Toyota Mirai

Introduction/Background

24/01/2018

METROLOGY for HYDROGEN VEHICLES
World Leaders Agreement – COP21 Paris
Regarding GHG emissions, there is no time to lose

Source: From the IPCC Working Group III 5th Assessment Report (2014)
Environmental Challenges

CLIMATE CHANGE

AIR QUALITY

ENERGY SECURITY
Energy Security

1 billion EUR of oil expenses per day
Future Vision: HyGrid (Hybrid Hydrogen – Electricity Grid)

- Renewable Energy: Wind power, Photovoltaic generation
- Biomass
- Wastewater
- Hydrogen tanks: High-volume, long-term storage
- Electrolysis
- Urban/residential: FCV, EV/PHV, Electricity storage facilities
- Electric Power generation units
- Thermal power generation
- Chemical plants

Energy Flow:
- Electricity
- Hydrogen
- Fossil fuels

Source: HyGrid Study Group HP
Using Hydrogen as a Storage for Renewables

Hydrogen is most promising for long-term and carbon-free seasonal storage

1 IEA data updated due to recent developments in building numerous 1MW hydrogen storage tanks

Hydrogen: Versatile, 0-Emission Energy Carrier

- **ZERO** carbon footprint potential
- **LONG** distance transport
- **HIGH** energy density
- **CLEAN** power and/or heat
- **SERVES** as feedstock in industry using CCU

- Biomass
- Batteries
- **H₂**
- **Urea**
- Methane
- Methanol
- many others
FCVs are essential for decarbonising transport

Bubble size represents relative annual energy consumption of this type in 2013.

1 Battery-hydrogen hybrid to ensure sufficient power.

2 Split in A- and B-segment LDVs (small cars) and C+-segment LDVs (medium to large cars) based on a 30% market share of A/B-segment cars and a 50% less energy demand.

Source: Toyota, Hyundai, Daimler
Mirai is not a car, it’s a symbol
Developing Hydrogen FCV for 20 years

1992
FCHV-3 Fuel
Hydrogen (adsorbing alloy)

1996
FCEV Fuel
H₂ Stored in adsorbing alloy

1999
FCHV-4 Fuel
Hydrogen stored in high-pressure tanks

2001
FCEV Fuel
Hydrogen stored in adsorbing alloy

2002
FCHV
Toyota-made tanks, 1st FCV homologated

2005
FCHV-adv Fuel
New stack, stainless steel cells

2009
FCV-R Fuel
Mirai precursor

2011
Mirai
Revolutionary Titanium stack, 3.1 kW/L world record

2015
FCHV-5 Fuel
Hydrogen generated on-board by reforming on gasoline

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Toyota 2050 Challenge

To go beyond zero environmental impact and achieve a net positive impact, Toyota has set itself six challenges. All these challenges, whether in climate change or resource and water recycling, are beset with difficulties, however we are committed to continuing toward the year 2050 with steady initiatives in order to realize sustainable development together with society.
Toyota 2050 Challenge

Toyota Environmental Challenge 2050
Contribution to a Better Society through Net Positive Impact

Challenge 1: New Vehicle Zero CO2 Emissions Challenge

Challenge 2: Life Cycle Zero CO2 Emissions Challenge

Challenge 3: Plant Zero CO2 Emissions Challenge

Challenge 4: Challenge of Minimizing and Optimizing Water Usage

Challenge 5: Challenge of Establishing a Recycling-based Society and Systems

Challenge 6: Challenge of Establishing a Future Society in Harmony with Nature

Zero Environmental Impact Challenge

Challenge of Achieving Zero
Challenge 1: New Vehicle Zero CO$_2$ Emissions Challenge

90% reduction of new vehicle CO$_2$ emissions by 2050 compared to 2010
Toyota’s Answer – Mirai, the obvious next step

We had a kind of feeling that “we could do it with the HYBRID, why not the FUEL CELL VEHICLE?”

Akio Toyoda
Hybrid Global Sales

1.5 million HV’s every year

10 million

1 M

5 M
Growth of HV in Europe

Toyota+Lexus Hybrid Sales Mix in Europe

0.0% 5.0% 10.0% 15.0% 20.0% 25.0% 30.0% 35.0% 40.0% 45.0% 50.0%

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

TOWARDS 50%
Toyota FCV sales plan in 2020

GLOBALTARGET: More than 30,000/year around 2020

2015: 700 vehicles/year
2016: ~2,000 vehicles/year
2017: ~3,000 vehicles/year
2018: ~3,000 vehicles/year
2019: ~3,000 vehicles/year
Mirai
= “Future” in Japanese
Mix of powertrains required to achieve 90% CO2 reduction.

Electrification will increase dramatically after 2020.
The Journey to Sustainable Mobility

• The right car, at the right place, at the right time, using the right source of energy: A mix of sources.
Using hybrid technology for Plug-In, EV and Fuel Cell

HYBRID
- Engine
- Motor
- Fuel Tank
- Battery

PLUG-IN HYBRID
- Engine
- Motor
- Fuel Tank
- Battery

ELECTRIC
- Motor
- Battery

FUEL CELL
- Engine
- FC Stack
- H₂ Tank
- Battery

TOYOTA
Fuel Cell Components

**FC stack**
- Innovative flow channel structure and Electrodes of cells for higher output
- Output/volume: 3.1kW/L

**Humidifier less**
- Internal circulation

**High pressure hydrogen tank**
- The light weight structure of carbon fiber reinforced plastic enabled Storage: 5.7 wt%*

**FC boost converter**
- Reduced number of cells in FC stack
- Common use of hybrid units

*Hydrogen mass/Tank mass

**FC main components developed in-house to achieve world leading performance**
Warranty Period like any other Toyota hybrid

- **3 years / 100,000 km**
  - Standard warranty for all general parts and components

- **5 years / 100,000 km**
  - Extended warranty for all hydrogen and high voltage parts

- Fuel tank
- FC stack
- HV battery
- Drive motor
- HV Inverter
- HV booster
Thank You

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