HYDROGEN DEMAND POTENTIAL AND ITS IMPACT IN APEC ECONOMIES

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Overview

CO_2-free Hydrogen is expected as one of the promising technologies toward mitigating climate change impacts. Some countries have delineated their policy roadmaps for hydrogen energy deployment in this regard. Especially, Asia and the Pacific region is expected to be the biggest hydrogen economy in the world involving production and consumption countries. Therefore, this study estimates the future demand potential of hydrogen energy in Asia-Pacific Economic Cooperation (APEC) economies being based on some deployment scenarios and evaluate the impact of such scenarios to the economies from viewpoints of CO_2 emission reduction and of energy security. This study contributes as a part of Asia-Pacific Energy Research Centre (APERC, 2018) [1].

Methods

This research estimates the hydrogen energy demand in the industry, transport, and electricity sectors in 2040 and in 2050. Basically, the estimation is based on the future energy demand outlook (BAU case) of APEC member economies conducted by APERC [2]. And the study calculates how much fossil energy demand in the each sector could be replaced by hydrogen energy being based on some scenarios. The scenario and method applied to each sector is as follows:

Industry : The study estimates the energy demand by sub-sector, and type of energy, in the assumption that 15% of the "theoretically replaceable" demand will be replaced by hydrogen in 2040 and 30% in 2050.

Transport : Considering the technological feasibility, light vehicles fueled by gasoline and heavy vehicles fyeled by gasoline or diesel can be replaced by fuel cell vehicles (FCVs). And the assumes that 15% of the annual new sales of those vehicles would be replaced by FCVs in 2040 and 30% in 2050.

Electricity : In the power generation sector, a portion of new coal and gas thermal power generation will be replaced by hydrogen-fired power generation to reduce CO_2 emissions. Although hydrogen production from renewable electricity (PV, wind, etc.) is important, large amount of stable supply is required to fuel baseload power plants. Therefore, the study assumes that the hydrogen would be produced by fossil fuels and the CO_2 emission from the hydrogen production is captured and stored (CCS). This means that the economies which have enough CCS potential (CCS economies) would produce hydrogen and export it to the economies which don't have CCS potential (non-CCS economies). Therefore, the hydrogen is not consumed by CCS economies but consumed only in non-CCS economies. The percentage of thermal power plants replaced by hydrogen power plant in non-CCS economies is basically set to 50% of newly installed capacity after 2035, but the percentage is adjusted in some economies according to their energy security situations.

After estimating the future hydrogen energy demand, the study estimates the amount CO_2 emission that could be avoided by substituting fossil fuel by hydrogen and evaluate the improvement of energy self-sufficiency rate of APEC as a whole.

Results

Based on scenario analysis, the demand for hydrogen in the entire APEC region is estimated to reach 116 Mtoe in 2040 and 352 Mtoe in 2050. Especially, the potential demand in China would reach 40 Mtoe in 2040 and 118 Mtoe in 2050 representing about 33% of APEC total. The detailed results of calculation is shown in Table 1.

Table 1 Estimated hydrogen energy demand in APEC economies

(ktoe)

	Hydrogen Demand in 2040				Hydrogen Demand in 2050			
	Industry	Transport	Electricity	Total	Industry	Transport	Electricity	Total
Australia	1,343	608	0	1,951	2,769	2,664	0	5,433
Brunei	3	16	0	20	8	67	0	74
Canada	1,130	1,199	0	2,329	2,376	4,762	0	7,138
Chile	263	291	909	1,462	600	1,151	3,153	4,904
China	15,925	8,229	15,730	39,883	33,958	30,973	53,435	118,366
Hong Kong	14	119	1,444	1,577	28	481	2,837	3,346
Indonesia	1,468	1,933	0	3,401	4,028	7,987	0	12,015
Japan	1,571	1,486	4,561	7,617	3,035	5,255	12,098	20,389
Korea	691	421	1,099	2,212	1,384	1,466	8,071	10,921
Malaysia	326	745	1,931	3,002	728	2,841	5,873	9,442
Mexico	2,206	1,971	117	4,294	5,276	7,935	357	13,569
New Zealand	71	55	0	126	162	227	0	389
PNG	47	26	0	74	154	164	0	318
Peru	198	400	0	598	498	1,976	0	2,474
Philippines	182	625	2,101	2,908	539	3,665	5,592	9,796
Russia	3,492	1,805	0	5,296	7,046	7,483	0	14,529
Singapore	123	59	378	560	255	166	956	1,377
Chinese Taipei	322	76	125	522	616	283	482	1,381
Thailand	1,024	587	5,160	6,771	2,585	2,446	13,935	18,966
United States	7,934	11,131	0	19,065	16,777	42,904	0	59,681
Vietnam	716	908	10,817	12,441	2,170	5,384	29,504	37,058
APEC Total	39,047	32,691	44,371	116,109	84,994	130,277	136,293	351,563

By replacing this amount of fossil fuel energy with hydrogen, it is estimated that 0.4 Gt-CO_2 emission can be avoided in 2040, and this number expands to 1.2 Gt-CO_2 in 2050. Given that emission in 2013 was 20 Gt-CO_2, hydrogen energy under the scenarios of this research can play an important role in decarbonizing APEC energy sector.

From the perspective of energy security, while hydrogen does not significantly improve the energy self-sufficiency of the whole APEC region, relatively large improvements can be expected in some economies such as Philippines and Vietnam, as shown in Table 2.

Table 2 Energy self-sufficiency in APEC economies under the hydrogen scenario in 2040

	Coal	Oil	Gas
Australia	100.0 (0.0)	12.6 (0.3)	100.0 (0.0)
Brunei	n.a.	100.0 (0.0)	100.0 (0.0)
Canada	100.0 (0.0)	100.0 (0.0)	100.0 (0.0)
Chile	1.6 (0.1)	2.7 (0.1)	16.9 (0.1)
China	86.4 (0.7)	35.4 (0.5)	58.0 (1.2)
Hong Kong	n.a.	n.a.	n.a.
Indonesia	100.0 (0.0)	21.2 (0.3)	53.3 (0.4)
Japan	n.a.	0.5 (0.0)	3.2 (0.1)
Korea	1.2 (0.0)	0.9 (0.0)	0.4 (0.0)
Malaysia	5.5 (0.4)	47.2 (0.5)	89.3 (0.9)
Mexico	78.7 (0.0)	100.0 (0.0)	99.0 (1.2)
New Zealand	100.0 (0.0)	32.0 (0.5)	100.0 (0.0)
PNG	n.a.	0.0 (0.0)	100.0 (0.0)
Peru	11.1 (0.1)	40.1 (0.9)	100.0 (0.0)
Philippines	23.6 (1.6)	1.5 (0.0)	52.3 (2.9)
Russia	100.0 (0.0)	100.0 (0.0)	100.0 (0.0)
Singapore	n.a.	n.a.	n.a.
Chinese Taipei	n.a.	0.0 (0.0)	1.2 (0.0)
Thailand	17.3 (1.2)	10.4 (0.1)	17.5 (1.0)
United States	100.0 (0.0)	79.0 (1.6)	100.0 (0.0)
Vietnam	36.4 (5.4)	0.2 (0.0)	51.4 (0.1)
APEC Total	100.0 (0.0)	76.5 (1.3)	93.1 (1.3)

Note: The numbers in brackets shows the difference between the BAU case of theAPERC Outlook.

Conclusions

Recently, more and more economies are considering future deployment of CO_2-free hydrogen energy and some of them have already begun various kind of demonstration projects of production, transport or utilization of hydrogen energy. But the forecasts of future hydrogen energy consumption conducted by APERC or any other international organizations are much lower than the result of this research.

To expand the hydrogen energy market, it is crucial to activate the demand by policy measures like renewable electricity which was strongly supported by Feed-in Tariff (FIT) or Renewable Portfolio Standard (RPS) scheme. Expansion of demand would attract investment and lead cost reduction of both hydrogen supply chain and appliances (FCVs, power plants, etc.). Cost reduction would further expand the demand and a virtuous cycle would be created.

References

[1] APERC, *Perspectives on Hydrogen in the APEC Region*, 2018.
[2] APERC, *APEC Energy Demand and Supply Outlook 6th Edition*, 2016.