

Honda's Hydrogen and Fuel Cell System Strategy for a wider scope of applications

24 September 2024

- **Company Name** : Honda Motor Co., Ltd.
- **Head Office** : 2-1-1, Minami-Aoyama, Minato-ku, Tokyo 107-8556, Japan
- **Established** : September 1948
- **Main Products** : Motorcycles, automobiles, and power products



Head Office
Tokyo, Japan



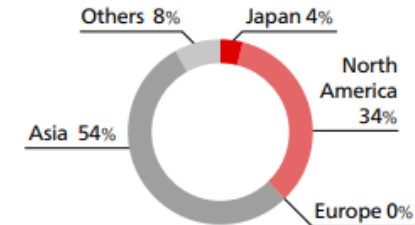
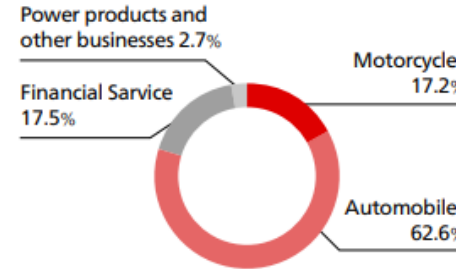
Director, President and Representative Executive Officer
Toshihiro Mibe

Consolidated financial results

~ 5 billion €

Consolidated sales revenue
16,907 billion yen

Consolidated operating profit
780.7 billion yen



Capital



86 billion yen

Number of Associates



Consolidated
197,039
Non consolidated
33,065

Honda group companies:
382 domestic and overseas affiliated companies



382
companies

Consolidated subsidiaries 313
+
Equity-method affiliated companies 69

The Value Honda provides

HONDA
The Power of Dreams



HONDA

The world's largest power unit manufacturer

30,000,000

power units / year



Honda's new Environmental and Safety Targets

Carbon neutrality
for all Honda products and
corporate activities

2050

Zero traffic collision
fatalities involving Honda
motorcycles and automobiles

Mobility



Power units



Energy



Robotics



A circular / resource-recycling society
that aims for "zero environmental impact"

2050



Carbon Neutrality
Net-zero CO₂ emissions



Clean Energy

100% utilization of carbon-free energy

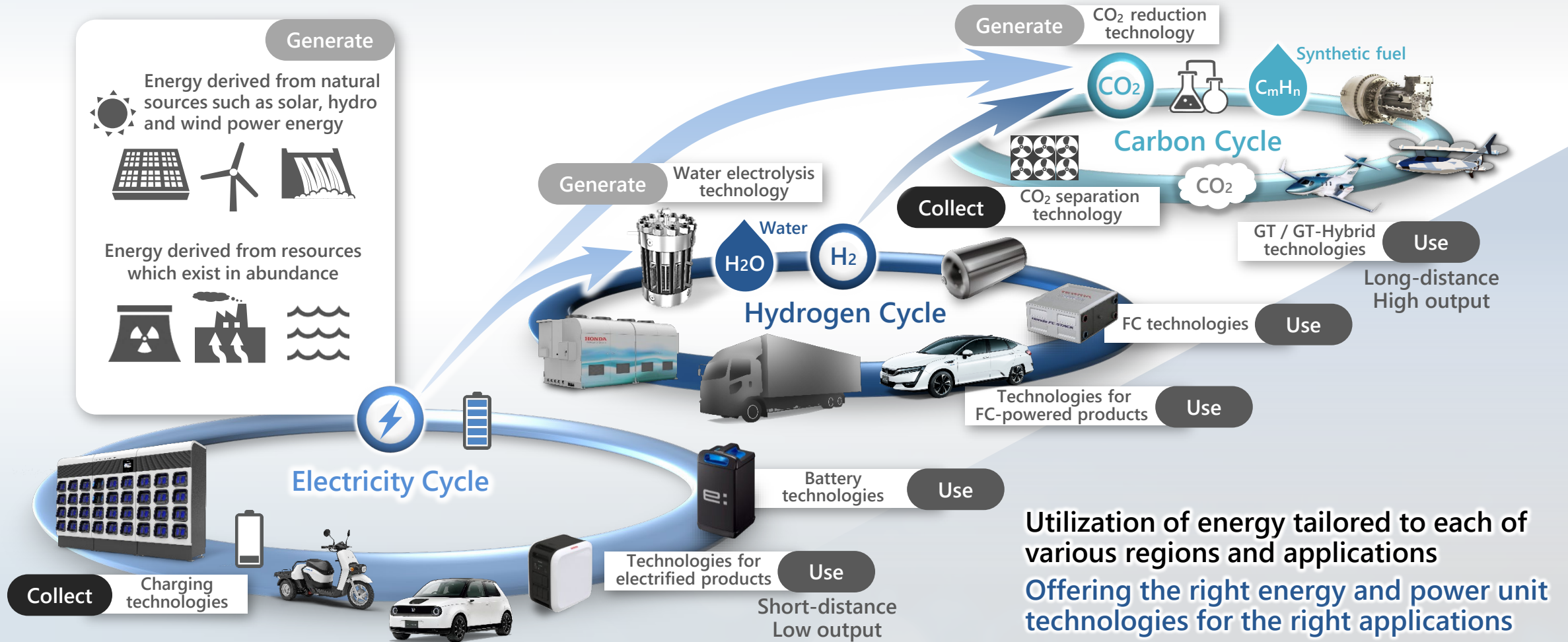


Resource Circulation

100% use of sustainable materials

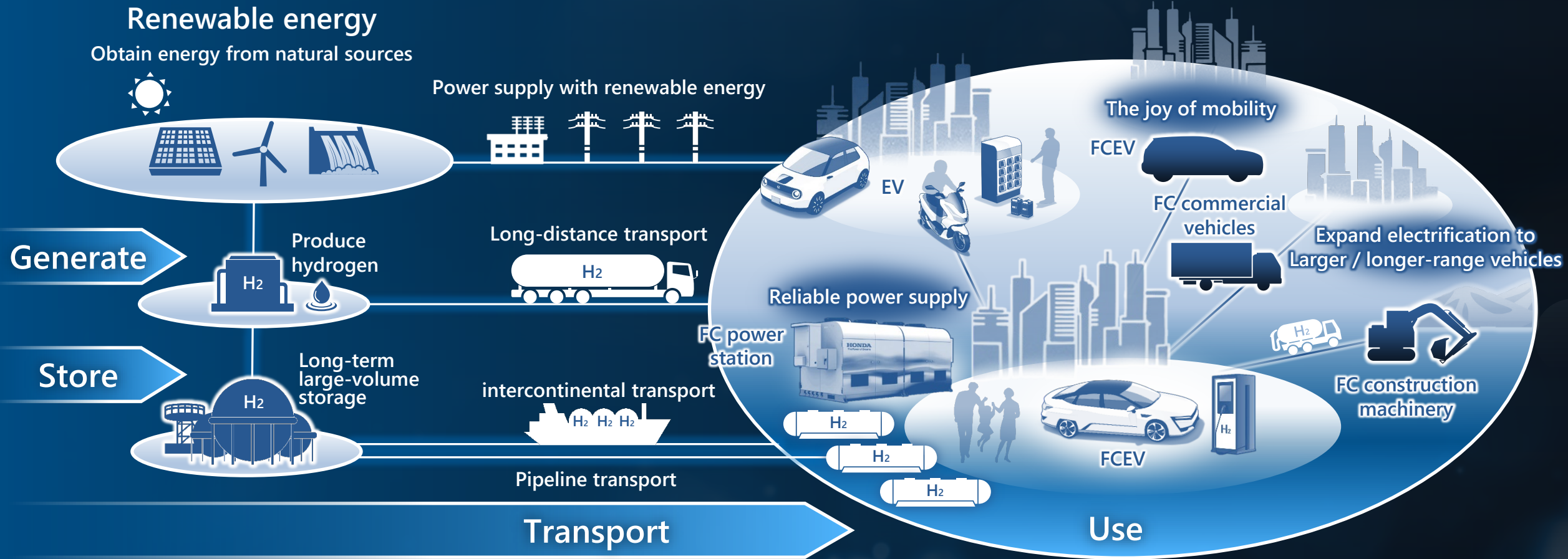
Multifaceted and multidimensional approach toward the realization of a Carbon Neutral Society

In addition to electricity derived from renewable energy sources, we will “circularly” use hydrogen and carbon as energy carriers



Offering clean mobility and reliable power supply through a smart combination of electricity and hydrogen energy

Realization of a carbon-neutral society



Commitment of Honda for FCEV

1998



Prototype

20kW system
(R&D use)

2002



FCX

First time in the world
Japan US simultaneous
launch
(EPA/CARB certified)

2008



FCX CLARITY

World's first
Production FC
Dedicated production
line

2016



CLARITY FUEL CELL

FC system
• Small sized FC in engine room
• 5 passengers
AC output from exterior power

2024



CR-V e:FCEV

FCEV Mass Production
GM/Honda FC stack
with PHEV capability

Having passed driving test under severe conditions, US/JP customers total driving mileage now exceeds 91 Million km

Test drives under diverse weather conditions conducted



Cold climate



High temperature and dry



Long winding uphill/downhill



Steep hill

Standard driving by normal users
High stressed usage by taxi drivers
Use of vehicles in dedicated projects



Taxi application



91 Million km

Accumulated mileage
(as of March 2022)

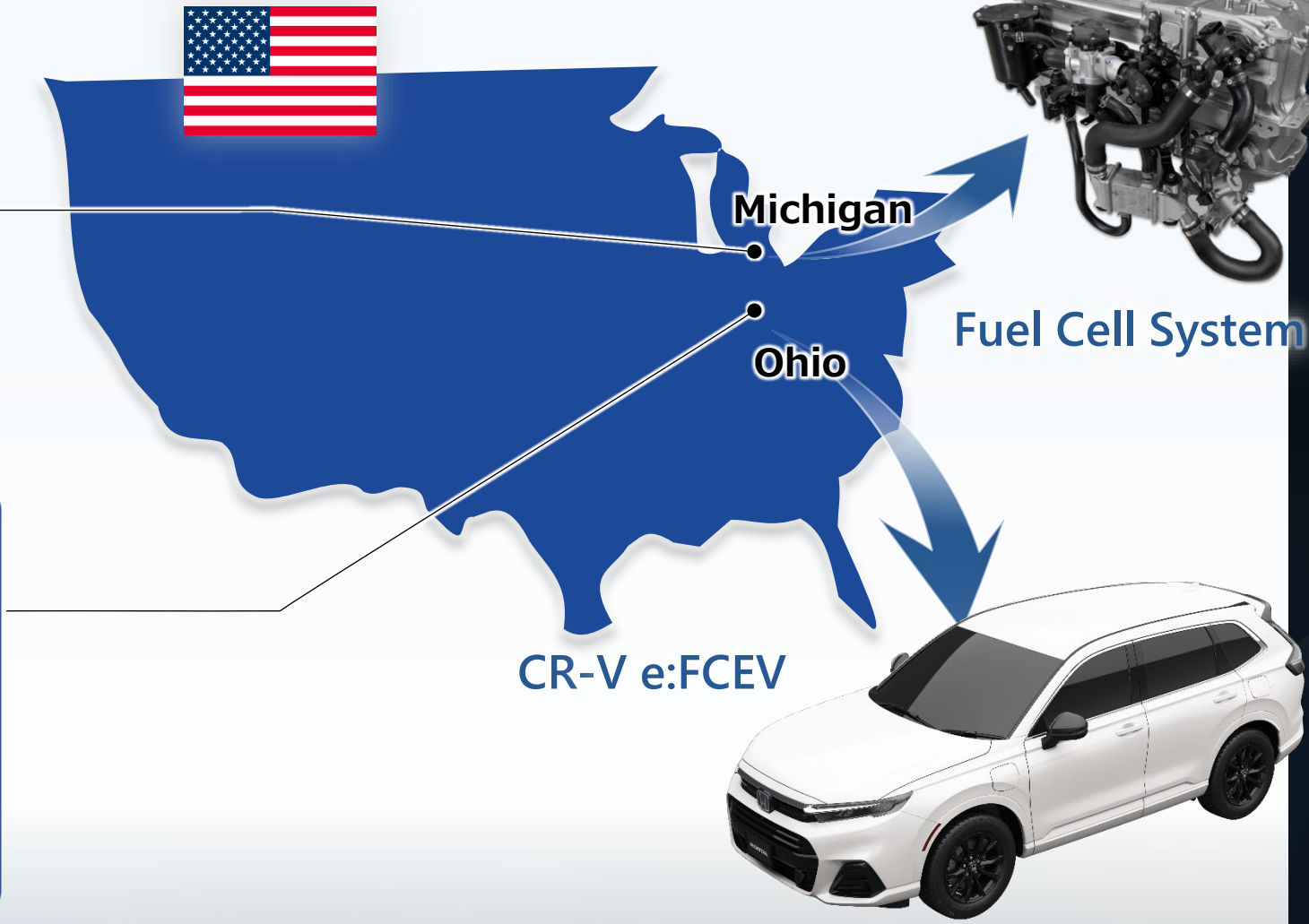
Fuel Cell System and CR-V e:FCEV Production Plants



Fuel Cell System Manufacturing, LLC



Performance Manufacturing Center



Michigan

Ohio

Fuel Cell System

CR-V e:FCEV

Fuel Cell System will be produced in Fuel Cell System Manufacturing, LLC (MI) JV with GM, and built in Performance Manufacturing Center (OH) to become CR-V e:FCEV.

Co-development,
Co-creation with GM



HONDA

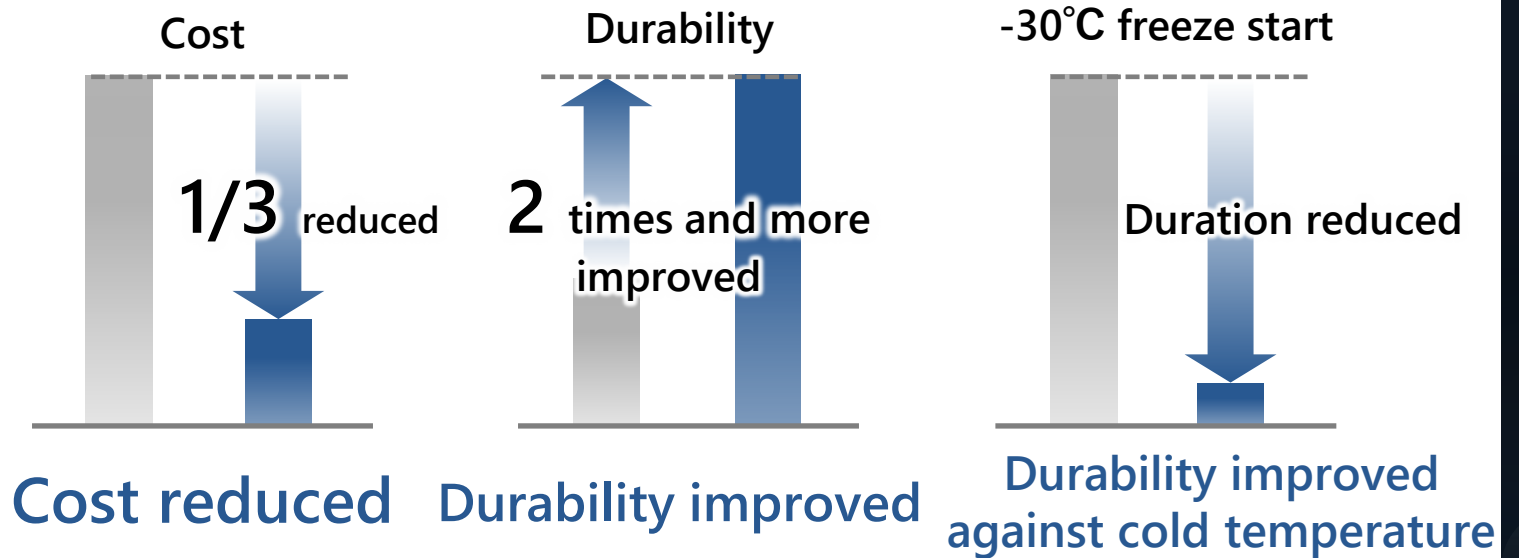
New Generation Fuel Cell system *



*Systematization based on fuel cells
Jointly developed by General Motors (GM) and Honda

Evolution from CLARITY FUEL CELL

— CLARITY FUEL CELL — CR-V e:FCEV

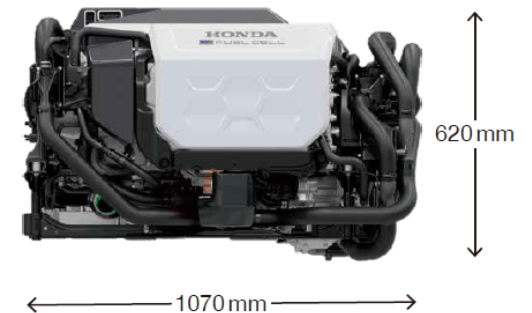


Main specifications

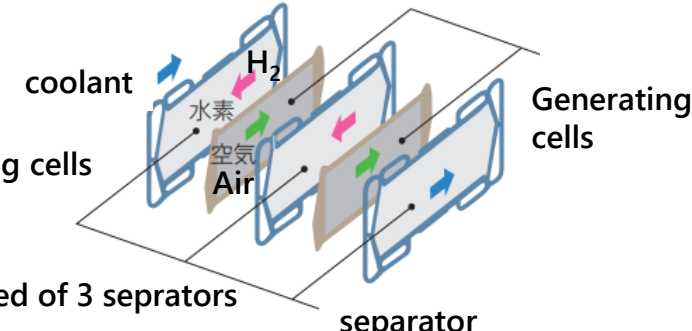
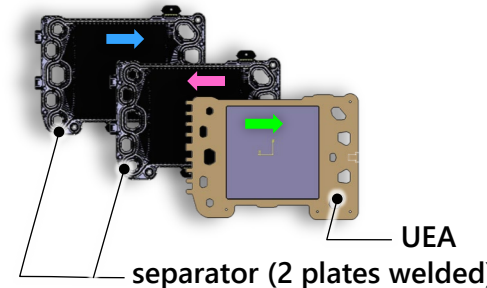
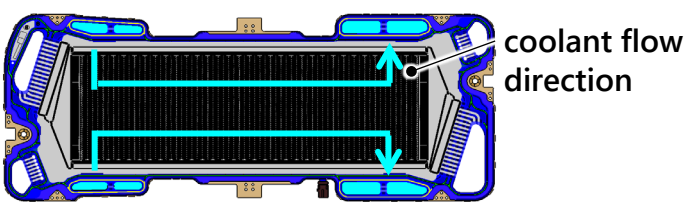
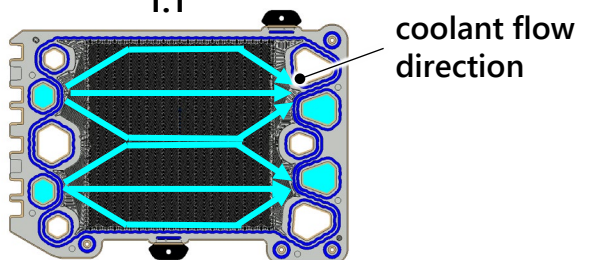
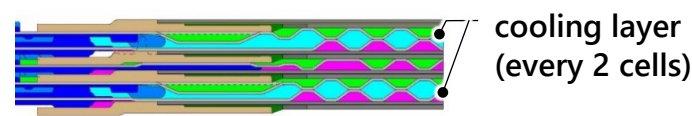
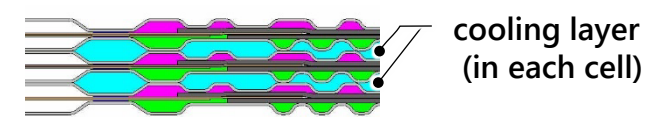
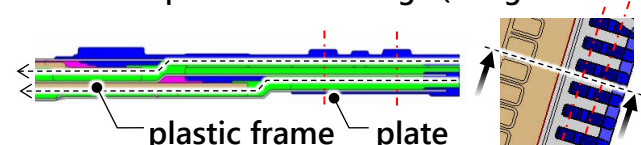
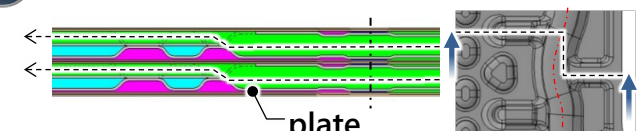
Maximum output	80 kW
Output voltage	275 - 600 V
Dimensions	732×1070×620 mm*
Weight	206 kg
Maximum efficiency	58 %
Minimum start-up temperature	-30 °C

The above are the main specifications of the fuel cell module scheduled to be released for sale. The contents are subject to change without notice. Listed values are based on the basic conditions specified by Honda.

*Excluding design cover



FC Stack (Cell Structure)

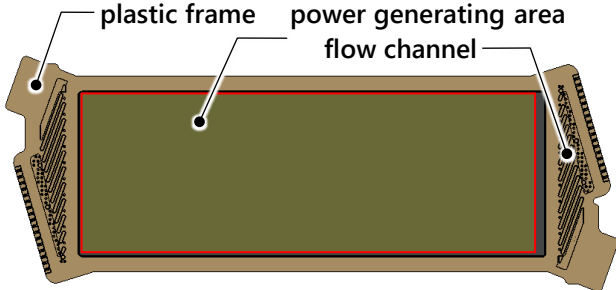
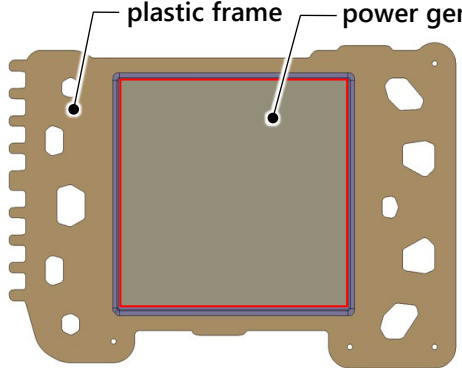
Cell type		CLARITY FUEL CELL	CR-V e:FCEV
Cell Unit Structure		<p>1 UNIT: 3 Separator + 2 generating cells</p>  <p>coolant H₂ Air separator Generating cells</p> <p>1 unit consisted of 3 separators and 2 MEAs</p>	<p>Low cost</p> <p>1 UNIT: 1 separator + 1 generating cell</p>  <p>separator (2 plates welded) UEA</p> <p>1 unit consists of 1 separator with 2 plates welded together and 1 sheet of UEA</p>
Gas Coolant · Supply purge	Aspect ratio	<p>1:3</p>  <p>coolant flow direction</p>	<p>Improved durability</p> <p>1:1</p>  <p>coolant flow direction</p>
	Cooling structure	<p>Alternate cooling structure</p>  <p>cooling layer (every 2 cells)</p>	<p>Improved durability</p> <p>Each cell with cooling function</p>  <p>cooling layer (in each cell)</p>
	Supply/purge	<p>Plate and plastic frame design (bridge structure)</p>  <p>plastic frame plate</p>	<p>Low cost</p> <p>Plate only structure (Tunnel)</p>  <p>plate</p>

— Anode (H₂)
— Cathode (Air)
— Coolant

FC Stack (Separator/Metal Seal)

Cell type		CLARITY FUEL CELL	CR-V e:FCEV
Planar/cross section structure			
Function	Gas seal	Silicon rubber seal	Low cost Metal seal, weld seal
	Energization	Au plating (after stamping)	Low cost PVD coating
	Insulation	Rubber coating	Low cost None (addressed by change in stack structure)
Corrosion resistance		Stainless material	Improved durability Stainless material + PVD coating

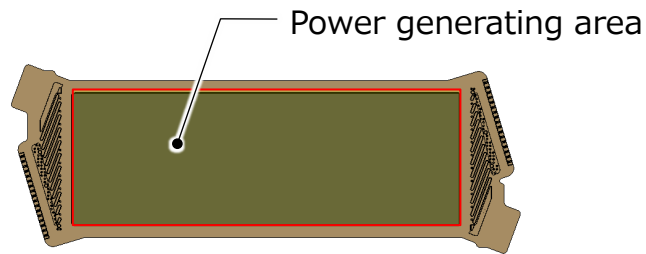
FC Stack (MEA/UEA)

MEA/UEA	CLARITY FUEL CELL	CR-V e:FCEV
Flat structure	 <p>Labels: plastic frame, power generating area, flow channel</p>	 <p>Labels: plastic frame, power generating area</p>
Plastic frame	Injection molding	Low cost Film lamination
Joint area	Resin impregnation	Low cost Pressurized by Separator
Pt/stack	→	Low cost Cost reduced by 80% against CLARITY
Electrolyte film	Single film (supplier made film)	Low cost Thickness reduced by 40% against CLARITY
Ce	→	Improved durability Ce amount optimized

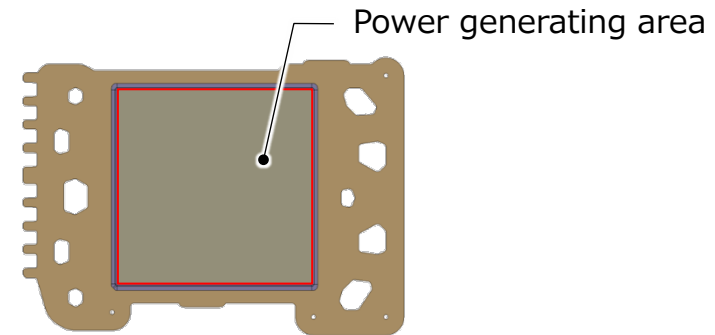
Low cost

Significant reduction of FC stack cell number still ensures equivalent net power

CLARITY Fuel Cell



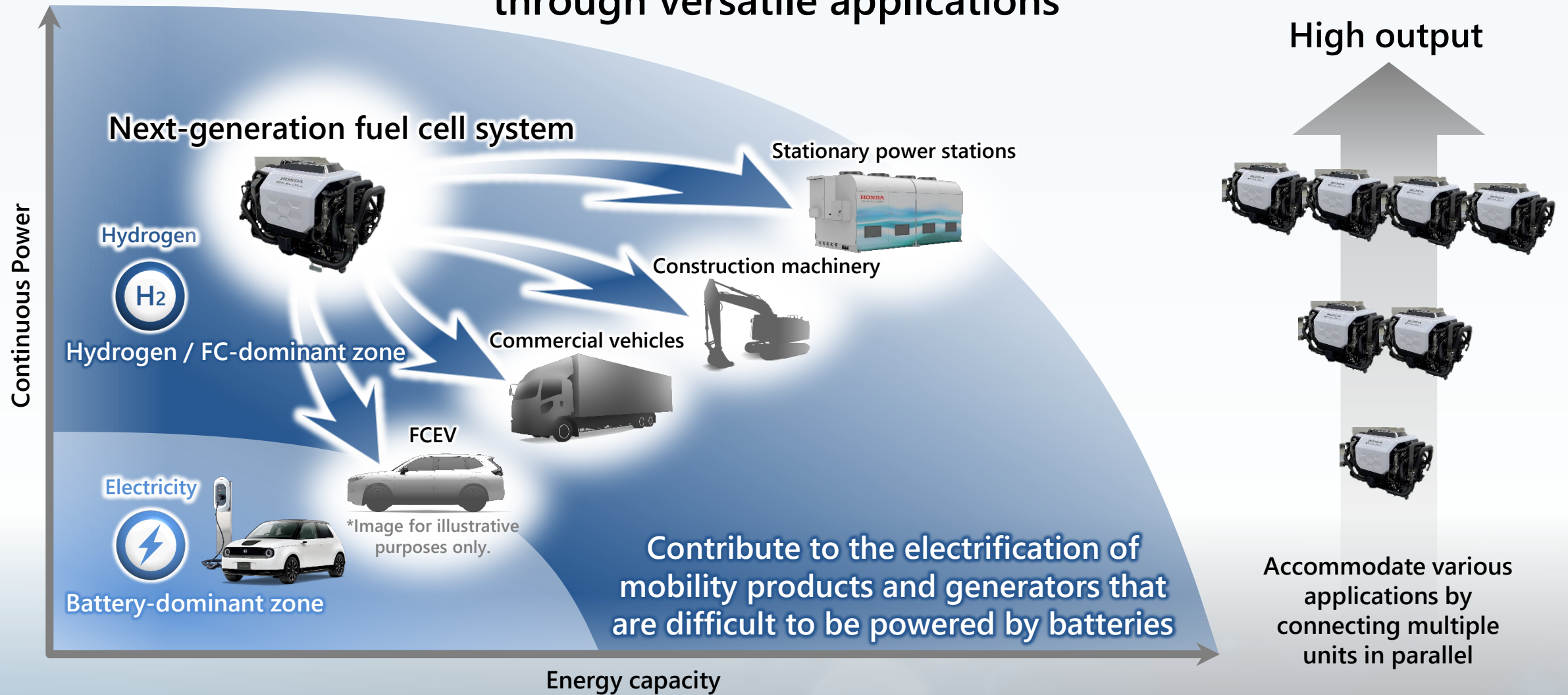
CR-V e:FCEV



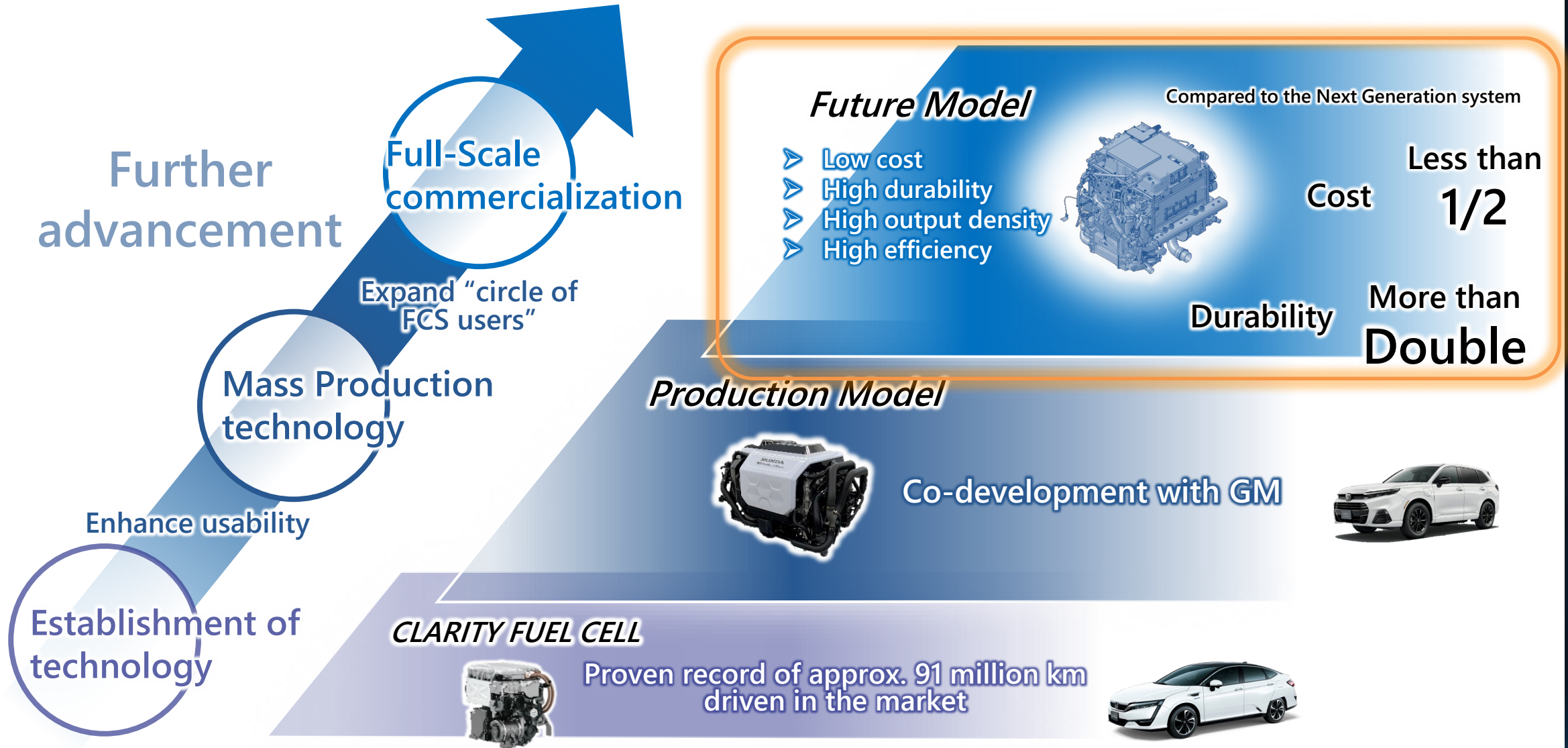
- Optimization of power generating area in Cell
- Lower power consumption of auxiliaries including electric motor

Versatile Applications of the next-generation Fuel Cell System

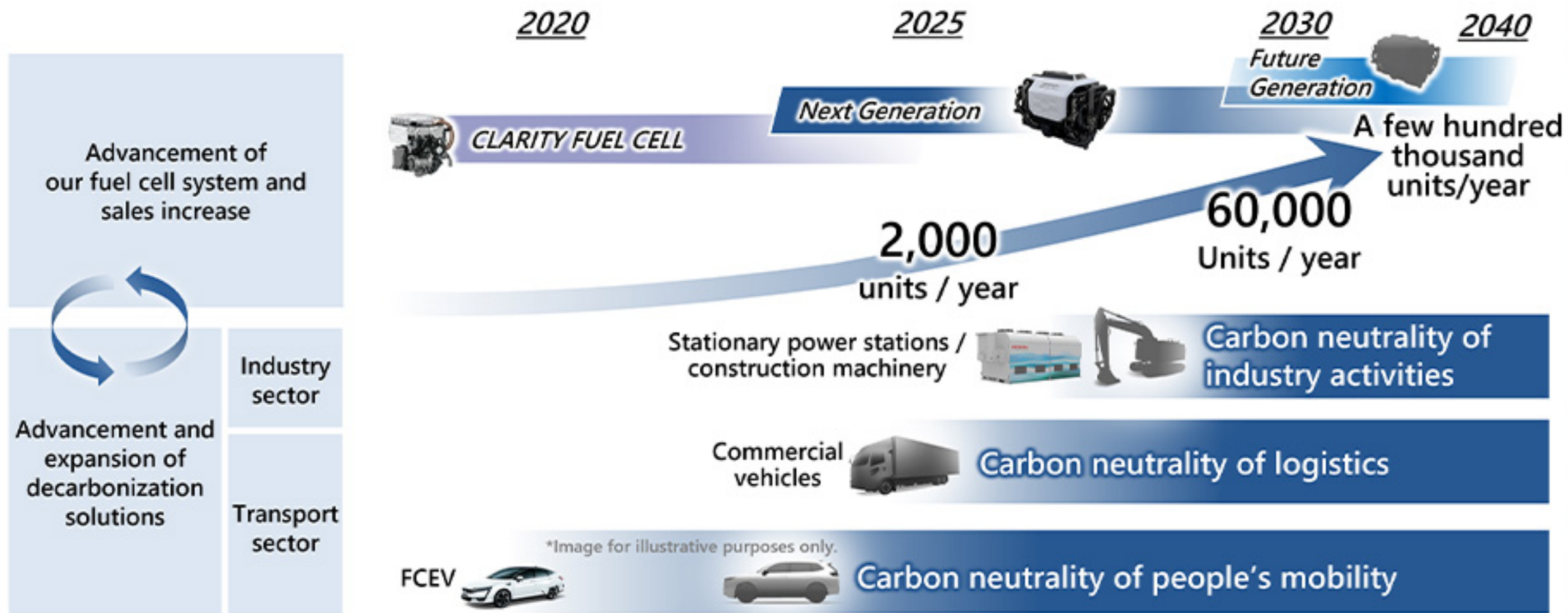
Offering clean mobility and reliable power supply through versatile applications



Future Generation • Targets toward full-scale Commercialization Phase



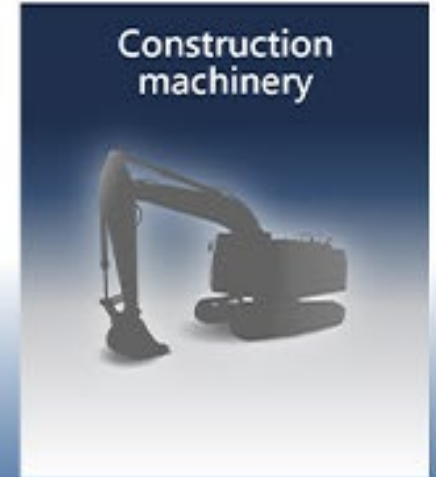
Fuel Cell Module Sales Targets



Honda will contribute to the realization of a carbon-neutral society by pursuing the advancement and expansion for both decarbonization solutions and fuel cell systems, as they are two wheels of the same vehicle

Transportation sector

Industry sector



Contributing to carbon neutrality with Honda know-how and fuel cell technology

Strive to live up to high expectations from the perspective of TCO (Total Cost of Ownership)

Carbon-neutral business operation

Lower initial investment due to economies of scale

Decline in hydrogen price with the widespread use

Honda will start external sales of its fuel cell system by mid-2020s and continue to expand applications from the transportation sector to the industry sector

Start of the joint research for FC Heavy Duty Truck with Isuzu 2020



■ GIGA FUEL CELL Truck description

Vehicle	Base model	CYJ77C-WX Low floor 8 x 4 rigid truck
	L/W/H	11,980 mm / 2,490 mm / 3,770 mm
	Total Vehicle Weight	25 t
Fuel Cell Stack	Type	PEFC (Honda FC stack)
	Power	103 kW × 4
High pressure H2 system	Charging pressure	70 MPa
	On-board H2	56 kg
Motor	Type	AC Synchronous motor
	Rated Power	320 kW
HV battery	Type	Lithium-ion battery
Driving range		> 800 km min (Isuzu evaluation mode)
Others	Output supply port	2 ports (CHAdeMO connector) Max. supply 530 kWh

GIGA FUEL CELL truck performing a final check run on a public road before the start of monitoring (photo taken on November 15, 2023)

Public road testing started in December 2023

Isuzu Selects Honda as Partner to Develop and Supply Fuel Cell System for its Fuel Cell-Powered Heavy Duty Truck



Start of the joint proof-of-concept validation of commercial FC truck
with Dongfeng Motor Corporation 2023

Cold climate



High altitude



Objective: verification of durability & environmental adaptability of
FC systems under multiple conditions in commercial use in China

Honda Class 8 Hydrogen Fuel Cell Truck Concept at ACT Expo 2024

■ Class 8 FUEL CELL Truck description

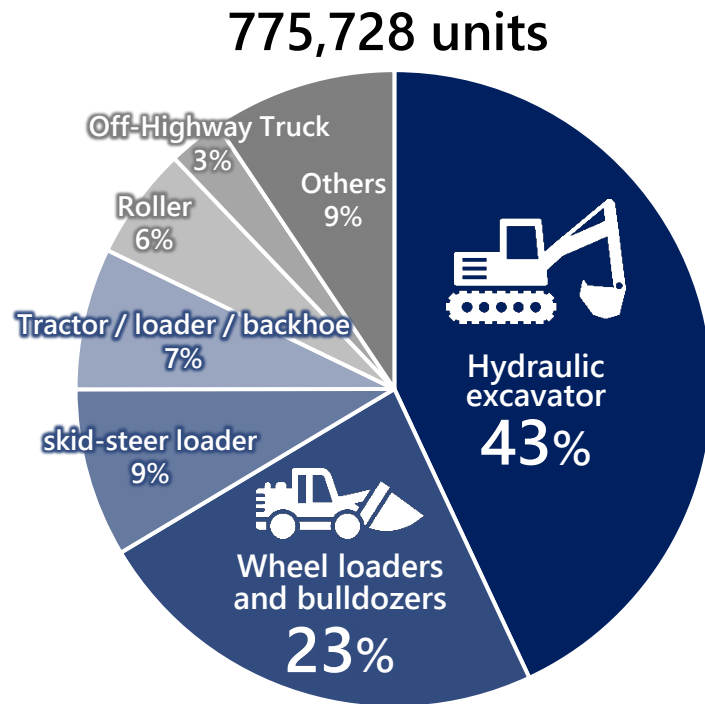


Class 8 Truck	L/W/H	8,000 mm / 2,490 mm / 4,000 mm
	Total Vehicle Weight	~ 37 t (tractor: 13 t + load: 24 t)
Fuel Cell Stack	Type	PEFC (Honda e:fuel cell FC stack)
	Power	80 kW _{net} x 3
High pressure H2 system	Charging pressure	70 MPa
	H2 capacity	82 kg
HV battery	Type	120 kWh Lithium-ion
Driving range	miles	> 400 miles at GWC
Top Speed	miles/h	70 miles per hour

Honda will begin the test drive demonstration project in the U.S. with the objective to validate the feasibility modular fuel cell system approach for various application

Construction machinery market

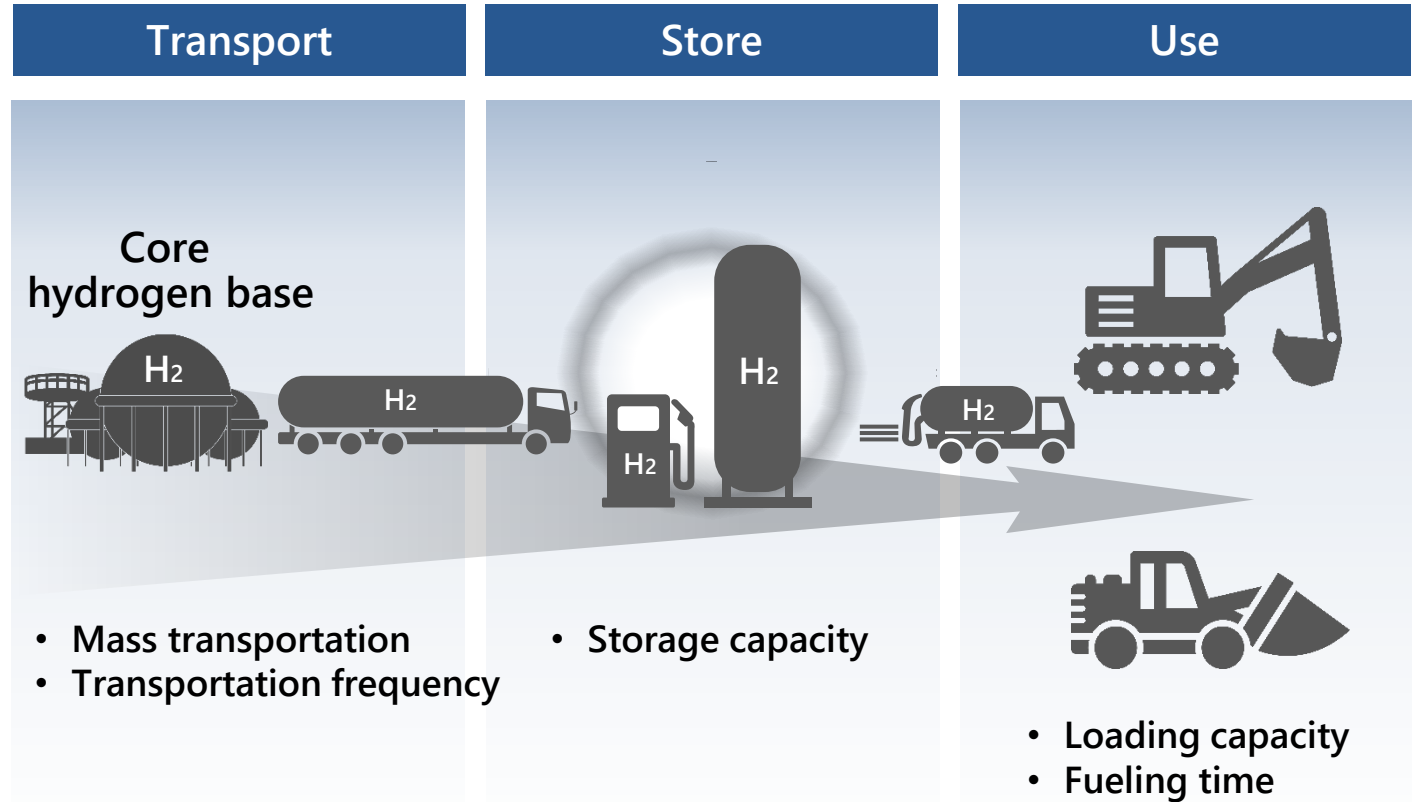
% of production volume by category
(Output more than 50kW, global market)



Hydraulic excavators account for more than 40%
Excavators and wheel loaders combined account
for more than 60%

Source: chart created by Honda based on data published by Power Systems Research (PSR)

Example of hydrogen supply chain for construction machinery



Collaborate with industry players to establish a
hydrogen supply chain

Creating a "Hydrogen Ecosystem"

Hydrogen supply: Honda activities to date

Japan



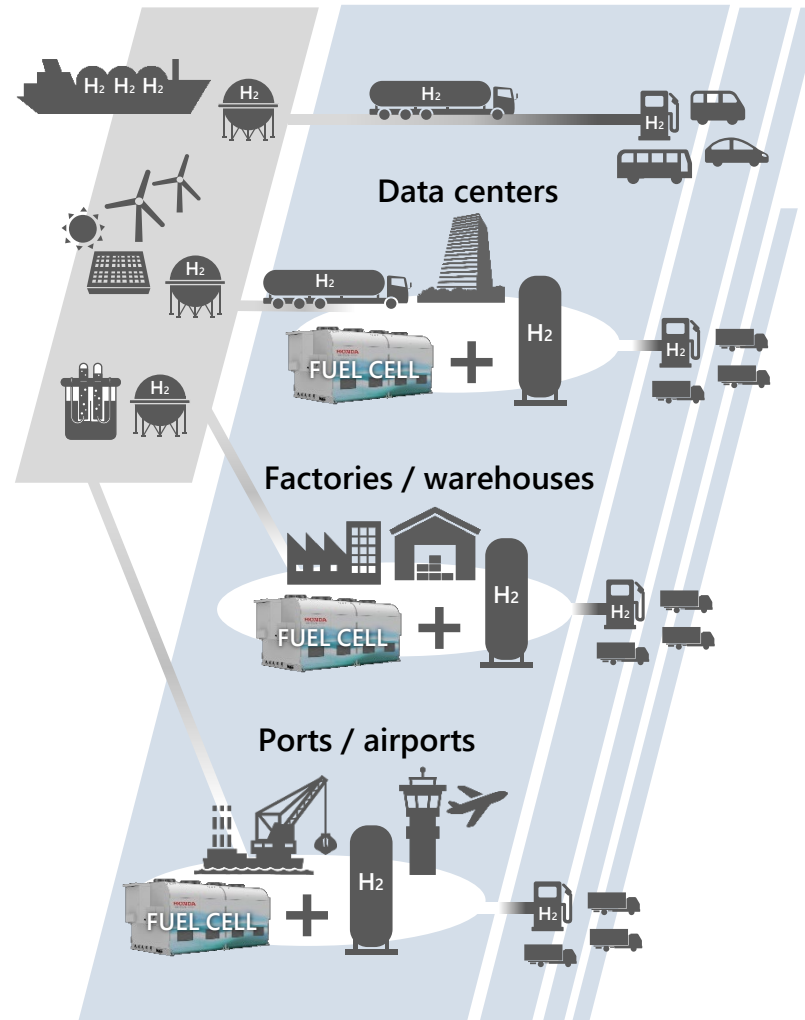
Supporting the installation and enhancement of hydrogen infrastructure

North America



Supporting the expansion of hydrogen station networks

Establishment of hydrogen ecosystem



Initiatives

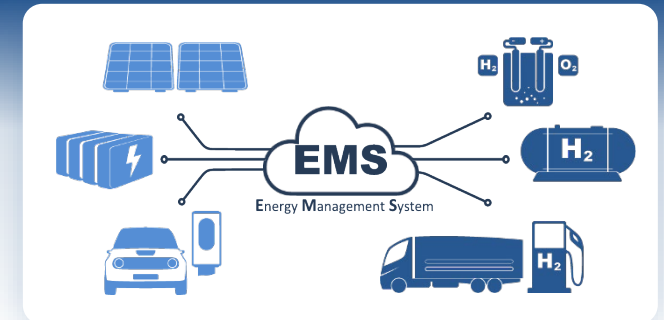
In Japan

Marubeni Iwatani



Discussing
Hydrogen supply
+ use of FC commercial vehicles

Demonstration testing in Europe



Honda R&D Europe (Deutschland) is building an energy ecosystem that combines renewable energy and hydrogen production / utilization

Robustness of Hydrogen Re-fueling Infrastructure

Honda is envisioning the use of Hydrogen with high energy density for widespread long-distance, heavy-duty mobility powered by fuel cell systems

The target range of heavy duty mobility is around 600 to 800 km thus requiring a Hydrogen Storage System Capacity of 60 to 80 kg

Assuming that the hydrogen is stored in highly compressed gaseous form, it is demanded to establish the related infrastructure to ensure hydrogen and fuel cell technology competitiveness

Looking at corporate fleet use cases and thus driving patterns, a fast re-fuelling of gaseous Hydrogen is demanded being below 10 minutes for 60 to 80 kg of Hydrogen and in high back-to-back sequences

The performance of such HRS requires a high maturity level when deployed since corporate fleet owners are less sensitive to HRS performance issues such as downtimes or less than 100% SOC fuellings compared to private customers

The intended HRS network therefore needs to serve at the utmost level to meet the needs of the customers to be reached by HD FC or HD H2 ICE Trucks