Chapter 5

Conclusions

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1. Introduction

The National Institute of Advanced Industrial Science and Technology (AIST) has been studying future mobility scenarios of East Asia Summit (EAS) countries since 2014. In the past AIST–Economic Research Institute for ASEAN and East Asia (ERIA) project, the scenarios for India, Indonesia, and Thailand were examined considering the potential of biofuels and electrified vehicles (xEVs). As the result, well-to-wheel CO_2 emissions were estimated for several scenarios by creating energy mix model.

However, in the previous project, the sustainability of biofuels and xEVs has not yet been taken into consideration. Diffusion of xEVs can contribute to CO_2 reduction, but may affect mineral resource demand induced by motors and batteries. Therefore, the aim of this project is to analyse future scenarios of EAS mobility which contribute to the Sustainable Development Goals 7, 12, and 13 in consideration of the balance between transport CO_2 reduction, biofuel use, and mineral resources demand. The outcome will contribute to the EAS Energy Research Road Map (Pillar 3: Climate Change Mitigation and Environmental Protection) corresponding to the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 3.5 Programme Area No.5: Renewable Energy and 3.6 Programme Area No.6: Regional Energy Policy and Planning).

In fiscal year 2020, the first phase of this project was conducted. Biofuel policies and strategies, as well as existing research on biofuels sustainability were assessed for the EAS countries (India, Thailand, Malaysia, Viet Nam, Indonesia, and Philippines). Moreover, a database was created to evaluate well-to-wheel CO_2 reduction and mineral resource demand based on the biofuel implementation and mobility electrification.

In this fiscal year 2021, working group meetings were conducted in December 2021 and April 2021. As the result, 'well-to-tank' greenhouse gas GHG (WTT GHG) emissions for producing biofuels, 'tank to wheel' GHG emissions for using biofuels, and demand and GHG emissions for producing mineral resources considering mobility electrification were evaluated. This chapter describes the conclusion and progress of each study (chapters).

2. Well-to-Tank CO_2 Emissions from Biofuels in East Asia Summit Countries

National policy and future projection of biofuels were clarified in Malaysia, Philippines, Viet Nam, and Thailand. The well-to-tank (WTT) GHG emissions from biofuels in the various countries in the region are summarised. Despite some variations in the emissions values from the different feedstock and countries, these are all lower than their fossil fuel counterparts (i.e. 2.92 kilogramme/litre gasoline as compared to ethanol and 83.8 gCO_2 eq/MJ diesel as compared to biodiesel). In the case of palm biodiesel production, the cultivation of oil palm has a significant contribution followed by biodiesel production and crude palm oil production. Crude palm oil production gains benefits from many by-products such as fibre, shell, empty fruit bunches, and biogas from palm oil mill effluent that can be used for energy. In the case of ethanol, the agriculture stage is once again quite a high contributor for both cassava and sugarcane molasses.

However, for the case of cassava, ethanol production, particularly distillation and dehydration, has a very high contribution to GHG emissions due to the use of fossil fuels. However, in the case of sugarcane molasses the use of biomass-based by-products such as bagasse and biogas from vinasse as energy sources reduce the contribution of ethanol production to GHG emissions. Transportation of feedstock and intermediates has a relatively modest contribution for all the biofuels.

3. Tank-to-Wheel CO_2 Emissions from Biofuels in East Asia Summit Countries

In this chapter, bottom-up energy demand model for transport sector was constructed, focusing on cars and motorcycles in six countries: Indonesia, Malaysia, Philippines, Thailand, Viet Nam, and India. Tank-to-wheel GHG emissions were estimated using the Low Emissions Analysis Platform (LEAP) system with input data on population, gross domestic product, vehicle history and projection, vehicle kilometre of travel (VKT), and fuel economy.

In particular, the tank-to-wheel greenhouse gas (TTW GHG) emissions are calculated according to the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) in this study. For fuel combustion in road transportation, the emissions factors are selected according to the Technology and Environmental Database. The TTW GHG emissions from fossil fuel combustion in road transportation comprise CO_2, CH_4, and N2O. These emissions are converted into the CO_2-equivalent unit by multiplied with the global warming potentials (GWP).

With relatively robust vehicle ownership model, the business-as-usual setting for energy consumption and WTT GHG emissions can be set as a baseline for investigation into impact from electric vehicle (EV) and biofuel policy. With best available projections of EV and biofuel, impact of energy consumption and TTW GHG emissions can be quantitatively illustrated. Of course, further refinement of model assumption, as well as data input, could help improve accuracy of the present model. However, the present model can evidently highlight important of motorcycle segment, which has potential to reduce energy consumption and TTW GHG emissions as much as car segment collectively in these six countries. Policies to support the decarbonisation of the road transportation sector by motorcycles must be equally treated as policies for the car segment.

4. CO_2 Emissions from Producing Mineral Resources by Mobility Electrification in East Asia Summit Countries

The long-term mineral resource demand associated with automobile electrification was estimated in EAS countries. In addition, CO_2 emissions from producing mineral resources and the potential for recycling in these countries were assessed by determining the amount of waste of these mineral resources and the effectiveness of introducing a circular economy under these conditions was evaluated.

In conclusion, the demand for neodymium is predicted to be a minimum of 4,075 t/y in 2040. If the recycle rate is 100%, secondary resources can cover 28.2% of total Nd demand in EAS countries. The total demand for cobalt is predicted to be 53,324 t/y in 2040. If the recycle rate is 100%, secondary resources can cover 16.1% of cobalt demand in EAS countries. However, considering that production of neodymium was 43,200 REO tons/year and cobalt was 140,000 tons/year in 2020 (USGS, 2021), it is predicted to be difficult that world supply can meet the target of EAS mobility electrification regarding the large increase of demand in China, the European Union, and the United States. Therefore, it is necessary to consider the balance between biofuels and mobility electrification based on the potential of secondary resources and circular economy.

Moreover, the total CO_2 emissions produced from neodymium magnets and lithium-ion battery cells production will be 1.9 Mt/y for neodymium magnets production and 8.4 Mt/y for lithium-ion battery cells production in 2040. If the recycle rate is 100%, secondary resources can reduce CO_2 emissions 446,856 t/y for neodymium magnets production and 91,759 t/y for lithium-ion battery cells production in 2040.

5. Conclusion and Future Aspects

Following the FY2020 project results, this study assessed the WTT GHG emissions from producing biofuels, TTW GHG emissions from using biofuels, and GHG emissions from producing mineral resources considering mobility electrification in EAS countries (India, Thailand, Malaysia, Viet Nam, Indonesia, and Philippines).

In conclusion, the synergies between biofuel implementation and mobility electrification were clarified, which highly contribute to the SDGs. National policies and future projections of biofuels were clarified in EAS countries and well-to-tank GHG emissions were all lower than their fossil fuel counterparts despite some variations in the emissions values from the different feedstock and countries. TTW GHG emissions are calculated according to the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) using the LEAP system. Mobility electrification will contribute to GHG reduction but causes 1.9 Mt/y GHG emissions for neodymium magnet production and 8.4 Mt/y for lithium-ion battery cell production.

For further studies, a case study of mobility scenarios considering the balance between CO_2 reduction and potential of biofuels/mineral resources will be conducted. This will bring more uniformity to the overall sustainability assessment of biofuels for the region. Furthermore, the synergies as well as multi-benefits between biofuel implementation and mobility electrification will be more clarified. Last, the sustainable mobility scenarios for EAS countries will be created considering the achievement of the SDGs.

References

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