# Testimony of Robert Wimmer

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## Hearing on The Road to Tomorrow: Energy Innovation in Automotive Technologies

Committee on Energy and Natural Resources

United States Senate

January 25, 2018

Chairman Murkowski, Ranking Member Cantwell and members of the committee, Toyota Motor North America appreciates the opportunity to testify before the Senate Energy Committee today.

Toyota has been doing business in the US for over 60 years. Over that time, we've directly invested over $24 billion, which we've used to build 10 manufacturing plants that produce nine different models, in addition to sales distribution and R & D centers. And just this month we announced a joint-venture plant with Mazda in Huntsville, AL, which will employ 4,000 associates. These jobs will add to the 136,000 Toyota/Lexus[1] jobs in the US.

Toyota is developing a portfolio of technologies to address energy and climate challenges, while also meeting the needs of customers. These technologies include advanced gasoline and diesel engines, more efficient transmissions, lighter weight materials, hybrid drive, plug-in hybrids and a number of Zero Emission Vehicle (ZEV) technologies such as battery electric vehicles (BEVs) and hydrogen fuel cell electric vehicles (FCEVs). This past December, Toyota announced our intent to sell more than 5.5 million electrified vehicles per year globally by 2030, with 1 million of those being BEVs and FCEVs. Toyota also plans to introduce 10 new BEVs globally by the early 2020s and have electrified vehicles across our entire model lineup by around 2025.

While all these options will likely be needed across global markets, much of the public and policy attention over the past 10-years has focused largely on BEVs, and to a lesser

[1] Includes Toyota manufacturing, supporting operations and dealerships

extent, PHEVs, especially here in the US. For Toyota, an integral part of our zero-emission strategy – in addition to battery electric and plug-in hybrid electric vehicles – are fuel cell vehicles. What differentiates FCEVs from other zero emission technologies is their long driving range (typically over 300 miles on a “fill” of hydrogen), their ability to quickly refuel (usually less than five minutes) and the scalability of fuel cell systems to virtually any size vehicle. Toyota believes retaining key consumer attributes of the internal combustion engine allows hydrogen fuel cell vehicles to appeal to the broadest range of buyers, ultimately leading to greater zero emission vehicle sales.

Fuel cells are not new. In fact, they were developed in the 1800s and provided electricity and drinking water for the Apollo and Space Shuttle astronauts. There are several different types of fuel cells, but those used to power on-road vehicles all function essentially the same way. They combine hydrogen gas, stored on-board in carbon fiber tanks, with oxygen from the ambient air, to produce electricity that powers the vehicle. A fuel cell’s only emission is a small amount of water vapor from the tailpipe.

Toyota introduced its first retail fuel cell vehicle, the Mirai, or “future” in Japanese, in 2015. It is a mid-sized sedan that represents the culmination of over two decades of R&D that started before the introduction of the first hybrid electric Prius or RAV4 EV. This extensive R&D allowed engineers to design the entire fuel cell powerplant and much of its assembly tooling in-house. Toyota even took advantage of its extensive knowledge of high-speed textile looms[2] to develop a significantly faster and more precise machine for winding carbon fiber around the hydrogen fuel tanks. This new tool optimizes tank design, while

[2] Toyota was founded in 1926 as **Toyoda Automatic Loom Works, Ltd.** producing a series of manual and machine-powered textile looms.

maximizing strength. The result is a lighter tank that takes less energy to manufacture, while meeting all US and global safety requirements for high-pressure tanks.

The “final exam” for this massive engineering effort and investment was the construction and real-world testing of over a hundred fuel cell vehicle prototypes. The objective was to ensure the technology’s, durability, performance and safety in all operating conditions and climates. The success of this multiyear test program allowed us to move forward with the Mirai production program.

Since its introduction in 2015, over 3,000 Mirai have been sold in California and 5000 globally. The vehicle has an EPA-estimated range of 312 miles on a tank of hydrogen and a fuel economy rating of 67 mile per gasoline-gallon equivalent (mpgge), about twice that of a standard mid-size sedan. The Mirai has a Manufacturer’s Suggested Retail Price (MSRP) of $57,500 (before government and/or manufacturer incentives) or can be leased for $349/month. Either way, customers receive three years of free fuel, maintenance and roadside assistance. Like Prius, the Mirai is a hybrid with a small battery pack that recovers energy while braking and aids in acceleration. In addition to great low-speed acceleration, like all fully electric vehicles, the Mirai cruises effortlessly at highway speeds. Along with Toyota, Honda and Hyundai are currently delivering fuel cell vehicles to customers in California. The State’s ZEV regulations, combined with its strong commitment to the success of fuel cell technology, made it the logical place to start.

The Mirai joins Toyota’s portfolio of 14 hybrid electric and plug-in hybrid electric vehicles offered in the US. Globally, Toyota has sold over 11 million electric drive vehicles ranging from sub-compacts to shuttle buses, which are estimated to have saved over 8.7 billion gallons of fuel and reduced $CO_2$ emissions by 85 million metric tons.

Another important aspect of fuel cell technology is its scalability. Like adding more cylinders to an engine, more cells can be added to a fuel cell stack to increase system power. In the same way, a larger hydrogen fuel tank can be added to increase range. This makes fuel cells the perfect zero emission technology for SUVs and trucks, which accounted for over 65% of the new vehicle sales in the U.S. in 2017.

Toyota currently is testing hydrogen fuel cells in transit buses and trucks. Over a decade ago, Toyota operated a small fleet of fuel cell buses at the Achi Expo in Japan. Since then, our fuel cell buses have been used to shuttle passengers at the Nagoya airport and on regular routes in Toyota City, and we recently announced that Toyota will build 100 second-generation hydrogen fuel cell buses for athlete transport during the 2020 Tokyo Olympics.

In the US, a small group of Toyota engineers in Southern California and Michigan have taken two Mirai fuel cell systems and integrated them into a Class 8 drayage truck (tractor trailer). This proof of concept truck has a range of 200 miles per tank and has a gross vehicle weight of 80,000 pounds. It is currently undergoing real-world testing by hauling cargo containers from Los Angeles/Long Beach ports to local destinations and rail yards. Our objective is to demonstrate how zero emission fuel cell technology can meet the performance needs of drayage operators, while eliminating all emissions from the vehicle. If successful, fuel cell drayage trucks could provide an opportunity to eliminate emissions and noise from often highly polluted and underprivileged port areas.

At the other end of the scalability spectrum, hydrogen fuel cells are being used to power nearly 20,000 fork lift trucks at warehouses around the country. Companies like Walmart and Amazon have embraced the technology for its superior performance and warehouse efficiency relative to battery powered fork trucks.

It is important to consider upstream greenhouse gas generation from fuel production when assessing the overall benefit of any zero-emission vehicle. Like electricity, hydrogen can be produced in a variety ways. Today, most hydrogen is efficiently produced from abundant domestic natural gas. Using hydrogen produced from natural gas, fuel cell vehicles generate about 50% of the greenhouse gases per mile of a conventional gasoline vehicle on a well-to-wheels basis. Hydrogen also can be produced renewably using electrolysis from wind, solar or hydropower, or using bio-methane captured at landfills and sewage treatment plants. Toyota currently is constructing the world's first megawatt-scale carbonate fuel cell power generation plant with a hydrogen fueling station at the Port of Long Beach to fuel our port operations. The Tri-Gen facility will use bio-waste sourced from California agricultural waste to generate water, electricity and hydrogen. When it comes online in 2020, Tri-Gen will generate approximately 2.35 megawatts of electricity and 1.2 tons of hydrogen per day. In addition to generating hydrogen and electricity, this process prevents these bio-methane gases from being released to the atmosphere. Ultimately, hydrogen will be produced by a combination of sources based on the region of the country, availability, price of the feedstock, and regulatory requirements.

Hydrogen is relatively simple to store and transport. Where electricity requires a battery for storage, hydrogen can be stored as a gas for extended period in tanks. This ability is the cornerstone of the DOE H2@Scale project and the Hydrogen Society concept. Both envision the generation and storage of low-cost hydrogen from excess wind or solar power. This would help to decarbonize the energy sector as renewable hydrogen could be used for vehicles, for industrial processes, or even turned back into the electricity grid in an emergency. Hydrogen generation can take place near where the renewable electricity is generated or hundreds of miles away off the grid. Likewise, the generated hydrogen can be transported and used elsewhere. As part of the Hydrogen Council, an international multi-industry organization, Toyota is exploring these concepts and promoting ways to transition hydrogen into the energy sector to help decarbonize society.

Toyota believes the greatest challenge to fuel cell vehicle success is not vehicle price nor consumer acceptance, but hydrogen refueling infrastructure. California is the leader in infrastructure in the US, having committed $200 million to co-fund 100 hydrogen fueling stations. To date, there are 31 stations open to the public with potentially another 12 expected to open later this year. Most stations are in the Los Angeles and San Francisco metropolitan areas. The remainder are connector stations that allow fuel cell vehicle drivers to travel between metro areas. While impressive, the station roll-out in CA has been slower than expected.

To accelerate station construction, Toyota has partnerships with several companies. In CA, we have partnered with First Element Fuel (FEF) on 19 stations and recently announced two additional partnerships, one with Shell to add refueling capabilities to seven stations in Northern CA and another with FEF for eight additional stations. In the Northeast, we have partnered with Air Liquide, an industrial gas supplier, on the development of 12 hydrogen stations in NY, NJ, MA, RI and CT. These states were selected for their large metro areas, customer demographics, contiguous proximity, and requirement that automakers sell zero emission vehicles. Most stations will be in the Boston and New York City metro areas, with a few connector stations to allow convenient travel between the two cities. Most stations will be completed this year, with vehicle deployment starting when a sufficient number of stations are operational to meet customer needs.

To insure the US remains competitive in this space, the federal government needs to take a much more proactive role supporting hydrogen infrastructure growth. In Japan, Korea, Germany and Scandinavia, the federal governments provide strong policy and financial support for both fuel cell vehicles and infrastructure. This has resulted in 91 operational hydrogen stations in Japan, 44 in Germany, and about 20 in Korea. Without robust federal support for hydrogen infrastructure, possibly part of a national infrastructure program, the numbers of fuel cell vehicles on our roads will remain modest.

The federal government can also help by assuring all zero emission vehicles are treated equally when it comes to vehicle and infrastructure incentives. Currently, zero emission battery electric vehicles are eligible for a consumer tax credit, which we support. But zero emission fuel cell vehicles are not. The fuel cell tax credit expired prior to any meaningful number of vehicles being on the road. The credit needs to be reinstated. We were pleased to see it included in Chairman Hatch’s tax extender package, but would encourage members to support a longer extension of the credit, so that both the industry and consumers can have greater cost certainty. Reinstatement of the credit also is important to reestablish parity among zero emission vehicles.

Toyota also supports the alternative fuel vehicle infrastructure tax credit, which, like the vehicle tax credit, has expired. Hydrogen stations are multi-million dollar investments. For the tax credit to be meaningful it needs to increase (from its current $30,000 cap) to a level that makes hydrogen infrastructure investment viable. These actions would send a signal to industry and the States that the federal government supports fuel cell and hydrogen technology, while addressing a primary concern of many investors.

We appreciate that the Committee does not have jurisdiction over tax policy, but thought it important to highlight government policies that would have a major impact on getting hydrogen fuel cell technology out into the market in the shortest time possible.

Finally, Toyota wants to recognize the Department of Energy for their ongoing support of hydrogen and fuel cell research, development and commercialization. Their investment of over a billion dollars for R&D has accelerated commercialization of the technology to the benefit of all. DOE supported Toyota's initial Cooperative Research and Development Agreement (CRADA) with a national lab and a real-world range test of our fuel cell prototype vehicle, the FCHV-adv in 2009. The vehicle demonstrated a range of over 430 miles on single fill of hydrogen. More recently, DOE's support of codes and standards development is benefiting station developers and automakers alike. Similarly, it's ongoing engagement with state and regional authorities to address technical questions related to tunnels and bridges, and to alleviate any concerns about the safety of the technology has been highly beneficial. DOE's continued support in these areas is critical to eliminating regulatory barriers that will slow rollout of the technology.

Toyota strongly believes that a portfolio of advanced technologies, highly efficient engines and a range of electric drive options are required to meet the sometimes-divergent needs of customers, regulators and society. With their longer range, ability to refuel quickly and scalability, hydrogen fuel cell electric vehicles are an important part of Toyota's portfolio.

We appreciate the opportunity to testify before the Committee today and would be happy to answer any questions.