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Hydrogen, make it the energy of the future in the EAS region

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High expectation for the hydrogen energy

Although the perspective differs by country, in general, expectations for growth in hydrogen energy exist among the East Asia Summit (EAS) member countries. For instance, Japan and Korea have established a hydrogen strategy and Australia is currently forming their own strategy.

World action toward climate change, as well as strategy to make it as the future engine of economic growth, makes hydrogen attractive. Renewable electricity, as a source of carbon-free energy has some challenges. For instance, electricity cannot supply enough energy, i.e. heat, for certain industrial processes. Or, fluctuating power output from variable renewable energies (VREs), namely solar PV and wind, is difficult to integrate into supply. In addition, output from hydro-power systems is vulnerable to changes in rainfall patterns and water inflow. Hydrogen is one of the options that can solve such difficulties with renewable electricity.

Currently, many pilot projects are progressing in the region to test the benefits of hydrogen. In Brunei Darussalam, together with Japanese Chiyoda co., hydrogen production from natural gas, shipped to Japan, is being tested. In Singapore, one of the micro-grid pilot projects includes the use of hydrogen.

The EAS region has the advantage of large hydrogen potential on both demand and supply sides. On the demand side, even a small market penetration can represent large hydrogen demand as the region shares 60% of the world's energy demand (IEA, 2019) and further growth is expected. According to Economic Research Institute for ASEAN and East Asia (ERIA), the region has potential to consume 49.4-217.8 Mtoe of hydrogen in 2040, depending on scenarios (ERIA, 2019).

On the supply side, the region can produce carbon-free hydrogen from untapped hydrocarbon resources by adopting steam reforming or gasification process together with carbon capture and storage (CCS) technology. Additionally, some countries endowed with good solar radiation or wind profile can produce hydrogen using water electrolysis. The total sum of hydrogen production potential is estimated to be as high as 1,798.5 Mtoe in 2040 (ERIA, 2019). The estimated production potential well surpasses the region's demand, so the region could possibly become a net hydrogen exporter.

Though, further investigation is needed

Though there is a strong hope for hydrogen energy, it also has many issues that need to be solved before commercialization. This paper will discuss four points.

1. Substantial cost reduction is needed

The foremost challenge of hydrogen energy is to reduce the cost of supply. We cannot expect healthy development of the hydrogen energy market unless it is cost competitive against other energies. The additional cost for CCS is critical when generating hydrogen by applying the steam reforming or gasification process to hydrocarbon. Conversion loss and low capacity factor push up the production cost using water electrolysis. Long haul transportation cost is high, particularly in gaseous form and cryogenic liquid form[1]. Development of distribution network, e.g. pipeline and fueling station, is another large cost component. For the demand side, fuel cell electric vehicles are expensive and commercial scale hydrogen gas turbine technology is still in the demonstration stage. Substantial cost reduction throughout the value chain, from production to consumption, is indispensable to make hydrogen as a fuel of choice.

Making best use of existing infrastructure is an effective approach to reducing cost. Construction of dedicated new infrastructure for hydrogen energy requires large capital expenditure and time. However, if hydrogen is blended with natural gas, after solving some technical challenges[2], or transformed into methane, we can keep using the existing natural gas infrastructure. Or, if hydrogen will be transformed into ammonia, commonly available low temperature storage tanks and ships can be utilized rather than cryogenic ones.

2. How to ensure necessary investment

Further investment in R&D and construction of the physical hydrogen supply chain is essential. However, such investment is associated with large risks when the future of hydrogen energy is uncertain. Therefore, when the market is immature, as it is today, government's role becomes important. Clear policy and support for R&D is essential. The governments of the EAS member countries are requested to increase engagement with industry through such policies and put hydrogen on self-sustained development path.

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[1] Boiling point of hydrogen is -252.9 degrees C.

[2] Technical adjustment may be required in some cases for combustion mode, measurement (change from volumetric meter to heat value meter), or specific industrial consumer that need carbon.

The history of LNG trade gives us a good reference. LNG trade in the EAS region begun in 1969 between US and Japan. At that time, as we see like in the hydrogen energy today, there was no LNG supply infrastructure and not enough natural gas demand. Under these conditions, long term contracts provided the foundation for large capital expenditure on both supply and demand sides. It provided confidence for LNG supply (i.e. sales) and demand (i.e. purchase), in turn guaranteed a project's future cash flow for financing. Furthermore, the Japanese government's strong policy for reducing air pollution fostered investment.

These mechanisms are thought to function effectively in developing hydrogen supply chain as well, particularly during the early days of market creation.

3. Establish and harmonize safety/technical standard

Establishment and harmonization of the technical standard including safety is crucial for two reasons. First, it is crucial to enhance social acceptance for hydrogen energy. The importance of social acceptance is obvious when we look at some examples in coal and nuclear power plants. The market for hydrogen might be limited if the public perceive hydrogen as dangerous.

However, at the same time, one needs to recognize that safety regulation affects the cost of supply. Excessive safety mandate will raise supply cost and thus would become a hindrance to its dissemination. The authority is requested to balance securement of safety and promotion of demand.

Second, it is crucial to reduce the transaction costs of hydrogen energy. For instance, additional cost for intermediate treatment may be required if producers supply different purity levels of hydrogen. Or, export destination may be limited if the shape or type of connector of hydrogen unloading arms differ by ship. International harmonization of technical standards can reduce transaction cost and thus support market development.

4. Constraint of carbon depot and water supply

One needs to bear in mind the possible long-term constraint of supplying carbon-free hydrogen. When employing steam reforming or gasification of hydrocarbon, capacity of CCS, or carbon capture, utilization and storage (CCUS), would become a constraint. Water electrolysis requires a reliable source of water. Even where water is available, competition for supply will come from other uses including drinking, farming, and industrial use. These constraints could possibly emerge when we consume a large amount of hydrogen in the future.

Conclusion

Hydrogen is one of the promising energies in the growing EAS region in terms of energy security and environmental sustainability. However, the hydrogen contains many challenges, e.g. cost reduction and build up physical supply chain.

Although some countries are presenting strong policy messages supporting hydrogen energy, it is not satisfactory to enjoy full benefit of hydrogen energy. Even when a country successfully utilizes hydrogen energy, limited market size will increase hydrogen supply cost, hinder opportunity for innovation, and cannot make it as a sustainable economic growth engine. In this light, the EAS region is strongly recommended to cooperate with each other for creating larger and growing hydrogen market. Fortunately, the region holds natural resources for generating hydrogen, innovative technologies, and vibrant industries. The region can bilaterally or multilaterally cooperate in many fields including technology transfer and financing. An example is cooperation between Brunei Darussalam and Japan. If we can combine these potential resources to open hydrogen society, the EAS region will become the world's leader in this field.

References

IEA, World energy balances 2019 edition

ERIA, Demand and supply potential of hydrogen energy in East Asia, 13 May 2019