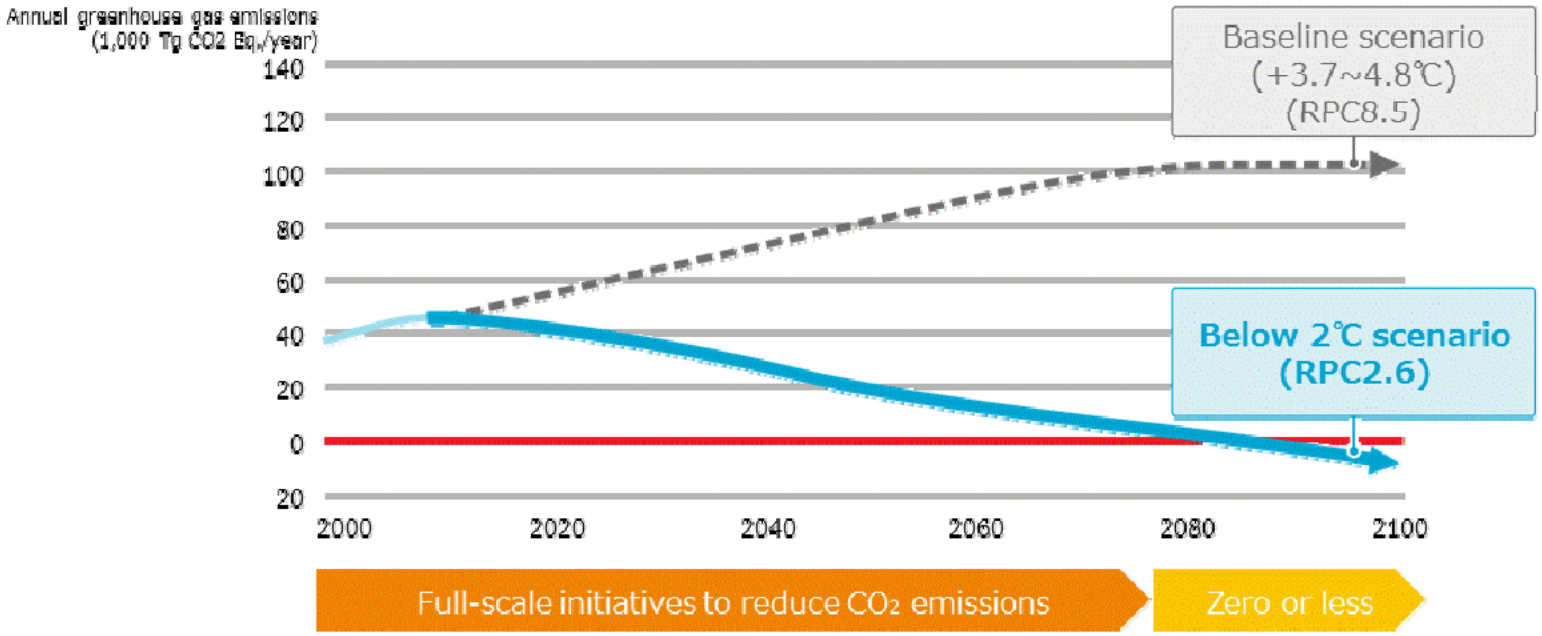
Toyota's experience with hydrogen – on the road towards the environmental challenge 2050

Gerald Killmann
Toyota Motor Europe
25th Oct 2016

Forecast international climate change



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

Regarding GHG emissions, there is no time to lose

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TOYOTA ENVIRONMENTAL CHALLENGE 2050

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.

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Toyota Environmental Challenge 2050

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CHALLENGE 1

New Vehicle
Zero CO_2
Emissions Challenge

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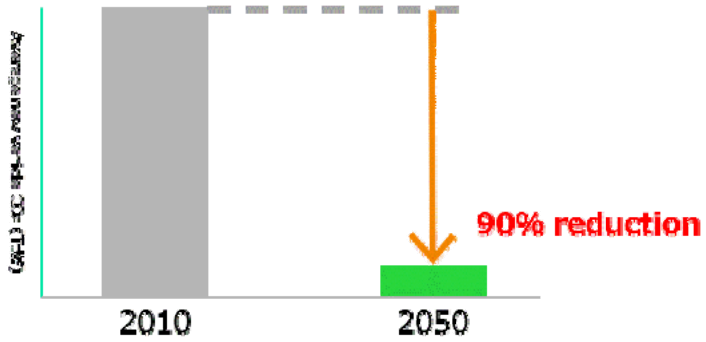
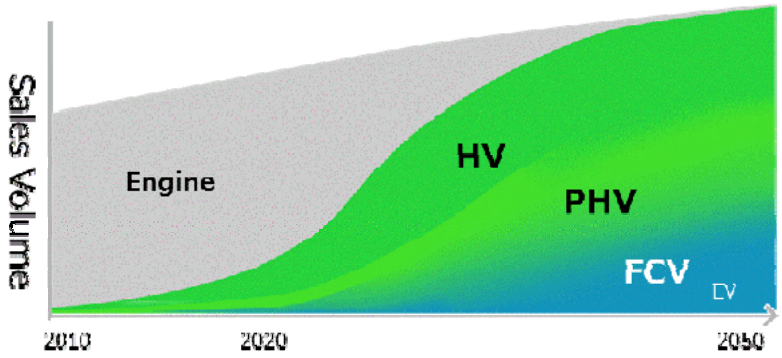
Challenge 1: New Vehicle Zero CO2 Emissions Challenge



90% reduction of new vehicle CO_2 emissions by 2050 compared to 2010

Development of next generation vehicles



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

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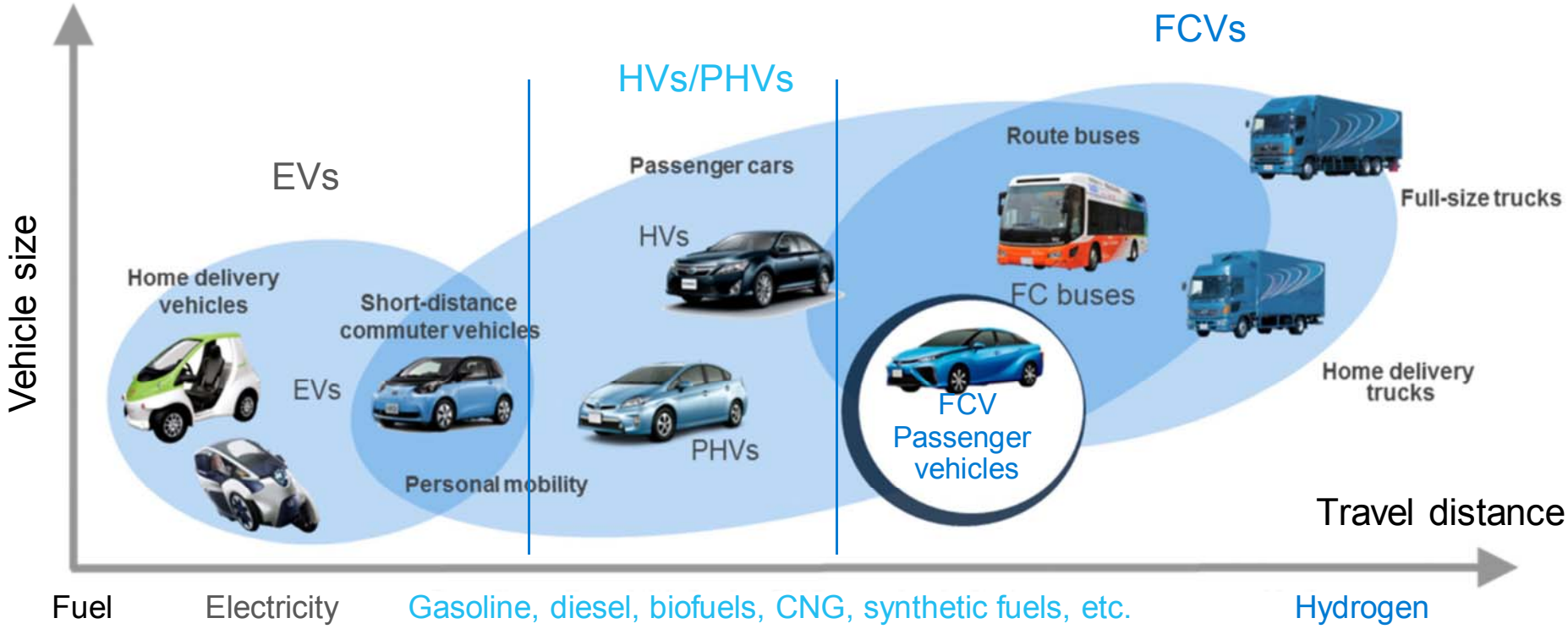
Consistent mobility roadmap



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

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Developing Hydrogen FCV for 20 years

1996 — FCEV Fuel
H_2 Stored in adsorbing alloy

2001 — FCHV-4 Fuel
Hydrogen stored in high-pressure tanks

2005 — FCHV
Toyota-made tanks, 1st FCV homologated

2011 — FCV-R Fuel
Mirai precursor

1996 · 1999 · 2001 · 2002 · 2005 · 2009 · 2011 · 2015

1999 — FCHV-3 Fuel
Hydrogen (adsorbing alloy)

2002 — FCHV-5 Fuel
Hydrogen generated on-board by reforming on gasoline

2009 — FCHV-adv Fuel
New stack, stainless steel cells

2015 — Mirai
Revolutionary Titanium stack, 3.1 kW/L world record

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Mirai

Eco car as easy as conventional car

0 emission

except water

550 km*

range

3-5 min

to refuel

* : According to NEDC

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4-seater Limousine

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ALWAYS A BETTER WAY

<4.9 m
Vehicle length

91 cm
Couple distance

361 l
Luggage capacity

Driving experience

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Quiet

NOISE SILENCER

ACOUSTIC GLASS

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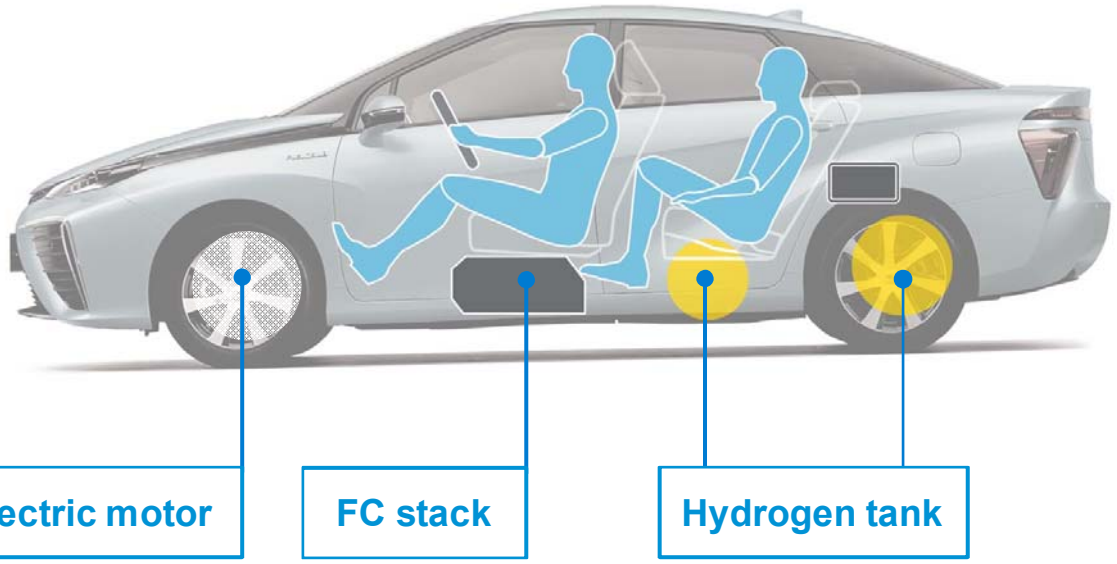
Excellent handling and agile cornering

Low center of gravity



High-rigidity body

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

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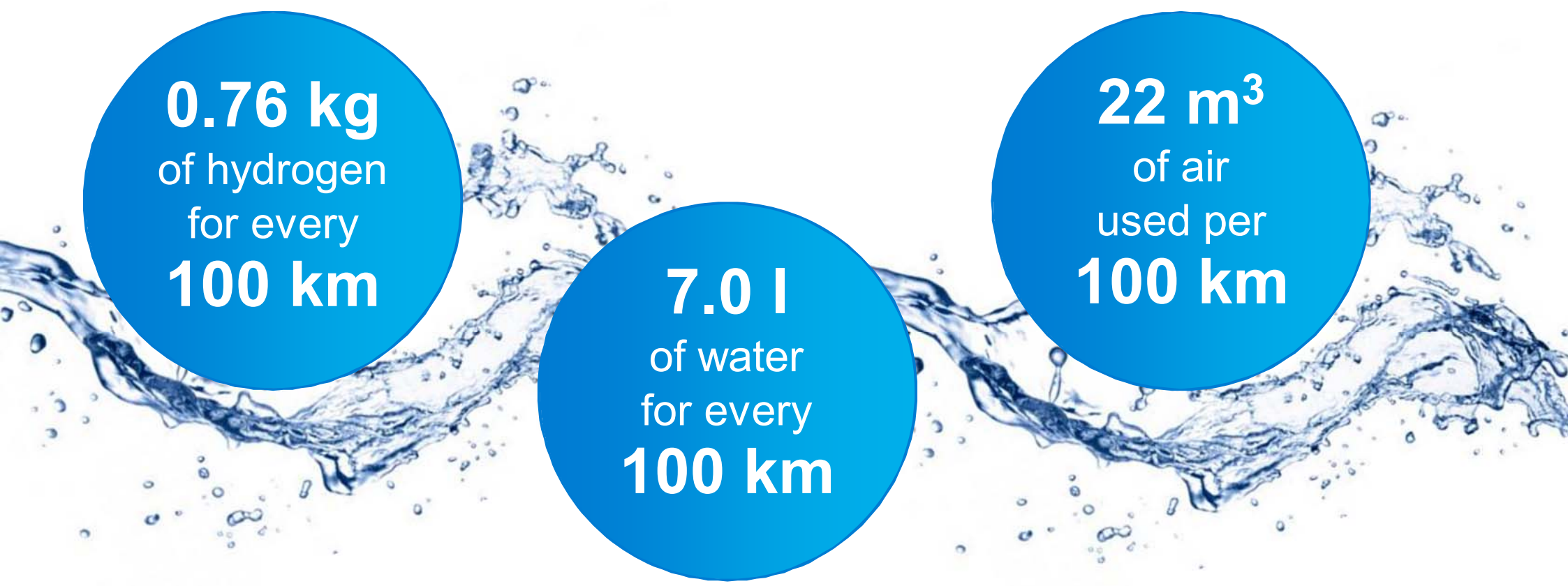
What Mirai consumes (and emits)*



In the homologation cycle (NEDC)

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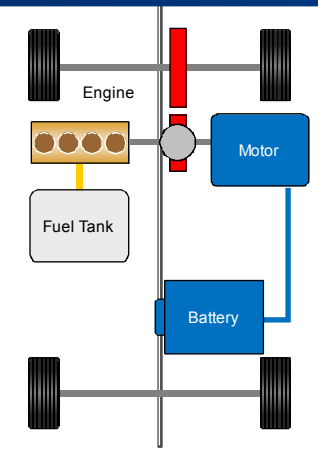
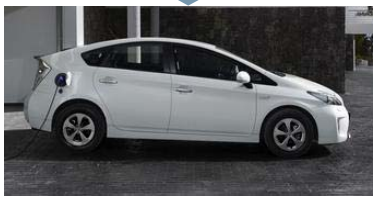
Nestled in our Hybrid DNA

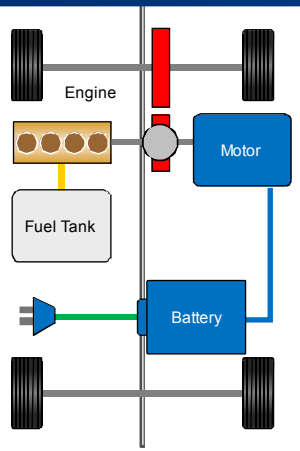
Using hybrid technology for Plug-In, EV and Fuel Cell

HYBRID

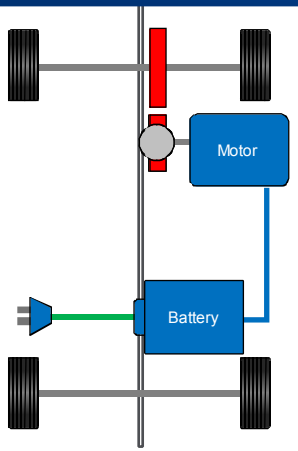




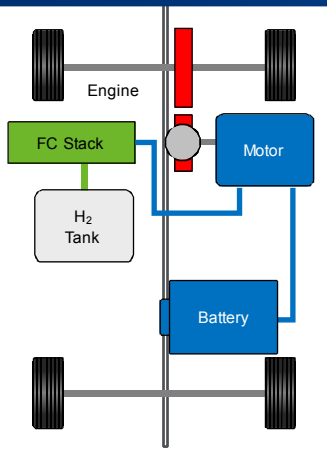
PLUG-IN HYBRID



ELECTRIC



FUEL CELL



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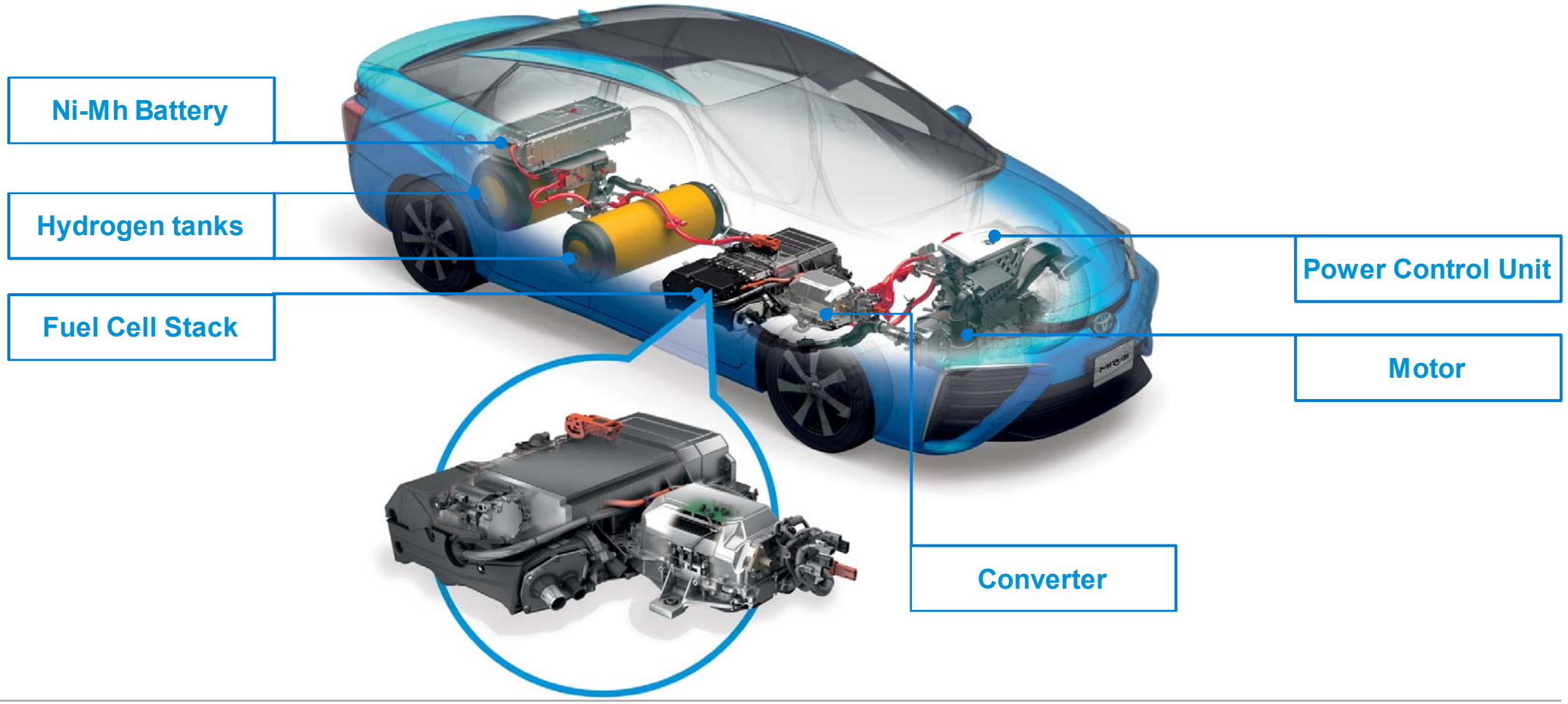
Toyota Fuel Cell System Components



Advances in technology: efficiency

Volume
-43%

Weight
-48%

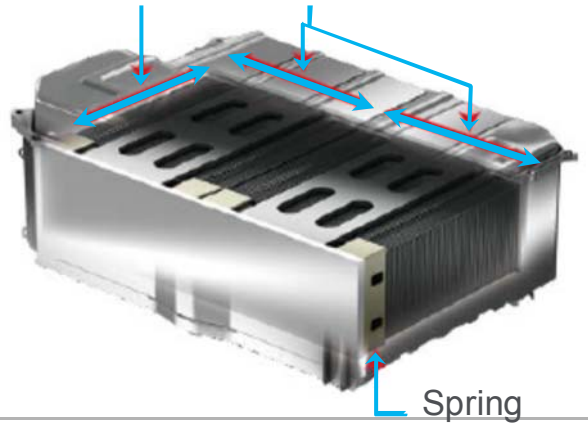
Power
+26%

2008 MODEL FUEL STACK

1.4 kW/L

(Maximum output: 90 kW/volume: 64L; weight: 108kg)

200 cells x dual-line stacking = 400 cells

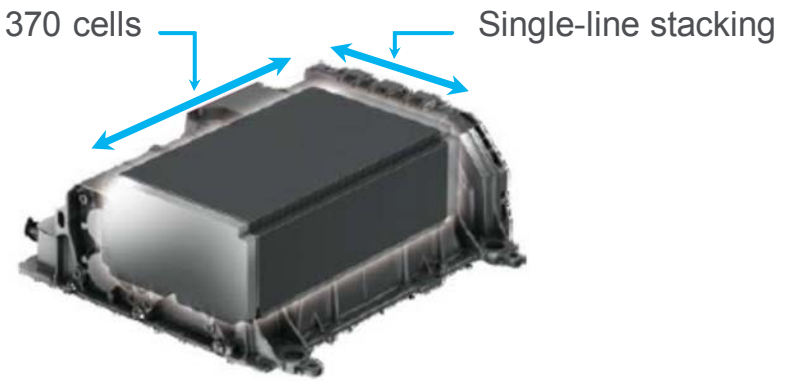


2.2 times better volume power density

MIRAI FUEL STACK

3.1 kW/L

(Maximum output: 114 kW / volume: 37L; weight: 56kg)



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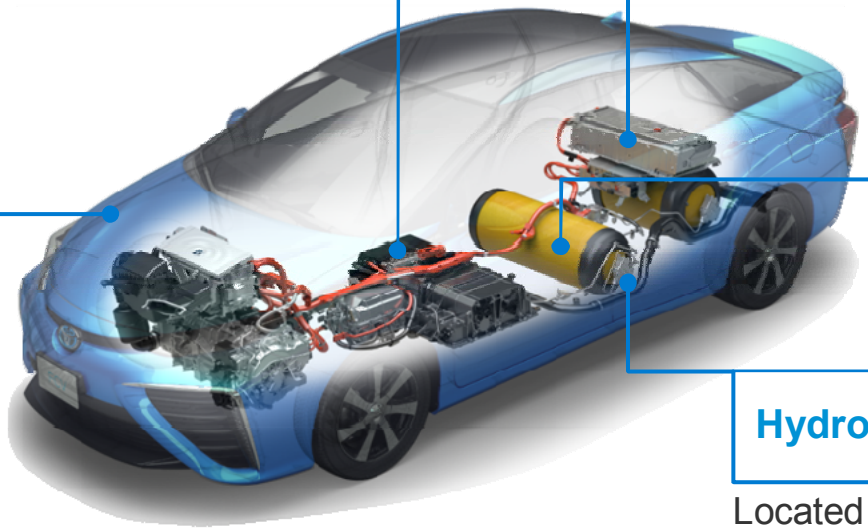
Ensuring safety on board

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.



High pressure Hydrogen tank

Made from reinforced carbon of the highest quality.

Impact safety structure

Protects the FC Stack and Hydrogen tanks in the event of an accident.

Hydrogen related parts

Located outside the cabin.

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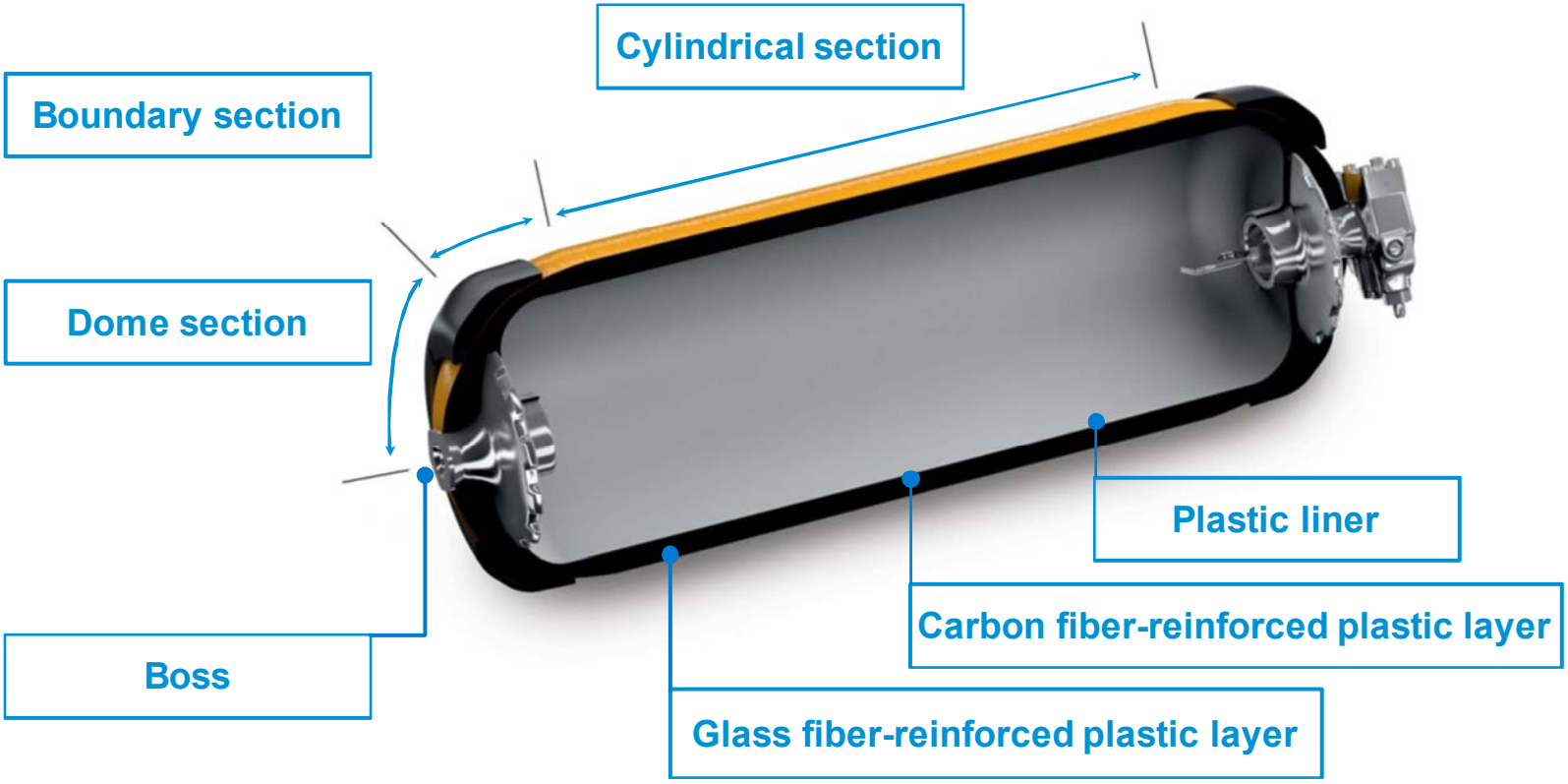
State of the art H_2 tank technology



5kg
H2 storage

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H_2 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

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Requirement for success

Standardization

700 bar !

Infrastructure

Customer

Main challenges: Cost and capacity to manufacture

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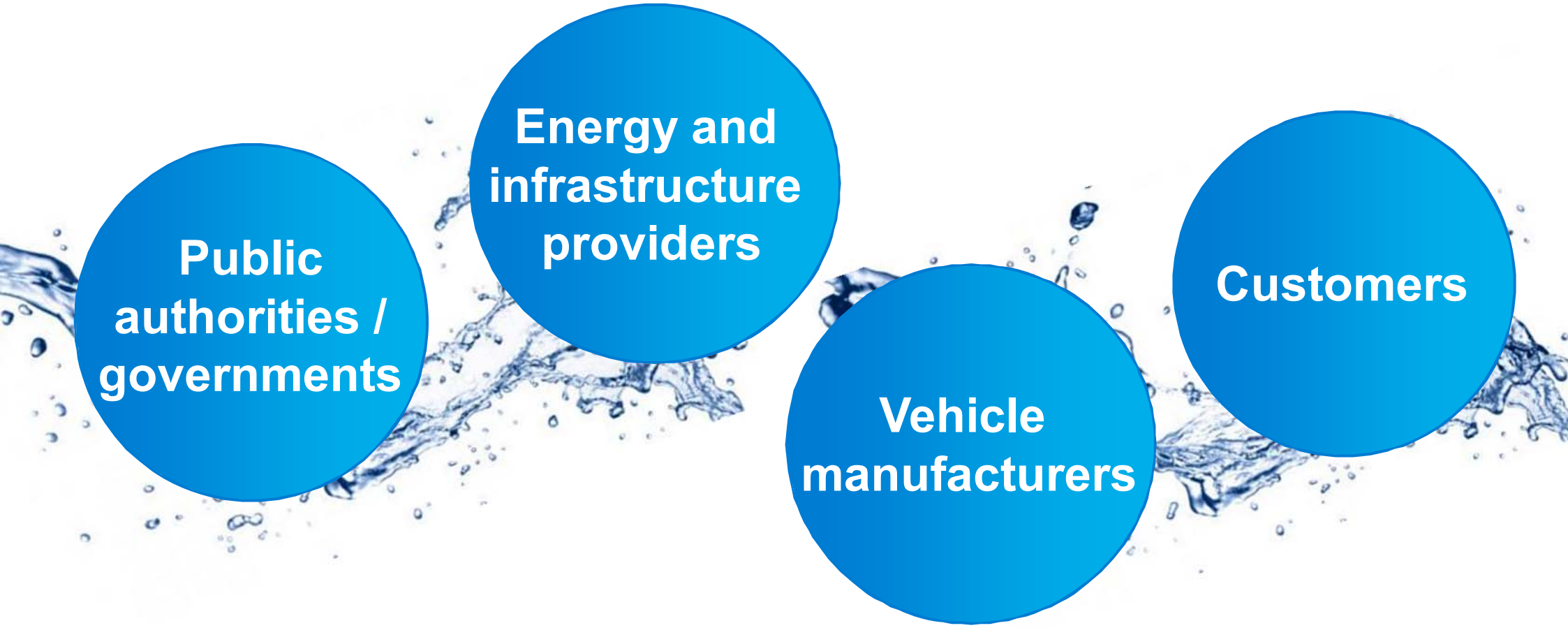
Collaboration needed to create H2 society

Small steps → big step



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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)

Source : METI

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**

	2015	2020	2025	2030
Number	80	160	320	900
FCV(cumulative)	introduction	40,000	200,000	800,000

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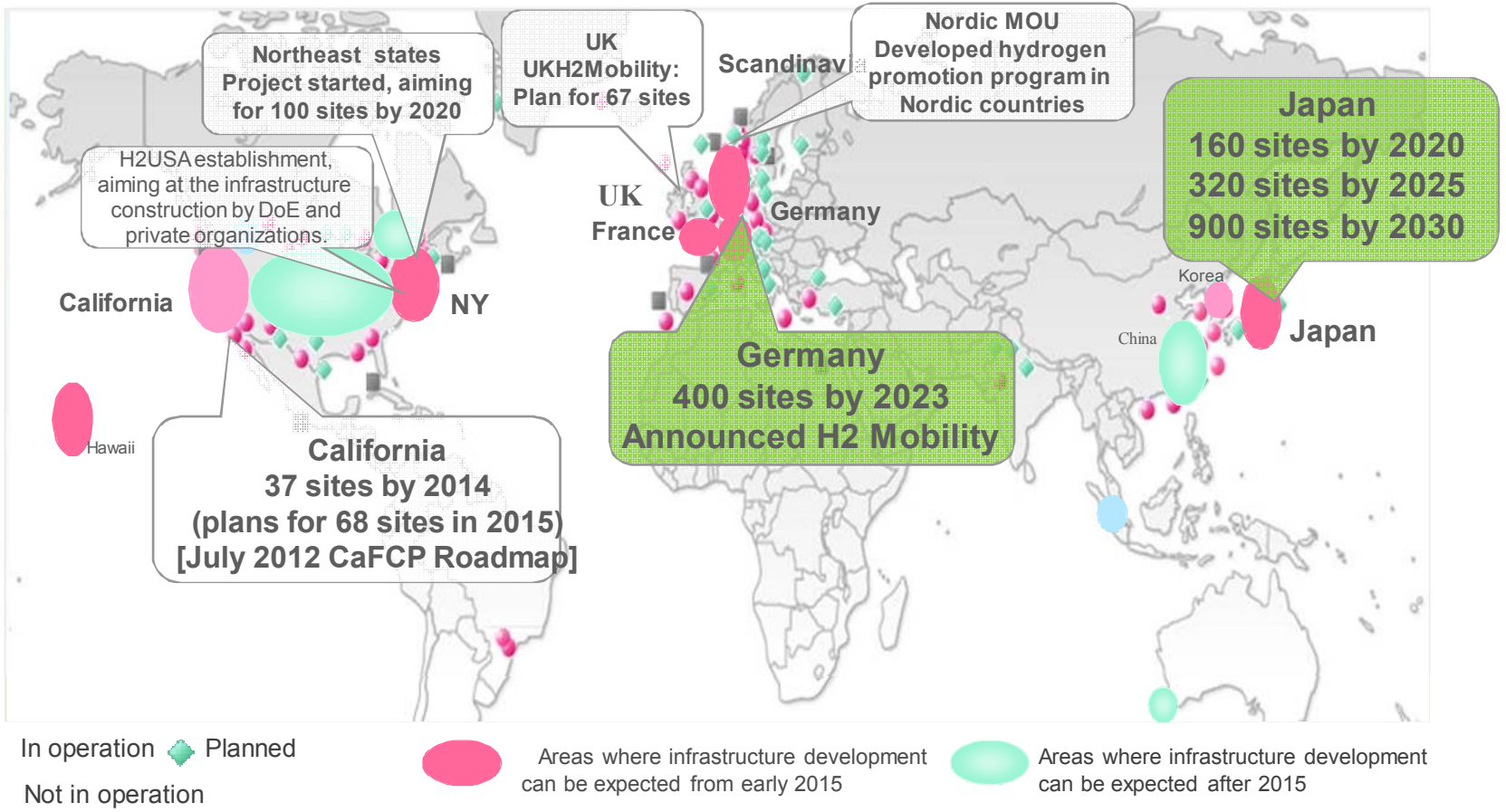
Worldwide locations of hydrogen stations



Several hundreds of hydrogen stations are expected by 2020

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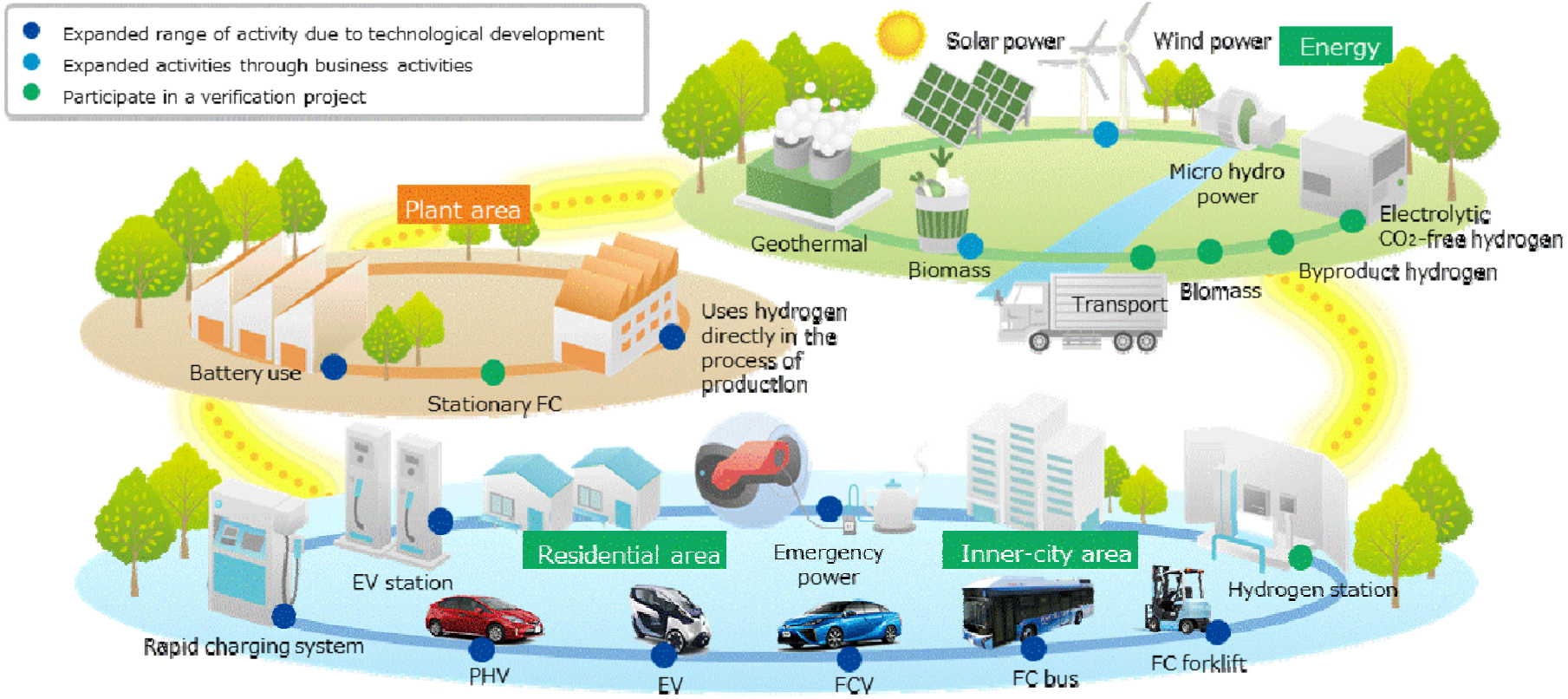
Creation of a future where people coexist with nature through use of renewable energy and CO2-free hydrogen



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