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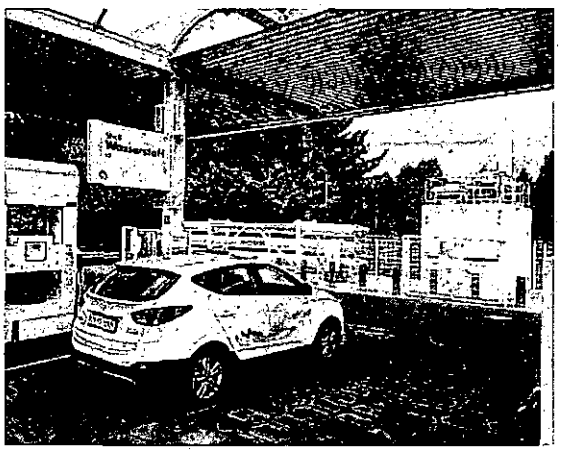

yundai ix35 fuel cell electric vehicle at a hydrogen eling station in Wuppertal, Germany.

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South Korea's Hydrogen Economy Ambitions

Moon Jae-in has an ambitious plan for South Korea to become a leader in hydrogen vehicles and fuel cells.

By Troy Stangarone
January 31, 2019

In a speech earlier this month, South Korean President Moon Jae-in laid out a vision for South Korea to develop the technology and infrastructure needed for a hydrogen-based economy.

To transition the Korean economy to hydrogen the Moon administration put forward a roadmap centered on three elements – increasing the production and use of hydrogen vehicles, expanding the production of fuel cells, and building a system for the production and distribution of hydrogen.

A key component of the plan rests on the development of South Korea as a leader in hydrogen fuel cell electric vehicles (FCEVs). At the moment, very few FCEVs are sold worldwide and they trail plug-in electric vehicles as an alternative to existing combustion engines. Through the first 11 months of 2018, plug-in electric vehicles were on pace to sell 2 million units and account for about 2 percent of automobiles sold worldwide. In contrast, by the end of 2017, only about 6,500 FCEVs had been sold worldwide, with over half of those sales in California. In 2018, sales of FCEVs only accounted for 2,300 units in the United States, with 1,700 being the Toyota Mirai.

Despite being the first company to commercially produce an FCEV, South Korean firm Hyundai has only produced a little less than 2,000 to date. Under Moon's plan, production of FCEVs in South Korea would double to 4,000 units this year and rise to over 80,000 units by 2022. The goal is to grow the market domestically and abroad to reduce per unit costs, with the expectation that the price of an FCEV will drop to around $27,000 once annual production reaches 100,000 units.

Related to its FCEV production goals, the Moon administration's roadmap also calls for South Korea to provide subsides for the introduction of FCEV taxis, as well as to put 2,000 public buses and 820 police buses powered by hydrogen on the road.

One obstacle to creating a new market for FCEVs, as with plug-in electric vehicles, is the development of an infrastructure of fueling stations. At the moment, there are less than 40 in the United States, and those are primarily in California. In Europe, most fueling stations are in Germany, where the joint venture H2 Mobility Deutschland currently has 52 refueling stations and expects grow that number to 100 by the end of the year. In South Korea, there are currently only 15 refueling stations for

FCEVs, though the government is looking to add 71 this year. In contrast, there are nearly 25,000 charging stations for electric vehicles across the United States and Canada.

To grow the number of refueling stations in South Korea, the government plans to loosen regulations by creating a regulatory sandbox that will allow domestic producers to experiment with new technologies without the concern of being burdened by regulations.

Outside of the transportation sector, the government aims to use fuel cells for household and commercial power generation. Under the current roadmap South Korea would aim to produce 15 gigawatts of power through fuel cells for industrial use by 2040, with 8 gigawatts for domestic industrial use, or 7 percent of its power generation. Another 2.1 gigawatts is expected for household use.

To move the hydrogen needed for its plans, South Korea is considering the construction of a pipeline to transport hydrogen around the country.

Hydrogen has a potentially unique appeal to the Moon administration as an alternative power source. In his remarks, Moon noted that South Korea is dependent on imports for 95 percent of its energy. While South Korea largely imports petroleum from the Middle East, it is also dependent upon imports for LNG, coal, and the nuclear fuel used to run its nuclear power plants.

Hydrogen, in contrast, is relatively abundant in nature and is a zero emission fuel. While fossil fuels are generally used to extract hydrogen from water, excess wind and solar power can be used to separate the hydrogen from the oxygen in water through electrolysis. The development of an efficient domestic hydrogen production and distribution system would allow South Korea to reduce its dependence on energy supplies from abroad.

Another advantage of the shift to hydrogen is improved air quality. In recent years, air pollution has become an increasing problem as Korea has experienced multiple days of dangerously high levels of fine dust, also known as PM2.5, and its air quality is now the worst in the OECD.

While China is one source of fine dust, a significant portion of the air pollution is produced domestically, with automobile emissions being one of the main sources. The switch to hydrogen vehicles would reduce air pollution, even if fossil fuels continued to be used to separate the hydrogen needed to power their fuel cells. If the Moon administration's target for FCEVs by 2030 is met, it estimates the switch would reduce South Korea's fine dust pollution by 10 percent annually.

One potential avenue for using hydrogen that the Moon plan does not currently cover is burning hydrogen to produce fuel. Existing coal and gas plants can be converted to burn either 100 percent hydrogen or a mixture of 30 percent hydrogen, 70 percent natural gas that would reduce carbon emissions by 10 percent. Mitsubishi Hitachi Power Systems is already working to convert one gas turbine in the Netherlands by 2024. Converting existing South Korean power plants to hydrogen could be an important part of any future shift towards a hydrogen economy.

There have also not been reports indicating that the Moon administration intends to tie its renewable energy goals to the use of wind and solar power to run electrolysis to produce hydrogen. This would further reduce South Korea's dependence on carbon-based fuels and improve its energy security.

Domestically, the plan has backing from Hyundai and the city of Ulsan. Prior to Moon's remarks, Hyundai had already set a goal of producing 500,000 FCEVs annually by 2030, and Ulsan had set the goal of becoming a leading center for the hydrogen economy. By 2030 it plans to have 40 percent of city buses run on hydrogen fuel cells (the first started this year), add 60 hydrogen refilling stations, and have 15 percent of personal vehicles run on hydrogen.

However, South Korea's goal to become a leader in the hydrogen economy will face competition. As previously noted, the Toyota Mirai is the leading FCEV and Japan already has a more extensive hydrogen refilling network with 97 stations and it is set to grow to 160 by 2020. Japan is also looking to make strides in fuel cell buses and has set a goal of 800,000 FCEVs by 2030. Germany is looking to lead European efforts and has set a goal of 1.8 million units by 2030. While it trails other countries, China is pushing into the market as well. It provided $12.4 billion in subsidies last year and has set a target of 1 million vehicles by 2030. Firms in the United States are also pursuing the technology and California's fuel emission standards could encourage production.

In the end, South Korea may be its own obstacle to success. If it is to succeed in transforming its economy and becoming a global leader in hydrogen, it will need policy continuity beyond the Moon administration — something that hasn't happened in the past. In the late 1990s, Korea also began supporting research in hydrogen power, but when the Lee Myung-bak administration took over in 2008 the emphasis shifted to the promotion of nuclear power and support for the development of hydrogen declined. Now the current administration is looking to phase out nuclear power. There is increasing support for