

supply chains, especially those based on renewable energy; (ii) help bring down the high CAPEX of hydrogen supply chains and FCEVs; and (iii) promote new energy market mechanisms to duly value and price the additional benefits of hydrogen energy sourced from renewables, such as balancing the grid against intermittency of renewables and carbon emission reduction.

The cost competitiveness of hydrogen energy and its downstream applications in power and road transport are similar to those of solar PV, wind power, and BEVs 10–20 years ago. Therefore, we have good reason to believe that supportive policies can help hydrogen energy and its related applications accelerate learning effects, economies of scale, and maturing of infrastructure and supply chains, thus substantially cutting the costs of producing and using hydrogen energy.

## References

- APAEC (2015), *ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025*. Jakarta: ASEAN Centre for Energy.
- Apostolou, D. and G. Xydis (2019), 'A Literature Review on Hydrogen Refuelling Stations and Infrastructure. Current Status and Future Prospects', *Renewable and Sustainable Energy Reviews*, 113, 109292.
- Bai, W. and L. Zhang (2020), 'How to Finance for Establishing Hydrogen Refueling Stations in China? An Analysis Based on Fuzzy AHP and PROMETHEE', *International Journal of Hydrogen Energy*, in press.
- Brandon, N.P. and Z. Kurban (2017), 'Clean Energy and the Hydrogen Economy', *Philosophical Transactions of the Royal Society A: Mathematical, Physical, and Engineering Sciences*, 375(2098), 20160400.
- Aakko-Saksa, P.T., C. Cook, J. Kiviaho, and T. Repo (2018), 'Liquid Organic Hydrogen Carriers for Transportation and Storing of Renewable Energy – Review and Discussion', *Journal of Power Sources*, 396, pp.803–23.
- Abe, J.O., A.P.I. Popoola, E. Ajenifuja, and O.M. Popoola (2019), 'Hydrogen Energy, Economy and Storage: Review and Recommendation', *International Journal of Hydrogen Energy*, 44 (29), pp.15072–86.
- Asia Pacific Energy Research Centre (APEREC) (2018), *Perspectives on Hydrogen in the APEC Region*. Tokyo: APERC.
- Barton, J.P. and D.G. Infield (2004), 'Energy Storage and Its Use with Intermittent Renewable Energy', *IEEE Transactions on Energy Conversion*, 19(2), pp.441–48.
- Cabrera, P., H. Lund, and J.A. Carta (2018), 'Smart Renewable Energy Penetration Strategies on Islands: The Case of Gran Canaria', *Energy*, 162, pp.421–43.
- Campíñez-Romero, S., A. Colmenar-Santos, C. Pérez-Molina, and F. Mur-Pérez (2018), 'A Hydrogen Refuelling Stations Infrastructure Deployment for Cities Supported on Fuel Cell Taxi Roll-Out', *Energy*, 148, pp.1018–31.

- Chen, F., N. Duic, L. Manuel Alves, and M. da Graça Carvalho (2007), 'Renewislands – Renewable Energy Solutions for Islands', *Renewable and Sustainable Energy Reviews*, 11(8), pp.1888–902.
- Di Profio, P., S. Arca, F. Rossi, and M. Filippini (2009), 'Comparison of Hydrogen Hydrates with Existing Hydrogen Storage Technologies: Energetic and Economic Evaluations', *International Journal of Hydrogen Energy*, 34(22), pp.9173–80.
- Dorotić, H., B. Doračić, V. Dobravec, T. Pukšec, G. Krajačić, and N. Duić (2019), 'Integration of Transport and Energy Sectors in Island Communities with 100% Intermittent Renewable Energy Sources', *Renewable and Sustainable Energy Reviews*, 99, pp.109–24.
- Eypasch, M., M. Schimpe, A. Kanwar, T. Hartmann, S. Herzog, T. Frank, and T. Hamacher (2017), 'Model-Based Techno-Economic Evaluation of an Electricity Storage System Based on Liquid Organic Hydrogen Carriers', *Applied Energy*, 185, pp.320–30.
- Frank E.D., A. Elgowainy, Y.S. Khalid, J.-K. Peng, and K. Reddi (2019), 'Refueling-Station Costs for Metal Hydride Storage Tanks on Board Hydrogen Fuel Cell Vehicles', *International Journal of Hydrogen Energy*, 44(57), pp.29849–61.
- Groppi, D., D. Astiaso Garcia, G. Lo Basso, F. Cumo, and L. de Santoli (2018), 'Analysing Economic and Environmental Sustainability Related to the Use of Battery and Hydrogen Energy Storages for Increasing the Energy Independence of Small Islands', *Energy Conversion and Management*, 177, pp.64–76.
- Hou, P., P. Enevoldsen, J. Eichman, W. Hu, M.Z. Jacobson, and Z. Chen (2017), 'Optimizing Investments in Coupled Offshore Wind–Electrolytic Hydrogen Storage Systems in Denmark', *Journal of Power Sources*, 359, pp.186–97.
- Kan, S. and Y. Shibata (2018), *Evaluation of the Economics of Renewable Hydrogen Supply in the APEC Region*. Tokyo: The Institute of Energy Economics.
- Khalili, S., E. Rantanen, D. Bogdanov, and C. Breyer (2019), 'Global Transportation Demand Development with Impacts on the Energy Demand and Greenhouse Gas Emissions in a Climate-Constrained World', *Energies*, 12(20), p.3870.
- Khosravi, A., R.N.N. Koury, L. Machado, and J.J.G. Pabon (2018), 'Energy, Exergy and Economic Analysis of a Hybrid Renewable Energy with Hydrogen Storage System', *Energy*, 148, pp.1087–102.
- Loisel, R., L. Baranger, N. Chemouri, S. Spinu, and S. Pardo (2015), 'Economic Evaluation of Hybrid Off-Shore Wind Power and Hydrogen Storage System', *International Journal of Hydrogen Energy*, 40(21), pp.6727–39.
- Ma, T., H. Yang, and L. Lu (2014), 'A Feasibility Study of a Stand-Alone Hybrid Solar–Wind–Battery System for a Remote Island', *Applied Energy*, 121, pp.149–58.
- Menanteau, P., M.M. Quéméré, A. Le Duigou, and S. Le Bastard (2011), 'An Economic Analysis of the Production of Hydrogen from Wind-Generated Electricity for Use in Transport Applications', *Energy Policy*, 39(5), pp.2957–65.
- Nagashima, M. (2018), 'Japan's Hydrogen Strategy and Its Economic and Geopolitical Implications', *Etudes de l'IFRI*, October.

- Nistor, S., S. Dave, Z. Fan, and M. Sooriyabandara (2016), 'Technical and Economic Analysis of Hydrogen Refuelling', *Applied Energy*, 167, pp.211–20.
- Olateju, B., A. Kumar, and M. Secanell (2016), 'A Techno-Economic Assessment of Large Scale Wind-Hydrogen Production with Energy Storage in Western Canada', *International Journal of Hydrogen Energy*, 41(21), pp.8755–76.
- Parra, D., L. Valverde, F.J. Pino, M.K. Patel (2019), 'A Review on the Role, Cost and Value of Hydrogen Energy Systems for Deep Decarbonisation', *Renewable and Sustainable Energy Reviews*, 101(2019), pp.279–94.
- Prasanna, A. and V. Dorer (2017), 'Feasibility of Renewable Hydrogen Based Energy Supply for a District', *Energy Procedia*, 122, pp.373–78.
- Reuß, M., T. Grube, M. Robinius, P. Preuster, P. Wasserscheid, and D. Stolten (2017), 'Seasonal Storage and Alternative Carriers: A Flexible Hydrogen Supply Chain Model', *Applied Energy*, 200, pp.290–302.
- Seyyedeh-Barhagh, S., M. Majidi, S. Nojavan, and K. Zare (2019), 'Optimal Scheduling of Hydrogen Storage Under Economic and Environmental Priorities in the Presence of Renewable Units and Demand Response', *Sustainable Cities and Society*, 46(101406).
- Singh, S., S. Jain, Venkateswaran PS, A.K. Tiwari, M.R. Nouni, J.K. Pandey, and S. Goel (2015), 'Hydrogen: A Sustainable Fuel for Future of the Transport Sector', *Renewable and Sustainable Energy Reviews*, 51, pp.623–33.
- Southall, G.D. and A. Khare (2016), 'The Feasibility of Distributed Hydrogen Production from Renewable Energy Sources and the Financial Contribution from UK Motorists on Environmental Grounds', *Sustainable Cities and Society*, 26, pp.134–49.
- Teichmann, D., W. Arlt, and P. Wasserscheid (2012), 'Liquid Organic Hydrogen Carriers as an Efficient Vector for the Transport and Storage of Renewable Energy', *International Journal of Hydrogen Energy*, 37(23), pp.18118–32.
- Xu, C., Y. Wu, and S. Dai (2020), 'What Are the Critical Barriers to the Development of Hydrogen Refueling Stations in China? A Modified Fuzzy DEMATEL Approach', *Energy Policy*, 142, 111495.
- Yan, X., C. Gu, F. Li, and Q. Ai (2017), 'Cost-Benefit Comparison of Different Techniques for Addressing Wind Curtailment', *Energy Procedia*, 142, pp.1759–64.
- Young, D.C., G.A. Mill, and R. Wall (2007), 'Feasibility of Renewable Energy Storage Using Hydrogen in Remote Communities in Bhutan', *International Journal of Hydrogen Energy*, 32(8), pp.997–1009.