Electrification of Road Transport in ASEAN and Energy Security:

Review, Quantitative Analysis and Policy Implications

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Extended Abstract

Electrification of transportation (or electric mobility), especially the public transportation in urban area, has progressed beyond the demonstration stage. While the electrification of public transportation theoretically brings many benefits, however, it also faces many limitations. Many ASEAN countries are very interested in the electrification of road transportation or electric mobility but these limitations must deserve careful scrutiny. This study reviews existing literature and sources of information regarding the status of application of electric vehicles in each ASEAN country, together with the collection and analysis of data on relevant issues such as current vehicle fleets, consumption of fuels, fuel mix of power generation, taxation and tariff imposed on electric vehicles, as well as incentives provided to adoption of electric vehicles. This study subsequently estimates the potential impacts of electrification of road transportation in these countries and examines how electric mobility enhances energy security of ASEAN countries using the 4A perspectives that comprises the availability of energy, the applicability of energy, the acceptability of energy and the affordability of energy. Lastly, this study extends the discussions to the standing challenges in different ASEAN countries for the electrification of road transportation and draws customized recommendations for these countries. Policy implications are drawn accordingly.

Key words:

JEL: N75, Q40, Q42, Q48,

1. Introduction

Electrification of transportation (or electric mobility), especially the public transportation in urban area, has progressed beyond the demonstration stage. In several cases, government plays a key role in using public finance – the tax money – to compensate for the positive externality of electrification of transportation as clean technologies. By 2017, the largest scale of electrification of public transportation took place in the city of Shenzhen, a city of Guangdong province of China. The city has achieved 100% electrification of its public bus system, with a total number of more than 5,000 full electric buses operating now. The city has also been operating more than 5,000 units of full electric taxis, about 30% of its total number of taxis. Its target is to fully electrify its taxi fleet by 2020. The electrification of its buses alone is estimated to contribute a reduction of more than 1 million ton of CO_2 emissions per year. Needless to say, as the main carrier of urban passenger transportation in the city with more than 10 million population, the electrification of buses and taxis also significantly contributes to the reduced reliance on fossil fuel. It is worth of noting that the city's power generation mix is mostly consisted of nuclear energy. Besides subsidizing the purchase as well as operation of the electric vehicles for public transportation, the city also subsidizes and facilitates the investment in charging infrastructure.[1] Many other Chinese cities are pursuing similar policies, although less as radical as Shenzhen.

In almost all Chinese cities, electric scooters, electric bikes, and electric tricycles are also extremely popular, in the recent years. These vehicles are not only used for carrying passengers, but also delivering small batches of cargo. These vehicles and their applications reveal the potential to further electrify the "last mile solution" for both passengers and distribution of goods and services.[2]

Technocrats such as Tesla and BYD, leaders in the manufacturing of electric vehicles and peripheral equipment, are also currently developing medium to large trucks. Industrial and commercial sectors will also be able to at least partially electrify their transportation, besides the electric forklift that had been applied for decades.[3]

In ASEAN countries, electric vehicles, together with PHEV, HEV, E-tricycles, and E-tuk tuk, are given special attention by policy makers, as one of the key future solutions not only to achieve clean and green transportation, but also improvement in energy supply security. Several countries are also eyeing on the possibility of new industrial opportunities in manufacturing EVs and peripheral equipment.

A study conducted by Nissan in 2018 for ASEAN countries reveal strong intention of ASEAN consumers to buy EVs. Among all 1,800 individuals surveyed, 37% of them have intention to buy EVs, with Philippines, Thailand and Indonesia having higher than average propensity to buy. The surveyed consumers also identified that installation of charging facility in home places, priority lanes for EVs, and free parking could provide strong incentives to further boost the choice of EVs.[4]

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[1] Source: Xinhuanet at http://news.xinhuanet.com/auto/2017-06/16/c_1121152846.htm accessed on 11-Oct-2017

[2] Source: URL: http://www.eet-china.com/news/article/201802081027, accessed on 6 June 2018

[3] Source:

[4] Source: The Voice of Vietnam, URL: English.vovo.vn/economy/Vietnamese-consumers-open-to-buying-electric-vehicles-369276.vov, accessed on 5 June 2018

This study explores how electric mobility enhances energy security of ASEAN by employing three different definitions of energy security. The specific research questions are presented in section 2. The methodology and data collection for answering the research questions are explained in section 3. Section 4 presents the analytical results. Section 5 discusses the derived challenges faced by ASEAN countries. Section 6 concludes and draws policy implications.

2. Research Questions

Firstly, we would like to understand the economics and environmental impacts of electrification of road transport sector in ASEAN countries. Li and Kochhan (2015) has shown a case study of passenger EV application in Singapore. Economic competitiveness of BEV in certain type of use in the island state has been proven, given the existing policy framework in the country. We would like to also give a survey on all ASEAN countries, regarding the existing vehicle fleets, fuel consumption and share, fuel mix in the power generation sector and so on, so as to estimate the potential of electrifying a certain country's various fleets, including both passenger vehicles, buses, and trucks – the main contributor to fossil fuel consumption in road transport. A subsequent question is how such would add to the energy security of the country.

However, while the electrification of public transportation theoretically brings many benefits, it also faces many limitations. The following table summarizes and compares the benefits and the limitations.

Table: Benefits and Limitations of the Electric Mobility

Benefits	**Limitations**
Reduction of emissions	High costs of vehicles, especially the battery of the vehicle
Reduced fuel costs (cost of electricity consumed per km is much cheaper than that of fossil fuel)	Battery Electric Vehicles (BEV) have significant range limits after each charging
Increase energy diversification	Heavy investment in charging infrastructure network required
Enhancing the capacity of the grid to absorb intermittent renewables (as an energy storage)	Proper fuel mix of power generation becomes key in reduction of emissions
Reduction of reliance on oil importation	Management of discarded batteries and the costs and pollution generated in treating them
Readiness of transiting into autonomous driving	Cannot replace heavy duty trucks, especially for long-haul cargo transportation
New industrial opportunities in producing the hardware and software of electric mobility systems	Cannot support long-distance passenger transportation
Less noises on the road as electric vehicles work in extremely quite ways	Need to convince and educate the users, especially the drivers, of electric vehicles to change behavior (e.g. instead of refueling once a week, remember to charge the vehicle every a few days, depending on usage)

While many ASEAN countries are very interested in the electrification of road transportation or electric mobility, these limitations must be carefully studied. This paper is thus dedicated to identify which of the above limitations stand as the most salient challenges on the way of electrification of road transportation in ASEAN countries. Accordingly, policy recommendations will be drawn.

3. Methodology and Data

This study will firstly review existing literature and sources of information regarding the status of application of electric vehicles in the country, together with the collection and analysis of data on relevant issues such as vehicle fleets, fuel consumption by road transport, power generation fuel mix, taxation and tariff imposed on electric vehicles, as well as incentives provided to adoption of electric vehicles.

Based on the statistics of the transport sector of the ASEAN countries, the potential impacts of electrifying the road transport on fossil fuel import dependence of these countries could be estimated. Since the transport sector typically consist more than 30% of total primary energy consumption of ASEAN countries, such potential is expected to be significant.

Subsequently, a 4A perspective framework will be applied to see how such impacts could be translated into energy security of a certain ASEAN country. The 4A includes the following:

1. The availability of energy resources (physical energy reserves at home and abroad, the latter means the country should be able to import energy from foreign countries)
2. The applicability of energy resources (energy technologies to harness the (narrowly defined) available resources)
3. The acceptability of society or economy (whether the society is willing to use the (narrowly defined) available and applicable energy, for example, nuclear energy in Japan is shunned)
4. The affordability of energy resources (the unit cost of using energy resources such as the levelized cost of electricity, LCOE)

Based on the work done by Tongsopit et al. (2016), an ASEAN energy security assessment has been done by applying the following indicators under the 4A framework.

Categorizing energy indicators according to the 4-A's criteria. Sources: APERC (2007), IAEA (2005), and IEEJ and ACE (2011).

	Availability	Applicability	Affordability	Acceptability
IAEA	• Share of households without electricity • Reserves to production ratio • Diversification of Primary Energy Demand • Dependence on imports (mtoe)	• Share of households without electricity • R&D • Energy use per unit GDP • commercial and transport energy intensity • energy efficiency measures	• Share of household income spent on fuel and electricity • Energy use per capita	• GHG emissions per capita • GHG emissions per unit GDP • Ambient air pollutant concentrations
APERC	• Reserves to production ratio (R/P ratio)	• Energy use per unit GDP • Industrial, household, agricultural, commercial and transport energy intensity	• Energy use per capita	• GHG emissions per capita • GHG emissions per unit GDP
IEEJ and ASEAN Center for Energy		• Energy use per unit GDP • Industrial, household, agricultural, commercial and transport energy intensity	• Energy use per capita	

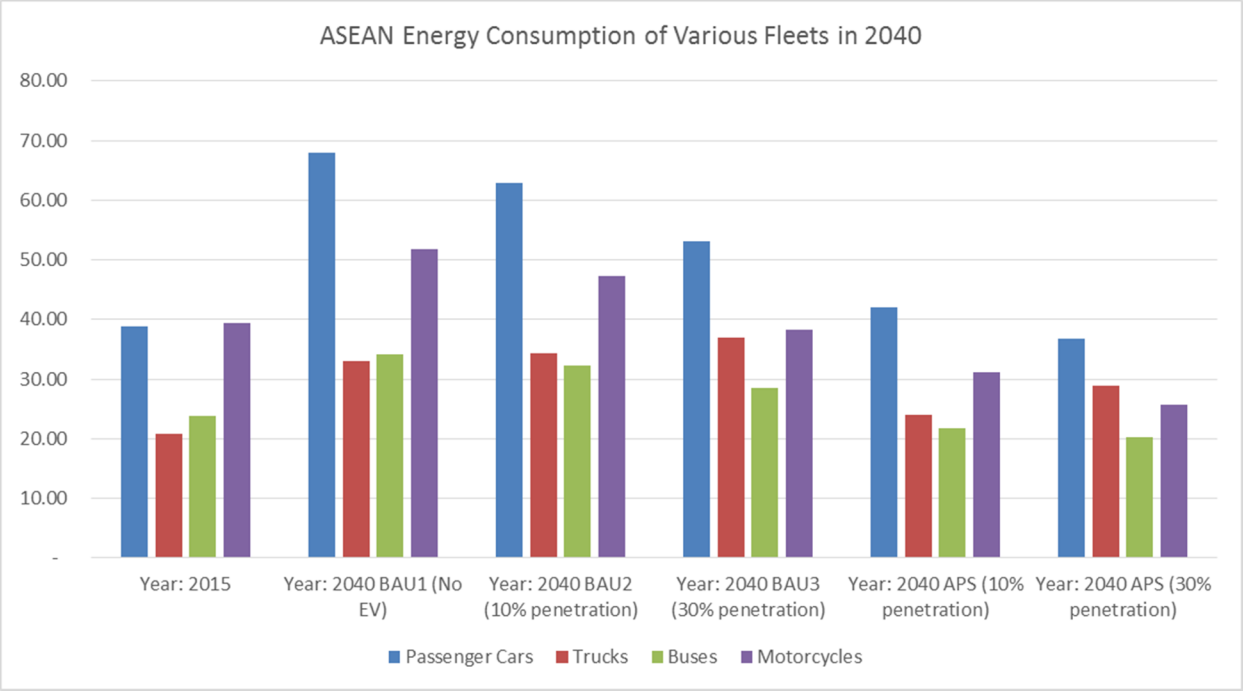
A majority of these indicators will be influenced by massive electrification of the road transportation sector. Our study will thus show such impacts.

4. Analytical Results

The following figure shows our preliminary results on the various motor vehicle fleets' final energy consumption in ASEAN. It can be seen that comparing the 2040 BAU scenario without any introduction of EV and the year 2015 statistics, ASEAN expects significant increases in final energy consumption by all types of fleets, including passenger cars, trucks, buses, and motorcycles. However, as electric vehicles penetrates into the fleets, reduction in the final energy consumption is very drastic.

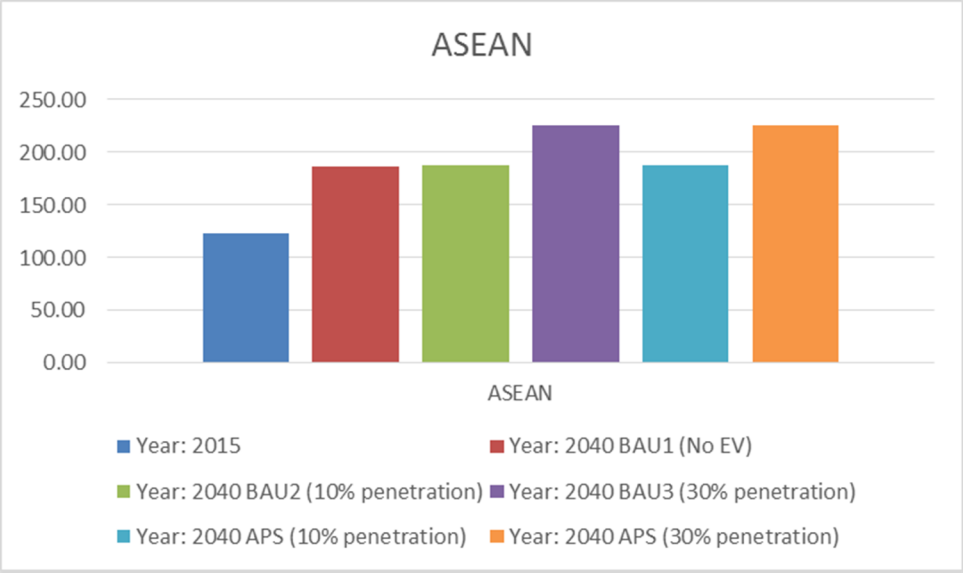
The APS scenarios actually assumes more aggressive improvements in the fuel economy of the motor vehicles, following the targets set by GFEI and IEA (2017). Combining the effects of both introduction of EV and higher fuel efficiency, ASEAN sees a possible future with lower final energy consumption in the road transport sector, as revealed by APS with 30% of EV penetration.

Figure X: ASEAN Final Energy Consumption by Various Fleets in 2040



However, the introduction of EV into road transport sector is a process of coupling the road transport and the power sector. The consumption of primary energy for generating electricity must be considered, in order to charge and power the EVs. For the purpose of this study, which is to estimate the implications on energy security, since many countries rely on imports for their consumption of fossil fuel, we estimate the amount of primary fossil energy that is necessary to generate the electricity, considering each countries' planned scenario of fuel mix for power generation (the BAU case of power sector), as well as the aggressive scenario of fuel mix for power generation (the APS case of power sector, which envisions the increasing share of REs and thus decreasing share of fossil fuel for power generation).

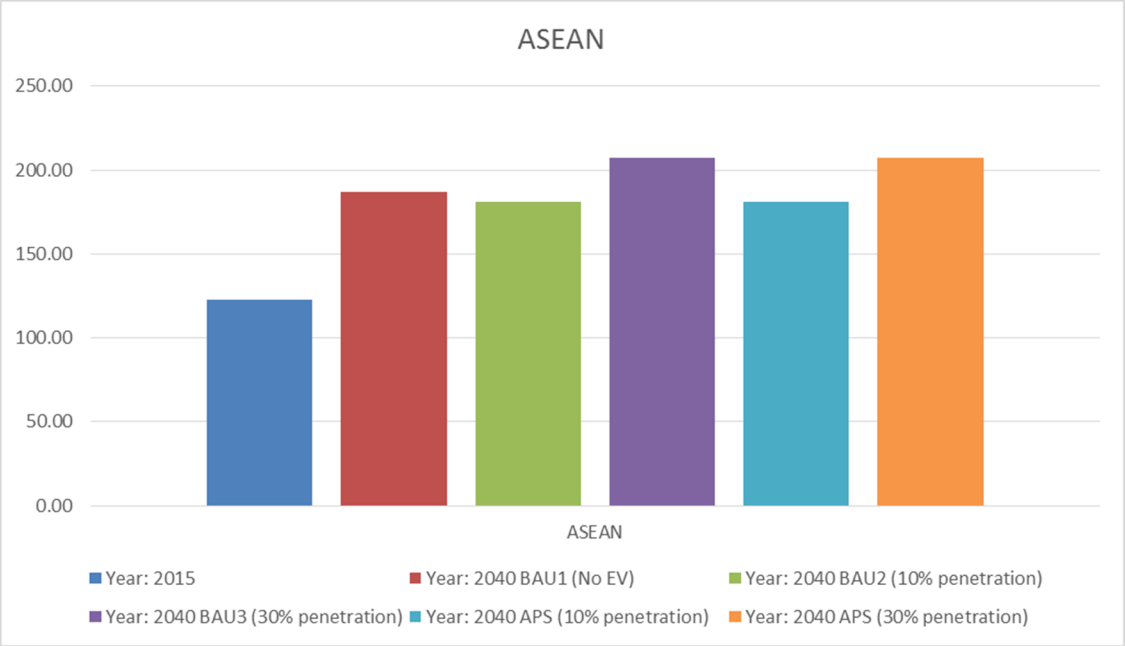
Figure X: ASEAN Primary Fossil Energy Consumption by Various Fleets in 2040 (BAU case for the Power Sector)



This figure shows that when the power sector's primary fossil energy consumption is considered, which is still going to be a main source of energy for power generation despite increasing capacity of renewables, the EV penetration actually does not contribute to save the consumption of primary energy. Instead, in the case of high penetration rate, say 30%, primary energy consumption will be significantly higher than if just 10% of EV penetration.

Even in the case of an APS scenario of the power sector is considered, the pattern is only slightly changed. Namely, if low penetration of EV at 10% for all countries and all fleets, primary consumption of fossil energy will be slightly reduced compared to the BAU 2040 scenario. However, if 30% of penetration of EVs is the case, there will still be substantial increase in the primary fossil energy consumption, although to a smaller extent than in the case of power sector in its BAU case.

Figure X: ASEAN Primary Fossil Energy Consumption by Various Fleets in 2040 (APS case for the Power Sector)



These results are yet to be fed into the 4As framework in order to access the impact on ASEAN countries' overall energy security.

5. Conclusions and Policy Implications

The introduction of EVs automatically implies the coupling of the road transport sector and the power generation sector. Thus, if the policies to promote the introduction of EVs in ASEAN wish to achieve improvements in energy security, more emphasis should also be given to the power generation sector. Higher efficiency of thermal generation, lower emissions from thermal generation, as well as the promotion of renewables' penetration are the most prominent policy options.

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