WORLD BANK GROUP

# THAILAND PUBLIC REVENUE AND SPENDING ASSESSMENT

# PROMOTING AN INCLUSIVE AND SUSTAINABLE FUTURE

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# CHAPTER 7
# RESPONDING TO CLIMATE CHANGE

# Chapter 7: Responding to Climate Change

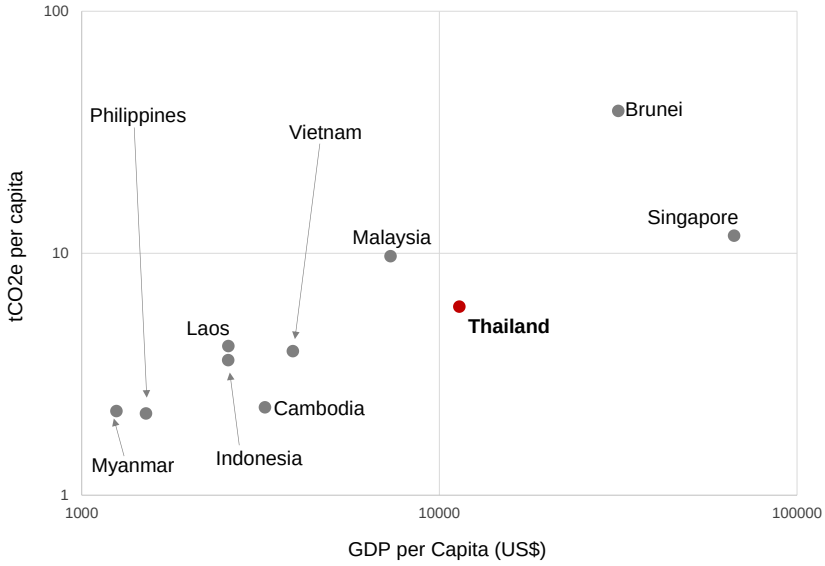
## 7.1 Introduction

**318. This chapter introduces some of the risks to macro-fiscal stability that are posed by climate change and discusses how fiscal policy could address these risks**. It examines various strategies for climate change mitigation and adaptation through a fiscal lens, assessing the possible implications for overall government spending and revenue collection. It concludes by providing recommendations to promote the adequacy, efficiency and equity of the government's fiscal policy response to the challenges posed by climate change. Broader issues around climate change in Thailand are not explored in this chapter but will be covered in future World Bank analytical support.

**319. Thailand is highly vulnerable to climate change.** Thailand is ranked as the third most vulnerable country in Southeast Asia to climate change, and the eighth most vulnerable country in the world. Its long coastlines, fragile agricultural system and susceptibility to extreme weather events make the country particularly vulnerable to climate change. As well as agriculture, the water and tourism sectors are particularly exposed to climate impacts, for example from increased occurrence of tropical storms, floods and droughts.

**320. Thailand is not a large emitter of greenhouse gas emissions but in the absence of further policy actions its emissions will increase as its economy grows**. Thailand's $CO_2$ emissions accounted for less than 0.9 percent of the global total in 2018.[167] Its per capita emissions are comfortably below the global average but are higher than those in several other ASEAN countries, reflecting higher income levels (Figure 7-1). Thailand's emissions per unit of GDP are also above the global average rate. At COP27, Thailand has pledged to reduce greenhouse gas emissions by 30-40 percent below a business-as-usual baseline level by 2030, which allows only a small increase in emissions over 2020-2030. Current uncertainties around COVID-19 recovery and the war in Ukraine mean it is not clear whether current policies are adequate to stabilize and reduce emission levels; additional policies may still be needed to meet the NDC targets.

**Figure 7-1: Per Capita GDP and GHG Emissions in ASEAN Countries, 2018**




Source: CAIT and WDI databases.

Note: Emissions levels exclude land use, land use change and forestry emissions.

**321. Fiscal policy can play a critical role in reducing Thailand's contribution to climate change.** Ambitious climate change mitigation can be achieved by combining well-designed tax policies that raise the price of carbon with regulatory and other non-tax instruments. The carbon prices assessed in Section 7.5 could raise revenues worth 1 percent of GDP; broader measures could potentially raise revenues worth at least 2 percent of GDP. The revenues raised from these

[167] CAIT database, see http://cait.wri.org/

instruments could be used to support other climate policies, including investments in measures to adapt to a changing climate. Fiscal policy could also facilitate the transition to a greener, low-carbon economy by providing direct investment in climate-smart infrastructure, such as renewable power generation and supporting research and development (R&D) in climate-smart technologies.

**322. Fiscal policy will also need to play a role in adapting to climate change in Thailand.** Climate change adaptation requires minimizing damage from climate-related natural disasters and reducing the costs of chronic impacts like loss of agricultural productivity. Climate adaptation measures could reduce some, but not all, of the associated costs of a changing climate. Many climate adaptation measures include large infrastructure projects, for example to provide protection against flood damage. Such infrastructure is usually regarded as a 'public good' because of the difficulty in identifying clearly who will benefit from it. Climate adaptation would therefore necessitate an increase in government spending, which would need to be accommodated by Thailand's overall fiscal framework.

**323. Environmental fiscal reform could help Thailand meet the challenges posed by climate change and the need to reduce greenhouse gas emissions, while relieving pressure on public budgets**. This chapter explores the current policy framework and estimates the likely levels of public spending that will be required to reduce emissions within Thailand and to adapt to the effects of a changing climate. It demonstrates the potential to shift more of the tax burden to activities that cause environmental harm, specifically through the release of greenhouse gas emissions. It shows that such a shift in taxation need not lead to economic costs, and would result in higher quality economic growth, with greater protection for the natural environment and improvements to air quality in urban areas. Environmental taxes could help fund actions to adapt to the effects of a changing climate, and investments in further decarbonization measures to meet Thailand's international commitments on emission reductions. However, the measures assessed in this chapter would not be sufficient to fully cover the costs of responding to the climate challenge.

## 7.2 Thailand is vulnerable to climate change

**324. Thailand is especially vulnerable to the effects of climate change because of its long coastlines, fragile agriculture system and susceptibility to extreme weather events**.[168] Examples of extreme weather events include tropical storms, floods and droughts. Climate change and variability is already causing severe impacts on Thailand's economy and its ecosystems. Estimates of the damage to the economy by mid-century range from 1 percent of GDP to 44 percent of GDP[169] (compared to a scenario with no climate impacts), indicating the high level of uncertainty around future climate impacts. Future World Bank analysis will include a detailed estimate of climate damages, based on Thailand's specific circumstances. However, potential costs in the range of 10-20 percent of GDP seem plausible, given previous World Bank analysis in nearby countries and Thailand's vulnerability to climate shocks.

**325. These climate vulnerabilities could have direct impacts on macro-fiscal sustainability, both in the short and long terms.** Although there is no comprehensive study of current climate costs to Thailand, there are several different channels through which economic production could be reduced through climate change. Damage to physical capital and infrastructure will reduce production. Labor productivity may be reduced due to increased temperatures or greater incidence of disease or illness. Some economic activities, including tourist activities, may lose international competitiveness. Any lost production will lead to reduced tax revenues and there may also be needs for increased public spending. For example, resources will be needed to repair or replace damaged public assets and compensation may be needed for owners of damaged private assets. Healthcare costs may also increase. Additional uncertainty could negatively impact investment levels, economic growth, asset prices and the government's credit rating.

**326. The costs of flooding alone in Thailand are high.** Since 1990, almost every province in Thailand has experienced flooding. The 2011 floods caused 680 deaths and resulted in economic damages to property worth an estimated THB 1.43 trillion[170] (12.6 percent of GDP). More than 5.5 percent of Thailand's land mass was under water at the time. Thailand's manufacturing and export sectors in Bangkok, Ayutthaya, Nakorn Sawan, Pathum Thani, and Samutsakorn were particularly

[168] https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15853-WB_Thailand%20Country%20Profile-WEB_0.pdf
[169] https://web.stanford.edu/~mburke/climate/map.php; https://www.swissre.com/risk-knowledge/mitigating-climate-risk/economics-of-climate-change-impacts-for-asia.html
[170] https://openknowledge.worldbank.org/handle/10986/26862

affected. The Thai government lost an estimated 3.7 percent of tax revenues in 2011 and 2.6 percent of revenues in 2012 because of the flooding. The public sector faced THB 141 billion of losses to property and an estimated reconstruction bill of THB 388 billion (3.4 percent of GDP). Bangkok remains especially vulnerable to flooding, having suffered six other major flooding events since 1980, despite the introduction of flood control measures (Box 7-1). Although several flood prevention measures have since been taken in Bangkok, they have often ended up diverting water to neighboring areas and increasing their vulnerability.[171] Thailand's Third Biennial Update Report (TBUR) on climate change[172] notes that total rainfall is currently increasing despite a reduction in the number of rainy days, which increases the future risk of flooding. Rising sea levels will further increase the flooding risks.

**327. Thailand is vulnerable to the effects of coastal erosion.** A combination of sea level rise and changing weather patterns could further accelerate coastal erosion. The TBUR reports that about 600km (23 percent of Thailand's coastline) is affected by an erosion rate of one to five meters per year. The total loss of land is estimated at 2 $km^2$ per year, with a value of THB 6 billion (0.04 percent of GDP). Cities and economic activities in coastal areas are especially vulnerable to coastal erosion.

**Box 7-1: Bangkok flooding**

**There is particular concern about the vulnerability of Bangkok and its perimeter provinces to the impacts of flooding and coastal erosion.** Bangkok lies on the delta of the Chao Phraya River, approximately 25 km inland from the Gulf of Thailand. The area is less than 2 meters above sea level and sits on former marshy land that is subject to periodic flooding. In addition, Bangkok is sinking because of excessive underground water use and the weight of large-scale high-rise development, suggesting that permanent water incursion may become possible. The TBUR notes that Bangkok is one of the most vulnerable cities in the world to the effects of changing rainfall patterns, sea level rises and coastal erosion. In 2015, Thailand's National Reform Council suggested that Bangkok could be submerged within 15 years if preventative action was not taken. An academic study in 2019 suggested that much of the area could lie under water by 2050.[173] An estimated 12 million people could be displaced, with a substantial share of the people affected already living below the poverty level.[174, 175]

**328. Thailand is also vulnerable to droughts and water shortages, with particularly adverse effects on the agriculture sector.** Changes in weather patterns resulting from climate change are increasing the frequency of droughts and water shortages. Agriculture (which accounts for about 9 percent of GDP) is particularly vulnerable to water shortages, with highly water-intensive rice production especially susceptible. A lack of rainfall also contributes to the overuse of fresh water from aquifers, leading to subsidence and land sinking in areas such as Bangkok. Changes in weather patterns resulting from climate change are increasing the frequency of droughts and water shortages. Costs to the government in providing compensation (mainly to farmers) are expected to increase over time. In 2019, it was reported that the government provided a one-off payment of THB 25 billion (0.15 percent of GDP) to farmers to compensate directly for damage to crops from drought and flooding.[176] Further measures to support affected farmers were also announced with a cost of THB 60 billion (0.36 percent of GDP).

**329. Other important economic sectors including tourism and manufacturing are also exposed to the impacts of climate change.** Tourism, which is mainly located on coastlines and accounts for an estimated 12 percent of GDP, is vulnerable to flooding and coastal erosion. The manufacturing of goods for exports is concentrated in and around Bangkok and is therefore vulnerable to flooding. Water supply, although small in economic terms, provides a critical input to several other sectors (including agriculture and tourism). Careful management of water resources will be important in reducing

[171] https://documents1.worldbank.org/curated/en/866821468339644916/pdf/571100WP0REPLA1egacities01019110web.pdf
[172] https://unfccc.int/documents/267629
[173] https://www.nature.com/articles/s41467-019-12808-z
[174] https://www.imf.org/en/Publications/CR/Issues/2021/06/02/Thailand-2021-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-50192
[175] https://documents1.worldbank.org/curated/en/866821468339644916/pdf/571100WP0REPLA1egacities01019110web.pdf
[176] https://www.bangkokpost.com/thailand/general/1755944/struggling-farmers-get-compensation

subsidence and preventing low-lying coastal areas from sinking further but will become more difficult if the frequency of droughts increases.

## 7.3 The need for adaptation

**330. There is already an urgent and pressing need in Thailand to adapt to the effects of a changing climate.** The country has already taken some adaptation measures, for example in the preparations and responses to disasters laid out in the National Disaster Prevention and Mitigation Plan from 2015. Public spending on 'Environmental Protection', has increased from less than THB 2 billion in 2012 to THB 14.7bn in 2021 (0.1 percent of GDP, or 0.6 percent of total public expenditure). However, the climate threats that Thailand faces will continue to grow. The costs of adapting to a changing climate will increase further.

**331. Thailand's National Adaptation Plan (NAP) is designed to meet the challenges of a changing climate.[177]** The design phase of the NAP started in 2015 but the final version has not yet been submitted to the United Nations. The NAP aims to improve resilience in all sectors, to strengthen capacity and awareness, and to accelerate the development of research, knowledge, and technology. The NAP has identified six focus areas: Water, agriculture/food, tourism, public health, natural resources, and human settlements. In each focus area, the NAP consolidates national, local, and sectoral expertise to develop a strategy for managing the effects of climate change. Target indicators have been suggested in each case although they are not always quantified. Thailand's NDC summarizes the aims within each focus area (Table 7-1).

**Table 7-1: Summary of Thailand's National Adaptation Plan**

| Focus area | Aims |
|---|---|
| Water resources management | Increase water security and reduce loss and damage from water-related disasters, by developing mechanisms for integrated water resources management and building adaptive capacity and climate resilience |
| Agriculture and food security | Maintain productivity and food security by increasing the ability to respond and manage risks in the agricultural sector |
| Tourism | Strengthen capacity towards climate resilience and sustainable growth by enhancing disaster management and climate risk reduction |
| Public health | Enhance the capacity of the public health system to manage health risks and reduce health impacts from climate change, by developing health impact surveillance and prevention mechanisms and enhancing access to good quality public health services |
| Natural resources management | Sustainably manage natural resources and biodiversity to respond to climate change impacts, by enhancing the conservation, rehabilitation and sustainable use of natural resources and biodiversity, and strengthening public participation |
| Human settlements and security | Enhance the capacity of individuals, communities and cities to adapt to climate change impacts in accordance with the local context, by developing mechanisms to manage climate risks and impacts |

Source: Adapted from Thailand's NDC.

**332. The management of water resources is a key component of Thailand's NAP that will need public funding.** The frequency of floods and droughts, and the high human and economic cost associated with them, makes water management a priority in Thailand. Thailand has developed National Water Resources Management Strategies (2015-2026) and a 20-Year Master Plan on Water Resources Management (2018-2037). The plans include targets for improving the sustainable provision of high-quality water across the country, for example through improved infrastructure of water collection and storage. The plans also include additional infrastructure to reduce the impacts of high rainfall, for example through improving drainage systems and protecting riverbanks. In many cases it will be difficult to match the beneficiaries of the measures to the costs, so the adaptation measures are effectively public goods and a substantial public investment could be required.

**333. A study from 2010 estimated the costs of protecting against flood damage in Bangkok at up to THB 56.9 billion[178] (0.4 percent of GDP in 2020).** Such an investment would be one-off and would protect against what was

[177] http://t-plat.deqp.go.th/en/nap-0-en/nap-en-main/

[178] Figures updated to 2020 prices. See page 57 https://documents1.worldbank.org/curated/en/866821468339644916/pdf/571100WP0REPLA1egacities01019110web.pdf

previously described as a '1 in 100' year event, but which will become more common because of climate change. It involves a combination of early warning systems, physical assets like dikes and pumping systems, land use changes and information campaigns. A further THB 1.0 billion would be required annually for operational and maintenance costs. The measures would reduce the land area flooded by about half and the costs of flooding by a similar proportion.

**334. The private sector has taken some adaptation measures to protect against future floods, reducing potential public adaptation costs.** After the 2011 floods, the Industrial Estate Authority of Thailand revised its design criteria for prevention measures, including improving drainage, raising flood barriers and installing water monitoring and warning systems. Some food and beverage companies undertook climate risk scenario assessments to identify risks of flooding or water shortages among operating plants. More recently, large companies have been disclosing climate risks for the Task Force on Climate-Related Financial Disclosures (TCFD). Private sector adaptation measures make sense where the benefits to individual companies are clear. Further cooperation between the public and private sectors could potentially limit duplication of efforts and reduce future public costs.

**335. Aside from the water management sector, the NAP proposes the development of new physical infrastructure.** For example, in the tourism sector there are measures to develop new infrastructure to reduce environmental footprints. Some of the costs of new infrastructure may be borne by the private sector. However, as with flood prevention, it may be difficult to identify clearly the beneficiaries and therefore a substantial contribution from public budgets may be required.

**336. World Bank analysis suggests that the cost of making new transport infrastructure climate resilient could be relatively modest, though retrofitting existing infrastructure would be more costly.** The analysis suggests that the increase in costs of climate proofing the new transport infrastructure would be only an additional 1.4 percent on top of current spending on new transport infrastructure, which could reduce related climate damages by nearly 70 percent. If annual investment in transport infrastructure matches recommended estimates[179], the annual additional cost would be THB 2.9 billion each year, increasing over time in line with GDP growth. However, this figure assumes that resilience is only added to climate-exposed infrastructure; costs could increase by a factor of five if the resilience measures are not well-targeted.[180] It should also be noted that the cost of retrofitting existing transport infrastructure to make it climate resilient could be much higher than the cost of climate-proofing new infrastructure.

**337. The NAP also includes many non-infrastructure measures that are aimed at building public and private sector capacity.** For example, the development of hazard mapping and early warning systems that allow government officials and private companies to forecast and prepare for climate events is a common theme across the focus areas. Most of the focus areas also consider the development and roll-out of new climate-friendly management practices and new technologies. In addition, there are measures that aim to build support networks. In most cases, these measures will require public-sector coordination and, although some measures are relatively low-cost, coordination issues mean that they will require predominantly public funding. International support is already being provided for some initial activities in the agriculture sector.[181]

**338. There are no specific cost estimates of Thailand's NAP available yet and costs are highly uncertain.** The NAP is both ambitious and far-reaching, covering the critical sectors of Thailand's economy. The measures in the NAP that aim to improve infrastructure will have high up-front costs, at least some of which will require public funding. The measures that seek to improve coordination and management will have lower up-front costs, but increased public-sector involvement, for example in maintaining early-warning systems, would mean persistent long-run costs. There will also be additional public costs for climate-proofing other public investments that are not formally part of the NAP.

**339. Drawing on global estimates, annual public adaptation costs will likely exceed 1 percent of Thailand's GDP by 2030.** UNEP's *Adaptation Gap Report 2021* reports that developing countries may need to spend US$ 140-300bn each year

[179] See page 9 https://openknowledge.worldbank.org/handle/10986/31291
[180] https://openknowledge.worldbank.org/bitstream/handle/10986/31916/WPS8896.pdf?sequence=4&isAllowed=y
[181] https://www.adb.org/sites/default/files/project-documents/53099/53099-001-tar-en.pdf, https://www.fao.org/in-action/naps/en/, https://www.fao.org/in-action/scala/en

on adaptation by 2030[182]. The likely upper end of this range is equal to 1 percent of current GDP in the developing world; it is derived from a review of national and sectoral studies[183] that are then aggregated to get a global total. However, given Thailand's particular vulnerability to climate change, its adaptation cost as a share of GDP is likely to be higher. Furthermore, the UNEP report notes that, by 2050, the annual cost could increase further to 1.6 percent of 2020's GDP level. IMF analysis finds that the annual cost of making all infrastructure climate resilient by 2025 would be 1.6 percent of GDP on average for all emerging markets.[184] This analysis builds on previous World Bank work[185] and draws on engineering-based estimates of the costs of improving resilience[186]. The report also acknowledges Thailand as having 'above-median' adaptation costs. In this chapter we take costs of 1.6 percent of GDP as a median estimate for adaptation costs. Formal estimates of the benefits of the adaptation measures are not yet available, but a halving of the costs of climate damages (i.e. to 5-10 percent of GDP based on the rough estimate of damages above) is plausible. It is important to note that adaptation measures would not fully eliminate the need for compensation to farmers and the other public costs of climate change.

## 7.4 Thailand is taking action to reduce emissions

**340. Thailand is not currently a major global emitter of greenhouse gases.** In 2018, Thailand's greenhouse gas emissions accounted for 0.9 percent of the global total. Its emissions per capita are lower than the global average rate but its emissions per unit of GDP are higher than the global average rate. Although greenhouse gas emission levels in Thailand steadily increased over 1980-1995 and 2000-2013, over 2013-2019 they remained broadly flat (Figure 7-2). Total emission levels have fallen during the covid-19 pandemic but are likely to return to previous levels once the economy fully reopens.

**341. The fiscal impact of reducing emissions levels depends on the choice of instruments used.** As this chapter discusses, some measures to reduce emissions will have fiscal costs, while carbon pricing instruments could raise revenues. However, the potential loss of revenues from fuel excise duties is a long-term concern.

**342. Industry, power, transport, and agriculture account for most of Thailand's GHG emissions.** In 2018, the power sector contributed 21 percent of Thailand's total GHG emissions (Figure 7-2). Industry accounted for a 26 percent share, transport 18 percent and agriculture 17 percent. Remaining emissions are attributed to other energy production (7 percent) buildings (4 percent) and waste (6 percent). Most power sector GHG emissions are $CO_2$ and most agricultural emissions are methane and nitrous dioxide. Industrial emissions include a growing proportion from F-gases. Industry, the power sector, transport and agriculture all face different decarbonization challenges in the coming decades and the availability of technological options to reduce emissions varies substantially across these sectors.

[182] The range is based on uncertainties and the rate of climate change. The report suggests that more recent estimates are closer to the top end of the range. Thailand's cost is estimated by taking a simple GDP share and hence ignores specific national vulnerabilities, likely underestimating the actual cost. See https://www.unep.org/resources/adaptation-gap-report-2021

[183] See page 12 https://unepdtu.org/wp-content/uploads/2018/10/unep-gap-report-2016-web-6-6-2016.pdf

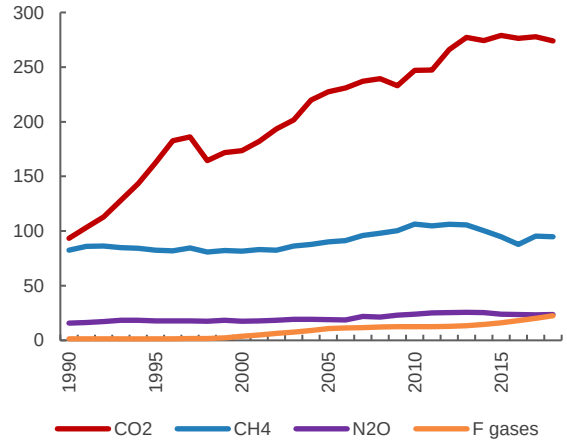
[184] https://www.imf.org/en/Publications/staff-climate-notes/Issues/2022/03/16/Macro-Fiscal-Implications-of-Adaptation-to-Climate-Change-512769

[185] https://openknowledge.worldbank.org/bitstream/handle/10986/31916/WPS8896.pdf?sequence=4&isAllowed=y

[186] This cost would include the measures to protect Bangkok and Thailand's transport system described earlier.

**Figure 7-2: Structure of Greenhouse Gas Emissions in Thailand**

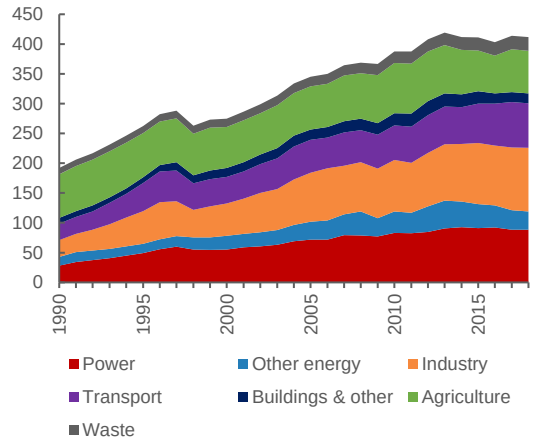
GHG emissions in Thailand, mtCO2eq




Source: EDGAR database[187].

Note: Excluding land use and land use change

Sectoral shares of total greenhouse gas emissions, 2018, mtCO2eq




Source: World Bank staff calculations, using the EDGAR database.

**343. Thailand's greenhouse gas emission reduction measures so far have focused on the energy and transport sectors.** Prior to 2020, Thailand's international climate commitments were underpinned by a Nationally Appropriate Mitigation Action (NAMA) roadmap that focused on the energy and transport sectors. The largest reported emission reductions have come from renewable electricity generation and the use of bioenergy for generating heat. There have likely been only small public costs from the measures so far.

**344. Further measures to reduce greenhouse gas emissions in Thailand could bring economic and financial benefits.** The following section shows that measures to reduce fuel consumption would reduce Thailand's dependence in imported fuel, boosting domestic activity rates. Measures to improve energy and resource efficiency could boost industrial competitiveness and related technological developments can enhance wider productivity. Improvements to air quality may also bring economic benefits through health effects. Finally, achieving emission reduction targets is likely to be a pre-requisite for gaining access to international finance to help fund adaptation measures.

**345. Thailand's most recent Nationally Determined Contribution (NDC) submitted to the UN pledges a reduction of at least 30 percent of all greenhouse gas emissions below a baseline level by 2030.** The target will increase to 40 percent below baseline by 2030 if the country receives access to technology development and transfer, financial resources, and capacity building support. The speed of economic recovery post-covid will determine how easy it is to meet the NDC targets.

**346. Thailand submitted a new Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS) to the UNFCCC in 2022, pledging to peak emissions in the 2020s and to reach carbon neutrality by 2050 and net zero emissions by 2065 (Figure 7-3).** The LT-LEDS will guide the country towards low-carbon development and serve as a basis for enhancing its subsequent NDCs. It builds on previous plans and lays out an approach for emission reductions, again with a strong focus on the electricity and transport sectors. . The macroeconomic assessment in the previous LT-LEDS suggested that most of the costs of decarbonization would arise in the period when emissions fall rapidly.

[187] See https://edgar.jrc.ec.europa.eu/dataset_ghg60 and Crippa et al (2021): https://data.europa.eu/doi/10.2904/JRC_DATASET_EDGAR

**Figure 7-3: Thailand's Long-Term Low Greenhouse Gas Emission Scenario**


Source: LT-LEDS (https://unfccc.int/sites/default/files/resource/Thailand%20LT-LEDS%20%28Revised%20Version%29_08Nov2022.pdf).
Note: IPPU denotes Industrial Processes and Product Use. LULUCF denotes Land Use, Land-Use Change and Forestry.

**347. Thailand's previous NDC included 15 specific measures to reduce greenhouse gas emissions, with some potential costs to government.** The NDC roadmap outlined 115.6 mtCO2eq of potential savings by 2030, mainly focusing on energy and transport. The previous Power Development Plan (PDP) estimated that costs of developing the power sector would be 0.4 percent of GDP annually. Although renewable costs have fallen, the level of climate ambition has increased and there is a moratorium on new coal power plants. A modest increase in costs is therefore expected, likely mostly to be borne by the consumers of electricity.

**348. Thailand's measures to reduce greenhouse gas emissions from transport include regulatory efforts, petroleum excise duties and vehicle taxation based on $CO_2$ emissions.** Excise duties are designed to reduce fuel consumption in vehicles, as well as raise revenues. There is both an excise duty on petroleum consumption and a tiered vehicle excise duty that is based on the vehicle's fuel efficiency. In fiscal year 2019, the revenues from petroleum taxes were THB 210bn and from vehicle taxes THB 133bn[188] (1.2 and 0.8 percent of GDP, respectively[189]), although in 2022 rates were reduced.

**349. Climate policy in the industrial and buildings sectors is mainly focused on energy efficiency and currently carries a small cost to government.** The Energy Conservation Promotion Act provides a general framework for energy efficiency for large industrial users, and mandates under the Building Energy Code and Factory Energy Code set standards for new commercial and residential buildings. Aside from ensuring enforcement, these policies have limited cost to public budgets. In addition, there are some incentives to promote energy efficiency, the use of rooftop solar and other renewable electricity generation in commercial and industrial buildings, which have a modest cost to the government. There are no excise duties on electricity or heating fuels in Thailand.

**350. Thailand still subsidizes some uses of energy, at a substantial fiscal cost.** Fuel subsidies in Thailand have two purposes: to stabilize prices and to reduce prices for low-income households. In 2022, as fuel prices increased in response to the war in Ukraine, Thailand introduced additional measures to stabilize prices, particularly of motor fuel. These measures – including reductions in excise duty and subsidies from the oil fund – are costly (see Chapter 2). Moreover, the Oil Fund, which aims to stabilize prices, poses a significant contingent liability to the government. The Oil Fund is designed to protect fuel users from large changes in international commodity prices. By fixing fuel prices, it makes a profit when oil

[188] http://interweb.excise.go.th/contents.php?lang=en&m=2&sub=8
[189] For comparison, duties on fuel and cars in the US raised 0.2 percent of GDP each in 2019. In the UK fuel duties raise 1.3 percent of GDP but duties on cars only 0.3 percent of GDP (source: OECD Revenue Statistics, 2021).

import prices are low, and a loss when import prices are high. In 2022, with oil prices at high levels following the onset of war in Ukraine, the Oil Fund was making a substantial loss, though replenishments have subsequently been made in 2023 as oil import prices have declined (see Chapter 2).

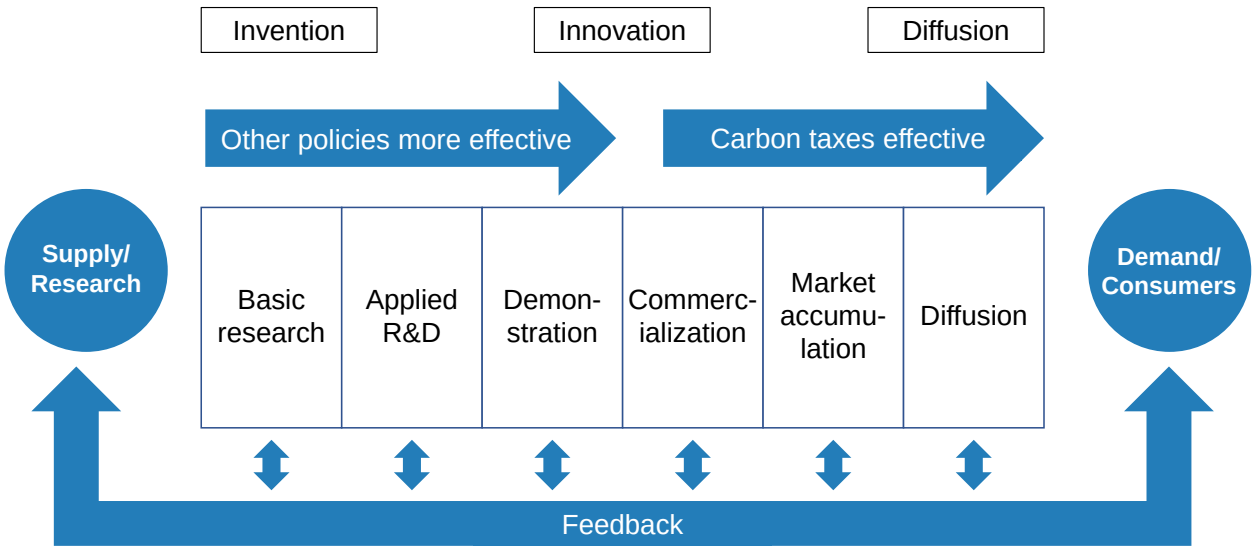
## 7.5 The potential for carbon pricing

**351. Additional policies will be required to meet Thailand's emission reduction targets; carbon pricing could be an effective tool for getting there.** As the economy recovers post-covid, GHG emissions will also increase, unless measures are taken to prevent emissions growth. Plans to reduce emissions in the power sector and transport sector (see Section 7.6) will slow emission increases, but it is likely that policies will be needed in other sectors too. Carbon pricing offers a possibility to reduce emissions across the whole economy. Carbon pricing could take the form of either a carbon tax, where the price is fixed, or an Emission Trading Scheme (ETS), where the rate of emission reduction is fixed. In this report we outline two specific proposals that have the potential to efficiently reduce emissions while at the same time raising revenues that can then be allocated to other uses: i) an ETS for the manufacturing sector (in this section) and ii) a carbon tax on the road transport sector (in Section 7.6). The choice of instruments and sectoral coverage is based on previous analysis and available current technologies, as described below.

**352. Carbon pricing may be an efficient way of reducing $CO_2$ emissions and it could raise revenues for Thailand's government.** $CO_2$ emissions result from 'market failure' because they cause damage to wider society without being incorporated into the pricing framework. The market failure provides strong justification for public intervention. In theory, a carbon price aligns firms' incentives with those of wider society by including the cost of emissions in the market price. The carbon price thus adapts firm behavior in a way that increases overall benefits to society. Carbon prices also allow firms to determine the lowest-cost ways to reduce emissions, thereby minimizing the overall cost of emission reduction. At the same time, and in contrast to most other climate policies, carbon pricing could raise revenues for Thailand's government, even from the informal sector. These revenues could be used to support low-carbon development, which usually increases the political feasibility of ambitious climate policy.

**353. The effectiveness of carbon pricing instruments depends on market structures and the availability of low-carbon technology.** For carbon pricing to be effective at changing behavior, a market system in which prices can freely change is required. If there are price rigidities, imposing a carbon price will still raise public revenues, but may not change behavior. Similarly, carbon pricing is only an effective way of reducing GHG emissions if there are low-carbon alternative technology options available. In sectors where low-carbon technologies do not yet exist, other policies, for example amending planning guidelines or public procurement, may be more appropriate in developing capacity (Figure 7-4).

**Figure 7-4: The Innovation Chain**



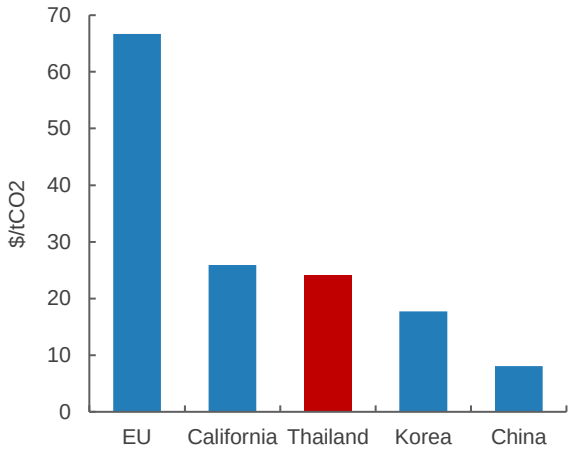

Source: Adapted from Grubb et al (2014)

**354. Thailand's Voluntary Emission Reduction Program (T-VER) could provide the basis for future emissions trading.** T-VER was set up in 2013 by Thailand's Greenhouse Gas Management Organization (TGO). It is a system of carbon credits that works at the individual project level, like how carbon offset schemes work in some other countries. Examples of projects covered by T-VER include energy efficiency schemes, renewable energy, and forestry/agriculture developments. T-VER could provide the framework for a future ETS if it was expanded and turned into a compulsory scheme.

**355. Thailand could consider introducing an ETS for the manufacturing sector.**[190] Previous World Bank analysis has found that, despite initial set-up challenges and higher administration costs, an ETS was preferred to a carbon tax by business, because of the perceived flexibility and the negative perception associated with introducing a new tax[191]. ETS allowances could be provided to business for free in a three-year pilot phase, then auctioned to all companies covered by the scheme, which would raise revenues for the Thai government. Proceeding in this manner it would be possible, although challenging, to auction all allowances by 2030. The World Bank's Partnership for Market Readiness (PMR) program helped to establish the legal basis for an ETS in Thailand and administration costs could be reduced by building on existing frameworks. The manufacturing sector was chosen because it includes a variety of production processes, some of which have low-carbon technology options. The power sector was excluded because of its market structure. Transport and households were excluded because of high transaction costs and lack of low-carbon technology options; however, some form of carbon tax may now be suitable for the transport sector (see Section 7.6).

**356. By setting an appropriate cap on manufacturing emissions, an ETS could help Thailand to meet its international climate commitments.** The modelling in the World Bank report found that an ETS with a cap that reduced emissions by 44 $mtCO_2eq$ (potentially enough to meet the NDC target if other sectors cut emissions too) would set a carbon price of THB 908/$tCO_2$ on energy and process emissions from the manufacturing sector. Although the carbon price is high compared to those used in some other countries, it is around one third of the current price applied in Europe (see Figure 7-5). Companies included in the ETS could potentially use offsets to cover up to 15 percent of their emissions through T-VER projects. Including offsets would reduce the ETS carbon prices, while simultaneously reducing GHG emissions in sectors not covered by the ETS. For example, the forestry sector has a key role in meeting Thailand's climate targets (see Section 7.7) but would not be included in the ETS.

**Figure 7-5: How Thailand's Carbon Price Could Compare to Those in Other Countries**




Source: Carboncredits.com, October 2022

[190] World Bank: Carbon Pricing in Thailand – Options Analysis.
[191] The previous study was carried out in 2018/19 and it is possible that other instruments would be preferrable in the post-covid economy. This issue will be explored in the forthcoming Country Climate Development Report for Thailand.

**Box 7-2: Emission trading and the power sector**

**The effectiveness of an ETS or other carbon pricing instrument could be enhanced substantially if it also included the power sector, but this would require structural reform of the sector in Thailand.** Almost all ETS operations around the world cover the power sector because the sector can reduce GHG emissions through technology switching. However, Thailand's highly regulated and centralized market structure would currently make an ETS ineffective in the sector because of a lack of competitive pressure which allows costs to be passed on to consumers. Power sector reform would therefore be needed to make carbon pricing effective in the sector; this will be explored in future World Bank analysis.

**357. It is estimated that an ETS for the manufacturing sector could raise THB 194 billion annually by 2030 (0.8 percent of GDP), if all allowances are auctioned.** The GDP impacts of the ETS depend on how quickly companies pass on the higher costs to households, and how the revenues generated are used by the government. In the modelling, higher costs for industry lead to a GDP loss of 0.2 percent compared to a baseline case because companies pass a share of the additional costs on to households (leading to loss of real income) and exports (leading to a loss of trade). However, if 30 percent of the revenues are used to reduce taxes on incomes, there could be a small increase in GDP (Table 7-2)[192]. There thus could be a 'double dividend' effect of improved economic performance (and increased public revenues) while simultaneously reducing GHG emissions. The benefits to GDP would largely occur through reduced imports of fossil fuels (i.e. a reduction in the fossil fuel intensity of output) and an improved trade balance. However, there could still be a negative impact on employment because of job losses in the extraction and carbon-intensive sectors. Further use of the revenues to reduce other taxes could increase GDP further and offset the negative employment effect at aggregate level.

**Table 7-2: Macroeconomic Impacts of An ETS on Industry in Thailand, 2030 (% from baseline)**

| Share of revenue used to reduce other taxes | Net revenue gain (% of GDP) | GDP impact | Employment impact |
|---|---|---|---|
| 0% | 0.8 | -0.2 | -0.2 |
| 10% | 0.7 | -0.1 | -0.2 |
| 30% | 0.6 | 0.1 | -0.1 |
| 100% | 0.0 | 0.6 | 0.1 |

Note: Scenario variants with no offsets.

Source: World Bank Carbon Pricing in Thailand report.

**358. Potentially harmful competitiveness effects from an ETS are unlikely to be substantial because Thailand is not a major exporter of carbon-intensive products; competitiveness concerns from not reducing emissions may be more serious.** If Thailand's trading partners do not implement carbon pricing or equivalent climate policy, manufacturing in Thailand could be placed at a competitive disadvantage. There could potentially be 'carbon leakage' where production in Thailand moves to other countries, leading to economic cost without reductions in global emissions. However, in practice, there is little international evidence of industry relocating because of climate policy. The sectors most likely to be affected are those that are carbon-intensive, lack low-cost decarbonization options and are commonly traded. Aside from some petroleum, Thailand is not a major exporter of products in these sectors. In contrast, fears of loss of competitiveness from not reducing emissions are growing. An estimated 78 percent of multinational companies claim they will remove high-carbon producers from their supply chains from 2025. If Thai companies do not take measures to reduce their carbon footprint, there is a risk they may become cut off from global supply chains[193].

**359. The impacts of a manufacturing-sector ETS on households in Thailand need not be substantial and could be offset by targeted use of a share of the revenues generated.** There would be some impact on households because the prices of some manufactured goods would increase. Impacts on lower-income households would likely be largely felt through higher food prices, for example because of higher fertilizer costs. However, these effects could potentially be offset

[192] In theory, the measure would also draw in more of the informal sector because all consumers would pay higher prices for manufactured goods, and formally recognized workers would pay lower tax rates.

[193] https://www.sc.com/en/media/press-release/carbon-dated-multinational-companies-planning-to-cut-suppliers-by-2025-for-failing-to-curb-carbon-emissions/

by using some of the revenues from the ETS to supplement incomes (in line with the social assistance recommendations in Chapter 6). To the extent that the power and buildings sectors are not included in an ETS, households would not face higher electricity prices, and the impact on households would be limited to the pass-through from higher prices of manufactured goods.

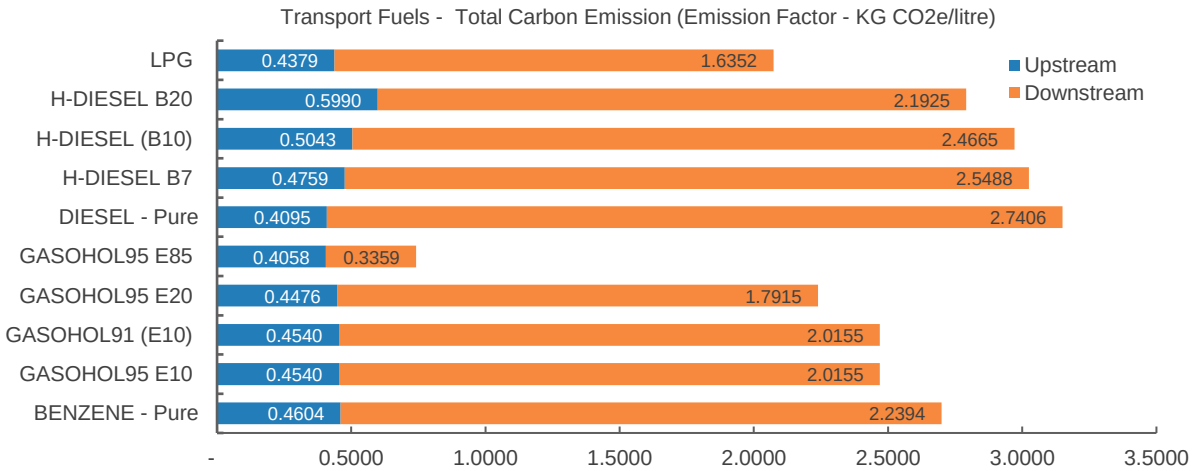
## 7.6 Carbon pricing in the road transport sector

**360. Recent advances in the electrification of passenger vehicles have increased the scope for carbon pricing in the road transport sector.** In 2018, transport accounted for 18 percent of Thailand's GHG emissions, with the largest share coming from road transport. Without further policy measures, transport emissions are likely to increase as the economy recovers, making it difficult to achieve emission reduction targets. Carbon pricing may be an effective policy instrument for the sector because it is not highly regulated, is not subject to competitiveness concerns and, with recent developments in electric vehicles (EVs), has low-carbon technologies available. Carbon pricing in the road transport sector could therefore both raise public revenues and reduce greenhouse gas emissions in Thailand.

**361. Decarbonizing transport could have additional benefits in Thailand.** Reducing greenhouse gas emissions is not the only reason to develop further the transport system. For example, a rapid roll-out of charging infrastructure will create jobs in the construction sector and, as already recognized by the Government of Thailand, developing domestic EV production could boost both export revenues and local employment levels. A shift to EVs would improve air quality in urban areas, reducing both healthcare costs and the estimated 40,000 deaths each year in Thailand that are linked to air pollution. A shift to public transport, or reduction in overall journeys taken, would also ease pressure on Thailand's roads.

**362. Existing excise duties on road transport fuel could be adjusted to reflect the fuel's carbon content.** Currently there are excise duties on petroleum, but other transport fuels are not taxed and the Oil Fund effectively subsidizes fuel when commodity prices are high. Rates of excise duty could be adjusted to reflect the carbon content of the fuels that are used (see Figure 7-6), which could incentivize more biofuel blending. This would effectively establish a carbon tax for the sector without needing the creation of a new instrument. The tax would apply to the use of vehicles. The excise duty applied to the purchase of new vehicles already differentiates between different levels of $CO_2$ emissions between vehicles. For cars, tax rates range from 2 percent for battery electric or fuel cell vehicles, to 40 percent for large conventional vehicles. For motorcycles, the tax rate is 1 percent for electric or highly efficient vehicles, but 18 percent for the most polluting vehicles.

**Figure 7-6: Carbon Footprint of Transport Fuels in Thailand**




| | BENZENE - Pure | GASOHOL9 5 E10 | GASOHOL9 1 (E10) | GASOHOL9 5 E20 | GASOHOL9 5 E85 | DIESEL - Pure | H-DIESEL B7 | H-DIESEL (B10) | H-DIESEL B20 | LPG |
|---|---|---|---|---|---|---|---|---|---|---|
| Upstream | 0.4604 | 0.4540 | 0.4540 | 0.4476 | 0.4058 | 0.4095 | 0.4759 | 0.5043 | 0.5990 | 0.4379 |
| Downstream | 2.2394 | 2.0155 | 2.0155 | 1.7915 | 0.3359 | 2.7406 | 2.5488 | 2.4665 | 2.1925 | 1.6352 |

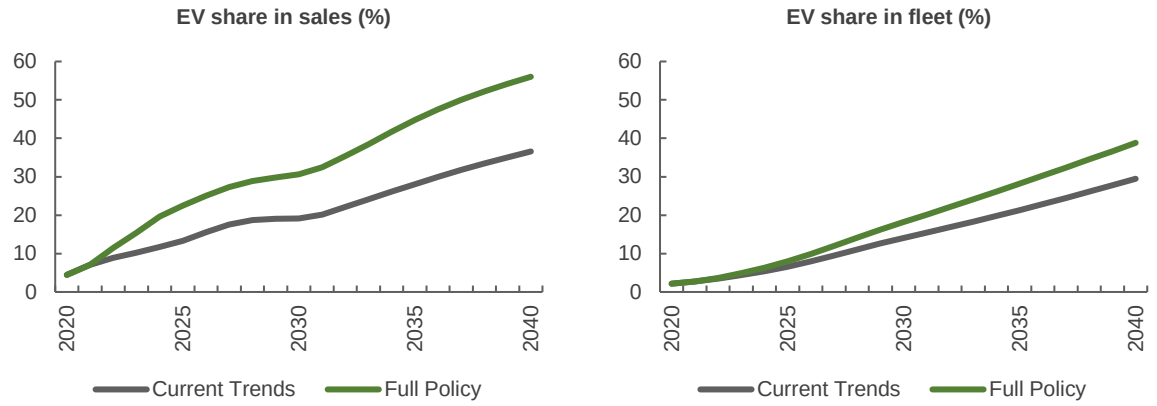
Source: Authors' calculations

*Fuel Consumption 2564 - EPPO

http://www.eppo.go.th/index.php/th/energy-information/situation-oil-electric?orders[publishUp]=publishUp&issearch=1

**363. The market share of low-carbon vehicles is currently low.** Current estimates give electric vehicles a market share of at most 2 percent in Thailand (most of which are in fact hybrid vehicles). As a result, the required infrastructure for electric vehicles, including public charging points, remains relatively underdeveloped. Even with plans to electrify the public fleet of vehicles (with all new sales for the public fleet being zero-emission by 2025[194]), model simulations suggest that current policy will not be sufficient to meet the target of 30 percent EV sales by 2030 (see 'current trends' in Figure 7-7). This section discusses the fiscal implications of policies that could make the target achievable.

**Figure 7-7: EV market shares in new vehicle sales and in the vehicle fleet**




Source: World Bank staff calculations using the FTT:Transport model.[195]

**364. As a single measure, carbon-based pricing of road transport could raise revenues, but will have limited environmental benefits.** There are two ways in which higher fuel costs could reduce greenhouse gas emissions. The first is through a reduction in distance travelled in private vehicles, in part by avoiding some journeys and in part by shifting some travel to public transport. The second is through a shift toward smaller cars. The model simulations show that a carbon price of THB 908/t$CO_2$ (the same rate used for manufacturing in the previous section) would increase fuel costs by only 7-8 percent, and would therefore have only a limited impact on either total distance travelled or choice of vehicle. Estimates of fuel price elasticities typically range between zero and one, suggesting that fuel consumption and related greenhouse gas emissions would only fall by around 5 percent.[196] Model results suggest there is no induced shift to electric vehicles so the policy would not contribute to the government's 2030 target for EV sales.

**365. A substantially increased carbon price applied to road transport fuel would reduce demand for private passenger transport but would still not incentivize large-scale adoption of electric vehicles.** A carbon price that increases fuel prices by 75 percent would reduce the average size of cars and the market share of large cars would fall by around 1.5 percentage points. There would also likely be a noticeable shift toward public transport and fewer journeys would be taken overall. However, even very high fuel prices provide only a weak incentive to invest in electric vehicles. Take-up rates for EVs are influenced much more by high up-front vehicle purchasing costs and the availability of charging infrastructure. Fuel taxation does not influence either of these factors and therefore has only a limited impact on EV take-up rates. Fuel taxation does, however, raise revenues that could be used for improving the transport system.

**366. Carbon-based pricing of road transport fuels could help with the transition to decarbonizing the transport sector, but only in combination with other policies.** Achieving a rapid transition to electric vehicles will require a combination of different policies. The main constraint on the speed of transition is the low base from which EVs are starting and a general lack of supporting infrastructure (mainly charging points). The Government of Thailand could therefore speed up EV uptake by either guaranteeing an initial market for EVs (as it to some extent already is through electrifying the public

[194] https://www.rvo.nl/sites/default/files/2021/10/E-Mobility%20in%20Thailand.pdf
[195] Lam and Mercure (2021), https://www.sciencedirect.com/science/article/abs/pii/S221462962100044X?dgcid=author#s0155
[196] https://www.taylorfrancis.com/chapters/edit/10.4324/9780203983645-13/long-run-demand-elasticities-gasoline-mikael-franz%C3%A9n-thomas-sterner

fleet) or by expanding the existing network of charging points to encourage private sector uptake. A recent World Bank analysis showed that providing the enabling infrastructure for EVs could be at least six times more cost-effective than buying or subsidizing EVs directly.[197] The green lines in Figure 7-7 show the simulation results for a scenario in which the government forces 5 percent of the vehicle fleet to electrify (e.g. by mandating licenses for taxis) and adds the charging infrastructure that is estimated for the same number of vehicles, encouraging further uptake. Combined with the moderate carbon tax of THB 908/$tCO_2$, this full set of policies is sufficient to increase the share of EVs in new vehicle purchases to around 30 percent by 2030 and to over 55 percent by 2040. The carbon price is thus only effective when other measures are introduced as well.

**367. Carbon pricing in the road transport sector could also generate positive GDP impacts.** Further model simulations using the World Bank's Carbon Pricing Assessment Tool (CPAT) show that applying carbon pricing on road transport fuel use and using the revenues for investment in EV and other infrastructure would have a small cost to GDP initially (0.1 percent). However, by 2030 the package of measures could increase GDP by 0.1 percent. These increases in GDP will persist because Thailand can permanently reduce its imports of oil and refined transport fuel. In this scenario Thailand's energy security also improves.

**368. Carbon pricing on motor fuel could raise revenues in the short term to cover transition costs such as investing in charging points for electric vehicles.** Table 7-3 provides an illustration of the possible impacts on public budgets of implementing the policies required to electrify road transport. A carbon tax of THB908 on motor fuels could raise around THB 60bn pa initially, with revenues gradually declining as the vehicle fleet electrifies, which also reduces revenues from existing excise duties. The revenues from the carbon tax could be used to pay for some of the near-term costs of switching to electric vehicles, for example in electrifying the public fleet or helping early adopters (e.g. taxis) to electrify. The revenues could also be used to provide charging infrastructure.

**Table 7-3: Illustrative impacts of electrifying transport on Thailand's public budget[198]**

| | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|
| **On GDP (%):** | 0.0 | 0.1 | 0.1 | 0.1 |
| | | | | |
| **On public budgets (% of GDP):** | | | | |
| Fuel/carbon duties | 0.3 | 0.2 | -0.1 | -0.7 |
| Vehicle excise duties | -0.1 | 0.0 | 0.0 | 0.0 |
| EV switching costs | -0.2 | -0.2 | -0.2 | 0.0 |
| New infrastructure | -0.1 | 0.0 | 0.0 | 0.0 |
| Public transport costs | -0.1 | 0.0 | 0.0 | 0.0 |
| Total | -0.2 | 0.0 | -0.3 | -0.7 |

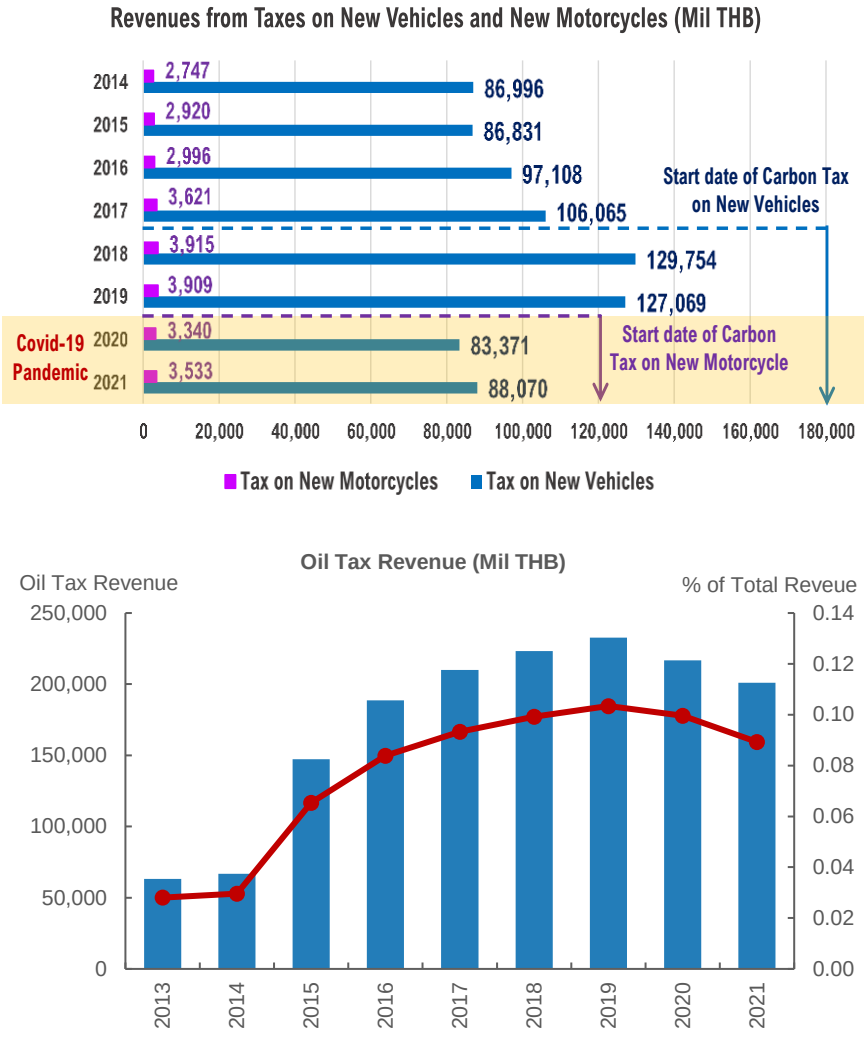
Source: World Bank staff calculations

**369. In the long run, fuel tax collection would fall as a result of these measures.** Excise duties on oil products are an important source of government revenue in Thailand, accounting for around 1.2 percent of GDP (see Figure 7-8). Excise duties on vehicles account for a further 0.8 percent of GDP. Although higher tax rates in the short term will boost revenues, a combination of electric vehicle take-up and improved efficiency in conventional vehicles will reduce all oil and vehicle excise duty revenues over time.

[197] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/225111639490843204/the-global-diffusion-of-electric-vehicles-lessons-from-the-first-decade

[198] Final values depend on the policy mix and are illustrative only. Here it is assumed that 20 percent of mandated EV purchase costs are covered by the public sector, either through direct purchases or subsidies, although excise duties on EVs are levied from 2030. Additional public investment in infrastructure and public transport are assumed to be made in the mid 2020s.

**Figure 7-8: Revenues from Vehicle and Oil Excise Taxes**




Source: Excise Tax Department

**370. Electrifying public transport in Thailand would carry a modest additional public cost.** In 2017 Thailand had 157,799 buses[199] of which 13,728 were publicly owned and on fixed routes in 2021. The cost of an electric bus is currently estimated to be US$ 550,000 compared to US$ 400,000-US$ 500,000 for a conventional bus in 2021.[200] If current buses were to be replaced with electric buses at the end of their lifetimes, the additional cost to Thailand's government of electrifying the fleet could be THB 45bn (0.3 percent of GDP), spread over several years. The figure could be substantially higher if buses were retired early (although many buses in Thailand are already beyond expected lifetimes) and there would also be some costs for charging equipment. However, battery costs will continue to fall and there are potential substantial cost savings from reduced diesel consumption. The lifetime cost of an electric bus is likely to become comparable to a diesel bus by around 2030, meaning that all the additional initial cost of more expensive buses would be offset by fuel savings.

**371. Overall, increased fuel taxation is likely to be a critical part of efforts to decarbonize Thailand's road transport sector, but it will not cover all the costs to the public sector.** As previously noted, carbon pricing is an effective instrument at reducing emissions only if technological alternatives are available. Currently, low uptake rates of electric vehicles mean that alternatives to conventional cars are still limited for many people, so any benefits in terms of reduced emissions will be realized through increased use of public transport, where it provides a viable alternative. By encouraging the development of charging infrastructure through public and private means, EVs will become realistic purchase options

[199] https://www.who.int/publications/i/item/9789241565684
[200] Department of Land Transport. In 2021, 120 electric buses were due to become operational. These are excluded from the calculation.

for a larger share of the population in Thailand, particularly as EV costs continue to fall. Fuel taxes will then incentivize a shift towards EVs, while simultaneously providing revenues to cover initial public investment costs and to offset losses for vulnerable groups. The scenarios developed in this report showed that a modest fuel tax increase could provide sufficient revenues to cover most of the investment costs in private vehicles (although more would be needed for public vehicles), while raising fuel prices by only 7-8 percent. The revenues from this tax could be used to cover most of the short-term investment costs of electrifying transport, but by 2035 the loss of revenues from existing fuel excise duties will mean that alternative sources of funding will be required.

## 7.7 The importance of the forestry sector

**372. The forestry sector can make a critical contribution to both climate change adaptation and mitigation in Thailand if it is adequately supported.** Most importantly, the forests play an important role in regulating the water cycle. The forests help control the water cycle by regulating precipitation, evaporation, and flows. The process of absorbing water and releasing water vapor in turn supports agricultural production that provides one quarter of jobs in Thailand. Forests also serve as buffers to natural calamities like floods by blocking and slowing down the flow of the runoff. At sea, mangrove forests protect Thailand's coastlines from storm damage and coastal erosion. Thailand's forests are also home to many plant and animal species and are therefore important for biodiversity.

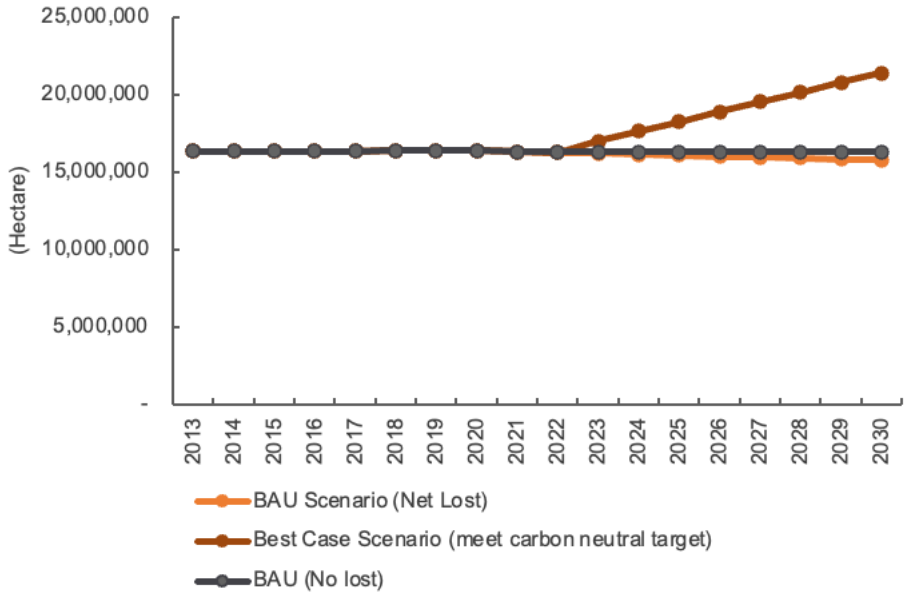
**373. A more actively managed forestry sector could contribute to all six focus areas of Thailand's National Adaptation Plan.** Forestry itself falls under the natural resources management category of the plan (see Table 7-1). However, it contributes to the other five focus areas as well. In addition to providing water management services that support agriculture, the forest creates benefits for tourism and human health. The role of the forest in reducing the exposure of human settlements to flooding is likely to be particularly important in coming decades. Restoring and increasing forest coverage is therefore already recognized as a key component of adapting to climate change in Thailand.

**374. The forestry sector also makes a positive contribution to reducing total GHG emissions.** The sector releases 12.3 mtCO2e/year of GHG emissions but absorbs 28.6 mtCO2e/year of emissions. It is therefore already a net reducer of GHG emissions. Thailand's LT-LEDS aims to increase annual net emission removals from the sector from 90 to 120 mtCO2e/year by 2050, which would offset more than 25 percent of current GHG emissions and would be a key factor in bringing emissions towards net-zero in the second half of the century.

**375. Despite efforts to increase forest coverage, the overall share of forested land is decreasing.** In 2020, forests covered 31.6 percent of Thailand's land mass. The corresponding share in 2008 was 33.4 percent. Despite efforts by several agencies in Thailand to promote reforestation, satellite images show that the level of forest coverage is decreasing by around 0.3 percent per year. Some forest has been degraded because of natural forest fires. However, the main reasons for deforestation on land are human encroachment and illegal logging. At sea, mangrove forests have been cleared for shrimp farming, with the pollution from these farms causing further damage.

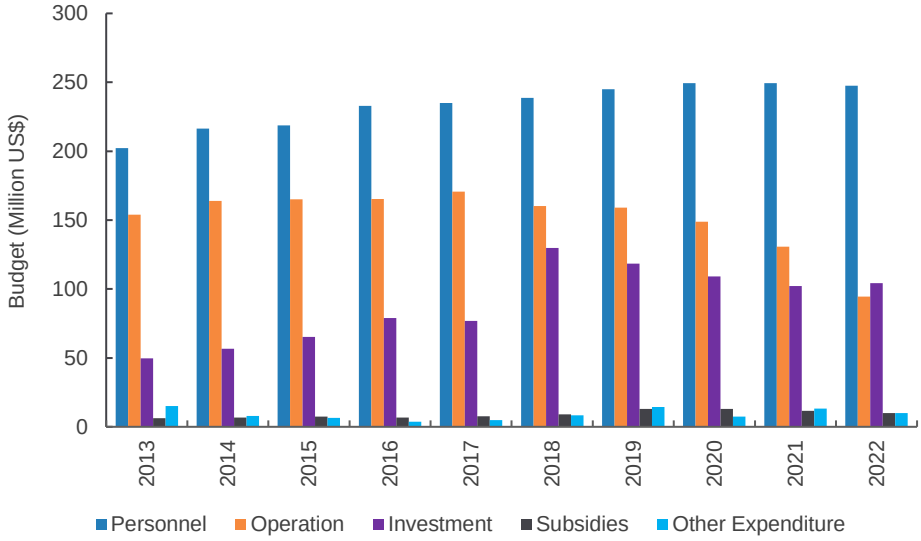
**376. To meet the LT-LEDS target, around 40 percent of Thailand's land mass would need to be covered by forest.** The share of land covered by forest would need to increase by more than half. Figure 7-9 shows that the government will face a double challenge: Deforestation would need to be virtually curtailed (moving from orange line to grey line in the figure) so that no existing forest land is lost, and substantial efforts would be needed to reforest parts of the country (grey line to brown line).

**Figure 7-9: Forest Coverage Over 2022-2037**




Source: Land Use Change Drivers, Law, Policy, Forest Institution and Governance, A National REDD+ Strategy, TEI 2020

**Figure 7-10: Forestry Budget Based on Expenditure Category**




Source: Department of National Park, Wildlife and Plant Conservation, Royal Forest Department and Department of Marine and Coastal Resources

**377. Most of the funding for forestry comes to agencies through the Ministry of Natural Resources and Environment.** In 2022, the US$ 544m funding for the forestry management program was 0.1 percent of GDP. Funding for forestry grew over 2012-2019 to peak at around US$ 630m but has since fallen because of budgetary pressures related to COVID-19. In contrast, the forest in Thailand has been valued for both the direct use values and the indirect use values from the mitigation and adaptation benefits of the inland forest and the coastal mangrove forest at US$ 33.3bn (6.1 percent of GDP).[201] (See Annex 7.1 Total Economic Values of Forest in Thailand) The funding is used for monitoring, forest management, forest protection and biodiversity conservation, fire management, reforestation, research, and legal

[201] Estimated from data and prior studies from the Department of National Park, Wildlife and Plant Conservation (DNP) and the Laem Phak Bia Environmental Research and Development Project.

implementation. Almost half the expenditure covers personnel costs, one third is used for other direct operating costs and the rest mostly funds investment (Figure 7-10). The agencies supplement their public income, for example by charging entrance fees to national parks and forest confession fee. However, this share of income currently accounts for only 6.1 percent of the agencies' total revenues. Private sector financial support accounts for only around 2 percent of revenues.

**378. Despite higher personnel and investment spending, the total area of forest coverage has not changed.** Notably, substantial real and nominal-terms increases in investment spending aimed at developing new forest have not led to an increase in tree cover area. Current targets for tree cover area look well out of reach. The trend from recent years suggests that additional spending on its own will not be sufficient to meet the targets; better planning is needed too. Transformation to area-based management through integrating multi-ministry and multi-departmental resources will be critical to increase forest cover area. Forest area-based management was demonstrated through the Community development schemes like Mae Fah Luang Foundation and The Royal Initiative Discovery Foundation, which have proven to be highly effective. The schemes have used only 40 percent of the budget allocated by the government to reforest and maintain forest cover over ten years, with the critical factor being local communities' engagement with rights to generate income from their local forests. The community forestry movement is growing, with an increasing number of communities formally registering as community forests since the passing of the Community Forest Act in November 2019. From 2011 to 2019 the registered land for community forests increased from 0.47 to 1.22 million hectares. Each registered community forest must submit its forest management plans to be approved by RFD; in return, RFD grants the community the forest access and rights to forest products.

**379. Nevertheless, a substantial increase in private and public sector funding to the forestry sector would be required if Thailand is to meet its LT-LEDS targets.** Based on the Comptroller General's Office reforestation and maintenance cost over ten years, the cost to increase forest coverage in line with the stated target would be nearly US$ 15bn (3 percent of GDP). It is possible that this cost could be reduced to US$ 7.1bn, if the land was used for economic forest plantation, rather than converted to natural forest (which would be better for biodiversity). However, even plantation costs in Thailand are high compared to those in other countries. The average cost of the government's allocation in the past ten years was US$ 2,150 per hectare, compared to US$ 1,200-1,600 in China. Community schemes returned lower costs of around US$ 1,000 per hectare. Any private land purchases would increase costs further. As noted above, better planning would be required to ensure that the additional spending is effective at increasing forestry coverage.

**380. International support for the forestry sector may become necessary to cover the funding required to meet the LT-LEDS target.** The current small share of self-generated revenues (for example from park entrance fees) within the sector suggests that it will not be possible to scale up income to the levels required to meet the LT-LEDS target. Public financing could be required, although there is no current mechanism in place. An alternative option would be to seek international support. Thailand has completed the Forest Carbon Partnership Facility to prepare for the REDD+ program. The latest progress on REDD+ implementation in Thailand is the submission of the Forest Reference emission Level to the UNFCCC in 2020.

**Box 7-3: Flexible funding to manage uncertainty in the forestry sector**

**Forest fires degrade forest quality, destroy wildlife, and contribute to air pollution; direct economic costs are estimated at US$ 130m annually with much higher indirect costs.** The number of forest fires each year is rising, despite increases in spending on fire protection (US$ 22.4m in 2022). Although the Thai government recognizes the need to reduce forest fires, current regulations are ineffective. The economic cost of forest fires, for example from loss of tourism activity is US$ 130m each year[202]. The economic damages caused by the health effects of increased air pollution could be as high as US$ 377m each year[203]. The preparation of budget requests for forestry is lengthy and rigid, making it difficult to deal with uncertainty around natural forestry processes, including forest fires. The budget request system takes 2-3 years for implementation. In some cases, urgent budget requests cannot be accommodated to cope with natural disaster risks. For example, in the case of forest fires, prescribed burning to prevent forest fires

[202] Estimated by the Bank of Thailand.
[203] Estimated by researchers at Chiang Mai University.

**Box 7-3: Flexible funding to manage uncertainty in the forestry sector**

may not be necessary during the El Nino year, but the budget has been approved and must be used. Additional flexibility could ensure better value from public expenditure in the sector and increased capacity to manage fires.

**381. Offsets linked to an Emission Trading Scheme could also provide support to the forestry sector.** For example, the ETS described for the manufacturing sector could generate US$ 3bn pa in offsets. These offsets could be provided by the forestry sector if they can be appropriately verified (e.g. building on the current T-VER program) and, if a sufficient proportion is used for forestry, could even cover the costs to meet the LT-LEDS target. Thailand's national Voluntary Emission Reduction Scheme (tVER) provides a template for such plans. In 2021, ten projects were registered with a total expected emission reduction of 334,285 tCO2e sequestrations per year.

**382. To summarize, the forestry sector will be a critical component of Thailand's response to climate change, but currently lacks a viable investment funding model.** The forestry sector will play a key role in both climate adaptation and in reducing Thailand's own emissions. It is an important part of the country's long-term emission reduction strategy. However, current annual public funding of US$ 0.54 billion falls well short of the amounts needed to increase forest coverage in line with the LT-LEDS target. An additional US$ 1.5 billion pa over ten years is required to reforest sufficient areas of land, potentially reducing to US$ 0.7 billion pa depending on the type of forest expanded (community schemes could potentially reduce costs further). A small share of this additional funding could come from raising park entrance fees and an expansion of the commercial forestry sector. The bulk of the funding would need to come through government revenues (including from carbon pricing), private sector investment in commercial forests, international support through REDD+, or the use of offset mechanisms in a carbon pricing scheme.

## 7.8 Macro-level outcomes

**383. Unless Thailand takes measures to adapt to climate change, the macro-fiscal impacts will be substantial.** Although highly uncertain, the GDP cost of climate change could be 10 to 20 percent by mid-century, with noticeable impacts possible even this decade. Losses of public infrastructure and compensation to private business owners could make the impacts on public budgets even higher. Climate change also increases the possibility of extreme outcomes, such as the potential need to relocate the city of Bangkok, which would require levels of public financing well beyond that discussed elsewhere in this chapter.

**384. The costs of climate change adaptation measures would likely be much lower than the costs of not acting, providing justification for immediate action.** The measures needed to adapt to climate change require substantial upfront expenditure (e.g., on new infrastructure) and incur annual running costs. Some of these costs could potentially be met by either the private sector or through international support, but because of the public goods nature of many of these measures, government contributions will be required. Some of the proposed climate adaptation measures could have immediate benefits, for example by reducing the costs of flood damage or providing fresh water during droughts. Although the included adaptation measures would substantially reduce the cost of climate change in Thailand, it is difficult to estimate by how much, and it is not possible to reduce the cost to zero. For example, agriculture would likely need further support because of less predictable weather patterns. However, the benefits of adaptation will almost certainly exceed the costs.

**385. The net annual cost of climate change measures to Thailand's public sector could be 1 percent of GDP by 2030 and 1.5 percent by 2040.** The cost of climate adaptation in Thailand is uncertain and depends on the policy mix, but it could increase from near zero today to 1.6 percent of GDP in the 2030s (see Section 7.6). As most adaptation measures are public goods, much of this cost will be borne by the government. In contrast, much of the cost of decarbonization may be borne by the private sector, and our analysis shows that public policy costs may be offset by carbon pricing measures that could raise up to 0.8 percent of GDP by 2030. However, revenues from fuel excise duties (1.2 percent of GDP) could fall rapidly if vehicles are electrified in line with government targets. Excise duties from car purchases (0.8 percent of GDP) could also fall because low-carbon vehicles are covered by lower tax rates, but revisions to excise duty rates after 2025 could offset this loss relatively easily once electric vehicles gain market share. It is assumed that other climate costs, including in the transport and forestry sectors, require a relatively modest net public contribution. Based on these assumptions, the net

cost of climate change adaptation and mitigation measures to Thailand's public sector will be around 1 percent of GDP by 2030, rising to 1.5 percent by 2040 (Table 7-4).

**Table 7-4: Illustrative budget impacts of climate adaptation and mitigation measures (% of GDP)**

| | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|
| Adaptation costs | -0.6 | -1.6 | -1.6 | -1.6 |
| Manufacturing carbon pricing | 0.3 | 0.8 | 1.0 | 1.0 |
| Fuel excise duties | 0.3 | 0.2 | -0.1 | -0.7 |
| Vehicle excise duties | -0.2 | 0.0 | 0.0 | 0.0 |
| Other transport measures | -0.4 | -0.2 | -0.2 | 0.0 |
| Forestry sector costs | -0.1 | -0.1 | -0.1 | -0.1 |
| Other mitigation costs | 0.0 | -0.1 | -0.1 | -0.1 |
| **Total** | **-0.7** | **-1.0** | **-1.1** | **-1.5** |

Source: World Bank staff calculations

## 7.9 Key policy recommendations

### Recommendation 1: Invest in climate adaptation measures to reduce future risks

**386. Public spending on climate adaptation measures will place a burden on public budgets but should provide a strong return on initial investments.** The analysis in this chapter has shown that there should be a priority on investment that reduces the impacts of climate change. If these investments were able to halve overall damages from climate change, they could generate benefits of three to six times their costs (based on a rough estimate of damages). They would also reduce the risk of extreme high-cost outcomes, particularly relating to Bangkok but also to vulnerable groups in other areas. Many adaptation investments are public goods and would therefore require public support. Costs could be minimized if steps are taken to identify vulnerable infrastructure and carrying out this exercise should be regarded as a priority. Some measures, including flood prevention around Bangkok, may return immediate benefits and could be prioritized. Other measures, including building early warning and community-based systems, could provide benefits with smaller public costs.

### Recommendation 2: Consider enhancing further Thailand's level of climate change mitigation ambition

**387. Thailand has already made commitments to reduce its own emissions but the public costs of doing so need not necessarily be substantial if the right policy mix is chosen.** Thailand's current level of climate ambition was increased in its 2022 NDC submission but falling technology costs could give scope for further increases. International support for climate adaptation (see below) will be easier to obtain if Thailand is visibly reducing its own emissions. Mitigation costs should be smaller than adaptation costs and much of the cost may be met by the private sector (e.g., in sectors such as electricity generation where low-carbon options are already cost-effective). However, some sectors will require public support or coordination to engage in emission reductions and there will be a cost to reducing the public sector's emissions. The policies assessed in this chapter could potentially achieve Thailand's NDC target, depending on how other sectors develop post-covid. The impacts of these policies on GDP would be largely neutral and there are potential improvements to air quality.

### Recommendation 3: Introduce carbon pricing, alongside other measures to reduce greenhouse gas emissions

**388. A portfolio of policies is required to address climate change in Thailand, but carbon pricing will be important for supporting overall budgets.** The level of complexity involved means that it is difficult to estimate the overall budgetary impacts of climate change mitigation policies. Broadly speaking, policies can be grouped into three categories: i) those that require substantial public funding, including addressing the public sector's own emissions, ii) regulatory measures that push costs to the private sector and require only limited public funding, and iii) policies that raise revenues while simultaneously reducing greenhouse gas emission levels. It will not be possible to meet ambitious climate targets without using a combination of all three types of policy. Carbon pricing covers the set of policies in the third group, including carbon taxes and Emission Trading Schemes; this chapter explored the possibility of introducing carbon pricing in the

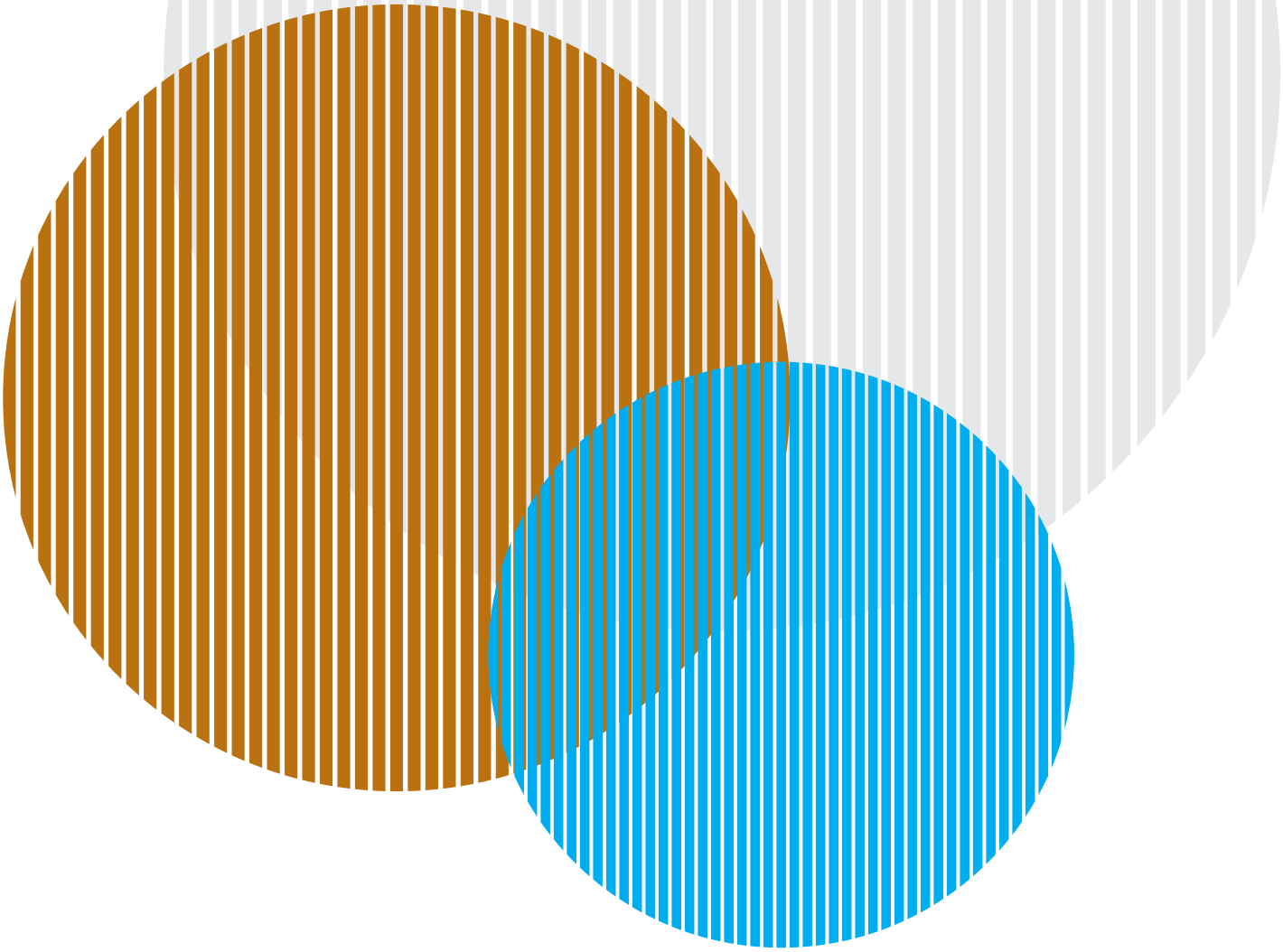
manufacturing and road transport sectors. Carbon pricing policies are important not just because they provide the necessary incentives for private sector operators to reduce GHG emissions, but because they raise public revenues as well. Revenues from carbon pricing could also be used to offset some of the negative socio-economic impacts of other climate policy impacts (including the carbon pricing itself) and to protect vulnerable populations from the impacts of climate change and extreme weather events. Explicit guidelines on the use of the revenues from carbon pricing (either for mitigation or adaptation purposes) could improve the political feasibility of price-based measures.

### Recommendation 4: Explore options for other sources of finance to fund adaptation and mitigation activities

**389. This chapter has identified numerous costs that will need to be borne by the public sector**. Although some costs may be recouped from higher tax receipts, other sources of financing should also be investigated. Measures may be needed to attract private sector investment, for example in the forestry sector. It is possible that some international finance may become available for mitigation measures if Thailand increases its level of ambition in reducing emissions; possible examples include cooperation through Article 6 of the Paris Agreement. Other mechanisms like using offsets in Emissions Trading Schemes may be valuable in getting finance to other sectors.

### Recommendation 5: Increase resources for climate-related research and education in Thailand

**390. Further research into the effects of climate change and climate change policy on Thailand is needed.** This chapter has taken a broad view of climate change and looked in depth at the manufacturing, passenger vehicles and forestry sectors. However, all sectors of the economy will be affected by climate change and therefore there is a broad need for climate awareness. Similarly, all sectors will need to take action to reduce greenhouse gas emissions, if Thailand is to meet its own long-term net-zero ambitions and stay in line with international targets. The ultimate impacts of climate change on public budgets in Thailand are highly complex and will depend on the interaction of all these effects across all the different sectors. Action taken on climate change in the rest of the world will also impact Thailand's economy, for example by determining the costs of clean technology or the costs of travel for foreign tourists. These issues will be explored further in future World Bank analysis.



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