$ under the NDC 20 percent scenario and 416 $MtCO_2e$ under the NDC 25 percent scenario.

Note that following the NDC target having been raised from 20-25 percent to 40 percent, GHG emissions reductions in each sector need to be revised accordingly.

In order to meet the GHG emission reduction targets committed under the NDC, Thailand has developed an NDC Roadmap on Mitigation (2021–2030), approved by Cabinet in 2017, as a mechanism to drive GHG mitigation actions. Implementing mitigation measures under the NDC Roadmap would result in GHG emissions of around 416-444 $MtCO_2eq$ in 2030 or around a 111–138.8 $MtCO_2e$ reduction. Table 2 shows the GHG mitigation measures in each sector in the NDC Roadmap on Mitigation (2021–2030).

TABLE 2: GHG MITIGATION MEASURES UNDER THE NDC ROADMAP ON MITIGATION (2021-2030)

| Sectors | Strategies |
|---|---|
| Energy and Transport | Household energy efficiency |
| | Renewable energy |
| | Solar power |
| | Wind power |
| | Power generation efficiency |
| | Biofuel for the transport sector |
| | Public transportation |
| | Vehicle efficiency |
| | Energy efficiency improvement in commercial building |
| | Energy efficiency for industrial process |
| Industrial Processes and Product Use (IPPU) | Clinker substitution in cement industry |
| | Refrigerant replacement |
| Waste Management | Waste management |
| | Municipal wastewater management |
| | Methane recovery |
| | Industrial wastewater treatment |

Source: NDC Roadmap on Mitigation (2021–2030)

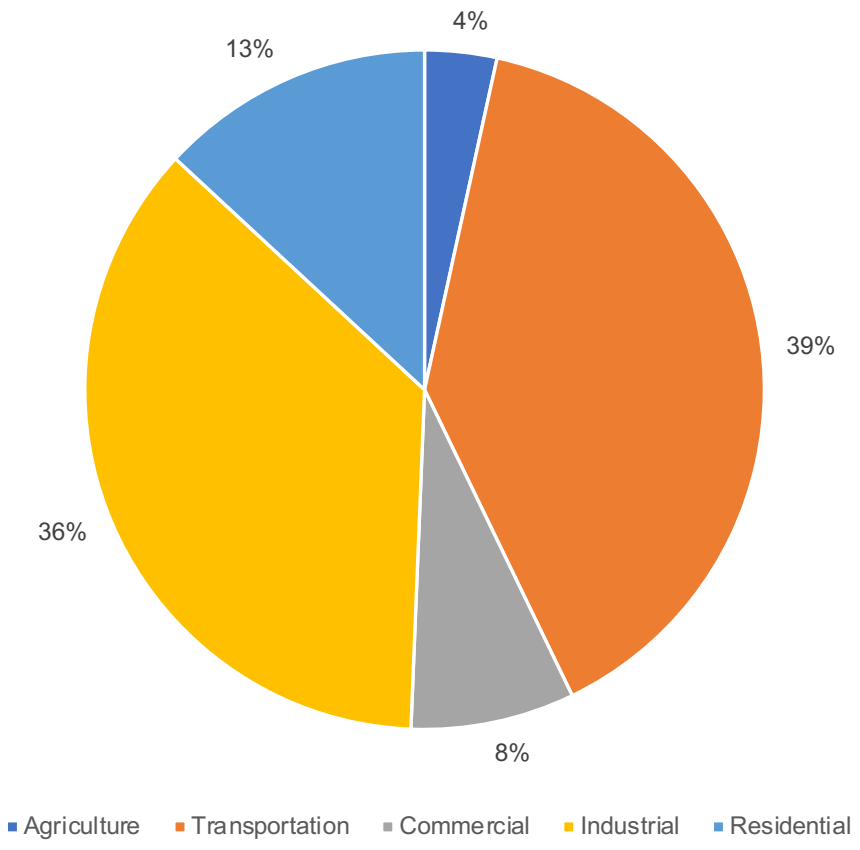
According to the NDC Roadmap, the energy and transport sector accounts for 20.4 percent, waste management accounts for 0.3 percent and the IPPU sector accounts for 0.1 percent of the 20 percent GHG reduction target under the NDC. Given that GHG emissions reduction from energy and transportation sectors accounts for 97.8 percent of Thailand's NDC GHG emission reduction target, decarbonization efforts in Thailand are focusing on the energy sector. Domestic energy policies and plans are essential instruments in achieving the emission reduction targets set by the nation's NAMA and NDC. Thailand's NDC was formulated based on 9 national level plans, 4 of them energy related: Power Development Plan, Energy Efficiency Development Plan, Alternative Energy Development Plan and the Smart Grid Development Master Plan. Table 3 shows final energy consumption by fuel type during 2010–2018. Figure 5 shows the share of final energy consumption by economic sector.

TABLE 3: FINAL ENERGY CONSUMPTION BY FUEL TYPE DURING 2010-2018

| Year | Solid Fossil Fuel | | Petroleum Products | | | | | | | Electricity | NG in Industry | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coal | Lignite | LPG | Premium | Regular | J.P. | Kerosene | Diesel | Fuel Oil | | Energy | Total | |
| 2010 | 6,861 | 880 | 4,781 | 2,166 | 3,360 | 3,851 | 12 | 15,932 | 2,359 | 13,112 | 5,764 | 5,764 | 59,078 |
| 2011 | 6,555 | 1,245 | 5,153 | 1,784 | 3,678 | 4,150 | 11 | 16,545 | 2,040 | 13,065 | 7,252 | 7,252 | 61,478 |
| 2012 | 6,991 | 703 | 5,627 | 1,770 | 3,970 | 4,162 | 11 | 17,722 | 1,948 | 13,998 | 8,444 | 8,444 | 65,346 |
| 2013 | 6,318 | 774 | 5,688 | 3,538 | 2,567 | 4,547 | 9 | 17,970 | 1,749 | 14,189 | 8,661 | 8,661 | 66,010 |
| 2014 | 7,700 | 592 | 5,638 | 3,659 | 2,678 | 4,506 | 9 | 18,156 | 1,613 | 14,588 | 8,879 | 8,879 | 68,018 |
| 2015 | 8,566 | 270 | 5,324 | 4,182 | 2,994 | 4,932 | 9 | 18,889 | 1,760 | 15,065 | 8,793 | 8,793 | 70,784 |
| 2016 | 8,369 | 234 | 5,034 | 4,869 | 3,035 | 5,287 | 9 | 19,507 | 2,075 | 15,783 | 8,763 | 8,763 | 72,965 |
| 2017 | 8,959 | 170 | 4,968 | 5,280 | 2,895 | 5,512 | 6 | 20,027 | 1,979 | 16,036 | 8,628 | 8,628 | 74,460 |
| 2018 | 10,083 | 182 | 4,799 | 5,734 | 2,711 | 5,800 | 6 | 20,336 | 2,074 | 16,131 | 8,725 | 8,725 | 76,581 |

Source: Energy Statistics of Thailand 2019, Energy Planning and Policy Office

FIGURE 5: SHARE OF FINAL ENERGY CONSUMPTION BY ECONOMIC SECTOR IN 2018

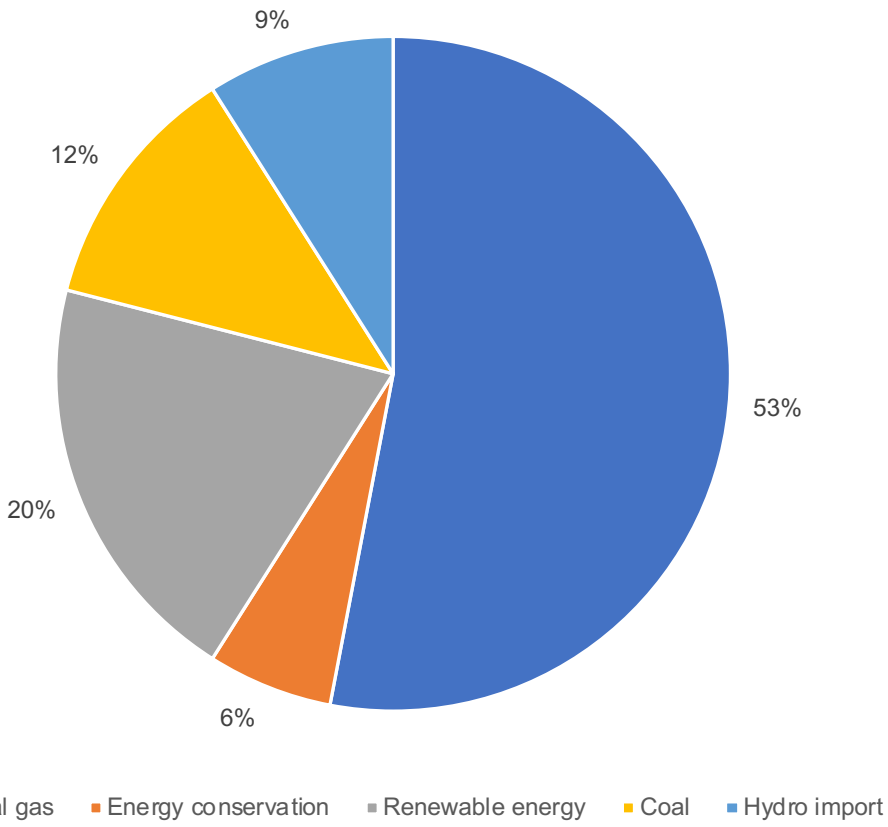



Source: Department of Alternative Energy Development and Efficiency

According to Figure 5, the transportation and industrial sectors are the economic sectors that account for the highest share of Thailand's final energy consumption. Transportation accounted for 39.41 percent while the industrial sector accounted for 36.26 percent of final energy consumption in 2018. In terms of electricity

production (Figure 6), natural gas accounted for the highest share of electricity production (around 53 percent) in 2018, followed by renewable energy (20 percent), coal (12 percent), imported hydro (nine percent) and energy conservation (six percent).

FIGURE 6: SHARE OF ELECTRICITY PRODUCTION BY FUEL TYPE



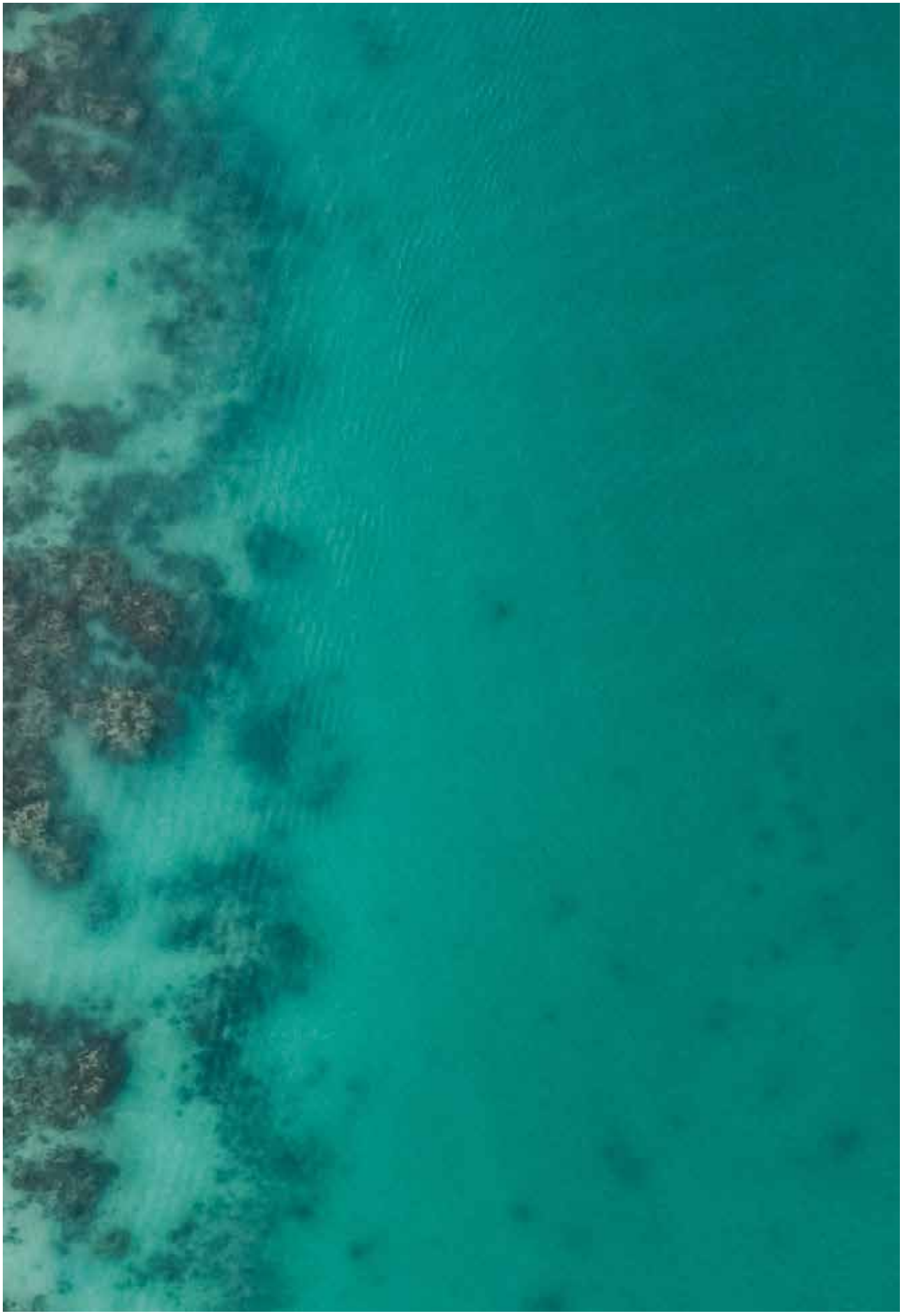

Source: Power Development Plan (PDP) 2018

Figure 7 shows the installed capacity of renewable power generation during 2015–2019. In recent years biomass constitutes the largest renewable power source, followed by solar and large-scale hydro power.

FIGURE 7: INSTALLED CAPACITY OF RENEWABLE POWER GENERATION DURING 2015–2019

| Installed Capacity of Renewable Power Generation 2015 - 2019 | | | | | Unit: MW |
|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 |
| Solar | 1,419.6 | 2,446.1 | 2,697.2 | 2,962.5 | 2,982.6 |
| Wind | 233.9 | 507.0 | 627.8 | 1,102.8 | 1,506.8 |
| Small Hydro Power | 172.1 | 182.1 | 182.3 | 187.7 | 187.8 |
| Large Hydro Power | 2,906.4 | 2,906.4 | 2,906.4 | 2,919.7 | 2,919.7 |
| Biomass | 2,726.6 | 2,814.7 | 3,157.3 | 3,372.9 | 3,410.1 |
| Biogas | 372.5 | 434.9 | 475.4 | 505.2 | 530.0 |
| MSW | 131.7 | 145.3 | 191.5 | 317.8 | 314.7 |
| Geothermal Power | - | - | - | 0.3 | 0.3 |

Source: Thailand Alternative Energy Situation 2019, Department of Alternative Energy Development and Efficiency



# 4. Examining Thailand's GHG reduction potential

Decarbonization efforts in Thailand target key economic sectors with high energy consumption. Figure 8 illustrates the share of final energy consumption by economic sectors, the majority of which is accounted for by the transportation sector and the industrial sector at 39.4 percent and 36.26 percent respectively. Therefore, existing decarbonization studies in Thailand focus on the industrial and transport sectors.

## Decarbonization potential in the industrial sector

Selvakkumaran et al. (2015) explored scenarios in the industrial sector using the Asia Pacific Integrated Model (AIM)/Enduse model. Scenarios include the BAU scenario and three other scenario groups: Emission Tax scenarios, GHG Reduction Target scenarios, and Low Carbon Society (LCS) scenarios (see Table 4). This study considered technology replacement strategies that result in lower $CO_2$ emissions, termed 'countermeasures'. Examples include: fuel type substitutions, improved efficiency in devices such as coal heaters, and carbon capture and storage (CCS) technologies. Lower LCS scenarios had low countermeasure penetration rates, and higher LCS scenarios had higher countermeasure penetration rates. Emissions tax scenarios range from an emission tax of US$50/t-$CO_2$ to US$500 USD/t-$CO_2$.

TABLE 4: SCENARIOS UNDER CONSIDERATION IN THE STUDY BY SELVAKKUMARAN ET AL. (2015)

| Scenario | Description | Share settings |
|---|---|---|
| BAU | Business as usual; Frozen Efficiency scenario | Controlled shares of only existing technologies |
| CM | Includes all the CMs possible, but optimization is strictly along the cost criteria since no external constraints are applied | Free share settings from 200 for all CMs. Serves as a control scenario, |
| LCS_Low | A LCS scenario which is conservative in its mitigation aspirations | Shares of CMs are controlled along conservative penetration expectations |
| LCS | A LCS scenario with moderate mitigation aspirations | Shares of CMs are controlled along expected penetration rates. |
| LCS_High | A LCS scenario which is very ambitious of its mitigations aspirations | Shares of CMs are controlled along the expected penetration rates. Emission peak is also expected. |
| Tax50 | Scenario which has an emission tax of 50 USD/t-CO2. Inclusive of all CMS. Selection of technologies is based on cost and emission tax criteria | Shares of CMs are allowed to be chosen freely from 2010. |
| Tax100 | Scenario which has an emission tax of 100 USD/t-CO2. Inclusive of all CMS. Selection of technologies is based on cost and emission tax criteria | Shares of CMs are allowed to be chosen freely from 2010. |
| Tax200 | Scenario which has an emission tax of 200 USD/t-CO2. Inclusive of all CMS. Selection of technologies is based on cost and emission tax criteria | Shares of CMs are allowed to be chosen freely from 2010. |
| Tax500 | Scenario which has an emission tax of 500 USD/t-CO2. Inclusive of all CMS. Selection of technologies is based on cost and emission tax criteria | Shares of CMs are allowed to be chosen freely from 2010. |
| CM20 | Scenario with emissions at 2050 limited to be 80% of the emissions of BAU. Technology selection is based on cost and emission constraint criteria. | Shares of CMs are allowed to be chosen freely from 2010. |
| CM30 | Scenario with emissions at 2050 limited to be 70% of the emissions of BAU. Technology selection is based on cost and emission constraint criteria. | Shares of CMs are allowed to be chosen freely from 2010. |
| CM40 | Scenario with emissions at 2050 limited to be 60% of the emissions of BAU. Technology selection is based on cost and emission constraint criteria. | Shares of CMs are allowed to be chosen freely from 2010. |
| CM50 | Scenario with emissions at 2050 limited to be 50% of the emissions of BAU. Technology selection is based on cost and emission constraint criteria. | Shares of CMs are allowed to be chosen freely from 2010. |

Source: Selvakkumaran et al. (2015)

The results from the study by Selvakkumaran et al. (2015) show that even though the Emissions Tax scenarios and Reduction Target scenarios showed greater cumulative $CO_2$ reduction than LCS scenarios, only LCS scenarios resulted in a long-term shift to sustainable technologies, such as CCS. Replacing existing technologies with sustainable technologies such as the countermeasures used in the analysis, allows for achievement of emissions reduction more rapidly. Results show that energy consumption under the LCS scenarios have the potential to mitigate up to 35 percent from BAU levels by 2050 with concurrent energy consumption reductions up to 7.7 percent.

## Decarbonization potential in the transport sector

Selvakkumaran and Limeechokchai (2015) used the AIM/Enduse model to study carbon and energy consumption reduction in the transport sector. Three scenarios were considered, namely the BAU scenario, the Emissions Tax scenarios, and the LCS scenarios. In the transport sector, the LCS scenarios with shifts in transportation modes deliver the most desirable results with potential to mitigate up to 1230 $MtCO_2$ from 2010 to 2050. The energy consumption reductions resulted from a shift in transportation modes towards more public transport, combined with better fuel economy in private vehicles.

In a separate study, Chunark et al. (2015) looked at carbon mitigation potential in the transport sector, focusing on a low-carbon transportation (LCT) strategy. The AIM/Enduse model was used and three scenarios were considered: BAU, the Smart Passenger transport LCT scenario and the Freight Transport LCT scenario. Under the Smart Passenger transport scenario, four countermeasures were included: fuel switching, modal shift, advanced technologies, and transport demand management. Under the Freight Transport LCS scenario, three countermeasures were included: fuel switching, advanced technologies, and transport demand management. Results from the analysis show that under the Smart Passenger transport scenario, emissions would be reduced by 8,203 $ktCO_2$, 16,521 $ktCO_2$, and 38,799 $ktCO_2$ in 2020, 2030, and 2050 respectively. Under the Freight Transport scenario emissions would be reduced by 987 $ktCO_2$, 3,503 $ktCO_2$, and 12,652 $ktCO_2$ in 2020, 2030, and 2050 respectively. Study results also revealed that in the short and medium term, fuel switching and advanced technologies are the most effective countermeasures, while transport demand management and modal shifts were more effective in the long term.

## Decarbonization potential in the residential sector

As shown in Figure 5, the residential sector is the third largest source of energy consumption in Thailand and therefore the decarbonization potential of the residential sector will also be explored. Kusumadewi and Limmeechokchai (2015) explored a demand side management (DSM) strategy to curb energy consumption in the residential sector, with a focus on energy efficiency improvement measures. The Long Range Energy Alternatives Planning (LEAP) model was used to compare the $CO_2$ emissions from the residential sector under the BAU scenario and the energy efficiency scenarios. Results show that the cumulative $CO_2$ emissions from the residential sector from 2010 to 2050 will be around 109.3 million tonnes under the BAU scenario, but will be around 94.7 million tonnes under the energy efficiency scenario, 13.6 percent lower than BAU.

Most existing efforts in the residential sector are project-based and aim to promote the use of energy-efficient electrical appliances and encourage green consumer lifestyle choices. These include the Energy Efficient Label No. 5, deviseed by the Energy Generating Authority of Thailand (EGAT).

## Decarbonization potential in the power sector

Actions in the power sector are focused on renewable energy transition. A study undertaken by Misila et. al (2017) focuses on the power sector, predicting GHG emissions under three renewable energy (RE) percentage scenarios – 100 percent RE, 50 percent RE, and 25 percent RE – under the PDP2015 plan, compared to BAU and NDC scenarios. Using the LEAP model, the study predicted that in the BAU scenario, GHG emissions will increase by 175,118 $ktCO_2e$ in 2030. Under the PDP2015 100 percent RE, 50 percent RE, and 25 percent RE scenarios, results demonstrate GHG emissions reduce by 41.69 percent under the 100 percent RE scenario, 23.75 percent under the 50 percent RE scenario and 10.4 percent under the 25 percent RE scenario. Therefore, if 50 percent RE (or higher) is achieved, Thailand will be able to achieve its NDC target to reduce GHG emissions 20 percent by 2030 under PDP2015.

Looking ahead, Thailand holds potential for an increasing share of renewable energy, especially from solar photovoltaic (PV) and biomass energy (Table 5). The country has an average daily irradiance value upwards of 5kWh/m2. PV panels carry the potential to generate up to 1557 TWh of electricity per year (Figure 8) (Hutfilter et al., 2019).

## TABLE 5: INSTALLED RENEWABLE ENERGY CAPACITY

| | Installed RE capacity (in MW) | IRENA | | | |
|---|---|---|---|---|---|
| Renewable energy capacities | Wind (onshore) | | | 628 | 2017 |
| | Wind (offshore) | - | - | - | - |
| | Solar (concentrated) | - | - | 5 | 2017 |
| | Solar (photovoltaic) | - | 49 | 2697 | 2017 |
| | Biogas | - | 103 | 475 | 2017 |
| | Bioenergy (solid biomass) | 598 | 1663 | 3349 | 2017 |
| | Hydropower | 2388 | 2393 | 2544 | 2017 |
| | Geothermal | - | - | - | - |

Notes: Calculation of most recent value based on latest available WB-WDI data and growth rates from BP (BP,2018)

$CO_2$ emissions do not include emissions from LULUCF

PPP- Purchasing Power Parity

GDP - Gross Domestic Product

Source: Decarbonising Asia 2019, Climate Analytics (Hutfilter et al., 2019

## FIGURE 8: IRRADIATION MAP FOR THAILAND


Source: SolarGIS

# 5. Impacts of decarbonization on the economy

There has been concern about the potential impacts of GHG mitigation on the country's economic development. A study by Rajbhandari et al. (2019) assessed the macroeconomic impacts of different GHG emissions reduction targets on the Thai economy using the dynamic computable general equilibrium (CGE) model. Rajbhandari et al. (2019) considered 14 scenarios, consisting of a BAU and 13 GHG emissions reduction target (ERT) scenarios. Among the 13 ERT scenarios, five represent constant GHG emissions reduction scenarios (ERT20, ERT25, ERT30, ERT40 and ERT50 with constant GHG emissions reduction during 2030 to 2050 of 20 percent, 25 percent, 30 percent, 40 percent and 50 percent, respectively). The remaining eight scenarios represent increasing levels of low, medium and high reduction targets during 2030 to 2050. The scenarios ERT20-30, ERT20-40, ERT20-50, ERT25-40 and ERT25–50 were formulated considering increasing levels of low to medium GHG emissions reduction targets of 20–30 percent, 20–40 percent, 20–50 percent, 25–40 percent and 25–50 percent, respectively, during 2030 to 2050.

This study formulated three peak emission scenarios with high GHG emissions reduction targets, namely ERT20-90, ERT25-90, and ERT50-90, which assume total GHG emissions will reach zero by 2060, to align with the global climate target of holding the increase in the average temperature to well below 2°C above pre-industrial levels and pursuing the efforts to limit the temperature increase to 1.5°C. Thailand's GDP was estimated to rise from US$335 billion in 2010 to US$1,576 billion in 2050 under the BAU scenario. The GDP was estimated to rise at a compound annual growth rate of 3.95 percent.

The results suggest that GHG reduction targets would cause a decline in GDP compared to BAU, with GDP rising at a lower compound annual growth rate, varying from 3.83 percent to 3.62 percent in ERT20 to ERT50, 3.79 percent to 3.63 percent in ERT20-30 to ERT25-50, and 3.86 percent to 3.69 percent in ERT20-90 to ERT50-90 scenarios, during 2010 to 2050. This study found that with increasing GHG emissions reduction targets, the GDP reduction compared to the BAU substantially increased throughout 2030 to 2050. The study found that household consumption and government spending accounts for the majority of GDP changes, with household consumption reducing while government spending increases. As a result, increasing the uptake of energy-efficient technologies that can improve household consumption has the potential to affect GDP reductions up to 39.6 percent under high emissions reduction scenarios (50–90percent reductions). Moreover, the model demonstrated that exports and imports would decrease as a result of emissions reduction scenarios; however, advanced technological changes can help lower abatement cost and counteract losses in GDP.

Compared to BAU, GDP reduction varies from two percent to 7.7 percent in 2030 and from 4.5 percent to 11.9 percent in 2050 under the ERT20 to ERT50 scenarios, respectively. Compared to the BAU, GDP reductions range from two percent to 2.6 percent in 2030 and 6.2 percent to 11.8 percent in 2050 in the low to medium reduction scenarios of ERT20-30 to ERT25-50, respectively. However, if Thailand aims to follow more ambitious GHG emissions reduction targets as specified by the ERT20-90 to ERT50-90 scenarios, the Thai economy will face a major decline in GDP around 2040 to 2050 in comparison to the BAU, with the most severe reduction expected in 2045. Rajbhandari et al. (2019) found that the GDP loss could be as high as 21 percent to 22.5 percent in 2045 under the ERT20-90 to ERT50-90 scenarios, respectively, compared to BAU.

The results from the study by Rajbhandari et al. (2019) show that the medium to peak emissions reduction scenarios could result in a serious loss in GDP compared to the BAU scenario. Therefore, the attainment of such stringent GHG emissions reduction targets could be challenging for Thailand. To lessen such negative impacts, it is necessary to develop and deploy energy-efficient and renewable energy based technologies would not only help in minimizing GHG emissions but also help in overcoming the GDP loss. Negative abatement costs of energy-efficient and renewable energy based technologies demonstrate potential to reduce the extent of GDP loss in the long run. Without a transformative change in the economic structure and energy system in Thailand, the Thai economy will face large costs in reducing GHG emissions.

# 6. Key challenges for renewable energy transition and improvement in energy efficiency in Thailand

As the preceding analysis shows, to meet its decarbonization goals Thailand would need to reduce activities in energy-intensive industries, improve end-use energy efficiency, switch fuels, deploy CCS technologies in the power and industrial sectors, expand renewable energy-based technologies and support a renewable energy transition to meet decarbonization goals.

## Energy efficiency promotion

Thailand's efforts to support improved energy efficiency include the establishment of legislation, financial support and an energy efficiency development plan. The Energy Efficiency Plan 2015–2036 is complementary to the Energy Conservation Act. The target is to reduce energy intensity by 30 percent by 2036 compared with 2010. The key focal point for driving energy efficiency is the Department of Alternative Energy Development and Energy Efficiency (DEDE). At present, there are three energy efficiency financial incentive programs governed by DEDE, namely the Energy Efficiency Revolving Fund (EERF), Energy Service Company Revolving Fund (ESCO Fund), and DEDE Demand Side Management Bidding (DSM Bidding) (Vivatpinyo and Pharino, 2019). Table 6 shows the overview of financial incentive programs for promoting energy efficiency investment. According to Vivatpinyo and Pharino (2019), EERF and DSM Bidding are suitably designed for large companies who have strong financial capacity, while the ESCO Fund is well designed for low collateral capacity companies. Energy efficiency measures under EERF are mostly well-known technologies that are proven to generate energy savings. The ESCO Fund is suitable for promoting new technologies according to project-based analysis. DSM Bidding can be designed for a wide-range of energy efficiency measures from simple to complex. Nevertheless, there are some challenges for these three financial incentive programs. For EERF, there are technical and financial risks to customers. For the ESCO Fund, there is a project risk in the possibility of insufficient financial incentives for investment in energy efficiency. For DSM Bidding, the challenge that remains is to expand financial support for complex technology instead of only well-known technologies.

TABLE 6: OVERVIEW OF FINANCIAL INCENTIVE PROGRAMS FOR PROMOTING ENERGY EFFICIENCY INVESTMENT

| | EERF | ESCO Fund | DSM Bidding |
|---|---|---|---|
| Type of program | Credit line for low-interest rate revolving loan fund | Venture capital, equipment leasing, de-risk mechanism, and technical facilitator | Subsidy via bidding mechanism |
| Project eligible | Energy efficiency/renewable energy | Energy efficiency/renewable energy | LED/VSD air |

Source: Vivatpinyo and Pharino, 2019

## Renewable energy transition

To promote renewable energy, the 20-year Alternative Energy Development Plan (AEDP) set a renewable energy target of 30 percent of final energy consumption and a target of 20 percent reduction in electricity consumption by 2036. To achieve the targets set in the AEDP, the Thai Government has supported renewable energy development through various fiscal and financial measures along with investment promotion. In addition, technological innovation and adoption has been emphasized to enhance the competitiveness of renewable energy. Despite the enactment of the Energy Conservation Promotion Law and existence of the AEDP, the share

of renewable energy in Thailand has only slowly increased, delaying the renewable energy transition in Thailand. Several challenges still remain and need to be addressed if the renewable energy targets are to be achieved in time (Sirasoontorn and Koomsup, 2017).

Examples of key actors to drive renewable energy transition include the Energy Policy and Planning Office (EPPO), Department of Alternative Energy Development and Efficiency (DEDE), Electricity Generating Authority of Thailand (EGAT) and the Energy Regulatory Commission (ERC). Going forward, it requires a government agency serving as a focal point and coordinator among all government bodies involved. Given that the renewable energy transition is a long-term process, policy uncertainties and discontinuities have been major obstacles and challenges to a smooth transition. Policy certainty and continuity is necessary to create a favorable environment for investment in renewable energy to help reduce the investment risks faced by the private sector. The third challenge for the renewable energy transition is a lack of coordination between public and private sectors. Fourth, infrastructure, grid-related issues and regulatory and administrative hurdles are also major impediments to the deployment of renewable energy. Fifth, given that renewable energy projects require financial resources, financial policies that improve availability and affordability of financial resources should be developed, ranging from providing public finance to incentivizing private sector financing. In Thailand, the main form of government financial support for renewable energy development is via feed-in-tariffs (FiTs) (Sirasoontorn and Koomsup, 2017). FiTs guarantee producers of renewable energy a fixed price which creates a favorable investment climate to invest in renewable energy. Renewable power producers receive a price premium over the purchase rate of state owned enterprises based on a feed-in adder (a payment per kWh for electricity produced by a renewable resource and fed into the grid). Eligible types of renewable energy include biomass, biogas, municipal solid waste, solar, wind and others. Thailand could learn from Indonesia's approach: the Indonesian Government launched a fossil subsidy reform, and increased renewable energy in the country's total energy mix. The subsidy reform placed pressure on fuel prices, with the majority of the impact felt by lower income households (Beaton and Lontoh, 2010). In response the Government of Indonesia established the Bantuan Langsun Tunai (BLT) program that eased the impact of increasing fuel prices on lower income households. Indonesia's combination of financial policies targeted at decreasing reliance on fossil fuel reduced the fiscal deficits that would have persisted without the subsidy reform, and the direct cash transfer initiative (BLT) made the reform politically feasible (Widjaja, 2012).

# 7. Current position of Thailand on net zero goal

Thailand submitted the Long-Term Green House Gas Emission Development Strategy to the UNFCCC at the end of October 2021. During COP26 in Glasgow, the Primer Minister made the announcement that Thailand will achieve carbon neutrality by 2050 and net zero GHG emissions by 2065 conditional on financial supports,technological supports and capacity building. In addition, for the energy sector, the National Energy Plan (NEP) framework was announced and the carbon neutrality target for the energy sector is set at 2065–2070.

# References

Beaton, Christopher, and Lucky Lontoh. Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies. International Institute for Sustainable Development, 2010. Print. Trade, Investment and Climate Change Series.

Hutfilter, Ursula Fuentes, et al. Country Profile Thailand Decarbonising South and South East Asia ., 2019. Print.

Pemika Misila, Pornphimol Winyuchakrit, Bundit Limmeechokchai. 2020. "Thailand's long-term GHG emission reduction in 2050: the achievement of renewable energy and energy efficiency beyond the NDC." Heliyon.

Pharino, A Vivatpinyo and C. 2018. "Challenges of Energy Efficiency Promoting Policy in Thailand." IOP Conf. Series: Earth and Environmental Science. IOP.

S. Selvakkumarana, B. Limmeechokchai , T. Masuib, T. Hanaokab. 2014. "An explorative analysis of CO emissions in Thai Industry sector under Low Carbon Scenario towards 2050." Energy Procedia.

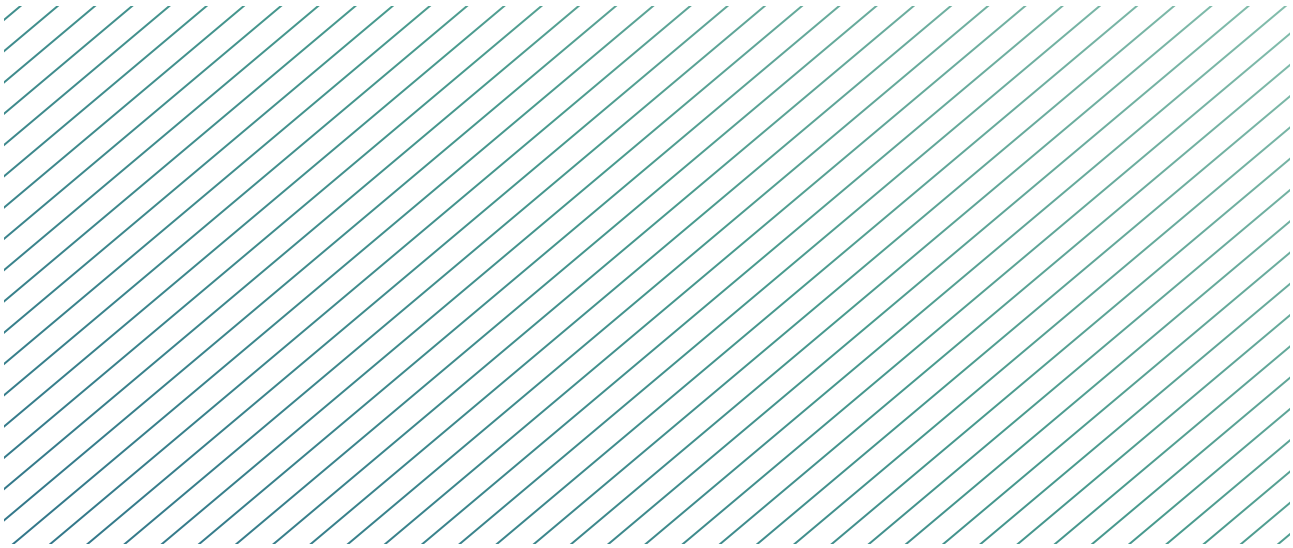
Salony Rajbhandari, Bundit Limmeechokchai and Toshihiko Masui. 2019. "The impact of different GHG reduction scenarios on the economy and social welfare of Thailand using a computable general equilibrium (CGE) model." Energy, Sustainability and Society.

Sirasoontorn, Puree and Praipol Koomsup. 2017. Energy Transition in Thailand: Challenges and Opportunities. Bangkok: Friedrich-Ebert-Stiftung Thailand Office.

Sujeetha Selvakkumaran, Bundit Limmeechokchai. 2015. "Low carbon society scenario analysis of transport sector of an emerging economy—The AIM/Endusemodellingapproach." Energy Policy.

Sujeetha Selvakkumaran, BunditLimmeechokchai, Toshihiko Masui, Tatsuya Hanaoka, Yuzuru Matsuoka. 2015. "A quantitative analysis of Low Carbon Society (LCS) measures in Thai industrial sector." Renewable and Sustainable Energy Reviews.

Widjaja, Muliadi. "An Economic and Social Review on Indonesia's Direct Cash Transfer Program to Poor Families in 2005." Economics and finance in Indonesia 60.2 (2012): 197-212. Web.



## FOR MORE INFORMATION

Please contact:

**DR. KANNIKA THAMPANISHVONG**

Senior Research Fellow

Thailand Development Research Institute

Kannika@Tdri.or.th

**DR. ATSAMON LIMSAKUL**

Senior Environmental Officer

Environmental Research And Training Center

Department Of Environmental Quality Promotion

Atsamonl@Gmail.com

**MS. NANNAPHAT SIRISON**

Duke University

Eyesirison@Gmail.com

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