

## List of Figures

Figure 2.1	Calculation Flow of Energy Consumption by Energy Mix Model	4
Figure 2.2	Comparison of Total Final Energy Demand across the Scenarios	16
Figure 2.3	Energy Demand by Vehicle Type in BAU Scenario	17
Figure 2.4	Energy Demand by Vehicle Type in AFS	17
Figure 2.5	Energy Demand by Vehicle Type in MES	18
Figure 2.6	Energy Demand by Vehicle Type in AES	18
Figure 2.7	Energy Demand by Vehicle Type in HPS	19
Figure 2.8	Energy Demand by Vehicle Type in OES	19
Figure 2.9	Comparison of Gasoline Consumption across the Scenarios	20
Figure 2.10	Comparison of Diesel Fuel Consumption across the Scenarios	21
Figure 2.11	Comparison of Ethanol Consumption across the Scenarios	22
Figure 2.12	Comparison of Biodiesel Consumption across the Scenarios	23
Figure 2.13	Well-to-Wheel CO <sub>2</sub> Emissions from Road Transport Sector (2015–30)	24
Figure 2.14	Tank-to-Wheel CO <sub>2</sub> Emissions from Road Transport Sector (2015–30)	25
Figure 2.15	Statistics of New xEV Registrations in Thailand	30
Figure 2.16	Statistics of Accumulative xEV Registrations in Thailand	31
Figure 2.17	Breakdown of New and Accumulative xEV Registrations by Vehicle Types in Thailand	31
Figure 2.18	Thailand’s EV Promotion Roadmap	33
Figure 2.19	R&D Action Plan to Support EV Industry in Thailand	33
Figure 2.20	Thailand’s EV Action Plan	34
Figure 2.21	EV Charging Standard (socket and inlet) in Thailand	35
Figure 2.22	EV Charging Station Subsidy Programme	35
Figure 2.23	Fiscal Incentive for Investment on xEVs in Thailand	38
Figure 2.24	Vehicle Stock Numbers Projection	41
Figure 2.25	Overall Scheme for Estimating Total Cost of Ownership	42

Figure 2.26	Simulation Results for Six Scenarios with BAU Scenario (Baseline), Energy Demand Reduction	46
Figure 2.27	Simulation Results for Six Scenarios with BAU Scenario (Baseline), Fossil Fuel Reduction	46
Figure 2.28	Simulation Results for Six Scenarios with BAU Scenario (Baseline), Greenhouse Gas Emission Reduction	47
Figure 2.29	Simulation Results for Six Scenarios with BAU Scenario (Baseline), Increased Bioethanol Demand	47
Figure 2.30	Simulation Results for Six Scenarios with BAU Scenario (Baseline), Increased Biodiesel Demand	48
Figure 2.31	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Excise Tax Reduction	48
Figure 2.32	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Additional Investment for xEVs	49
Figure 2.33	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Cost of CO <sub>2</sub> Reduction	49
Figure 2.34	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Cost of Energy Reduction	50
Figure 2.35.	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Cost of Fossil Oil Reduction	50
Figure 2.36	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Total Cost of Ownership: Sedan Case	51
Figure 2.37	Simulated Cost Results for Six Scenarios with BAU Scenario (Baseline), Total Cost of Ownership: Pickup Case	51
Figure 2.38	Specific CO <sub>2</sub> Emissions Based on Fuel Type	59
Figure 2.39	Oil Consumption in BAU Scenario (NEP oil limit for road	62
Figure 2.40	Total Cost (cost of fuel, infrastructure, etc.) from 2015 to 2035 for BAU Scenario	62
Figure 2.41	Comparison of Oil Consumption from 2015 to 2035 of Biofuel Scenarios and BAU	63
Figure 2.42	Comparison of Carbon Emissions from 2015 to 2035 of Biofuel Scenarios and BAU	64
Figure 2.43	Comparison of Total Cost (cost of fuel, infrastructure, etc) from 2015 to 2035 for Biofuel Scenarios and BAU	65
Figure 2.44	Comparison of Oil Consumption from 2015 to 2035 of xEV Scenarios and BAU	66

Figure 2.45	Comparison of Carbon Emissions from 2015 to 2035 of xEV Scenarios and BAU	67
Figure 2.46	Comparison of Total Cost (cost of fuel, infrastructure, etc) from 2015 to 2035 for xEV Scenarios and BAU	67
Figure 2.47	Comparison of Oil Consumption from 2015 to 2035 of CNG Implementation Scenario Combined with Other Scenarios and BAU	69
Figure 2.48	Comparison of Carbon Emissions from 2015 to 2035 of CNG Implementation Scenario Combined with Other Scenarios and BAU	70
Figure 2.49	Comparison of Total Cost (cost of fuel, infrastructure, etc) from 2015 to 2035 of CNG Implementation Scenario Combined with Other Scenarios and BAU	71
Figure 2.50	Cost per Mtoe Oil Consumption Reduction for Each Measure	72
Figure 2.51	Cost per million ton-CO <sub>2</sub> Emissions Reduction for Each Measure	73
Figure 2.52	The 2017 Toyota Prius, Test Drive by Energy Secretary	76
Figure 2.53	Alternative Fuels and Energy Technologies Roadmap 2017–2040	77
Figure 2.54	Ateneo De Manila University’s Electric Jeepneys	79
Figure 2.55	Electric Jeepneys Ride for Free in Muntinlupa City	79
Figure 2.56	Electric Jeepneys inside Muntinlupa City’s Filinvest City Alabang	80
Figure 2.57	Electric Jeepneys Plying New Route from Makati City to Mandaluyong City	80
Figure 2.58	Nissan Electric Vehicle, ‘Leaf’ Model	81
Figure 2.59	Toyota HEV ‘Prius’ Campus Tour at Mapua University	82
Figure 2.60	Mitsubishi Motors Corporation’s Handover of PHEVs and i-MIEVs	82
Figure 3.1	Actual and Projected Domestic Crude Oil Production and Fuel Products Consumption	87
Figure 3.2	Forms of Renewable Energies to Meet the New and Renewable Energy Target in 2025	88
Figure 3.3	Typical Municipal Solid Waste Composition	94
Figure 3.4	Alternative Fuel Production from Non-Conventional	99

	Resources	
Figure 3.5	Effect of Pentose (C5 sugar) Utilisation on Ethanol Production	102
Figure 3.6	Effect of Lignin Content on Ethanol Production	103
Figure 3.7	GHG Emissions from Ethanol Production	104
Figure 3.8	Effect of Biomass Species on GHG Emissions in WTW	104
Figure 3.9	Bioenergy Value Chain	106
Figure 3.10	Well-to-Wheel Analysis Outline	107
Figure 3.11	Ethanol Well-to-Tank GHG Emissions Calculated in Toyota and Mizuho (2008)	108
Figure 3.12	Ethanol Well-to-Tank GHG Emissions Calculated in METI (2010)	109
Figure 3.13	Well-to-Wheel GHG Emissions of Gasoline and Bioethanol Pathways Calculated in Wang et al. (2012)	111
Figure 4.1	Well-to-Wheel CO <sub>2</sub> Emissions from Road Transport Sector (2030) Based on Simulation	117
Figure 4.2	Figure 4.2. Energy Composition in Power Generation	118
Figure 4.3	Figure 4.3. Estimated Total Potential Bioenergy from Harvesting and Wood Processing Residue (2013)	120

## List of Tables

Table 2.1	Model Parameters Based on Vehicle Type for Base Year (2015)	8
Table 2.2	Model Parameters Based on Fuel Type for Base Year (2015)	8
Table 2.3	Fuel Cost Assumptions	9
Table 2.4	BAU Scenario Conditions	10
Table 2.5	AFS Conditions	11
Table 2.6	MES Conditions	12
Table 2.7	AES Conditions	13
Table 2.8	HPS Conditions	14
Table 2.9	OES Conditions	15
Table 2.10	Overall Cost of xEVs Introduction for 2030 and Cumulative from 2015 to 2030 (in US\$ billion)	26
Table 2.11	Number of EV Charging Stations in Thailand (as of 11 August 2020)	36
Table 2.12	Revised Excise Tax Rate Table for Automobiles to Promote xEV Investment	37
Table 2.13	Vehicle Statistics in Thailand (a) with xEV Price Assumption (b)	40
Table 2.14	Opportunity Cost to the Government from Lower Excise Tax for xEV	41
Table 2.15	Vehicle Kilometres Travelled Used in the Model	42
Table 2.16	Total Cost of Ownership, Details in Capital Cost	43
Table 2.17	Total Cost of Ownership, Details in Operation Cost	43
Table 2.18	Total Cost of Ownership, Details in Fuel/Energy Cost	44
Table 2.19	Total Cost of Ownership, Details in Battery Cost Assumption	44
Table 2.20	xEVs Share in Various Scenarios	53
Table 2.21	Impact of Combination Scenario (alternative fuel + minimum HEV)	54
Table 2.22	Mandatory Biofuel Content based on Regulation No.12 Year 2015	55
Table 2.23	Government EV Plan and Vehicle Sales Forecast for Cars, Trucks, and Buses	56

Table 2.24	Government EV Plan and Vehicle Sales Forecast for Motorcycles	56
Table 2.25	Average Annual Mileage (km travelled) by Type of Vehicle	57
Table 2.26	Fuel Economy Based on Vehicle and Fuel Type	58
Table 3.1	Estimated Total Potential Bioenergy (GJ) from Harvesting and Wood Processing Residues in 2013, Indonesia, by Province	90
Table 3.2	Biomass Potential from Agricultural Waste	93
Table 3.3	Biomass Distribution Potential for Electricity	95
Table 3.4	Total Capacity of Power Plants using Biomass Derived Fuel, 2018	96
Table 3.5	Composition of Lignocellulosic Biomass	100
Table 3.6	Ethanol Yield from Lignocellulosic Biomass	101
Table 3.7	Life Cycle GHG Emissions of Bioethanol in Thailand Calculated in Silalertruksa and Ghewala (2011)	110