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*Toyota's hydrogen fuel cell electric Class 8 truck*

# AN INTRODUCTION TO HYDROGEN FUEL CELLS

## Hydrogen fuel cells enable electricity production with zero emissions - and platinum plays a key role. What are they and where does platinum fit in?

The use of electricity from hydrogen fuel cells is fast gaining recognition as an alternative to electricity from fossil fuels or batteries in electric vehicles. A fuel cell is a device that generates electricity through an electrochemical reaction, not combustion.

In a platinum-based hydrogen fuel cell, hydrogen and oxygen are combined to generate electricity, with heat and water as the only by-products. Molecules of hydrogen and oxygen react and combine using a proton exchange membrane (PEM) which is coated with a platinum catalyst.

Platinum is especially suited as a fuel cell catalyst as it enables the hydrogen and oxygen reactions to take place at an optimal rate, while being stable enough to withstand the complex chemical environment within a fuel cell and high electrical current density, performing efficiently over the long-term.

Fuel cells share many of the characteristics of a battery – silent operation, no moving parts and an electrochemical reaction to generate power. However, unlike a battery, fuel cells need no recharging and will run indefinitely when supplied with fuel. A fuel cell can have a battery as a system component to store the electricity it is generating.

Today, hydrogen fuel cells power a range of applications, from providing silent energy to homes, mobile homes and boats and backup power to businesses. Platinum-based hydrogen fuel cells are particularly important in providing 'green' electric mobility and are already being used to move goods across the supply chain – from hydrogen powered trucks to fork-lift trucks moving goods around a warehouse.

Passenger transportation is also using fuel cells, with hydrogen-fuelled ferries, trains, trams and buses appearing with increasing frequency in a number of cities around the globe.

Many of the world's leading automotive companies are developing, or have developed, hydrogen platinum-based fuel cell electric vehicles (FCEVs) as a preferred technology in response to the challenge of improving air quality and reducing tail-pipe emissions to zero.

FCEVs combine the emissions-free driving of battery electric vehicles with the quick refuelling times and range of a traditional gasoline or diesel car.

Unlike battery electric vehicles, they also have the advantage of providing 'high load capacity', meaning that FCEVs maintain a consistent power output even as the load increases, for example when going uphill or towing.

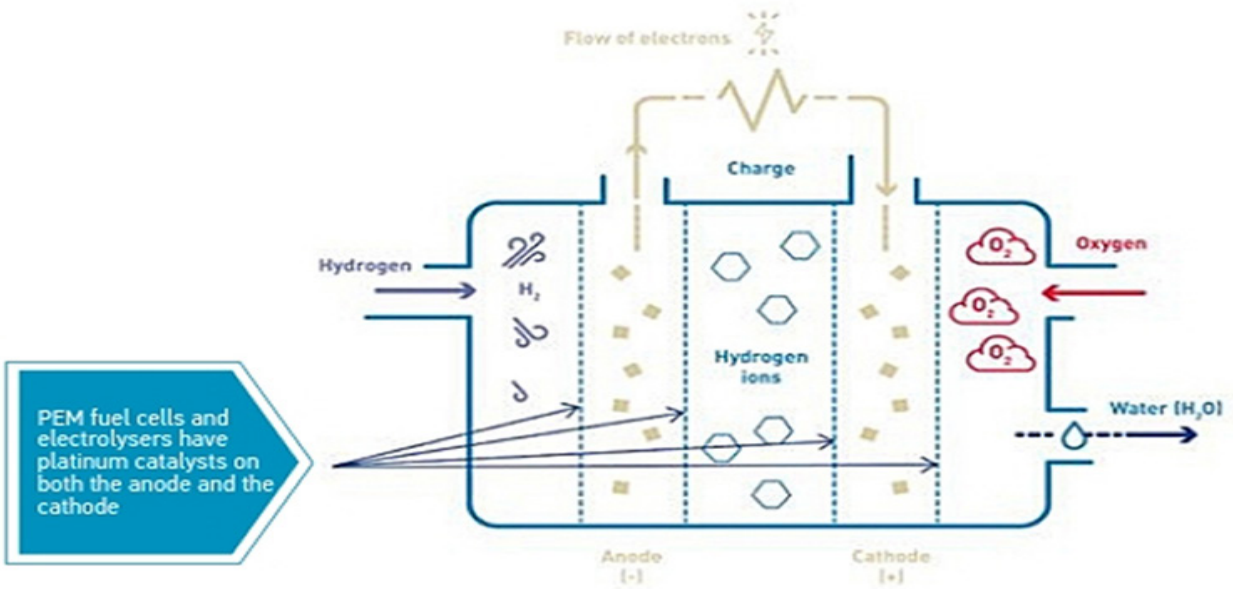
### FCEVs becoming increasingly commercial

Governments, non-government organisations, fuel producers, fuel distributors and automotive companies continue to collaborate on building out the infrastructure needed to support widespread FCEV

adoption. This includes developing renewable hydrogen sources and hydrogen refuelling stations. Certain regions are advancing plans for FCEVs vigorously, especially Europe, China, Japan, South Korea and, within the US, California.

In China alone it is estimated that there will be at least 50,000 FCEVs on the road by 2025, and one million by 2030 (source: JM PGM Market Report May 2018). Growth in the FCEV market is expected, over the long-term, to have a positive impact on platinum demand.

## Inside a platinum-based fuel cell




Source: Graphic from Airliquide Proton Exchange Membrane

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