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Circularity is part of the answer to enable a faster energy transition. On the affordability question, some of these resources are scarce but there is also a question on hydrogen, for example, green hydrogen is very promising but raises a huge question of affordability and cost. You have also been thinking precisely about that, could you tell us about that?

Yim Hyo-Sung

I think government subsidies are undoubtedly the most important factor going forward to bring down the cost of hydrogen and make it affordable for customers. Hydrogen is an expensive fuel right now and the basic rationale behind the economics is that green hydrogen prices will come down as equipment manufacturers like Linde in Germany, Air Products in France, and Siemens, make more electrolyzers to bring down the investment costs for hydrogen production facilities in line with increased demand for hydrogen. This will drive prices for hydrogen down along with lower renewable energy costs. However, according to Bloomberg New Energy Finance, in 2022, the cost of producing green hydrogen in Korea is USD 7.85 and they forecast this will come down to USD 2.47 by 2030 and to USD 1.43 by 2050. Recently however, I have been concerned that the demand for hydrogen is not growing as fast as we would like. For example, in Korea the government's initial plan was to have 67 000 hydrogen cars sold and running in the market by the end of 2022. As of the end of October this year, that number was 27 870 cars, so only 43% of the target has been met.

Why is this? When you look at customer burden, I think that customers are very well-subsidised when they buy a hydrogen car. For example, the price of a Hyundai's hydrogen car, Nexo, is USD 57 000 but the government provides around USD 26 000, or about 46%, so customers can buy the car for USD 31 000, roughly the same as a mid-sized SUV, such as the Santa Fe. Customers are definitely not losing by buying hydrogen cars in Korea.

In terms of fuel cost, there is a de facto price cap on the hydrogen used to fuel the cars, which is around USD 7 per kilogram. If you want to compare the cost of hydrogen to diesel and gasoline, you have to compare it in terms of the cost per kilometre. The cost for hydrogen cars is 9.5 cents per kilometre compared to 11 cents for gasoline and 10.6 cents for diesel, so again, customers definitely have an incentive to buy hydrogen cars in terms of fuel.

However, in the end, when we ask customers why they are not buying more hydrogen cars they complain about the lack of stations where they can refuel their cars. However, if you ask hydrogen suppliers like Hyosung, we complain that there are not enough vehicles out there for

us to build more hydrogen stations. This dilemma really becomes the classic question of which comes first, the chicken or the egg. The average loss incurred by a single hydrogen station in 2021 was USD 76 000 and the government covered around 61% of those costs but that does not include the 50% depreciation costs for actually investing in the facilities. The government gives you 50% of the money you need to build a hydrogen station, but they do not provide funding for the other 50%, so that is a cost to the hydrogen fuel station. If you factor in the depreciation cost, the government subsidy only covers around 40%. I do not think businesses are going to build more hydrogen stations if they are losing money every year.

As I mentioned, the basic rationale behind hydrogen is more demand, producing more electrolyzers and bringing down the cost, but if demand is not increasing as high as we would like, then electrolyzer manufacturers will not be producing more. I think this is where the government really has to think about at what volumes they want to subsidize the hydrogen industry. Government funding will definitely be the most important factor between now and 2030 and 2040 in generating hydrogen demand, until the price of hydrogen really becomes affordable for customers.

Lucia Sinapi-Thomas

Thank you, Hyo-sung because on the back of this detailed pragmatic example based on the Korean market, it is clear that a whole value chain is needed for hydrogen including retail and the cars. As a source of affordable energy, it requires a lot of investments, not just subsidies for the end consumer.