Chapter 6

Conclusions and Policy Recommnedations

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Chapter 6

Conclusion and Policy Recommendations

1. Conclusion

This study consists of following five parts:

a. Review of existing energy polices, especially those pertaining to climate, renewables, and hydrogen, where applicable;

b. Forecast of hydrogen demand potential, including its competitiveness with respect to natural gas and coal for power generation and gasoline and diesel for road and rail transportation;

c. Forecast of hydrogen production potential, including its costs by several technologies, as well as supply costs at a charging station;

d. Well-to-wheel analysis of the economic feasibility and carbon emissions of FCVs using hydrogen;

e. Site visits to the Ministry of Energy or similar offices of selected EAS region countries (data and discussion contents with selected EAS Ministries of Energy include confidential information; as a result, these are only outlined).

The review of energy policies covers ASEAN 7 countries (except Cambodia, Lao PDR, and Myanmar due to their small hydrogen demand and supply potentials), and Australia, China, India, Japan, Republic of Korea, and New Zealand. By reviewing renewables policies, the potential of solar/PV and wind energy is drawn from national power development plans, which is used to forecast the future hydrogen production in chapter 4. The governments of Australia, China, India, Japan, Republic of Korea, and New Zealand have already formulated their hydrogen policies, and Japan and New Zealand are set to draw their hydrogen roadmap.

The scenario approach was applied to forecast EAS countries' hydrogen demand potential in 2040 because of the lack of historical demand data for hydrogen used as energy. Hydrogen basically is used/will be used as transport fuel (vehicles), fuel for power generation, and industrial heat. As a result, we assume three scenarios, applied to these three sectors depending on level of hydrogen penetration. For example, 2%, 10%, and 20% are assumed scenarios for gasoline consumption replaced by hydrogen. For power generation, targeting an additional 20% from 2015, 10%, 20%, and 30% of hydrogen as a mixing rate with natural gas are the assumed scenarios. Scenario 3 represents the highest hydrogen consumption in each sector. As a result, fossil fuel consumption shows a 2% drop from the business-as-usual baseline described by EAS energy outlook prepared by ERIA in 2018 in Scenario 3, with CO_2 emissions also decreasing by 2.7% from the baseline. The impact of the hydrogen demand potential thus looks lower than expected and assumptions of hydrogen penetration could be pessimistic. Deeper study on hydrogen technologies on the demand side should be implemented as a next step.

According to the study on prices, hydrogen for FCVs (US¢30–40/Nm^3 on average) seems to be competitive compared with ordinary gasoline and diesel oil in some parts of the local supply chain, but it will be still higher on average. For hydrogen use for power generation and industry, the prices will be in the government target range, but still will need to improve to get close to the natural gas prices (US$10/mmbtu), even with carbon offset prices (US$41/tonne-$CO_2$) in the case of overseas transportation from Southeast Asia to Japan (around 5,000 km).

There are two types of hydrogen production sources: fossil fuels, such as natural gas and coal (lignite) to apply reforming and gasification technologies, and renewable energy, such as hydro power and solar/PV to apply water electrolysis. Based on the proven fossil fuel reserves and climate data, including solar radiation and wind speed, two hydrogen production scenarios are projected: 'potential' and 'forecast'. The 'potential' scenario refers to technically available production based on the proven reserve and the climate data. The 'forecast' scenario refers to the volume balanced with total forecasted hydrogen demand of the EAS region in 2040, because exporting countries cover the demand of importing countries and intra-regional countries cover their own demand. As a result, a large amount of hydrogen is projected as 'potential' and constitutes more than enough to cover the hydrogen as 'forecast'.

Although the projected production cost by each technology indicates around US¢10–20/Nm^3 in 2040, the hydrogen supply costs at a station, which include transportation costs, will be US¢40–50/Nm^3, as mentioned above. To compete with fossil fuels, further technology development will be expected.

Applying the well-to-wheel analysis, a comparison study focused on total cost (vehicle price, fuel cost, taxes and fees, and other costs related to vehicle operation), fuel consumption, and CO_2 emissions among ICEVs, HEVs, PHEVs, EVs, and FCVs. As a result, the total cost of owning and driving FCVs will be lower than conventional and fossil fuel-powered vehicles by 2030; in the case of bus fleets, this will occur if the capital cost of FCVs can be reduced by 50% compared to current levels. If the decreases in capital cost were to reach 70% in all three fleets, namely passenger cars, buses, and trucks, FCVs would become competitive against conventional vehicles. Depending on the assumptions about the energy and pathway mixes used in producing hydrogen, FCV energy consumption could compete not only with conventional vehicles, but even with EVs, especially in the case of bus fleets. In terms of CO_2, EVs marked lowest, followed by FCVs. This analysis fully depends on assumptions such as those regarding the price data of vehicles, hydrogen supply chains, and transport fuels. Consequently, the price of FCVs will be essential for their competitiveness against other alternative vehicle powertrains from the perspective of total cost analysis.

Regarding the site surveys, we had meetings with hydrogen stakeholders in the following six countries: Australia, India, Indonesia, Malaysia, New Zealand, and Thailand. The meetings consisted of introducing the progress of this study, receiving comments from the stakeholders on its forecasted demand and production potentials, and addressing the countries' hydrogen policies. Australia, New Zealand, Brunei Darussalam, Sarawak state of Malaysia, Japan, Republic of Korea, and China have already started to take actions toward the hydrogen economy, but other countries have only looked at the possibility of hydrogen promoted by developed countries such as Japan.

2. Policy Recommendations

Based on the study results, the following policy recommendations are extracted:

a. Many EAS countries, especially developing ones, currently do not have a clear hydrogen policy. These countries have many energy choices, including fossil fuels, biomass, and renewables such as hydro power and new energy such as solar/PV. In this regard, hydrogen is one of their choices and ERIA should pay attention this point. A comparison study between hydrogen and other energy regarding cost and CO_2 emissions will be implemented for these countries.

b. Hydrogen demand fully depends on its supply costs and prices of FCVs and hydrogen power generation systems. In this study, ERIA applied the scenario approach for penetration of hydrogen demand, but it is recommended that, after deeper research on FCVs and hydrogen power systems with the collaboration of experts, the scenarios be revised.

c. Hydrogen supply costs at stations are forecasted to be US¢40–50/Nm^3, which will be in the range of gasoline prices in some cases, but it is still higher on average than gasoline. The higher price comes from higher supply chain costs, especially hydrogen carrier synthesis (converting hydrogen gas to liquid carrier) and hydrogen regeneration (separating hydrogen gas from liquid carrier). Consequently, deeper study on hydrogen supply chains, including technology research, will be necessary. The technologies of low-cost hydrogen carrier synthesis and hydrogen regeneration might be crucial.

d. Places with high hydrogen demand are usually different from those where it is produced. The study extracted Australia, Brunei Darussalam, Indonesia, Sarawak State of Malaysia, and New Zealand as hydrogen production sites. On the other hand, Japan and Republic of Korea have a large hydrogen demand. Consequently, in order to establish overseas hydrogen supply chains, the following studies are needed: a) standardisation for global trading; b) Investment in shipping and receiving terminals at both sides; and c) seeking for scale merits.

e. With this in mind, a working group to discuss common understandings on hydrogen and standardisation of the supply chain will be set up and meetings will be held regularly. Members of the working group will consist of EAS countries that have interest in developing their hydrogen production and demand potentials.