Chapter 2

Economic and Energy Outlook up to 2040

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Chapter 2

Economic and Energy Outlook up to 2040

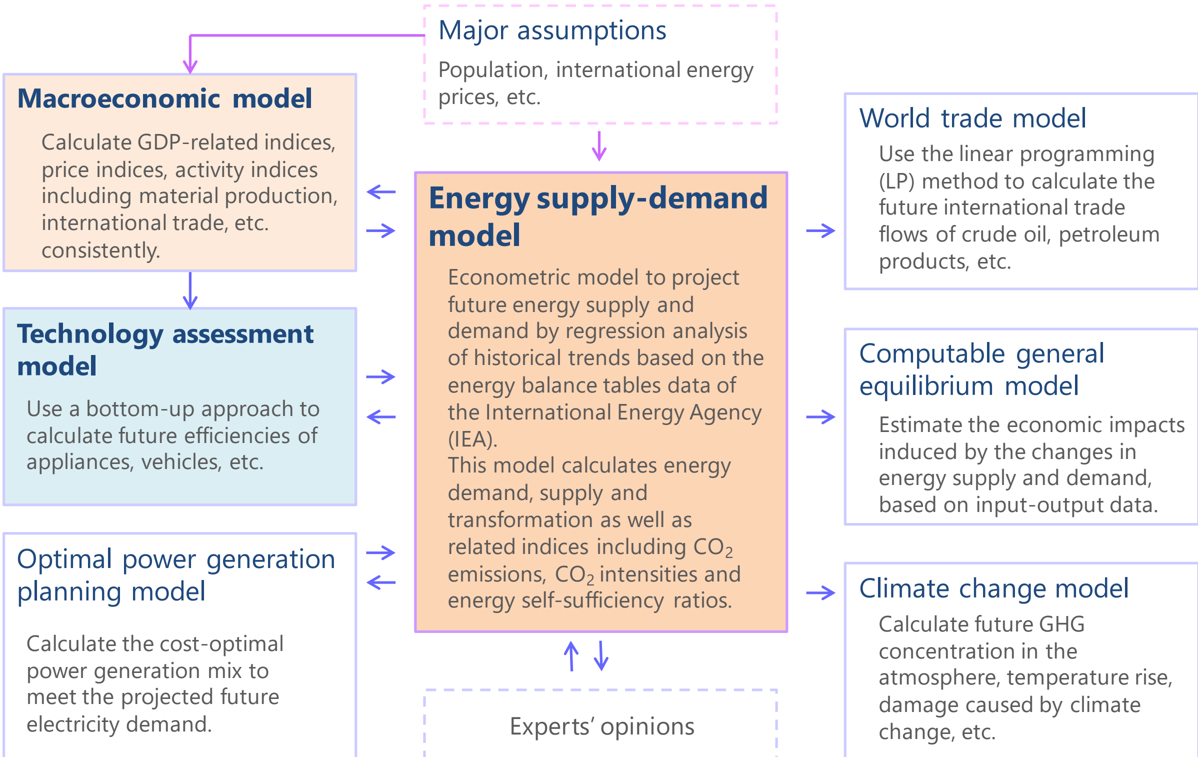
1 Modelling Framework

This study develops some scenarios focusing on xEV penetration and examines how each scenario might influence the energy and economy. To quantitatively assess the influences, we build economic and energy models for Indonesia, Thailand, Malaysia, and Viet Nam.

1.1 Economic and Energy Analysis Model

We use the energy analysis model of the Institute of Energy Economics, Japan (IEEJ) (Figure 2-1). The energy supply–demand model allows the projection of future energy supply and demand by regression analysis of historical trends. The model, which can calculate energy demand, supply, and transformation, as well as related indices, including CO_2 emissions and energy self-sufficiency rate, relies on the energy balance tables of the International Energy Agency (IEA).

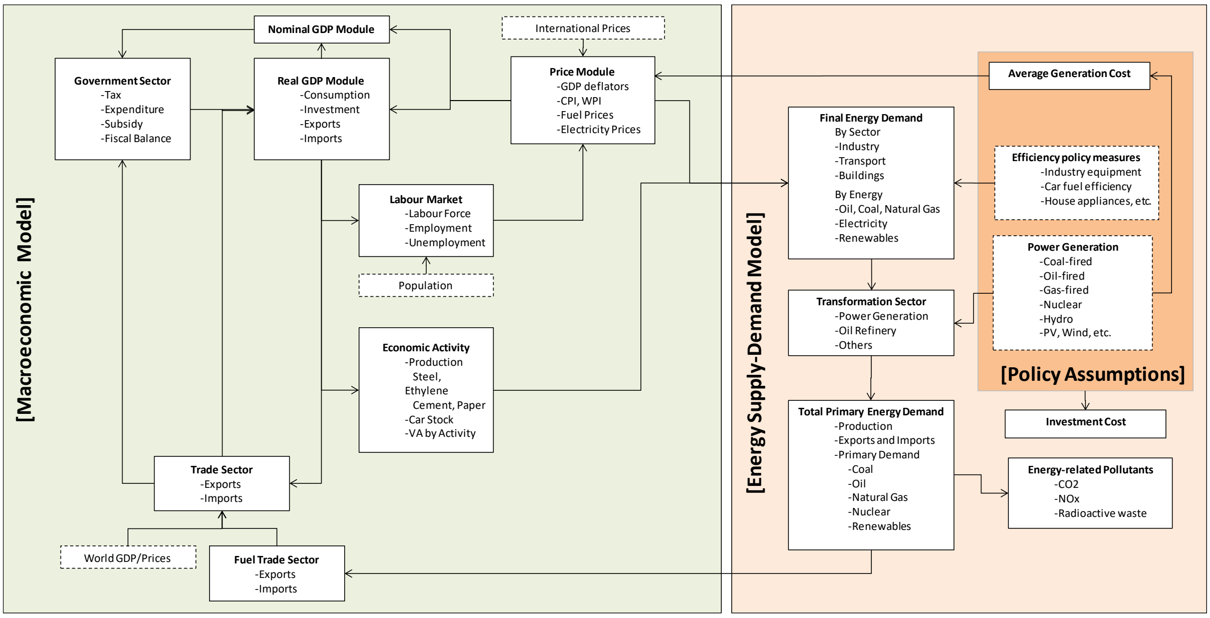
Figure 2-1. The Institute of Energy Economics, Japan's Energy Modelling Framework



GHG = greenhouse gas, GDP = gross domestic product.
Source: IEEJ (2019).

Energy supply and demand structure changes influence the macroeconomy through energy trade and costs. In other words, the macroeconomy and energy structure depend on each other. Econometric models that integrate them can project future macroeconomic and energy supply and demand structures (Figure 2-2).

Figure 2-2. Macroeconomic and Energy Model



CPI = consumer price index, WPI = wholesale price index, VA = value added, PV = photovoltaic, GDP = gross domestic product.
Source: ERIA (2019).

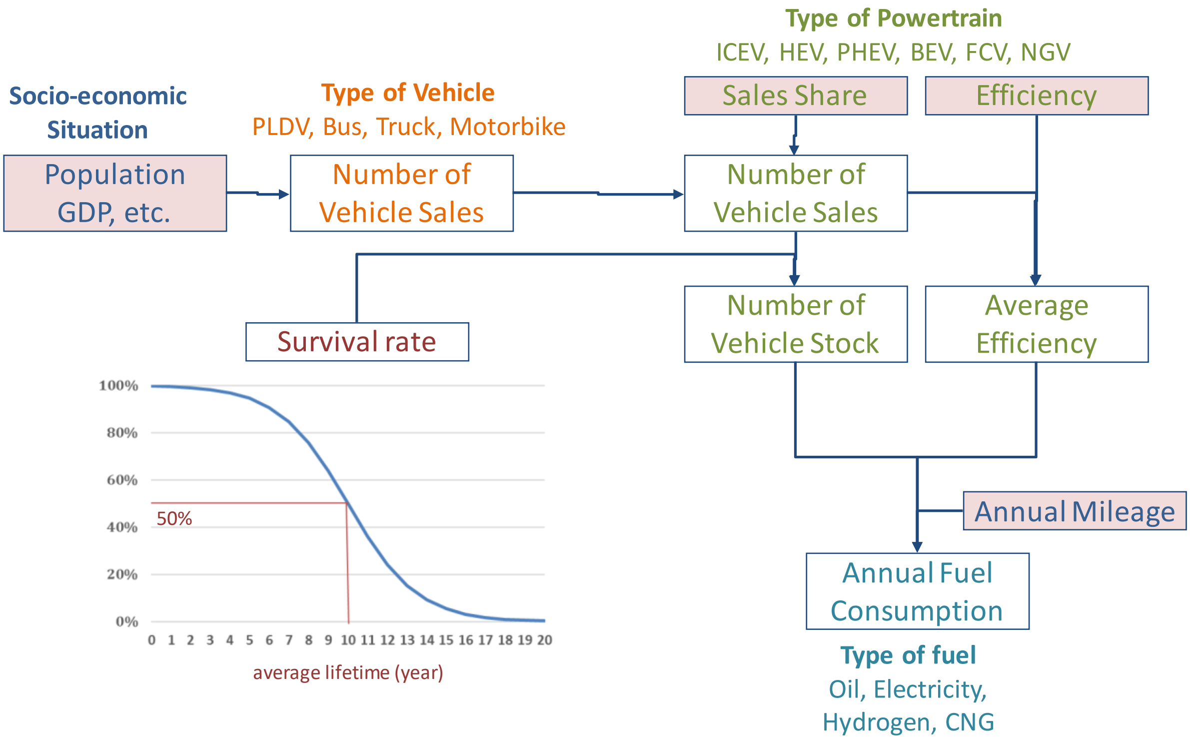
The macroeconomic model projects a commensurately balanced economic structure, including consumption, investment, trade, government, and general prices, and calculates economic activity indicators (including production and vehicle ownership) that directly and indirectly influence energy demand. The model is an econometric one that includes interdependent variables and allows prices and other variables to serve as coordinators amid a widening supply–demand gap to achieve partial equilibrium.

Assumptions for more energy-efficient household appliances and automobiles are needed for the energy supply–demand model. These assumptions are based on the technology assessment model, which uses the bottom-up approach to calculate future efficiencies of appliances, vehicles, etc.

1.2 Technology Assessment Model for Automobiles

The technology assessment for automobiles employs the turnover model, which deals with four vehicle types: passenger light-duty vehicle (PLDV), bus, truck, and motorbike (Figure 2-3). To analyse how a powertrain mix, especially electrification, could affect fuel demand in the road sector, this model considers six types of powertrain: internal combustion engine vehicle (ICEV), HEV, PHEV, BEV, fuel-cell vehicle, and natural-gas vehicle.

Figure 2-3. Technology Assessment Model (Vehicle Turnover Model)



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, PLDV = passenger light-duty vehicle, CNG = compressed natural gas, GDP = gross domestic product.
Source: ERIA (2019)

After estimating future vehicle sales and shares of powertrain types (see the next section), the model estimates future stock, based on the survival rate. The survival rate describes how many vehicles are on the road in a certain year after being sold. A logistic curve is utilised to shape survival rates and set 50% as the average lifetime. When addressing the powertrain type for each year's sales, the model can estimate average fuel efficiency on the road.

Total fuel consumption in each year can be calculated by multiplying the number of vehicles, average fuel efficiency, and annual mileage. Fuel types analysed in this study are oil, electricity, hydrogen, and compressed natural gas.

1.3 Multinomial Logit Model for Powertrain Choice

Powertrain sales shares are estimated using the multinomial logit model. We set utilities for using each powertrain and then calculate the ratio of the exponential function of its utility using Napier's number (e). This ratio is considered selection probability: sales share.

$$(\boldsymbol{equation}\ 1)\ Sales\ Share_i = \frac{exp(Utility_i)}{\sum_i exp(Utility_i)}$$

i (type of powertrain) = ICEV, HEV, PHEV, BEV, fuel-cell vehicle, natural gas vehicle

$$(equation\ 2)\ \ Utility_i = U(Vehicle\ cost_i, Fuel\ cost_i, Cruising\ distance_i, GDP, etc.)$$

The utility is estimated by initial cost, running cost, income level, cruising distance, charging time, and so on. When the initial and running cost is lower, the utility is higher. The utility for xEVs depends on cruising distance. Higher income is assumed for users that purchase more expensive cars.

2 Reference Scenario

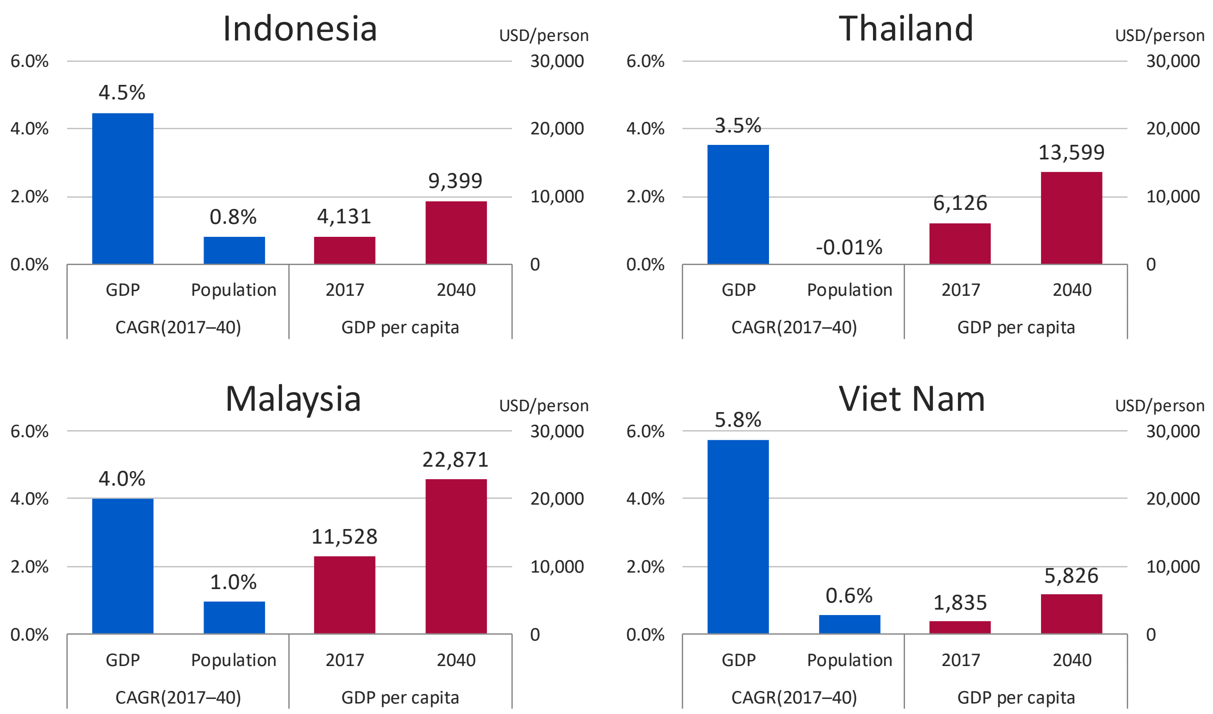
A reference scenario is used as the baseline to evaluate quantitative effects of alternatives. The reference scenario is assumed to continue historical trends without strengthening policy measures.

2.1 Demographic Assumptions

Population assumptions are from the United Nations' World Population Prospects (Figure 2-4). According to the reference scenario, population will grow at about 1% annually until 2040 in Indonesia, Malaysia, and Viet Nam. In Thailand, population will peak by 2030, then decline almost to today's level due to ageing.

Average GDP growth will be higher in Viet Nam (5.8%) and Indonesia (4.5%). Both countries have a young demographic structure and the potential to increase their GDP per capita. Malaysia, a richer country, is also growing steadily at about 4%. In Thailand, economic growth will be more moderate than in other countries due to demographic factors.

Figure 2-4. Assumptions for GDP and Population



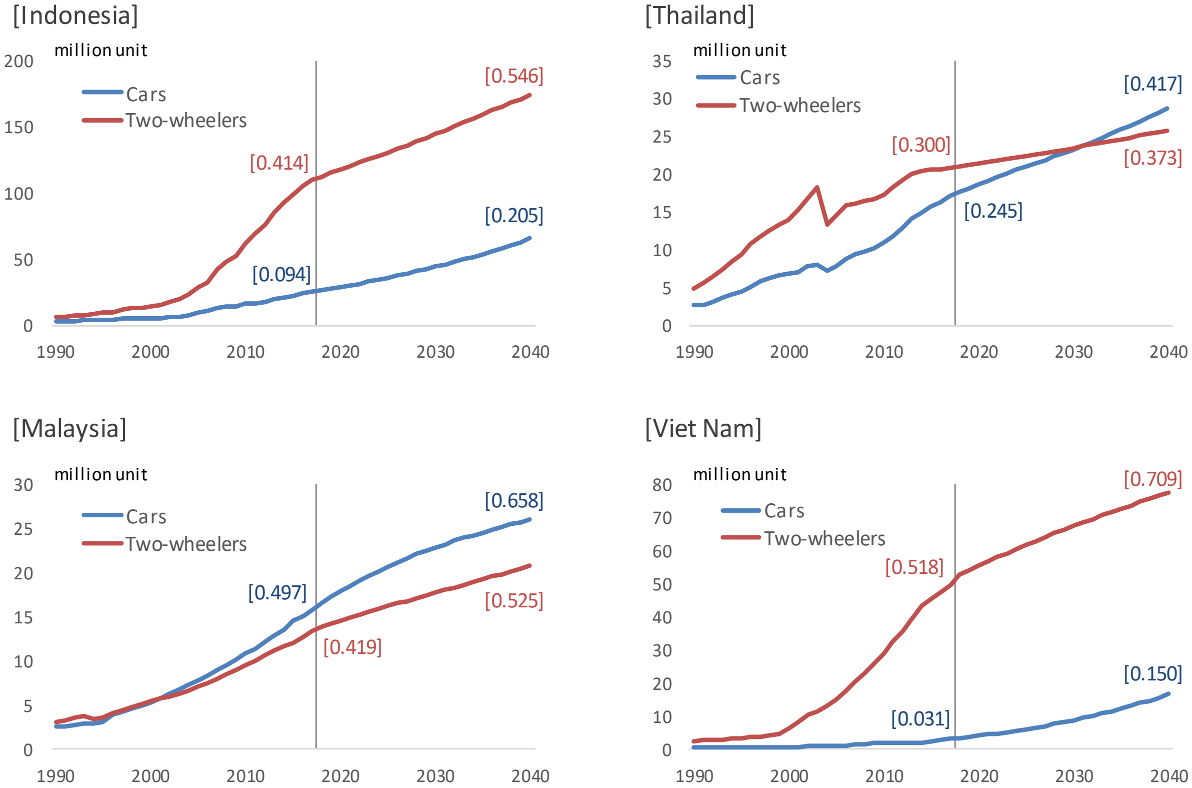
GDP = gross domestic product, CAGR = compound annual growth rate.
Sources: World Bank (2019), United Nations (2019), and author's analysis.

2.2 Automobile Penetration

According to the reference scenario, the car (PLDV, bus, and truck) stock[2] in the four countries is projected to increase 2.3 times to 136 million units by 2040 (Figure 2-5), from 131 per 1,000 people in 2017 to 255 in 2040, which is still much lower than the Organisation for Economic Co-operation and Development average of 617 per 1,000 people in 2017. Cars in Viet Nam will increase more than five times and in Indonesia around three times. Growth in Thailand and Malaysia will be less than two times because ownership rates are already relatively high.

Motorcycles, which are more than three times the number of cars today, will increase 1.5 times. Growth will be more moderate than for cars in all countries. Each country except Malaysia will have higher motorbike than car ownership. In Viet Nam, especially, more than 500 per 1,000 people own motorbikes and that number could increase to about 700 by 2040.

Figure 2-5. Outlook for Vehicle Stock



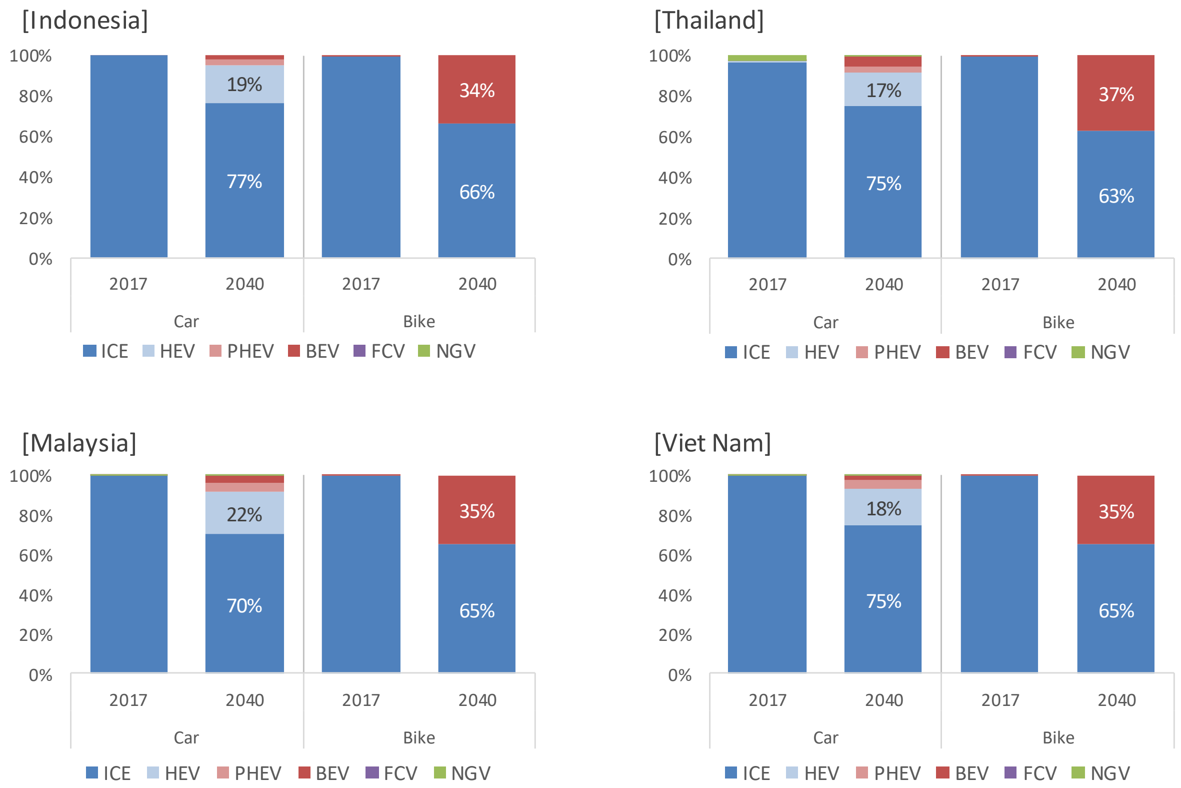
Note: Numbers in parentheses show stocks per person.
Sources: Indonesia: BPS – Statistics Indonesia (2018) https://www.bps.go.id/ (accessed 1 August 2019); Viet Nam: Ministry of Transport (2018) https://mt.gov.vn/en/Pages/default.aspx (accessed 1 August 2019); Thailand: Department of Land Transport (2018) https://www.dlt.go.th/en/ (accessed 1 August 2019); Malaysia: Malaysia Informative Data Centre (2018) https://mysidc.statistics.gov.my/index.php?lang=en (accessed 1 August 2019); and authors' analyses.

[2] We do not consider the effects of carsharing, the future of which is challenging to estimate.

For the mix by powertrain (Figure 2-6), conventional ICEVs will remain dominant up to 2040 and HEVs will gradually increase their sales share to around 20% in the reference scenario.Sales shares of PHEVs and BEVs will increase to only around 3% of total car sales by 2040 due to higher costs and shorter cruising distances than those of other powertrains.

E-motorcycles will make up around 35% of the motorcycle market due to the small price gap between ICEVs and BEVs.

Figure 2-6. Sales Share by Powertrain



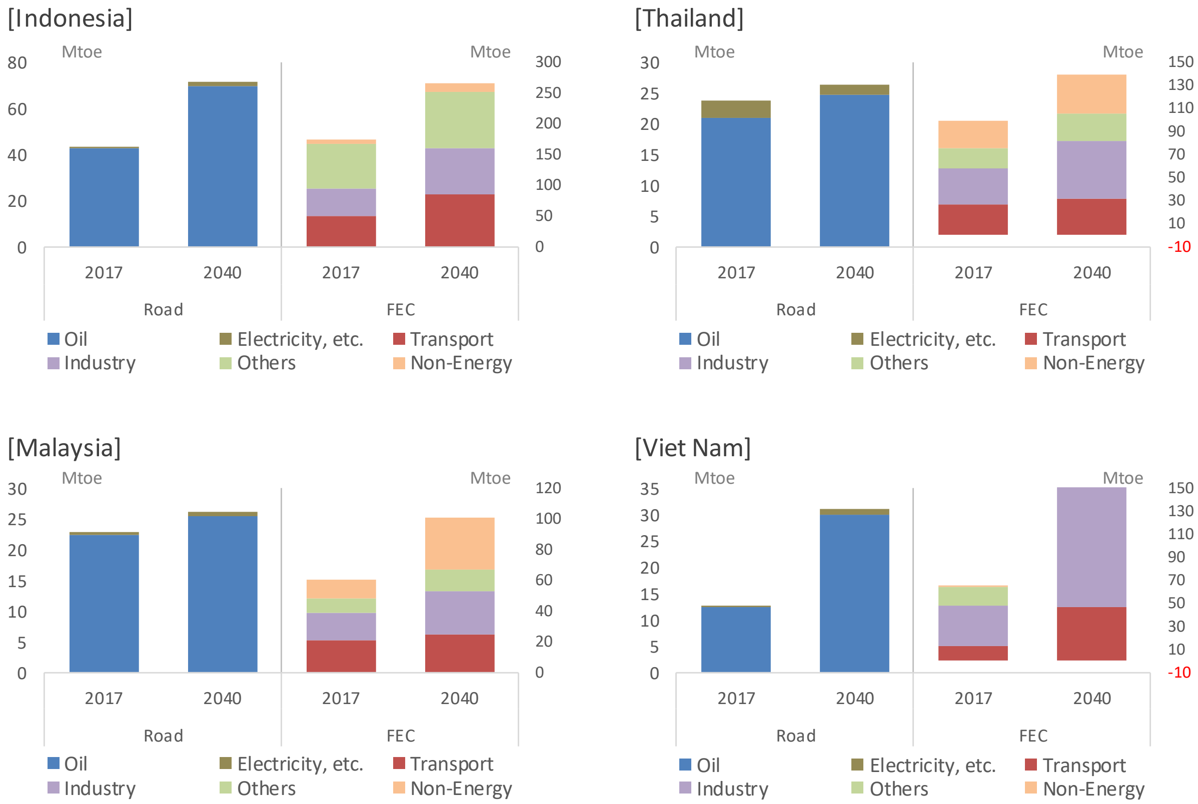
BEV = battery electric vehicle, FCV = fuel-cell vehicle, HEV = hybrid electric vehicle, ICE = internal combustion engine vehicle, NGV = natural gas vehicle, PHEV = plug-in hybrid vehicle.
Source: Authors' analysis.

2.3 Fuel Consumption in the Road Sector

According to the reference scenario, road sector fuel consumption, mostly oil, will increase 1.5 times by 2040 in the four countries (Figure 2-7). Growth of energy demand will be slow relative to car stocks due to efficiency improvements, including the shift to HEVs from ICEVs. Consumption in Viet Nam will increase by 2.5 times by 2040, whilst in Malaysia, oil consumption for automobiles will peak and then decline before 2040.

Energy demand in the transport sector, including the road sector, will rapidly increase. Transport sector shares in the final energy consumption will rise by 4% in Indonesia and Viet Nam, respectively. Meanwhile, in Thailand and Malaysia, the shares in the final energy consumption will decline by 5 and 10 percentage points, respectively, in 2040 from today.

Figure 2-7. Energy for the Road Sector and Total Final Consumption



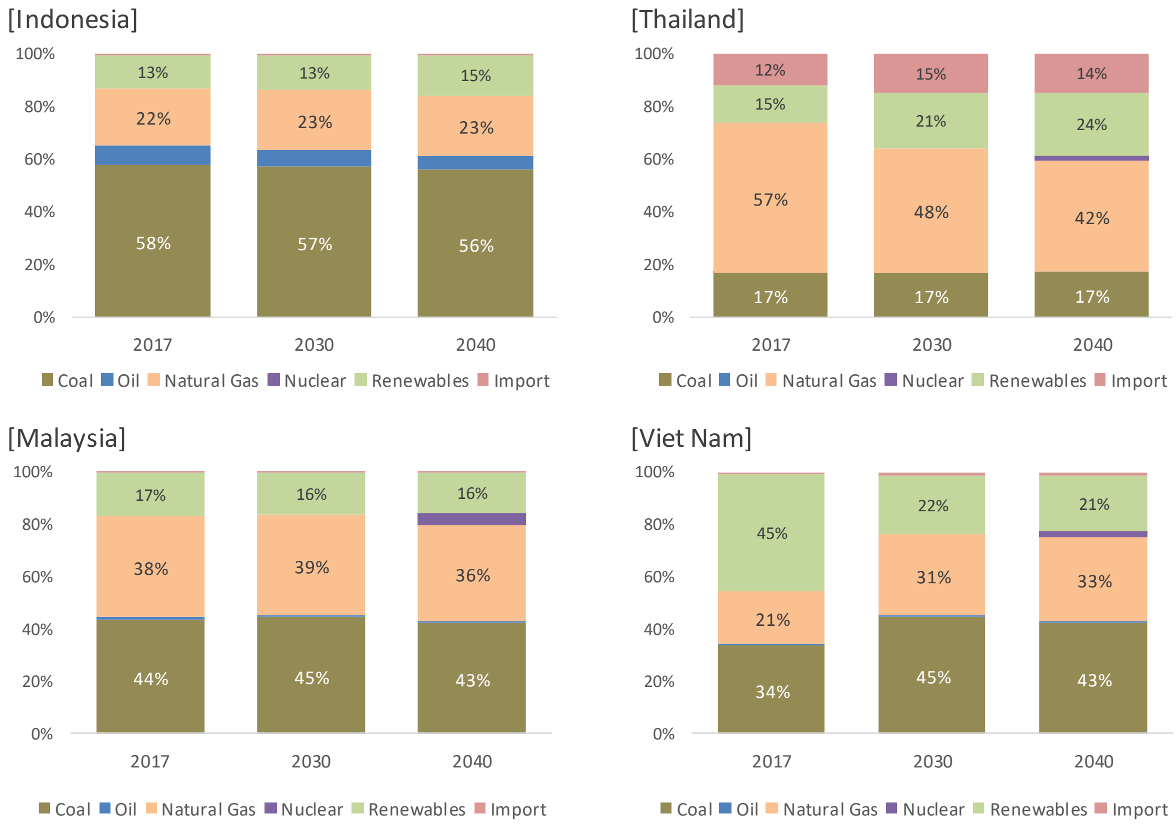
Mtoe = million tonnes of oil equivalent, FEC= final energy consumption.
Source: IEA (2019a), IEEJ (2019), and authors' analysis.

2.4 Primary Energy Demand and CO_2 Emissions

According to the reference scenario, the demand for electricity will grow faster than other fuels, along with developments in the economy and living standard improvements. In the four countries, the power demand will increase by 4.2% annually, and the share of electricity demand in the final consumption will increase from 16% today to 23% in 2040. The power demand will increase by 2.8 times in Indonesia and 3.6 times in Viet Nam, while, in Thailand and Malaysia, the demand will increase at a relatively slow pace, by 2.0 times and 1.8 times, respectively.

The growing demand for electricity will mainly be met by thermal power generation with its relatively low cost and abundant resources (Figure 2-8). In Indonesia, coal-fired power will remain mainstream, with more than 50% of the generation mix. In Thailand, the proportion of natural gas will decrease, while renewable energy, such as solar and biomass, will increase. In Malaysia, the dependency on the thermal generation will remain unchanged but nuclear power is expected to be introduced. In Viet Nam, thermal power generation will meet the growing electricity demand. The share of renewable energy, mainly hydropower, will dramatically decrease.

Figure 2-8. Power Generation Mix



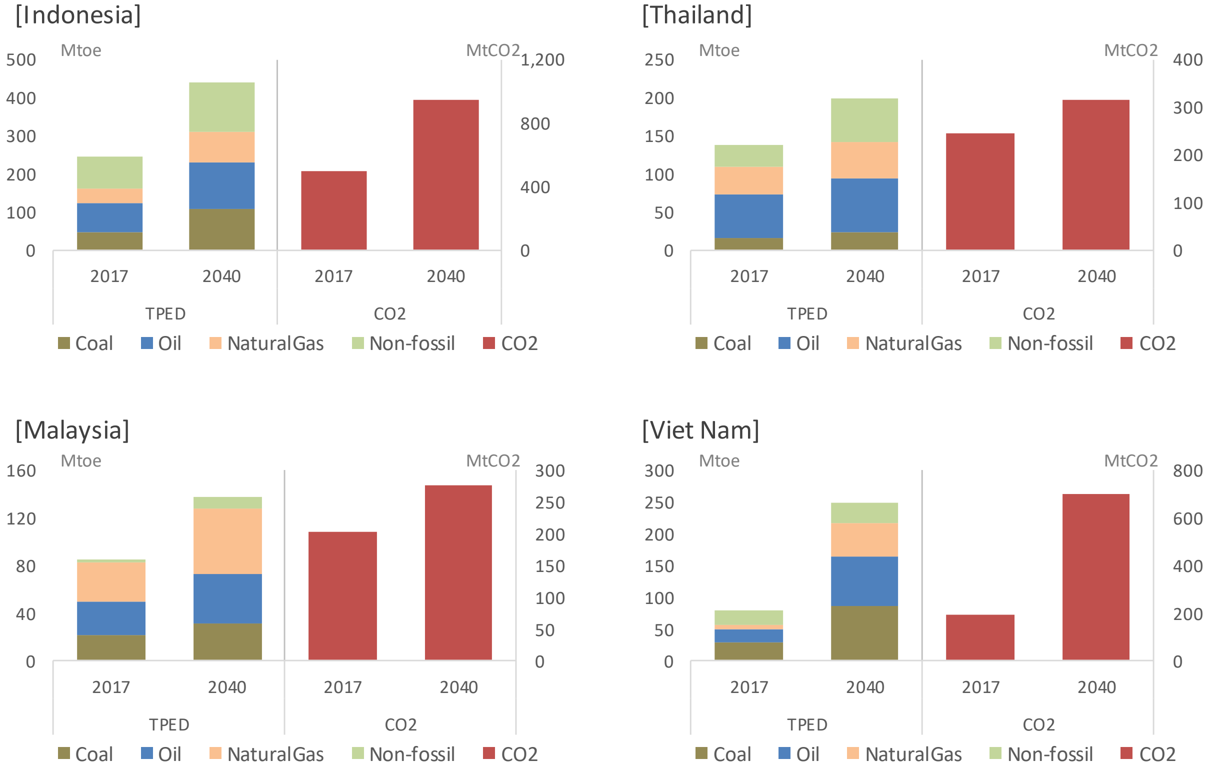
Source: IEA (2019a), IEEJ (2019), and authors' analysis.

Total primary energy demand, which combines the final energy consumption and the transformation sector, including power generation, will increase annually by 2.6% in Indonesia, 5.1% in Viet Nam, 1.6% in Thailand and 2.1% in Malaysia (Figure 2-9). These growth rates are much lower than their economic growth rates, which means that energy efficiency is rapidly improving.

Coal demand will grow at higher rates than other fuels in each country, especially in power generation, to meet rapidly growing electricity demand. Gas demand will also grow rapidly due mainly to its use in the generation sector. Oil demand, mainly for transport and building, and chemical feedstock will grow more slowly than other fossil fuels. Fossil-fuel dependence ratios will still be high, at 70%–90% in 2040, similar to the today's levels.

Maintaining high fossil-fuel dependency will lead to increasing CO_2 emissions, which will increase annually by 2.9% in Indonesia and 5.8% in Viet Nam, higher than energy-demand growth, meaning that their energy mix will become more carbon-intensive (Figure 2-9). Meanwhile, in Thailand and Malaysia, CO_2 emissions will grow at lower rate than energy demand growth.

Figure 2-9. Primary Energy Demand and CO2 Emissions



CO2 = carbon dioxide, MtCO2= million tonnes of carbon dioxide, Mtoe= million tonnes of oil equivalent, TPED = total primary energy demand.

Source: IEA (2019a), authors' analysis.