Number/code: OM/ML2

Title: SPREADING THE USE OF HYDROGEN ENERGY

Guidelines section:

	Governance	X	Operational management

	Context of the event		*Procurement*
	Event	X	*Mobility and logistics*
	Stadium management		

Description

Hydrogen energy is a next-generation energy that emits zero CO2 in its entire lifecycle, when renewable energies are used in the production phase, as it only emits water in the consumption phase. The TMG (the subject that constructs new venues) is spreading the use of hydrogen energy such as promoting the use of fuel-cell vehicles and installing hydrogen stations to realise a hydrogen society.

In the Tokyo 2020 Games, fuel-cell vehicles are going to be used as official vehicles. In addition, hydrogen energy is going to be actively used by building hydrogen supply systems such as the construction of hydrogen pipelines, and the Olympic Village is going to be used as the model for realising a hydrogen society as one of the legacies of the Games. The TMG is also planning to use hydrogen produced using renewable energies generated in Fukushima in the Tokyo 2020 Games through the cooperation with the prefecture of Fukushima that suffered intensive damage in the Great East Japan Earthquake. Also, hydrogen stations will be installed after the Tokyo 2020 Games to transport hydrogen from there to other areas and districts. Pure hydrogen fuel cells installed individual areas and districts will then supply electricity and heat to buildings.

Tokyo is going to lead the construction of hydrogen society, strengthen the resilience of the city, and produce legacies such as the construction of new business models for using hydrogen in residential areas. The use of hydrogen energy will be increased using the Tokyo 2020 Games as an opportunity and leave hydrogen society as one of the legacies of the Tokyo 2020 Games. Hydrogen stations will be installed after the Tokyo 2020 Games to transport hydrogen from there to other areas and districts[1].

Other examples:

TOTAL supported the Green Goal programme of the 2006 FIFA World cup in Germany by making available two buses with hydrogen-powered engines introduced by Hyundai[2]. The buses were used

[1] https://tokyo2020.org/en/games/sustainability/sus-plan/data/20180611-sus-plan-2_EN.pdf (p.33)
[2] https://www.oeko.de/oekodoc/292/2006-011-en.pdf

for the airport shuttle service in Berlin and emit practically no pollutants. In Hamburg, too, World Cup guests were brought to the stadium – for example, from Stellingen city-rail station – in hydrogen buses.

The professional American football team Philadelphia Eagles has also incorporated hydrogen technology into the stadium's infrastructure. They have partnered with PDC Machines to furnish Lincoln Financial Field with a SimpleFuel hydrogen refueling unit. The SimpleFuel hydrogen station, which has been designed to take only the inputs of water and electricity to produce clean hydrogen fuel, will power vehicles and material handling equipment in an effort to further reduce the stadium's carbon footprint. This initiative is part of the broader sustainability and eco-friendly project, called the Eagles' Go Green program[3].

Fuel cell vehicles prototypes have also made appearances in race car competitions. Students from the Dutch college Delft University of Technology developed, tested, and raced the Forze VIII, which finished second in a field of 43 petrol-powered race cars. This was the first time a hydrogen fuel cell vehicle beat a petrol-powered race car in an official race. The car can accelerate from 0 km/hr to 100 km/hr in less than 4 seconds. Its top speed is 210 km/hr. Refueling takes three minutes. Additionally, Plug Power has burst onto the scene of Formula One racing by partnering with Formula One constructor Alpine F1. Plug Power's logo will be featured on the A521 car and Alpine F1's racewear.

Gillette Stadium, home to the New England Patriots, utilizes fuel cells to meet nearly 50% of the stadium's energy demand. The stadium uses Bloom Energy's Energy Servers, which provide 2 megawatts (MW) of power. The Energy Servers are solid oxide fuel cells. The incorporation of the Energy Servers is expected to reduce Gillette Stadium's CO2 emissions by 1,500 metric tons per year compared to their previous reliance on grid power. The Energy Servers were installed in a microgrid-ready manner, which will allow the stadium to easily scale-up to a microgrid.

Hydrogen fuel cells in sports are not limited to the National Football League. LSK Enterprises, an ice resurfacer repair specialist, developed a fuel cell-powered ice resurfacer eP-ICEBEAR. The eP-ICEBEAR has been used for skating and hockey rinks. The eP-ICEBEAR was the first hydrogen-powered ice resurfacer and was displayed for the first time in 2006.

Environmental benefits

Emissions from Hydrogen fueled vehicles consist of water and no environmentally harmful emissions that come from conventional petrol powered vehicles, including hybrids. Since hydrogen for the fuel cells in the above-mentioned cases was produced with certificated electricity from renewable sources, the buses and vehicles were not only pollutant-free but also CO^2-neutral.

For instance, in order to generate real environmental benefits, hydrogen should be produced from wind, solar, and biomass resources instead of fossil fuels. In the past, the most developed methods of hydrogen production were not necessarily environmentally sustainable. For example, producing hydrogen from coal without carbon capture and storage, will further aggravate the problem of global warming[4].

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[3] https://www.fchea.org/in-transition/2021/7/19/fuel-cells-in-sports

[4] According to studies by Cornell and Stanford University researchers, "Blue" hydrogen, that involves a process for making hydrogen by using methane in natural gas, may harm the climate more than burning fossil fuel. For instance, the carbon footprint to create blue hydrogen is more than 20% greater than using either natural gas or coal directly

According to a study of the climate protection effect of green hydrogen introduction in German road transport, transitioning heavy-duty vehicles to green hydrogen could achieve a deep reduction in emissions, potentially equal to -57 $MtCO_2eq$ annually, which translates to about a 7 percent drop in German greenhouse gas emissions for the current conditions.[5] The green hydrogen scenario also promises to deliver the largest reduction in air pollutants: up to 42 percent for NMVOCs, NO_x and CO, compared to emissions from the German energy sector for the current conditions. However, producing hydrogen with the current (fossil fuel-intense) electricity mix would result in an increase or minimal effect (i.e., no benefit) in emissions of some pollutants[6].

Economic benefits

Forecasts put the cost of driving a conventional petrol powered vehicle in 2010 at US44c a mile, compared to US6c a mile for a fuel cell powered vehicle.

However, the primary challenge to green hydrogen adoption and use is its high cost. Green hydrogen currently costs three times as much as natural gas in the U.S., and may remain high without subsidies and other policy supports.[7]

Producing green hydrogen is much more expensive than producing gray or blue hydrogen because electrolysis is expensive, although prices of electrolyzers are coming down as manufacturing scales up. Currently, gray hydrogen costs about €1.50 euros ($1.84 USD) per kilogram, blue costs €2 to €3 per kilogram, and green costs €3.50 to €6 per kilogram, according to a 2020 study published in August 2020 [8].

Julio Friedmann, senior research scholar at Columbia University's Center on Global Energy Policy, affirms that the fact that 70 million tons of hydrogen are produced every year and that it is shipped in pipelines around the U.S. shows that there are clear technical issues of distributing and using hydrogen[9].

For instance, the commercialization of Green hydrogen is also limited by existing infrastructure. Growing demand of green hydrogen will require enormous investment and construction of electricity transmission, distribution and storage networks, and much larger volumes of zero-carbon power generation, as well as electrolyzer production systems, some hydrogen pipelines, and hydrogen fueling systems. An 88 million tons per annum (Mtpa) green hydrogen production by 2030, corresponding to the Stated Policies Scenario from the International Energy Agency (IEA) for that year, could cost $2.4 trillion and require 1,238 gigawatts (GW) of additional zero-carbon power generation capacity.[10]

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for heat, or about 60% greater than using diesel oil for heat, according to new research published Aug. 12 in Energy Science & Engineering: https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956

[5] Institute for Advanced Sustainability Studies, "Analysis of the climate protection effect of green hydrogen on heavy duty vehicles" December 2020: https://www.sciencedaily.com/releases/2020/12/201201124119.htm

[7] Columbia University Center on Global Energy Policy, "Green Hydrogen in a Circular Carbon Economy: Opportunities and Limits", August 2021: https://www.energypolicy.columbia.edu/research/report/green-hydrogen-circular-carbon-economy-opportunities-and-limits

[8] van Renssen, S. The hydrogen solution?. *Nat. Clim. Chang.* **10,** 799–801 (2020). https://doi.org/10.1038/s41558-020-0891-0

[9] Columbia Climate School, "Why we need green hydrogen": https://news.climate.columbia.edu/2021/01/07/need-green-hydrogen/

[10] Columbia University Center on Global Energy Policy, "Green Hydrogen in a Circular Carbon Economy: Opportunities and Limits", August 2021: https://www.energypolicy.columbia.edu/research/report/green-hydrogen-circular-carbon-economy-opportunities-and-limits

According to Friedmann, in order to address these limitations and bring down the price of green hydrogen so that more people will buy it, there is the need to: 1) Government support for innovation into novel hydrogen production and use; 2) Price supports for hydrogen, such as an investment tax credit or production tax credit similar to those established for wind and solar that helped drive their prices down; 3) A regulatory standard to limit emissions.

On the positive economic benefits, a McKinsey study estimates that by 2030, the U.S. hydrogen economy could generate $140 billion and support 700,000 jobs. [11]

According to The Renewable Hydrogen Fuell Cell Collaborative, as hydrogen fuel cell technology advances and market demand continues to increase, every aspect of the technology will demand qualified employees – from hydrogen production and distribution to fuel cell manufacturing and vehicle maintenance. Analyses show that FCEV (Fuel Cell Electric Vehicles powered by hydrogen) market penetration alone is projected to create 100,000 new jobs in the United States by 2035 and 300,000 jobs by 2050.[12]

Applicability and replicability potential

Overall, green hydrogen brings important environmental benefits, but there are still significant hurdles that stand in the way of commercialising clean and sustainable means of producing hydrogen, as well as developing the vehicle technologies required to efficiently store and use hydrogen, and building the extensive infrastructure that would be needed to support its widespread use in motor vehicles. As a result, it will take time before hydrogen can even begin to make a significant contribution to reducing global warming pollution, improving air quality, and reducing oil dependence[13].

[11]https://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/5e7ca9d6c8fb3629d399fe0c/1585228263363/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf
[12] http://www.midwesthydrogen.org/benefits/
[13] https://www.nrdc.org/sites/default/files/hydrogen.pdf