EXECUTIVE SUMMARY

This report contains the outcome of four pilot scale projects on assessment of sustainability of biofuels in East Asia conducted in selected countries, viz. India, Indonesia, the Philippines and Thailand. Most of the countries in the East Asian region are heavily dependent on fossil fuel imports to meet their energy needs. This is not only increasing the financial burden on their national economy but also threatening their energy security. Governments in this region are looking for various energy alternatives and, in this regard, biomass energy, especially liquid biofuels such as bioethanol and biodiesel, have emerged on the forefront. Biofuels' blending with the fossil fuels would result in foreign exchange saving due to lesser imports of fossil fuels, may reduce greenhouse gas (GHG) emissions, and increase social benefits due to employment generation from biomass energy development. Thus, development of biomass energy could be a boon for the East Asian region. However, some negative impact of bioenergy development on biodiversity and food security cannot be ignored. Efforts are needed to ensure that development of bioenergy is sustainable in the long run.

The assessment methodology used in the pilot studies is based on the guidelines developed by an expert working group (WG) of ERIA. In addition, an integrated assessment and sustainability indicators are suggested, which integrate three indicators of environmental, economic and social assessments into a single indicator. This may facilitate decision-making as it is relatively straightforward to rank various options when each option has a single "sustainability value" attached to it. A visualization technique is presented wherein all three indicators are shown together in a single diagram.

Some major biomass feedstocks used for energy in the East Asian region include sugarcane, cassava, palm oil coconut oil and non-edible tree oils such as Jatropha seed oil. The choice of feedstock depends on its availability and cost for production of biofuels. The case studies involved primary data collection through field surveys of concerned stakeholders in each country. The results of sustainability assessment of biofuel production are expressed in terms of environmental, economic and social impacts and indicators used for these impacts were Greenhouse Gas Emissions (GHGs), total value added (TVA) and Human Development Index (HDI), respectively.

In case of India, economic assessment indicates that cost incurred during the Jatropha cultivation stage is much higher than the revenue generated, which is not economically viable. In biodiesel production stage, both TVA and net profit are quite attractive, provided the raw material is available at a reasonable price. During the lifecycle of biodiesel production process, a TVA of 522,569,245 INR and a net profit of 280,323,245 INR per year were estimated. On environmental fronts, companies expect some carbon saving and an additional revenue from carbon credits. GHG saving potential estimated during the process shows a net carbon saving of 2,771,681 tonnes of CO_2eq per year. On social fronts, several positive results are visible during various stages of biodiesel production, the main being employment generation for local people increasing their income, which may result in an overall improvement in their living standard.

Biofuel program in Indonesia was carefully designed but was not running as smoothly as planned originally. It was observed that the cassava utilisation for ethanol in Lampung Province is facing a competition for raw material from tapioca factories. Environmental assessment shows that during bioethanol production GHG emissions depend upon whether the biogas from waste water treatment is flared or not. Economic assessment indicates that processing cassava for bioethanol increased the value added of cassava by about 950-1108 IDR per L of bioethanol or about 146.6-171 IDR per kg of cassava. On social assessment, the HDI values for cassava farmers in the study region were estimated lower than the HDI values for North Lampung, in general. In case of Jatropha biodiesel, farmers in Way Isem receive a very low benefit from cultivation stage, however, utilisation of Jatropha waste increased their earnings significantly. Environmental assessment indicates that GHG emissions from Jatropha plantation and Crude Jatropha Oil (CJO) processing were 59% and 82%, respectively. HDI and GDI estimates for Jatropha farmers in North Lampung indicate that life quality, education, and income for the people in Way Isem were quite low.

Economic analysis of the Philippines study shows that considering the production costs and revenues for each product, the net profit per unit of product is highest for copra production (at 6.76 PHP per kg) and lowest for CME production (at 0.122 PHP per L). The cumulative total profit for all product forms is about 38,000 PHP per ha and the Total Value Added from the biodiesel industry in the province of Quezon would be 13.74 billion PHP. The use of CME to replace petro diesel will result in net savings or GHG emission reduction of 2,823.97 kg-CO_2eq per ha per year. In terms of social indices, the computed HDI is 0.784 while the change in HDI is 0.004 indicating a higher level of social development. In terms of living standard, the majority (66%) of coconut farmers perceived that there has been an improvement in their living conditions due to coconut farming. In general, the results show that majority of the employees benefited from their respective employment in the biodiesel production chain.

In Thailand study, environmental assessment for the lifecycle of ethanol production indicates that the overall GHG emissions associated with the ethanol production and consumption stages are lower than that of gasoline. Increasing the utilisation of the materials produced during various unit processes in the biorefinery complex results in reducing the GHG emissions. Economic assessment of the overall process of bioethanol production indicates that the TVA for the whole biorefinery complex amounts to 3,715,458,551 THB and it is economically viable. For social assessment, the HDI of the sugarcane plantation, biorefinery complex, and Khon Kaen were observed as 0.736, 0.797 and 0.763, respectively. Thus, although sugarcane farmers have a lower social development than an average person in Khon Kaen or employee at the biorefinery complex, they still benefit from a steady income as a result of the contract farming, which links them to the sugar mill and guarantees an annual income. Employees at the biorefinery have a higher social development (shown by a positive change of 0.034 in HDI) as compared to the Khon Kaen.

It is concluded that the four pilot projects were implemented primarily to test the WG methodology, and findings of the studies using WG guidelines, in general, were satisfactory. However, some locale-specific modifications may be needed for future applications of the guidelines. The data collection exercise to calculate various indices was complex and time consuming and required personnel who are well–versed with the methodologies and the biomass industry.

The results of pilot studies indicate that indicators GHG savings as the environment indicator; net profit, TVA and forex savings as economic indicators; and change in HDI as the social indicator are appropriate and can be used for the East

Asian Region. For enhancing the application and output of the sustainability assessment methodology, it is recommended that clarity of goals and scope of study is pre-defined; Units and measurements are harmonised; Data collection procedures used should be standardised; Reporting format of the study results is uniform; and, international standards should be adopted. It is emphasized that utilisation of all by-products in the production of biomass energy is necessary to increase the sustainability of the biomass energy project.

Finally, it is suggested that the ‘Guidelines for Sustainability Assessment of Biomass Utilisation’ are robust enough for studies at community, regional and national levels and they may be applied to each country in the East Asian region with minor locale-specific modifications.