Fuel Cell Vehicle Development and Initial Market Creation

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Seiji Sano

Project General Manager

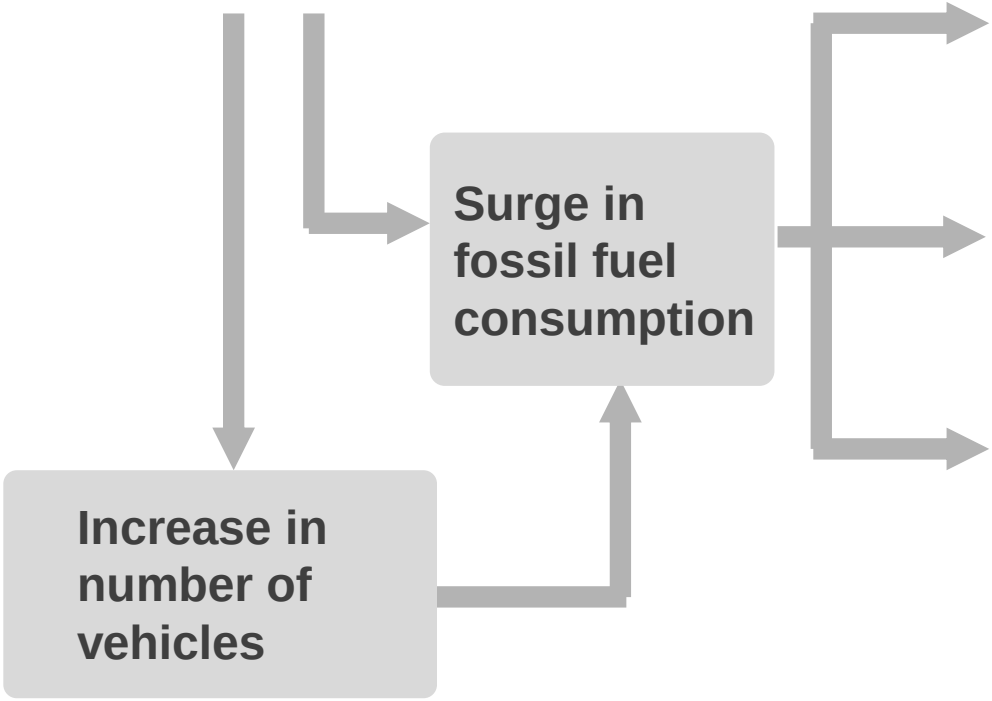
R&D Management Div.

Toyota Motor Corporation

1. Background of FCV Development

1-1. Severe situations surrounding automobile

1. Population growth
2. Economic growth



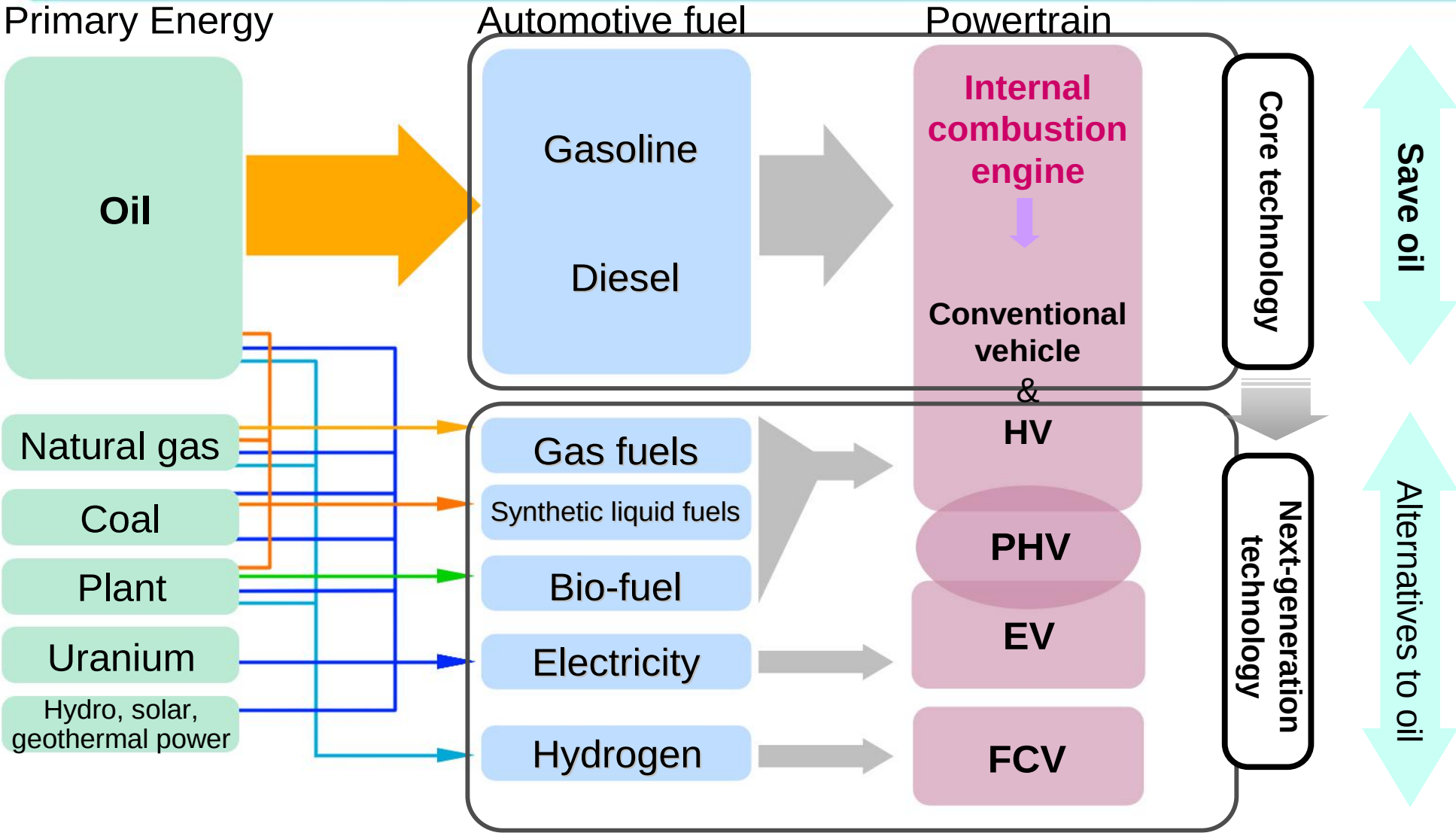
1. Concern about future oil supply

2. Increase in CO2 emissions (global warming)

3. Increase in air pollution

Sustainability is required for automobile.

1-2. Approach to sustainability



Saving oil and alternatives to oil are important for sustainability.

1-3. Activities for saving oil and alternatives to oil

Saving oil (Low emission)

Alternatives to oil (Zero emission)

Utilize electricity and hydrogen.

HV

PHV

EV

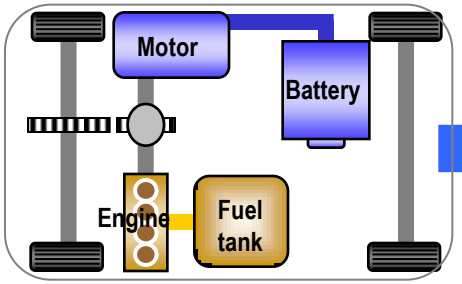
FCV

Time

HV, PHV, EV, and FCV have an important role for saving oil and alternatives to oil.

1-4. Core technology for PHV･EV･FCV

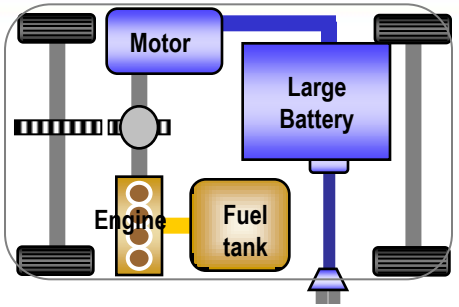
HYBRID SYNERGY DRIVE



HV

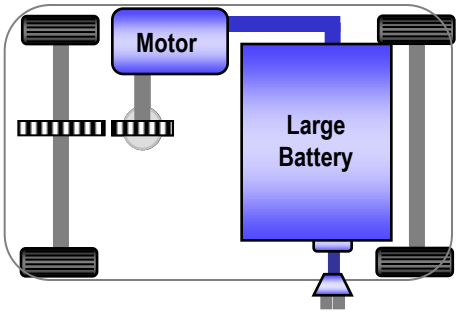
Energy saving
(Fuel economy improvement)

PHV



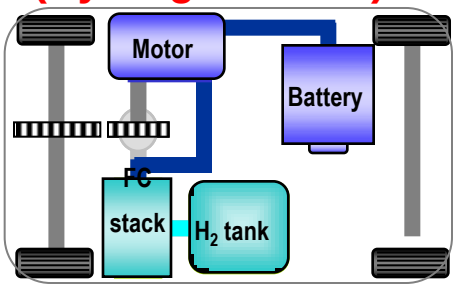
ELECTRIC DRIVE

EV (Battery EV)



PLUG-IN HYBRID

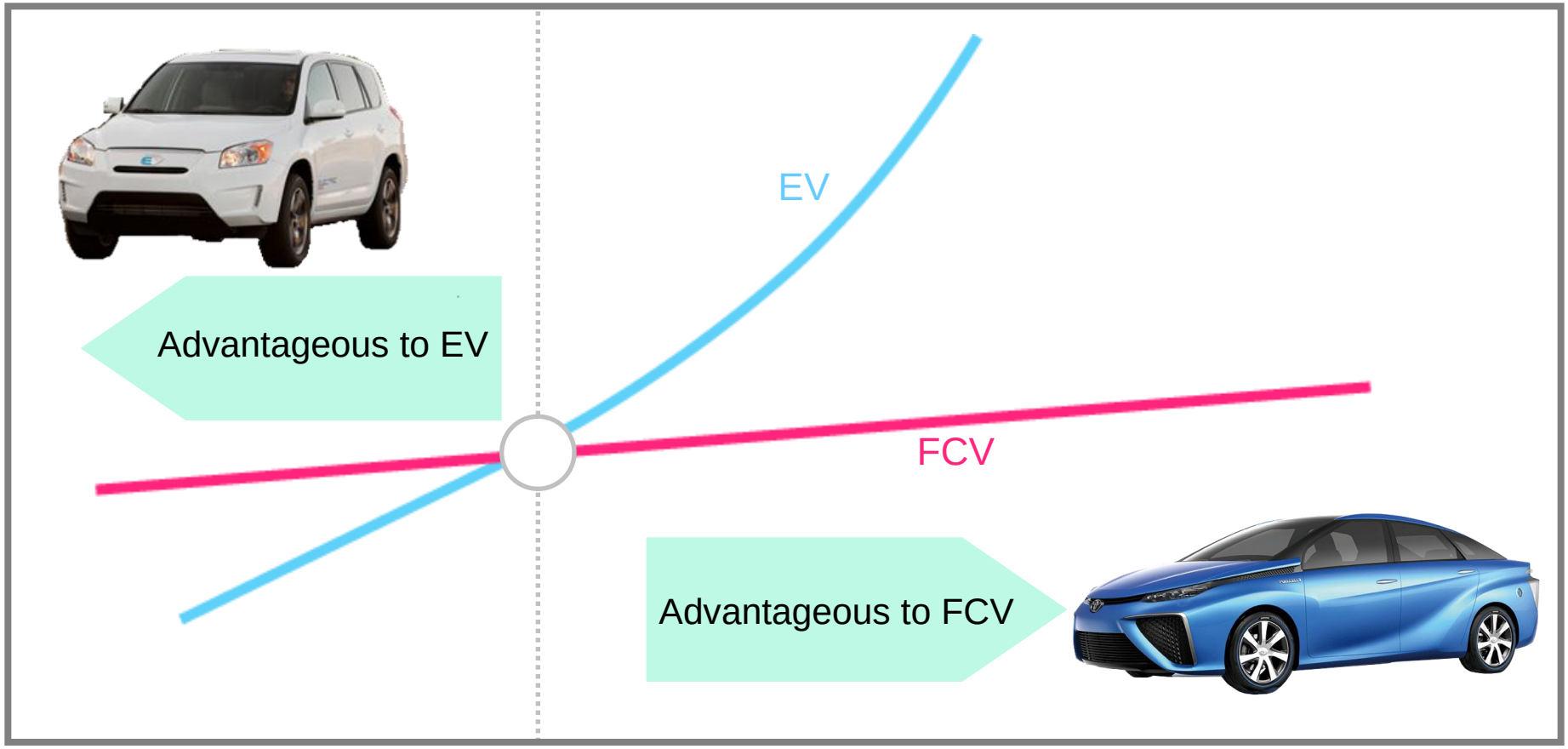
FCHV (Hydrogen FCEV)



FUEL CELL HYBRID

Hybrid technology is a core technology for PHV, EV, and FCV.

1-5. System cost comparison between EV and FCV



FCV system cost doesn't drastically increase even if range is longer.

→ In mid-to-long range, FCV has an advantage over EV.

1-6. Advantage of FCV

Energy diversification

- Hydrogen can be produced from various primary energy sources

Zero emissions

- Zero CO_2 emissions during driving

Driving pleasure

- Smooth and quiet operation
- Smooth start and good acceleration at low and medium speeds

Usability

- Practical cruising range (approx. 700 km) ※
- Refueling time (approx. 3 min.)
- Cold-start capability (-30ºC)

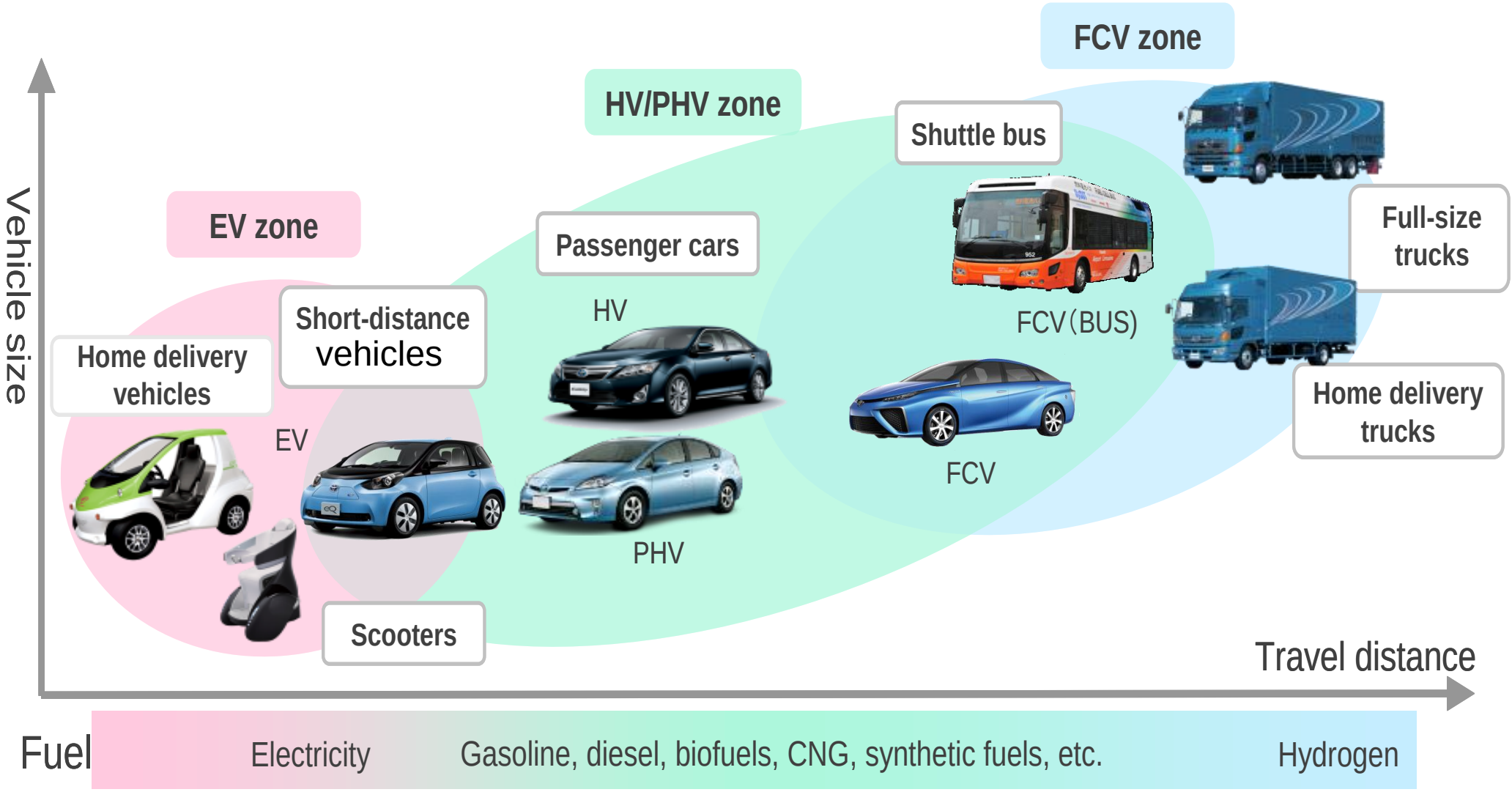
※JC08 mode, Toyota measurement

Large power supply capability for emergencies

- Power supply capabilities are 4-5 times that of an EV, and can supply power to an average household for more than a week

Usability (cruising range, refueling time, and cold-performance) and power supply capability for emergency are advantage to EV.

1-7. Vehicle power train map in the future



EV: Short-distance, FCV: Medium-to-long distance

2. FCV Development in TOYOTA

2-1. History of FCV development in TOYOTA

Current status:
Aim to realize both cost reduction and durability/reliability for 2015 commercialization.

2008 Model (from June 2008)

Almost the same level as conventional vehicles excluding cost
→ No restriction. Cold startability has no problem.

- **Longer cruising range; 330 → 830km @ 10-15 mode**
- **Better cold startability (-30℃)**
- **Higher durability and reliability**
- **Over 100 vehicles were introduced in the US, EU and Japan (Running distance: over 2M km in total)**

2005 Model (from July 2005)

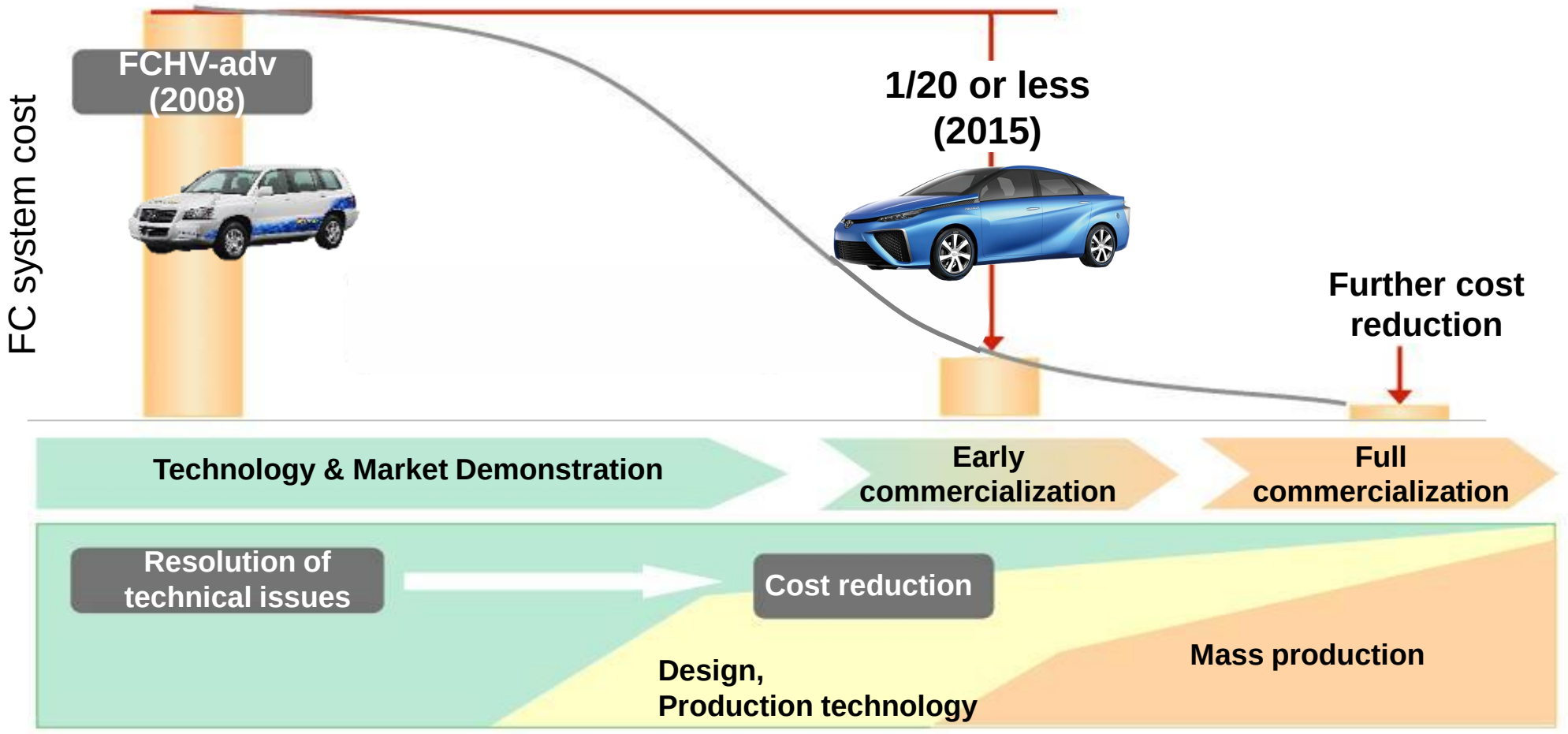
- **Performance was improved but the use was still limited due to restriction.**
  - **Longer cruising range; 300 → 330 km@10-15 mode**
  - **Higher motor output; 80 → 90 kW**
- **It was authorized as a model**
- **It was introduced into Osaka area in addition to Tokyo and Nagoya areas.**

2002 Model (from December 2002)

- **Basis of FC technology was established. (authorized by the Minister)**
- **Issues were cold startability, cruising range and durability.**
  → *Limited users / Restricted conditions*
- **17 vehicles were leased both in the US and Japan.**

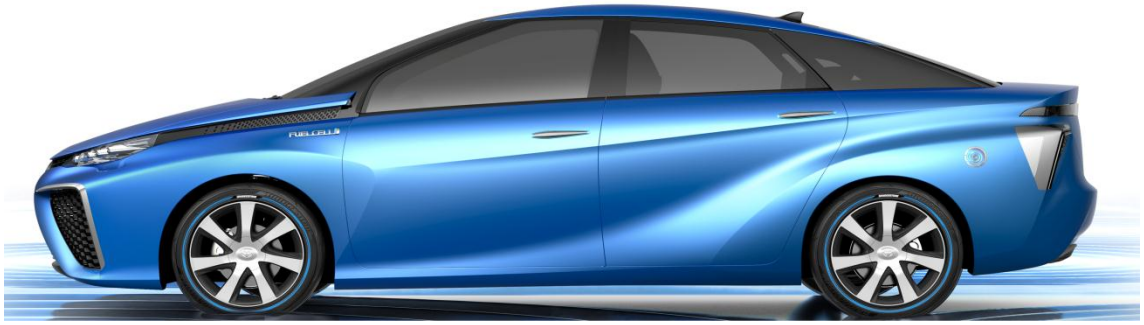
FCV has been improved step by step.

2-2. FC system cost reduction



Early commercialization: less than 1/20 compared to 2008 model
Full commercialization: further cost reduction

2-3. Concept vehicle debuted at 2013 Tokyo Motor Show



[TOYOTA FCV CONCEPT]

Length（mm）	4,870
Width（mm）	1,810
Height（mm）	1,535
Wheel Base（mm）	2,780
Passenger（person）	4
Cruising range（km）	Approx.700 （in JC08 test cycle）
Maximum speed（km/h）	170以上
Cold-start temperature（℃）	-30

2-4. Driving test on public road

Test	Place
Public road test	Japan, U.S.A
Cold test	Hokkaido, Canada
Hot test	U.S.A Death Valley

FCV is being assured reliability by repeating various driving tests.

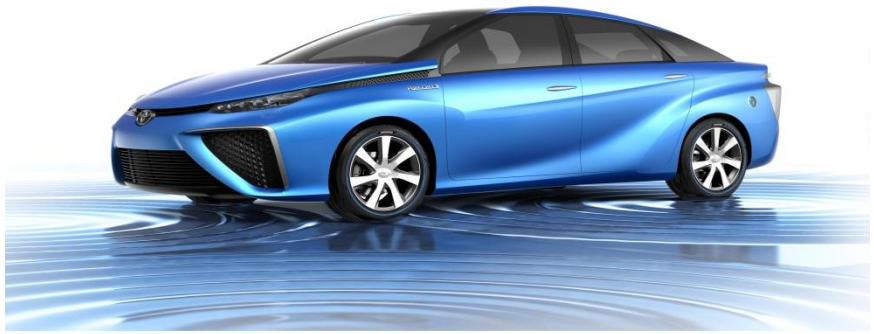
2-5. Toyota future plan for FC vehicle

- Launch of sedan type FCV around 2015
  - In Japan, will introduce into the four major metropolitan areas where infrastructure will be prepared.
  - Set an affordable price

- Launch of FC bus and FC forklift around 2016

- Aim to expand FCV commercialization toward 2020 onwards.

Launch in around 2015

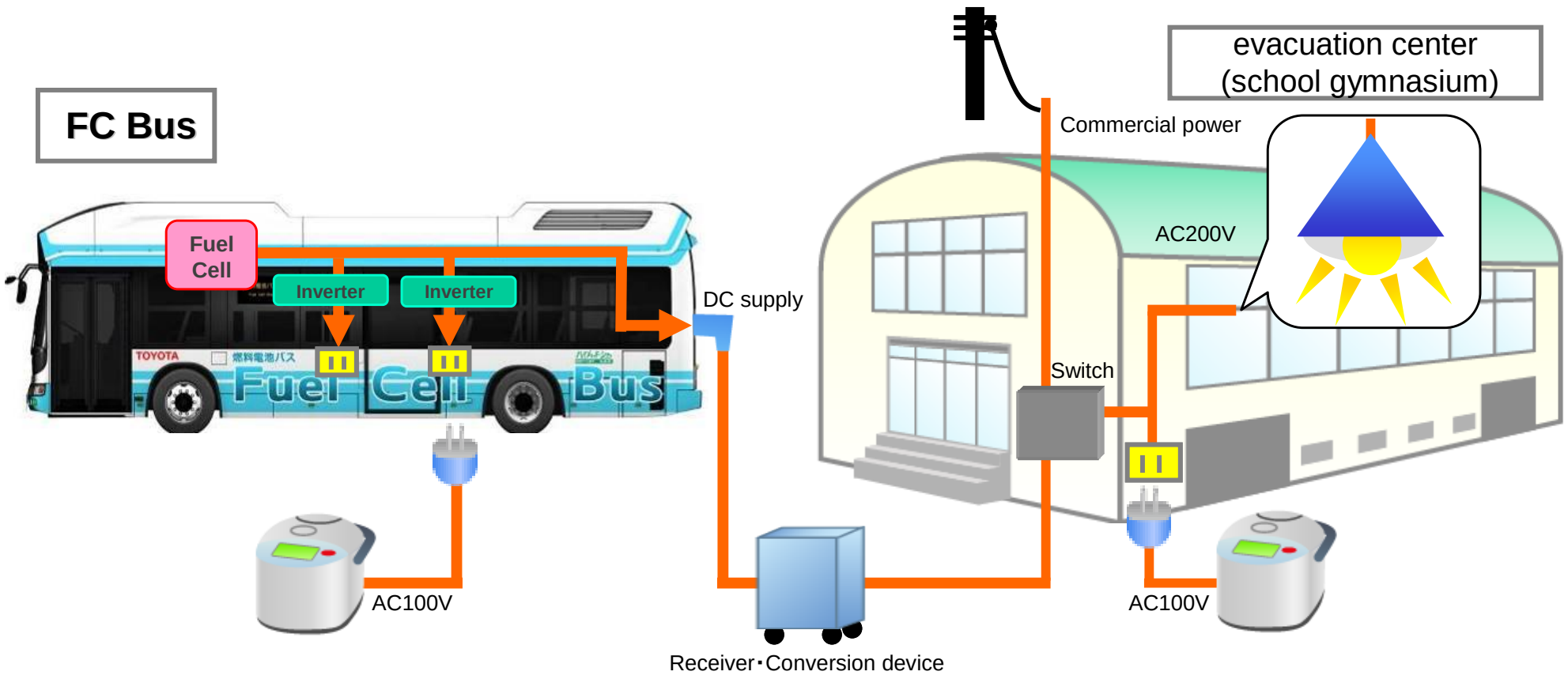


"FCV-Concept" at 2013 Tokyo Motor Show

Launch in around 2016

"FC Bus" Airport transportation Service Ltd. design

2-6. Power supply image by V2H system



FC bus can supply power for lighting to evacuation center (school gymnasium) for about 5 days.

2-7. FC related project in Toyota group

Toyota Motor Corporation

FCV

「TOYOTA FCV CONCEPT」

Revealed at 2013 Tokyo Motor Show

Hino Motors, Ltd.

FC bus

Toyota Industries Corporation

FC forklift

Launch in around 2016

Aisin Seiki Co., Ltd.

Co-gen. SOFC system for household use

Osaka Gas, Kyocera, and Chofu Seisakusho

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

Launched April 2012

Toyota Tsusho Corporation

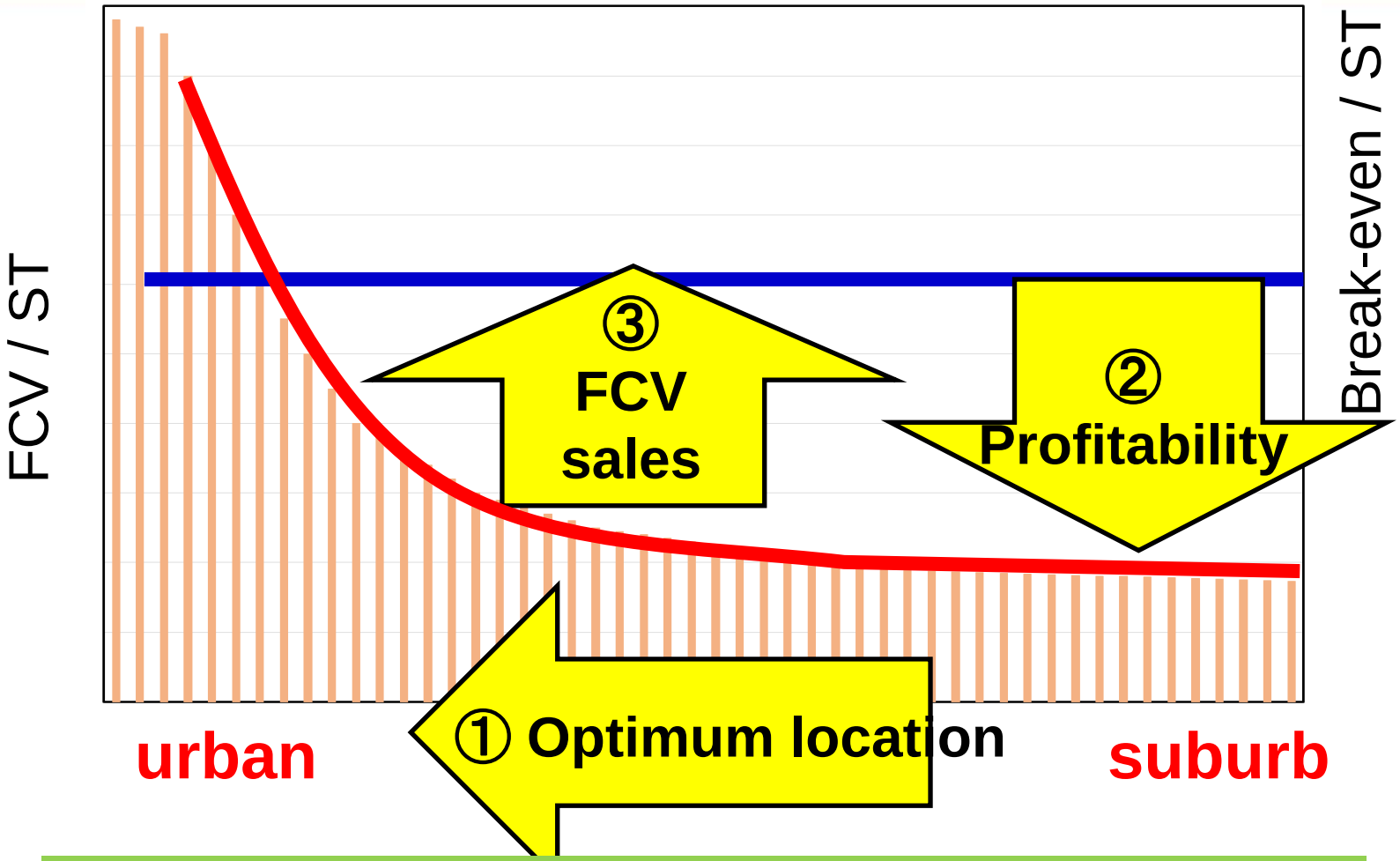
Hydrogen filling station

Toyota Tsusho Air Liquid Hydrogen Energy Corporation

Several projects are ongoing.

3. Initial Market Creation

3-2. Approach to create initial market



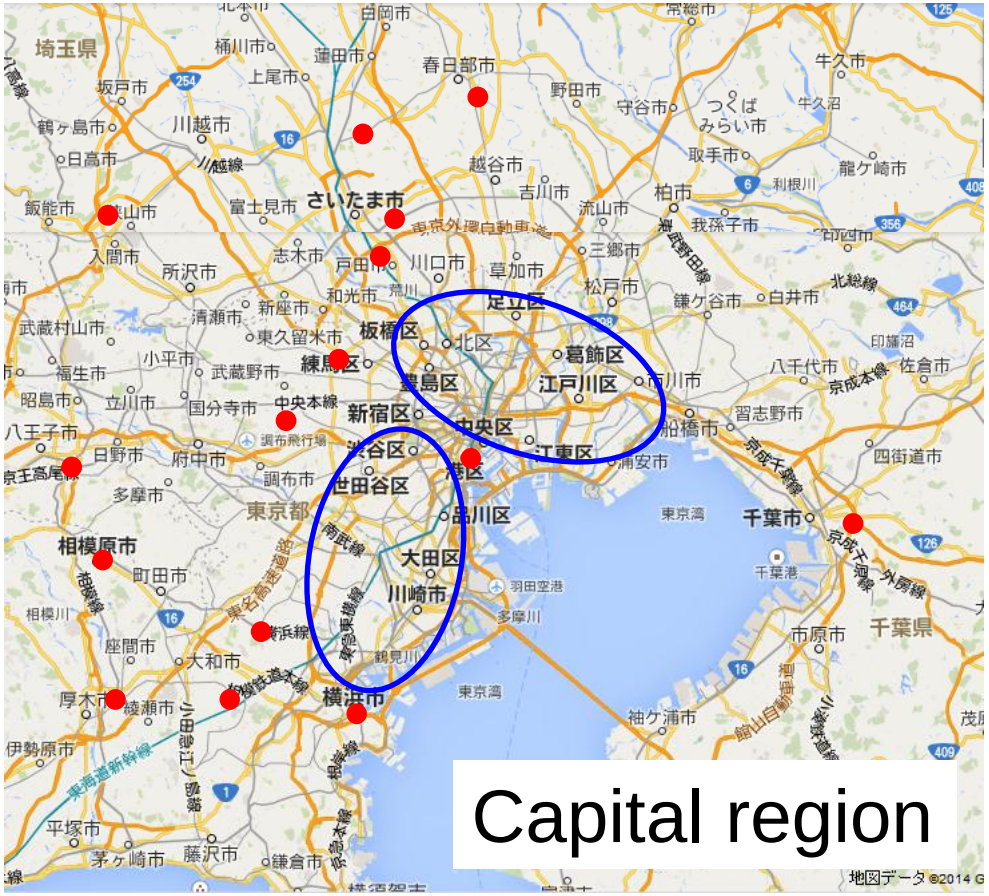
1. Concentrate in the urban area
2. Increase profitability (reduction of capex and opex)
3. Increase FCV sales

⇒ Cooperation with government and hydrogen infrastructure industry

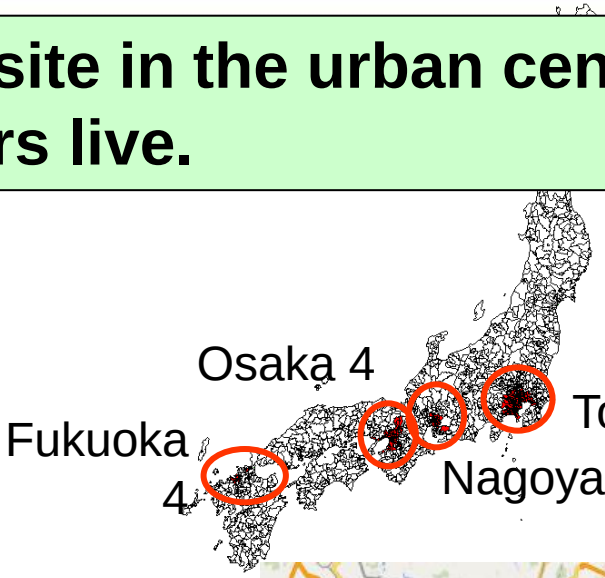
3-3. Issue of optimum location in the urban center area

There is very little HRS planned site in the urban center area where a lot of potential customers live.

- HRS planned site



Capital region



Osaka region

4. Summary

1. **TMC advances the preparation for 2015 early commercialization of FCV.**
2. **TMC will also continue efforts to reduce cost and develop more attractive FCV toward for full commercialization**
3. **Closer cooperation with government and hydrogen infrastructure is necessary for commercialization.**

Thank you for your attention.

The Eco-car

For

You.