List of Tables

Table 1.1	Gross Domestic Product (in constant 2010 US dollar	9
	prices) and Population in EAS17 Countries (2017–2050)	
Table 1.2	Imported Price Assumption for Real Oil, Natural Gas, and Coal	11
Table 1.3	Assumptions of Energy-Saving Targets under the Alternative Policy	11
	Scenario in EAS17	
Table 3.1	Energy Supply and Consumption, 2017	46
Table 4.1	Power Generation Facilities by Fuel	56
Table 4.2	Gross Domestic Product and Population	56
Table 4.3	Installed Capacity, Business as Usual (megawatts)	57
Table 4.4	Installed Capacity, Alternative Policy Scenario (megawatts)	57
Table 4.5	Intended Nationally Determined Contribution Targets	59
Table 4.6	Results of Carbon Dioxide Emissions by 2050 (million tons of carbon equivalent)	70
Table 10.1	Assumption of Annual Average Growth of Gross Domestic Product and Population	156
Table 11.1	Gross Domestic Product Growth Assumptions by Sector to 2050 (% per year)	174
Table 11.2	Population Growth Assumption to 2050	174
Table 11.3	Potential Mitigation Scenarios	176
Table 12.1	Installed Capacity and Power Generation by Fuel Type, 2018–2019	192
Table 12.2	Yearly Plan for the Construction of Power Plant Projects	194
Table 12.3	Installed Capacity and Power Supply in Three Scenarios for 2030	194
Table 17.1	Targets on Reduction of GHG Emissions, Energy Saving and Renewables Development	283
Table A1-1	ASEAN Member States Individual INDCs	313

List of Figures

Figure 1.1	Average Annual Growth Rate of Gross Domestic Product and Population	7
	in EAS17 Countries	
Figure 1.2	Average EAS17 Thermal Efficiency under Business as Usual	10
Figure 1.3	Average EAS17 Thermal Efficiency under Alternative Policy Scenario	10
Figure 1.4	Final Energy Consumption by Sector, Business as Usual (1990–2050)	13
Figure 1.5	Final Energy Consumption Share by Sector (1990–2050)	13
Figure 1.6	Final Energy Consumption by Fuel (1990–2050)	14
Figure 1.7	Final Energy Consumption Share by Fuel (1990–2050)	14
Figure 1.8	Primary Energy Supply in EAS17 (1990–2050)	15
Figure 1.9	Share of Primary Energy Mix by Source (1990–2050)	16
Figure 1.10	Energy Mix of Power Generation in EAS17 (1990–2050)	16
Figure 1.11	Share of Power Generation Mix in EAS17 (1990–2050)	17
Figure 1.12	Energy Indicators in EAS17 (Business as Usual)	18
Figure 1.13	Energy Indicators in EAS17 (Alternative Policy Scenario)	18
Figure 1.14	Total Final Energy Consumption, Business as Usual and Alternative Policy	19
	Scenario	
Figure 1.15	Final Energy Consumption by Sector, Business as Usual and Alternative	20
	Policy Scenario	
Figure 1.16	Total Primary Energy Supply, Business as Usual and Alternative Policy	20
	Scenario	
Figure 1.17	Primary Energy Supply by Source, Business as Usual and Alternative Poli-	21
	cy Scenario	
Figure 1.18	Total Carbon Dioxide Emissions, Business as Usual and Alternative Policy	22
	Scenario	
Figure 1.19	Investment Share by Power Source (EAS17, Business as Usual)	23
Figure 1.20	Investment Share by Power Source (EAS17, Alternative Policy Scenario)	23
Figure 1.21	Investment Share by Power Source (ASEAN, Business as Usual)	24
Figure 1.22	Investment Share by Power Source (ASEAN, Alternative Policy Scenario)	24
Figure 1.23	Total Energy Infrastructure Investment (EAS17, Business as Usual and	25
	Alternative Policy Scenario)	

ix

Figure 1.24	Share of Energy Infrastructure Investment (EAS17, Business as Usual and Alternative Policy Scenario)	25
Figure 1.25	Total Energy Infrastructure Investment (ASEAN, Business as Usual and Alternative Policy Scenario)	26
Figure 1.26	Share of Energy Infrastructure Investment (ASEAN, Business as Usual and Alternative Policy Scenario)	26
Figure 2.1	Gross National Product and Population (1990–2050)	35
Figure 2.2	Final Energy Consumption by Sector, Business as Usual	37
Figure 2.3	Final Energy Consumption by Fuel Type, Business as Usual	37
Figure 2.4	Primary Energy Supply by Fuel Type, Business as Usual	38
Figure 2.5	Power Generation, Business as Usual	39
Figure 2.6	Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario	40
Figure 2.7	Total Primary Energy Supply, Business as Usual and Alternative Policy Scenario	41
Figure 2.8	Primary Energy Supply by Fuel, Business as Usual and Alternative Policy Scenario	41
Figure 2.9	Carbon Dioxide Emissions from Energy Combustion, Business as Usual and Alternative Policy Scenario	42
Figure 3.1	Final Energy Consumption by Sector, Business as Usual	48
Figure 3.2	Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario	49
Figure 3.3	Primary Energy Supply by Source, Business as Usual and Alternative Poli- cy Scenario	49
Figure 3.4	Reduction of Primary Energy Supply, Business as Usual and Alternative Policy Scenario	50
Figure 3.5	Carbon Dioxide Emissions from Energy Consumption, Business as Usual and Alternative Policy Scenario	51
Figure 4.1	Primary Energy Supply by Source, Business as Usual	60
Figure 4.2	Final Energy Consumption by Sector, Business as Usual	61
Figure 4.3	Final Energy Consumption by Fuel, Business as Usual	62
Figure 4.4	Power Generation by Fuel, Business as Usual	62
Figure 4.5	Carbon Dioxide Emissions from Energy Consumption, Business as Usual	63

Figure 4.6	Energy and Carbon Dioxide Indicators	64
Figure 4.7	Comparison of Scenarios and Total Primary Energy Supply by 2050	65
Figure 4.8	Comparison of Electricity Generation Scenarios by 2050	66
Figure 4.9	Comparison of Scenarios by Carbon Dioxide Emission by 2050	66
Figure 4.10	Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario	67
Figure 4.11	Primary Energy Supply by Fuel, Business as Usual and Alternative Policy Scenario	68
Figure 4.12	Total Primary Energy Saving Potential by Fuel, Business as Usual and Alternative Policy Scenario	69
Figure 4.13	Carbon Dioxide Emission by Fuels, Business as Usual and Alternative Policy Scenario	69
Figure 5.1	Final Energy Consumption by Sector, Business as Usual	78
Figure 5.2	Final Energy Consumption by Fuel, Business as Usual	78
Figure 5.3	Final Energy Consumption, Business as Usual and Alternative Policy Scenario	79
Figure 5.4	Primary Energy Supply by Fuel Type, Business as Usual	80
Figure 5.5	Primary Energy Supply by Source, Business as Usual and Alternative Poli- cy Scenario	81
Figure 5.6	Total Primary Energy Supply, Business as Usual and Alternative Policy Scenario	81
Figure 5.7	Carbon Dioxide Emissions from Energy Consumption, Business as Usual and Alternative Policy Scenario	82
Figure 5.8	Power Generation, Business as Usual	83
Figure 5.9	Energy Indicators, Business as Usual	84
Figure 6.1	Trends in Installed Electricity Generation Capacity from Utilities, 2009–2010 to 2018–2019	90
Figure 6.2	Final Energy Consumption by Sector, Business as Usual	92
Figure 6.3	Final Energy Consumption by Fuel, Business as Usual	92
Figure 6.4	Primary Energy Supply by Source, Business as Usual	93
Figure 6.5	Electricity Generation, Business as Usual	94
Figure 6.6	Carbon Dioxide Emissions, Business as Usual	95
Figure 6.7	Final Energy Consumption, Alternative Policy Scenario	95

Figure 6.8	Final Energy Consumption, Business as Usual and Alternative Policy Scenario 5	96
Figure 6.9	Primary Energy Supply by Source, Alternative Policy Scenario	96
Figure 6.10	Total Primary Energy Supply, Business as Usual and Alternative Policy	97
-	Scenario 5	
Figure 6.11	Total Primary Energy Supply by Fuel, Business as Usual and Alternative	98
	Policy Scenario 5	
Figure 6.12	Carbon Dioxide Emissions from Energy Combustion, Business as Usual	98
	and Alternative Policy Scenario	
Figure 6.13	Carbon Dioxide Emissions from Energy Combustion, Business as Usual	99
	and Alternative Policy Scenario 5	
Figure 7.1	Energy Efficiency and Conservation Assumptions	104
Figure 7.2	Final Energy Consumption by Sector	106
Figure 7.3	Final Energy Consumption by Energy, Business as Usual	107
Figure 7.4	Primary Energy Supply, Business as Usual	108
Figure 7.5	Power Generation by Type of Fuel	110
Figure 7.6	Thermal Efficiency, Business as Usual	110
Figure 7.7	Energy Intensity and Other Energy Indicators (1990=100)	111
Figure 7.8	Comparison of Scenarios' Total Primary Energy Supply by 2050	112
Figure 7.9	Comparison of Scenarios' Electricity Generation by 2050	113
Figure 7.10	Comparison of Scenarios' Carbon Dioxide Emissions by 2050	113
Figure 7.11	Final Energy Consumption by Sector, Business as Usual and Alternative	114
	Policy Scenario	
Figure 7.12	Primary Energy Supply by Source, Business as Usual and Alternative Poli-	115
	cy Scenario	
Figure 7.13	Total Primary Energy Supply, BAU and APS	116
Figure 7.14	Energy Intensity, BAU and APS	116
Figure 7.15	Carbon Dioxide Emissions from Energy Consumption, BAU and APS	117
Figure 7.16	Power Generation Mix, BAU and APS	118
Figure 8.1	Annual Growth Rate of Gross Domestic Product and Population	123
Figure 8.2	Energy Balance Target in 2030	124
Figure 8.3	Thermal Efficiency, Business as Usual	125
Figure 8.4	Final Energy Consumption by Sector, Business as Usual	126
Figure 8.5	Final Energy Consumption by Source, Business as Usual	127

Figure 8.6	Primary Energy Supply, Business as Usual	127
Figure 8.7	Indices of Energy and Carbon Dioxide Intensities, Energy per Capita, and	128
	Carbonisation Rate, Business as Usual (1990–2050)	
Figure 8.8	Final Energy Consumption by Sector, Business as Usual and Alternative	129
	Policy Scenario (2017 and 2050)	
Figure 8.9	Primary Energy Supply by Source, Business as Usual and Alternative Poli-	130
	cy Scenario (2017–2050)	
Figure 8.10	Power Generation Mix, Business as Usual and the Alternative Policy Sce-	131
	nario (2017–2050)	
Figure 8.11	Total Energy Consumption, Business as Usual and the Alternative Policy	131
	Scenario (1990, 2017, and 2050)	
Figure 8.12	Carbon Dioxide Emissions from Fossil Fuel Combustion, Business as Usu-	132
	al and the Alternative Policy Scenario	
Figure 9.1	Growth Assumptions for Gross Domestic Product and Population (1990–	136
	2050)	
Figure 9.2	Final Energy Consumption by Sector, Business as Usual (1990–2050)	138
Figure 9.3	Final Energy Consumption by Energy, Business as Usual (1990–2050)	138
Figure 9.4	Final Energy Consumption by Sector, Alternative Policy Scenario (1990–	139
	2050)	
Figure 9.5	Final Energy Consumption by Energy, Alternative Policy Scenario (1990–	140
	2050)	
Figure 9.6	Final Energy Consumption by Sector, Business as Usual versus the Alter-	140
	native Policy Scenario (2017 and 2050)	
Figure 9.7	Final Energy Consumption by Energy, Business as Usual versus the Alter-	141
	native Policy Scenario (2017 and 2050)	
Figure 9.8	Primary Energy Supply by Energy, Business as Usual (1990–2050)	142
Figure 9.9	Total Primary Energy Supply: Alternative Policy Scenario (2017–2050)	143
Figure 9.10	Total Primary Energy Supply, Business as Usual and the Alternative Policy	144
	Scenario (2017 and 2050)	
Figure 9.11	Primary Energy Supply by Source, Business as Usual versus the Alterna-	144
	tive Policy Scenario	
Figure 9.12	Power Generation by Source, Business as Usual versus the Alternative	145
	Policy Scenario	

Figure 9.13	Carbon Dioxide Emissions from Energy Consumption, Business as Usual	146
	and Alternative Policy Scenario (2015 and 2040)	
Figure 9.14	Energy and Carbon Intensities (1990–2040)	147
Figure 10.1	Total Final Energy Consumption by Sector	152
Figure 10.2	Total Final Energy Consumption by Sector	153
Figure 10.2	Final Energy Consumption by Sector	157
Figure 10.4	Sectors' Share in Final Energy Consumption	157
Figure 10.5	Fuels' Share in Final Energy Consumption	158
Figure 10.6	Final Energy Consumption by Fuel Type	158
Figure 10.7	Primary Energy Supply	160
Figure 10.8	Electricity Generation 2050	161
Figure 10.9	Energy Intensity and Other Energy Indicators (2000 = 100)	162
Figure 10.10	Comparison of Scenarios for Total Primary Energy Supply (2050)	163
	Comparison of Scenarios for Electricity Generation (2050)	163
Figure 10.12	Comparison of Scenarios (2050)	164
Figure 10.13	Final Energy Demand by Sector – Business as Usual, and Alternative	165
	Policy Scenario 5	
Figure 10.14	Total Primary Energy Demand – Business as Usual, and Alternative Policy Scenario 5	165
Eiguro 10 1E	Energy Intensity (2010–2018)	166
		167
Figure 10.10	Final Energy Intensity – Business as Usual and Alternative Policy Scenario 5	107
Figure 10.17	Primary Energy Intensity— Business as Usual and Alternative Policy Sce- nario 5	167
Figure 10.18	Carbon Dioxide Emissions from Energy Combustion – Business as Usual	168
	versus Alternative Policy Scenario 5	
Figure 11.1	Modelling Structure	173
Figure 11.2	Primary Energy Supply by Fuel Type, Business as Usual (1990–2050)	177
Figure 11.3	Share of Primary Energy Supply by Fuel Type, Business as Usual (1990– 2050)	178
Figure 11.4	Final Energy Consumption by Fuel Type, Business as Usual (1990–2050)	178
Figure 11.5	Share of Final Energy Consumptionby Fuel Type, Business as Usual (1990–2050)	179

Figure 11.6	Final Energy Consumption by Sector, Business as Usual (1990–2050)	180
Figure 11.7	Share of Final Energy Consumption by Sector, Business as Usual (1990– 2050)	180
Figure 11.8	Power Generation by Fuel Type, Business as Usual (1990–2050)	181
Figure 11.9	Share of Power Generation by Fuel Type, Business as Usual (1990–2050)	182
Figure 11.10	Thermal Efficiency by Fuel Type, Business as Usual (1990–2050)	182
Figure 11.11	Energy Indicators, Business as Usual (1990–2050)	183
Figure 11.12	Final Energy Consumption by Sector, Business as Usual and the Alterna- tive Policy Scenario (2017 and 2050)	184
Figure 11.13	Primary Energy Supply by Fuel Type, Business as Usual and the Alterna- tive Policy Scenario (2017 and 2050)	185
Figure 11.14	Total Primary Energy Supply, Business as Usual and the Alternative Policy Scenario (2017 and 2050)	186
Figure 11.15	Carbon Dioxide Emissions from Energy Combustion, Business as Usual and the Alternative Policy Scenario (2017 and 2050)	187
Figure 11.16	Generation Capacity Mix of Fossil Fuels versus Renewable Energy for Business as Usual and the Alternative Policy Scenario in 2025	187
Figure 11.17	Final Energy Intensity (Excluding Non-Energy) for Business as Usual and the Alternative Policy Scenario	188
Figure 11.18	Carbon Dioxide Intensity for Business as Usual and the Alternative Policy Scenario	189
Figure 12.1	Final Energy Consumption by Sector, Business as Usual	199
Figure 12.2	Final Energy Consumption by Fuel, Business as Usual	200
Figure 12.3	Primary Energy Supply by Source, Business as Usual	201
Figure 12.4	Power Generation Mix, Business as Usual	202
Figure 12.5	Energy Intensity, Carbon Dioxide Intensity, and Energy per Capita	203
Figure 12.6	Comparison of Scenarios to Total Primary Energy Supply by 2050	203
Figure 12.7	Comparison of Scenarios of Electricity Generation by 2050	205
Figure 12.8	Comparison of Scenarios or Carbon Dioxide Emissions by 2050	205
Figure 12.9	Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario	206
Figure 12.10	Primary Energy Supply by Source, Business as Usual and the Alternative Policy Scenario	207
Figure 12.11	Evolution of Primary Energy Supply, Business as Usual and the Alterna- tive Policy Scenario	208

Figure 12.12	Carbon Dioxide Emissions from Energy Consumption, Business as Usual	208
	and the Alternative Policy Scenario	
Figure 12.13	Electricity Demand, Business as Usual and the Alternative Policy Scenario	209
Figure 12.14	Electricity Demand by Sectors, Business as Usual and the Alternative	210
	Policy Scenario	
Figure 12.15	Share of Power Generation Capacity in 2050, Business as Usual and the	210
	Alternative Policy Scenario	
Figure 13.1	Gross Domestic Product and Population	215
Figure 13.2	Power Generation by Fuel, Business as Usual	215
Figure 13.3	Final Energy Consumption by Sector, Business as Usual	217
Figure 13.4	Final Energy Consumption by Fuel, Business as Usual	217
Figure 13.5	Final Energy Consumption by Sector, Business as Usual and the Alterna-	218
	tive Policy Scenario	
Figure 13.6	Primary Energy Supply by Fuel, Business as Usual	219
Figure 13.7	Primary Energy Intensity and Energy per Capita Indicator, Business as	220
	Usual	
Figure 13.8	Primary Energy Supply by Fuel, Business as Usual and the Alternative	221
	Policy Scenario	
Figure 13.9	Total Primary Energy Supply, Business as Usual and the Alternative Policy	221
	Scenario	
Figure 13.10	Carbon Dioxide Emissions from Energy Consumption, Business as Usual	222
	and Alternative Policy Scenario	
Figure 14.1	Total Final Energy Consumption by Sector, BAU	233
Figure 14.2	Share of Total Final Energy Consumption, BAU	233
Figure 14.3	Total Final Energy Consumption by Fuel, BAU	234
Figure 14.4	Share of Total Final Energy Consumption, BAU	235
Figure 14.5	Total Primary Energy Supply by Energy, BAU	236
Figure 14.6	Share of Total Primary Energy Supply by Energy, BAU	236
Figure 14.7	Power Generation by Fuels, BAU	237
Figure 14.8	Thermal Efficiency, BAU	238
Figure 14.9	Energy Intensity, Energy Per Capita and Energy Elasticity	238
Figure 14.10	Total Primary Energy Supply by Energy, BAU and APS, by 2050	239
Figure 14.11	Total Primary Energy Supply by Energy, BAU and APS, by 2050	241
Figure 14.12	CO ₂ Emissions by Fuels in 2050, BAU and APS	242

Figure 14.14	Final Energy Consumption by Sector in 2050, BAU vs APS	244
Figure 14.15	Total Primary Energy Supply by Fuel in 2050, BAU vs APS	244
Figure 14.16	Total Primary Energy Supply in 2050, BAU vs APS	245
Figure 14.17	CO ₂ Emissions in 2050, BAU vs APS	245
Figure 15.1	Final Energy Consumption by Sector, BAU	258
Figure 15.2	Final Energy Consumption by Fuel, BAU	259
Figure 15.3	Primary Energy Supply, BAU	260
Figure 15.4	Electricity Generation, BAU	261
Figure 15.5	Energy Indicators, BAU	262
Figure 15.6	Final Energy Consumption by Sector in 2050, BAU and APS1-5	263
Figure 15.7	Total Primary Energy Supply by Fuel in 2050, BAU and APS1-5	263
Figure 15.8	Primary Energy Supply by Fuel, BAU and APS5	264
Figure 15.9	Electricity Generation in 2050, TWh	265
Figure 15.10	$\rm CO_2$ Emissions from Energy Consumption, BAU and APS	265
Figure 16.1	Final Energy Consumption by Fuel, BAU	272
Figure 16.2	Final Energy Consumption by Sector, BAU	273
Figure 16.3	Primary Energy Supply by Fuel, BAU	274
Figure 16.4	Power Generation by Fuel, BAU	275
Figure 16.5	Thermal Efficiency by Fuel, BAU	276
Figure 16.6	Energy Indicators	276
Figure 16.7	Final Energy Consumption by Sector, BAU and APS	277
Figure 16.8	Primary Energy Supply by Source, BAU and APS	278
Figure 16.9	Total Primary Energy Supply, BAU and APS	279
Figure 16.10	$\rm CO_2$ Emissions from Energy Consumption, BAU and APS	279
Figure 17.1	Final Energy Consumption by Sector, BAU (1990–2050)	286
Figure 17.2	Final Energy Consumption by Fuel, BAU (1990–2050)	288
Figure 17.3	Primary Energy Supply, BAU (1990–2050)	289
Figure 17.4	Power Generation by Type of Fuel, BAU (1990–2050)	290
Figure 17.5	Energy Indicators (1990–2050)	291
Figure 17.6	Total Final Energy Consumption by Sector in BAU and APSs	292
Figure 17.7	Total Final Energy Consumption by Fuel, BAU and APS5 (2017 and 2050)	293
Figure 17.8	Final Energy Consumption by Sector, BAU and APS5 (2017 and 2050)	294
Figure 17.9	Total Primary Energy Supply by Fuel in BAU and APSs	294

Figure 17.10	Primary Energy Saving Potential by Fuel, BAU and APS5 (2017 and 2050)	295
Figure 17.11	Evolution of Primary Energy Supply, BAU and APS5 (1990, 2017, and	296
	2050)	
Figure 17.12	CO ₂ Emissions by Fuel, BAU and APSs	296
Figure 17.13	Evolution of CO_2 Emissions, BAU and APS5 (1990, 2017, and 2050)	297
Figure 18.1	Gross Domestic Product and Population	302
Figure 18.2	Final Energy Consumption by Sector in BAU vs. APS	304
Figure 18.3	Power Generation, BAU	305
Figure 18.4	Final Energy Consumption by Sector in BAU vs. APS	306
Figure 18.5	Electricity Generation under APS	307
Figure 18.6	Total Primary Energy Supply in BAU vs. APS	307
Figure 18.7	Total Primary Energy Supply by Fuel in BAU vs. APS	308
Figure 18.8	CO ₂ Emission Trends in BAU vs. APS	309
Figure 18.9	Energy Indicators under APS	310

Gross Domestic Product (GDP) and Population of ASEAN	313
Final Energy Demand by Sector, BAU	316
Final Energy Demand by Fuel, BAU	317
Primary Energy Consumption, BAU	319
Electricity Generation, BAU	319
Energy Indicators, BAU	320
Total Final Energy Demand in 2050, BAU and APS	321
Total Final Energy Demand by Sector in 2050, BAU and APS	322
Total Final Energy Demand by Fuel in 2050, BAU and APS	323
Total Primary Energy Consumption in 2050, BAU and APS	323
Total Primary Energy Consumption by Fuel in 2050, BAU and APS	324
Electricity Generation in 2050	325
Electricity Generation in 2050 by sources	325
$\rm CO_2$ Emissions from Energy Consumption, BAU and APS	326
	Final Energy Demand by Sector, BAU Final Energy Demand by Fuel, BAU Primary Energy Consumption, BAU Electricity Generation, BAU Energy Indicators, BAU Total Final Energy Demand in 2050, BAU and APS Total Final Energy Demand by Sector in 2050, BAU and APS Total Final Energy Demand by Fuel in 2050, BAU and APS Total Primary Energy Consumption in 2050, BAU and APS Total Primary Energy Consumption by Fuel in 2050, BAU and APS Electricity Generation in 2050 Electricity Generation in 2050 by sources