Leading the Transition to a Hydrogen Society

Reykjavik, 15/11/2017
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General Manager Business Strategy
Toyota Motor Europe

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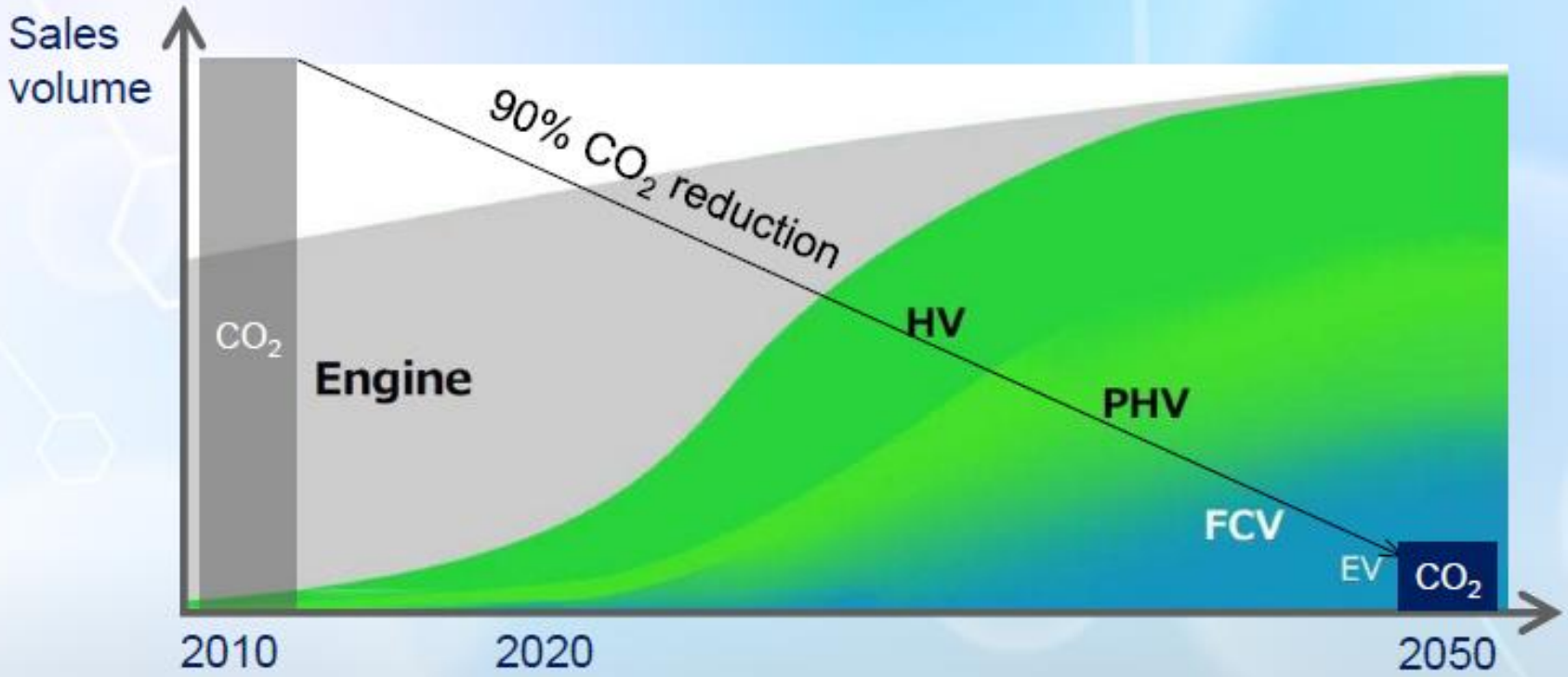
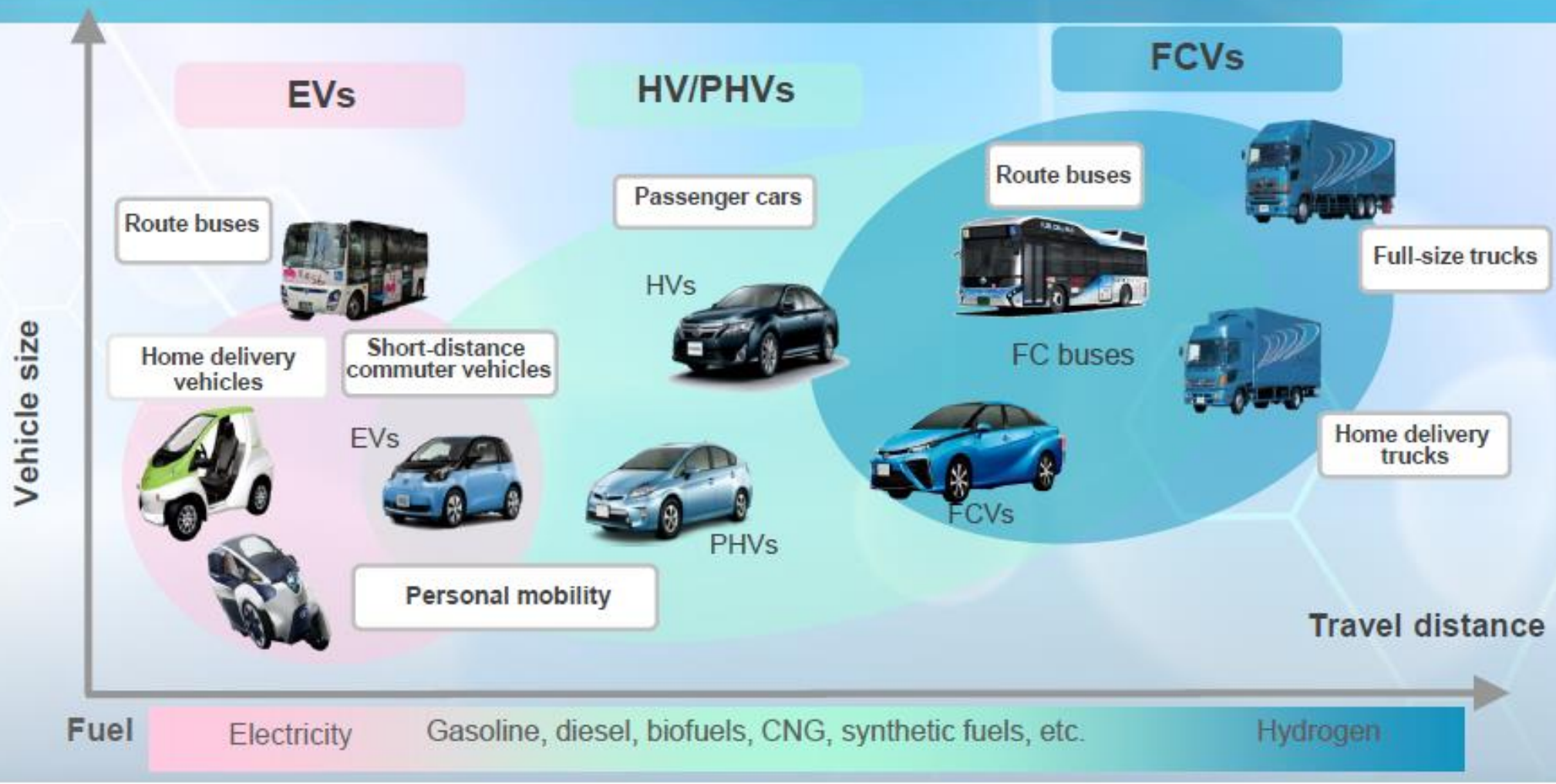
The Toyota Environmental Challenge 2050 is our North Star

A portfolio of powertrains are required to achieve 90% CO_2 reduction (challenge 2050)

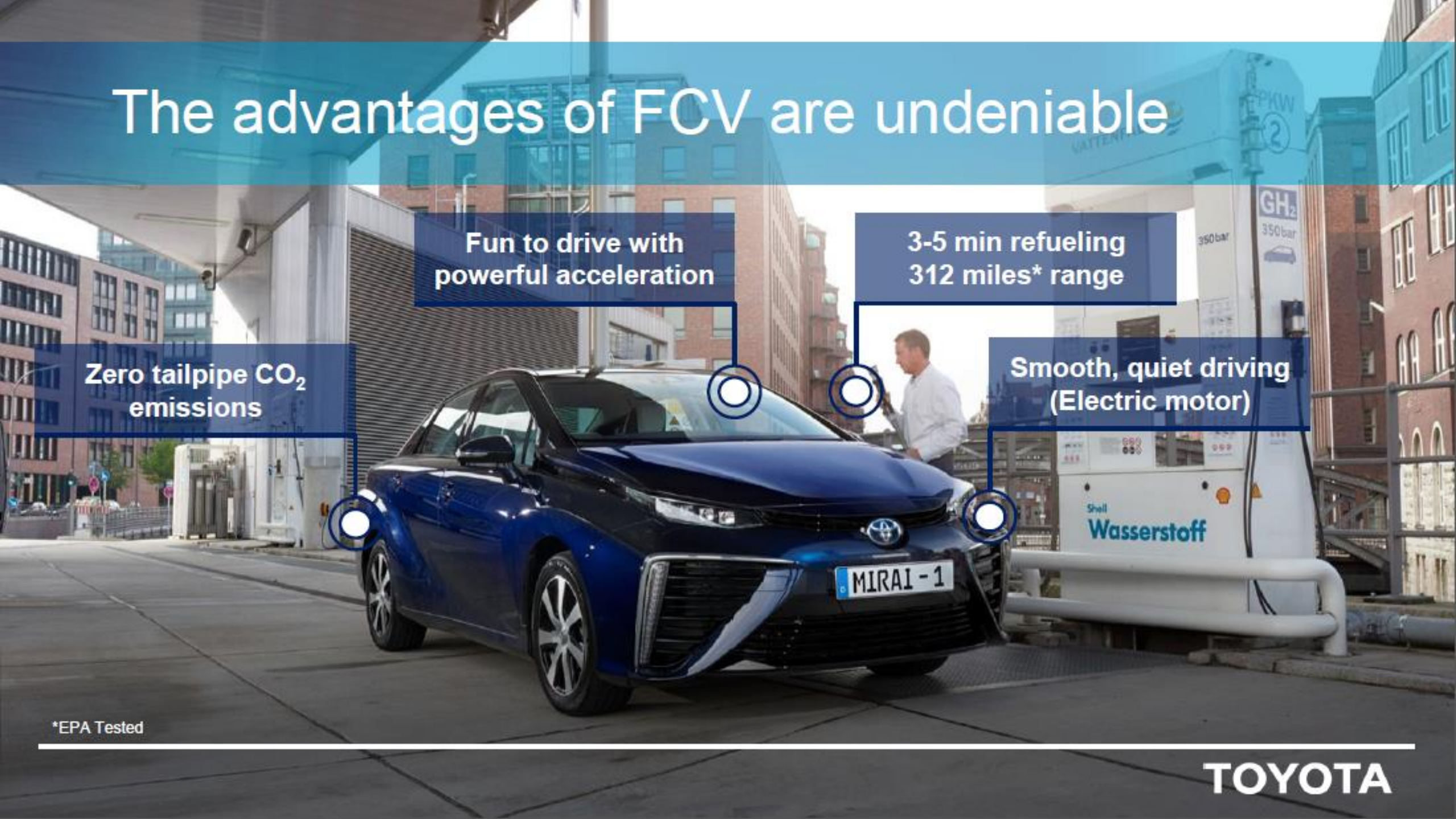


- Electrification will increase dramatically after 2020
- Regulations (incl. in the US) are driving such need for reductions in all OEMs

…with sales based on Customer Needs



The advantages of FCV are undeniable



*EPA Tested

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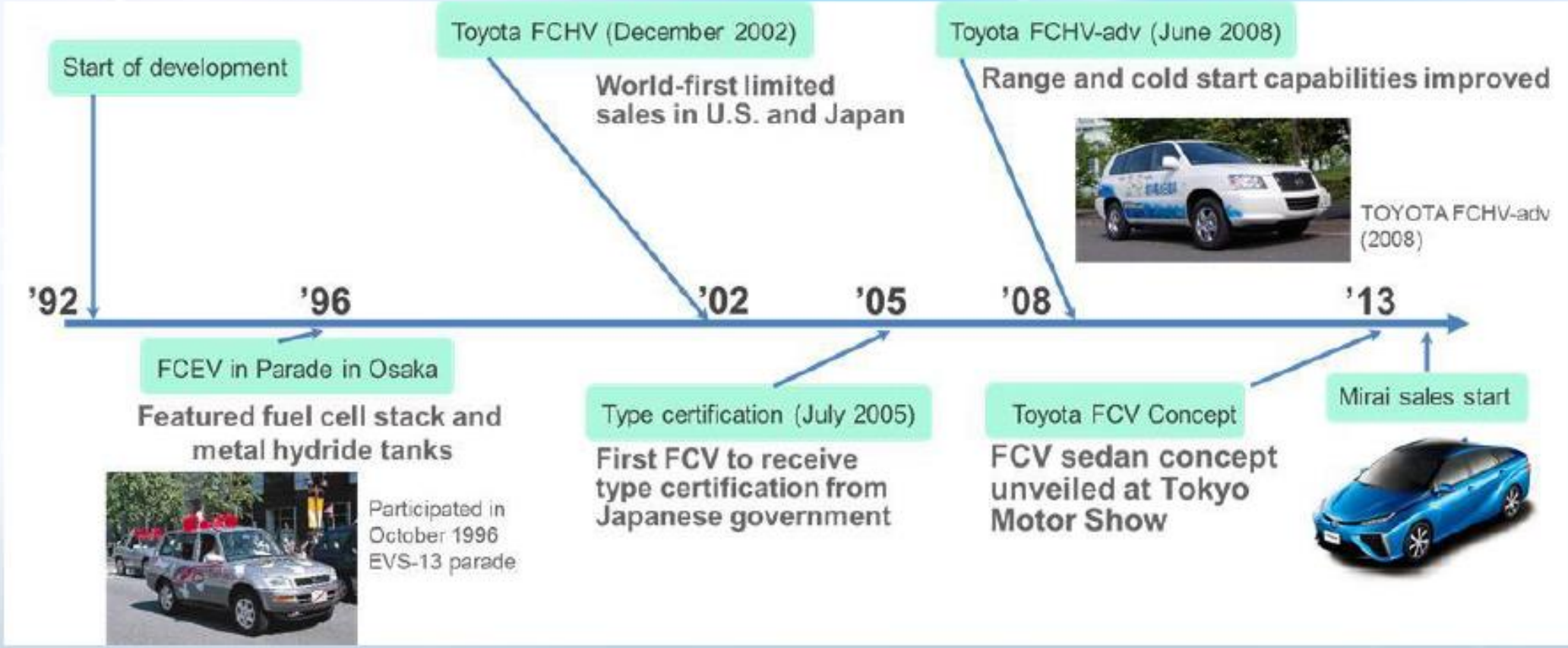
The Mirai is the Culmination of 25 years of Fuel Cell Vehicle R&D…



The future is MIRAI

FC stack

- Innovative flow channel structure and Electrodes of cells for higher output

Output/volume; 3.1kW/L

world top level

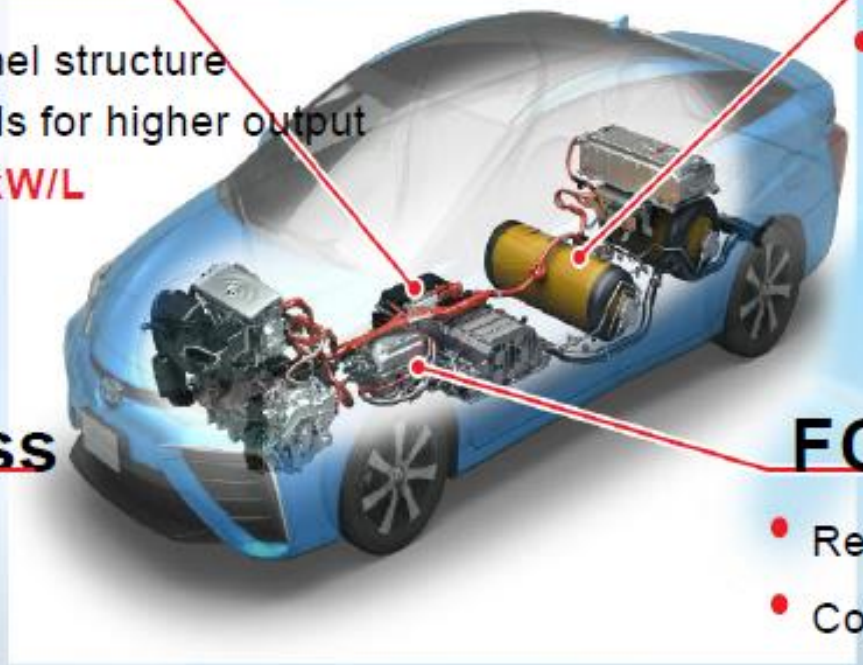
High pressure hydrogen tank

- The light weight structure of carbon fiber reinforced plastic enabled

Storage; 5.7 wt%*

world top level

*Hydrogen mass/Tank mass



Humidifier less

- Internal circulation

FC boost converter

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

FC main components developed in-house to achieve leading performance

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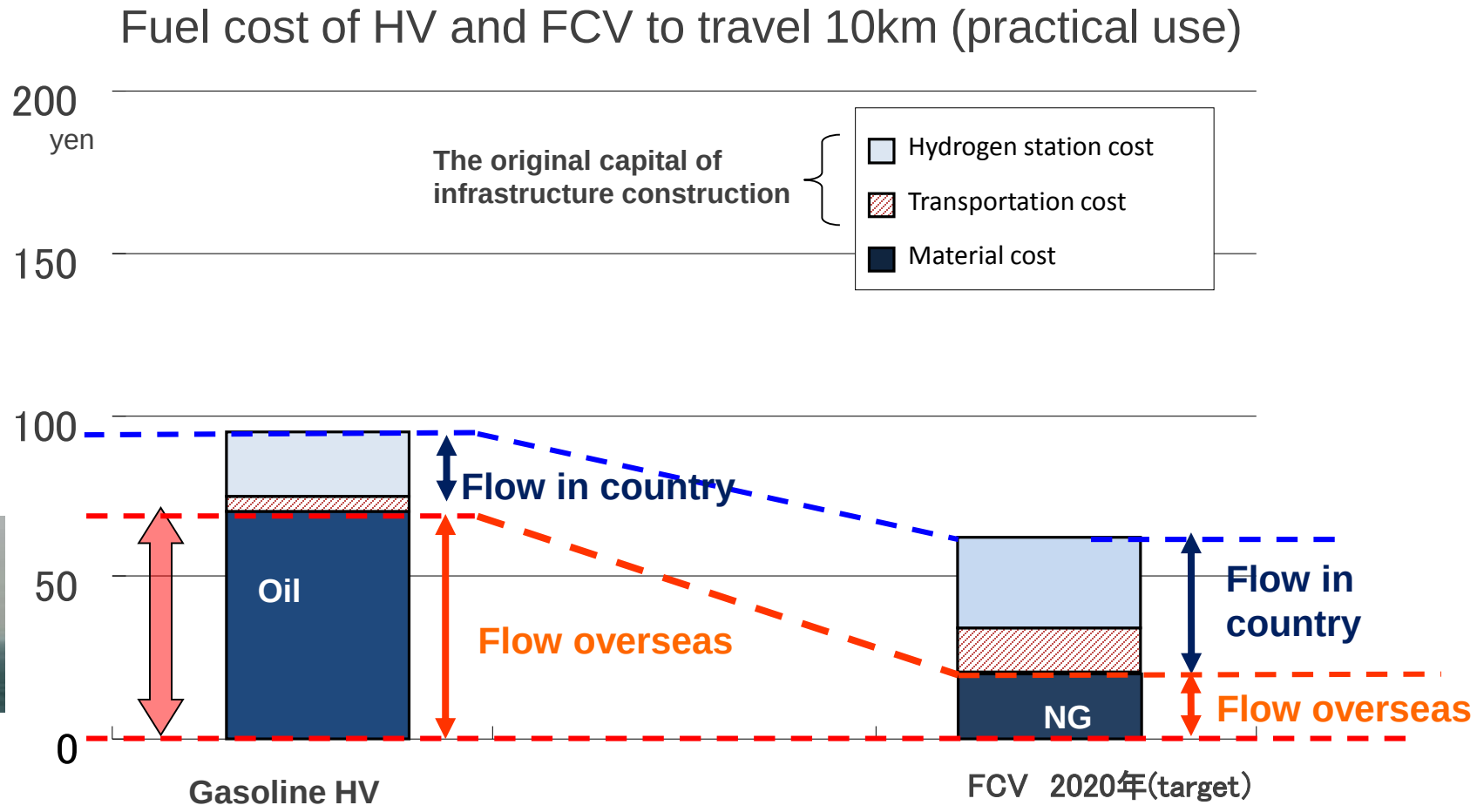
High additional value



Data: The Institute of Applied Energy

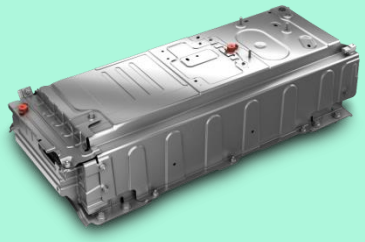
An overseas outflow of the value of hydrogen is smaller than that of the Gasoline.

High additional value

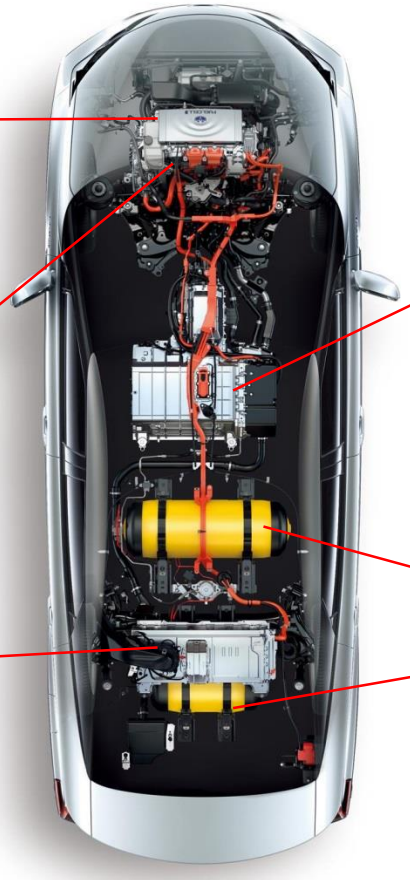
HV Technology

Power Control Unit

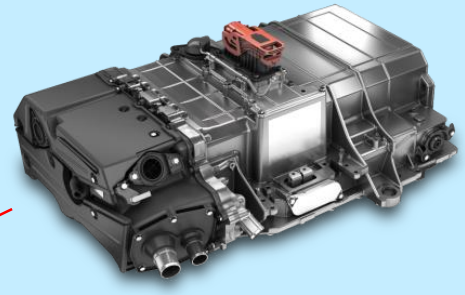
Motor



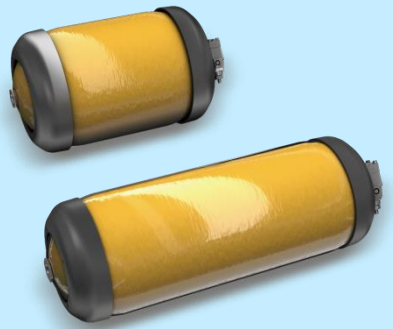
Battery



FC Technology



FC Stack
（electrolyte membrane, separator）



High pressure hydrogen tank
(Carbon fiber)

Developing and introduction FCV have a big effect on international competitiveness maintenance , industrial upbringing and job creation.

FC system costs have been reduced significantly and efforts are ongoing for further gains

Fuel cell system costs have been reduced significantly and cost reduction efforts are ongoing

MIRAI: our first mass-production Fuel Cell sedan

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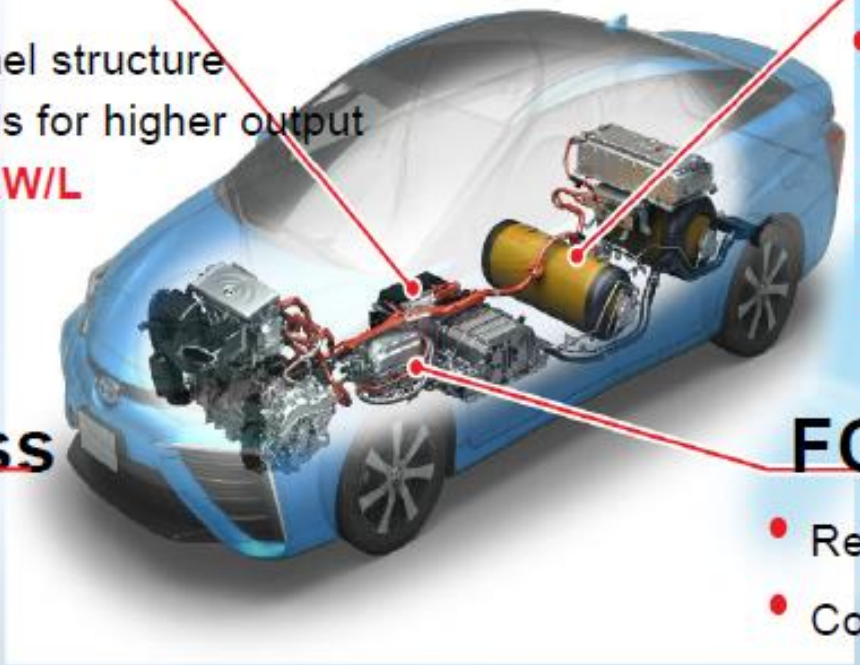

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MIRAI: our first mass-production Fuel Cell sedan

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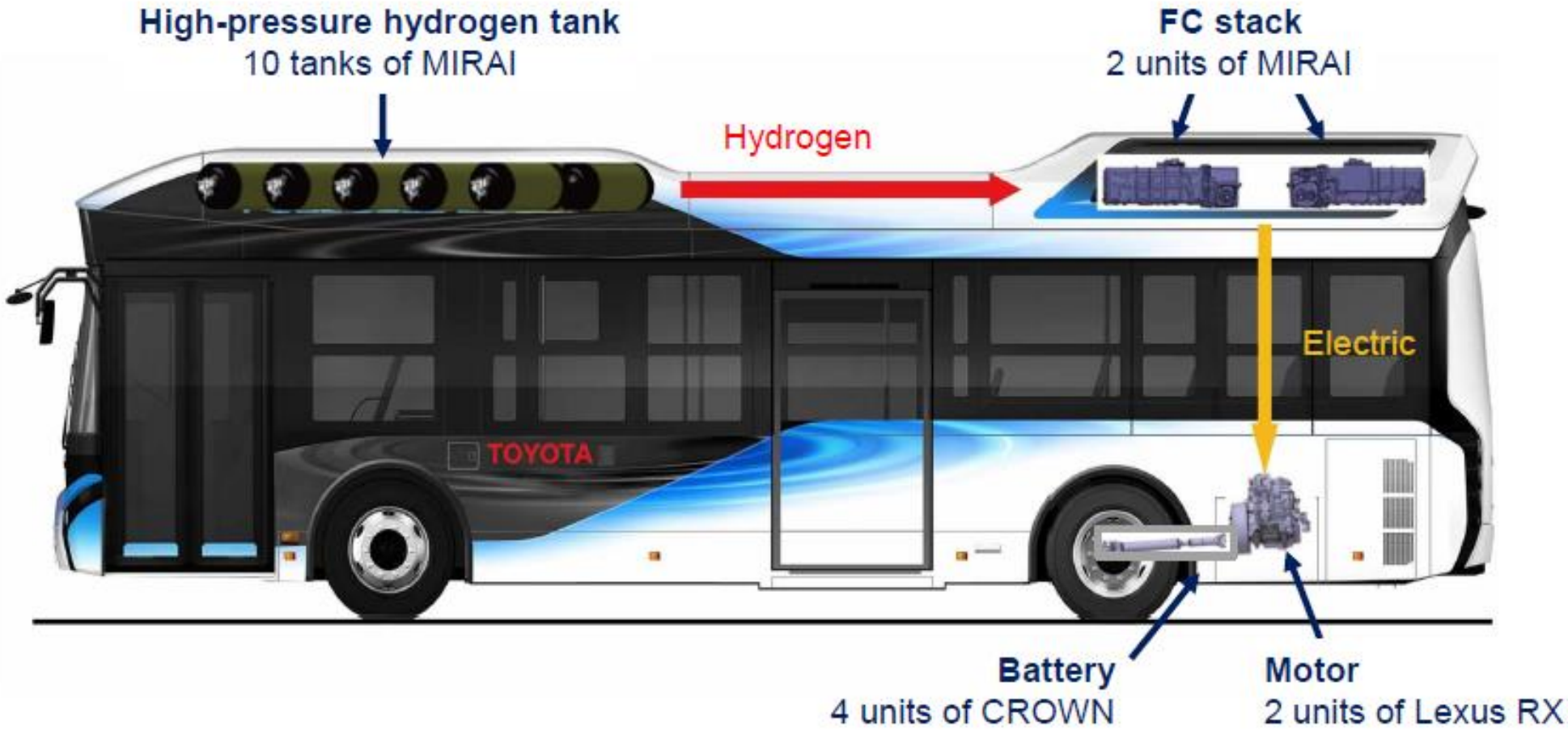
Toyota is also making FC Buses



And recently, Toyota Opened a Portal to the Future of Zero Emission Trucking in US

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…and hydrogen is safe

01 STABLE MOLECULE

LESS ENERGY CONTENT THAN LPG or CNG 02

04 NEEDS O2 (4-74%) TO COMBUST

DISPERSES QUICKLY 03

Source: www.mathesongas.com/pdfs/products/Lower-(LEL)-&-Upper-(UEL)-Explosive-Limits-.pdf

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Toyota ensures 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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H2 tanks pass extremely demanding testing

Tank designers and inspectors run a multitude of tests in laboratories to ensure safety

Burst test

Bonfire tests

Crush test
150 t force (Power-tech)

Gunshot test
(tested at Powertech[1])

[1]Armour-piercing 7mm test according to UN Technical Regulation

- Mirai complies with all U.S. and international vehicle safety standards

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The Toyota Group looks beyond FCEV

Toyota Motor Corporation

FCV

「MIRAI」

Hino Motors, Ltd.

FC bus

Toyota Industries Corporation

FC forklift

Pilot program period:
Dec. 2012-Mar. 2014

Location:
Kita Kyushu
Plant, Toyoda Gosei

Aisin Seiki Co., Ltd.

Co-gen. SOFC system for household use

Generation efficiency: 46.5%
(world's highest level)

Launched April 2012

Osaka Gas, Kyocera,
and Chofu Seisakusho

Toyota Tsusho Corporation

Hydrogen filling station

Ecoful-town at Toyota city
(HySUT : Iwatani Corporation, TOHO GAS CO., LTD)

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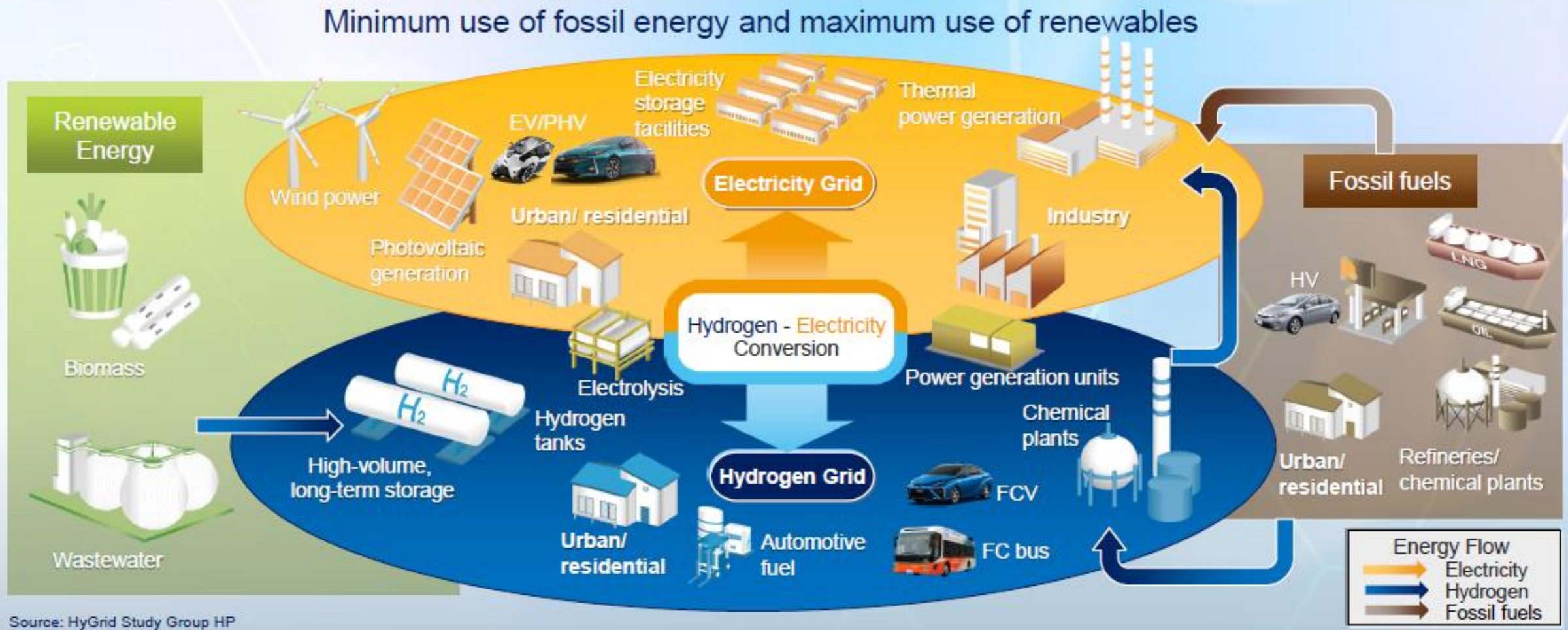
Future vision: HyGrid (Hybrid Grid)



Source: HyGrid Study Group HP

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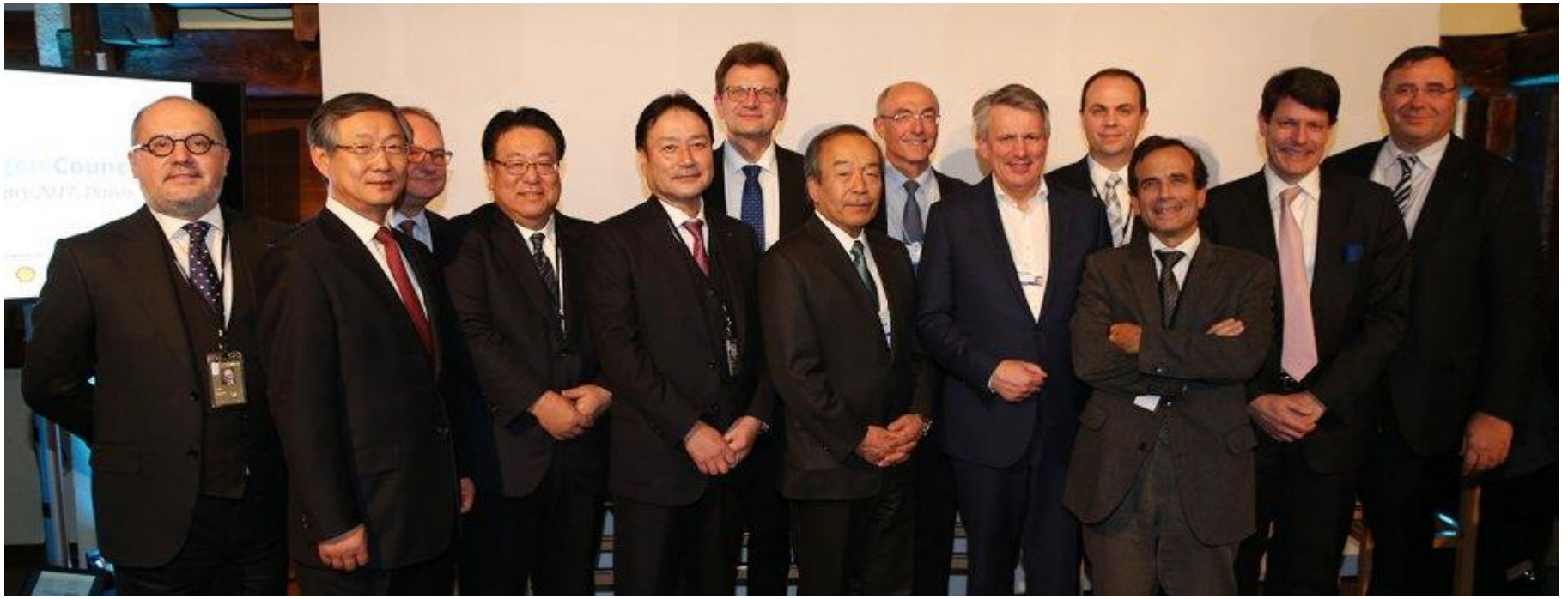
Cooperation to create H2 society

Zero CO_2 Challenge only possible in cooperation with stakeholders

Global industry leaders joined to promote hydrogen



Air Liquide · ALSTOM · AngloAmerican · BMW GROUP · DAIMLER · ENGIE · GM

HONDA · HYUNDAI · Iwatani · Kawasaki · PLASTIC OMNIUM · Statoil · THE LINDE GROUP

TOTAL · TOYOTA

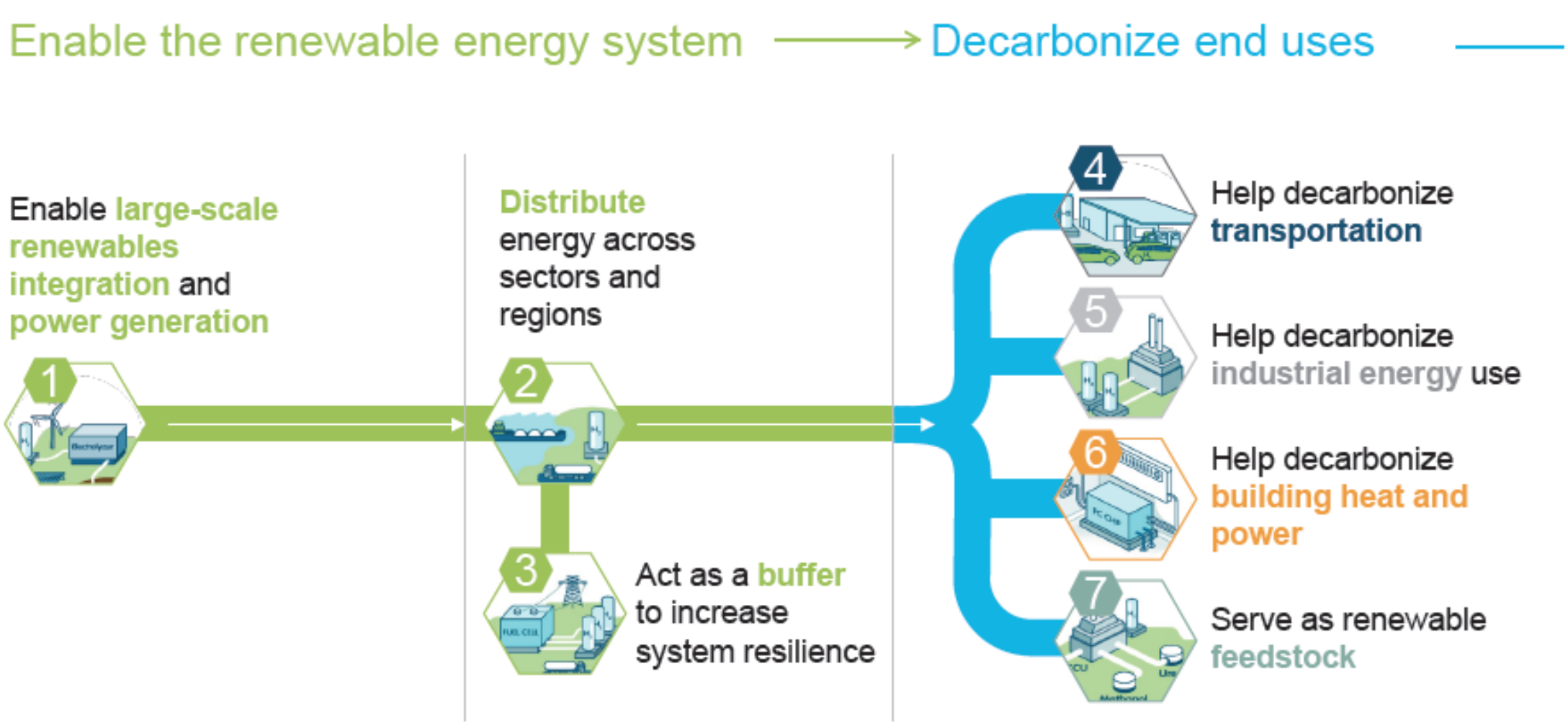
Our vision

Hydrogen Council

SOURCE: Hydrogen Council; IEA ETP Hydrogen and Fuel Cells CBS; National Energy Outlook 2016

Hydrogen can play 7 roles in the transition

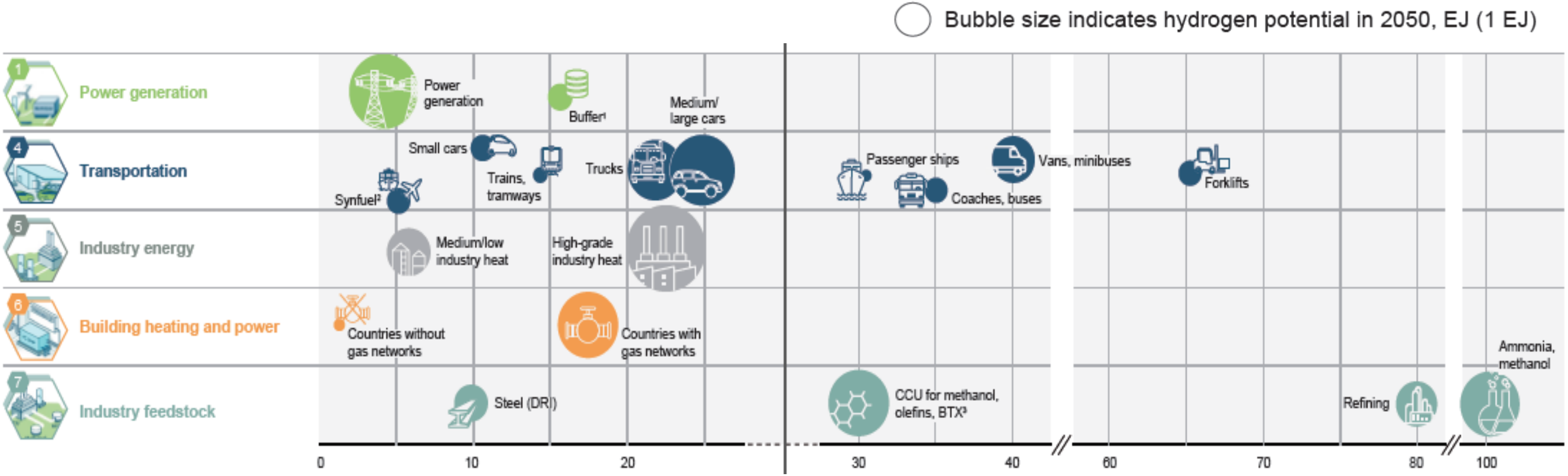
Hydrogen Council



SOURCE: Hydrogen Council

Hydrogen potential 2050

Hydrogen Council



Relative importance by 2050
Market share potential in segment, percent

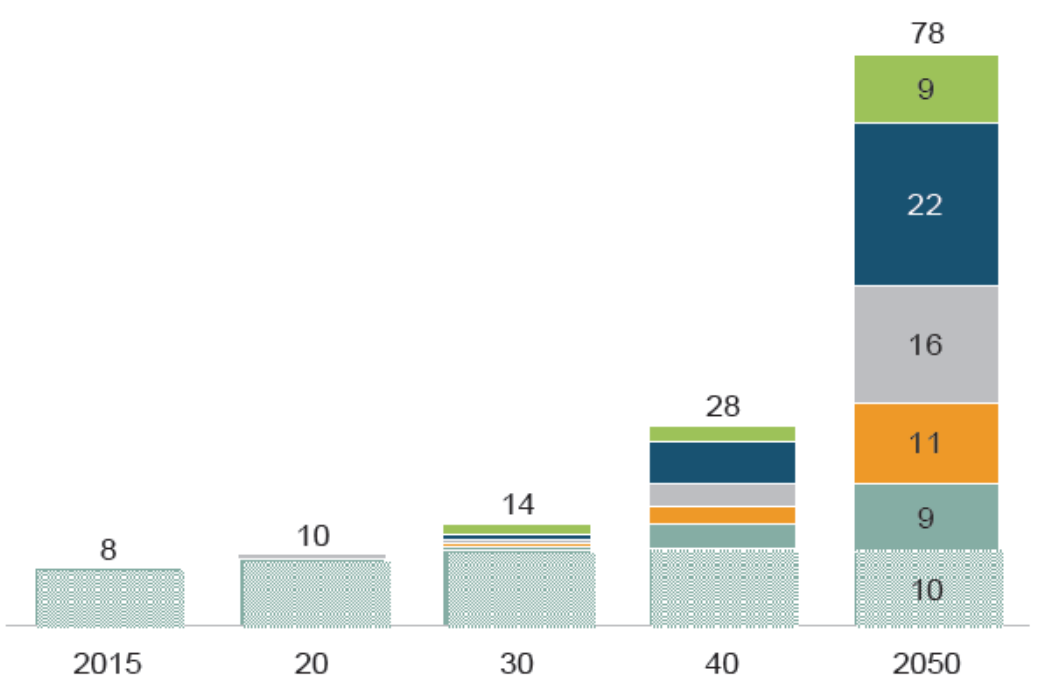
1 Percent of total annual growth in hydrogen and variable renewable power demand
2 For aviation and freight ships
3 Percent of total methanol, olefin, BTX production using olefins and captured carbon

SOURCE: Hydrogen Council

Hydrogen demand and CO2 reduction 2050

Hydrogen Council

Global energy demand supplied with hydrogen, EJ



1 Power generation, buffering

4 Transportation

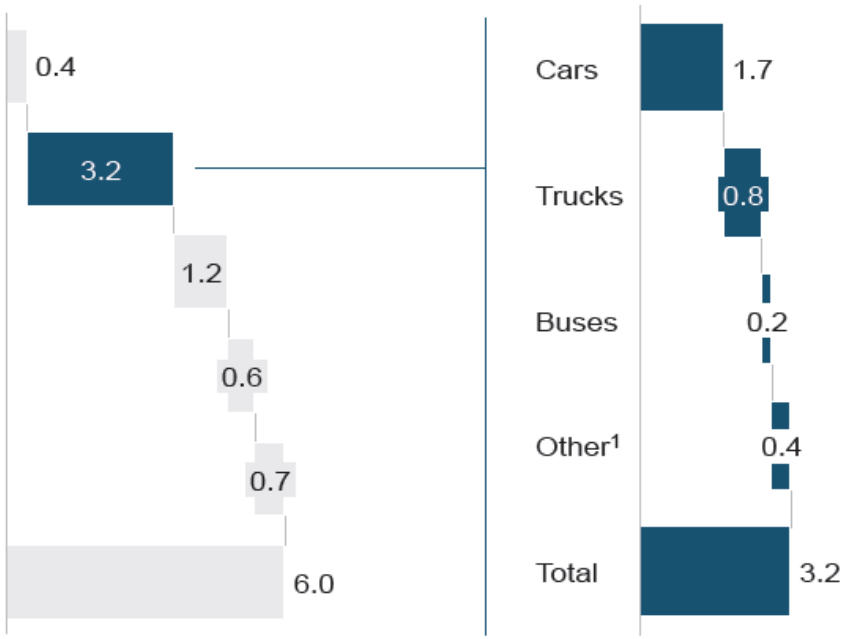
5 Industrial energy

6 Building heat and power

7 New feedstock (CCU, DRI)

Existing feedstock uses

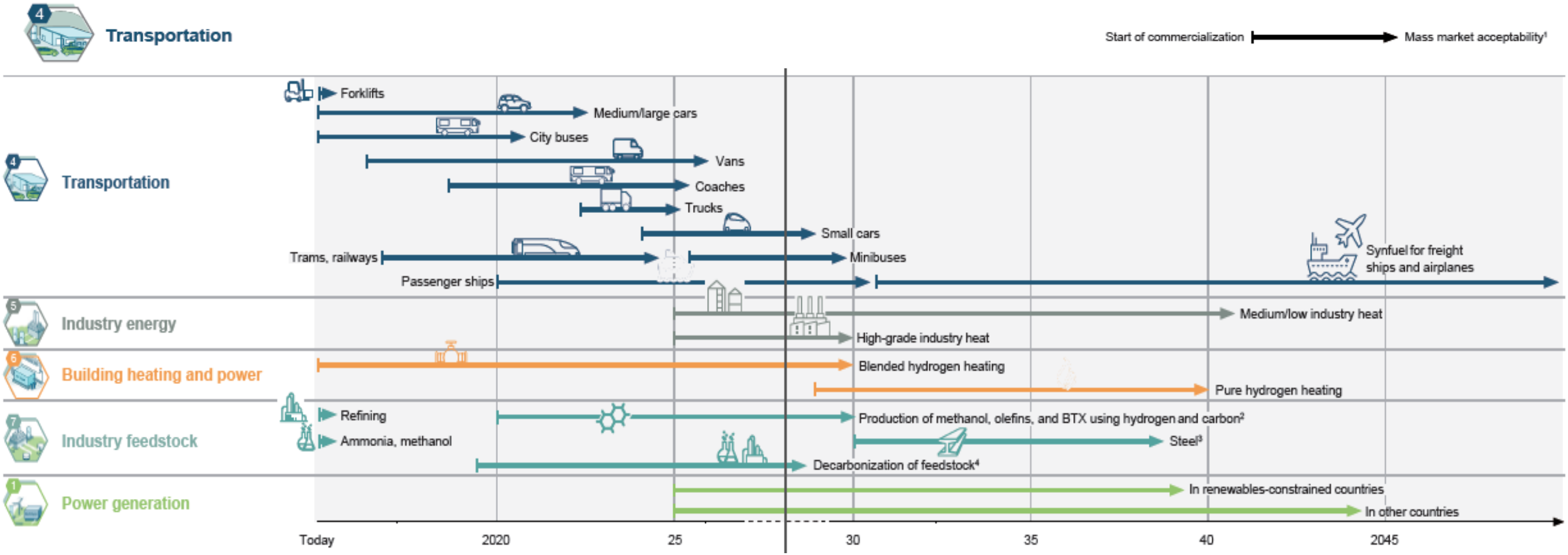
CO_2 avoidance potential 2050, Gt



SOURCE: Hydrogen Council

Hydrogen demand and CO2 reduction 2050

Hydrogen Council

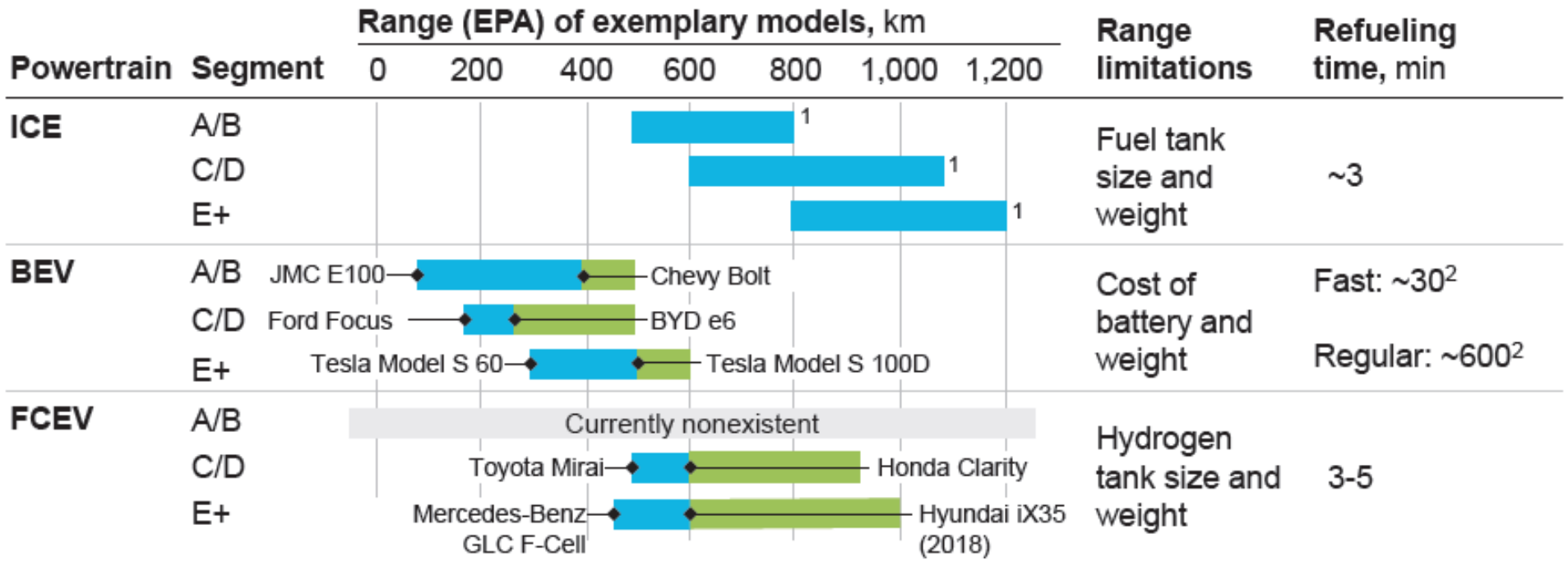


1 Defined as sales >1% within segment in priority markets
2 Market share refers to the amount of production that uses hydrogen and captured carbon to replace feedstock
3 DRI with green hydrogen, iron reduction in blast furnaces, and other low-carbon steel making processes using hydrogen
4 Market share refers to the amount of feedstock that is produced from low-carbon sources

SOURCE: Hydrogen Council

Hydrogen driving range

4 Transportation



1 Indicative
2 Charging time depends on battery size and charge rate; PHEV indication refers to a 8.7 kWh battery and home charging at a standard domestic socket; BEV indication refers to a 24 kWh battery at 50kW for fast charging and a standard domestic socket for regular charging

SOURCE: EV-volumes.com; OEM websites; web and press search

Range today Range by 2030

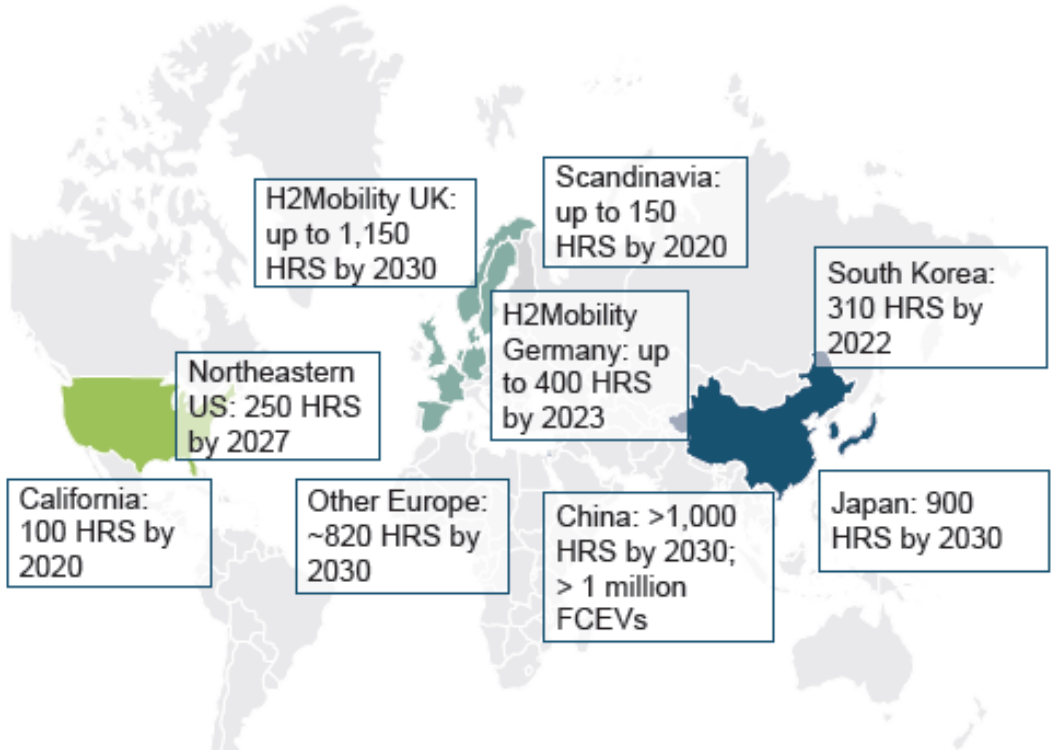
Hydrogen infrastructure

Hydrogen Council

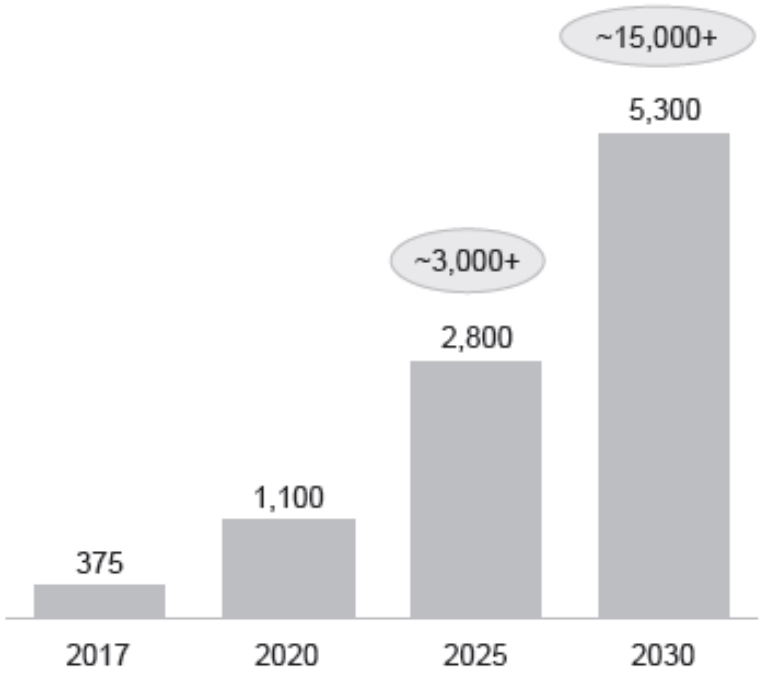
4 Transportation

Needed stations for roadmap[2]

Latest announced investments in hydrogen refueling stations (selected countries)



Current global announcements[1]



1 Announcements for shaded countries/regions: California, Northeastern US, Germany, Denmark, France, Netherlands, Norway, Spain, Sweden, UK; Dubai; China, Japan, South Korea

2 Equivalent number of large stations (1,000 kg daily capacity)

SOURCE: Air Liquide; Honda; Hydrogen Mobility Europe; H2Mobility; E4tech; NREL; web search

Hydrogen Council

"If you are passionate about what you think is right, keep moving forward. I am convinced that we can create the right conditions for mass adoption of hydrogen for a better society for our children."

Takeshi Uchiyamada
Chairman Toyota Motor Corporation

Summary

→ The hydrogen future has already begun

→ Hydrogen is not an option it is a necessity and makes business sense

→ More efforts are required to meet the 2050 vision

→ A broad societal consensus is required to make this happen

THANK YOU

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