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 at analysing 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 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).

First, as a follow up to previous ERIA projects, 'Study of Renewable Energy Potential and Its Effective Usage in East Asia Summit Countries' and 'Evaluation of CO_2 Emissions Reduction by Mobility Electrification and Alternative Biofuel Introduction in East Asia Summit Countries', the topic of biofuel policies and implementation, especially from the sustainability aspect, is continuously monitored in the context of mobility transition into electric vehicles across EAS countries.

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 following information on biofuel policies and implementation mechanism, as well as potential CO_2 reduction, are collected.

- Past and current national plan for biofuels (ethanol and biodiesel) promotion
- National biofuels (ethanol and biodiesel) standard and their blends with fossil fuel
- Government support and/or incentives for biofuels (ethanol and biodiesel), e.g. subsidies, mandates, targets
- Biofuels (ethanol and biodiesel) blending acceptance by vehicle manufacturer
- Statistics of biofuels (ethanol and biodiesel) and their fossil counterpart landscape
- CO_2-related information (well-to-tank) for biofuels (ethanol and biodiesel) and their fossil counterpart

As seen from the rich content and journey of biofuel policies and implementation schemes in the selected EAS countries of India, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam, each country has its own unique approach and target. In addition, multiple benefits of biofuel

implementation not only lie in reduced fossil fuel imports and reduced tank-to-wheel CO_2 emissions, but also value added and demand creation for agricultural products. However, these biofuel policies and implementation schemes must be carefully pursued within the context of sustainability, especially during the transition towards electric mobility in the future.

Second, 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'.

As the result, this report provides an update on the status of sustainability assessment of biofuels in the East Asia region. Six indicators, two each for environmental, economic, and social assessment, were selected from the suggestions by the previous working group of ERIA. These indicators are also aligned with those provided by the Global Bioenergy Partnership. The results have been collected based on information existing in the public domain and presented for Thailand, Indonesia, Malaysia, Viet Nam, Philippines, and India. Most of the countries have had some life cycle assessment studies for biofuels which cover at the minimum, GHG emissions. In general, GHG emissions reduction has been observed for biofuels as compared to the fossil fuel counterparts, although some studies have cautioned that these reductions could be overturned should forest land be converted to agriculture for cultivating biofuel feedstock. However, water consumption for the environmental assessment as well as economic and social indicators were not identified in the literature. Only Thailand and Viet Nam have had studies covering most of the indicators. In Thailand, there have been research studies from academia that have provided the information whereas for Viet Nam, it has been from a recent study by the Food and Agriculture Organisation of the United Nations. It is hoped that at the next step, information on all the proposed indicators can be computed at the national level rather than at a case study level by using the approach suggested by the Global Bioenergy Partnership.

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

More particular, the following two methods were adopted for estimation.

Method 1 predicted the number of automobiles that were sold and discarded as described above, and then the number of xEVs sold was calculated by using Deloitte's prediction of automobile electrification and integrating the Nd and Co content.

Method 2 estimated the demand and disposal of neodymium and cobalt by using the target values for vehicle electrification in each country, which were evaluated in this project.

As the conclusion, the demand for neodymium is predicted to be a minimum of 2,996 tons per year (t/y) to a maximum of 4,809 t/y in 2050 based on Method 1 and a minimum of 3,200 t/y to a maximum of 5,295 t/y in 2030 based on Method 2 (including India). If the recycle rate is 100%, secondary resources can cover 47% to 50% of neodymium demand based on Method 1 and 21% to 25% based on Method 2.

Moreover, the total demand for cobalt is predicted to be a minimum of 1,397 t/y to a maximum of 89,762 t/y in 2050 based on Method 1 and a minimum of 1,614 t/y to a maximum of 103,720 t/y in 2030 on Method 2. If the recycle rate is 100%, secondary resources can cover 42% of cobalt demand based on Method 1 and 16% based on Method 2.

However, considering that production of neodymium was 43,200 t/y and cobalt was 140,000 t/y in 2020, it is predicted it will be difficult for world supply to meet the target of EAS mobility electrification regarding the large increase of demand in China, the European Union, and the United States.

For further studies, well-to-wheel CO_2 reduction of biofuel implementation and dynamic material flow analysis of mineral resource will be conducted. The sustainability assessment will then be conducted with more concrete data for each (environmental, social, and economic) indicators using country-level information rather than discrete and specific case studies from the literature that may have been designed for a different purpose. 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 with all sustainability indicators. At last, the sustainable mobility scenarios for EAS countries will be created considering the achievement of the SDGs.