Chapter 4

The Economic and Greenhouse Gas Emission Impacts of Electric Vehicles

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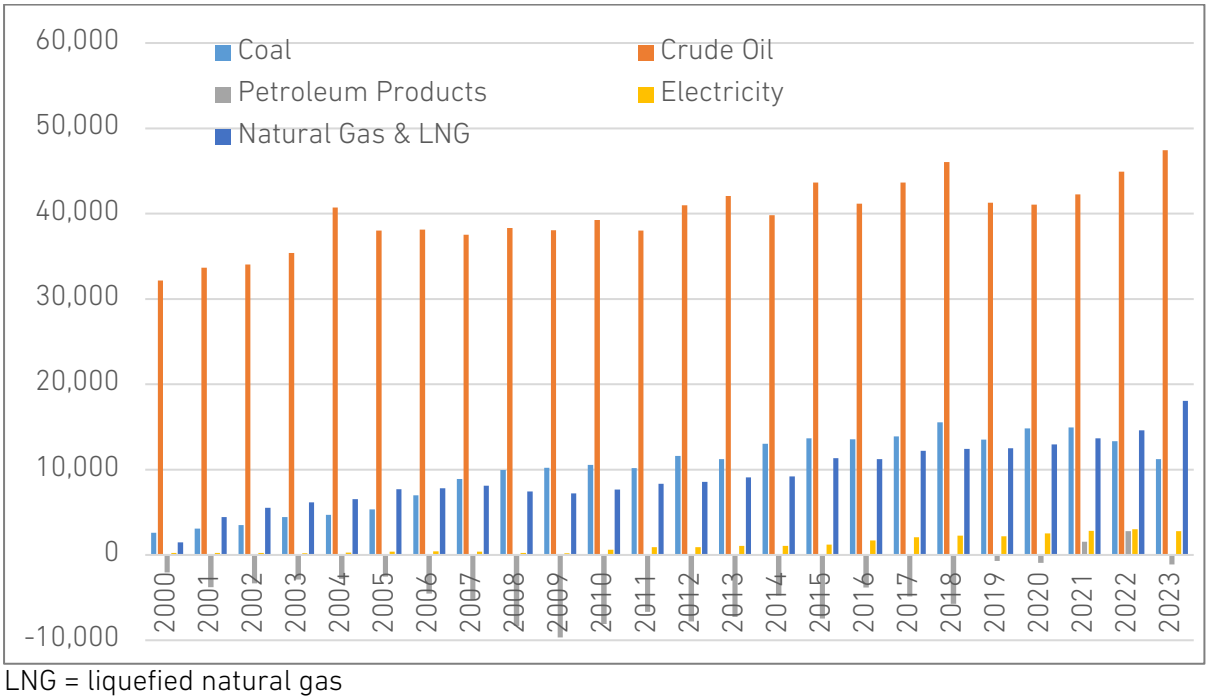
1. Introduction

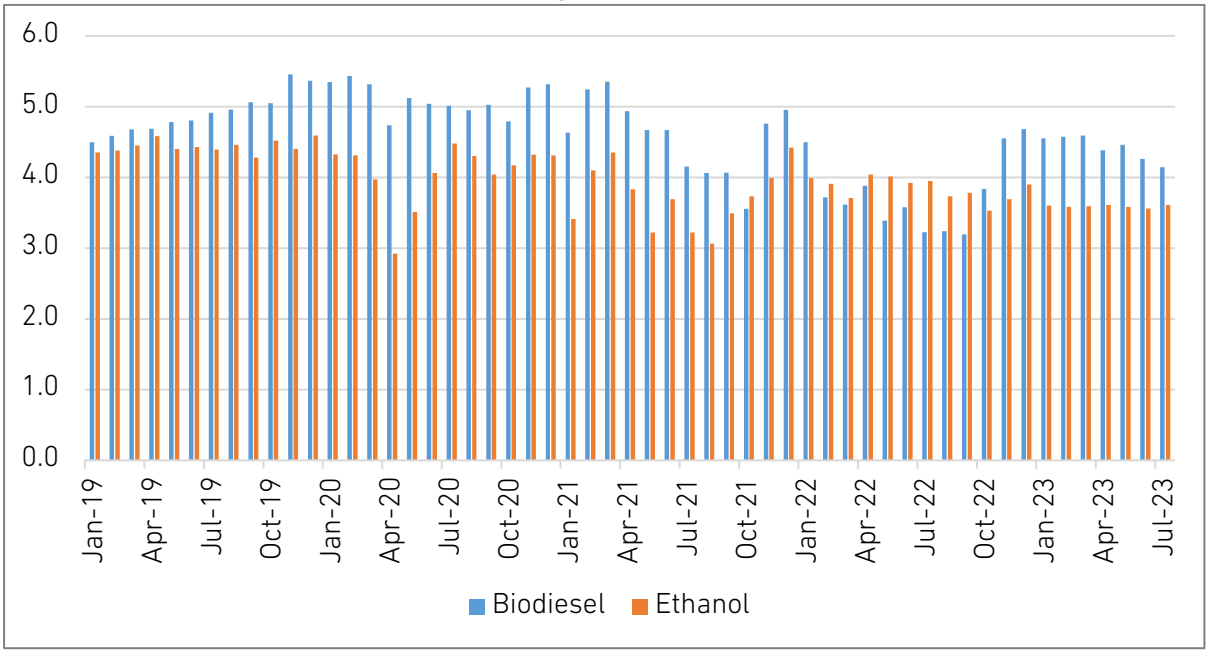
The economy in Thailand has long been intertwined with the fossil fuel and automotive sectors. Despite a constrained domestic petroleum supply necessitating substantial crude oil imports to sustain transport sector growth, fossil fuels remain pivotal energy sources, as depicted in Figure 4.1. Since 2001, Thailand has enacted policies to bolster domestic biofuel production and consumption, initially through tax incentives and price subsidies for bioethanol and biodiesel producers. This approach, subject to periodic updates, has consistently augmented production and demand, as illustrated in Figure 4.2, positioning Thailand as the world's 7th largest biofuel producer in 2021.

Figure 4.1. Net Imports of Commercial Primary Energy
(Unit: KTOE, Kilo Tonnes of Oil Equivalent)



LNG = liquefied natural gas
Source: Energy Statistics of Thailand (2024), Energy Policy and Planning Office (EPPO), Thailand's Ministry of Energy

Figure 4.2. Thailand's Biofuel Consumption, 2019–2023
(Daily Average in Million Litres)



Source: Department of Energy Business, Thailand's Ministry of Energy

Simultaneously, the automotive industry, which has seen growth since the 1990s, has been strategically nurtured by the Government of Thailand through tax and investment incentives, focusing on specific vehicle categories such as fuel-efficient and biofuel cars and light pick-up trucks. Consequently, Thailand achieved a global rank of 18th in car exports in 2020, exporting a total of $8.28 billion.[1]

Amidst evolving challenges, energy and industrial policies have undergone revisions. Globally, the surge in awareness and initiatives to reduce greenhouse gas (GHG) emissions is notable. Domestically, the advent of electric vehicles (EVs) poses a potential disruption to the existing industrial policy strategy. Additionally, alterations in biofuel targets and fiscal conditions have prompted adjustments in fuel cross-subsidy rates. Given these factors, this study employs a general equilibrium approach to explore the comprehensive impacts on the economy and proposes forward-looking policies, considering the intricate interplay amongst energy sources, GHG emissions, industrial output, and fiscal health.

The study sets out to achieve the following objectives:

(1) Perform a comprehensive review of pertinent national strategies and policies, including:

- Alternative Energy Development Plan 2018–2037 (Ministry of Energy)
- Thailand's Mid-Century, Long-Term Low Greenhouse Gas Emission Development

[1] In this report, $ refers to US dollar.

Strategy (Ministry of Natural Resources and Environment)
- National Development Plan for the Electric Vehicle (Ministry of Energy and Ministry of Industry)
- Fiscal Sustainability Framework (Ministry of Finance)

(2) Develop the social accounting matrix (SAM) and dynamic computable general equilibrium (CGE) model

(3) Examine the comprehensive impacts on the economy

2. Review of Related Policies

2.1. National Policy on Electric Vehicles

The National Electric Vehicle Policy Committee has approved the "30@30" policy plan, aiming for zero-emission vehicles (ZEVs) to account for at least 30% of total vehicle production by 2030. This plan comprises potential reductions in import duties and excise taxes, as well as conditional subsidies for imported electric vehicles (EVs). It is structured in a three-phase development:

- Phase 1 (2021–2022): The focus is on encouraging electric motorcycle use and developing supportive infrastructure nationwide.
- Phase 2 (2023–2025): The aim is to foster the EV industry, including EVs and battery production, targeting cost benefits via economies of scale.
- Phase 3 (2026–2030): Aspiration is to drive the 30@30 policy by making production of cars, pick-up trucks, and motorcycles 30% of total automotive production in 2030, in conjunction with domestic battery production.

The National Electric Vehicle Policy Committee established specific targets for production and promotion of ZEVs during a meeting on May 12, 2023. This coordinated effort of multiple sectors that all aimed to reach the target by 2030 resulted in the following goals:

(1) Production of 725,000 cars and pick-up trucks, 675,000 motorcycles, and 34,000 buses/trucks, as well as a plan for three-wheeled vehicles, passenger boats, and rail system production.

(2) Promotion of 440,000 cars and pick-up trucks, 650,000 motorcycles, 33,000 buses/trucks, as well as a target to promote 12,000 public fast-charge stations and 1,450 battery-swapping stations for electric motorcycles.

The following measures have been designed to boost ZEVs:

- Manufacturing promotion: The EV and parts industry will be encouraged to establish Thailand as a production hub for EVs and their components, including defining essential vehicle and parts standards, thus supporting business transitions to EVs, and developing workforce strategies.
- Demand stimulus: This will include tax and non-tax measures, with rapid

implementation actions such as promoting electric motorcycles for commercial transport and governmental use.

- Infrastructure development: There will be a move to: encourage the creation of electric charging stations; enact relevant laws and regulations; promote smart grid technology, domestic production, and utilisation of electric vehicle batteries; manage used batteries; and focus on workforce development.
- Financial and tax incentives: These are one of the main policy instruments. Table 4.1 shows the new excise tax rates, aimed at promoting the production of EVs.

Table 4.1. Excise Tax Rates

Vehicle Category	Effective Date	Former Rates	New Rates	Eligibility and Conditions
Battery EV	June 2022	8%	2%	Eligible car manufacturers must satisfy specific criteria as stated in the Excise Announcements.
PHEV*	January 2026	8%–26%	5%–10%	The new tax rates are structured to encourage the production of PHEVs with smaller fuel tanks and a longer driving range per charge.
ICE passenger cars**	January 2026	30%–35%	29%–38%	Tax rates will incrementally rise based on variables such as vehicle classification, fuel type, engine capacity, and levels of carbon and particulate matter emissions.
Fuel cell EV	January 2026	2%	1%	

cc = cubic centimetres; EV = electric vehicle; g/km = grammes per kilometre; ICE = internal combustion engine; PHEV = plug-in hybrid electric vehicle.
* with cylinder up to 3,000 cc
** with cylinder up to 3,000 cc, and carbon emission above 150 g/km
Source: National Electric Vehicle Policy Committee and Baker & McKenzie.
https://insightplus.bakermckenzie.com/bm/industrials-manufacturing-transportation/thailand-ev-landscape-how-it-looks-now-and-whats-on-the-horizon

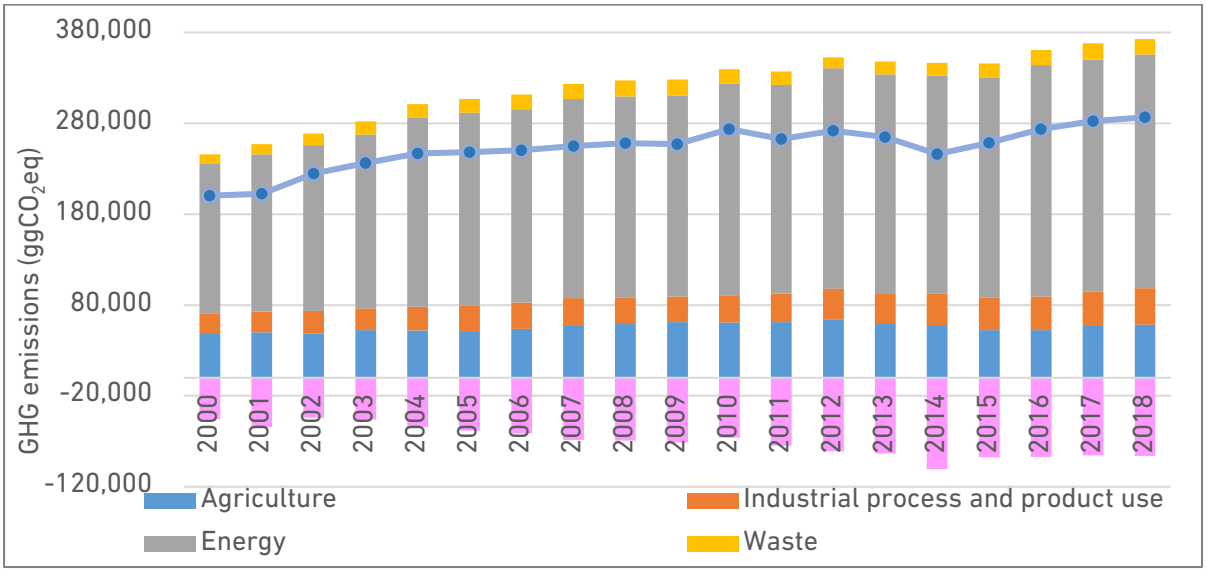
2.2. Thailand's Greenhouse Gas Emission Mitigation Plan

2.2.1. Thailand's Emission Profile

Figure 4.3 illustrates the upward trend in Thailand's GHG emissions from 2000 to 2018. The total GHG emissions (excluding land use, land-use change, and forestry (LULUCF)) during this period increased from 245,899.56 gigagrams of carbon dioxide equivalent.

($ggCO_2eq$) to 372,648.77 $ggCO_2eq$, at an average annual growth rate of 2.34%. Concurrently, carbon dioxide (CO_2) removal efforts expanded, rising from 45,443.60 $ggCO_2eq$ in 2000 to 85,968.30 $ggCO_2eq$ in 2018. The net GHG emissions consequently increased from 200,455.96 $ggCO_2eq$ in 2000 to 286,680.47 $ggCO_2eq$ in 2018, with an average yearly growth rate of 2.01%.

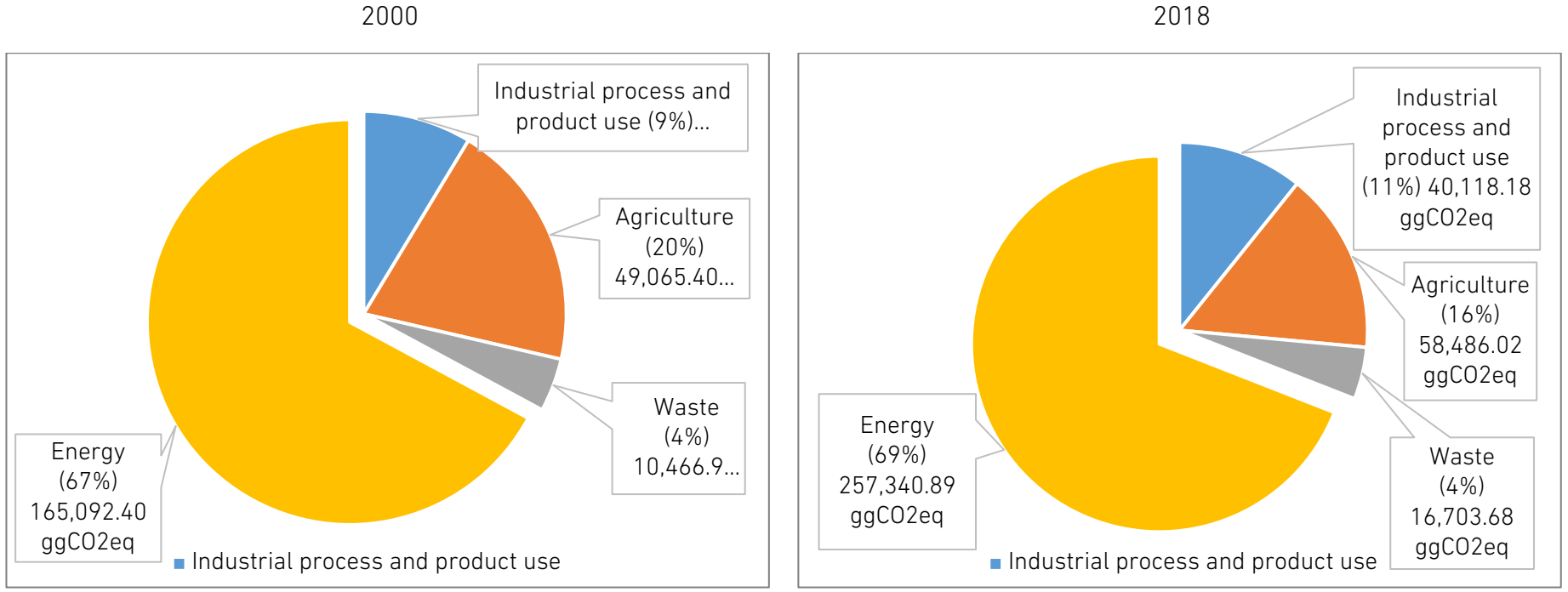
Figure 4.3. Thailand's Greenhouse Gas Emission Trends



$ggCO_2eq$ = gigagrams of carbon dioxide equivalent; GHG = greenhouse gas; LULUCF = land use, land-use change, and forestry.
Source: UNFCCC (2022).

Figure 4.4 illustrates the changes in GHG emissions in Thailand from 2000 to 2018, with the energy sector emerging as the primary contributor. During this period, emissions from the energy sector surged by 55.88%, growing from 165,092.40 $ggCO_2$ to 257,340.89 $ggCO_2$. This sector's share of total emissions increased from 67.14% in 2000 to 69.06% in 2018. Meanwhile, the agricultural sector's emission contribution decreased from 19.95% to 15.69%. The industrial processes and product use (IPPU) and waste sectors conversely experienced a slight uptick in their emission shares, rising from 4.26% to 4.48%.

Figure 4.4. Total Greenhouse Gas Emissions by Sector, 2000 and 2018
(Excluding Land Use, Land-Use Change, and Forestry)



$ggCO_2eq$ = gigagrams of carbon dioxide equivalent
Source: UNFCCC (2022).

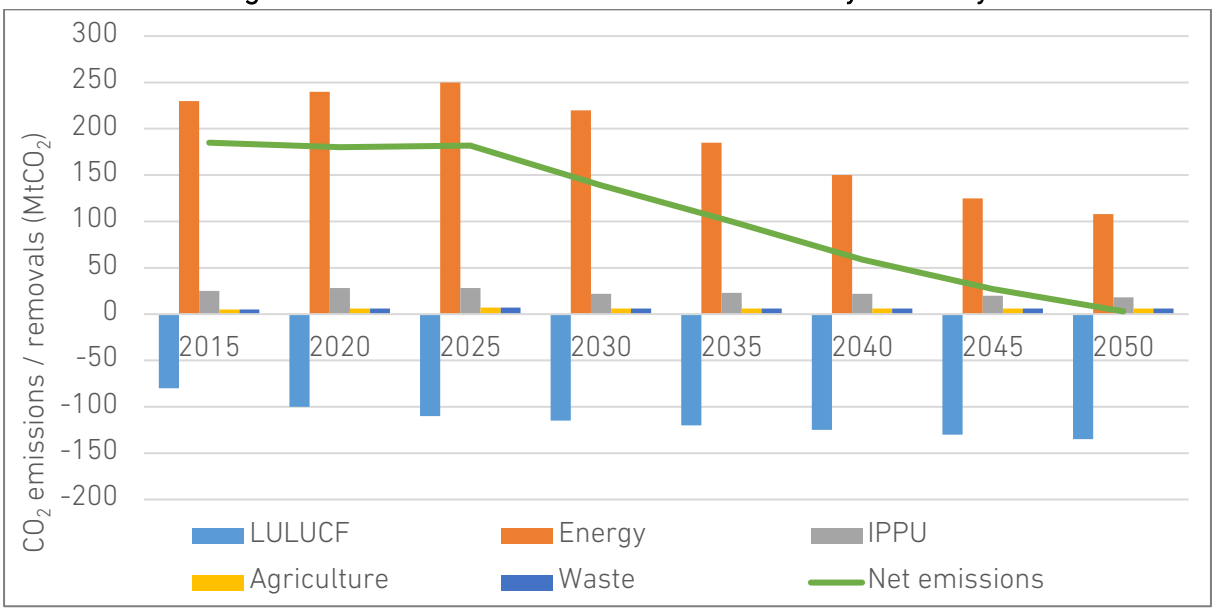
2.2.2. Thailand's Roadmap to Achieving Carbon Neutrality

Thailand has committed to achieving carbon neutrality by 2050, with a primary focus on reducing CO_2 emissions from the energy sector, which is the main contributor to GHG emissions. The country's preliminary National Energy Plan 2022 outlined strategic guidance to relevant entities to transition toward cleaner energy systems and align with the 2050 carbon neutrality goal. In this framework:

- at least 50% of the new power generation capacity is expected to be derived from renewable sources by 2050.
- the market is projected to be dominated by EVs, specifically battery electric vehicles and plug-in hybrid electric vehicles (PHEV), targeting a 69% share by 2035.
- emissions from the IPPU, waste, and agriculture sectors are forecasted to conform to the 1.5-degree pathway, with the IPPU sector, particularly the cement industry, being a major source of CO_2 emissions. The implementation of carbon capture (usage) and storage technologies is foreseen to mitigate carbon in this sector further.
- an enhanced contribution to carbon removal is anticipated from the LULUCF sector, projected to reach 120 metric tonnes of CO_2 ($MtCO_2$) in nationwide CO_2 removal by 2037.

Figure 4.5 illustrates Thailand's pathway to 2050 carbon neutrality, with net emissions expected to reach 137.3 $MtCO_2$ in 2030, declining to 63.1 $MtCO_2$ in 2040. This comprehensive plan highlights the multi-faceted approach required to realise the ambitious goal of carbon neutrality in Thailand.

Figure 4.5. Thailand's 2050 Carbon Neutrality Pathway



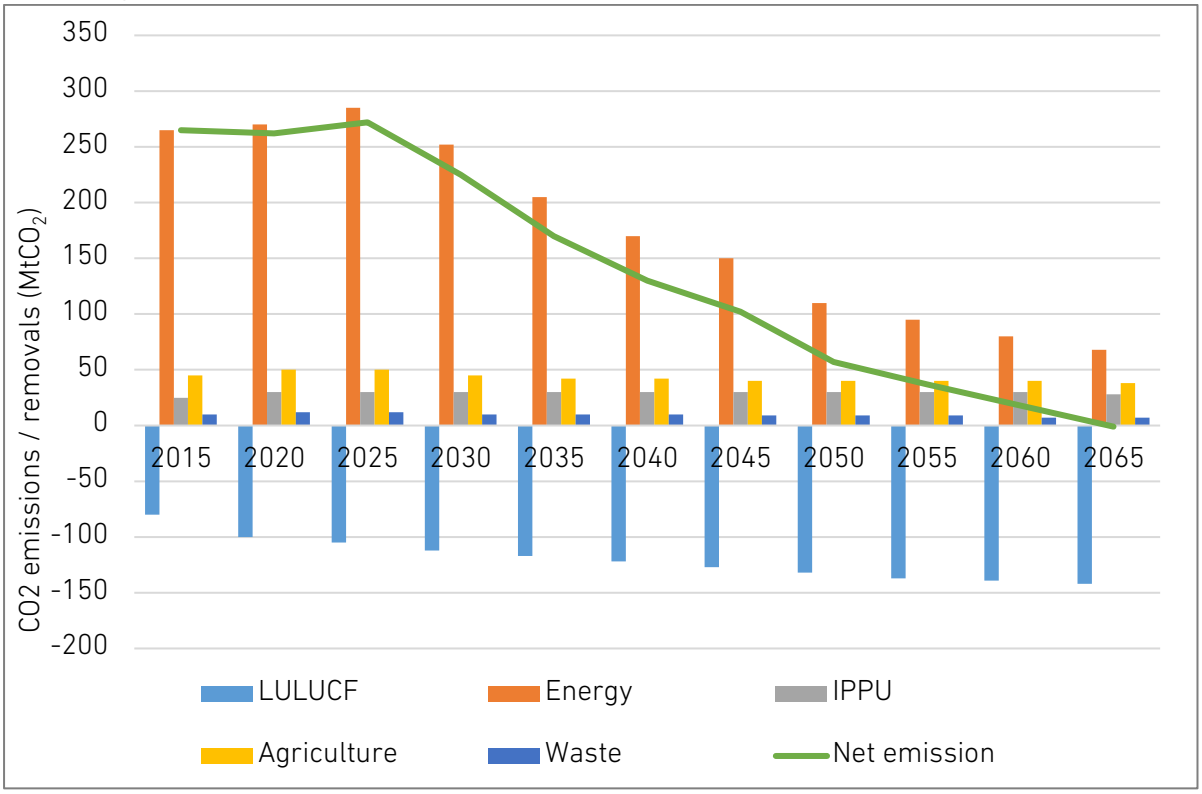
IPPU = industrial processes and product use; LULUCF = land use, land-use change, and forestry; $MtCO_2$ = metric tonnes of carbon dioxide.
Source: UNFCCC (2022).

2.2.3 Thailand's Roadmap to Achieving Net-Zero Greenhouse Gas Emissions

Figure 4.6 outlines Thailand's plan to achieve net-zero GHG emissions by 2065, with the LULUCF sector's contribution of 120 $MtCO_2$ projected to remain constant from 2037 until the end of the 21st century. This projection aligns with the National Strategy (2018–2037) objectives to increase forest and green areas to 55% of Thailand's total land area.

Thailand is expected to reach a net emission level of 64.1metric tonnes of CO_2 equivalent (MtCO2e) by 2050 under the 2065 net-zero GHG emission. GHG emissions are anticipated to peak at 388 $MtCO_2e$ in 2025, after which the energy sector will become key to reducing emissions. Following 2050, emissions are projected to align with the Intergovernmental Panel on Climate Change 1.5-degree pathway, reflecting Thailand's ambition to balance GHG emissions and carbon sequestration by 2065.

Figure 4.6. Thailand's 2065 Net-Zero Greenhouse Gas Emission Pathway



GHG = greenhouse gas; IPPU = industrial processes and product use; LULUCF = land use, land-use change, and forestry; $MtCO_2e$ = metric tonnes of carbon dioxide equivalent.
Source: UNFCCC (2022).

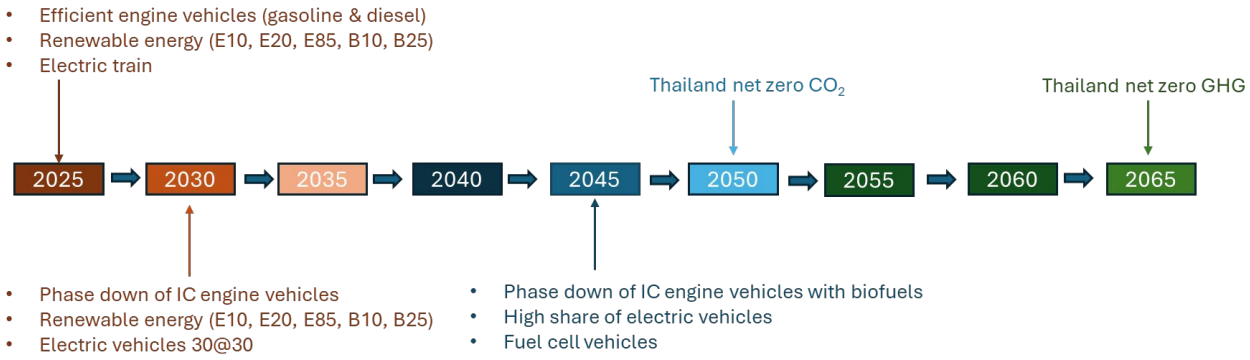
Thailand's net-zero GHG emission strategy will depend on the phase-out of coal and the incorporation of negative emission technologies in the energy sector. Essential components of this approach include the utilisation of bioenergy with carbon capture and storage and direct air capture and storage.

2.2.4 Roadmap for Greenhouse Gas Mitigation in Transportation

Thailand's transport sector primarily utilises fossil fuels, which comprise gasoline, diesel, compressed natural gas, fuel oil, and liquefied petroleum gas (LPG), complemented by mandatory biofuel blends. Figure 4.7 shows that the potential for decarbonisation in this sector depends on the adoption of cleaner and more efficient technologies, such as hybrid, PHEV, electric, and fuel cell EVs. Fuel cell technology appears especially promising for long-haul truck segments.

It is crucial to emphasise that the transport sector's shift towards electrification must be preceded by the decarbonisation of the power sector. Unlike the well-to-wheel GHG emissions of internal combustion engine (ICE) vehicles, EV's emissions are directly tied to the GHG emissions of the power sector. Therefore, without an increased emphasis on cleaner and renewable technologies within the power sector, electrification in the transport sector may yield negligible GHG reductions or potentially even exacerbate emissions.

Figure 4.7. Net-Zero Greenhouse Gas Emissions Timeline for the Transport Sector



B = biodiesel; CO_2 = carbon dioxide; E = ethanol; GHG = greenhouse gas; IC = internal combustion.
Source: UNFCCC (2022).

The transition to cleaner technologies in the transport sector, such as EVs, presents challenges but is facilitated by the anticipated decline in battery costs. The prices of EVs and hydrogen-powered fuel cell electric vehicles are expected to decrease significantly by 2030. The market share for new battery EVs and PHEV is projected to reach at least 30% by that time, while the phasing out of ICE vehicles is set to commence post–2035 (as detailed in Figure 4.5). Strategies to enhance the efficiency of ICE vehicles comprise the adoption of EURO 5 and EURO 6 standards, the promotion of liquid biofuels, and the elimination of petroleum subsidies.

Energy efficiency improvements in the transport sector can be realised through behavioural changes, road surface enhancements, and engine performance upgrades.

2.3. Fiscal Sustainability Framework

The preservation of fiscal sustainability along with the adherence to fiscal discipline holds profound significance for the Thai economy. Not only do these factors ensure that the government, the private sector, and the public have confidence in the country's fiscal stability, but they also help build trust amongst domestic and foreign investors. Fiscal stability also enhances the country's fiscal credibility on the global stage, such as with international financial institutions and credit rating agencies.

To achieve the goal of fiscal sustainability in the medium- and long-term, the Ministry of Finance, through the Office of Fiscal Policy, has developed a framework for fiscal sustainability, which comprises revenue estimates, expenditure, fiscal balance, and public debt for a medium-term period of five years. This framework serves as a guideline for fiscal management and is considered along with the government's policy plans and measures. The indicators and targets of the fiscal sustainability framework have been established and adjusted several times. The current indicators are as follows:

- Indicator 1: The public debt should not exceed 60% of GDP.
- Indicator 2: The debt burden should not exceed 15% of the budget.
- Indicator 3: The budget should be balanced.
- Indicator 4: Investment expenditure should not be less than 25% of the budget.

In establishing this fiscal sustainability framework, the Fiscal Policy Office has utilised a crucial tool, namely, the Fiscal Sustainability Model. This model is utilised for estimating the revenue, expenditure, fiscal balance, and public debt of the government. The estimation incorporates various assumptions regarding revenue and expenditure within the budgetary framework, derived from plans and measures that relate to government policy, such as debt repayment expenditure and investment outlays from the government's large-scale investment projects.

The Fiscal Policy Office has continually revised the indicators and targets of the fiscal sustainability framework to ensure they remain appropriate for the country's economic and fiscal conditions, and to foster fiscal sustainability. The Fiscal Policy Office consistently disseminates the fiscal sustainability framework to the public via the office's monthly fiscal situation report. Table 4.2 exemplarily shows the statistics during 2018–2022. Essentially, indicators 1 and 2 have been consistently satisfied. However, indicators 3 and 4 are constantly violating the thresholds.

Table 4.2. Main Indicators of Fiscal Sustainability Framework

Fiscal year	2018E	2019E	2020E	2021E	2022E
Fiscal sustainability framework targets and indicators					
Public debt outstanding /GDP	≤ 60	≤ 60	≤ 60	≤ 60	≤ 60
Debt/budget (%)	≤ 15	≤ 15	≤ 15	≤ 15	≤ 15
Budget balance (million baht)					
Capital expenditure/budget (%)	≥ 25	≥ 25	≥ 25	≥ 25	≥ 25
Performance within the framework of fiscal sustainability					
1. Public debt outstanding /GDP (1.2/1.1)	**43.3**	**44.4**	**45.7**	**47.4**	**47.9**
1.1 Nominal GDP (million baht)	17,091,700	18,117,200	19,204,200	20,433,300	21,659,300
1.2 Outstanding public debt (million baht)	7,402,143	8,036,764	8,775,918	9,691,581	10,381,773
2. Debt/budget (2.1/3.2)	**8.7**	**9.3**	**9.8**	**10.4**	**10.9**
2.1 Debt obligation (million baht) (2.1.1 + 2.1.2)	259,610	297,971	324,767	359,364	392,644
2.1.1 Pay the principal of the loan (million baht)	78,206	96,000	99,000	104,100	108,300
2.1.2 Interest and fees (million baht)	181,404	201,971	225,767	255,264	284,344
3. Budget balance (million Baht) (3.1–3.2)	**(450,000)**	**(450,000)**	**(527,000)**	**(584,000)**	**(578,000)**
3.1 Net government revenue (million baht)	2,550,000	2,750,000	2,773,000	2,886,000	3,032,000

Fiscal year	2018E	2019E	2020E	2021E	2022E
3.2 Expenditure budget (million baht)	3,000,000	3,200,000	3,300,000	3,470,000	3,610,000
4. Capital expenditure/budget (4.1/3.2)	**21.6**	**21.8**	**22.0**	**21.9**	**21.5**
4.1 Capital expenditures (million baht)	649,138	698,848	725,003	758,927	776,098

GDP = gross domestic product.
Note: All data are still estimates. The finalised statistics will be officially announced by the Fiscal Policy Office of the Ministry of Finance.
Source: Government of Thailand, Ministry of Finance. https://www.fpo.go.th/main/Statistic-Database.aspx and https://www.fpo.go.th/main/Economic-report/

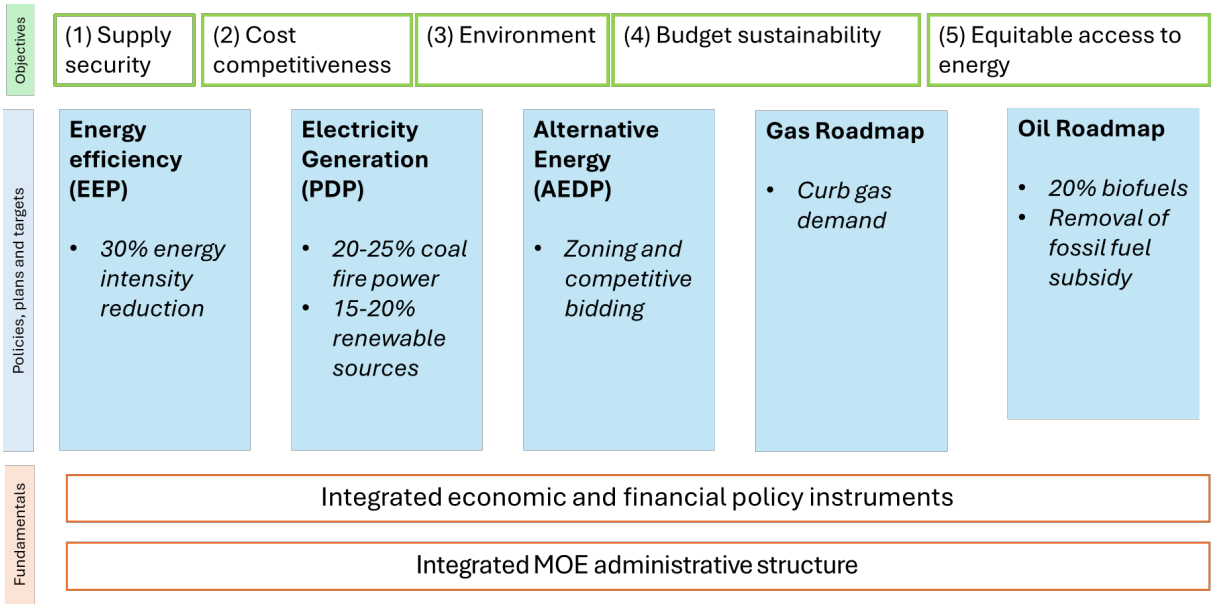
2.4. Energy Plans

Thailand's energy policies have been governed by five major plans, which are:

- The Power Development Plan 2018–2037 (PDP 2018 Rev.1)
- The Alternative and Renewable Energy Development Plan 2018–2037 (AEDP 2018)
- The Energy Efficiency Plan 2018–2037 (EEP 2018)
- The Natural Gas Management Plan 2018–2037 (Gas Plan 2018)
- The Fuel Management Plan (Oil Plan 2015–2037).

As shown in Figure 4.8, these strategies are anticipated to guide the nation's energy policy and advancement towards enhanced efficiency and sustainability. The main contexts of each plan are summarised in the next sections.

Figure 4.8. The Structural Relationship of all Energy Plans



AEDP = Alternative and Renewable Energy Development Plan; EEP = Energy Efficiency Plan; LNG = liquefied natural gas; MOE = Ministry of Energy; PDP = Power Development Plan.
Source: Government of Thailand. Ministry of Energy.

2.4.1. Power Development Plan 2018–2037

The PDP 2018 Rev.1 is a comprehensive strategy formulated by the Energy Regulatory Commission of Thailand. Its primary aim is to ensure a sufficient electricity supply that supports the country's socio-economic development. This plan is a blueprint for enhancing the nation's electricity generation and transmission infrastructure over the next 15 to 20 years. Periodic updates to the PDP align with revised electricity demand forecasts to adapt to changing economic conditions.

The PDP provides forecasts for electricity demand, which is essential for strategic planning. Reliable predictions guarantee that investments in expanding power generation will adequately meet growing electricity needs. On the technical side, the PDP specifies the future construction of large-scale power projects as well as smaller-scale power plants, including renewable energy sources. The PDP also identifies the following to provide sufficient details for research and planning:

- the proportion of types of fuels used in electricity generation;
- the expansion of electricity transmission systems;
- estimates of financial investment in the expansion of power generation and transmission systems;
- the impact on electricity prices;
- the amount of GHG emissions.

2.4.2. Alternative and Renewable Energy Development Plan 2018–2037

Thailand imports various energy sources, such as crude oil, refined oil, natural gas, coal, lignite, and electricity. Official statistics show that the country heavily depends on imported crude oil and coal/lignite, with import rates at 85% and 78%, respectively. To reduce this dependency and diversify risk more evenly, boosting domestic energy production through alternative energy sources is crucial. This strategy also supports eco-friendly and sustainable energy solutions.

The nation possesses an abundance of agricultural resources that can be converted into energy, such as biomass, biogas from energy crops, biodiesel, and ethanol. Additionally, industrial waste and wastewater can be harnessed for energy production. Thailand is also rich in natural energy potential, particularly solar energy, receiving an average of 18.2 megajoules of solar radiation per square metre daily. Some areas also show significant promise for wind energy, with capacities estimated between 600 and 2,000 watts per square metre. These alternative energy sources hold great promise for enhancing Thailand's energy security in the future. Concurrently, the AEDP 2018 initiative plays a crucial role in reducing greenhouse gas emissions, aiding the country's pursuit of a zero-emission target.

2.4.3. Energy Efficiency Plan 2018–2037

Energy efficiency and conservation are essential components of Thailand's energy strategy. The manufacturing and industrial sectors, which are pivotal to the economy, have the potential to significantly reduce emissions by implementing energy-efficient processes.

The promotion of energy conservation is driven not only by environmental concerns but also by significant financial incentives. Economic factors have gained significance because of the price volatility and energy supply. Consequently, the public sector has

taken the lead in encouraging investments in the energy sector. The EEP 2018 was established and enforced as a government-led initiative to promote energy efficiency and conservation.

Thailand's EEP 2018 targets a 30% reduction in energy consumption by 2037, based on 2010 levels. The Board of Investment (BOI), the government agency supervising and promoting private investment, proactively supports energy conservation, efficiency, and savings. Financially, to promote corporate investment in energy improvements, the BOI has introduced incentives. Investments in six specific areas can benefit from a 50% reduction in corporate income tax for three years. The investments that align with the BOI's criteria are:

- utilisation of alternative energy;
- energy enhancement through machinery adoption and improvement;
- efficiency augmentation in research, development, or engineering design;
- efficiency improvements in production processes conforming to international sustainability certification; and
- implementation of digital technology.

2.4.4. Natural Gas Management Plan 2018–2037

The Gas Plan 2018, spanning from 2018 to 2037, aims to secure a stable natural gas supply at reasonable prices and efficiently manage infrastructure to bolster Thailand's economic and social progress while reducing environmental harm. This strategy aligns with the nation's long-term strategic goals and energy reform initiatives. The plan's four main objectives are:

- increasing natural gas use across economic sectors to minimise air pollution;
- expediting natural gas exploration and production domestically, including in joint and overlapping areas;
- developing sufficient and efficient natural gas infrastructure to meet regional needs; and
- fostering competition in the natural gas sector to ensure energy sector stability and sustainability.

The Gas Plan 2018, revised from the Gas Plan 2015, reflects updates in Thailand's PDP 2018 Rev.1 and lower-than-expected natural gas consumption. This revised plan responds to the current production levels in the Gulf of Thailand, which have reduced the need for additional natural gas from existing contracts. It forecasts a modest annual increase in natural gas demand of 0.7%, growing from 4,676 million cubic feet per day in 2018 to 5,348 million cubic feet per day by 2040. While demand is expected to rise in power generation and industrial sectors, it is projected to decline in gas separation plants and transportation.

Natural gas supply sources will include domestic production, imports from Myanmar, and liquefied natural gas (LNG) imports. By 2040, new natural gas or LNG contracts are expected to account for about 68% of the total supply, a decrease from earlier projections. Thailand's LNG terminal capacity is projected to reach 34.8 million tonnes annually by 2030, with potential expansion to 47.5 million tonnes per year, indicating the possibility of underutilized capacity. The plan also emphasizes promoting the use of natural gas across various economic sectors and enhancing Thailand's position in the energy market.

2.4.5. Fuel Management Plan 2018–2037

The Oil Plan 2018, covering the period from 2018 to 2037, aims to provide a steady fuel supply to support economic growth by balancing fossil fuels and biofuels. The plan focuses on improving the quality of eco-friendly fuels and developing efficient infrastructure, aligning with the nation's long-term strategy for competitive and sustainable growth. This plan integrates with the EEP 2018 and AEDP 2018, which set targets for using biodiesel and ethanol in transportation. It also complements the Gas Plan 2018 by promoting the use of natural gas in transportation, especially for large trucks.

The Oil Plan 2018 is in line with Thailand's 20-year energy reform strategy, which aims to overhaul the energy structure in the transportation sector. Measures include promoting electric vehicles (EVs), supporting ethanol usage, and reducing LPG usage. By 2037, overall fuel consumption is expected to increase by 43%, with the transport sector being the main consumer. Based on current demands and projections, the Oil Plan 2018 forecasts 2037 fuel consumption across six categories: gasoline, diesel (including high-speed diesel), jet fuel, kerosene, heating oil, LPG for transport, and natural gas for vehicles.

The Oil Plan 2018 sets forth four key goals for fuel management:

- Fuel security: Maintain a minimum of 50 days' fuel reserve and diversify crude oil sources.
- Eco-friendly domestic fuel: Prioritise biofuels, with high-speed diesel B10 for diesel vehicles and ethanol E20 for gasoline vehicles and achieve Euro 5 standards by 2024.
- Efficient fuel infrastructure: Support economic growth using northern and northeastern oil pipeline systems and the expansion of LPG storage facilities.
- Regulatory framework: Foster competitive fuel markets by revising and implementing policies, laws, and regulations, including updating the Fuel Trade Act B.E. 2543 (2000), for which a new draft is in progress.

3. Research Methodology

3.1. Social Accounting Matrix

Table 4.3 provides a comprehensive account of all the sectors, institutions, and other elements incorporated in the SAM created in this research. This SAM is based on the official 2015 Input-Output table released by the Office of the National Economic and Social Development Council. It aims to accurately represent the main transactions within the Thai economy and has several features.

- It incorporates 47 production sectors and 53 commodities. The aggregated official Input-Output table published by the Office of the National Economic and Social Development Council is the main source of data along with the authors' augmentation to include production activities related to EVs.
- The labour and capital are factors of production. Capital is the aggregate of land, buildings, machinery, and other capital-intensive inputs.
- It uses an aggregate household with the aggregate pattern of expenditure and saving.
- It encapsulates the government's role, especially in revenue collection and budget expenditure and covers three categories of taxes — direct tax, indirect tax, and import tariffs.
- The accounts of savings and investment are derived from information listed in the official Input-Output table. This study augments the details of household-specific savings amounts by using data from the Household Socio-Economic Survey. The values of gross fixed capital formation are directly sourced from the official Input-Output table.
- The last entity is 'the rest of the world', representing the aggregate activities of other nations. In particular, 'the rest of the world' engages in transactions of international trade and transfers.

Figure 4.9 depicts the main structure of SAM. Tables 4.3–4.5 list all sectors, institutions, and other items on the constructed SAM table.

Figure 4.9. The Main Structure of the Social Accounting Matrix

	Primary factors	Households	Firms	Government	Tax	Rest of the world	Activities	Commodities	Saving-investment
Primary factors									
Households	Primary factors ownership	Institutional Transfer				Transfer from rest of the world			
Firms	Primary factors ownership								
Government					Tax income				
Tax		Direct tax						Indirect tax	
Rest of the world								Import	
Activities								Domestic commodities supply	
Commodities		Private consumption		Public consumption		Export	Intermediate demand		Investment and change in inventories
Saving-investment		Private saving			Public saving	Borrowing from abroad			

Source: Author's calculations.

Table 4.3. Production Activities on the Social Accounting Matrix Table

Number	Abbreviation	Description
1	AGR_A	Agriculture forestry and fisheries
2	SGC_A	Sugarcane planting
3	CAS_A	Cassava planting
4	OPM_A	Oil palm plantation
5	COA_A	Coal production
6	CRD_A	Petroleum exploration and production
7	MIN_A	Mining
8	FOD_A	Food and beverage manufacturing
9	CPO_A	Crude palm oil production
10	SUG_A	Sugar production
11	CHM_A	Chemicals paper and textiles
12	PTR_A	Oil refinery
13	PDP_A	Pure biodiesel production
14	ETH-C_A	Ethanol production from cassava
15	ETH-M_A	Ethanol production from molasses
16	OPR_A	Lubricants and other petroleum
17	MNM_A	Metals and non-metals manufacturing
18	MHE_A	Machinery and electrical equipment
19	PVM_A	Solar panel manufacturing
20	BAT_A	Manufacturing of battery for internal combustion vehicle
21	BAT-E_A V	Battery manufacturing for electric vehicle
22	TRI_A	Machinery manufacturing for transportation
23	TRM_A	Maintenance of internal combustion vehicles
24	EV-MAIN_A	Electric vehicle maintenance
25	ICE-PROD_A	Internal combustion vehicle manufacturing
26	EV-PROD_A	Electric vehicle manufacturing
27	OMF_A	Other industries
28	ISVP_A	Independent private power plants
29	EGAT_A	Electricity Generating Authority of Thailand (EGAT)

Number	Abbreviation	Description
30	EGAT-TRAN_A	Power transmission and distribution
31	MEA-PEA_A	Metropolitan Electricity Authority and Provincial Electricity Authority
32	PRO_A	Solar rooftop electricity generation
33	GSP_A	Natural gas separation plant
34	WSP_A	Construction and waterworks
35	TRD_A	Trade and services
36	RAI_A	Rail transport
37	RDP_A	Transport (passenger) by road
38	RDF_A	Transport (cargo) by road
39	LDS_A	Land service
40	OCW_A	Water transportation coastal and sea
41	POR_A	Port services
42	AIR_A	Air freight
43	LGS_A	Logistics services
44	COM_A	Telecommunications
45	BUS_A	Business and financial services
46	PUB_A	Public administration
47	UNC_A	Other unspecified service activities

Source: Author's calculations.

Table 4.4. Commodities on the Social Accounting Matrix Table

Number	Abbreviation	Description
1	AGR_C	Agriculture forestry and fisheries
2	SGC_C	Sugarcane planting
3	CAS_C	Cassava planting
4	OPM_C	Oil palm plantation
5	COA_C	Coal production
6	CRD_C	Petroleum exploration and production
7	NGR_C	Natural gas production
8	MIN_C	Mining
9	FOD_C	Food and beverage manufacturing
10	SUG_C	Sugar production
11	MOL_C	Molasses production
12	CPO_C	Crude palm oil
13	CHM_C	Chemical product
14	LPG_C	Liquefied petroleum gas
15	GSH_C	Kerosene
16	JET_C	Jet fuel
17	DIE_C	Diesel
18	FUO_C	Fuel oil
19	ATB_C	Other petroleum products
20	B100_C	Biodiesel
21	ETH_C	Ethanol
22	OPR_C	Other products
23	MNM_C	Metals and non-metals manufacturing
24	MHE_C	Machinery and electrical equipment
25	PVM_C	Solar panel manufacturing
26	BAT_C	Battery manufacturing for internal combustion vehicle
27	BAT-EV_C	Battery manufacturing for electric vehicles
28	TRI_C	Machinery manufacturing for transportation
29	TRM_C	Maintenance of internal combustion vehicles

Number	Abbreviation	Description
30	EV-MAIN_C	Electric vehicle maintenance
31	ICE-PROD_C	Internal combustion vehicle manufacturing
32	EV-PROD_C	Electric vehicle manufacturing
33	OMF_C	Other industries
34	ELE-ISVP_C	Independent private power plants
35	ELE-EGAT_C	Electricity Generating Authority of Thailand
36	EGAT-TRAN_C	Power transmission and distribution
37	ELE_C	Metropolitan Electricity Authority and Provincial Electricity Authority
38	PRO_C	Solar rooftop electricity generation
39	PNG_C	Natural gas
40	WSP_C	Construction and waterworks
41	TRD_C	Trade and services
42	RAI_C	Rail transport
43	RDP_C	Transport (passenger) by road
44	RDF_C	Transport (cargo) by road
45	LDS_C	Land service
46	OCW_C	Water transportation coastal and sea
47	POR_C	Port services
48	AIR_C	Air freight
49	LGS_C	Logistics services
50	COM_C	Telecommunications
51	BUS_C	Business and financial services
52	PUB_C	Public administration
53	UNC_C	Other unspecified service activities

Source: Author's calculations.

Table 4.5. Factors of Production and Institutions on the Social Accounting Matrix Table

Abbreviation	Description
Lab	Labour
Capital	Capital
HH	Aggregate household
Govt	Government
TD	Direct tax
TM	Import tax
TI	Indirect tax
RoW	Rest of the world
SAV_INV	Saving and investment
VSTK	Change in stock

Source: Author's calculations.

3.2. The Main Structure of Computable General Equilibrium Model

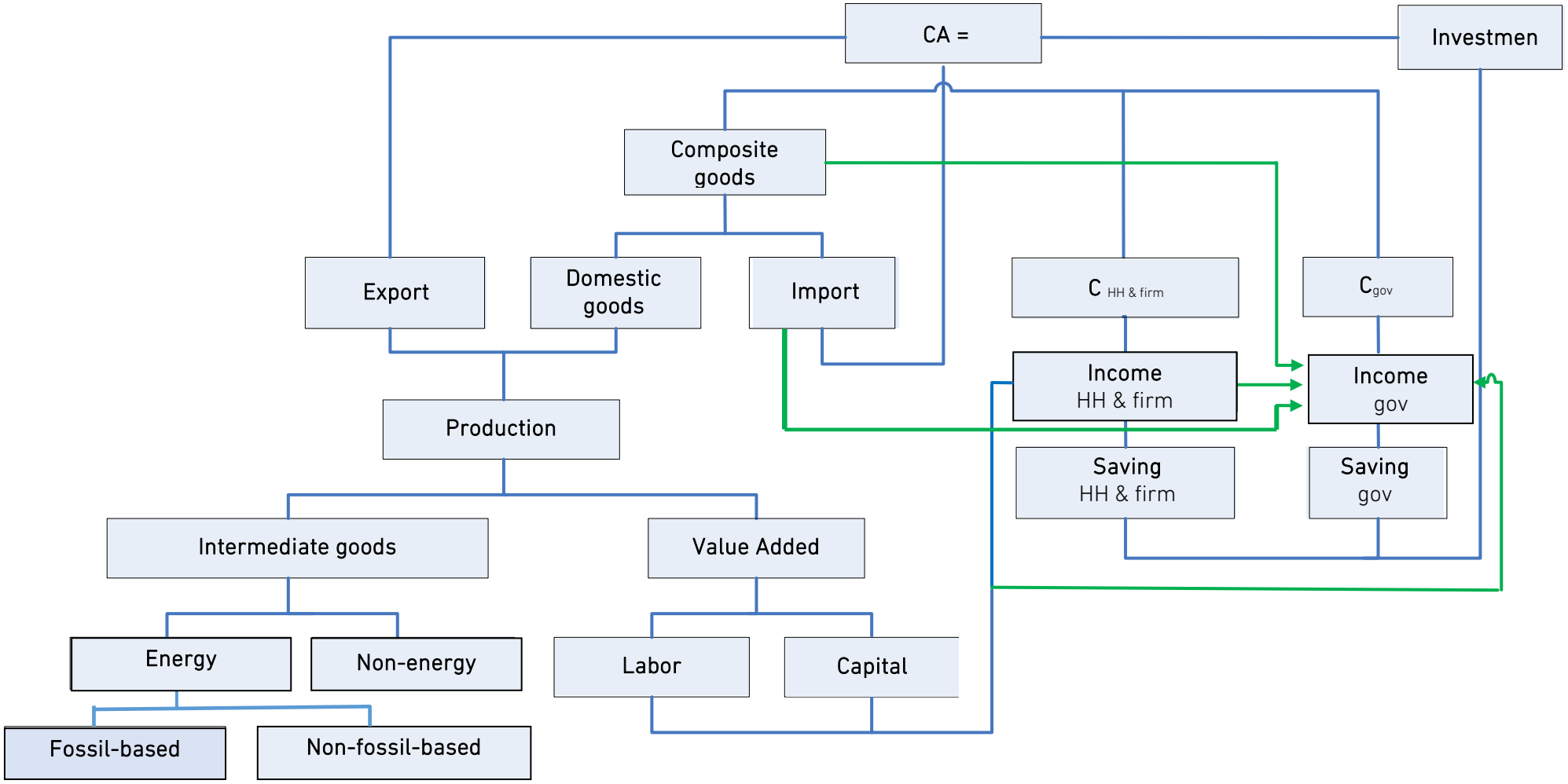
The CGE model is a structural model that replicates the main nationwide relationships amongst various economic entities. In general, it represents annual economic activities and transactions. Constructed based on general equilibrium theory, the model maintains the economy-wide equilibrium, in which price adjustment is the main mechanism of equilibrating the balance of all markets. The impact simulations can be conducted by incorporating exogenous shocks, causing a ripple effect throughout the economy, and achieving a new equilibrium. Due to its ability to analyse the impact on the entire economic system, the CGE model is widely applied in policy-oriented studies.

In the CGE model, all relationships are based on microeconomic theory. Each economic entity is represented as mathematical equations governing its behaviour in achieving optimal objectives under resource and technological constraints. In practice, the model represents the simultaneous adjustments of production behaviours of various industries, consumptions of many household classifications, the interventions of government, and the influences of international trade. Hence, many equations are incorporated into a system, causing the mode to be large and complex. To determine the impact on the economic system, various endogenous and exogenous variables must be defined. Endogenous variables are values computed by the model, while exogenous variables, such as policy-oriented variables, are set by the users (or the modeller).

The production sector utilises production factors to create goods and services, including primary factors such as labour and capital, and intermediate factors, which include all

goods and services in the market. As shown in Figure 4.10, each production sector combines the intermediate goods and primary factors (e.g., labour and captivating) to produce the goods and services, subsequently distributed for domestic consumption and export. For domestic consumption, the domestically produced products are combined with imported goods and become final goods consumed by households, the government, the investment sector, and exported abroad. Households use income from labour and capital returns to purchase goods and services, with the remainder used for savings and investment. The government generates income from taxes on households and the production sector to spend on fiscal budget and public investment. Following the macroeconomic concept of saving and investment balance, savings from private and public sectors finance the purchase of capital for production in the next annual cycle (i.e., the investment). It is notable that this saving and investment relationship institutes capital accumulation, which is the main dynamic process of economic growth.

Figure 4.10. The Main Structure of the Computable General Equilibrium Model



CA = current account; Cgov = government consumption; gov = government; KA = capital account; CHH & firm = private consumption (household and firm); HH = aggregate household.
Source: Author's calculations.

As defined by microeconomic theory, production and consumption activities, concurrently influenced by the market system, are the crucial structures of the economy. Based on this foundation, the CGE model comprises all markets, including goods, services, and production factor markets. All prices and quantities simultaneously adjust until reaching the economy-wide equilibria. When changes from external factors affect prices and/or quantities of goods and services in a particular market, the producers and consumers alter their production and consumption until reaching the new equilibrium levels of goods and services in all markets are achieved. Based on a foundation of general equilibrium theory, the economy-wide market equilibria are the main mechanism of the model. Hence, Walras's law is conventionally applied as a crucial criterion for determining the validity of the developed CGE model.

The main analytical framework for this study is the standard structure of the dynamic CGE model introduced by Decaluwé et al. (2013). It comprises the production behaviour of all sectors governed by a multi-level nested structure with the mathematical specifications of constant elasticity substitution technology. The CGE model has been constructed using the 2015 SAM table, with details previously described in Section 3.1, as the baseline.

3.3. Inclusion of Electric Vehicles in the Standard Computable General Equilibrium Model

The dynamic computable CGE model used for evaluating the impact of electricity primarily draws from the mathematical framework and parameters established by Haputta et al. (2022), Phomsoda, Puttanapong, and Piantanakulchai (2021a and 2021b), Haputta et al. (2020), and Kaenchan et al. (2019). This model incorporates the production and use of EVs based on methodologies developed by Guo et al. (2022), Guo et al. (2022), Lin and Wu (2021), Chen et al. (2021), Shibusawa and Miyata (2017), and Miyata, Shibusawa, and Fujii (2018). The cost structure for EV production in this model is informed by research from Suehiro and Purwanto (2020) and Lutsey and Nicholas (2019). Additionally, the model's assumptions about future battery costs are aligned with projections made by Mauler et al. (2021).

3.4. Simulation Strategy

The critical aspects of this study include the specifics and prospective developments in EV production and usage. As outlined in Table 4.6, the cost structure, focusing on major EV components and their associated expenses follows the studies by Suehiro and Purwanto (2020) and Lutsey and Nicholas (2019).

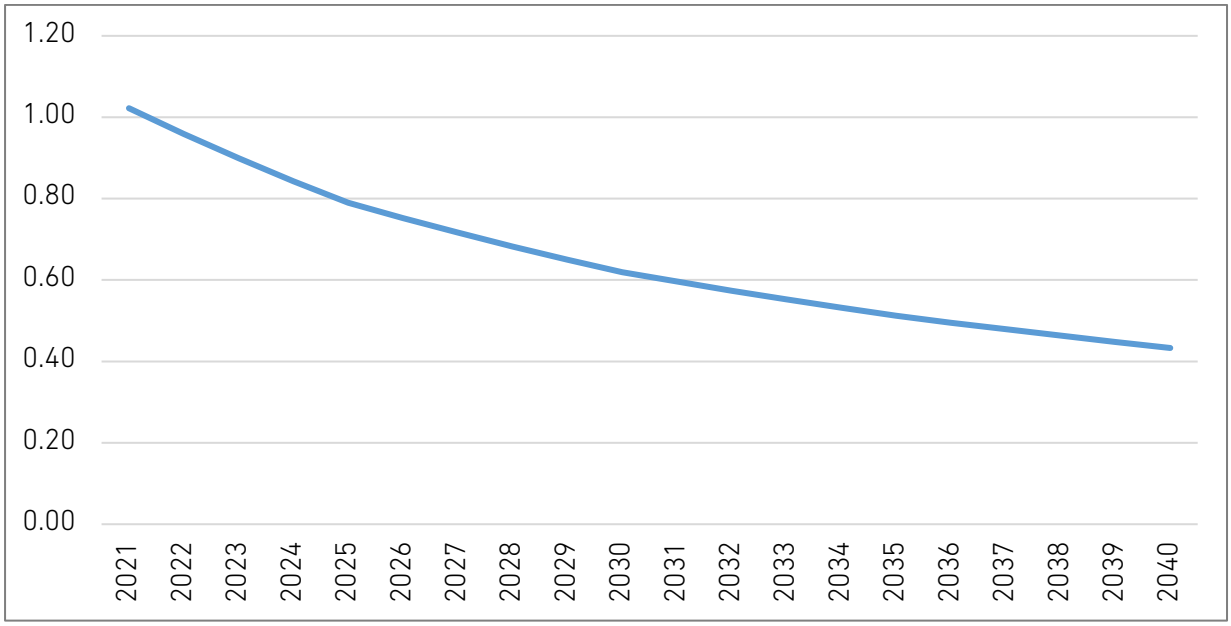
Table 4.6. Cost Structure of Electric Vehicle Production

Parts	2021 (%)	2025 (%)
Battery pack	30.16	30.62
Thermal management	0.66	0.86
Power distribution	0.66	1.13
Inverter	1.83	2.00
Electric drive module	3.15	4.13
DC converter	0.39	0.51
Controller	0.13	0.18
Control module	0.24	0.32
High voltage cables	0.88	1.16
On-board charger	0.72	0.78
Charging cord	0.39	0.52
Vehicle assembly	33.04	45.54
Indirect cost	27.76	12.25
Total	100.00	100.00

% = percent; DC = direct current.
Note: Numbers may not sum precisely due to rounding.
Source: Lutsey and Nicholas (2019) and author's estimation.

Figure 4.11 illustrates that the battery price is projected to decrease exponentially over time, in line with the findings of Mauler et al. (2021). Assuming a rise in domestic production and an increasing market demand for EVs, the share of EV production will align with the 30@30 strategy, with this trend expected to continue expanding through to 2040, the terminal year of our simulation. Technically speaking, in the simulated model, the escalation in EV production was primarily a consequence of a sustained increase in investments directed towards EV manufacturing, a factor that was externally preset in the model's parameters. Additionally, the surge in demand for EVs was influenced by modifications in the parameters that depict the marginal propensity to consume both ICE and EV cars. The underlying assumption here was a gradual but steady shift in consumer preference, favouring the substitution of ICE vehicles with EVs as shown in Figure 4.12.

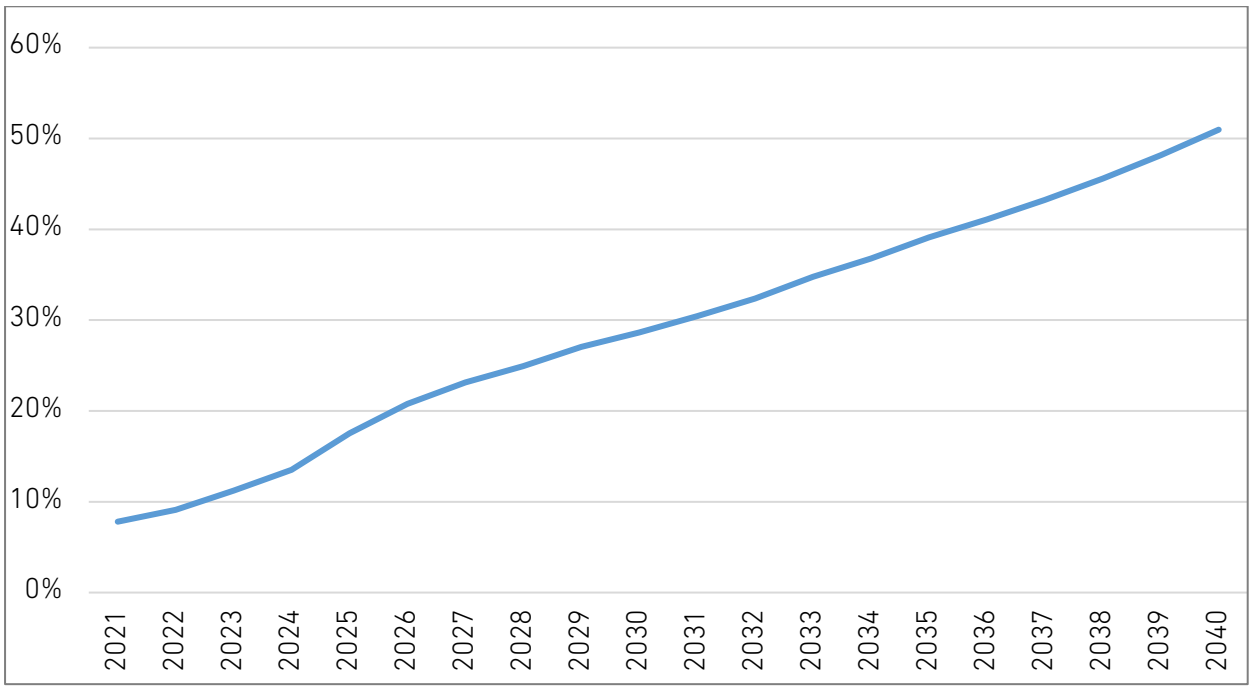
Figure 4.11. The Price Index of Electric Vehicle Batteries over the Projected Period (2021–2040)



Source: Authors' calculation.

Figure 4.12. The Proportion of Electric Vehicles to the Total Domestic Production of Vehicles

(%)



Source: Author's calculation.

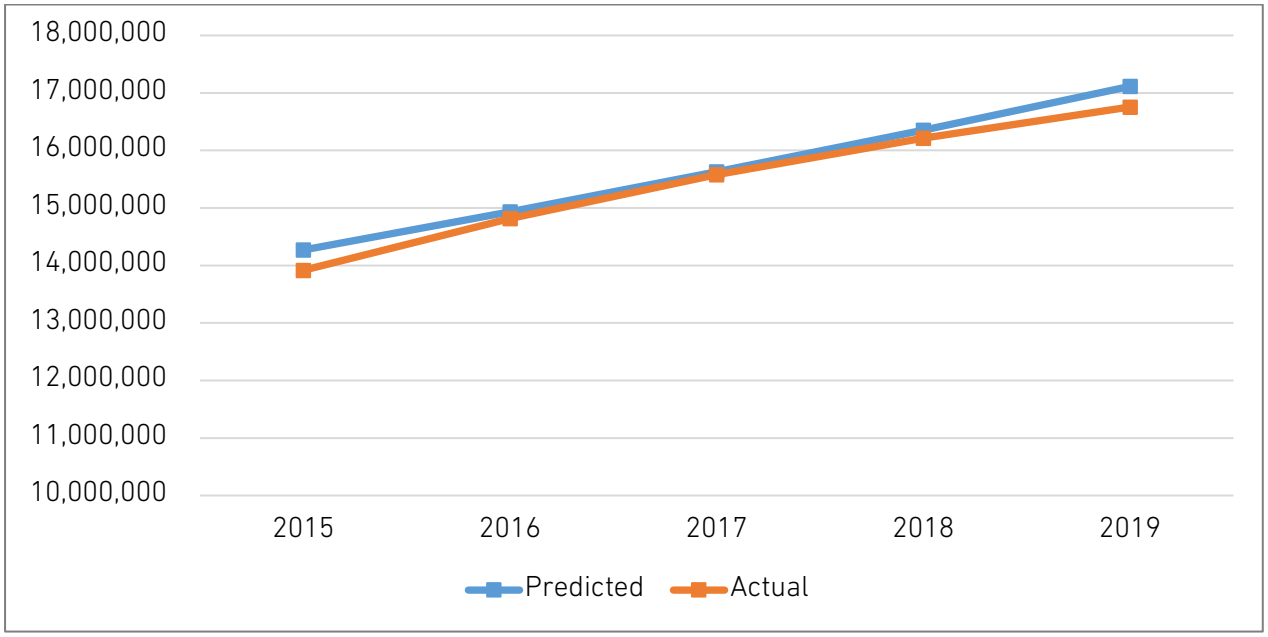
4. Research Methodology

4.1. Social Accounting Matrix

To verify the compatibility of the developed model to replicate the main characteristics of the Thai economy, the simulation results were generated with the aim of ascertaining the model's accuracy.

Figure 4.13 depicts the predictive performance of the developed dynamic CGE model, closely replicating the value of real GDP during 2015–2019. Furthermore, Table 4.7 shows the comparison between the actual and simulated values of the main macroeconomic indices for the period 2015–2019. Using the -mean-square error values as the criterion, these in-sample simulation results indicate that this model can replicate the dynamic adjustment of the Thai economy, giving confidence that it can be used to accurately study future policies.

Figure 4.13. A Comparison of Real Gross Domestic Product



Source: Author's calculation.

Table 4.7. A Comparison between Actual and Simulated Values of Macro Indication during 2015–2019

Macroeconomic Indicators	Sources	2015	2016	2017	2018	2019	RMSE (%)
Real GDP	Predicted	14,283,653.18	14,938,992.79	15,638,025.90	16,362,934.42	17,127,257.15	1.62
	Actual	13,916,250.00	14,816,268.00	15,581,153.00	16,214,622.00	16,756,074.00	
Private consumption	Predicted	7,205,527.24	7,540,744.92	7,897,377.99	8,260,140.78	8,644,883.39	3.12
	Actual	7,056,809.00	7,296,683.00	7,579,744.00	8,002,725.00	8,448,321.00	
Gross fixed capital formation	Predicted	3,334,347.04	3,567,452.74	3,814,944.99	4,076,455.16	4,352,289.75	8.63
	Actual	3,371,068.00	3,459,899.00	3,579,845.00	3,726,894.00	3,814,370.00	
Import	Predicted	6,728,685.48	7,801,051.11	8,399,835.43	7,788,875.42	8,565,105.25	12.05s
	Actual	7,861,679.00	7,806,464.00	8,397,736.00	9,771,154.45	8,543,405.00	
Export	Predicted	8,091,690.73	8,456,061.44	8,837,577.22	9,235,348.50	9,651,870.77	12.25
	Actual	9,295,635.00	9,785,868.00	10,326,731.00	10,616,164.00	10,086,594.00	
CPI	Predicted	1.000	1.007	1.015	1.020	1.028	0.35
	Actual	1.000	1.002	1.009	1.019	1.027	

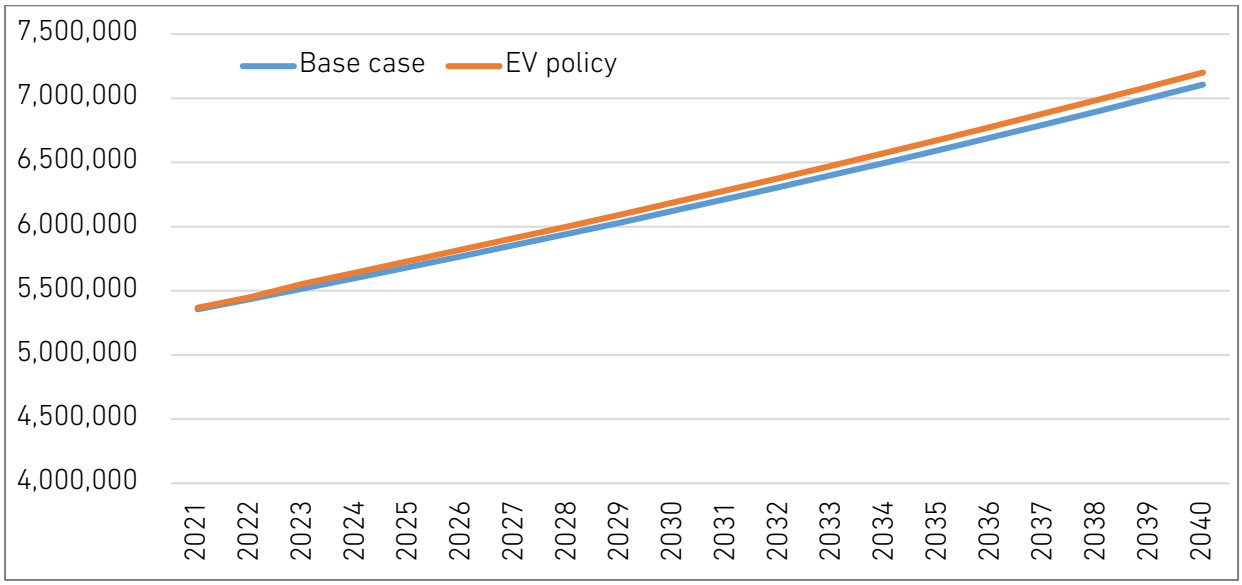
CPI = consumer price index; GDP = gross domestic product; RMSE = root-mean square error
Source: Author's calculation.

4.2. Impacts of the Electric Vehicle Policy

4.2.1. Impacts on Macroeconomic Indicators

The developed general equilibrium model in this research demonstrates the changes in every sector within Thailand's economic system across various dimensions. In terms of the macroeconomic perspective, the primary consideration is the impact on gross domestic product (GDP), which reveals a net positive influence on the total economic measure. As shown in Figure 4.14, the simulation outcome indicated the continuous growth of GDP throughout the forecast period, both in terms of current and real GDP values. This estimation result reveals that increasing the proportion of EVs has a positive effect, leading to economic expansion.

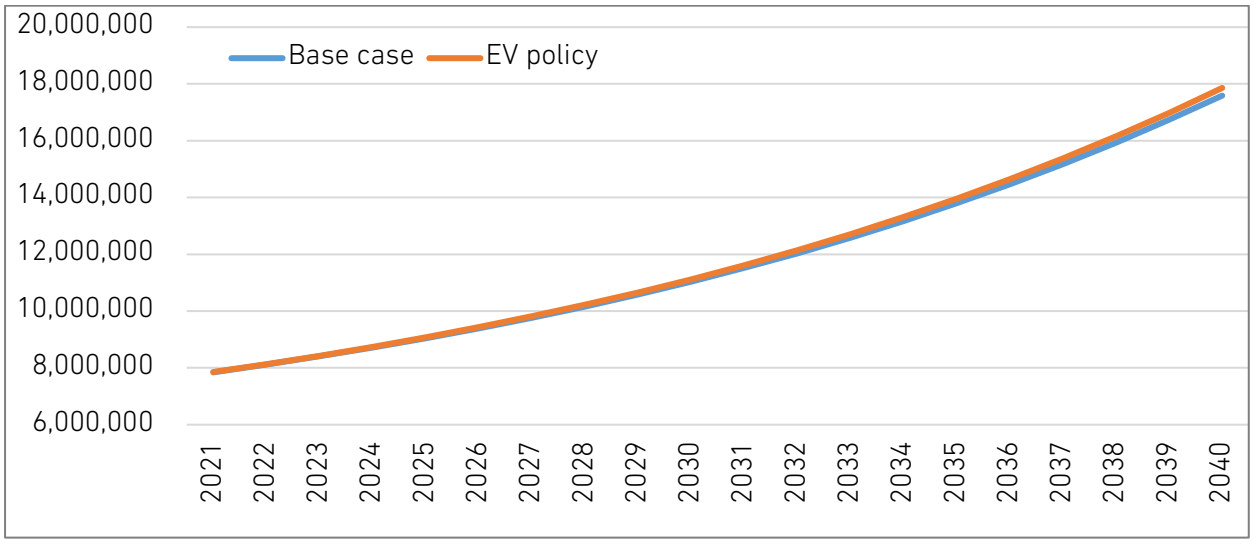
Figure 4.14. The Impact of the Electric Vehicle Policy on Real Gross Domestic Product
(million baht at 2021 prices)



EV = electric vehicle
Note: Numerical results are shown in Table A.1.
Source: Author's calculation.

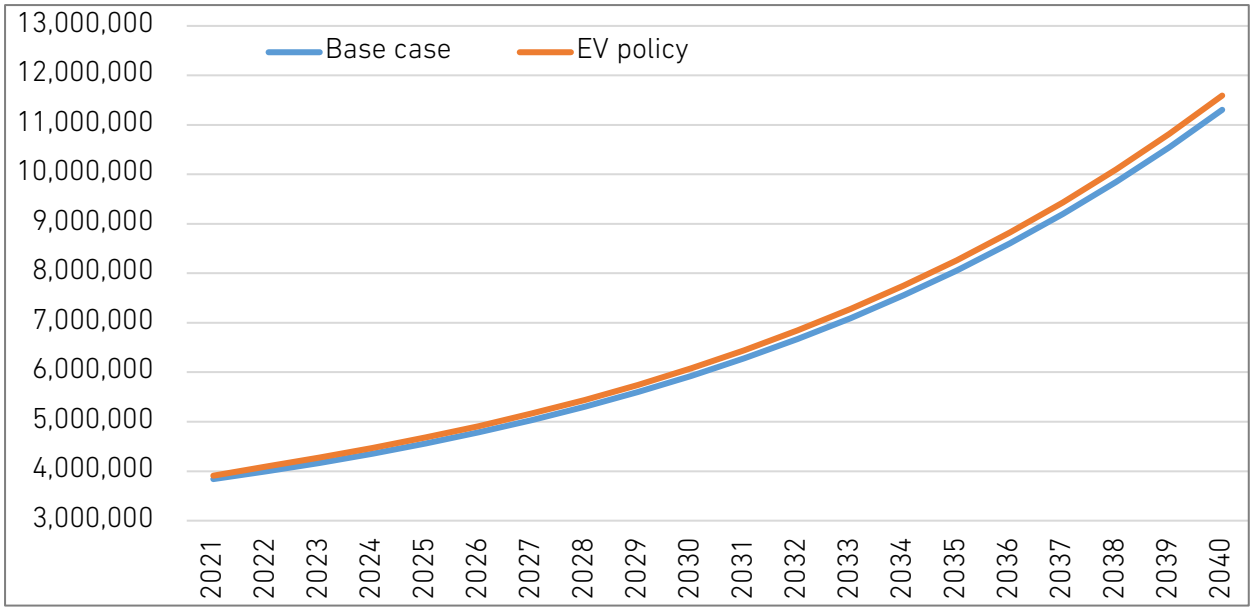
When considering the main components of GDP, it is evident that total private consumption continuously increases, as shown Figure 4.15. Furthermore, overall investment (i.e., gross fixed capital formation) also continuously expands, as indicated by Figure 4.16. Both values are components that reflect changes in economic activity values resulting from domestic sectors and arise from households and the private sector. They benefit from an expansion of the proportion of vehicle usage in the country, reflecting the transmission of government policy impacts to the private sector and households, leading to macroeconomic expansion in the long-term.

Figure 4.15. The Impact of the Electric Vehicle Policy on Total Private Consumption
(million baht at 2021 prices)



EV = electric vehicle.
Note: Numerical results are shown in Table A.2.
Source: Author's calculation.

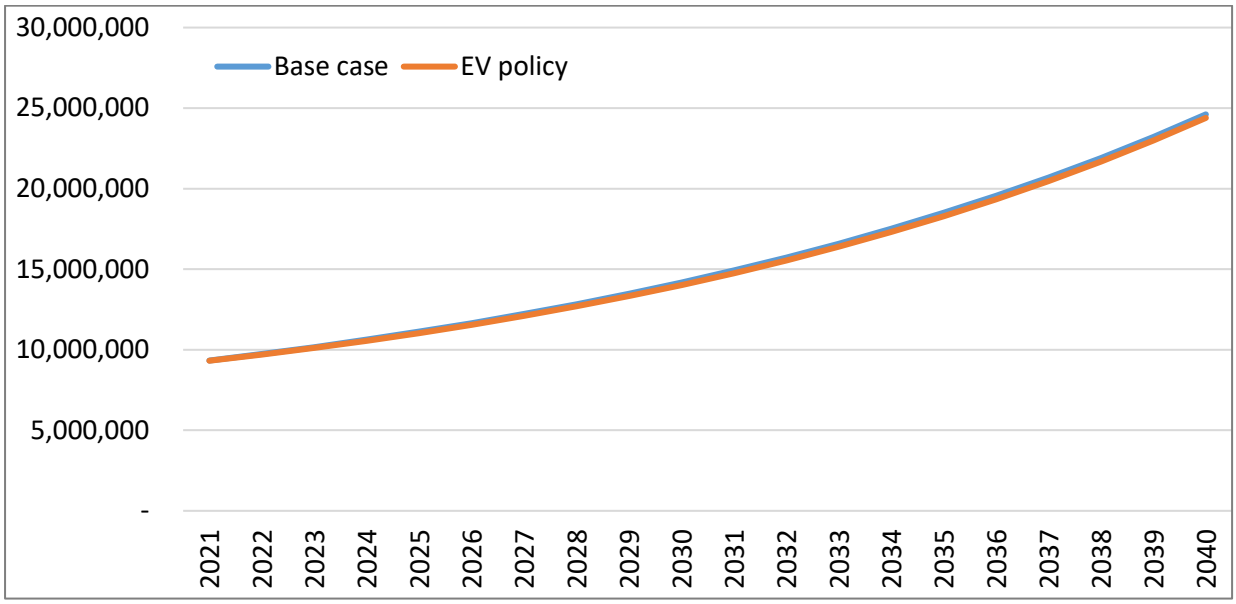
Figure 4.16. The Impact of the Electric Vehicle Policy on Gross Fixed Capital Formation
(million baht at 2021 prices)



EV = electric vehicle.
Note: Numerical results are shown in Table A.3.
Source: Author's calculation.

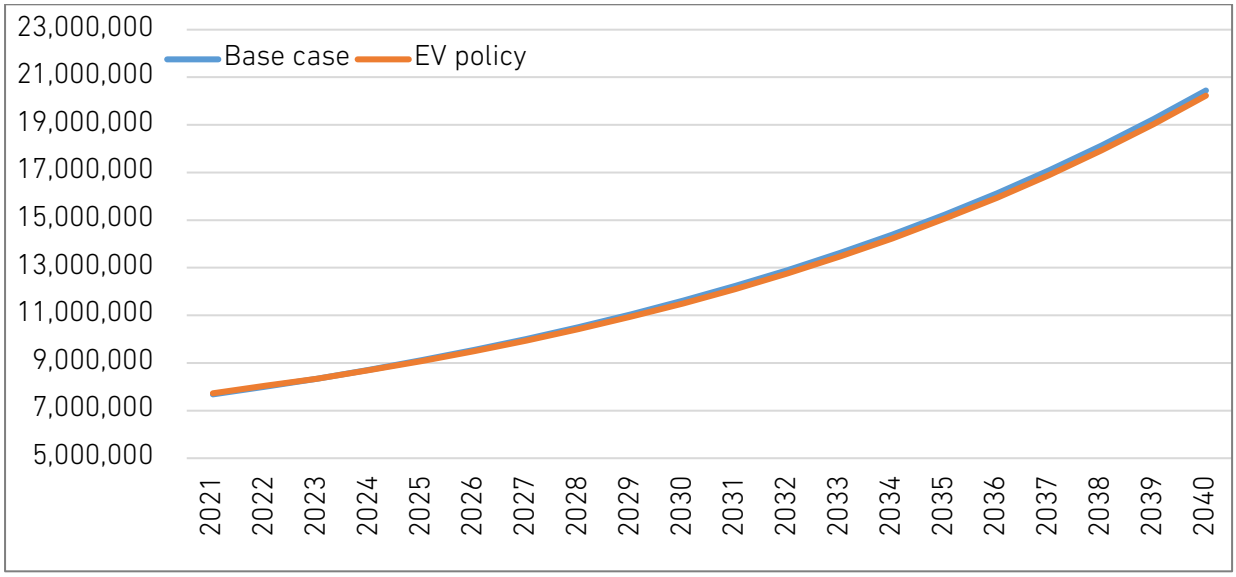
The impacts of EV policy on international trade are shown in Figures 4.17–4.19. The simulated result indicates that the expansion of EV production and utilisation will lead to a slight decline in export and import. Thus, the net current account will also marginally decrease.

Figure 4.17. The Impact of the Electric Vehicle Policy on Total Export
(million baht at 2021 prices)



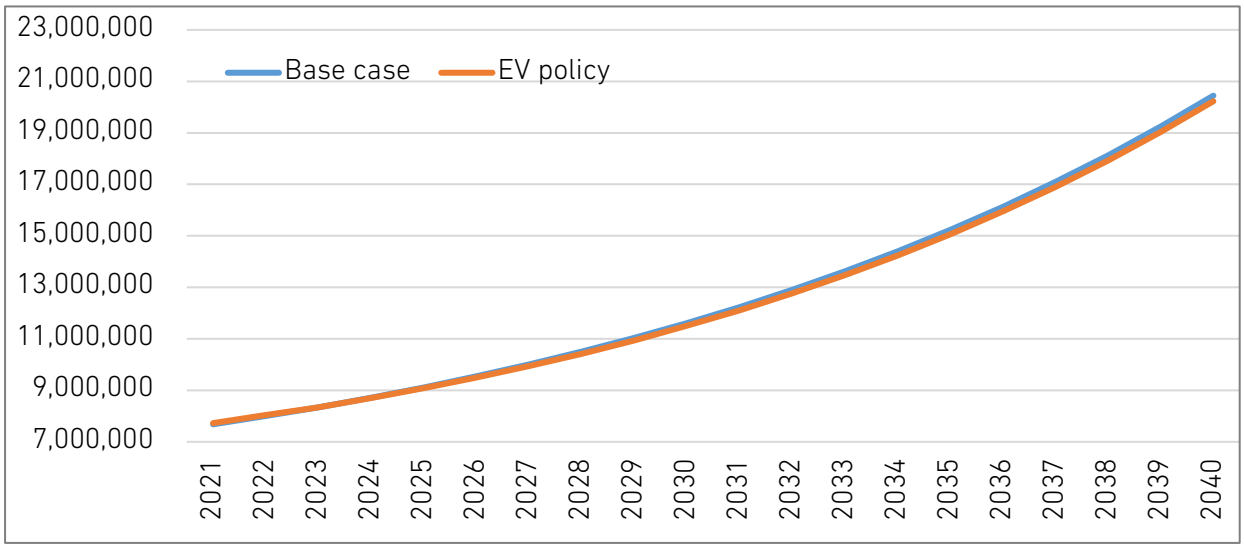
EV = electric vehicle.
Note: Numerical results are shown in Table A.4.
Source: Author's calculation.

Figure 4.18. The Impact of the Electric Vehicle Policy on Total Import
(million baht at 2021 prices)



EV = electric vehicle.
Note: Numerical results are shown in Table A.5.
Source: Author's calculation.

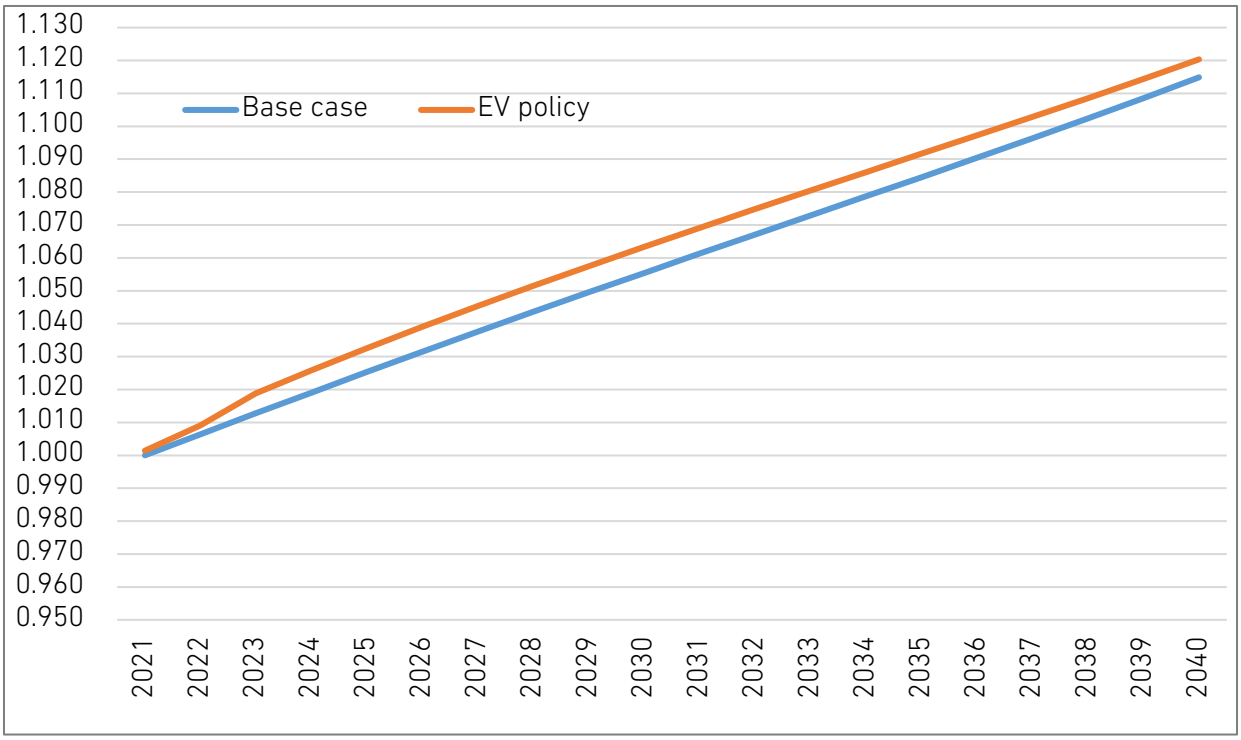
Figure 4.19. The Impact of the Electric Vehicle Policy on Net Current Account Balance
(million baht at 2021 prices)



EV = electric vehicle.
Note: Numerical results are shown in Table A.6.
Source: Author's calculation.

Considering the impact on the consumer price index (CPI), the economic expansion results in higher inflation than the base case due to an increase in overall demand (aggregate demand), both from overall consumption and overall investment, affecting product price levels. However, as shown in Figure 4.20, it was found that the CPI increased only slightly from the base case in all future scenarios because there was also an expansion of overall supply. Therefore, the change in the product price level does not significantly affect the overall economy.

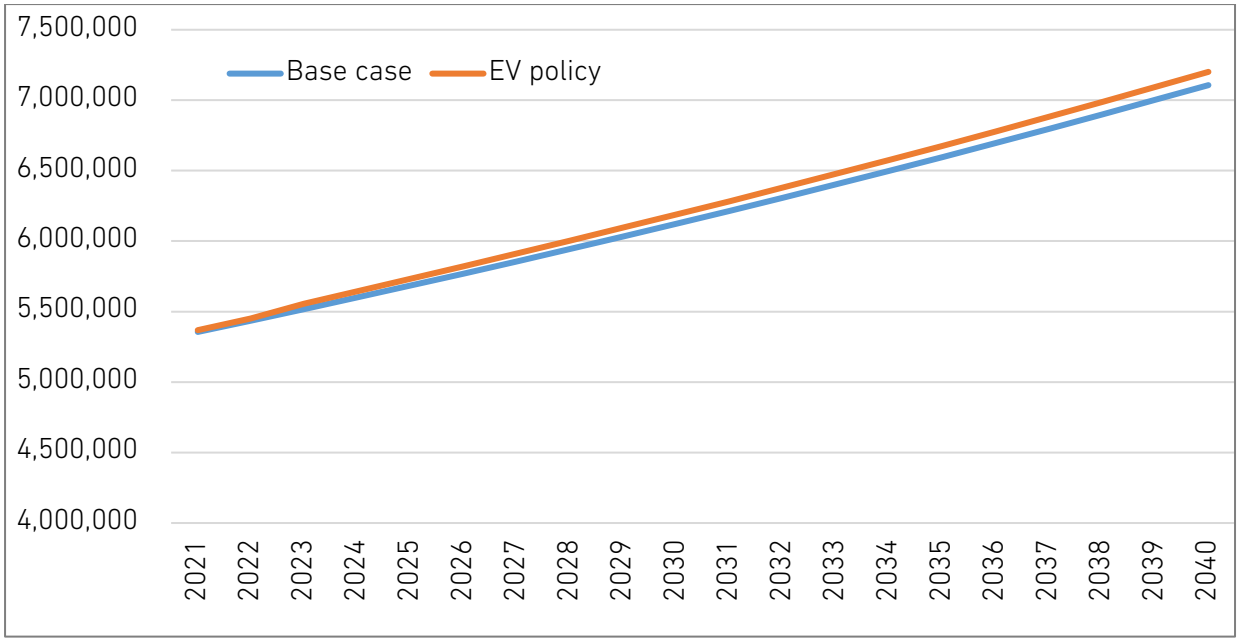
Figure 4.20. The Impact of the Electric Vehicle Policy on The Consumer Price Index
(Year 2021 = 1.00)



EV = electric vehicle.
Note: Numerical results are shown in Table A.7.
Source: Author's calculation.

Figure 4.21 illustrates the impact on the total value of wage income. This simulation outcome indicates a positive impact as the total monetary value of employment will rise until 2040. This macro indicator represents the other aspect of economy-wide benefit, which subsequently improve household's consumption.

Figure 4.21. The Impact of the Electric Vehicle Policy on The Total Value of Employment
(million baht at 2021 prices)



EV = electric vehicle.
Source: Author's calculation.

4.2.2. Impacts on Production by Sector

The simulation results identify the details of the interconnections amongst various sectors within the economic system, enabling an analysis of sectoral impacts. The details of the impacts of changes in production by sector are shown in Table 4.8.

Table 4.8. The Sectoral Impacts of the Electric Vehicle Policy
(Average Change in Total Output)

Abbreviation	Description	Average (%)	Max (%)	Min (%)
AGR	Agriculture, forestry, and fisheries	0.54	1.20	-0.02
AIR	Air freight	-2.04	0.01	-3.33
BAT	Manufacturing of batteries for internal combustion vehicles	8.10	27.38	-0.05
BAT-EV	Batteries for EV	-5.07	9.31	-11.62
BUS	Business and financial services	0.58	0.92	0.07
CAS	Cassava planting	-2.92	0.06	-4.58
CHM	Chemicals paper and textiles	-0.69	0.00	-1.05
COA	Coal production	0.43	1.56	-0.01
COM	Telecommunications	0.46	1.08	0.00
CPO	Crude palm oil production	-5.70	0.12	-8.34
CRD	Petroleum exploration and production	-11.51	0.05	-18.56
EGAT	Electricity Generating Authority of Thailand	-0.68	0.82	-3.58
EGAT-TRAN	Power transmission and distribution	2.27	5.28	0.10
ETH-C	Ethanol production from cassava	-26.09	0.33	-45.48
ETH-M	Ethanol production from molasses	-6.62	0.20	-8.21
EV-MAIN	EV maintenance	31.32	57.22	1.03
EV-PROD	EV manufacturing	108.90	245.40	0.98
FOD	Food and beverage manufacturing	0.60	1.31	-0.05
GSP	Natural gas separation plant	-18.37	0.07	-26.10
ICE-PROD	Internal combustion vehicle manufacturing	-7.51	0.19	-18.36
ISVP	Independent private power plants	3.82	10.14	0.10
LDS	Land service	0.63	1.10	0.09
LGS	Logistics services	0.09	0.60	-0.08
MEA-PEA	Metropolitan Electricity Authority and Provincial Electricity Authority	2.25	5.23	0.10
MHE	Machinery and electrical equipment	-1.01	0.06	-1.44
MIN	Mining	-0.16	0.28	-0.44
MNM	Metals and non-metals manufacturing	-0.66	0.05	-1.08

Abbreviation	Description	Average (%)	Max (%)	Min (%)
OCW	Water transportation coastal and sea	-0.17	0.46	-0.80
OMF	Other industries	-0.96	0.02	-1.29
OPM	Oil palm plantation	-5.06	0.11	-7.46
OPR	Lubricants and other petroleum	-0.92	0.05	-1.49
POR	Port services	-0.16	0.12	-0.35
PRO	Solar rooftop electricity generation	71.56	164.67	0.12
PTR	Oil refinery	-13.71	0.25	-19.91
PUB	Public administration	0.11	0.32	-0.04
PVM	Solar panel manufacturing	12.35	45.23	-0.13
RAI	Rail transport	1.30	1.88	0.07
RDF	Transport (cargo) by road	0.39	0.76	0.18
RDP	Transport (passenger) by road	1.87	2.51	-0.01
SGC	Sugarcane planting	-0.31	0.04	-0.54
SUG	Sugar production	-0.43	0.05	-0.68
TRD	Trade and services	5.05	8.80	0.08
TRI	Machinery manufacturing for transportation	0.01	0.48	-0.26
TRM	Maintenance of internal combustion vehicles	0.94	1.28	0.24
UNC	Other unspecified service activities	2.71	3.82	0.03
WSP	Construction and waterworks	1.25	1.46	1.01

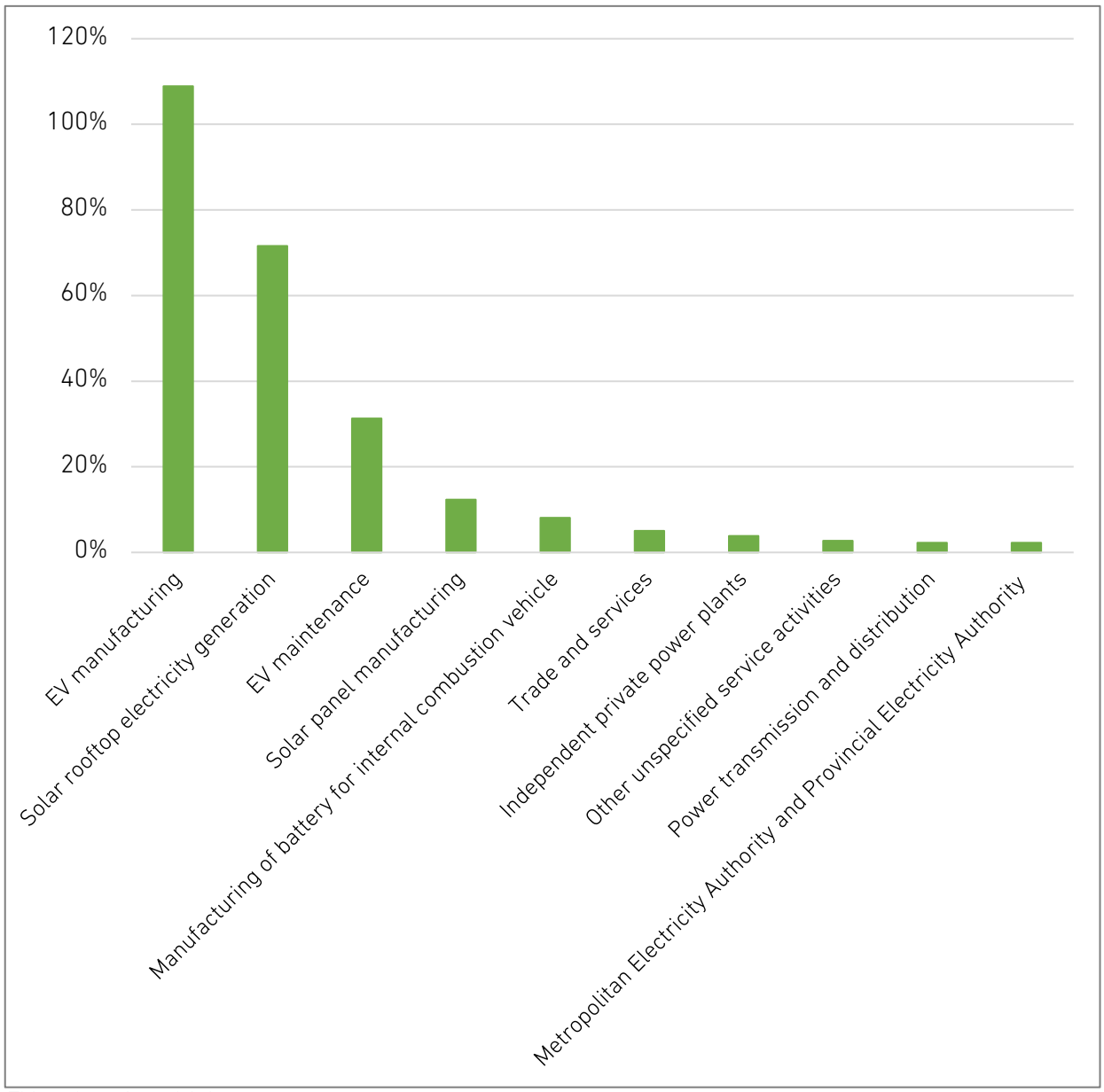
EV = electric vehicle
Note: Numerical results are shown in Table A.7.
Source: Author's calculation.

According to Figure 4.22 and Table 4.8, the impact of transformative technology will positively affect 24 production activities, while the rest will be negatively impacted. The greatest increase in production is in sectors related to the production and use of EVs as listed below.

(1) EV manufacturing (increasing by 0.978% to 245.399%)
(2) Solar rooftop electricity generation (increasing by 0.11% to 164.670%)
(3) EV maintenance (increasing by 1.032% to 57.219%)
(4) Solar panel manufacturing (increasing by -0.132% to 45.229%)
(5) Manufacturing of batteries for internal combustion vehicles (increasing by -0.047% to 27.377%)

(6) Trade and services (increasing by 0.080% to 8.800%)
(7) Independent private power plants (increasing by 0.102% to 10.144%)
(8) Other unspecified service activities (increasing by 0.02% to 3.820%)
(9) Power transmission and distribution (increasing by 0.102% to 5.277%)
(10) Metropolitan Electricity Authority and Provincial Electricity Authority (increasing by 0.101% to 5.230%)

Figure 4.22. The Sectors with the Highest Positive Impacts Due to the Electric Vehicle Policy
(%)



EV = electric vehicle.
Source: Author's calculation.

However, the simulation result also indicates a negative impact on some production sectors. This is due to the implications of the new policy promoting the production and use of EVs, and the energy scheme allowing electricity production from household rooftops (solar rooftops). As illustrated in Figure 23, the most negatively impacted sectors include:

(1) Ethanol production from cassava (changing between -45.489% and 0.327%)

(2) Natural gas separation plant (changing between -26.096% and 0.067%)

(3) Oil refinery (changing between -19.908% and 0.250%)

(4) Petroleum exploration and production (changing between -18.562% and 0.052%)

(5) Internal combustion vehicle manufacturing (changing between -18.361% and 0.189%)

(6) Ethanol production from molasses (changing between -8.209% and 0.203%)

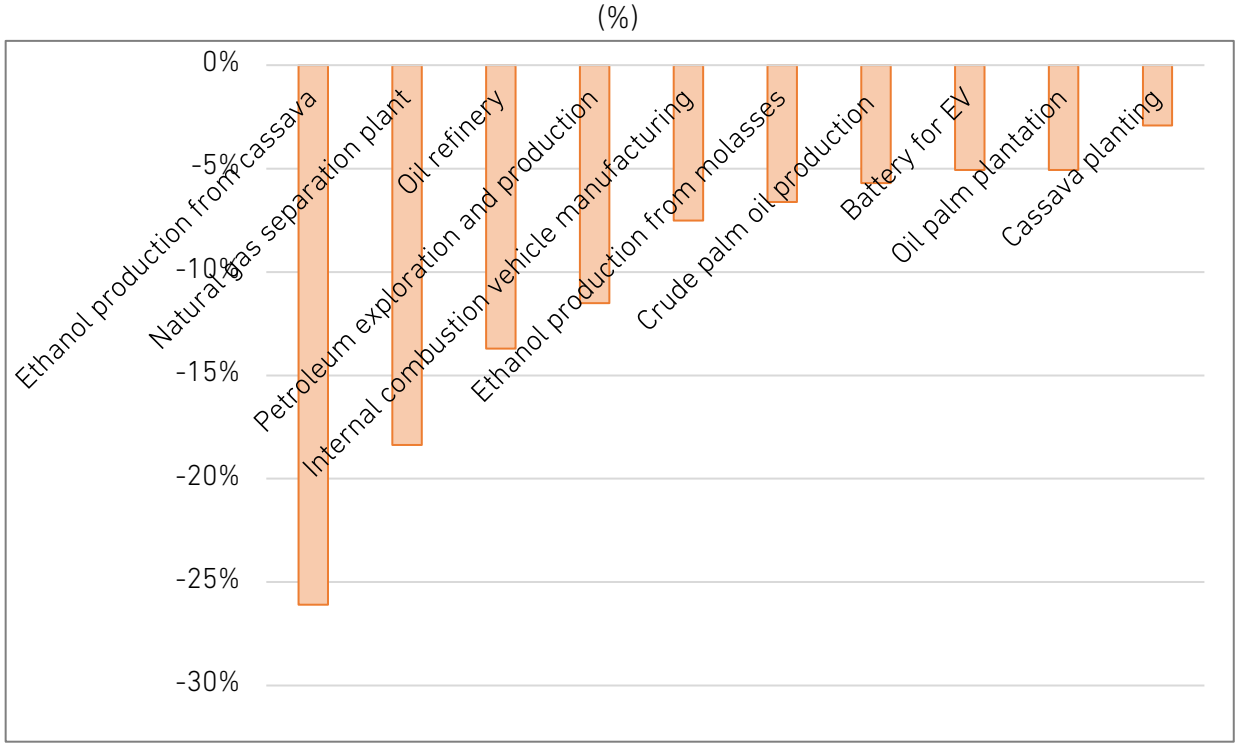
(7) Crude palm oil production (changing between -8.341% and 0.115%)

(8) Batteries for EV (changing between -11.620% and 9.310%)

(9) Oil palm plantation (changing between -7.462% and 0.106%)

(10) Cassava planting (changing between -4.579% and 0.060%)

Figure 4.23. The Sectors with the Highest Negative Impacts Due to the Electric Vehicle Policy

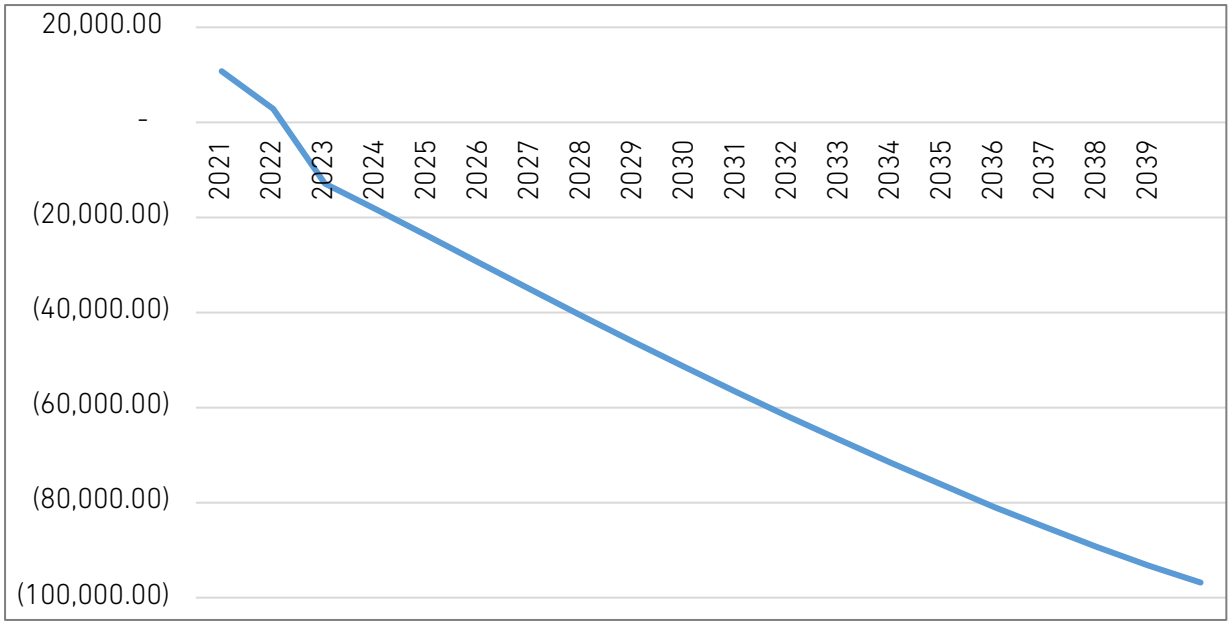


EV = electric vehicle.
Note: Numerical results are shown in Table A.8.
Source: Author's calculation.

4.2.3. Impacts on Fiscal Status

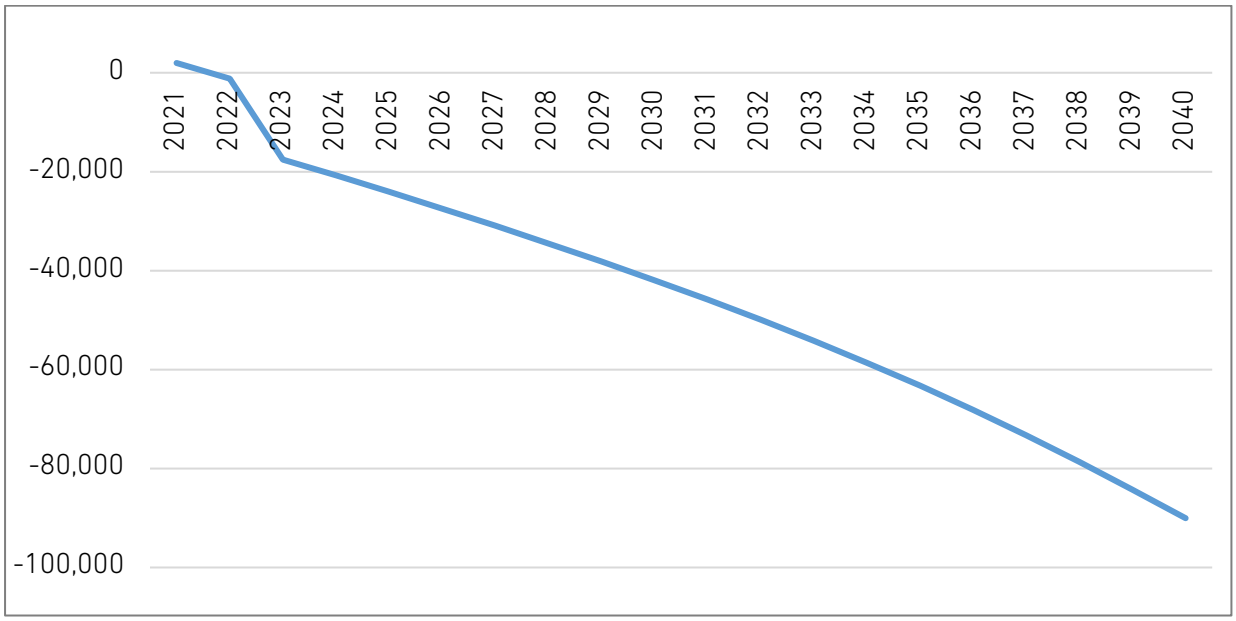
One of the main focuses of this study is the fiscal stability of the Government of Thailand. The simulation result generated by the developed CGE model indicates the declining total government revenue. As shown in Figure 4.24, the total income of the Government of Thailand will decline during 2021–2040. Figures 4.25–4.27 show the structure of revenue sources, which is a combination of direct tax, indirect tax, and tariffs. The implementation of EV policy can lead to the decline of indirect tax and tariffs, substantially contributing to the long-term trend of declining total revenue.

Figure 4.24. Changes in Total Government Revenue Due to The Electric Vehicle Policy
(million baht)



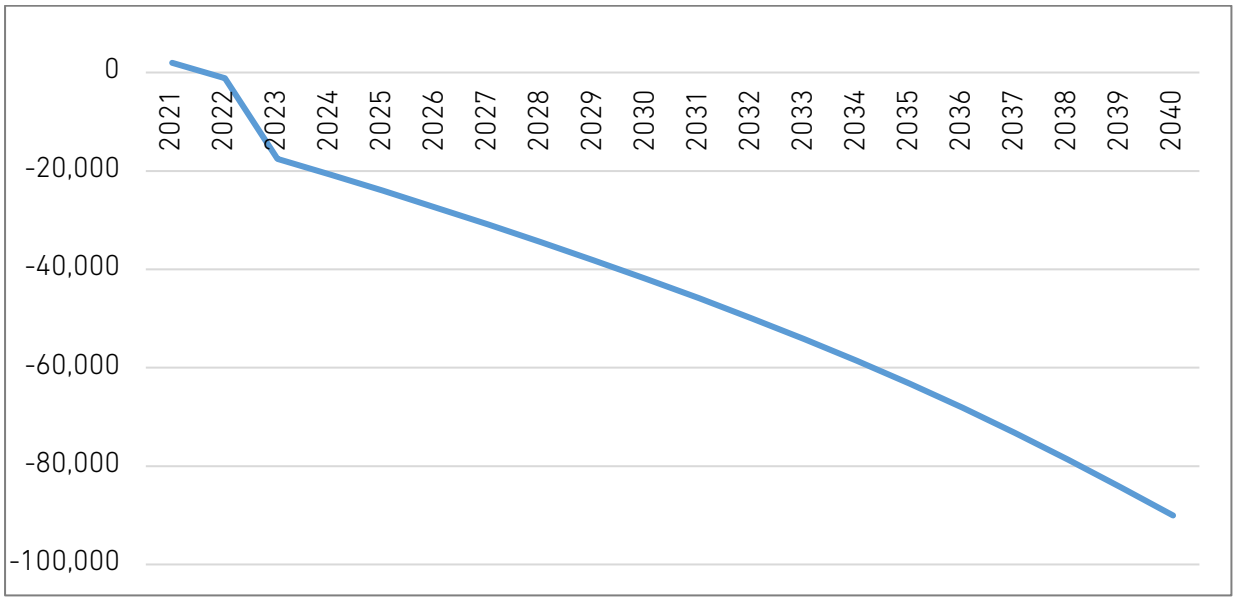
Note: Numerical results are shown in Table A.8.
Source: Author's calculation.

Figure 4.25. Changes in Total Direct Tax Due to the Electric Vehicle Policy
(million baht)



Note: Numerical results are shown in Table A.9.
Source: Author's calculation.

Figure 4.26. Changes in Total Indirect Tax due to the Electric Vehicle Policy
(million baht)



Note: Numerical results are shown in Table A.10.
Source: Author's calculation.

Following the conventional specification of the CGE model, the real value of current government consumption was set as the exogenous variable. Hence, its market price value can be varied due to inflation. Thus, as indicated in Table 4.9, the annual market price values of current government consumption were slightly inflated due to the low level of inflation.

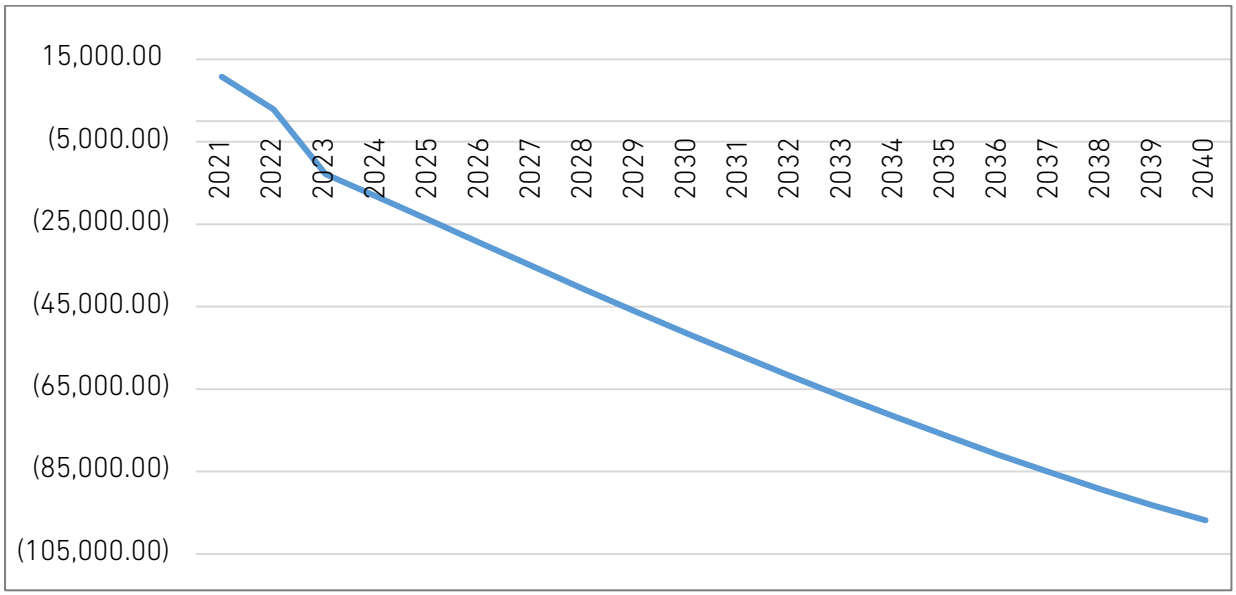
Table 4.9. Current Government Consumption
(million baht)

Year	Base case	EV policy	Change (%)
2021	2,501,024.40	2,503,455.15	0.10
2022	2,575,176.45	2,579,756.43	0.18
2023	2,650,179.52	2,660,591.27	0.39
2024	2,725,913.68	2,737,979.36	0.44
2025	2,802,231.50	2,815,638.22	0.48
2026	2,878,995.44	2,893,442.84	0.50
2027	2,956,073.12	2,971,359.76	0.52
2028	3,033,342.81	3,049,372.33	0.53
2029	3,110,694.67	3,127,383.37	0.54
2030	3,188,033.16	3,205,307.94	0.54
2031	3,265,279.13	3,283,064.42	0.54
2032	3,342,372.04	3,360,650.28	0.55
2033	3,419,272.21	3,438,033.72	0.55
2034	3,495,962.86	3,515,200.18	0.55
2035	3,572,451.89	3,592,171.78	0.55
2036	3,648,773.21	3,668,966.78	0.55
2037	3,724,987.53	3,745,621.52	0.55
2038	3,801,182.55	3,822,258.70	0.55
2039	3,877,472.50	3,899,012.01	0.56
2040	3,953,997.03	3,976,198.66	0.56

EV = electric vehicle.
Source: Author's calculation.

Figure 4.27 show the impacts on fiscal balance. With continuously declining revenue, the fiscal balance is predicted to be negative during 2023–2040. This result highlights a serious concern about future fiscal sustainability. As previously discussed in Section 2.3, to avoid fiscal insolvency, the public debt per GDP ratio and the government budget have been targeted. However, the EV policy will incur the future fiscal burden. Therefore, the cost and benefit of this policy should be thoroughly examined and discussed.

Figure 4.27. Fiscal Balance Due to The Electric Vehicle Policy
(million baht)

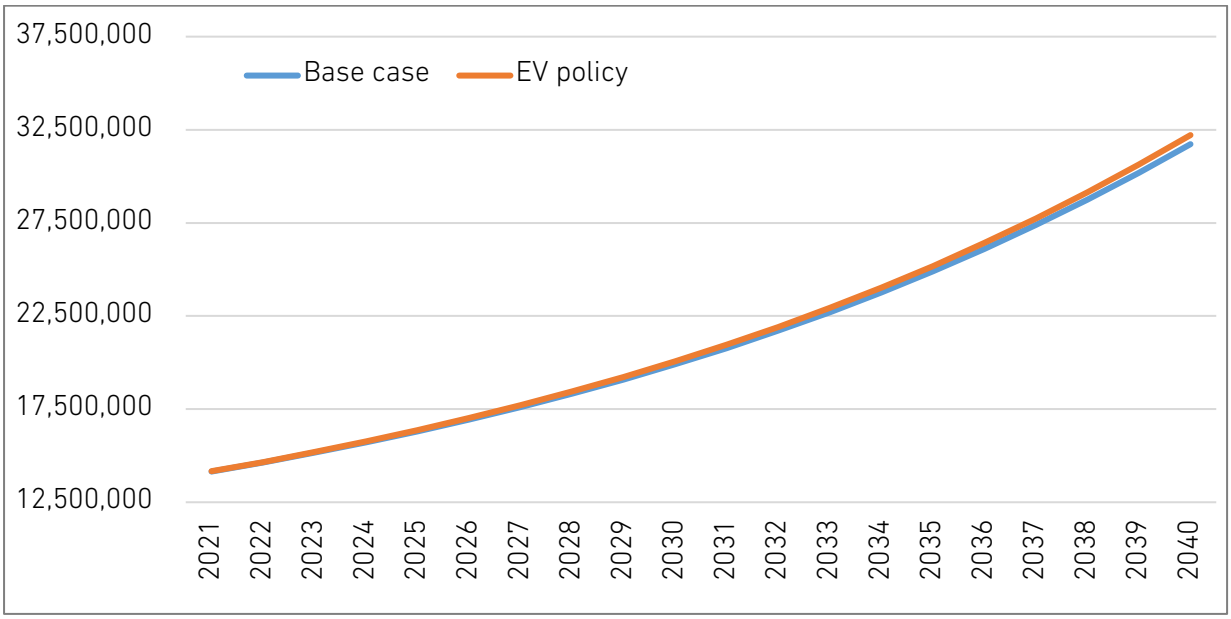


Note: Numerical results are shown in Table A.11.
Source: Author's calculation.

4.2.4. Impacts on Aggregate Household

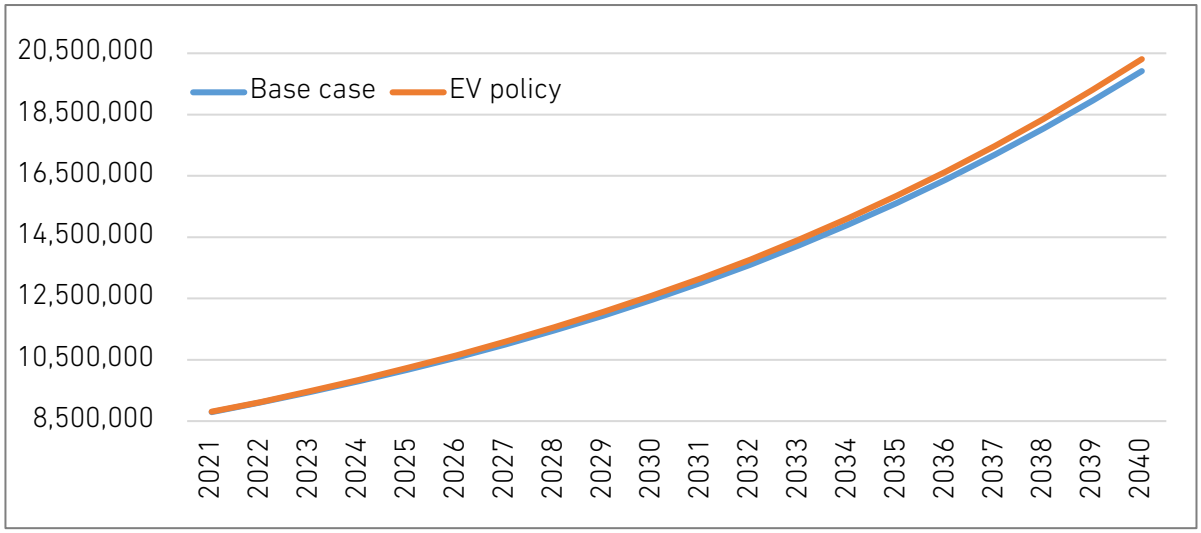
As shown and discussed in Section 4.2.1, the CGE model forecasted that the economy of Thailand would benefit from the EV policy. Main macro indicators identify the expansion of GDP and employment. Based on these results, this section further examines the details of impacts of the aggregate household. As displayed in Figure 4.28, the income of the aggregate household will continuously increase. In particular, as shown in Figures 4.29 and 4.30, the income from both capital and wages will rise. This change is the outcome of the expanding economy. Notably, the percentage change on capital is greater than that of wage. This disparity creates concerns, and its impact on income inequality should be investigated.

Figure 4.28. Impact of the Electric Vehicle Policy on Aggregate Household Income
(million baht at 2021 prices)



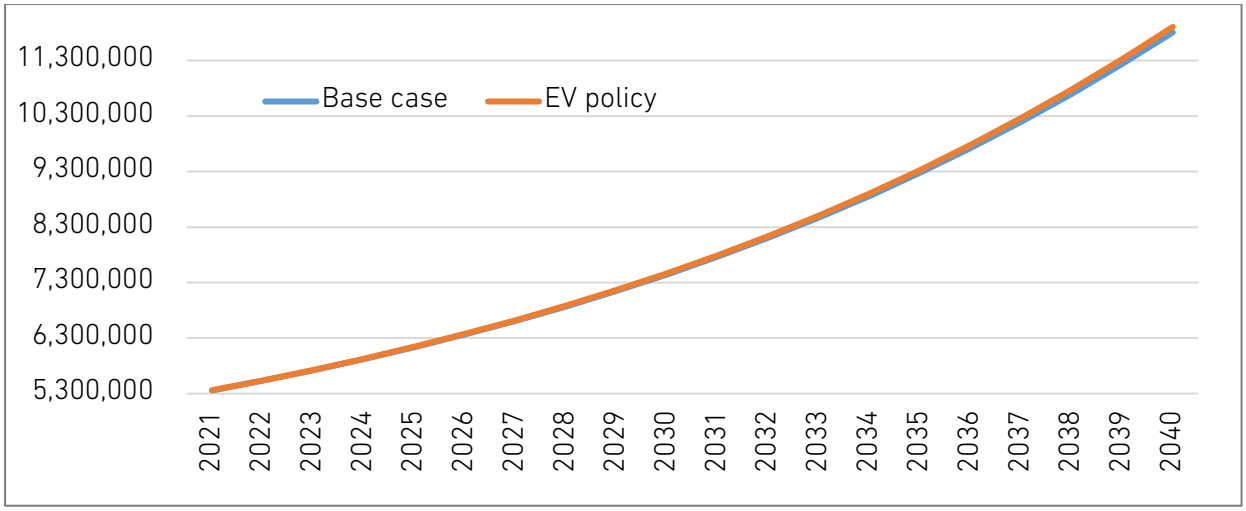
EV = electric vehicle.
Note: Numerical results are shown in Table A.12.
Source: Author's calculation.

Figure 4.29. Impact of the Electric Vehicle Policy on Aggregate Household Income from Capital
(million baht at 2021 prices)



EV = electric vehicle.
Note: Numerical results are shown in Table A.13.
Source: Author's calculation.

Figure 4.30. Impact of the Electric Vehicle Policy on Aggregate Household Income from Wages
(million baht at 2021 prices)



EV = electric vehicle.
Note: Numerical results are shown in Table A.14.
Source: Author's calculation.

In addition to the increment of income, the structure of production is shaped by the varied characteristics of the changes in consumption patterns. Table 4.10 lists the changes in consumption share. Goods and services with the highest and lowest changes in consumption are shown in Figures 4.31 and 4.32. Influenced by the EV policy, the changes in purchases of EV cars and related services are amongst the highest increment, while fossil fuels and related activities are ranked the lowest. Since this model allows for the implementation of solar rooftops as the alternative energy source, the aggregate household also increases the share of this new electricity supply.

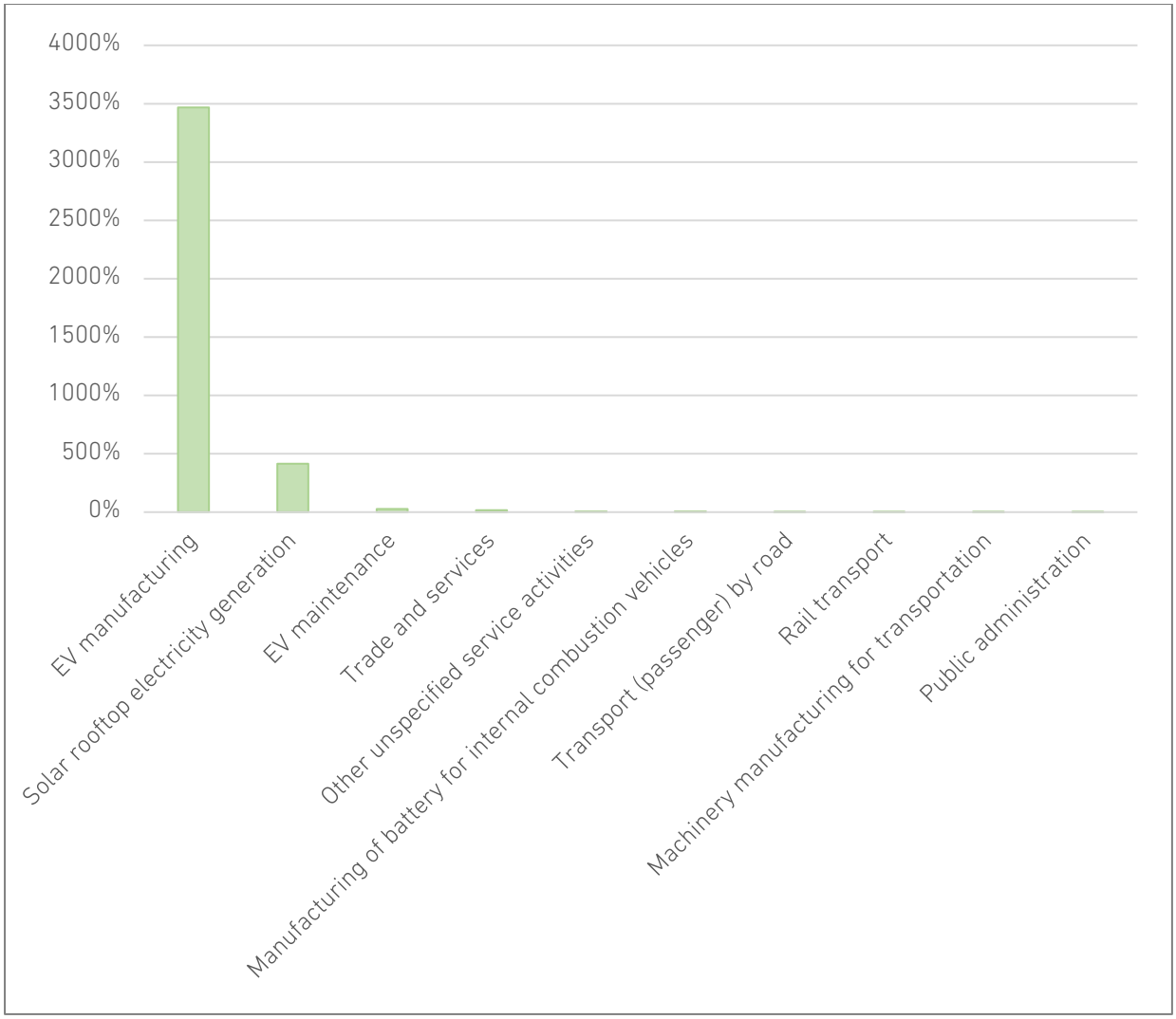
The new consumption pattern corresponds to the change in the sectoral production shown in Section 4.2.2. Hence, the simulation result from CGE model indicates that the EV policy can generate impacts on the structure of both supply and demand. This simulation outcome also suggests the related policies which should support the economy-wide adjustment.

Table 4.10. Change in Household Consumption
(% from base case)

Abbreviation	Description	Average
AGR	Agriculture, forestry, and fisheries	1.0
AIR	Air freight	0.9
BAT	Manufacturing of batteries for internal combustion vehicles	5.4
BUS	Business and financial services	1.5
CAS	Cassava planting	1.3
CHM	Chemicals paper and textiles	1.8
COM	Telecommunications	1.5
DIE	Diesel	-62.2
ELE	Electricity	0.3
EV-MAIN	EV maintenance	26.4
EV-PROD	EV manufacturing	3466.5
FOD	Food and beverage manufacturing	1.4
ICE-PROD	Internal combustion vehicle manufacturing	-22.7
LDS	Land service	1.3
LGS	Logistics services	1.6
MHE	Machinery and electrical equipment	1.9
MNM	Metals and non-metals manufacturing	2.0
OCW	Water transportation coastal and sea	1.3
OMF	Other industries	1.8
OPM	Oil palm plantation	1.6
OPR	Lubricants and other petroleum	1.4
PNG	Petroleum and natural gas	-72.6
PRO	Solar rooftop electricity generation	414.8
PUB	Public administration	2.0
RAI	Rail transport	2.2
RDF	Transport (cargo) by road	1.8
RDP	Transport (passenger) by road	2.3
SGC	Sugarcane planting	1.1
SUG	Sugar production	1.3
TRD	Trade and services	16.6
TRI	Machinery manufacturing for transportation	2.0
TRM	Maintenance of internal combustion vehicles	1.6
UNC	Other unspecified service activities	5.7
WSP	Construction and waterworks	1.6

EV = electric vehicle.
Source: Author's calculation.

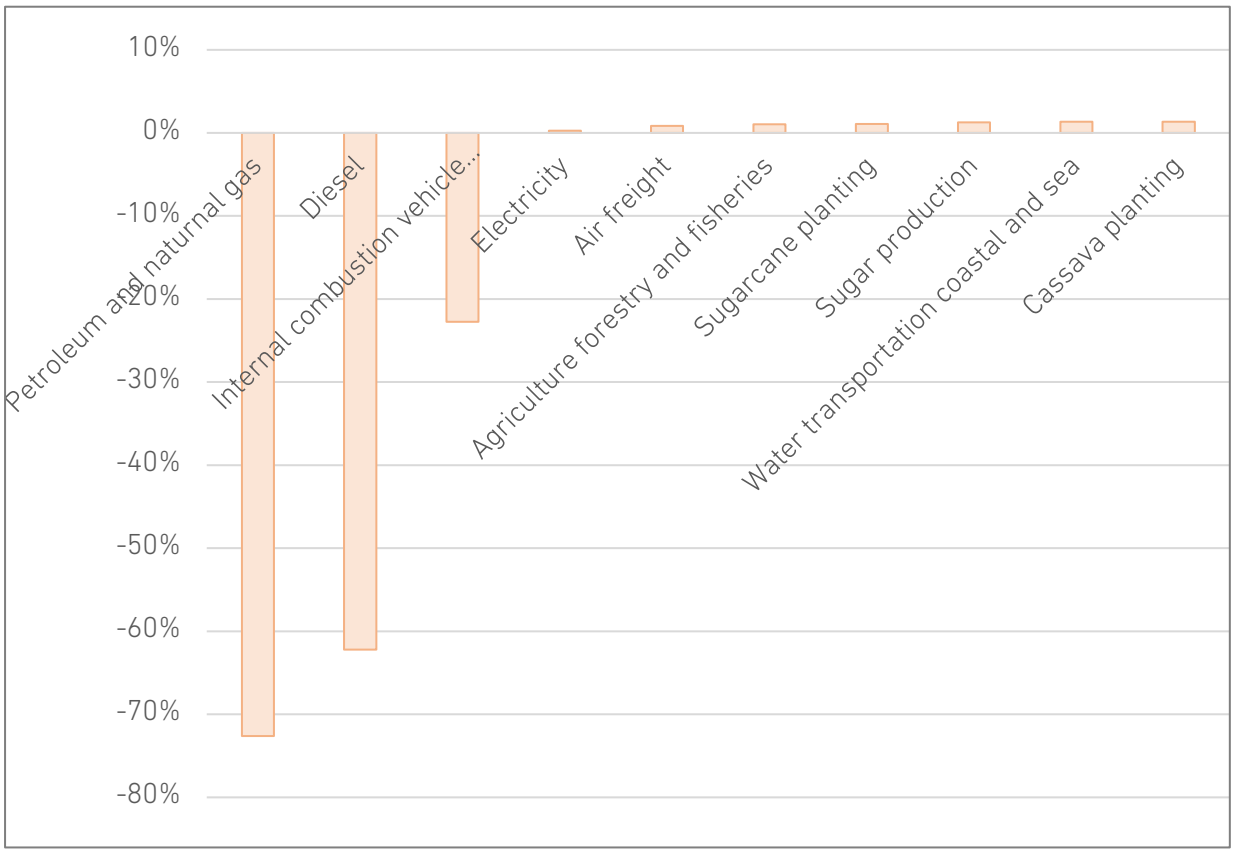
Figure 4.31. Top Ten Goods and Services with the Highest Increment in the Consumption Basket
(%)



EV = electric vehicle.
Source: Author's calculation.

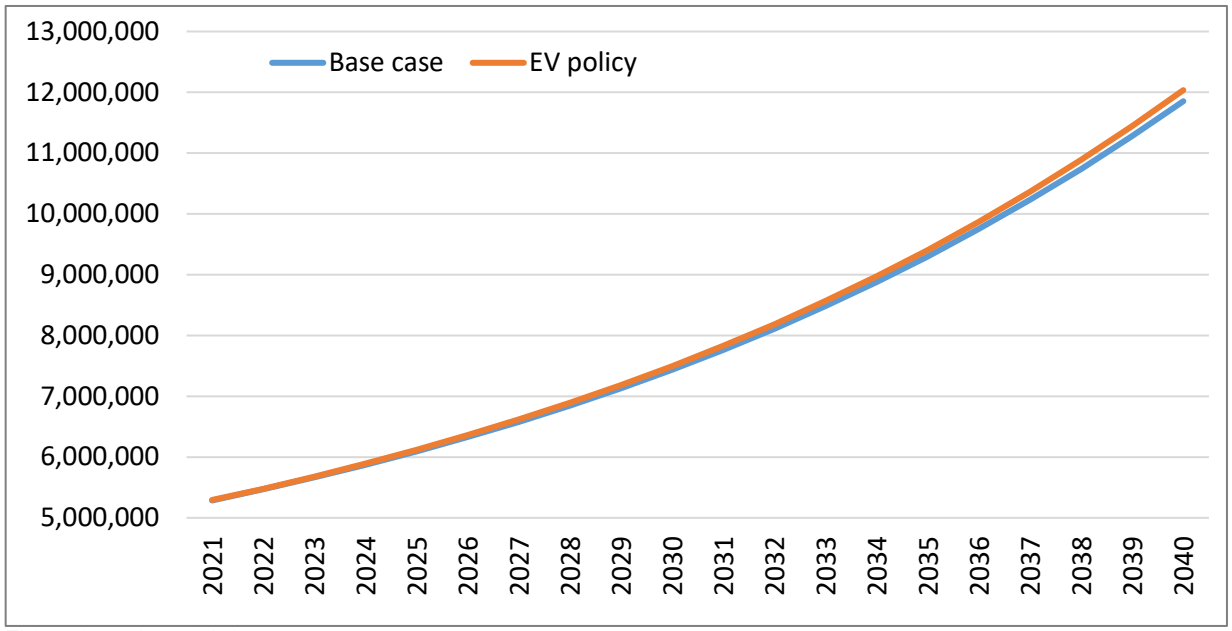
Figure 4.32. Top Ten Goods and Services with the Lowest Increment in the Consumption Basket

(%)



Source: Author's calculation.

Figure 4.33. Impact of the Electric Vehicle Policy on Aggregate Household Saving
(million baht at 2021 price)



EV = electric vehicle.
Note: Numerical results are shown in Table A.15.
Source: Author's calculation.

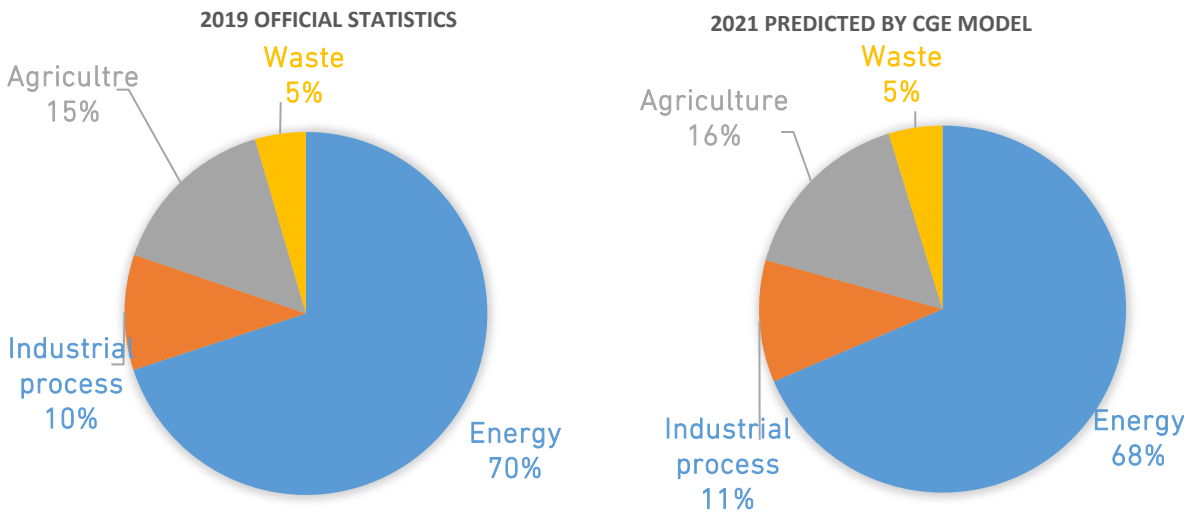
The changes in income and consumption patterns of aggregate household will ultimately affect saving. As indicated by Figure 4.33, the EV policy will consistently increase the saving of aggregate household. This outcome is a combination of increasing income and altered consumption basket.

4.2.5. Impacts of Greenhouse Gas Emissions

The developed CGE model includes the ability to estimate GHGs emissions. With details of fossil-based intermediate goods and sources of energy for each production activity, the simulation results can quantify the amount of GHGs emissions categorised by specific fuel or activity.

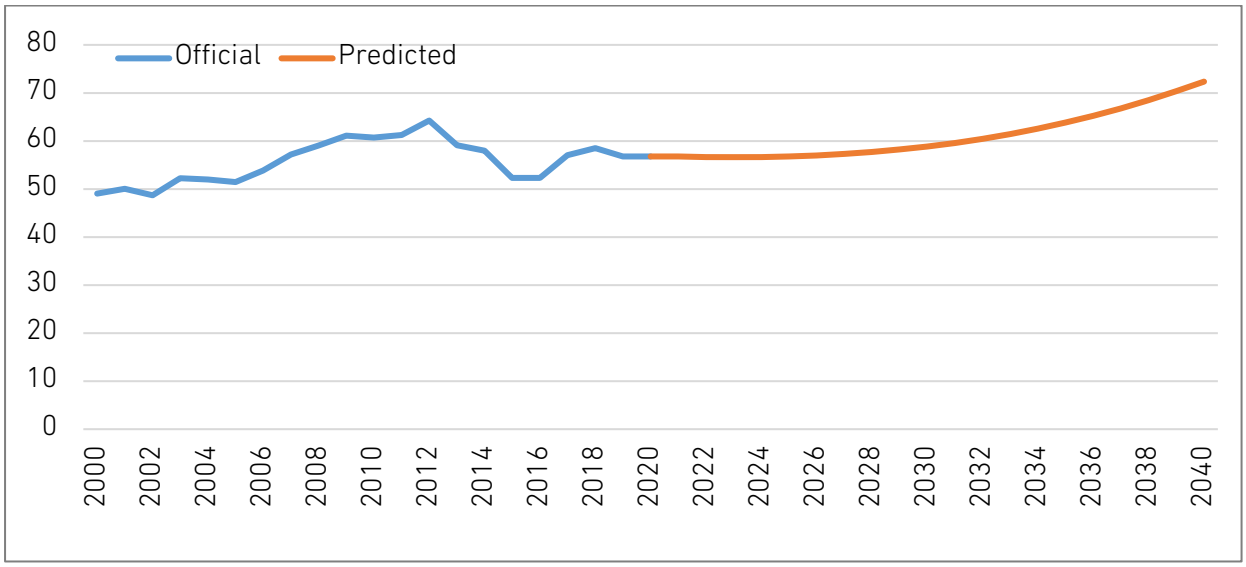
Figure 4.34 compares the GHG emission classified by activity between the simulation results and the official statistics. This comparison shows that the CGE model can closely replicate the structure of GHG emissions in Thailand. Additionally, Figures 4.35–4.38 illustrate the predicted paths of GHG emissions for each activity. This forecast of base case scenario indicates that without an emission reduction policy, emissions will grow continuously.

Figure 4.34. Greenhouse Gas Emissions Classified by Activity



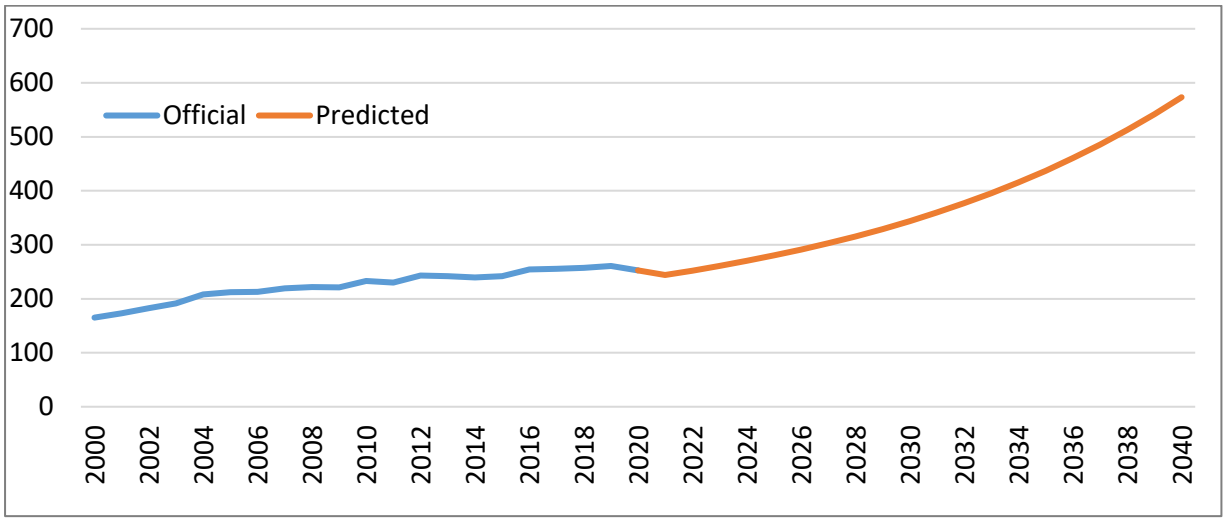
CGE = computable general equilibrium.
Source: Thailand Greenhouse Gas Management Organization and model's prediction.

Figure 4.35. Greenhouse Gas Emissions from Agriculture (Base Case)
(million tonnes CO_2 equivalent)



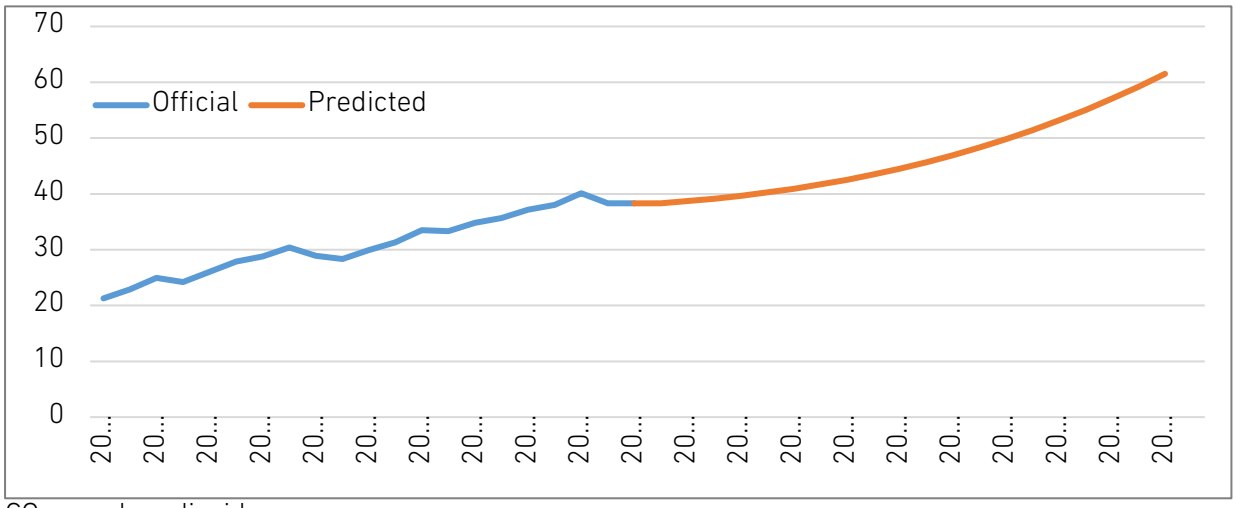
CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

Figure 4.36. Greenhouse Gas Emissions from Energy (Base Case)
(million tonnes CO_2 equivalent)



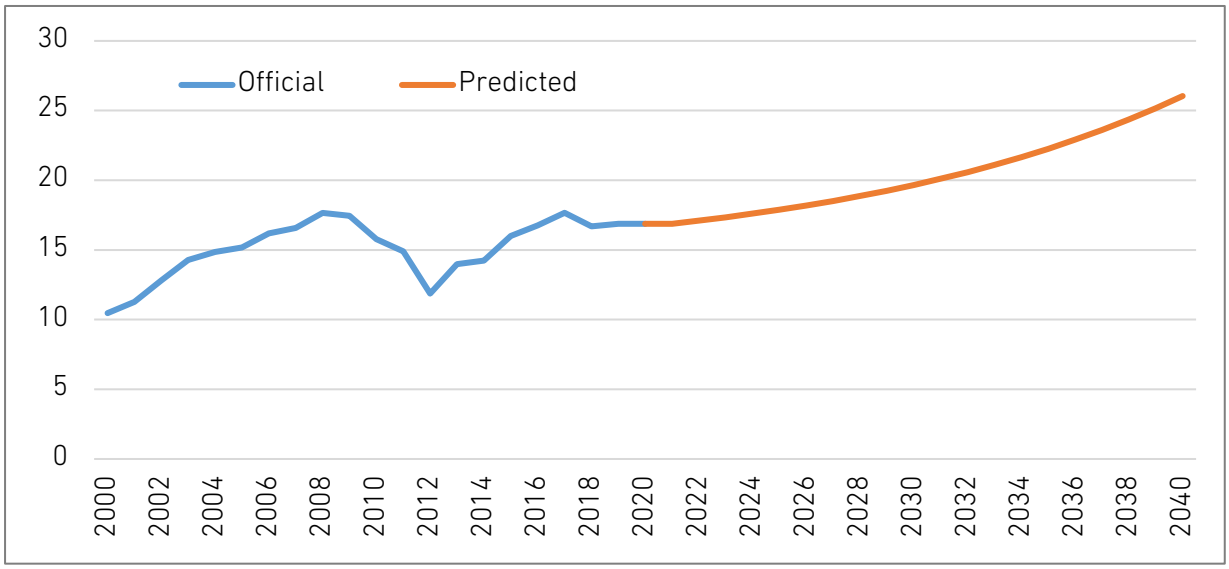
CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

Figure 4.37. Greenhouse Gas Emissions from Industrial Processes (Base Case)
(million tonnes CO_2 equivalent)



CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

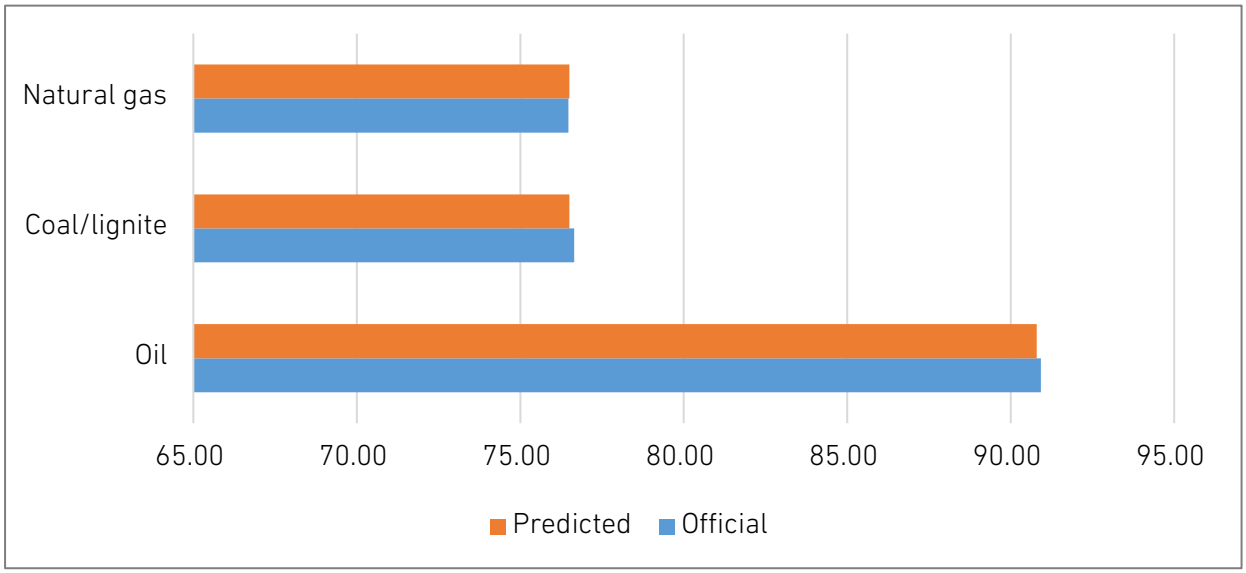
Figure 4.38. Greenhouse Gas Emissions from Waste (Base Case)
(million tonnes CO_2 equivalent)



CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

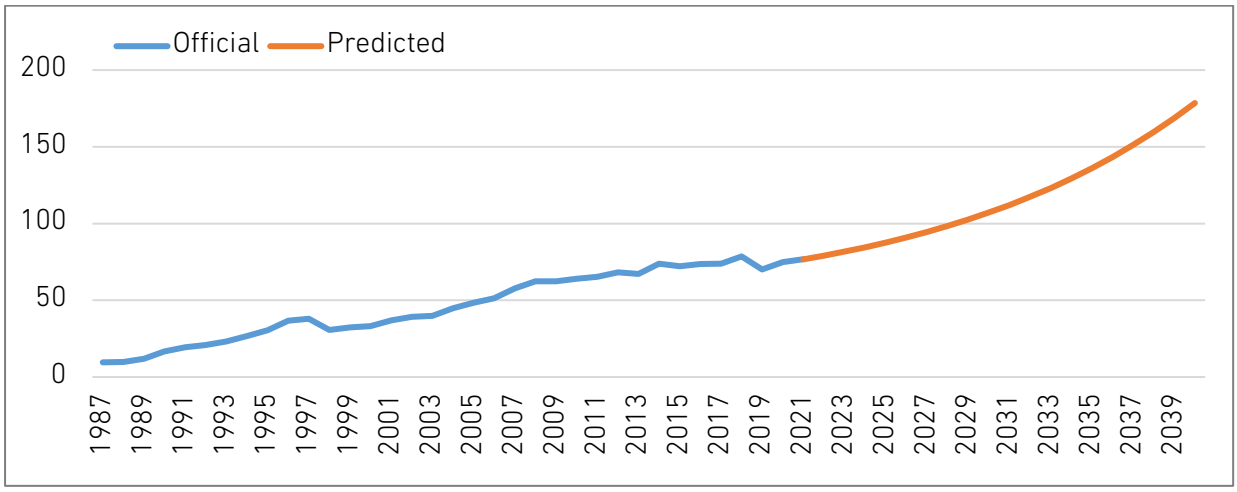
Figures 4.39–4.42 show the specific emission paths in the energy sector. Figure 4.39 shows the predictive performance of the CGE model, which can replicate the emission close to the official statistics for each fuel. Figures 4.40–4.42 illustrate the paths of each fossil fuel, driven by the economic growth of the base case scenario.

Figure 4.39. Greenhouse Gas Emissions from Main Energy Sources in 2021
(million tonnes CO_2 equivalent)



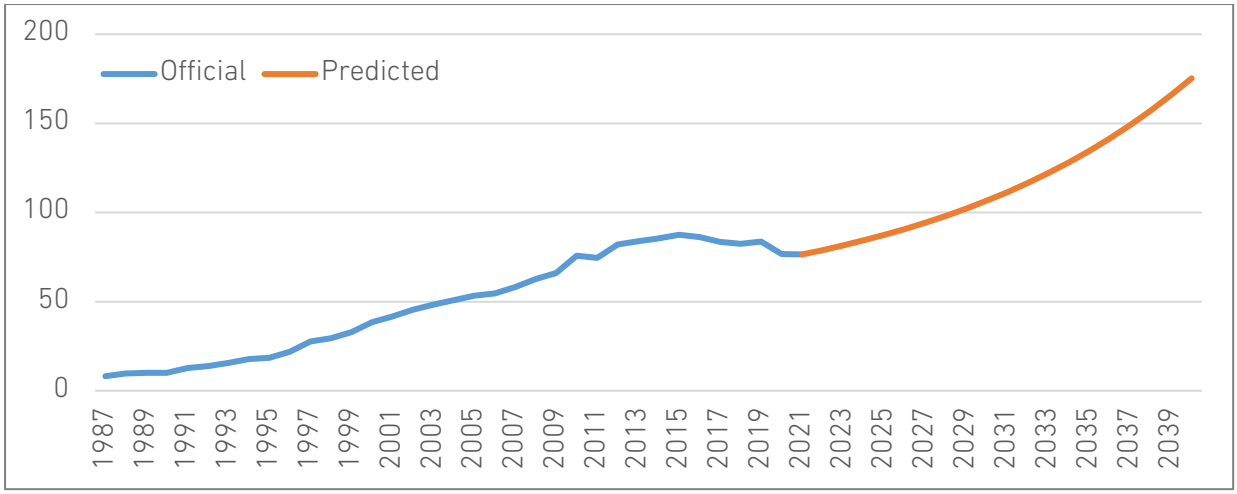
CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

Figure 4.40. Greenhouse Gas Emission from Coal (Base Case)
(million tonnes CO_2 equivalent)



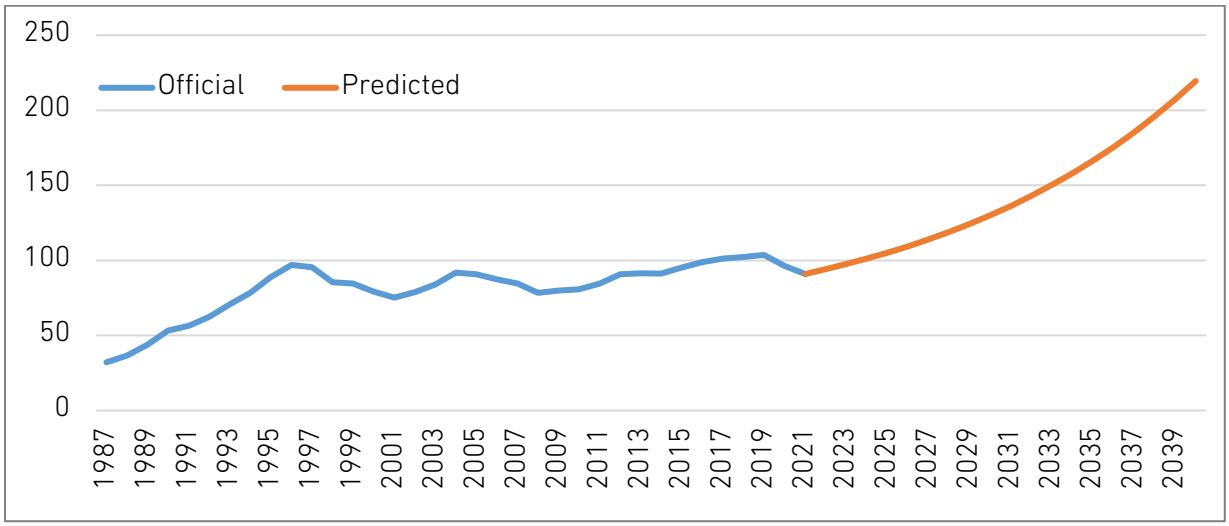
CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

Figure 4.41. Greenhouse Gas Emissions from Natural Gas (Base Case)
(million tonnes CO_2 equivalent)



CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

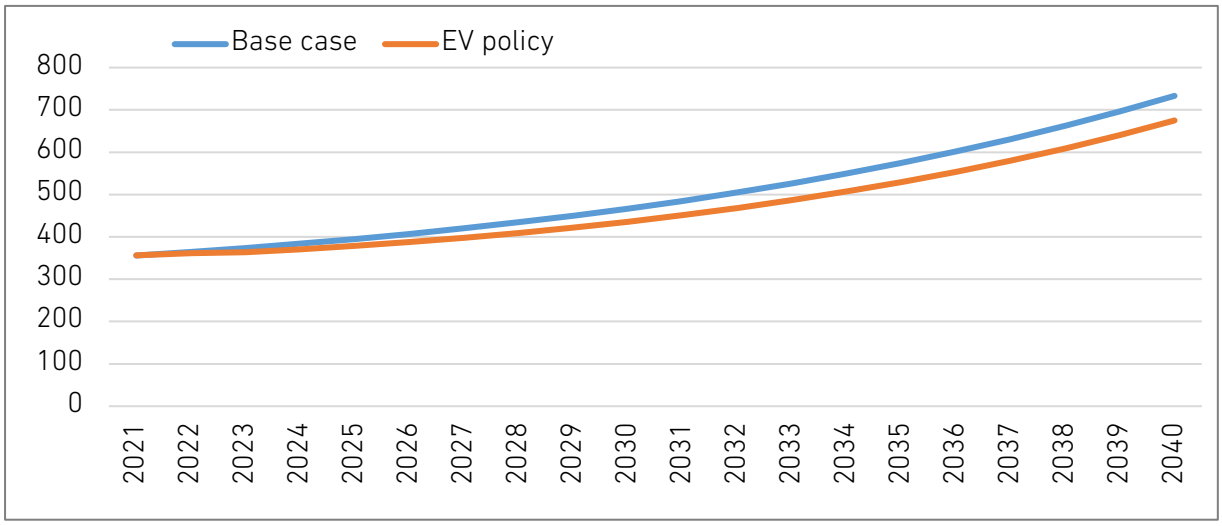
Figure 4.42. Greenhouse Gas Emissions from Oil (Base Case)
(million tonnes CO_2 equivalent)



CO_2 = carbon dioxide.
Source: Thailand Greenhouse Gas Management Organisation (for official statistics) and the model's prediction.

With the EV policy, the simulation outcome produced by the CGE model indicates the alternative path, which generates a lower amount of GHG emission. As shown in Figure 4.43 and Table 4.11, the expansion of EV production and utilisation can continuously reduce the GHG emission. Specifically, the reduction will reach approximately 8% during the period 2035–2040. This simulation result suggests that EV policy will lower GHG emissions through both direct and indirect effects. This prediction is in line with international experience, as documented by Wu, Zhou, and Gohlke (2024), Xu et al. (2021), Plötz et al. (2021), Bahamonde-Birke (2020), Fritz, Plötz and Funke (2019), Bellocchi et al. (2018), Teixeira and Sodré (2018), Falcão, Teixeira, and Sondré (2017), Mishina and Muromachi (2017) and McLaren et al. (2016).

Figure 4.43. The Impacts of The Electric Vehicle Policy on Greenhouse Gas Emissions
(million tonnes CO_2 equivalent)



CO_2 = carbon dioxide; EV = electric vehicle.
Source: Author's calculation.

Table 4.11. The Impact of The Electric Vehicle Policy on Total Greenhouse Gas Emissions
(million tonnes CO_2 equivalent)

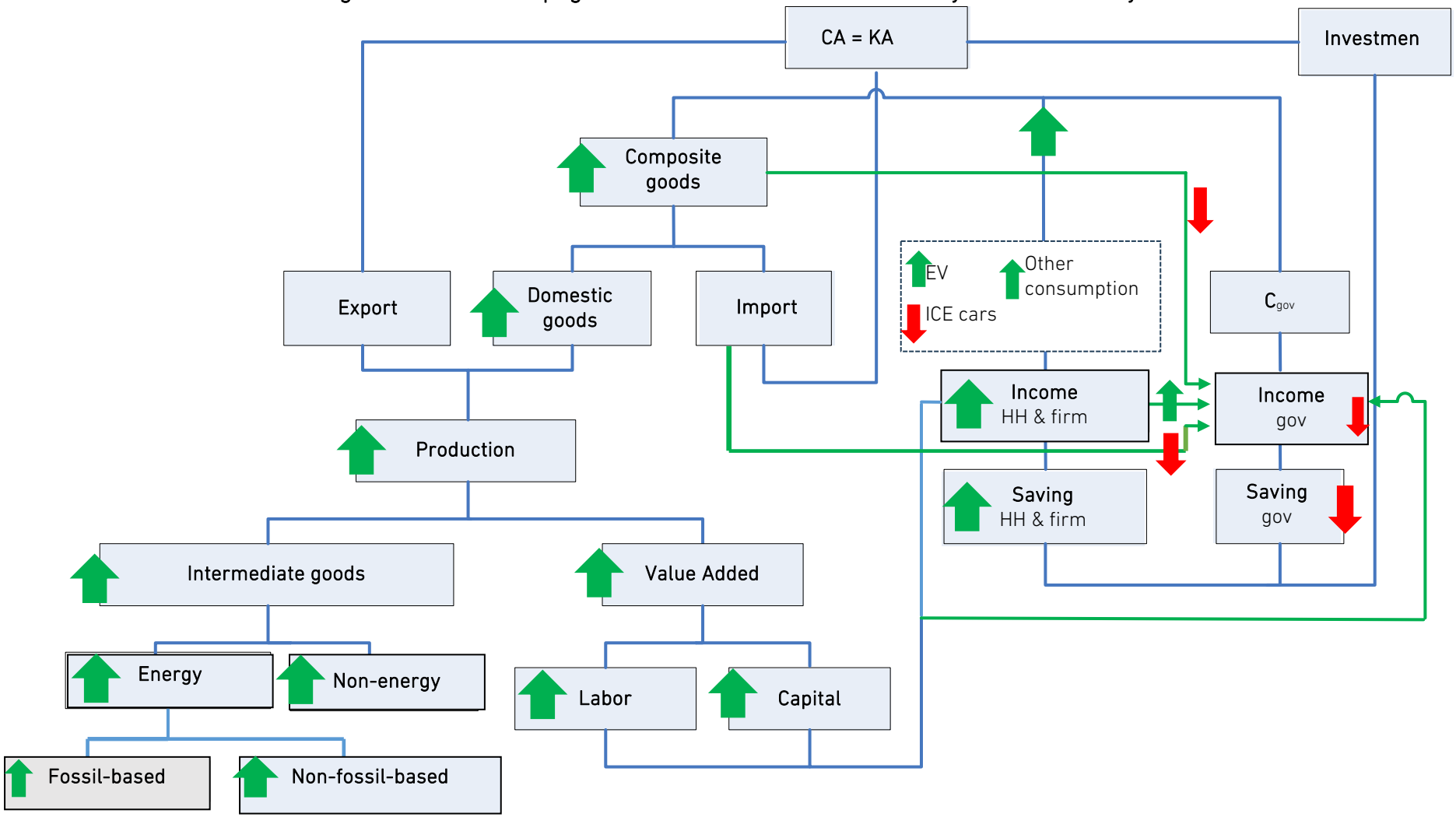
Year	Base case	EV policy	Change (%)
2021	355.98	356.42	0.12
2022	364.53	361.13	-0.93
2023	373.85	363.73	-2.71
2024	384.00	370.78	-3.44
2025	395.06	378.82	-4.11
2026	407.10	387.89	-4.72
2027	420.20	398.08	-5.26
2028	434.45	409.40	-5.77
2029	449.93	421.96	-6.22
2030	466.75	435.90	-6.61
2031	485.00	451.30	-6.95
2032	504.79	468.24	-7.24
2033	526.24	486.85	-7.48
2034	549.45	507.19	-7.69
2035	574.56	529.45	-7.85
2036	601.69	553.70	-7.98
2037	630.97	580.13	-8.06
2038	662.55	608.96	-8.09
2039	696.56	640.36	-8.07
2040	733.16	675.08	-7.92

CO_2 = carbon dioxide; EV = electric vehicle.
Source: Author's calculation.

4.3. Discussion and Policy Recommendations

This study applied the CGE model to explore the economy-wide impacts of implementing the EV policy. The simulation results indicated that the targeted production of EV (i.e., 30@30 scheme), along with switching consumption patterns of household toward more utilisation of EV, can lead to positive impacts on GDP, household income, household saving, total employment, and the reduction of GHG emissions. Also, the production sectors related to EV production and solar rooftops can produce the highest expansion. Figure 4.44 illustrates this economy-wide transmission mechanism.

Figure 4.44. The Propagation of The Electric Vehicle Policy in the Economy

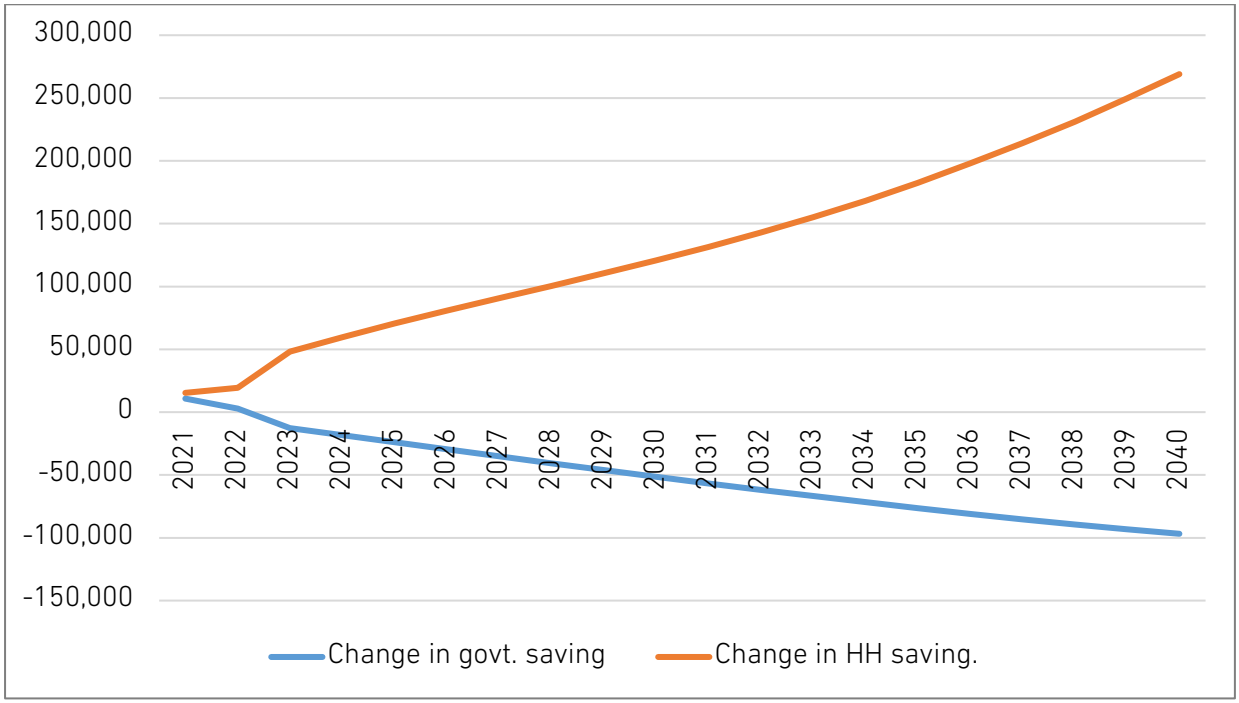


CA = current account; KA = capital account; Cgov = government consumption; EV = electric vehicle; Gov = government; HH = aggregate household; ICE = internal combustion engine.
Source: Author's calculation.

However, even though the simulation outcome indicated the net positive impacts on GDP, this policy can yield a negative impact on the current account, inflation, fiscal balance, and production activities related to ICE vehicles, biofuels, and fossil fuels.

Notably, as previously discussed in Sections 4.2.3 and 4.2.4, the impacts on household and fiscal status are opposite. Figure 4.45 reflects this serious concern, showing that the aggregate household can continuously create more savings, while the fiscal status (i.e., government saving) will be incrementally worsening. This result clearly identifies the future violation of some fiscal indicators as listed in Section 2.3.

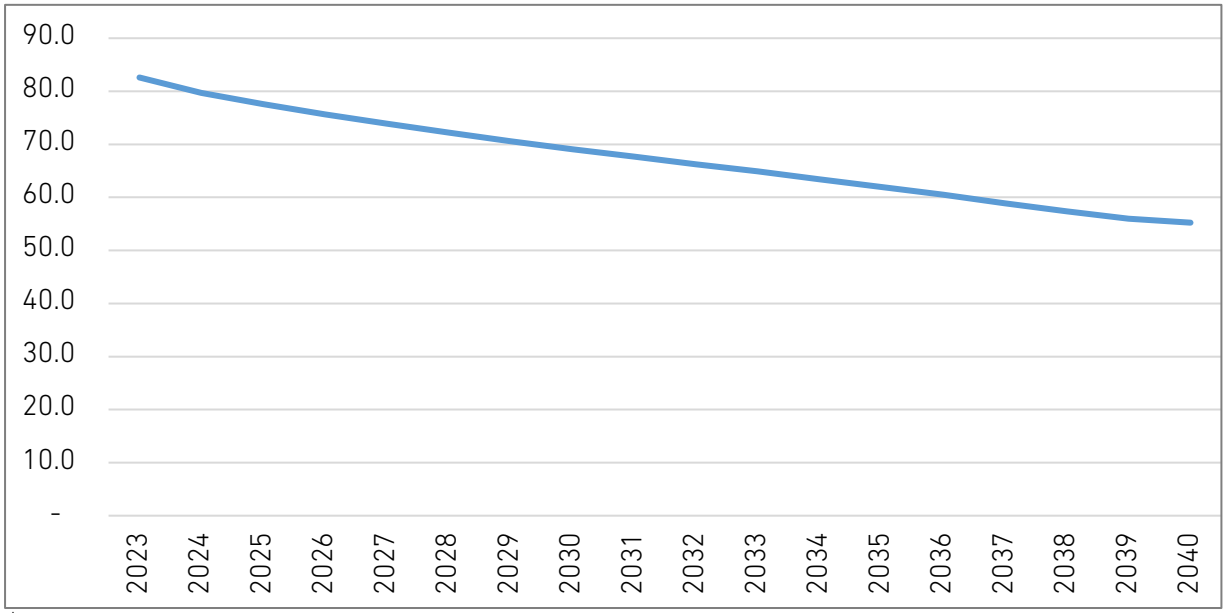
Figure 4.45. Impacts on The Savings of Government and Aggregate Household
(million baht)



Govt = government; HH = aggregate household.
Source: Author's calculation.

The implication of EV policy can lead to the reduction of GHG. By computing the ratio of additional fiscal deficit per additional GHG reduction, Figure 4.46 illustrates the equivalent cost of GHG reduction (adjusted by CPI). It shows that this deflated cost will be $82.60 in 2023 and will steadily decline to $55.20 in 2040. This value will be a very useful criterion for policy evaluation. This result suggests that the reduction in GHG emissions will place a substantial financial burden on the government, leading to a consistent increase in the budget deficit as shown in Figure 4.46.

Figure 4.46. The Ratio of Greenhouse Gas Reduction to Budget Deficit Change
($ per tonne CO_2 equivalent)



$ = US dollar; CO_2 = carbon dioxide.
Source: Author's calculation.

These key findings lead to the following policy recommendations.

1) With the future adjustment of production structure, the government should formulate policies supporting the restructure and reallocation of producers and labour working in the supply chains of ICE vehicles, biofuels, and fossil fuels. This impact mitigation scheme would reduce the negative impacts that might incur future economic and social consequences caused by production contraction and unemployment in the affected sectors.
2) Notably, the simulation result indicated the increasing import of EV batteries. This trend identified the insufficient capability of domestic production. Thus, the development and expansion of EV battery production should be supported.
3) New fiscal policies are required to manage fiscal sustainability. Additional revenues such as carbon tax and an annual EV ownership tax might be the new sources. These proposed taxes would reallocate some portion of the aggregate household savings to finance the budget deficit.
4) The equivalent cost of GHG reduction due to EV policy, as shown in Table 4, should be consistently updated and verified. It will be the crucial benchmark for evaluating the fiscal cost and environmental benefit of EV policy. It should also be compared internationally and domestically with alternative policy instruments (such as the carbon tax or the market price of carbon price).

4.4. Limitations

The limitations of this study are fourfold.

1) The sensitivity analysis of the elasticity of substitution between ICE and EV cars should be undertaken.
2) The changing behaviour of household triggered by EV policy should be additionally explored. Specifically, a sensitivity analysis of the elasticity parameters of the consumption basket should be conducted.
3) The production of ICE cars is an aggregate sector. The impact of EV policy on the supply chain of ICE car production can be enriched if this sector is disaggregated into detailed activities.
4) For future study, the other costs (such as the life cycle assessment of EV cars and batteries) should be incorporated to extend the coverage of the analysis.

5. Conclusion

This study developed a dynamic CGE model for examining the economy-wide impacts of implementing EV policy in Thailand. The constructed CGE model is based on a SAM table extended from the 2015 official Input-Output table. The model was calibrated to replicate the production and utilisation induced by the national EC promotion plan (30@30 policy). Following the national target for EV manufacturing to account for 30% of total car production by 2030, the simulation results showed that this policy will yield a net positive impact on the Thai economy.

Real GDP, total employment, total income, total household consumption, and the production of goods and services related to EV cars will all increase.

On the other hand, this policy will lead to an increasing fiscal deficit, influenced by the declining indirect tax and tariffs. In addition, production sectors related to ICE cars, biofuels, and fossil fuels will contract. To maintain fiscal sustainability, the government should restructure its revenues related to fossil fuels and seek new sources of income such as carbon tax or annual EV ownership tax.

The constructed CGE model incorporated the details of GHG emissions, showing that the EV policy will reduce the total emissions. However, this change is multidimensional. The fiscal deficit burdens the GHG reduction. This study showed that the cost of reducing one tonne of CO_2 is equivalent to a fiscal deficit of $55.20–$82.60. This key finding can be used as the criterion for policy evaluation.

Future studies should include a sensitivity analysis of elasticity parameters, especially the selection between ICE and EV cars. A similar test should also be undertaken to examine the sensitivity of a household's consumption basket after purchasing an EV car. Finally, the details of sectors related to ICE production should be enriched, allowing the investigation of impacts on the supply chain of automotive parts.

References

Bahamonde-Birke, F.J. (2020), 'Who Will Bell the Cat? On the Environmental and Sustainability Risks of Electric Vehicles', *Transportation Research Part A: Policy and Practice*, 133, pp.79–81. https://doi.org/10.1016/j.tra.2019.12.001

Bellocchi, S., M. Gambini, M. Manno, T. Stilo, and M. Vellini (2018),' Positive Interactions between Electric Vehicles and Renewable Energy Sources in CO2-Reduced Energy Scenarios: The Italian Case', *Energy*, 161, pp.172–82. https://doi.org/10.1016/j.energy.2018.07.068

Chen, Z., A.L. Carrel, C. Gore, and W. Shi (2021), 'Environmental and Economic Impact of Electric Vehicle Adoption in the U.S', *Environmental Research Letters*, 16(4), 045011. https://doi.org/10.1088/1748-9326/abe2d0

Decaluwé, B., A. Lemelin, V. Robichaud, and H. Maisonnave (2013), *PEP-1-t. Standard PEP Model: Single-Country, Recursive Dynamic Version*. Politique Économique et Pauvreté/Poverty and Economic Policy Network, Université Laval, Québec. https://www.pep-net.org/research-resources/cge-models

Falcão, E.A.M., A.C.R. Teixeira, and J.R. Sodré (2017), 'Analysis of CO2 Emissions and Techno-Economic Feasibility of an Electric Commercial Vehicle', *Applied Energy*, 193, pp.297-307. https://doi.org/10.1016/j.apenergy.2017.02.050

Fritz, M., P. Plötz, and S.A. Funke (2019), 'The Impact of Ambitious Fuel Economy Standards on the Market Uptake of Electric Vehicles and Specific CO2 Emissions. *Energy Policy'*, 135, 111006. https://doi.org/10.1016/j.enpol.2019.111006

Government of Thailand, Ministry of Energy. PowerPoint presentation delivered at https://policy.thinkbluedata.com/node/4350

Government of Thailand, Ministry of Finance. Statistics Database. https://www.fpo.go.th/main/Statistic-Database.aspx (accessed 15 March 2024)

Guo, N., X. Zhang, Y. Zou, G. Du, C. Wang, and L. Guo (2022), 'Predictive Energy Management of Plug-In Hybrid Electric Vehicles by Real-Time Optimization and Data-Driven Calibration', *IEEE Transactions on Vehicular Technology*, 71(6), pp.5677–89. https://doi.org/10.1109/TVT.2021.3138440

Guo, Z., T. Li, B. Shi, and H. Zhang (2022), 'Economic Impacts and Carbon Emissions of Electric Vehicles Roll-Out towards 2025 Goal of China: An Integrated Input–Output and Computable General Equilibrium Study', *Sustainable Production and Consumption*, 31, pp.165–74. https://doi.org/10.1016/j.spc.2022.02.009

Haputta, P., T. Bowonthumrongchai, N. Puttanapong, and S.H. Gheewala (2022), 'Effects of Biofuel Crop Expansion on Green Gross Domestic Product', *Sustainability*, 14(6), 3369. https://doi.org/10.3390/su14063369

Haputta, P., N. Puttanapong, T. Silalertruksa, A. Bangviwat, T. Prapaspongsa, and S.H. Gheewala (2020), 'Sustainability Analysis of Bioethanol Promotion in Thailand using a Cost–Benefit Approach', *Journal of Cleaner Production*, 251, 119756. https://doi.org/10.1016/j.jclepro.2019.119756

Kaenchan, P., N. Puttanapong, T. Bowonthumrongchai, K. Limskul, and S.H. Gheewala (2019), 'Macroeconomic Modeling for Assessing Sustainability of Bioethanol Production in Thailand', *Energy Policy*, 127, pp.361–73. https://doi.org/10.1016/j.enpol.2018.12.026

Lin, B. and W. Wu (2021), 'The Impact of Electric Vehicle Penetration: A Recursive Dynamic CGE Analysis of China', *Energy Economics*, 94, 105086. https://doi.org/10.1016/j.eneco.2020.105086

Lutsey, N., and M. Nicholas (2019), 'Update on Electric Vehicle Costs in the United States through 2030', *International Council on Clean Transportation Working Paper Series*, No. 6. Washington, D.C.: ICCT https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

Mauler, L., F. Duffner, W.G. Zeier, and J. Leker, (2021), 'Battery Cost Forecasting: A Review of Methods and Results with an Outlook to 2050', *Energy & Environmental Science*, 14, 4712–39. https://doi.org/10.1039/d1ee01530c

McLaren, J., J. Miller, E. O'Shaughnessy, E. Wood, and E. Shapiro (2016), 'CO2 Emissions Associated with Electric Vehicle Charging: The Impact of Electricity Generation Mix, Charging Infrastructure Availability, and Vehicle Type', *The Electricity Journal*, 29(5), pp.72–88. https://doi.org/10.1016/j.tej.2016.06.005

Mishina, Y. and Y. Muromachi (2017), 'Are Potential Reductions in CO2 Emissions via Hybrid Electric Vehicles Actualized in Real Traffic? *The Case of Japan*', *Transportation Research Part D: Transport and Environment*, 50, pp.372–84. https://doi.org/10.1016/j.trd.2016.11.019

Miyata, Y., H. Shibusawa, and T. Fujii (2018), 'Economic Impact of Subsidy Policies to Electric Vehicle Society in Society in Toyohashi City in Japan — A CGE-Modeling Approach', *The Singapore Economic Review*, 63(2), pp.409–29. https://doi.org/10.1142/S0217590817400185

Plötz, P., C. Moll, G. Bieker, and P. Mock (2021 'From Lab-to-Road: Real-World Fuel Consumption and CO2 Emissions of Plug-In Hybrid Electric Vehicles', *Environmental Research Letters*, 16(5), 054078. https://doi.org/10.1088/1748-9326/abef8c

Phomsoda, K., N. Puttanapong and M. Piantanakulchai (2021), 'Economic Impacts of Thailand's Biofuel Subsidy Reallocation Using a Dynamic Computable General Equilibrium (CGE) Model', *Energies*, 14(8), 2272. https://doi.org/10.3390/en14082272

Phomsoda, K., N. Puttanapong, and M. Piantanakulchai (2021), 'Assessing Economic Impacts of Thailand's Fiscal Reallocation between Biofuel Subsidy and Transportation Investment: Application of Recursive Dynamic General Equilibrium Model', *Energies*, 14(14), 4248. https://doi.org/10.3390/en14144248

Shibusawa, H. and Y. Miyata (2017), 'Evaluating the Economic Impacts of Hybrid and Electric Vehicles on Japan's Regional Economy: Input–Output Model Approach', in H. Shibusawa, K. Sakurai, T. Mizunoya, and S. Uchida (Eds.), *Socioeconomic Environmental Policies and Evaluations in Regional Science (Vol. 24). New Frontiers in Regional Science: Asian Perspectives.* Springer. https://doi.org/10.1007/978-981-10-0099-7_33

Suehiro, S. and A.J. Purwanto (eds.) (2020), *The Influence on Energy and the Economy of Electrified Vehicles Penetration in ASEAN.* Economic Research Institute for ASEAN and East Asia. Retrieved from https://www.eria.org/publications/the-influence-on-energy-and-the-economy-of-electrified-vehicle-penetration-in-asean/

Teixeira, A.C.R. and J.R. Sodré, (2018), 'Impacts of Replacement of Engine Powered Vehicles by Electric Vehicles on Energy Consumption and CO2 Emissions', *Transportation Research Part D: Transport and Environment*, 59, pp.375–84. https://doi.org/10.1016/j.trd.2018.01.004

United Nations Framework Convention on Climate Change (UNFCCC) (2022), *Thailand's Fourth National Communication*. Bangkok: Government of Thailand, Office of Natural Resources and Environmental Policy and Planning.

Wu, X., Y. Zhou, and D. Gohlke (2024), 'Adoption of Plug-in Electric Vehicles: Local Fuel Use and Greenhouse Gas Emissions Reductions across the U.S', Argonne National Laboratory, https://www.anl.gov/publications/adoption-of-plugin-electric-vehicles-local-fuel-use-and-greenhouse-gas-emissions-reductions-across-the-us

Xu, B., A. Sharif, M. Shahbaz, and K. Dong (2021), 'Have Electric Vehicles Effectively Addressed CO2 Emissions? Analysis of Eight Leading Countries using Quantile-on-Quantile Regression Approach', *Sustainable Production and Consumption*, 27, pp.1205–14. https://doi.org/10.1016/j.spc.2021.03.002

Appendix

Table A.1. Impact of the Electric Vehicle Policy on Gross Domestic Product

	GDP at Market Price (million baht)			Real GDP (million baht at 2021 prices)		
Year	Base Case	EV Policy	Diff (%)	Base Case	EV Policy	Diff (%)
2021	15,411,517.31	15,455,787.09	0.29	15,411,517.31	15,425,282.21	0.09
2022	16,048,405.73	16,104,320.45	0.35	15,879,133.79	15,906,153.02	0.17
2023	16,724,121.36	16,859,414.90	0.81	16,380,783.80	16,434,762.40	0.33
2024	17,442,496.62	17,607,994.42	0.95	16,919,242.39	16,983,500.43	0.38
2025	18,207,389.45	18,401,810.86	1.07	17,497,485.28	17,571,587.67	0.42
2026	19,022,841.94	19,244,200.39	1.16	18,118,701.13	18,202,194.35	0.46
2027	19,893,096.37	20,140,198.33	1.24	18,786,303.91	18,879,310.45	0.50
2028	20,822,635.06	21,095,582.53	1.31	19,503,938.50	19,607,377.95	0.53
2029	21,816,197.61	22,115,385.70	1.37	20,275,482.96	20,390,838.22	0.57
2030	22,878,794.66	23,205,360.29	1.43	21,105,046.78	21,234,401.90	0.61
2031	24,015,713.61	24,370,619.25	1.48	21,996,965.24	22,142,746.42	0.66
2032	25,232,519.38	25,617,852.43	1.53	22,955,789.54	23,120,930.66	0.72
2033	26,535,049.84	26,953,212.95	1.58	23,986,272.70	24,174,803.42	0.79
2034	27,929,406.68	28,383,381.65	1.63	25,093,351.23	25,308,374.71	0.86
2035	29,421,942.06	29,914,822.34	1.68	26,282,122.42	26,528,379.23	0.94
2036	31,019,241.44	31,554,122.39	1.72	27,557,817.89	27,839,073.78	1.02
2037	32,728,103.23	33,306,997.66	1.77	28,925,773.50	29,246,725.06	1.11
2038	34,555,515.87	35,182,130.86	1.81	30,391,396.47	30,758,107.95	1.21
2039	36,508,633.13	37,186,743.11	1.86	31,960,130.48	32,379,165.40	1.31
2040	38,594,748.34	39,326,950.55	1.90	33,637,419.69	34,115,306.34	1.42

EV = electric vehicle; GDP = gross domestic product.
Note: Figure 4.14 shows the graphical representation of these results.
Source: Author's calculation.

Table A.2. Impact of the Electric Vehicle Policy on Total Private Consumption

	Private Consumption at Market Price (million baht)			Real Private Consumption (million baht at 2021 prices)		
Year	Base Case	EV policy	Diff (%)	Base Case	EV Policy	Diff (%)
2021	7,843,620.74	7,866,404.48	0.29	7,843,620.74	7,855,296.60	0.15
2022	8,169,162.87	8,198,063.93	0.35	8,117,056.25	8,124,468.39	0.09
2023	8,514,224.66	8,585,740.47	0.84	8,406,840.68	8,427,449.31	0.25
2024	8,880,761.95	8,969,095.60	0.99	8,714,580.81	8,743,490.87	0.33
2025	9,270,740.49	9,375,323.36	1.13	9,041,960.38	9,079,728.99	0.42
2026	9,686,210.44	9,806,049.66	1.24	9,390,705.63	9,437,497.06	0.50
2027	10,129,317.49	10,263,792.70	1.33	9,762,596.90	9,818,548.53	0.57
2028	10,602,323.00	10,751,481.05	1.41	10,159,467.54	10,225,023.29	0.65
2029	11,107,613.22	11,271,620.73	1.48	10,583,205.05	10,658,858.35	0.71
2030	11,647,706.15	11,827,111.49	1.54	11,035,748.14	11,122,253.67	0.78
2031	12,225,254.33	12,420,481.89	1.60	11,519,081.03	11,617,190.10	0.85
2032	12,843,044.88	13,055,141.09	1.65	12,035,224.35	12,146,107.71	0.92
2033	13,503,996.76	13,734,100.76	1.70	12,586,222.97	12,711,072.67	0.99
2034	14,211,155.60	14,460,877.34	1.76	13,174,131.02	13,314,811.85	1.07
2035	14,967,686.32	15,238,550.70	1.81	13,800,994.74	13,959,074.81	1.15
2036	15,776,863.77	16,070,540.56	1.86	14,468,833.45	14,646,299.17	1.23
2037	16,642,061.73	16,959,516.42	1.91	15,179,619.59	15,377,821.27	1.31
2038	17,566,740.60	17,909,811.60	1.95	15,935,258.41	16,156,168.24	1.39
2039	18,554,434.15	18,924,975.93	2.00	16,737,568.15	16,983,057.87	1.47
2040	19,608,735.83	20,007,927.39	2.04	17,588,261.66	17,858,767.14	1.54

EV = electric vehicle.
Note: Figure 4.15 shows the graphical representation of these results.
Source: Author's calculation.

Table A.3. Impact of the Electric Vehicle Policy on Gross Fixed Capital Formation

	Gross Fixed Capital Formation at Market Price (million baht)			Real Gross Fixed Capital Formation (million baht at 2021 prices)		
Year	Base Case	EV Policy	Diff (%)	Base Case	EV Policy	Diff (%)
2021	3,840,172.65	3,923,257.03	2.16	3,840,172.65	3,909,145.50	1.80%
2022	4,018,472.66	4,104,001.99	2.13	3,996,468.40	4,094,657.25	2.46%
2023	4,211,536.75	4,299,725.03	2.09	4,167,867.02	4,273,735.29	2.54%
2024	4,421,187.85	4,512,684.08	2.07	4,355,823.85	4,467,507.73	2.56%
2025	4,649,224.19	4,744,343.07	2.05	4,561,872.96	4,679,599.98	2.58
2026	4,897,534.72	4,996,564.34	2.02	4,787,680.76	4,911,175.00	2.58
2027	5,168,103.53	5,271,304.67	2.00	5,035,051.41	5,164,914.12	2.58
2028	5,463,034.76	5,570,591.04	1.97	5,305,937.22	5,442,810.83	2.58
2029	5,784,561.64	5,896,663.95	1.94	5,602,441.92	5,747,137.00	2.58
2030	6,135,054.25	6,251,888.79	1.90	5,926,822.73	6,080,172.22	2.59
2031	6,517,022.54	6,638,764.92	1.87	6,281,490.12	6,443,852.37	2.58
2032	6,933,116.73	7,059,940.50	1.83	6,669,005.98	6,841,238.09	2.58
2033	7,386,124.82	7,518,209.99	1.79	7,092,079.88	7,275,400.40	2.58
2034	7,878,967.77	8,016,503.77	1.75	7,553,563.53	7,748,460.29	2.58
2035	8,414,692.33	8,557,878.68	1.70	8,056,443.35	8,264,135.79	2.58
2036	8,996,461.89	9,145,508.52	1.66	8,603,831.15	8,824,690.43	2.57
2037	9,627,545.66	9,782,726.69	1.61	9,198,953.10	9,434,317.18	2.56
2038	10,311,306.38	10,472,822.52	1.57	9,845,137.19	10,096,362.24	2.55
2039	11,051,187.01	11,219,267.21	1.52	10,545,799.37	10,814,396.50	2.55
2040	11,850,696.89	12,025,601.84	1.48	11,304,428.80	11,592,252.99	2.55

EV = electric vehicle.

Note: Figure 4.16 shows the graphical representation of these results.

Source: Author's calculation.

Table A.4. Impact of the Electric Vehicle Policy on Total Exports
(million baht)

	Total Exports		
Year	Base Case	EV Policy	Diff (%)
2021	9,329,456.26	9,318,533.46	-0.12
2022	9,731,741.71	9,704,856.97	-0.28
2023	10,162,906.37	10,107,793.09	-0.54
2024	10,624,776.99	10,554,188.55	-0.66
2025	11,119,437.08	11,033,059.14	-0.78
2026	11,649,185.10	11,547,167.30	-0.88
2027	12,216,554.02	12,099,125.31	-0.96
2028	12,824,311.46	12,691,816.69	-1.03
2029	13,475,465.36	13,328,618.34	-1.09
2030	14,173,267.14	14,012,912.84	-1.13
2031	14,921,215.05	14,748,496.92	-1.16
2032	15,723,056.92	15,539,065.98	-1.17
2033	16,582,792.35	16,389,019.56	-1.17
2034	17,504,674.40	17,302,166.81	-1.16
2035	18,493,210.69	18,283,586.13	-1.13
2036	19,553,163.95	19,337,613.82	-1.10
2037	20,689,552.23	20,469,957.61	-1.06
2038	21,907,648.75	21,685,796.35	-1.01
2039	23,212,981.89	22,990,846.35	-0.96
2040	24,611,335.26	24,391,498.20	-0.89

EV = electric vehicle.
Note: Figure 4.17 shows the graphical representation of these results.
Source: Author's calculation.

Table A.5. Impact of the Electric Vehicle Policy on Total Imports
(million baht)

	Total Imports (million baht)		
Year	Base Case	EV Policy	Diff (%)
2021	7,680,707.86	7,727,040.12	0.60
2022	8,000,555.88	8,038,089.73	0.47
2023	8,345,161.26	8,344,873.52	0.00
2024	8,716,144.63	8,698,143.91	-0.21
2025	9,115,373.09	9,079,992.43	-0.39
2026	9,544,917.92	9,493,184.02	-0.54
2027	10,007,073.48	9,939,705.07	-0.67
2028	10,504,356.89	10,421,822.10	-0.79
2029	11,039,513.06	10,942,476.88	-0.88
2030	11,615,517.22	11,504,488.49	-0.96
2031	12,235,577.64	12,111,501.96	-1.01
2032	12,903,137.64	12,766,464.81	-1.06
2033	13,621,877.10	13,473,374.13	-1.09
2034	14,395,713.39	14,235,420.84	-1.11
2035	15,228,801.63	15,057,371.29	-1.13
2036	16,125,534.44	15,943,196.82	-1.13
2037	17,090,541.24	16,898,415.18	-1.12
2038	18,128,687.22	17,927,409.75	-1.11
2039	19,245,072.28	19,035,444.33	-1.09
2040	20,445,030.17	20,228,659.56	-1.06

EV = electric vehicle.
Note: Figure 4.18 shows the graphical representation of these results.
Source: Author's calculation.

Table A.6. Impact of the Electric Vehicle Policy on Net Current Account Balance

	Net Current Account (million baht)		
Year	Base Case	EV Policy	Diff (%)
2021	7,680,707.86	7,727,040.12	0.60
2022	8,000,555.88	8,038,089.73	0.47
2023	8,345,161.26	8,344,873.52	0.00
2024	8,716,144.63	8,698,143.91	-0.21
2025	9,115,373.09	9,079,992.43	-0.39
2026	9,544,917.92	9,493,184.02	-0.54
2027	10,007,073.48	9,939,705.07	-0.67
2028	10,504,356.89	10,421,822.10	-0.79
2029	11,039,513.06	10,942,476.88	-0.88
2030	11,615,517.22	11,504,488.49	-0.96
2031	12,235,577.64	12,111,501.96	-1.01
2032	12,903,137.64	12,766,464.81	-1.06
2033	13,621,877.10	13,473,374.13	-1.09
2034	14,395,713.39	14,235,420.84	-1.11
2035	15,228,801.63	15,057,371.29	-1.13
2036	16,125,534.44	15,943,196.82	-1.13
2037	17,090,541.24	16,898,415.18	-1.12
2038	18,128,687.22	17,927,409.75	-1.11
2039	19,245,072.28	19,035,444.33	-1.09
2040	20,445,030.17	20,228,659.56	-1.06

EV = electric vehicle.
Note: Figure 4.19 shows the graphical representation of these results.
Source: Author's calculation.

Table A.7. Impact of the Electric Vehicle Policy on the Consumer Price Index

	Consumer Price Index		
Year	Base Case	EV Policy	Diff (%)
2021	1.000	1.001	0.141
2022	1.006	1.009	0.262
2023	1.013	1.019	0.593
2024	1.019	1.026	0.661
2025	1.025	1.033	0.707
2026	1.031	1.039	0.735
2027	1.038	1.045	0.750
2028	1.044	1.051	0.757
2029	1.050	1.057	0.756
2030	1.055	1.063	0.751
2031	1.061	1.069	0.739
2032	1.067	1.075	0.723
2033	1.073	1.080	0.705
2034	1.079	1.086	0.682
2035	1.085	1.092	0.657
2036	1.090	1.097	0.627
2037	1.096	1.103	0.594
2038	1.102	1.109	0.559
2039	1.109	1.114	0.523
2040	1.115	1.120	0.490

EV = electric vehicle.
Note: Figure 4.20 shows the graphical representation of these results.
Source: Author's calculation.

Table A.8. Total Government Revenue
(million baht)

Year	Base Case	EV Policy	Change	Change (%)
2021	2,905,988.74	2,916,755.76	10,767.02	0.37
2022	3,023,277.48	3,026,093.56	2,816.08	0.09
2023	3,148,603.49	3,135,762.94	-12,840.55	-0.41
2024	3,282,692.86	3,264,363.75	-18,329.11	-0.56
2025	3,426,270.11	3,402,332.56	-23,937.55	-0.70
2026	3,580,117.47	3,550,513.55	-29,603.92	-0.83
2027	3,745,068.97	3,709,883.04	-35,185.93	-0.94
2028	3,922,020.04	3,881,259.55	-40,760.48	-1.04
2029	4,111,929.58	4,065,699.86	-46,229.73	-1.12
2030	4,315,822.87	4,264,266.05	-51,556.82	-1.19
2031	4,534,792.71	4,478,003.20	-56,789.50	-1.25
2032	4,770,000.19	4,708,103.90	-61,896.28	-1.30
2033	5,022,674.57	4,955,825.26	-66,849.31	-1.33
2034	5,294,112.48	5,222,437.05	-71,675.43	-1.35
2035	5,585,676.53	5,509,326.98	-76,349.55	-1.37
2036	5,898,793.22	5,817,827.28	-80,965.93	-1.37
2037	6,234,950.37	6,149,710.67	-85,239.69	-1.37
2038	6,595,694.08	6,506,331.62	-89,362.46	-1.35
2039	6,982,625.28	6,889,313.92	-93,311.36	-1.34
2040	7,397,396.12	7,300,574.98	-96,821.14	-1.31

EV = electric vehicle.
Note: Figure 4.24 shows the graphical representation of these results.
Source: Author's calculation.

Table A.9. Total Government Revenue from Direct Tax
(million baht)

Year	Base Case	EV Policy	Change	Change (%)
2021	1,019,017.02	1,021,977.01	2,959.99	0.29
2022	1,061,310.37	1,065,065.10	3,754.73	0.35
2023	1,106,139.65	1,115,430.74	9,291.10	0.84
2024	1,153,758.95	1,165,234.96	11,476.01	0.99
2025	1,204,423.66	1,218,010.72	13,587.06	1.13
2026	1,258,400.13	1,273,969.24	15,569.11	1.24
2027	1,315,967.12	1,333,437.69	17,470.57	1.33
2028	1,377,418.41	1,396,796.53	19,378.12	1.41
2029	1,443,064.03	1,464,371.34	21,307.31	1.48
2030	1,513,231.10	1,536,538.85	23,307.74	1.54
2031	1,588,264.23	1,613,627.55	25,363.31	1.60
2032	1,668,525.52	1,696,080.35	27,554.83	1.65
2033	1,754,394.18	1,784,288.53	29,894.34	1.70
2034	1,846,265.90	1,878,708.91	32,443.01	1.76
2035	1,944,551.85	1,979,741.64	35,189.80	1.81
2036	2,049,677.48	2,087,830.99	38,153.51	1.86
2037	2,162,081.11	2,203,323.76	41,242.65	1.91
2038	2,282,212.30	2,326,782.94	44,570.64	1.95
2039	2,410,530.15	2,458,669.70	48,139.55	2.00
2040	2,547,501.51	2,599,363.14	51,861.63	2.04

EV = electric vehicle.
Note: Figure 4.25 shows the graphical representation of these results.
Source: Author's calculation.

Table A.10. Total Government Revenue from Indirect Tax
(million baht)

Year	Base Case	EV Policy	Change	Change (%)
2021	171,482.40	173,454.61	1,972.21	1.15
2022	177,892.77	176,717.93	-1,174.84	-0.66
2023	184,725.42	167,165.32	-17,560.09	-9.51
2024	192,053.38	171,310.39	-20,742.99	-10.80
2025	199,923.36	175,890.50	-24,032.87	-12.02
2026	208,386.00	180,951.39	-27,434.61	-13.17
2027	217,491.27	186,571.34	-30,919.94	-14.22
2028	227,292.25	192,800.40	-34,491.85	-15.18
2029	237,845.05	199,690.41	-38,154.64	-16.04
2030	249,209.47	207,267.39	-41,942.07	-16.83
2031	261,449.02	215,580.72	-45,868.30	-17.54
2032	274,631.06	224,683.51	-49,947.55	-18.19
2033	288,826.71	234,635.23	-54,191.48	-18.76
2034	304,110.82	245,479.95	-58,630.87	-19.28
2035	320,561.78	257,289.60	-63,272.17	-19.74
2036	338,261.39	270,114.91	-68,146.48	-20.15
2037	357,294.65	284,031.72	-73,262.94	-20.50
2038	377,749.48	299,114.89	-78,634.59	-20.82
2039	399,716.48	315,438.14	-84,278.33	-21.08
2040	423,288.63	333,247.99	-90,040.63	-21.27

EV = electric vehicle.
Note: Figure 4.26 shows the graphical representation of these results.
Source: Author's calculation.

Table A.11. Fiscal Balance
(million baht at market price)

Year	Base Case	EV Policy	Change	Change (%)
2021	404,964.34	415,731.36	10,767.02	2.66
2022	447,222.34	450,038.42	2,816.08	0.63
2023	495,266.70	482,426.15	-12,840.55	-2.59
2024	549,755.96	531,426.86	-18,329.11	-3.33
2025	611,345.11	587,407.56	-23,937.55	-3.92
2026	680,744.72	651,140.80	-29,603.92	-4.35
2027	758,715.04	723,529.11	-35,185.93	-4.64
2028	846,075.49	805,315.00	-40,760.48	-4.82
2029	943,706.70	897,476.97	-46,229.73	-4.90
2030	1,052,553.30	1,000,996.48	-51,556.82	-4.90
2031	1,173,625.05	1,116,835.54	-56,789.50	-4.84
2032	1,307,997.50	1,246,101.22	-61,896.28	-4.73
2033	1,456,811.79	1,389,962.49	-66,849.31	-4.59
2034	1,621,273.83	1,549,598.40	-71,675.43	-4.42
2035	1,802,652.72	1,726,303.16	-76,349.55	-4.24
2036	2,002,278.69	1,921,312.76	-80,965.93	-4.04
2037	2,221,540.41	2,136,300.71	-85,239.69	-3.84
2038	2,461,881.81	2,372,519.36	-89,362.46	-3.63
2039	2,724,798.65	2,631,487.29	-93,311.36	-3.42
2040	3,011,834.69	2,915,013.55	-96,821.14	-3.21

EV = electric vehicle.
Note: Figure 4.27 shows the graphical representation of these results.
Source: Author's calculation.

Table A.12. Aggregate Household Income

(million baht)

Year	Aggregate Household Income at Market Price (million baht)			Real Aggregate Household Income (million baht at 2021 prices)		
	Base Case	EV Policy	Change (%)	Base Case	EV Policy	Change (%)
2021	14,148,459.48	14,189,557.20	0.29%	14,148,459.48	14,169,520.60	0.15
2022	14,735,678.04	14,787,810.27	0.35%	14,641,687.21	14,655,057.36	0.09
2023	15,358,106.49	15,487,107.96	0.84%	15,164,405.41	15,201,579.61	0.25
2024	16,019,272.83	16,178,610.60	0.99%	15,719,512.40	15,771,660.86	0.33
2025	16,722,722.91	16,911,371.31	1.13%	16,310,045.37	16,378,173.03	0.42
2026	17,472,154.82	17,688,322.89	1.24%	16,939,118.11	17,023,521.30	0.50
2027	18,271,439.02	18,514,007.75	1.33%	17,609,942.05	17,710,868.58	0.57
2028	19,124,654.59	19,393,708.47	1.41%	18,325,824.22	18,444,074.82	0.65
2029	20,036,105.87	20,331,945.47	1.48%	19,090,169.30	19,226,634.03	0.71
2030	21,010,334.89	21,333,949.36	1.54%	19,906,474.39	20,062,514.57	0.78
2031	22,052,126.33	22,404,281.21	1.60%	20,778,318.66	20,955,289.51	0.85
2032	23,166,507.68	23,549,090.52	1.65%	21,709,346.97	21,909,360.30	0.92
2033	24,358,744.17	24,773,809.77	1.70%	22,703,247.85	22,928,453.91	0.99
2034	25,634,329.59	26,084,782.00	1.76%	23,763,726.62	24,017,489.14	1.07
2035	26,998,972.85	27,487,562.74	1.81%	24,894,474.29	25,179,621.87	1.15
2036	28,458,581.21	28,988,320.52	1.86%	26,099,133.37	26,419,249.13	1.23

	Aggregate Household Income at Market Price (million baht)			Real Aggregate Household Income (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base Case	EV Policy	Change (%)
2037	30,019,240.34	30,591,870.62	1.91%	27,381,261.77	27,738,781.42	1.31
2038	31,687,192.16	32,306,029.59	1.95%	28,744,296.21	29,142,777.21	1.39
2039	33,468,810.95	34,137,200.66	2.00%	30,191,516.47	30,634,335.10	1.47
2040	35,370,578.66	36,090,647.33	2.04%	31,726,012.22	32,213,954.72	1.54

EV = electric vehicle.
Note: Figure 4.28 shows the graphical representation of these results.
Source: Author's calculation.

Table A.13. Aggregate Household Income from Capital
(million baht)

	Aggregate Household Income from Capital at Market Price (million baht)			Real Aggregate Household from Capital (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base case	EV policy	Change (%)
2021	8,792,721.52	8,821,231.55	0.32	8,792,721.52	8,808,775.39	0.18
2022	9,166,894.52	9,203,532.86	0.40	9,108,423.92	9,120,911.05	0.14
2023	9,563,161.24	9,653,114.70	0.94	9,442,547.76	9,475,144.88	0.35
2024	9,983,817.21	10,096,809.03	1.13	9,796,995.16	9,842,838.28	0.47
2025	10,431,094.05	10,566,470.98	1.30	10,173,679.14	10,233,320.93	0.59
2026	10,907,322.21	11,063,882.74	1.44	10,574,563.99	10,648,055.47	0.69
2027	11,414,925.82	11,591,955.17	1.55	11,001,661.23	11,089,095.21	0.79
2028	11,956,452.69	12,154,053.67	1.65	11,457,035.70	11,558,917.44	0.89
2029	12,534,581.74	12,752,977.55	1.74	11,942,804.11	12,059,683.74	0.98
2030	13,152,130.14	13,392,014.31	1.82	12,461,131.30	12,593,893.32	1.07
2031	13,812,054.30	14,073,989.69	1.90	13,014,221.90	13,163,757.67	1.15
2032	14,517,447.86	14,802,842.15	1.97	13,604,308.30	13,772,115.82	1.23
2033	15,271,536.22	15,581,839.99	2.03	14,233,634.93	14,421,177.18	1.32
2034	16,077,668.15	16,415,211.61	2.10	14,904,439.35	15,114,259.60	1.41

	Aggregate Household Income from Capital at Market Price (million baht)			Real Aggregate Household from Capital (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base case	EV policy	Change (%)
2035	16,939,304.79	17,306,114.84	2.17	15,618,930.76	15,853,039.86	1.50
2036	17,860,006.35	18,258,533.94	2.23	16,379,266.57	16,640,383.03	1.59
2037	18,843,416.91	19,275,202.92	2.29	17,187,527.91	17,477,539.94	1.69
2038	19,893,247.76	20,360,748.57	2.35	18,045,695.03	18,367,121.15	1.78
2039	21,013,259.86	21,518,973.11	2.41	18,955,623.56	19,310,881.40	1.87
2040	22,207,246.00	22,752,842.53	2.46	19,919,022.66	20,308,836.04	1.96

EV = electric vehicle.
Note: Figure 4.29 shows the graphical representation of these results.
Source: Author's calculation.

Table A.14. Aggregate Household Income from Wages
(million baht)

	Aggregate Household Income from Wage at Market Price (million baht)			Real Aggregate Household Income from Wage (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base Case	EV Policy	Change (%)
2021	5,355,737.96	5,368,325.65	0.24	5,355,737.96	5,360,745.22	0.09
2022	5,568,783.52	5,584,277.40	0.28	5,533,263.29	5,534,146.31	0.02
2023	5,794,945.25	5,833,993.25	0.67	5,721,857.65	5,726,434.73	0.08
2024	6,035,455.62	6,081,801.57	0.77	5,922,517.24	5,928,822.58	0.11
2025	6,291,628.86	6,344,900.34	0.85	6,136,366.23	6,144,852.10	0.14
2026	6,564,832.61	6,624,440.16	0.91	6,364,554.12	6,375,465.82	0.17
2027	6,856,513.19	6,922,052.58	0.96	6,608,280.82	6,621,773.37	0.20
2028	7,168,201.89	7,239,654.81	1.00	6,868,788.52	6,885,157.38	0.24
2029	7,501,524.13	7,578,967.92	1.03	7,147,365.19	7,166,950.29	0.27
2030	7,858,204.75	7,941,935.04	1.07	7,445,343.08	7,468,621.25	0.31
2031	8,240,072.04	8,330,291.52	1.09	7,764,096.76	7,791,531.85	0.35
2032	8,649,059.81	8,746,248.37	1.12	8,105,038.66	8,137,244.48	0.40
2033	9,087,207.95	9,191,969.78	1.15	8,469,612.92	8,507,276.74	0.44
2034	9,556,661.44	9,669,570.39	1.18	8,859,287.27	8,903,229.55	0.50
2035	10,059,668.07	10,181,447.89	1.21	9,275,543.53	9,326,582.01	0.55

	Aggregate Household Income from Wage at Market Price (million baht)			Real Aggregate Household Income from Wage (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base Case	EV Policy	Change (%)
2036	10,598,574.86	10,729,786.58	1.24	9,719,866.80	9,778,866.10	0.61
2037	11,175,823.43	11,316,667.70	1.26	10,193,733.86	10,261,241.48	0.66
2038	11,793,944.40	11,945,281.02	1.28	10,698,601.18	10,775,656.05	0.72
2039	12,455,551.09	12,618,227.55	1.31	11,235,892.92	11,323,453.70	0.78
2040	13,163,332.66	13,337,804.80	1.33	11,806,989.55	11,905,118.68	0.83

EV = electric vehicle.
Note: Figure 4.30 shows the graphical representation of these results.
Source: Author's calculation.

Table A.15. Impact of the Electric Vehicle Policy on Aggregate Household Saving

	Aggregate Household Saving at Market Price (million baht)			Real Aggregate Household Saving (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base Case	EV Policy	Change (%)
2021	5,285,821.72	5,301,175.70	0.29	5,285,821.72	5,293,690.09	0.15
2022	5,505,204.80	5,524,681.24	0.35	5,470,090.11	5,475,085.16	0.09
2023	5,737,742.18	5,785,936.74	0.84	5,665,376.05	5,679,264.21	0.25
2024	5,984,751.93	6,044,280.04	0.99	5,872,762.34	5,892,244.85	0.33
2025	6,247,558.76	6,318,037.23	1.13	6,093,383.67	6,118,835.96	0.42
2026	6,527,544.25	6,608,303.99	1.24	6,328,403.35	6,359,936.12	0.50
2027	6,826,154.41	6,916,777.36	1.33	6,579,021.15	6,616,726.99	0.57
2028	7,144,913.17	7,245,430.89	1.41	6,846,472.56	6,890,650.63	0.65
2029	7,485,428.62	7,595,953.40	1.48	7,132,029.58	7,183,012.39	0.71
2030	7,849,397.64	7,970,299.03	1.54	7,436,998.69	7,495,294.83	0.78
2031	8,238,607.77	8,370,171.77	1.60	7,762,717.08	7,828,832.85	0.85
2032	8,654,937.28	8,797,869.07	1.65	8,110,546.44	8,185,270.81	0.92
2033	9,100,353.23	9,255,420.48	1.70	8,481,864.80	8,566,001.11	0.99
2034	9,576,908.09	9,745,195.75	1.76	8,878,056.47	8,972,861.38	1.07
2035	10,086,734.69	10,269,270.39	1.81	9,300,500.38	9,407,030.66	1.15
2036	10,632,039.96	10,829,948.97	1.86	9,750,557.38	9,870,151.66	1.23

	Aggregate Household Saving at Market Price (million baht)			Real Aggregate Household Saving (million baht at 2021 prices)		
Year	Base Case	EV Policy	Change (%)	Base Case	EV Policy	Change (%)
2037	11,215,097.50	11,429,030.44	1.91	10,229,556.67	10,363,124.93	1.31
2038	11,838,239.26	12,069,435.05	1.95	10,738,782.22	10,887,653.52	1.39
2039	12,503,846.66	12,753,555.03	2.00	11,279,459.34	11,444,895.04	1.47
2040	13,214,341.33	13,483,356.81	2.04	11,852,742.31	12,035,036.16	1.54

EV = electric vehicle.
Note: Figure 4.33 shows the graphical representation of these results.
Source: Author's calculation.