FACTSHEET: A TALE OF TWO FUELS

A COMPARISON BETWEEN A HYDROGEN AND A PETROL CAR vs 1 - 18 Oct 19

The vehicles selected for this comparison are the hydrogen[i] powered Toyota Mirai and the similar sized petrol driven Holden Malibu. Performance figures are as factory specified, and the costs are calculated for a 500 km journey, a common distance between refills.

Hydrogen is sold by kg weight, similar to other gases. In order to compare apples with apples, petrol quantity is converted to kilograms. One litre of 91 unleaded petrol weighs 0.7 kg.

As hydrogen does not (yet) attract a government fuel excise charge, the price used is the cost per kg charged by the manufacturer. For a true comparison, the 91 unleaded petrol price is the cost charged by the Singapore refinery where Australia sources most of its fuel. Freight, Australian government excise, and GST are not included.

91 unleaded ex-refinery: 65 cents per litre 93 cents per kilogram
Hydrogen (green[ii]) ex-factory: between AUD$5.69 and $8.13 per kilogram[iii]

TOYOTA MIRAI **HOLDEN MALIBU**

Fuel	HYDROGEN	91 UNLEADED PETROL
Weight	1,848 kg	1,588 kg
Length	4,890 mm	4,865 mm
Width	1,816 mm	1,555 mm
Fuel capacity	5 kg	51 kg (73 litres)

ALL URBAN DRIVING (factory figures)

MIRAI ***(Hydrogen)***	**MALIBU** ***(Unleaded petrol)***
0.69 kg/100 km	11 litres/100 km = 7.7 kg/100 km
145 km/kg	13 km/kg
500 km uses 3.448 kg	500 km uses 38.46 kg
3.448 kg @ $5.69 per kg = $19.62	38.46 kg @ $0.93 per kg = $35.77
3.448 kg @ 8.13 per kg = $28.03	

MIXED HIGHWAY AND URBAN DRIVING

MIRAI ***(Hydrogen)***	**MALIBU** ***(Unleaded petrol)***
0.76 kg/100 km	8 litres/100 km = 5.6 kg/100 km
131.6 km/kg	17.86 km/kg
500 km uses 3.8 kg	500 km uses 28 kg
3.8 kg @ $5.69 per kg = $21.62	28 kg @ $0.93 per kg = $26.04
3.8 kg @ $8.13 per kg = $30.89	

ALL HIGHWAY DRIVING

MIRAI *(Hydrogen)*	MALIBU *(Unleaded petrol)*
0.91 kg / 100 km	7 litres / 100 km = 4.9 kg/100 km
110 km/kg	20.4 km/kg
500 km uses 4.545 kg	500 km uses 24.5 kg
4.545 kg @ $5.69 per kg = $25.86	24.5 kg @ $0.93 per kg = $22.78
4.545 kg @ $8.13 per kg = $36.95	

From these tables we can see the following:
One kg of hydrogen drives the Mirai between 5 and 11 times as far as 1 kg of petrol drives the Malibu, depending on whether it's city or highway driving. The reason for this is twofold. Firstly, hydrogen contains over three times the energy of petrol. Secondly, a fuel cell is more than twice as efficient at converting that hydrogen into the electricity needed to power the electric motors that drive the wheels. Petrol has only 1/3 of the energy of hydrogen, and petrol engines deliver only 18%-30% of that energy to the wheels.

Even at today's prices, hydrogen is more economical than petrol for urban driving, which is where most cars are used, on short trips. The hydrogen car's economy improves as speeds reduce, while the petrol car's economy improves at highway speeds. Petrol engines have only one speed where they are most economical, so engineers generally set that close to the highway speed limit.

Fuel cell cars are more flexible in power consumption, i.e. low consumption at low speed and higher consumption at higher speeds. Low hydrogen fuel consumption during stop-start driving is greatly enhanced by regenerative braking as the brakes generate electricity and feed it back into the battery each time they're applied.

THE FUTURE

In September 2018 IRENA (International Renewable Energy Agency) had this to say:
"It is impossible to come to a unified conclusion on an industrial hydrogen price as the variation in targeted sales prices across countries and applications is too diverse."

As hydrogen is at least 5 times more efficient than petrol, it reaches parity at 5 times the $0.93 per kg price in Australia, i.e. $4.65 per kg. Japan has a target kg price for 'green' hydrogen of US$3.00 (AUD$4.44). We are hoping to supply hydrogen to Japan. Australia has abundant renewable resources so there's no reason why we can't come in under that target. The price of petrol is unlikely to decrease, especially when carbon prices begin to ramp up. The price of clean electricity is now below that of coal/gas/uranium.[iv]

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[i] See http://repowergladstone.com.au/wp-content/uploads/2019/10/Gladstone-hydrogen-ammonia-centre.pdf

[ii] '**Green**' hydrogen is made by electrolysis using electricity from renewable sources, eliminating CO_2 emissions. '**Fossil Fuel**' hydrogen is made from and/or with fossil fuels emitting green-house gasses.

[iii] Hydrogen prices vary widely because they depend on two major variables: **throughput volume** and **cost of electricity**. Hydrogen is produced with electricity. Prices for electric power are decreasing rapidly, due partly to cheap renewable electricity, e.g. a recent solar electricity bulk supply contract in Portugal priced the electricity at AUD 2.4 cents per kwh.

[iv] http://repowergladstone.com.au/wp-content/uploads/2019/10/Fact-sheet-Thermal-coal-in-terminal-decline-Gladstone-version.pdf