Executive Summary

Reducing greenhouse gas (GHG) emissions in the transport sector is now attracting attention worldwide, especially after the Paris Agreement in 2015. To meet this target, East Asia Summit (EAS) countries have been making great efforts to introduce biofuels on a large scale considering the potential of their resources. Meanwhile, the introduction of electrified vehicles (xEVs) is now expanding rapidly, which can be another efficient option to reduce GHG emissions in the transport sector. Therefore, creating a future mobility fuel scenario with the balance of biofuel vehicles and xEVs is necessary.

In this regard, this project aims to analyse the future scenario of EAS mobility, which highly contributes to the Sustainable Development Goals (SDGs) (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 Association of Southeast Asian Nations (ASEAN) Plan of Action for Energy Cooperation 2016–2025, 3.5 Programme Area No.5: Renewable Energy, and 3.6 Programme Area No.6: Regional Energy Policy and Planning).

In financial year (FY) 2020, existing biofuel policies and implementation plans were updated from selected EAS countries as a foundation to accommodate emerging electric vehicle trends during mobility energy transition. As the result, the information on biofuel policies and implementation mechanism, as well as potential CO_2 reduction, are collected. Moreover, the progress of sustainability assessment of biofuels in the East Asia region were evaluated with examples of some of the participating countries using the sustainability indicators proposed by the earlier ERIA project on 'Sustainable Biomass Utilisation Vision in East Asia'.

Following FY2020 progress, this report provides evaluation results of 'well-to-tank' CO_2 emissions from producing biofuels, 'tank-to-wheel' CO_2 emissions from using biofuels, and demand and CO_2 emissions from producing mineral resources considering mobility electrification.

First, national policy and future projection of biofuels were clarified in Malaysia, Philippines, Viet Nam, and Thailand. The well-to-tank 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 kilogrammes per litre gasoline as compared to ethanol and 83.8 grammes of CO_2 equivalent per megajoule of 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, have 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 reduces the contribution of the ethanol production to GHG emissions. The transportation of feedstock and intermediates has a relatively modest contribution for all the biofuels.

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

In particular, the tank-to-wheel greenhouse gas emissions in this study are calculated according to the Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories. For fuel combustion in road transportation, the emissions factors are selected according to the available Technology and Environmental Database. The tank-to-wheel greenhouse gas emissions from fossil fuel combustion in road transportation comprise CO_2, CH_4, and N_2O. These emissions are converted into the CO_2-equivalent unit by multiplied with the global warming potentials.

Third, 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 tons per year (t/y) in 2040. If the recycle rate is 100%, secondary resources can cover 28.2% of total neodymium 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.

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

For further studies, a case study of mobility scenario considering the balance between CO_2 reduction and potential of biofuels and/or 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. At last, the sustainable mobility scenarios for EAS countries will be created considering the achievement of the SDGs.