Chapter 3

Impacts on the 3Es by xEV Penetration

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Chapter 3

Impacts on the 3Es by xEV Penetration

1. Alternative Scenarios

The four countries may have challenging issues related to the 3Es in the reference scenario. Therefore, this study sets alternative scenarios for xEV penetration and power generation mix, and then evaluates their impacts on the 3Es in each country.

1.1. Scenario Assumptions for EV Penetration

Remarkable vehicle technology development in recent years has accelerated the penetration of EVs, although their market share is still small. Various countries have announced policies to promote xEVs, including a ban on ICEVs from 2030, not only to mitigate climate change but also to improve air quality in big cities and reduce crude oil imports.

Some alternative scenarios confirm that promoting xEVs will have an impact on the 3Es. The policy target scenario achieves the government target for xEV penetration. Indonesia announced a policy to ban sales of ICEVs by 2040 whilst a Ministry of Industry roadmap targets increasing the sales share of low carbon emission vehicles (HEVs, PHEVs, BEVs) to 20% by 2025. Thailand targets introducing 1.2 million PHEVs and BEVs by 2036. Malaysia targets introducing 202,000 BEVs (100,000 cars, 2,000 buses, 100,000 motorcycles) by 2030. Viet Nam has no numerical target for xEVs.

The BEV ambitious scenario sets BEV market share at almost 100% by 2040. The HEV bridge scenario is assumed to start with low-cost HEVs, and BEVs are gradually introduced starting around 2030 when the cost of BEVs starts to decline.

The e-motorcycle advanced scenario considers the large number of motorcycles in ASEAN countries. It is highly possible that e-motorcycles will become popular soon because they are cheaper to produce than cars. Market share is assumed to reach almost 100% by 2040.

1.2. Scenario Assumptions for Power Generation Mix

EV penetration's impact on energy and the economy largely depends on the power generation mix. Therefore, we consider alternative scenarios for power generation mix and for xEV dissemination. In the reference scenario, the power generation mix is based on past trends and power development plans. Each government sets the target for introducing renewable energy sources.

Indonesia aims to use renewable energy to cover 23% of primary energy supply by 2025, which requires 26% renewable energy share for the power generation mix. In Malaysia, the minister for energy, science, technology, environment, and climate said that the share of renewable energy in the power generation mix will be increased by 20% by 2030. Viet Nam aims to raise the share of renewable energy in the power generation mix to 32% by 2030 and 43% by 2050 (Ministry of Industry and Trade, 2015). The policy target scenario sets the power generation mix up to 2040 according to these government targets. In Thailand, which has no government target for renewable energy, the policy target scenario follows the Thailand Power Development Plan (Ministry of Energy, 2015).

1.3. Alternative Scenarios

In addition to the reference scenario, four alternative scenarios are set for xEVs and one for power generation mix. We analyse seven alternative scenarios and compare them with the reference scenario to quantitatively examine the influence of the 3Es (Table 3.1).

- Scenario 0: Continuing historical trends without strengthening policy measures.
- Scenario 1: Gradual transition from HEV to BEV penetration under the reference power generation mix
- Scenario 2: Rapid transition to BEV with 100% sales in 2040 under the reference power generation mix
- Scenario 3: Rapid transition to battery motorcycles with 100% sales in 2040 under the reference power generation mix
- Scenario 4: xEV penetration with the policy target under the targeted (and cleaner) power generation mix
- Scenario 5: Gradual transition from HEV to BEV penetration under the targeted (and cleaner) power generation mix
- Scenario 6: Rapid transition to BEV with 100% sales in 2040 under the targeted (and cleaner) power generation mix
- Scenario 7: Rapid transition to battery motorcycles with 100% sales in 2040 under the targeted (and cleaner) power generation mix

Table 3.1: Alternative Scenarios

		Power Generation Mix Scenario	
		Reference	Policy Target (RE advanced)
xEV Scenario	Reference	0	-
	Policy target	-	4
	HEV bridge (start with HEV, then to BEV)	1	5
	BEV ambitious (nearly 100% sales in 2040)	2	6
	E-motorcycle advanced (nearly 100% sales in 2040)	3	7

BEV = battery electric vehicle; e-motorcycle = electric motorcycle; HEV = hybrid electric vehicle; xEVs = electric vehicles (including HEV, PHEV, and BEV).

Source: Authors.

1.4. Assumptions for Investments and Subsidies

In analysing the alternative scenarios, we estimate the amount of required investment (vehicles, charging equipment, power generation equipment) as the additional investment from the reference scenario. In more detail, the investment amount for vehicles is calculated by summing up vehicle price (Table 2-9) multiplied by sales number by powertrain type for each scenario. The same applies for charging equipment and power generation equipment. The additional investment is considered part of demand in GDP each year, which will stimulate economic activity.

The alternative scenarios for xEVs might not be realised unless strong promotion policies such as economic incentives are implemented. Therefore, subsidies for xEVs are necessary and we estimate the total subsidy amount for each scenario. Subsidies to xEVs are granted to shorten the payback period to half the average lifetime. The payback period is a usage period in which the vehicle price and the total fuel cost of driving are equal for ICEVs and xEVs. If xEV prices are lowered due to technological progress, subsidies will stop when the payback period falls below half the average life time.

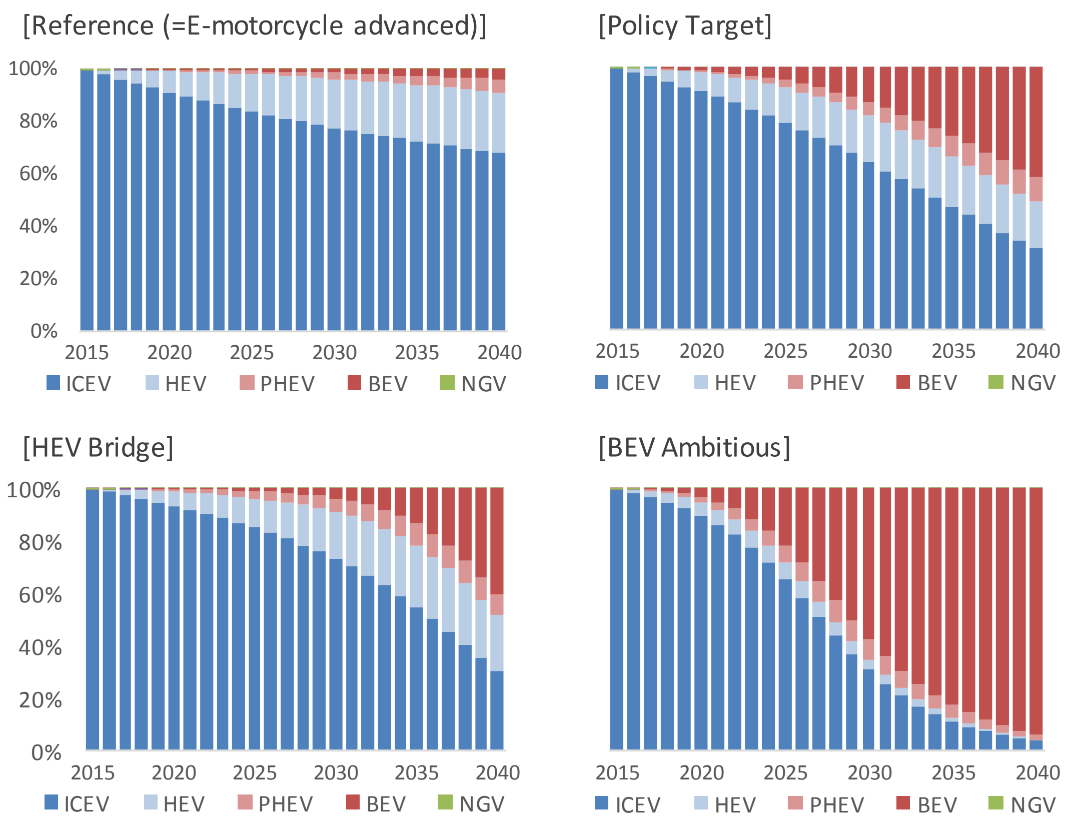
2. Results of Alternative Scenarios

2.1. Indonesia

In 2016, Indonesia had 23.7 million cars, accounting for about 40% of all cars in ASEAN. With high economic growth of about 5% per year, the country will have 2.8 times more cars by 2040. The country has 104.8 million motorcycles, more than four times the number of cars, or 400 motorcycles per 1,000 people. As incomes increase, motorcycles will increase

1.7 times in 2040, more slowly than cars. Powertrain sales share of cars and motorcycles by scenario are shown in Figure 3.1 and Figure 3.2.

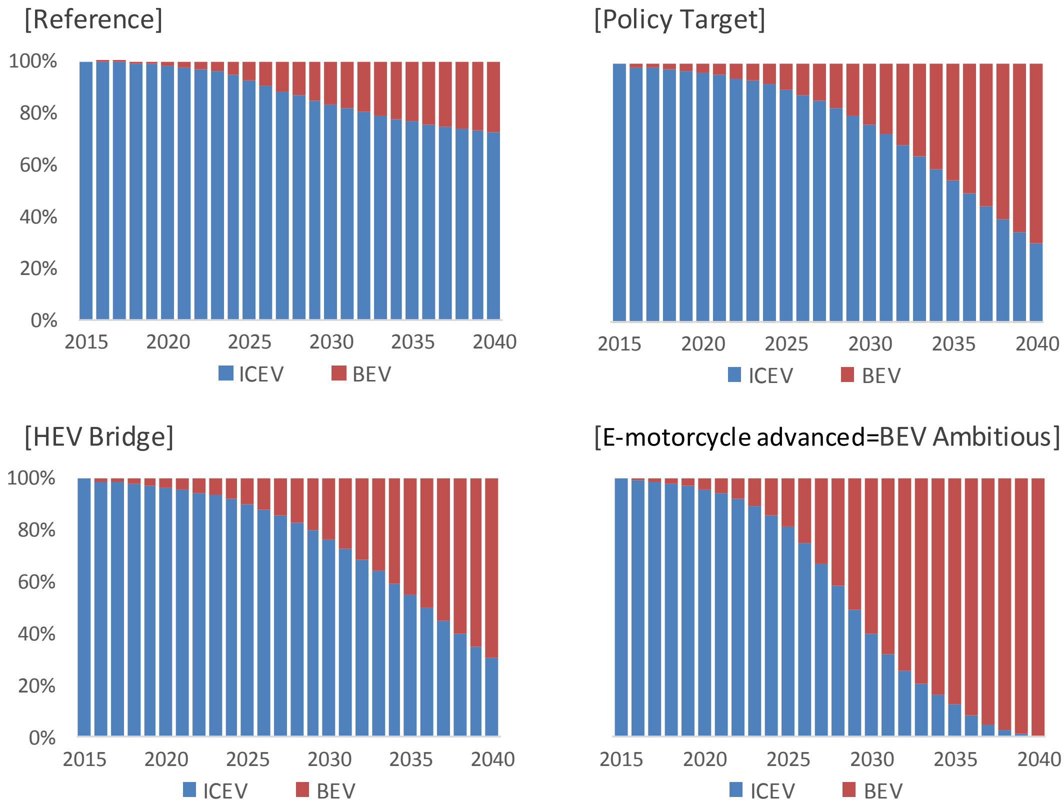
Figure 3.1: Powertrain Sales Share of Cars by Scenario, Indonesia



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.

Source: Authors' analysis.

Figure 3.2: Powertrain Sales Share of Motorcycles by Scenario, Indonesia

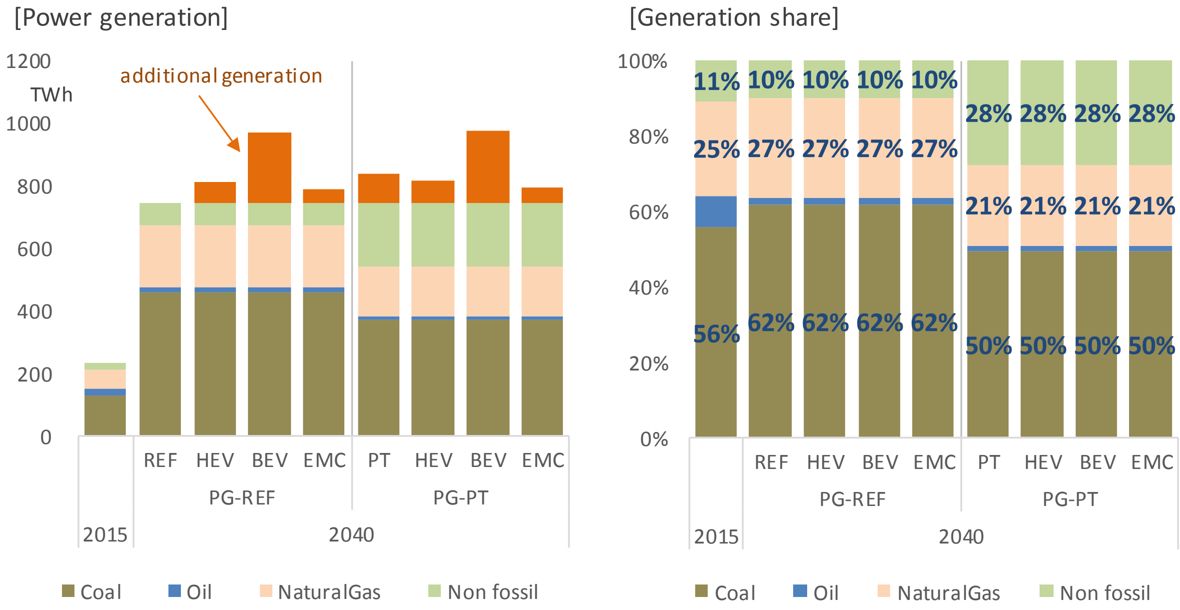


BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle

Source: Authors' analysis.

Electricity demand will increase due to EV penetration. In 2040, in the BEV ambitious scenario, required power generation increases by 220 TWh or 30% more than in the reference scenario, where power generation mix is 62% coal, 27% gas, and 9% non-fossil fuel (CO_2 emissions per kWh are 666 g-CO_2/kWh). In the policy target scenario, power generation mix is 51% coal, 21% gas, and 25% non-fossil fuel (CO_2 emissions per kWh are 535 g-CO_2/kWh), promoting low carbonisation.

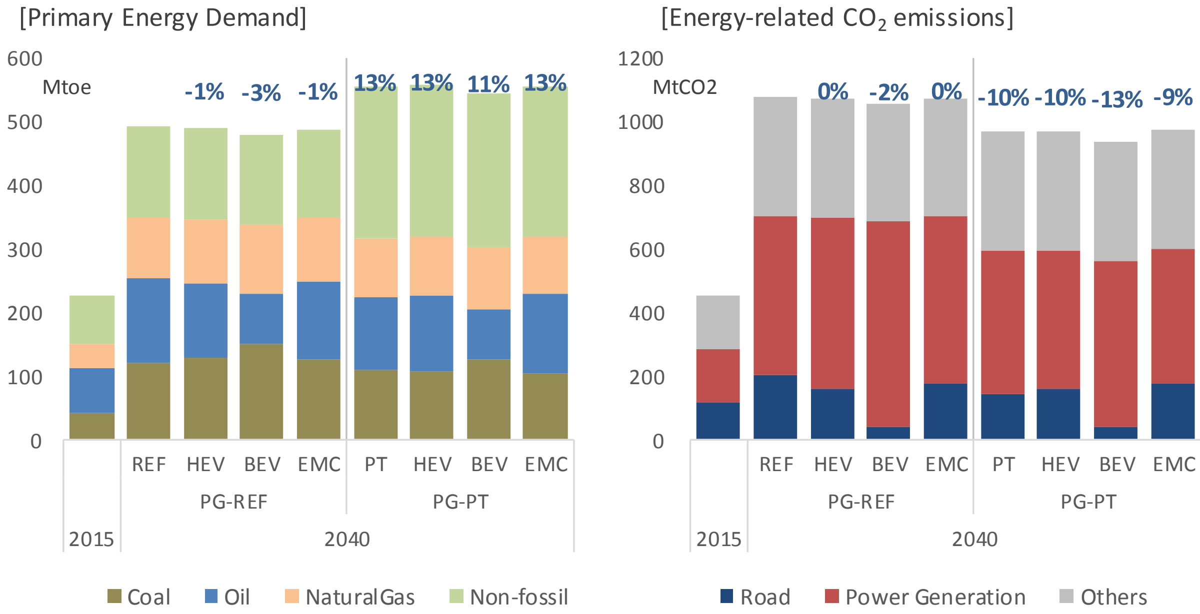
Figure 3.3: Power Generation and Generation Mix, Indonesia



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Note: Not including electricity imports.
Source: IEA (2017), authors' analysis.

Primary energy demand in the reference scenario for the power generation mix in the HEV bridge scenario and in the BEV ambitious scenario decreases by only 1% and 3%, respectively, compared with the reference scenario (Figure 3-4). The reason is that in the BEV ambitious scenario, oil demand in the transport sector decreases (52 Mtoe), whilst fuel input to the power generation sector increases (44 Mtoe). xEV penetration does not lead to large emission reductions, and the difference in emissions between the HEV bridge and the BEV ambitious scenarios is only around 2%. In the policy target scenario for power generation mix, the difference in emissions between the HEV bridge and the BEV ambitious scenarios increases to about 3%. In the policy target scenario for power generation mix, primary energy demand increases because the share of geothermal power generation with low conversion efficiency (5%) is high.

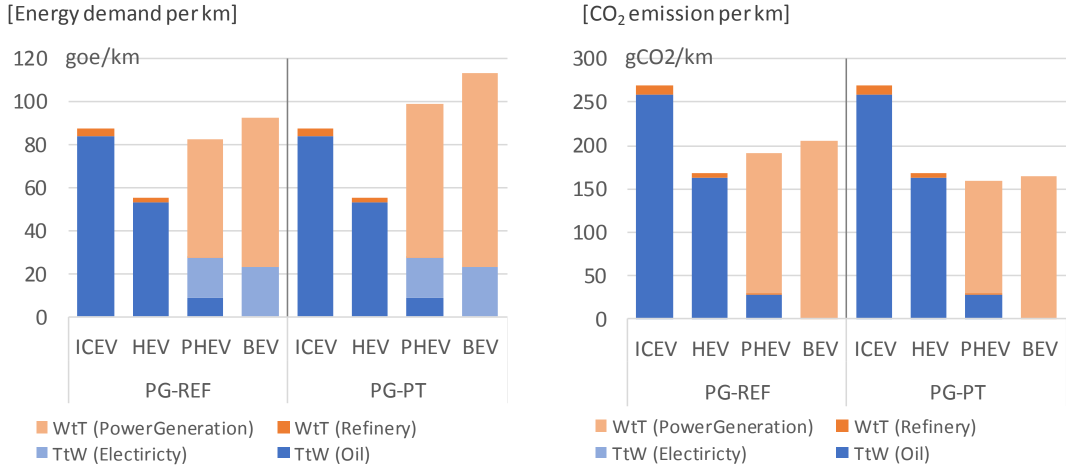
Figure 3.4: Primary Energy Demand and Energy-related CO_2 Emissions, Indonesia



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Notes: 1. % shows the change rate from the reference scenario. 2. Replacing fossil-fuel thermal powers with geothermal power (primary conversion efficiency of 5%) increases primary energy.
Source: IEA (2017), authors' analysis.

In 2040, BEVs consume more energy than ICEVs because consumption is small in tank to wheel but large in well to tank. Energy consumption in well to tank under the policy target scenario for power generation mix increases because the share of geothermal power generation with low conversion efficiency is high. BEVs produce less CO_2 emissions than ICEVs and a certain CO_2 reduction effect can be expected. However, BEVs' CO_2 emissions in the reference scenario for power generation mix are larger than HEVs' (Figure 3-5). In the policy target scenario for power generation mix, BEVs' CO_2 emissions are slightly lower than HEVs'.

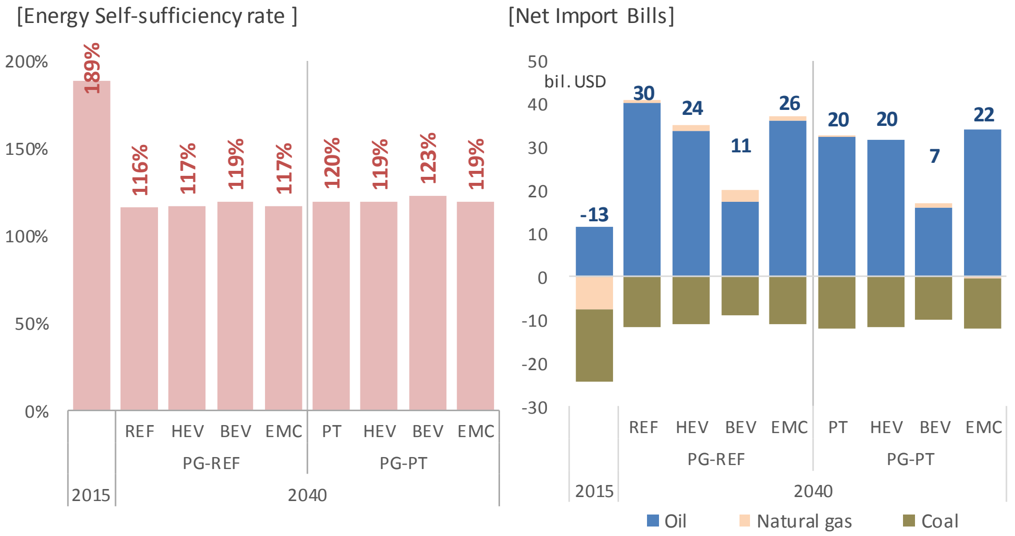
Figure 3.5: Well to Wheel by Powertrain, 2040, Indonesia



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target, TtW = tank to wheel, WtT = well to tank.
Note: Well to tank does not include energy consumption in fossil-fuel production and transport.
Source: Authors' analysis.

Indonesia's energy self-sufficiency drops significantly in 2040 but the difference between scenarios is not large. The net import value of energy in the reference scenario in 2040 is US$30 billion but that in the BEV ambitious scenario greatly decreases to US$11 billion. The net import value of energy in the policy target scenario for power generation mix is further reduced.

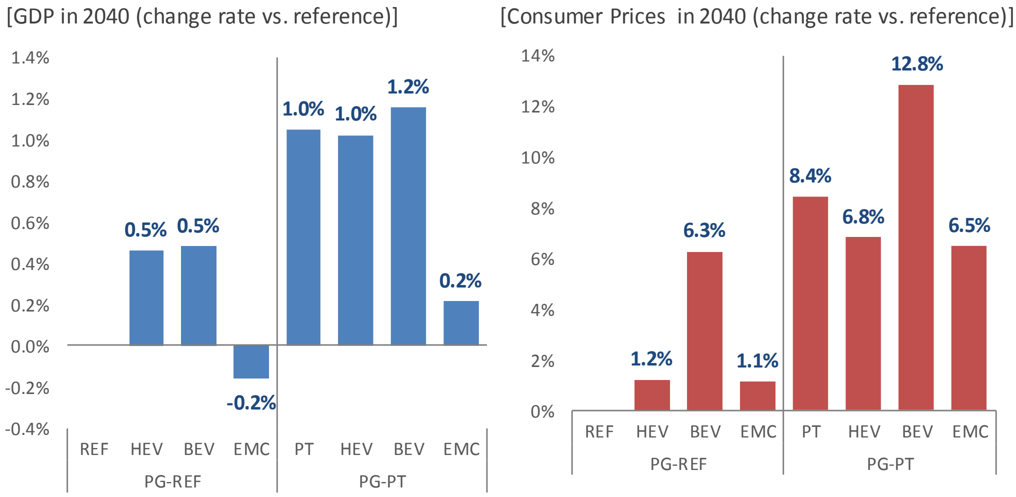
Figure 3.6: Energy Self-sufficiency Rate and Net Import Bills, Indonesia



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target,
Source: IEA (2017), authors' analysis.

xEVs' impact on GDP is slightly positive because suppression of net imports such as petroleum and investments (additional cost for conventional technology) in xEVs (and low-carbon power) stimulate the economy.[3] The economic impact of the e-motorcycle advanced scenario is insignificant. Investments in xEVs (and low-carbon power) do not expand production investments or supply capacity. As a result, supply and demand are tight and general prices rise greatly. In 2040, consumer prices in the BEV ambitious + policy target scenario for power generation mix are 13% higher than in the reference scenario.

Figure 3.7: Impacts on GDP and Consumer Prices, Indonesia



BEV = battery electric vehicle ambitious, EM C= electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Source: IEA (2017), authors' analysis.

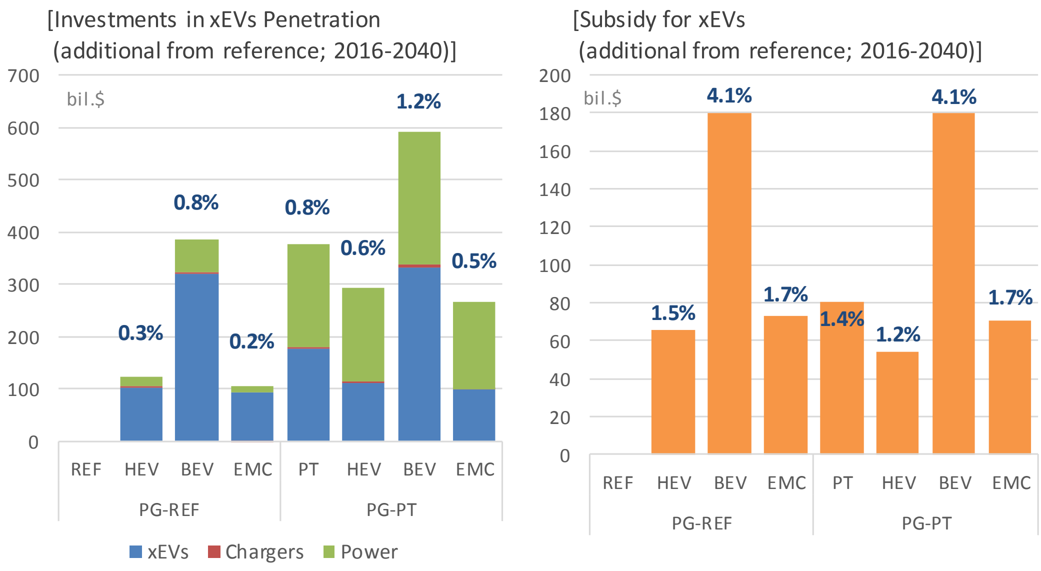
Investment in xEV penetration (vehicles, charging facilities, power-generating equipment) reaches US$123 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$386 billion in the BEV ambitious scenario. Cumulative investment accounts for 0.3% and 0.8% of cumulative GDP, respectively. In the policy target scenario for power generation mix, further investments in low-carbon power are required.

The HEV bridge and the BEV ambitious scenarios may not be realised in business as usual. To encourage purchase, subsidies will be required to bridge the price differences between ICEVs and xEVs. Assuming grant subsidies that shorten the payback period to half the average lifetime, the total subsidy is US$65 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$180 billion in the BEV ambitious scenario. Cumulative subsidy accounts for 1.5% and 4.1% of the cumulative government budget, respectively. However, subsidies to energy (gasoline, diesel oil, and electricity) are not considered. When BEVs increase, oil demand decreases and electricity demand increases. If the dropped subsidy for

[3] Purchase of personal passenger cars and motorcycles is not investment but consumption. Budget-constrained consumers will not stimulate the economy.

oil exceeds the additional subsidy for electricity, the total amount may decrease, but if the subsidy for electricity is larger, the total amount increases.

Figure 3.8: Investments and Subsidy for xEVs, Indonesia

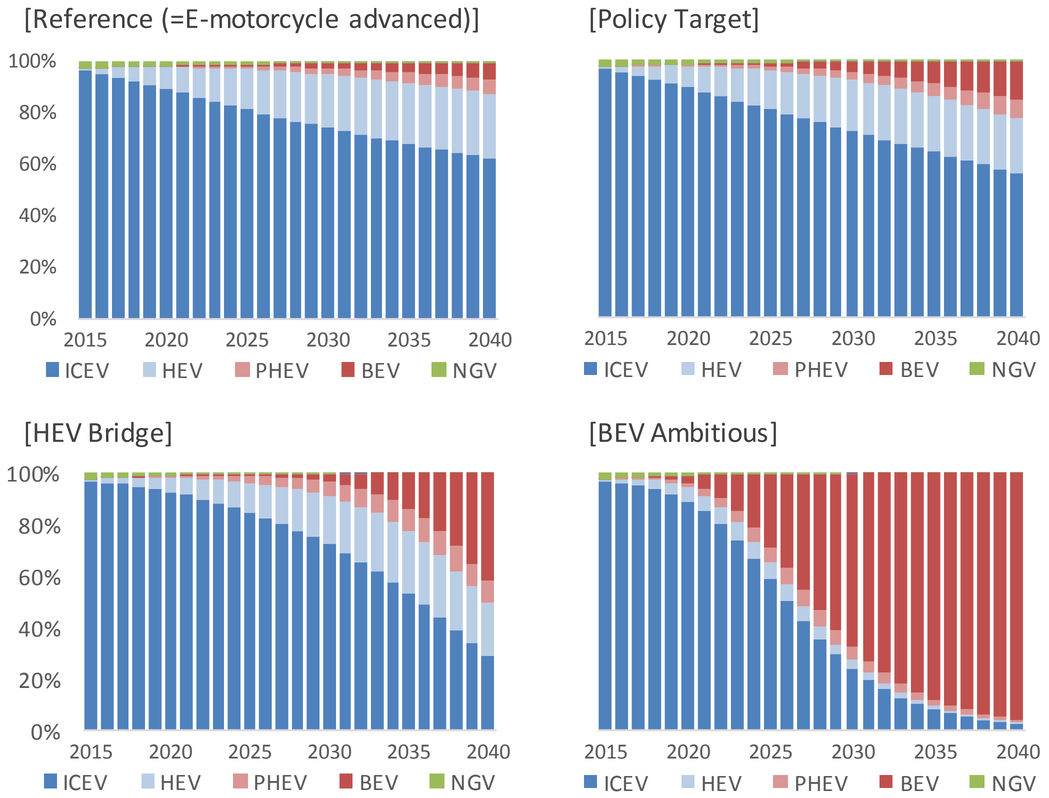


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Notes: 1. Assuming grant subsidies that shorten the payback period to half the average lifetime. 2. % shows investment ratios of GDP and subsidy ratios of government revenue.
Source: IEA (2017), authors' analysis.

2.2. Thailand

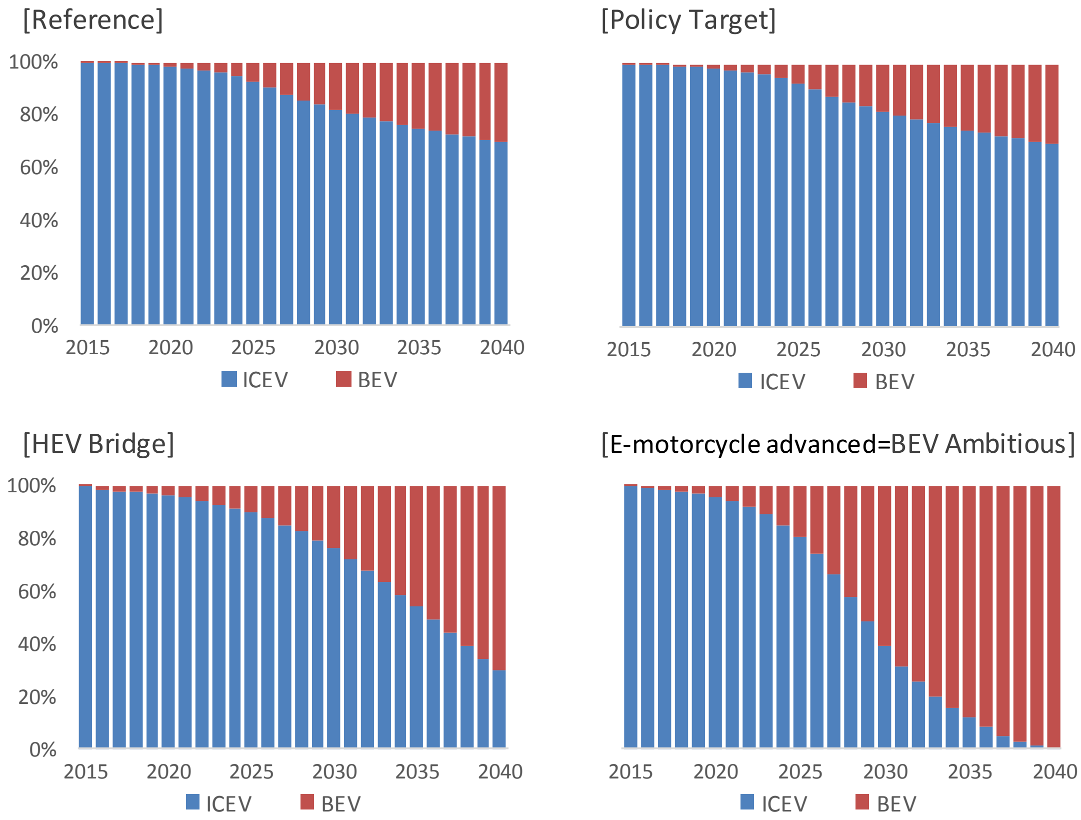
In 2016, Thailand had 16.2 million cars, accounting for less than 30% of all cars in ASEAN. With relatively moderate economic growth and an ageing society, the country will see the number of cars in 2040 increase 1.8 times, less than in other ASEAN countries. The country has 20.5 million motorcycles. As people shift from motorcycles to cars, motorcycles in 2040 will increase 1.3 times and outnumber cars. Powertrain sales share of cars and motorcycles by scenario are shown in Figure 3 and Figure 3.

Figure 3.9: Powertrain Sales Share of Cars by Scenario, Thailand



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.
Source: Authors' analysis.

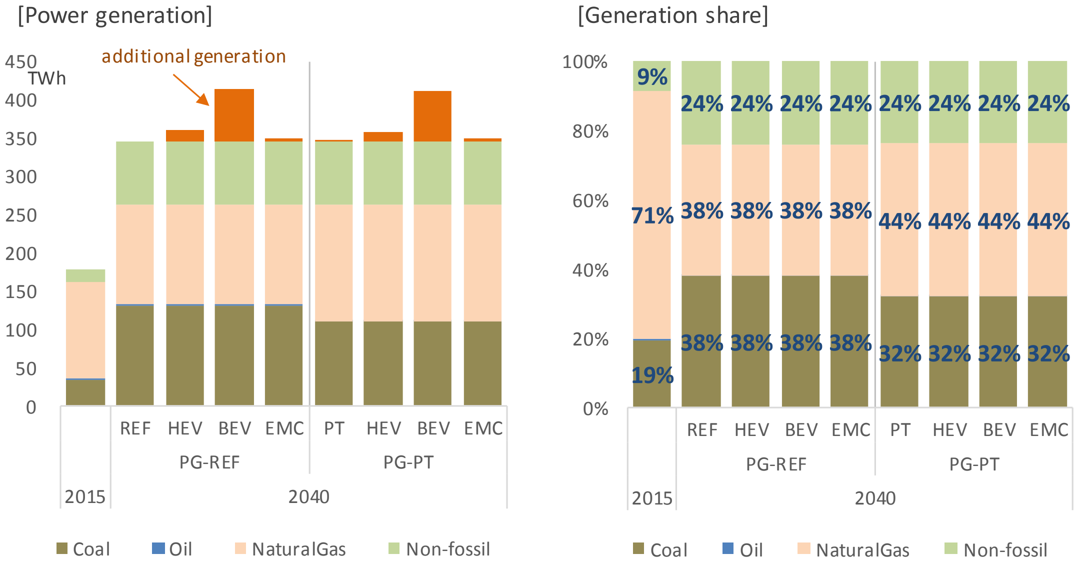
Figure 3.10: Powertrain Sales Share of Motorcycles by Scenario, Thailand



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.
Source: Authors' analysis.

Electricity demand will increase due to EV penetration. In 2040, in the BEV ambitious scenario, required power generation increases by 69 TWh or 20% more than in the reference scenario, where power generation mix is 38% coal, 38% gas, and 24% non-fossil fuel (CO_2 emissions per kWh are 490 g-CO_2/kWh). In the policy target scenario, power generation mix is 32% coal, 44% gas, and 24% non-fossil fuel (CO_2 emissions per kWh are 464 g-CO_2/kWh), promoting low carbonisation.

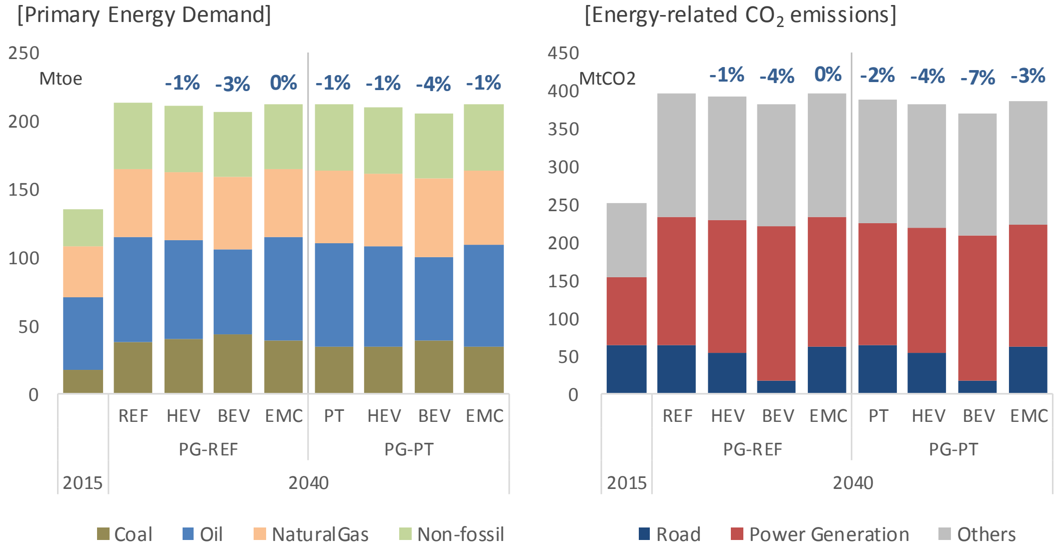
Figure 3.11: Power Generation and Generation Mix, Thailand



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Note: Not including electricity imports.
Source: IEA (2017), authors' analysis.

Primary energy demand under the reference scenario for the power generation mix in the HEV bridge scenario and in the BEV Ambitious scenario decreases by 1% and 3%, respectively, compared with the reference scenario (Figure 3.12). The reason is that in the BEV ambitious scenario, oil demand in the transport sector decreases (15 Mtoe), whilst fuel input to the power generation sector increases (12 Mtoe). xEV penetration does not lead to large emission reductions, and the difference in emissions between the HEV bridge and the BEV ambitious scenarios is only around 3%.

Figure 3.12: Primary Energy Demand and Energy-related CO_2 Emissions, Thailand

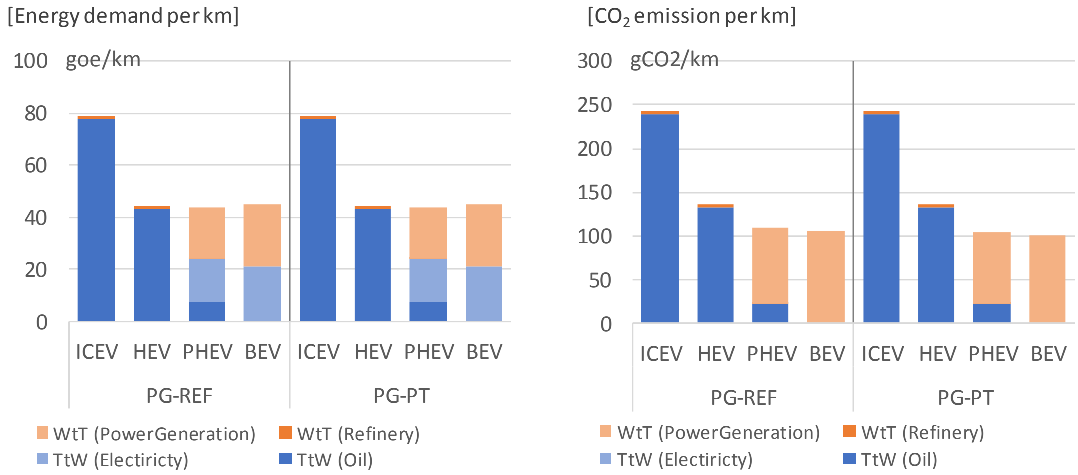


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Note: % show change rates from the reference scenario.
Source: IEA (2017), authors' analysis.

In 2040, BEVs consume less energy than ICEVs and almost the same as HEVs because consumption is small in tank to wheel but large in well to tank. BEVs produce less CO_2 emissions than HEVs and a certain CO_2 reduction effect can be expected. In terms of energy consumption and CO_2 emissions, however, there is not so much difference between policy target and reference scenarios (Figure 3.13).

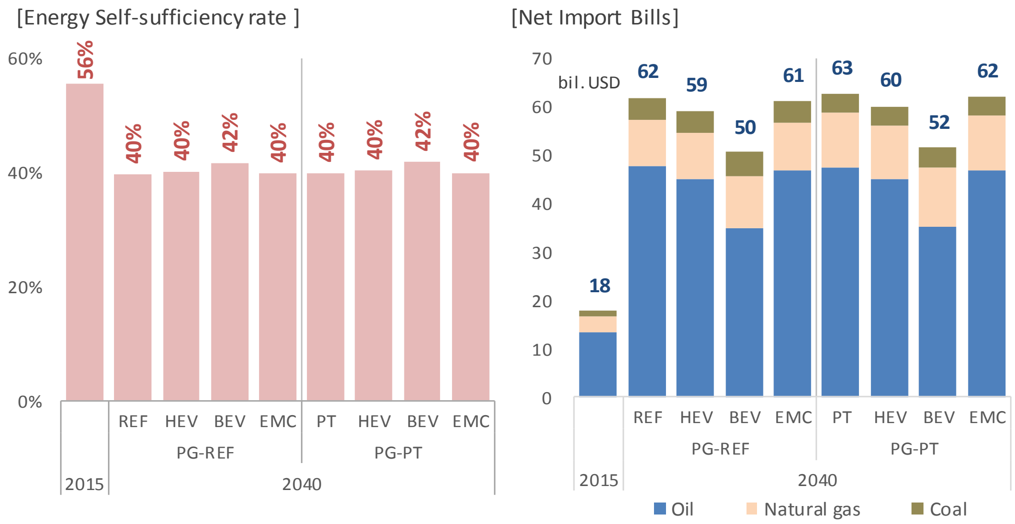
Thailand's energy self-sufficiency drops significantly in 2040 but the difference between scenarios is not large. The net import value of energy in the reference scenario in 2040 is US$62 billion but that in the BEV ambitious scenario greatly decreases to US$50 billion. In the policy target scenario for power generation mix, the energy import value is slightly larger because the share of gas-fired power generation with high gas price is high.

Figure 3.13: Well to Wheel by Powertrain in Cars in 2040, Thailand



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF= reference, PG = power generation, PT = policy target, ,WtT = well to tank, TtW = tank to wheel.
Note: Well to tank does not include energy consumption in fossil-fuel production and transport.
Source: Authors' analysis.

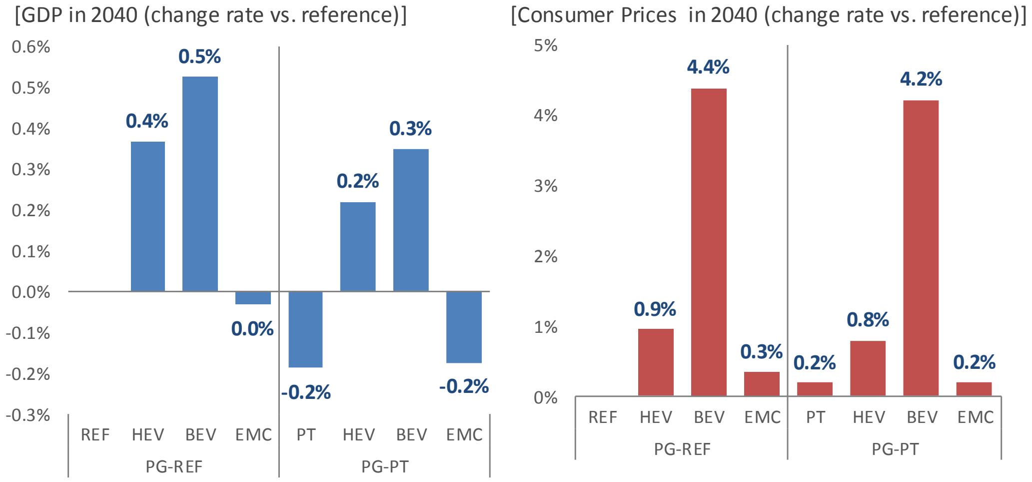
Figure 3.14: Energy Self-sufficiency Rate and Net Import Bills, Thailand



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Source: IEA (2017), authors' analysis.

xEVs' impact on GDP is slightly positive because suppression of net imports such as petroleum and investments (additional cost for conventional technology) in xEVs (and low-carbon power) stimulate the economy. The economic impact of the e-motorcycle advanced scenario is insignificant. In the policy target scenario for power generation mix, the positive impact on GDP is small because energy import value is slightly larger than in the reference scenario. Investments in xEVs (and low-carbon power) do not expand production investments or supply capacity. As a result, supply and demand in the economy are tight and general prices rise greatly. In 2040, consumer prices in the BEV ambitious + policy target scenario for power generation mix are 4% higher than in the reference scenario.

Figure 3.15: Impacts on GDP and Consumer Prices, Thailand

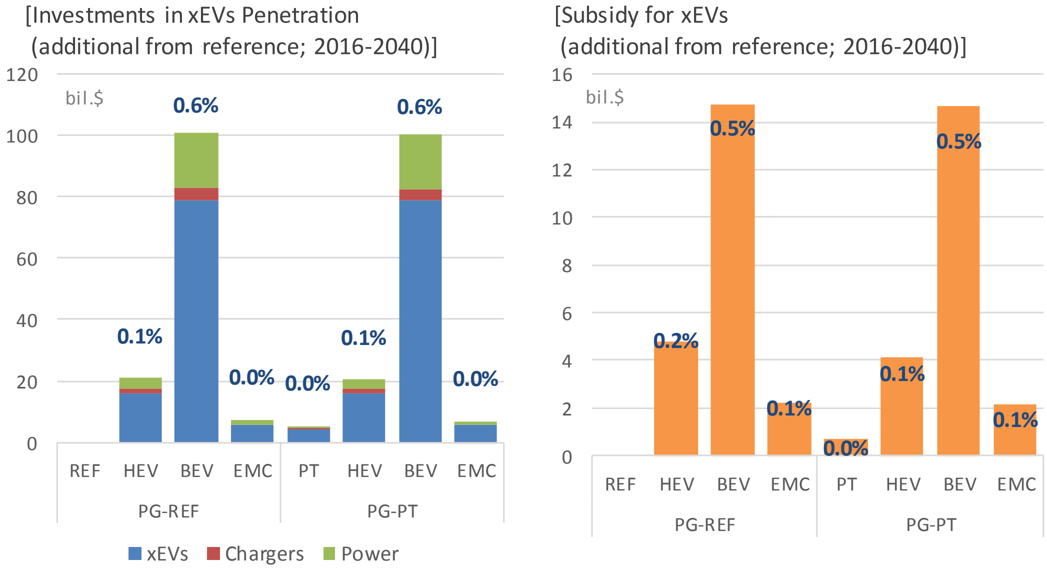


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Source: IEA (2017), authors' analysis.

The investment in xEV penetration (vehicle, charging facility, power-generating equipment) reaches US$21 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$101 billion in the BEV ambitious scenario. Cumulative investment amounts account for 0.1% and 0.6% of cumulative GDP, respectively.

The HEV bridge and the BEV ambitious scenarios may not be realised in business as usual. To encourage purchase, subsidies will be required to bridge the price differences between ICEVs and xEVs. Assuming grant subsidies that shorten the payback period to half the average lifetime, the total subsidy is US$5 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$15 billion in the BEV ambitious scenario. Cumulative subsidy accounts for 0.2% and 0.5% of the cumulative government budget, respectively. However, subsidies to energy (gasoline, diesel oil, and electricity) are not considered. When BEVs increase, oil demand decreases and electricity demand increases. If the dropped subsidy for oil exceeds the additional subsidy for electricity, the total amount may decrease, but if the subsidy for electricity is larger, the total amount increases.

Figure 3.16: Investments and Subsidies for xEVs, Thailand

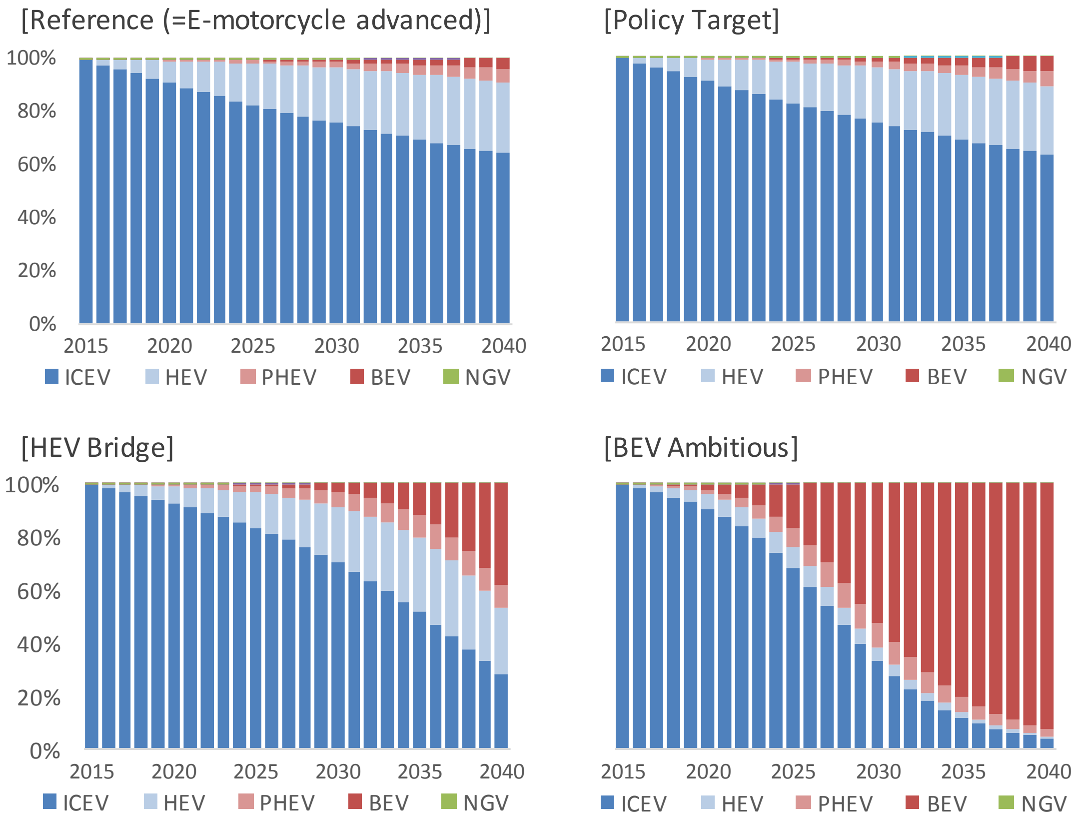


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Notes: 1: Assuming grant subsidies that shorten the payback period to half the average lifetime. 2. % shows investment ratios of GDP and subsidy ratios of government revenue.
Source: IEA (2017), authors' analysis.

2.3. Malaysia

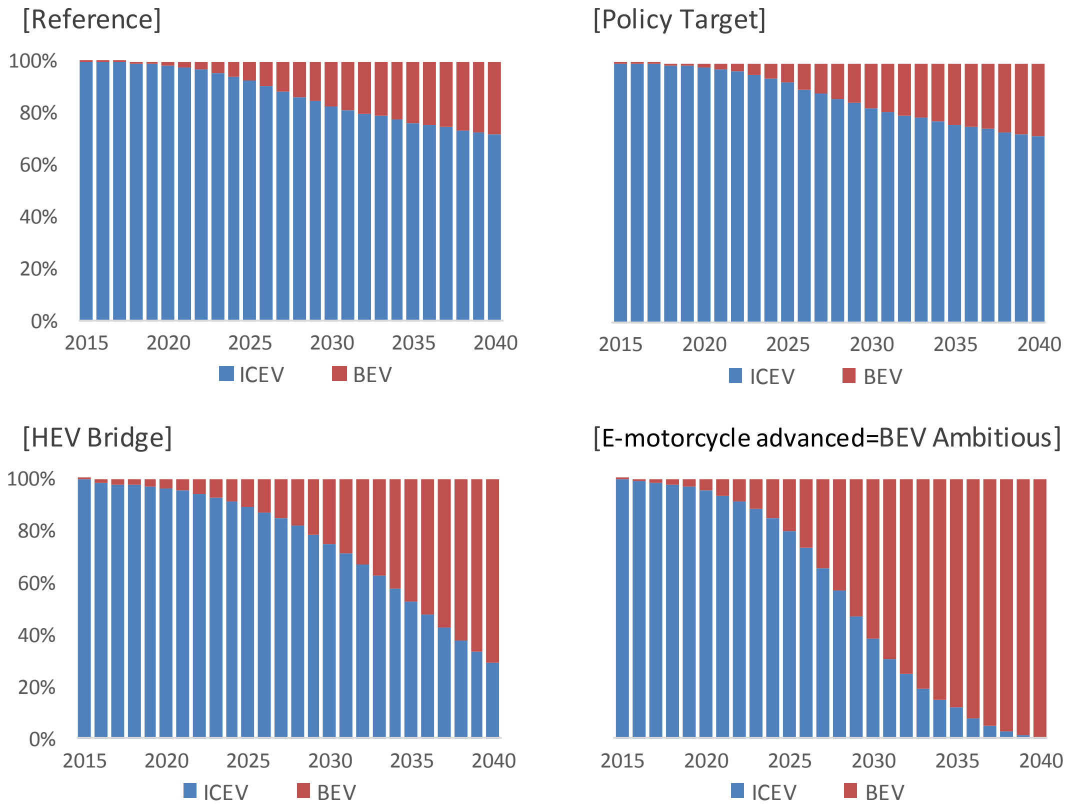
In 2016, Malaysia had 14.9 million cars, or about 485 cars per 1,000 people, which is around five times the average for ASEAN. With annual economic growth of 4%, the country will have 1.7 times more cars in 2040, and car ownership will exceed the current OECD average. The country has 12.7 million motorcycles, slightly fewer than cars. In 2040, motorcycles will increase 1.6 times, more slowly than cars. Powertrain sales share of car and motorcycles by scenario are shown in Figure 3.17 and Figure 3.18.

Figure 3.17: Powertrain Sales Share of Cars by Scenario, Malaysia



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.
Source: Authors' analysis.

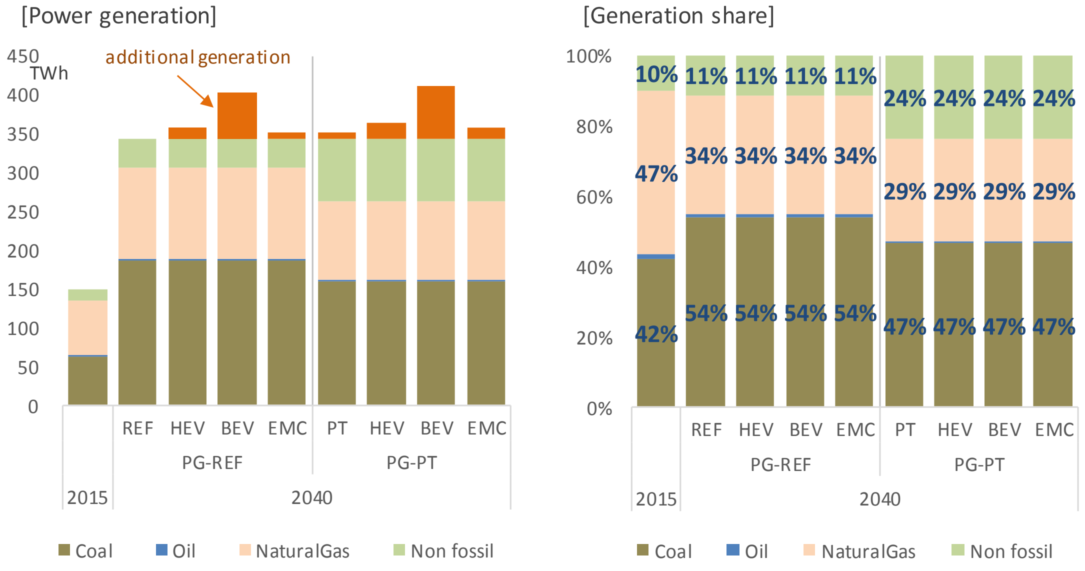
Figure 3.18: Powertrain Sales Share of Motorcycles by Scenario, Malaysia



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.
Source: Authors' analysis.

Electricity demand will increase due to EV penetration. In 2040, in the BEV ambitious scenario, required power generation increases by 58 TWh or 17% more than in the reference scenario, where power generation mix is 54% coal, 34% gas, and 11% non-fossil fuel (CO_2 emissions per kWh are 642 g-CO_2/kWh). In the policy target scenario, power generation mix is 47% coal, 29% gas, and 24% non-fossil fuel (CO_2 emissions per kWh are 551 g-CO_2/kWh), promoting low carbonisation.

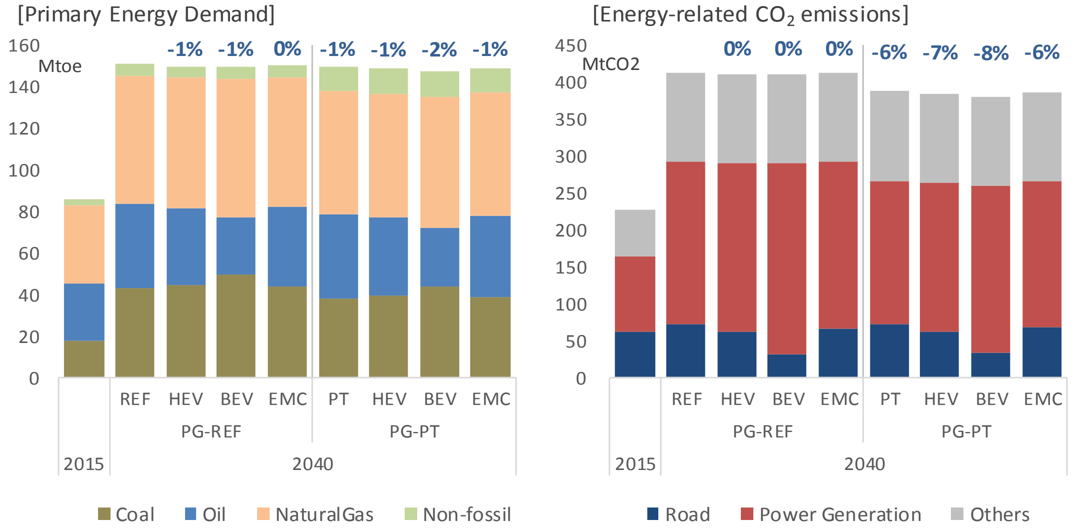
Figure 3.19: Power Generation and Generation Mix, Malaysia



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Note: Not including electricity imports.
Source: IEA (2017), authors' analysis.

Primary energy demand under the reference scenario for the power generation mix in the HEV bridge scenario and in the BEV ambitious scenario both decrease by only 1% compared with the reference scenario (Figure 3-20). The reason is that in the BEV ambitious scenario, oil demand in the transport sector decreases (13 Mtoe), whilst fuel input to the power generation sector increases (12 Mtoe). The scenarios contribute little to emission reductions. In the policy target scenario for power generation mix, the difference in emissions between the HEV bridge and the EV ambitious scenarios increases to about 1%.

Figure 3.20: Primary Energy Demand and Energy-related CO_2 Emissions, Malaysia

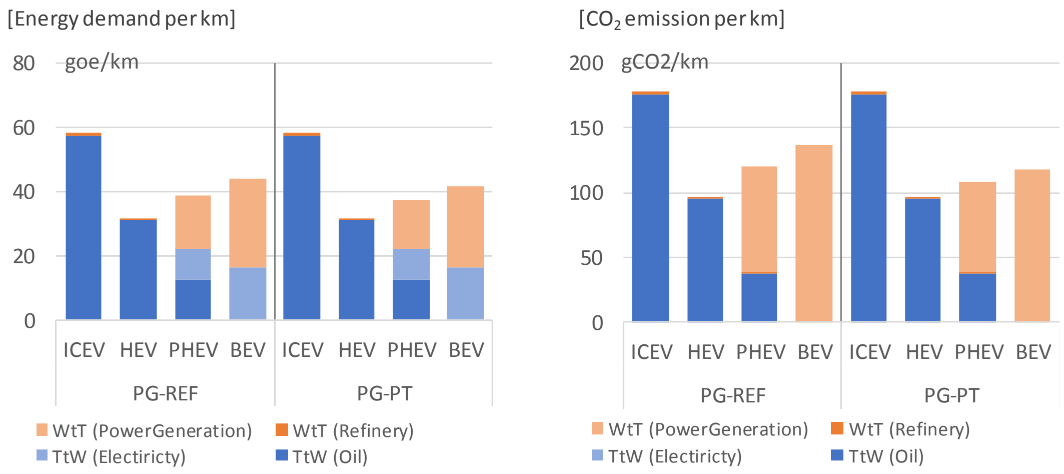


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Note: % show change rates from the reference scenario.
Source: IEA (2017), authors' analysis.

In 2040, BEVs consume less energy than ICEVs and more than HEVs because energy consumption is small in tank to wheel but large in well to tank. BEVs produce less CO_2 emissions than ICEVs and a certain CO_2 reduction effect can be expected. However, BEVs' CO_2 emissions in the policy target scenario for power generation mix remain larger than HEVs'.

Malaysia's energy self-sufficiency drops significantly in 2040 but the difference between scenarios is not large. The net import value of energy in the reference scenario in 2040 is US$14 billion but that in the BEV ambitious scenario greatly decreases to US$6 billion. The net import value of energy in the policy target scenario for power generation mix is further reduced.

Figure 3.21: Well to Wheel by Powertrain in Cars in 2040, Malaysia

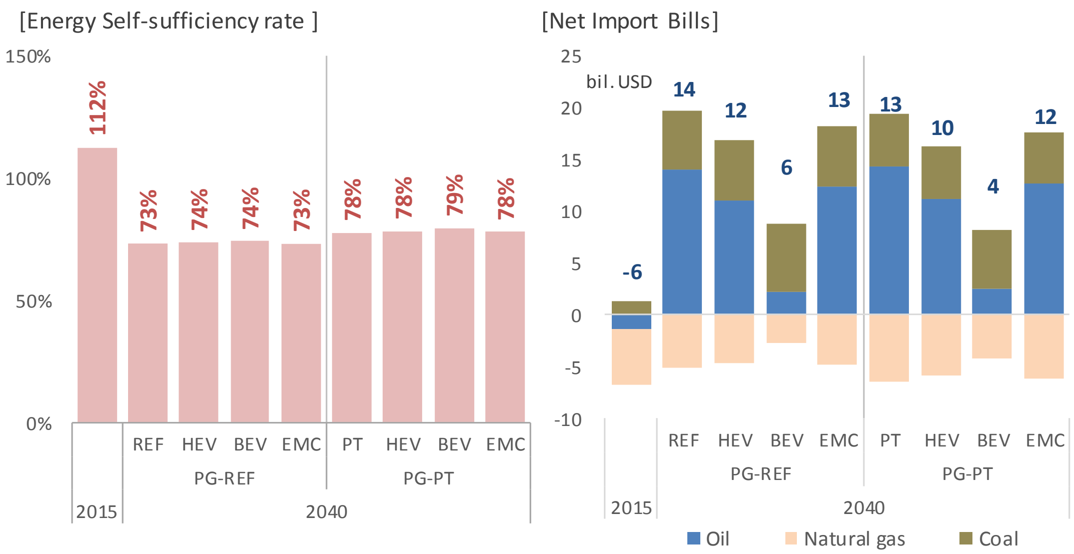


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target, TtW = tank to wheel, WtT = well to tank.

Note: Well to tank does not include energy consumption in fossil-fuel production and transport.

Source: Authors' analysis.

Figure 3.22: Energy Self-sufficiency Rate and Net Import Bills, Malaysia

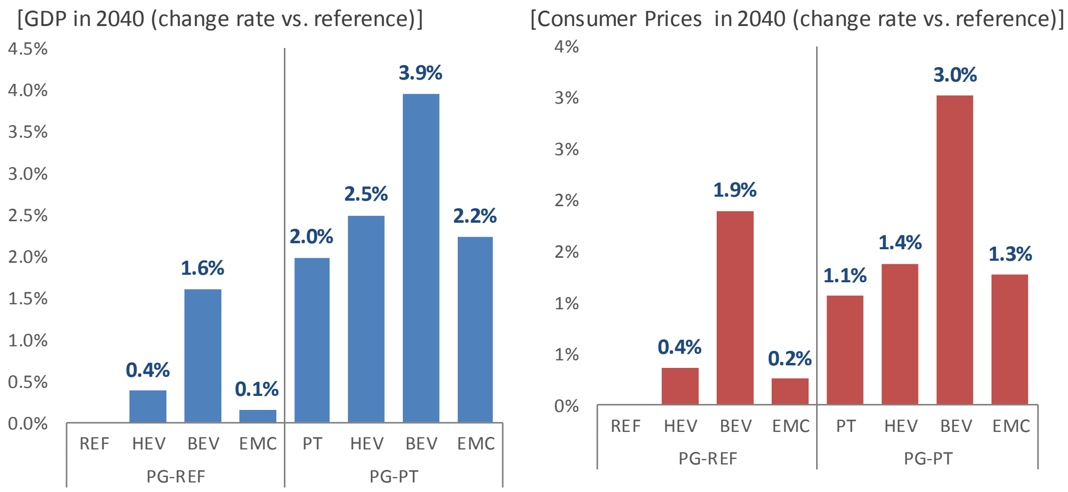


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.

Source: IEA (2017), authors' analysis.

xEVs' impact on GDP is positive because suppression of net imports such as petroleum and investments (additional cost for conventional technology) in xEVs (and low-carbon power) stimulate the economy. The economic impact of the e-motorcycle advanced scenario is insignificant. Investments in xEVs (and low-carbon power) do not expand production investments or supply capacity. As a result, supply and demand are tight and general prices rise greatly. In 2040, consumer prices in the BEV ambitious + policy target scenario for the power generation mix are 3% higher than the reference scenario.

Figure 3.23: Impacts on GDP and Consumer Prices, Malaysia

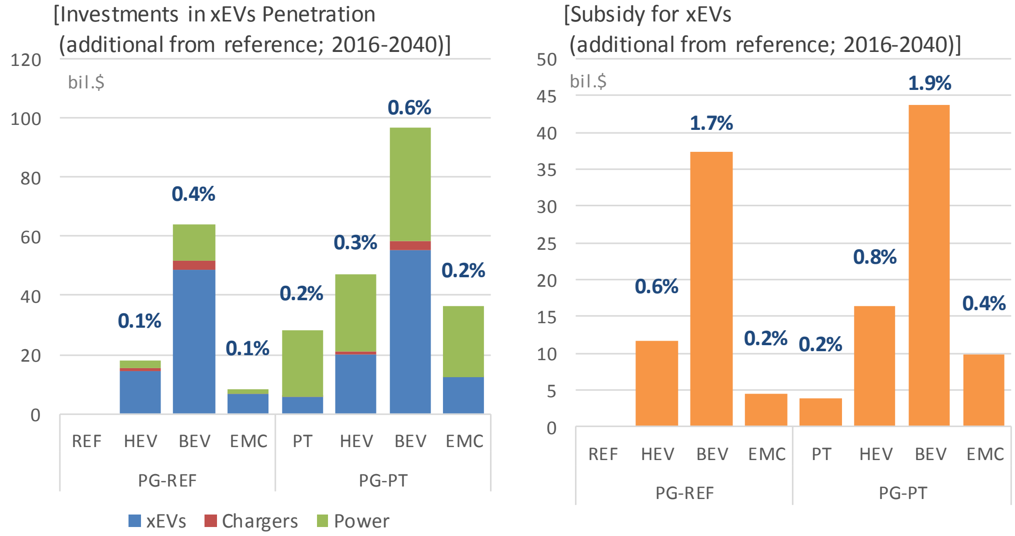


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Source: IEA (2017), authors' analysis.

Investment in xEV penetration (vehicle, charging facility, power-generating equipment) reaches US$18 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$64 billion in the BEV ambitious scenario. Cumulative investment accounts for 0.1% and 0.4% of cumulative GDP, respectively. In the policy target scenario for power generation mix, further investments for low-carbon power are required.

The HEV bridge and the BEV ambitious scenarios may not be realised in business as usual. To encourage purchase, subsidies will be required to bridge the price differences between ICEVs and xEVs. Assuming grant subsidies that shorten the payback period to half the average lifetime, the total subsidy is US$12 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$37 billion in the BEV ambitious scenario. Cumulative subsidy accounts for 0.6% and 1.7% of the cumulative government budget, respectively. However, subsidies to energy (gasoline, diesel oil, and electricity) are not considered. When BEVs increase, oil demand decreases and electricity demand increases. If the dropped subsidy for oil exceeds the additional subsidy for electricity, the above total amount may decrease, but if the subsidy for electricity is larger, the total amount increases.

Figure 3.24: Investments and Subsidy for xEVs, Malaysia

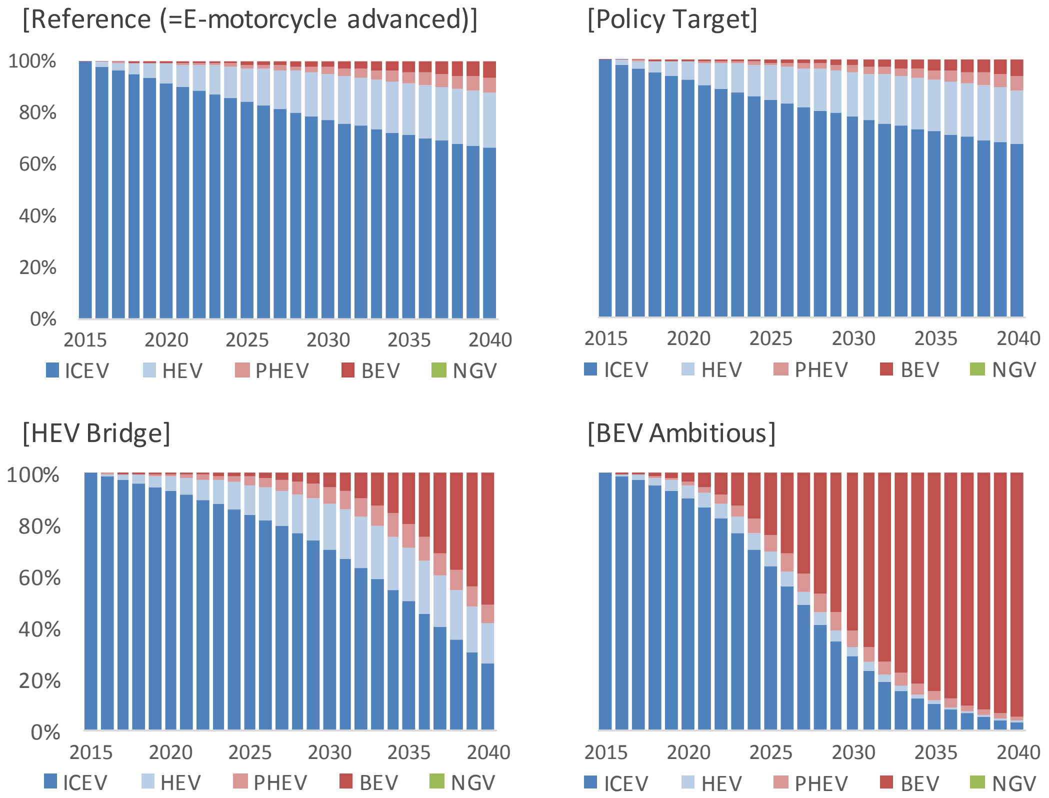


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Notes: 1. Assuming grant subsidies that shorten the payback period to half the average lifetime. 2. % shows investment ratios of GDP and subsidy ratios of government revenue.
Source: IEA (2017), authors' analysis.

2.4. Viet Nam

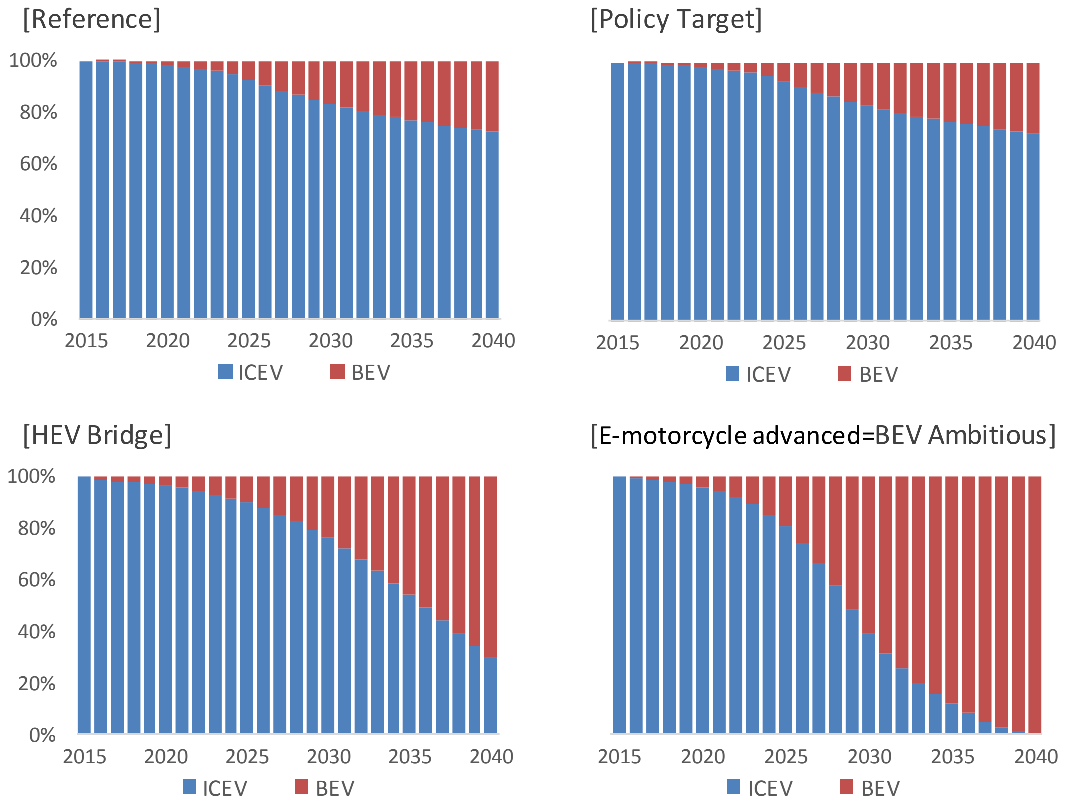
In 2016, Viet Nam had 2.5 million cars, or 27 cars per 1,000 people, far fewer than in other ASEAN countries. With high economic growth of 6% per year, the country will have 6.5 times more cars in in 2040. The country has 47.1 million more motorcycles than cars, with 500 motorcycles per 1,000 people. Because people can shift from motorcycles to cars, motorcycles will increase 1.6 times in 2040, more slowly than cars. Powertrain sales share of cars and motorcycles by each scenario are shown in Figure 3 and Figure 3.

Figure 3.25: Powertrain Sales Share of Cars by Scenario, Viet Nam



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.
Source: Authors' analysis.

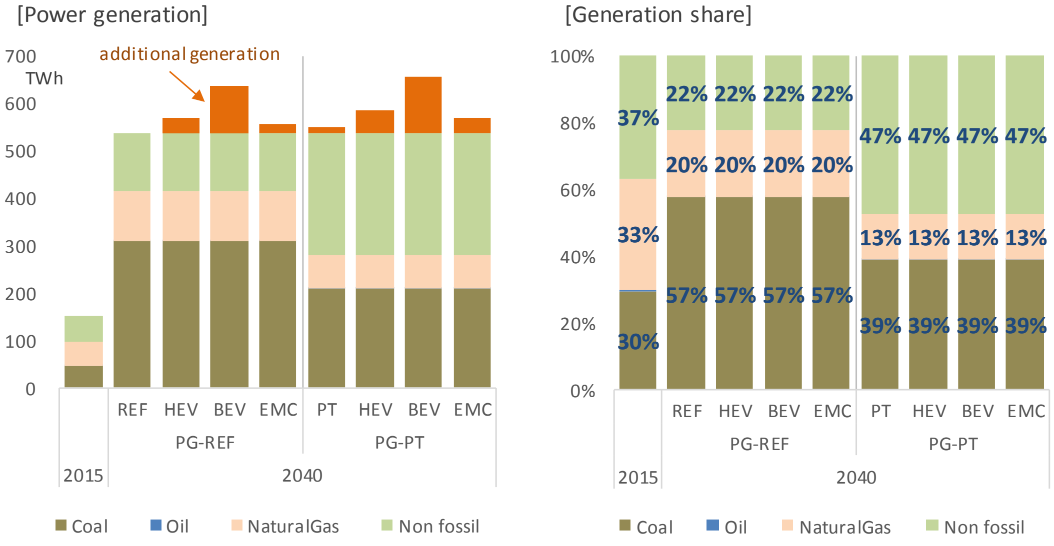
Figure 3.26: Powertrain Sales Share in Motorcycles by Scenario, Viet Nam



BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICEV = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle
Source: Authors' analysis.

Electricity demand will increase due to EV penetration. In 2040, in the BEV ambitious scenario, required power generation increases by 100 TWh or 19% more than in the reference scenario, where power generation mix is 57% coal, 20% gas, and 22% non-fossil fuel (CO_2 emissions per kWh are 614 g-CO_2/kWh). In the policy target scenario, power generation mix is 39% coal, 13% gas, and 47% non-fossil fuel (CO_2 emissions per kWh are 416 g-CO_2/kWh), promoting low carbonisation.

Figure 3.27: Power Generation and Generation Mix, Viet Nam



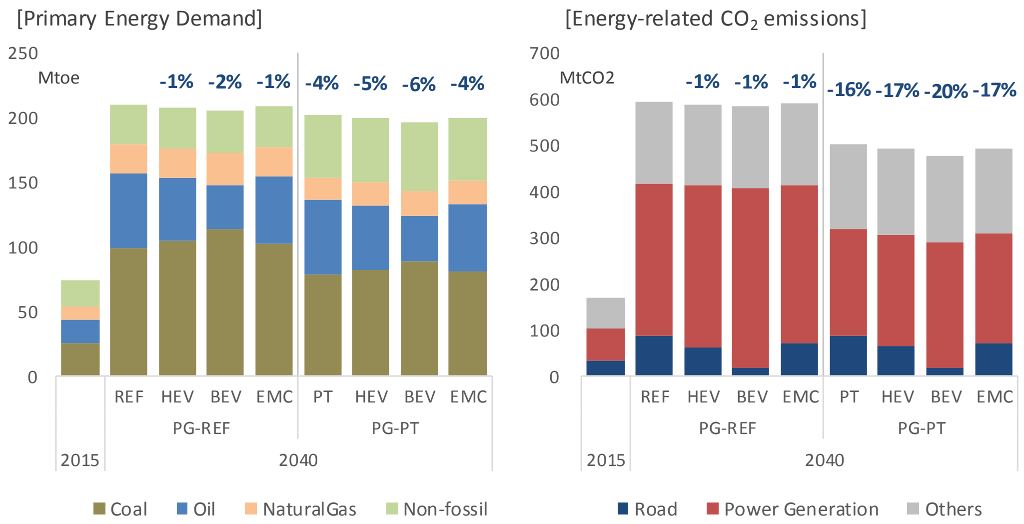
REF = reference, PT = policy target, HEV = HEV bridge, BEV = BEV ambitious, EMC = e-motorcycle advanced, PG = power generation.

Note: Not including electricity imports.

Source: IEA (2017), authors' analysis.

Primary energy demand under the reference scenario for the power generation mix in the HEV bridge scenario and in the BEV ambitious scenario decreases by only 1% and 2%, respectively, compared with the reference scenario (Figure 3-28). The reason is that in the BEV ambitious scenario, oil demand in the transport sector decreases (23 Mtoe), whilst fuel input to the power generation sector increases (19 Mtoe). xEV penetration does not lead to large emission reductions, and the difference in emissions between the HEV bridge and the BEV ambitious scenarios is insignificant. In the policy target scenario for power generation mix, the difference in emissions between the HEV bridge and the BEV ambitious scenarios increases to about 3%.

Figure 3.28: Primary Energy Demand and Energy-related CO_2 Emissions, Viet Nam



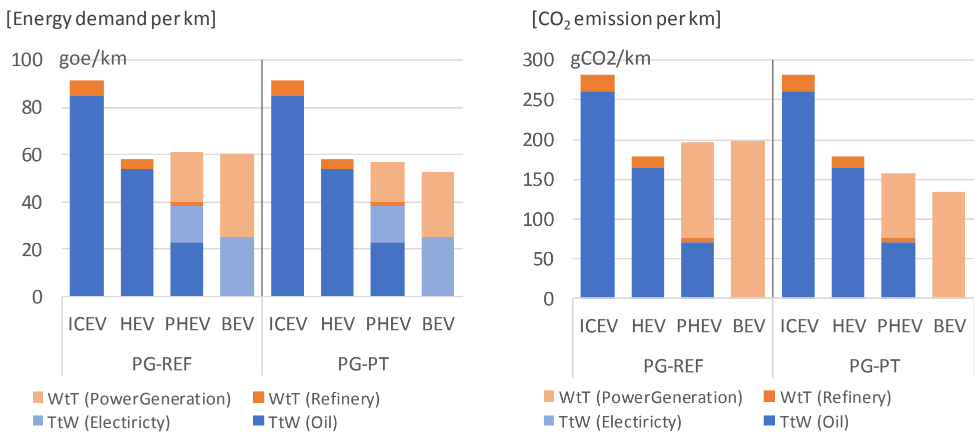
BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.

Notes: 1. % shows the change rate from the reference scenario. 2. Replacing by geothermal power (primary conversion efficiency of 5%) increases the primary energy.

Source: IEA (2017), authors' analysis.

In 2040, BEVs consume less energy than ICEVs and almost the same as HEVs because consumption is small in tank to wheel but large in well to tank. BEVs produce less CO_2 emissions than ICEVs and a certain CO_2 reduction effect can be expected. However, BEVs' CO_2 emissions in the reference scenario for power generation mix are larger than HEVs' (Figure 3.29). In the policy target scenario for power generation mix, BEVs' CO_2 emissions are lower than HEVs'.

Figure 3.29: Well to Wheel by Powertrain in Cars in 2040, Viet Nam



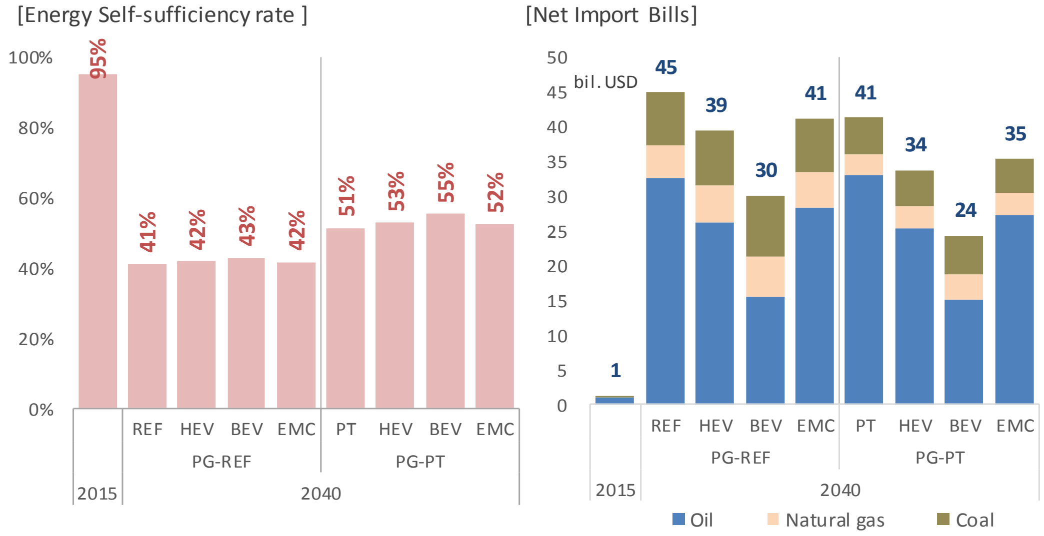
BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target, TtW = tank to wheel, WtT = well to tank.

Note: Well to tank does not include energy consumption in fossil fuel production and transport.

Source: Authors' analysis.

Viet Nam's energy self-sufficiency drops significantly in 2040 but the difference between scenarios is not large. The net import value of energy in the reference scenario in 2040 is US$45 billion but that in the BEV ambitious scenario greatly decreases to US$30 billion. The net import value of energy in the policy target scenario for power generation mix is further reduced.

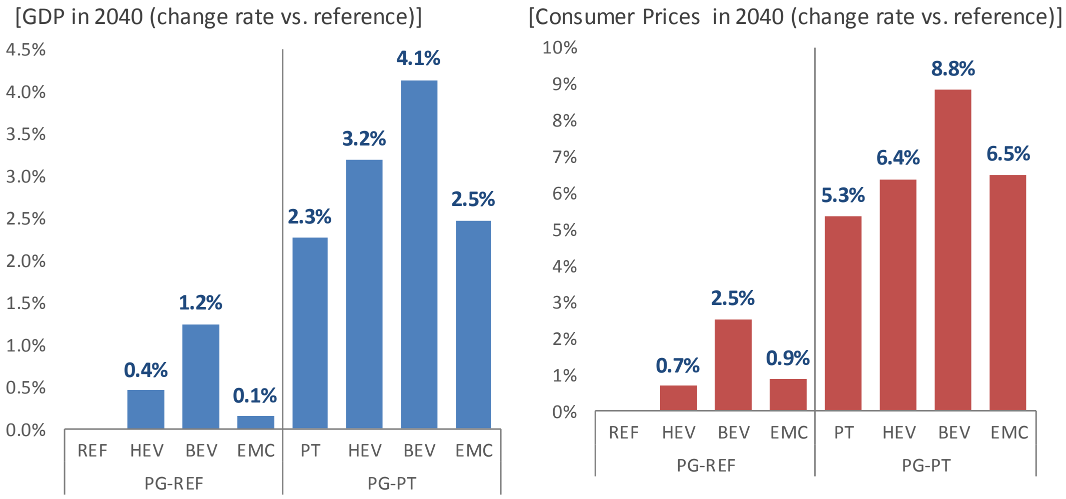
Figure 3.30: Energy Self-sufficiency Rate and Net Import Bills, Viet Nam



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Source: IEA (2017), authors' analysis.

xEVs' impact on GDP is slightly positive because suppression of net imports such as petroleum and investments (additional cost for conventional technology) in xEVs (and low-carbon power) stimulate the economy. The economic impact of the e-motorcycle advanced scenario is insignificant. Investments in xEVs (and low-carbon power) do not expand production investments or supply capacity. As a result, supply and demand are tight and general prices rise greatly. In 2040, consumer prices in the BEV ambitious + policy target scenario for power generation mix are 9% higher than in the reference scenario.

Figure 3.31: Impacts on GDP and Consumer Prices, Viet Nam

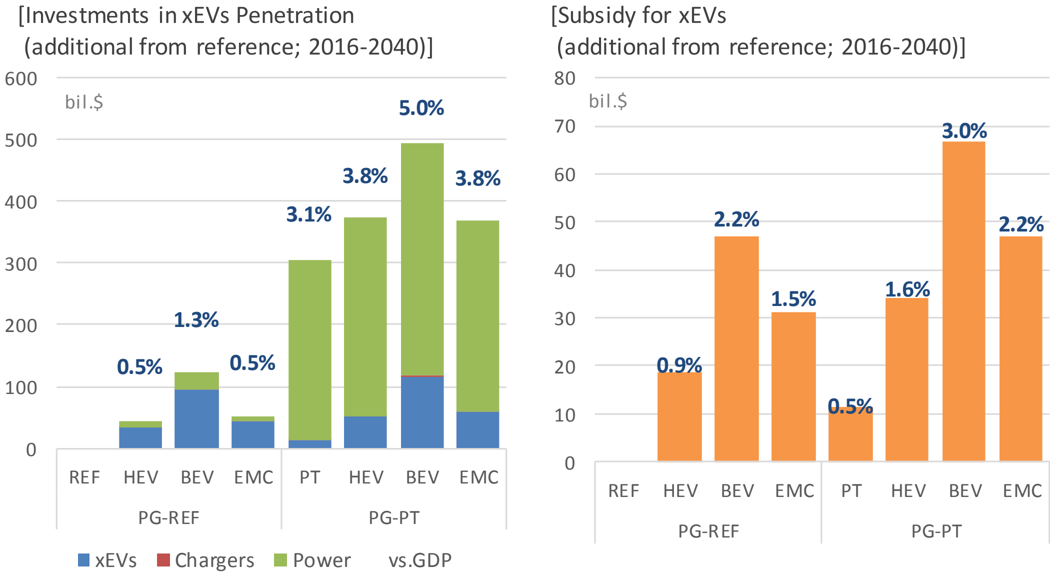


BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Source: IEA (2017), authors' analysis.

Investment in xEV penetration (vehicle, charging facility, power-generating equipment) reaches US$44 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$123 billion in the BEV ambitious scenario. Cumulative investment accounts for 0.5% and 1.3% of cumulative GDP, respectively. In the policy target scenario for power generation mix, further investments for low-carbon power are required.

The HEV bridge and the BEV ambitious scenarios may not be realised in business as usual. To encourage purchase, subsidies will be required to bridge the price differences between ICEVs and xEVs. Assuming grant subsidies that shorten the payback period to half the average lifetime, the total subsidy will be US$19 billion (cumulative in 2016–2040) in the HEV bridge scenario and US$47 billion in the BEV ambitious scenario. Cumulative subsidy accounts for 0.9% and 2.2% of the cumulative government budget, respectively. However, subsidies to energy (gasoline, diesel oil, and electricity) are not considered. When BEVs increase, oil demand decreases and electricity demand increases. If the dropped subsidy for oil exceeds the additional subsidy for electricity, the above total amount may decrease, but if the subsidy for electricity is larger, the total amount increases.

Figure 3.32: Investments and Subsidy for xEVs, Viet Nam



BEV = battery electric vehicle ambitious, EMC = electric motorcycle advanced, HEV = hybrid electric vehicle bridge, REF = reference, PG = power generation, PT = policy target.
Notes: 1. Assuming grant subsidies that shorten the payback period to half the average lifetime. 2. % shows investment ratios of GDP and subsidy ratios of government revenue.
Source: IEA (2017), authors' analysis.

3. Implications of the Results

The influence of xEV penetration on overall energy demand and CO_2 emissions is not large. BEVs, especially, will decrease oil demand in the transport sector but increase fuel input to the power generation sector. If CO_2 emissions are not reduced in the power generation sector, BEV penetration will have limited effect on reducing CO_2 emissions, which is a big issue in ASEAN countries that largely depend on coal-fired power generation. The energy self-sufficiency ratios in each scenario are not much different because imports of petroleum products for vehicles will decrease whilst imports of coal and natural gas for power generation will increase.

Even if coal and natural gas imports increase, a decrease in imports of petroleum products leads to a decrease in net imports of energy because the unit cost of petroleum products per calorific value is higher than that of coal and gas. BEVs improve the trade balance more than HEVs do, which has a positive impact on the economy. Investment in xEVs stimulates the economy. BEVs have a slightly bigger effect on the economy than HEVs do because investment in BEVs is bigger than in HEVs. Since investment in the xEV environment does not contribute to expanding the supply capacity of goods and services, supply and demand in the whole economy will tighten and general prices will rise greatly.

The required investments in xEV penetration, including vehicles, charging facilities, and power-generation capacity, are large. Investment costs for BEVs are several times more than for HEVs. Investment in low-carbon power supply such as renewable energy is required to make clean BEVs based on well to wheel. Fund procurement for xEV penetration must be considered. The HEV bridge and BEV ambitious scenarios may not be realised in business as usual unless subsidies bridge the price differences between ICEVs and xEVs. Total subsidies for BEVs will be several times those for HEVs and put pressure on government finances.

The HEV bridge and BEV ambitious scenarios are not significantly different in their influence on the 3Es' energy and environment (CO_2 emissions). The influence of the 3Es' economy on GDP is also small but the BEV ambitious scenario greatly increases prices. The scenario also has implementation costs such as investment funds and subsidies for xEV penetration, which are several times larger than for the HEV bridge scenario.