**CILT Q&A** (2021. 05.06) answered by Ronald Grasman

1. Why cars? (Why are cars the main targets for deploying fuel cells?)
2. To achieve economies of scale  
   In order to bring down the cost to the level where CV meets TCO parity, many FCs should be created.
3. Compatibility with Renewable energy grid   
   Many countries are convert the backbone of energy systems to hydrogen. abundance of hydrogen will be produced from renewable energy. Unlike electrical energy, hydrogen energy can be stored for a long time. It is a socio-technical topic, which reduces the variability of the energy grid.
4. viable fast charging infrastructure

EVs are having relatively dense charging stations. It costs about 100,000 to 200,000 euros to build an fast charging station for Electric Passenger Vehicles on the highway, which can charge dozens of vehicles. Assuming that it takes 20 minutes to one charge, it can charge about 5-60 units per day. HRS, on the other hand, costs 3-5 million euros to build, but can charge hundreds of PVs per day. Therefore, charging cost of BEV and FCEV come into a very similar range.

1. efficiency of BEV vs FCEV

The battery is more efficient, but there is something hydrogen does when it comes to storing renewable energy: Stabilizing the electric grid. This is why we are having BEV and FCEV together.  
BEVs are very heavy and expensive when they drive long range. FCEVs are also expensive now, but FCEV has a steep cost decline curve. We can be sure that we have already developed a lot of BEV lineups. FCET has better energy density and weight ratio. In addition, pumps, hoses, compressors and control units used in the traditional automotive industry can be used. The stack gets smaller and cheaper every year. In the future, the stack will not be a heavy/super expansive element.

1. Hydrogen Purity

We follow the standards for purity of hydrogen (SAE J2719). Each element has different requirements but usually requires 99.97% hydrogen purity. Many elements require 100ppm limit but some elements require 300ppm.

1. Hydrogen ship development plan  
   We are usually working with SI. Among our affiliates, there is also a ship builder called Hyundai Heavy Industry, and is in discussions with European integrators and ship builders. Since we are beginners in the maritime field, we are considering only river barges, not ocean vessels.
2. UAM, Airplain development plan  
   Hydrogen is suitable for long range air applications. Looking at the zero e (3 prototype) concept proposed by Airbus, it uses a blended wing configuration that can be loaded with a large number of hydrogen tanks. Therefore, it can fly long distances.  
   hydrogen for aviation requires very high energy density. That's why we are considering other storage systems such as liquid hydrogen.  
   However, UAM is a new field for HMG. We are not a manufacturer of aircraft like Airbus or Boeing, and this is not our core business area. We intend to promote this as open air mobility.
3. Where will the biggest fuel cell station be?  
   Japan, America (California), Germany. In Germany, there have been hydrogen mobility activities of public-private partnership for nearly 10 years that respond to hydrogen charging needs. There are already over 80 HRSs. It is true that the CV refueling sector has not yet been developed much in all countries.  
   in the UK, there are some HRS too, even though we can’t sure if this could be modified for CV. This is why Element Energy's William is working for the AHFC consortium.
4. Hydrogen storage/transport method
5. high-pressure gaseous hydrogen transported by tube trailer: 500-800 bar, sometimes over 1000 bar.
6. Liquefied hydrogen: Cooled to almost zero Celsius and transported to the pipeline. There’s no need to compress but difficult to transport in very low temperatures and under pressure. Most of Liquefied hydrogen is extracted through pumps from natural gas grid. Another option is pipeline transport, which will only be possible in the distant future when very large scale of production and consumption occurs.
7. cryo-compressed hydrogen : mixed state. The method that combines the advantages of compressed hydrogen and liquid hydrogen
8. Compression pressure  
   Currently, almost all of hydrogen charging pressures are standardized at 350 bar to 700 bar around the world. This varies by application. PVs have a small packaging space, so there is a high possibility that you have to go to 700 bar even though 700 bar tanks are expensive. but it is slightly mixed for CV. 350bar and 700bar However, CV can use 350 bar and 700 bar together.  
   Hyundai's Swiss FC truck uses 350 bar. However, FC buses operating in Korea use 700 bar. What to use depends on the country-specific use case and application characteristics.
9. Does the payload vary with pressure?   
   Yes. The 700 bar tank is a bit heavier because the carbon fiber wraps it thicker, but it saves space. If you use 350 bar, the payload will be slightly reduced because you have to cover the weight of the additional cylinder.  
   However, this is not a major difference, it only changes a few tens of kilometers. Not a few hundred km.
10. What role should government mainly play?  
    While many government subsidies are being used to bridge the price gap between ICE, but the more important role is building infrastructure. Especially in hydrogen, government must intervene until hundreds of PVs and dozens of CVs are charged per one HRS per day. You cannot build a hydrogen station for 500,000 euros for one truck. Until there are many fleets and a big turnover, the government has to help.
11. Amount of hydrogen used for hydrogen trucks  
    Hyundai’s Swiss FC trucks use 30kg of hydrogen per day and runs 400km. a 36-ton truck requires 60-80kg per day, which can run about 1,000km.
12. Why pay-per-use model?  
    In the current situation where infrastructure is scarce, the pay-per-use model eliminates the uncertainty resulting from HRS lack. Trucks are often a means of livelihood, so people worry that they can’t use them after buying. The pay-per-use model would be a solution until we have a significant number of HRS. It is also useful when selling to customers with fleets.

What HRS do Swiss FC trucks use?

Public HRS. We didn't want to create an exclusive Hyundai eco system. We want trucks and PVs from other OEMs to use HRS. Because this is a way to reduce cost per km.

Gen set

The ETCR box contains two FCs and the power range is as small as 200kW. It is for small applications such as electricity supply in construction sites and telecom towers. We are not yet making an MW-class stationary generator that connects 10 to 30 FCs, but there is no reason not to do so. Currently we are working with a big Korean company to make an MW scale generator. But our specialty is to make the base block.