Toyota’s experience with hydrogen – on the road towards the environmental challenge 2050
Forecast international climate change

Regarding GHG emissions, there is no time to lose
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 Environmental Challenge 2050

**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**

**Toyota Environmental Challenge 2050**

Contribution to a Better Society through Net Positive Impact

**Net Positive Impact Challenge**

**Challenge of Achieving Zero**
Toyota Environmental Challenge 2050

CHALLENGE 1

New Vehicle
Zero CO₂
Emissions Challenge

CO₂ 0
Toyota Environmental Challenge 2050

Challenge 1: New Vehicle Zero CO2 Emissions Challenge

90% reduction of new vehicle CO2 emissions by 2050 compared to 2010

Development of next generation vehicles

Next generation vehicles to accelerate technological development to follow market expansion of HV
Consistent mobility roadmap

EVs: Short-range
HVs & PHVs: General use
FCVs: Medium- to long-range

Vehicle size vs. Travel distance

Fuel: Gasoline, diesel, biofuels, CNG, synthetic fuels, etc.
Hydrogen

EVs
HVs/PHVs
FCVs
Developing Hydrogen FCV for 20 years

- **FCEV Fuel**: H₂ Stored in adsorbing alloy
- **FCHV-4 Fuel**: Hydrogen stored in high-pressure tanks
- **FCHV**: Toyota-made tanks, 1st FCV homologated
- **FCV-R Fuel**: Mirai precursor
- **FCHV-3 Fuel**: Hydrogen (adsorbing alloy)
- **FCHV-5 Fuel**: Hydrogen generated on-board by reforming on gasoline
- **FCHV-adv Fuel**: New stack, stainless steel cells
- **Mirai**: Revolutionary Titanium stack, 3.1 kW/L world record
Mirai

= “Future” in Japanese
Eco car as easy as conventional car

0 emission
except water

550 km*
range

3-5 min
to refuel

* : According to NEDC
4-seater Limousine

<4.9 m
Vehicle length

91 cm
Couple distance

361 l
Luggage capacity
Driving experience

154 hp

9.6 s
0-100 km/h

335 Nm

torque

3 s
40-70 km/h

178 km/h
top speed
Excellent handling and agile cornering

- Low center of gravity
- High-rigidity body
- Electric motor
- FC stack
- Hydrogen tank
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**
What Mirai consumes (and emits)*

- 0.76 kg of hydrogen for every 100 km
- 7.0 l of water for every 100 km
- 22 m³ of air used per 100 km

In the homologation cycle (NEDC)
Nestled in our Hybrid DNA

Using hybrid technology for Plug-In, EV and Fuel Cell
Toyota Fuel Cell System Components

- Ni-Mh Battery
- Hydrogen tanks
- Fuel Cell Stack
- Power Control Unit
- Motor
- Converter
Advances in technology: efficiency

Volume -43%
Weight -48%
Power +26%

2008 MODEL FUEL STACK
1.4 kW/L
(Maximum output: 90 kW/volume: 64L; weight: 108kg)
200 cells x dual-line stacking = 400 cells

2.2 times better volume power density

MIRAI FUEL STACK
3.1 kW/L
(Maximum output: 114 kW / volume: 37L; weight: 56kg)
370 cells
Single-line stacking

Spring
Ensuring safety on board

**Toyota FC stack**
Steel frame and aircraft grade fibre-reinforced plastic used in protect the FC Stack.

**Hydrogen sensors**
Provide warnings and can shut off tank main stop valves.

**Impact safety structure**
Protects the FC Stack and Hydrogen tanks in the event of an accident.

**High pressure Hydrogen tank**
Made from reinforced carbon of the highest quality.

**Hydrogen related parts**
Located outside the cabin.
State of the art H₂ tank technology

- Cylindrical section
- Boundary section
- Dome section
- Boss
- Plastic liner
- Carbon fiber-reinforced plastic layer
- Glass fiber-reinforced plastic layer

5kg H₂ storage
H₂ tank tests are extremely severe

Tank designers and inspectors run a load of harsh tests in laboratories

- Burst test
- Bonfire tests
- Crush test @150 tons force (Powertech)
- Gunfire test (tested@Powertech)

Armour-piercing 7mm test according to UN Technical Regulation
Why do we introduce Mirai now

- Standardization
- Infrastructure
- Customer
Requirement for success

Main challenges:
- Cost and capacity to manufacture

700 bar!
Collaboration needed to create H2 society
Small steps → big step

- Public authorities / governments
- Energy and infrastructure providers
- Vehicle manufacturers
- Customers
Vehicle sales

Sales in areas where H2 stations are in place and in surrounding areas.

Annual vehicle production spread step by step.

2015: 700 vehicles/year
2016: approx. 2,000 vehicles/year
2017: approx. 3,000 vehicles/year

=> More than 30,000/year around 2020 and later
H2 and Fuel Cell strategic roadmap in Japan

FCV + Hydrogen stations (Revised in March/2016)

Fuel Cell Vehicle (FCV)

◇ Target

■ 40 thousands by 2020, 200k by 2025, 800k by 2030
◇ Target Introduction of volume zone FCV into the market around 2025

Hydrogen Station

◇ Clarify the construction target and sustainability establishment

■ 160 stations by 2020FY, 320 by 2025FY
※ around 900 capacity stations necessary to fulfill 2030 vehicle target
◇ make stations economically sustainable before later half decade in 2020

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Source: METI
Several hundreds of hydrogen stations are expected by 2020
Toyota Environmental Challenge 2050
Creation of a future where people coexist with nature through use of renewable energy and CO2-free hydrogen
Thank you for your kind attention!