Chapter 3

Analysis on Impacts to Energy Demand and Supply Situation

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Chapter 3

Analysis on Impacts to Energy Demand and Supply Situation

As mentioned in Chapter 1, electric vehicle (EV) penetration will bring a change in the energy demand supply situation of the Lao People's Democratic Republic (Lao PDR). The change will see a decrease in demand for gasoline and transport diesel oil and an increase in electricity demand for EVs. Thus in this chapter, reflecting this change into the Energy Balance Table (EBT) of the Lao PDR in 2040 by Kimura and Phoumin (2021) which is also in line with the Ministry of Energy and Mines Lao PDR and ERIA (2018 and 2020b), we analysed the impacts to energy demand supply to be brought by EV penetration.

1. Changes in Energy Demand from Penetration of Electric Vehicles

The changes in energy demand from the penetration of EVs in 2040 are summarised in Table 3.1. The changes depend on the scenarios with EV penetration ratio of 10% (10% of vehicle stock will be shown as EV10%), 30%, and 50%. The balance defined as the increase in electricity demand minus the decrease in oil demand will be minus in the three scenarios, in other words, energy consumption will be saved.

Why will the decrease in petroleum consumption be larger than the increase in electricity demand? For example, in the case of the Nissan LEAF, 40 kilowatt hours (kWh) of electricity can run for 400 kilometres (km) according to Nissan's catalogue, so that necessary electricity of thermal basis is estimated as 40 kWh * 860 kilocalories (kcal)/kWh = 34.4 megacalories (Mcal). On the other hand, in the case of the Toyota Prius, its fuel economy as noted in its catalogue is around 35 km/litre, so that necessary gasoline is estimated as 400 km/35 km/litre * 7,970 kcal/litre = 91.1 Mcal. This is one reason why we can expect a large decrease in petroleum demand due to the penetration of EVs.

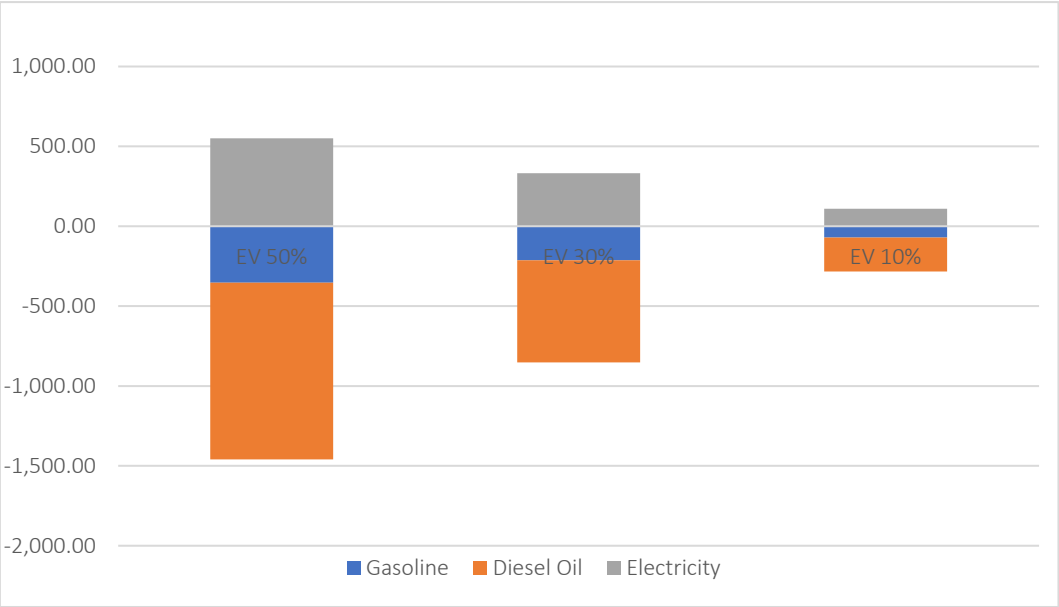
Table 3.1: Changes in Energy Demand from EV Penetration in 2040 (ktoe)

	Gasoline	Diesel Oil	Electricity	Balance
EV 50%	-353.82	-1105.87	551	-908.69
EV 30%	-212.29	-640.347	331.1	-521.537
EV 10%	-70.76	-213.449	110.08	-174.129

ktoe = kiloton of oil equivalent.

Source: Authors' calculation.

Figure 3.1: Changes in Energy Demand by Penetration of EVs in 2040 (ktoe)



ktoe = kiloton of oil equivalent.
Source: Author's calculation.

2. New Energy Balance Table 2040 to Incorporate Impacts of Electric Vehicle Penetration

Based on the Lao PDR's Energy Balance Table (EBT) of the business-as-usual (BAU) scenario in 2040 (shown in Table 3.2), a new EBT will be produced to reflect the changes of energy demand shown in Table 3.3. As power generation assumption, 100% of electricity will come from hydropower plants. The Lao PDR's EBT of EV penetration scenario in 2040 is shown in Table 3.2.

Table 3.2: Lao PDR Energy Balance Table of BAU Scenario in 2040

Lao PDR Energy Balance Table 2040 Unit: ktoe	Coal	Petroleum Products							Hydro	Solar etc	Others	Electricity	Total
		Total	Motor Gasoline	Jet Fuel	Gas/Diesel Oil	Fuel Oil	LPG	Other Petroleum Products					
Indigenous Production	9,654	0							4,004	258	1,819		15,735
Imports		1,836	353	50	1,348	44	40	1				26	1,862
Exports		0										-3,783	-3,783
International Marin Bunkers		0											0
International Aviation Bunkers		-41		-41									-41
Stock Changes		0											0
Total Primary Energy Supply	9,654	1,795	353	9	1,348	44	40	1	4,004	258	1,819	-3,757	13,773
Transfer		0											0
Total Transformation Sector	-9,182	0	0	0	0	0	0	0	-4,004	-258	-246	6,752	-6,937
Main Activity Producer	-9,182	0							-4,004	-258	-246	6,752	-6,937
Charcoal Processing		0											0
Loss & Own use		0										-366	-366
Discrepancy	1	0	0	0	0	0	0	0	0	0	-1	0	0
Total Final Energy Consumption	471	1,795	353	9	1,348	44	40	1	0	0	1,574	2,629	6,469
Industry sector	471	249			205	44					44	1,188	1,952
Transport sector	0	1,469	353	9	1,106	0	0	1	0	0	0	580	2,049

Domestic Air Transport		9		9									9
Road		1,460	353		1,106			1				551	2,011
Railway		0										29	29
Other sector	0	77	0	0	37	0	40	0	0	0	1,530	861	2,468
Residential sector		27					27				1,145	484	1,656
Commercial sector		13					13				385	377	775
Agriculture sector		37			37								37

BAU = business-as-usual.

Source: Kimura and Phoumin (2021).

Table 3.3: Lao PDR Energy Balance Table of EV 50% Scenario with 100% Hydropower in 2040

Lao PDR Energy Balance Table 2040 Unit: ktoe	Coal	Petroleum Products							Hydro	Solar etc	Others	Electricity	Total
		Total	Motor Gasoline	Jet Fuel	Gas/Diesel Oil	Fuel Oil	LPG	Other Petroleum Products					
Indigenous Production	7,326	0							4,632	258	1,819		14,035
Imports		1,836	353	50	1,348	44	40	1				26	1,862
Exports		0										-3,783	-3,783
International Marine Bunkers		0											0
International Aviation Bunkers		-41		-41									-41
Stock Changes		0											0
Total Primary Energy Supply	7,326	1,795	353	9	1,348	44	40	1	4,632	258	1,819	-3,757	12,073
Transfer		0											0
Total Transformation Sector	-6,854	0	0	0	0	0	0	0	-4,632	-258	-246	6,752	-5,238
Main Activity Producer	-6,854	0							-4,632	-258	-246	6,752	-5,238
Charcoal Processing		0											0
Loss & Own use		0										-366	-366
Discrepancy	1	0	0	0	0	0	0	0	0	0	-1	0	0
Total Final Energy Consumption	471	1,795	353	9	1,348	44	40	1	0	0	1,574	2,629	6,469
Industry sector	471	249			205	44					44	1,188	1,952
Transport sector	0	1,469	353	9	1,106	0	0	1	0	0	0	580	2,049

Domestic Air Transport		9		9									9
Road		1,460	353		1,106			1				551	2,011
Railway		0										29	29
Other sector	0	77	0	0	37	0	40	0	0	0	1,530	861	2,468
Residential sector		27					27				1,145	484	1,656
Commercial sector		13					13				385	377	775
Agriculture sector		37			37								37

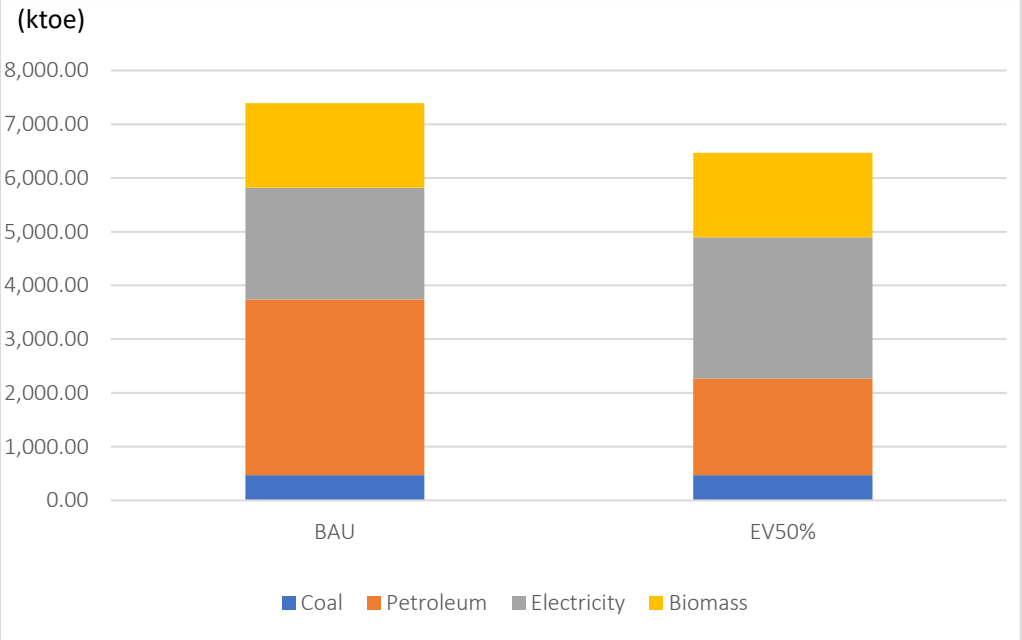
ktoe = kiloton of oil equivalent.

Source: Author's calculation.

3. Impact on Total Final Energy Consumption

The total final consumption (TFEC) of the EV penetration scenario is much lower than in the BAU scenario (Figure 3.2). Thus, EV penetration will bring the Lao PDR significant energy savings.

Figure 3.2: Comparison of TFEC Between BAU and EV 50% in 2040



BAU = business-as-usual, ktoe = kiloton of oil equivalent, TFEC = total final energy consumption.
Source: Author's calculation.

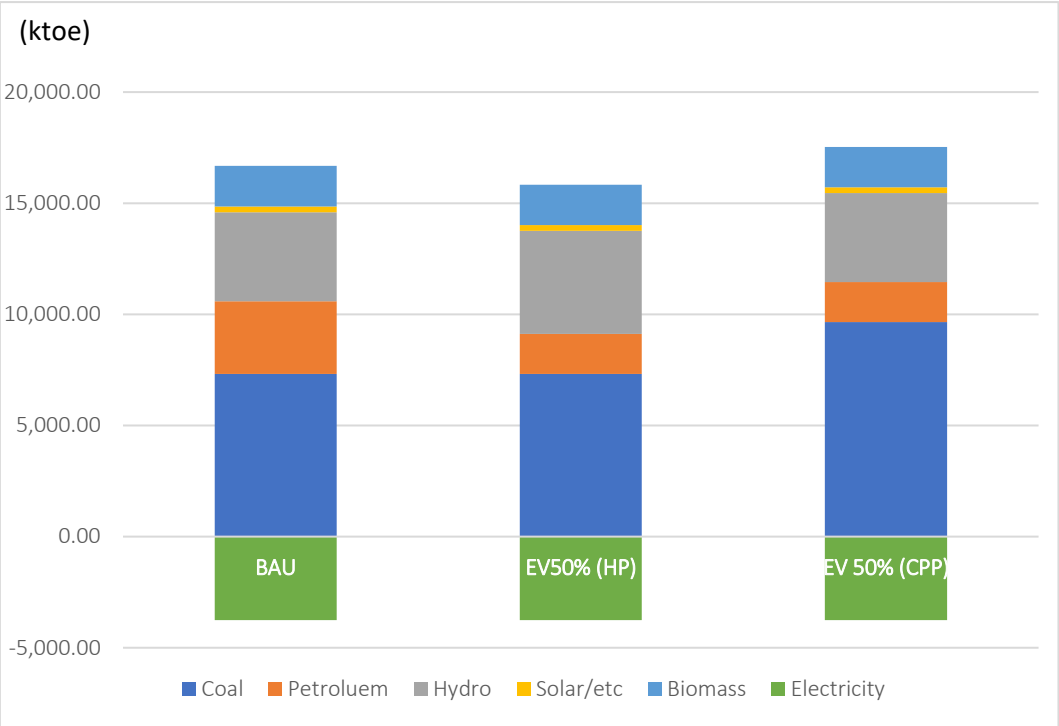
4. Impact on Total Primary Energy Supply

If we analysed the impact of EV total primary energy supply (TPES), we need to assume that the power generation mix to meet additional electricity demand comes from EVEV penetration. Referring to the current power generation mix in the Lao PDR; the following two cases are assumed:

- 100% hydropower generation
- 100% coal-fired power generation

Based on the new EBT of EV 50% shown in Table 3.3, the two cases mentioned above are incorporated into the new EBT and the results including BAU are show in Figure 3.3.

Figure 3.3: Impact on TPES by EV Penetration in 2040



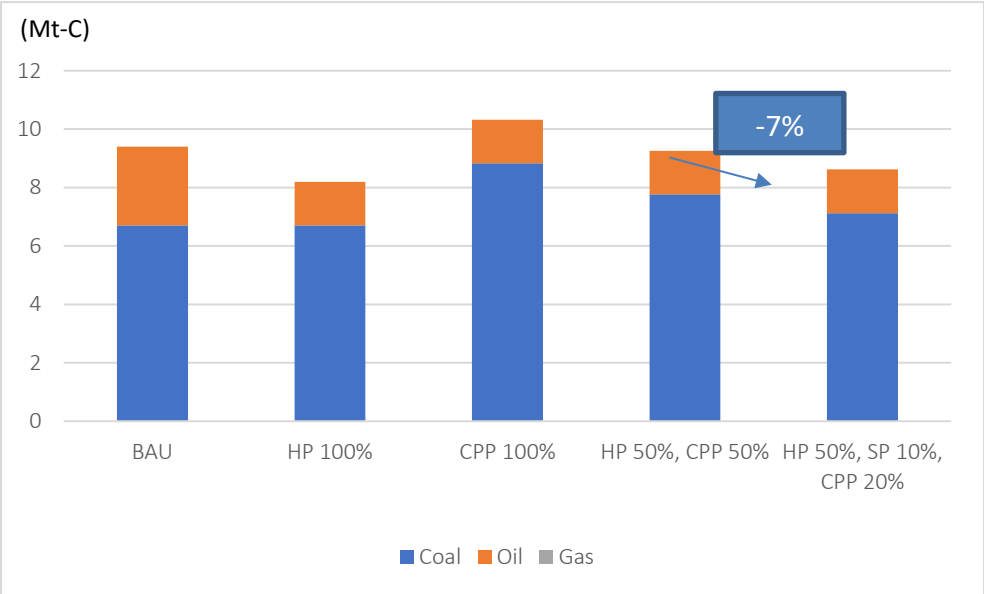
BAU = business-as-usual, CPP = coal-fired power plant, HP = hydropower plant, ktoe = kiloton of oil equivalent, TPES = total primary energy supply.
Source: Author's calculation.

If the Lao PDR generates the additional electricity for EVEV penetration from hydropower plants, the TPES will decrease from the BAU scenario of around 850 ktoe. But if it generates the electricity from coal-fired power plants, the TPES from BAU is around the same amount of 850 ktoe due to different thermal efficiencies – 100% for hydropower, and 27% for coal-fired power generation. In other words, coal-fired power generation needs lots of coal for heating boilers.

5. Impact on CO_2 Emissions

The penetration of EVs will also impact CO_2 emissions in the Lao PDR in 2040 but it depends on the power generation mix. Figure 3.4 shows CO_2 emissions of BAU, EV 50% with hydropower generation, EV 50% with coal-fired power generation, EV 50% with 50% hydropower generation and 50% coal-fired power generation, and finally EV 50% with 70% hydropower, 10% solar power, and 20% from coal-fired power generation.

Figure 3.4: Comparison of CO_2 Emissions amongst Four Cases in 2040



BAU = business as usual, CPP = coal-fired power plant, HP = hydropower, ktoe = kiloton of oil equivalent, Mt-C = million ton of carbon.
Source: Authors' calculation.

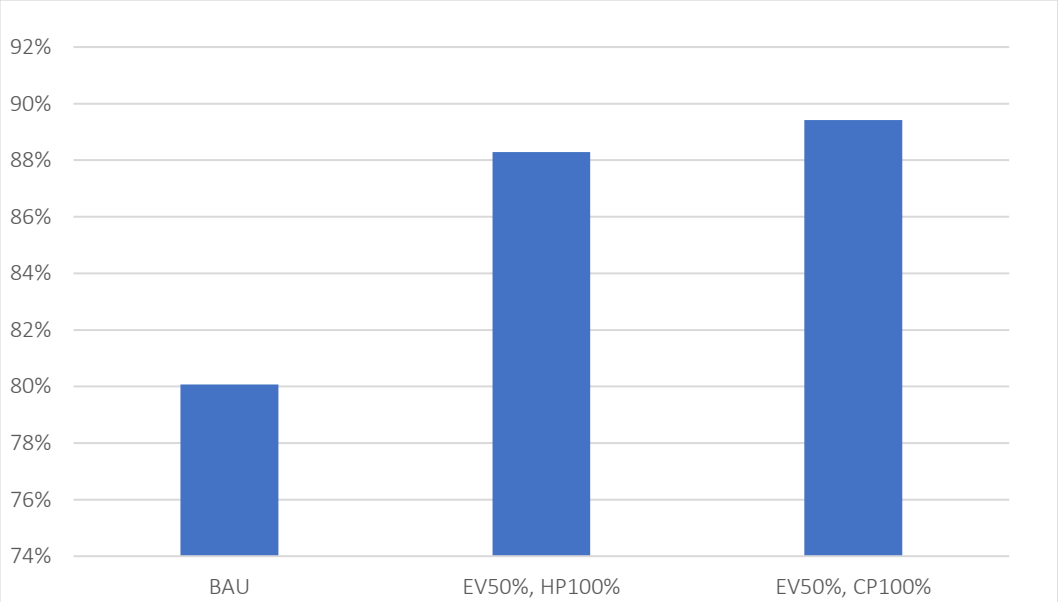
CO_2 emissions in the case of 100% hydropower generation is forecast as 8.2 million tons of carbon (Mt-C), which will be lower than BAU (9.4 Mt-C), but CO_2 emissions to apply 100% coal-fired power generation will increase to 10.3 Mt-C from BAU. In the case of 50% hydropower and 50% coal-fired power, CO_2 emissions will slightly decrease to 9.2 Mt-C compared to BAU. Thus, in terms of CO_2 emissions, hydropower generation is a good option for the Lao PDR.

We need also to pay attention to the different capacity factors of hydropower in the wet and dry seasons. Usually, the capacity factor of hydropower in the dry season is much lower than in the wet season, thus the Lao PDR imports electricity from Thailand due to electricity supply shortages every year. Consequently, the selection of 100% hydropower generation is risky for the Lao PDR.I. In this regard mixing power generation using hydropower and coal-fired power is recommended with attention paid to maximising hydropower with a range of round 50%.

6. Impact on Energy Supply Security

Finally, we analyse how EVEV penetration will contribute to energy supply security in the Lao PDR. Usually, we apply an import dependency ratio for analysing energy supply security level, which is defined as indigenous production/total supply. Total supply is also defined as indigenous production plus imports. Figure 3.5 shows the import dependency ratio of the three cases which are BAU, EV 50% with hydropower 100%, and EV 50% with coal-fired power 100%.

Figure 3.5: Domestic Energy Dependency Ratio of the Three Cases



BAU = business as usual, CPP = coal-fired power plant, HP = hydropower.
Source: Authors' calculation.

The penetration of EVs will contribute to improving the domestic energy dependency ratio and it means EVs will increase the demand for domestic energy supply such as hydropower generation and coal consumption, and decrease petroleum imports such as gasoline and diesel oil.

7. Conclusions

The penetration of EVs in the Lao PDR will, on the one hand, decrease gasoline and diesel oil consumption and on the other hand, increase electricity consumption. As a result, the TFEC of the Lao PDR will decrease. Thus, the penetration of EVs will contribute to the energy savings of the road transport sector.

If electricity to be consumed by EVs will be generated by hydropower plants, CO_2 emissions will largely decrease 13% from the BAU scenario. But if the electricity will be generated by coal-fired power plants, CO_2 emissions will increase 9.8% from BAU. Thus, the Lao PDR has to consider increasing the hydropower capacity to meet the additional electricity demand for EVs. However, it is true that hydropower's output in the dry season declines due to lack of water flow, thus a power generation mix of hydropower and coal-fired power is strongly recommended and the appropriate ratio of both capacity factors will be around 70% and 30%, respectively.

EVEV penetration will also contribute to improve energy supply security of the Lao PDR. A decrease in transport fuel consumption such as gasoline and diesel oil will decrease oil imports into the Lao PDR and in parallel, an increase of hydropower and coal-fired power will increase the supply of domestic energy. Thus, energy supply security of the Lao PDR will improve if EV penetration proceeds in the Lao PDR.