



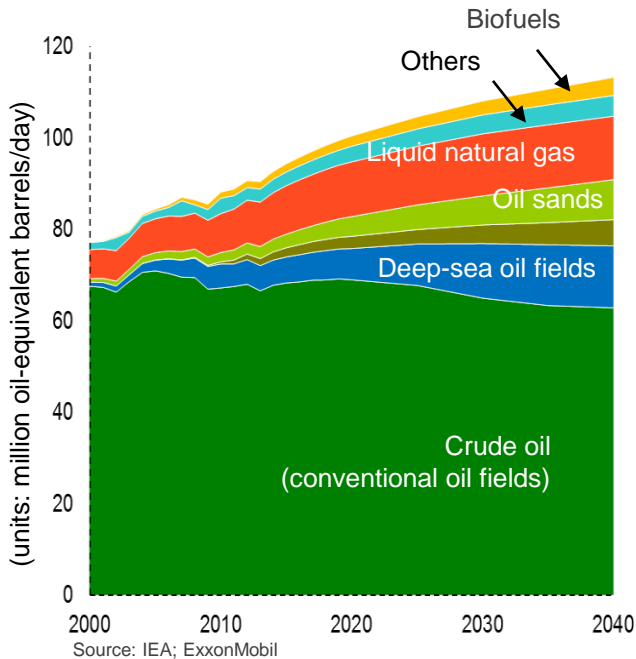
Toyota's Effort Towards Sustainable Mobility

Oct. 20 2014

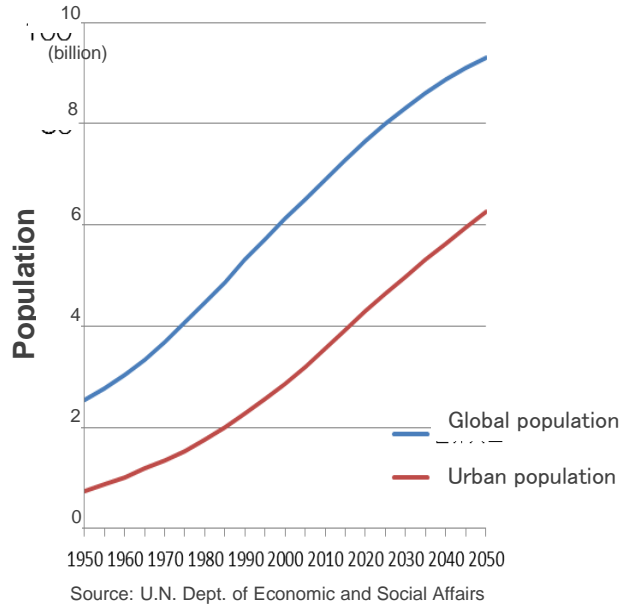
Katsuhiko Hirose
Toyota Motor Corporation



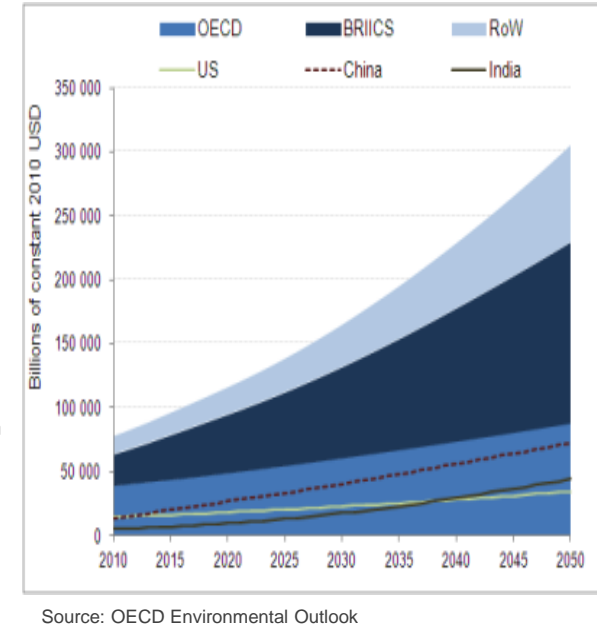
Global liquids supply by type



Global and urban population



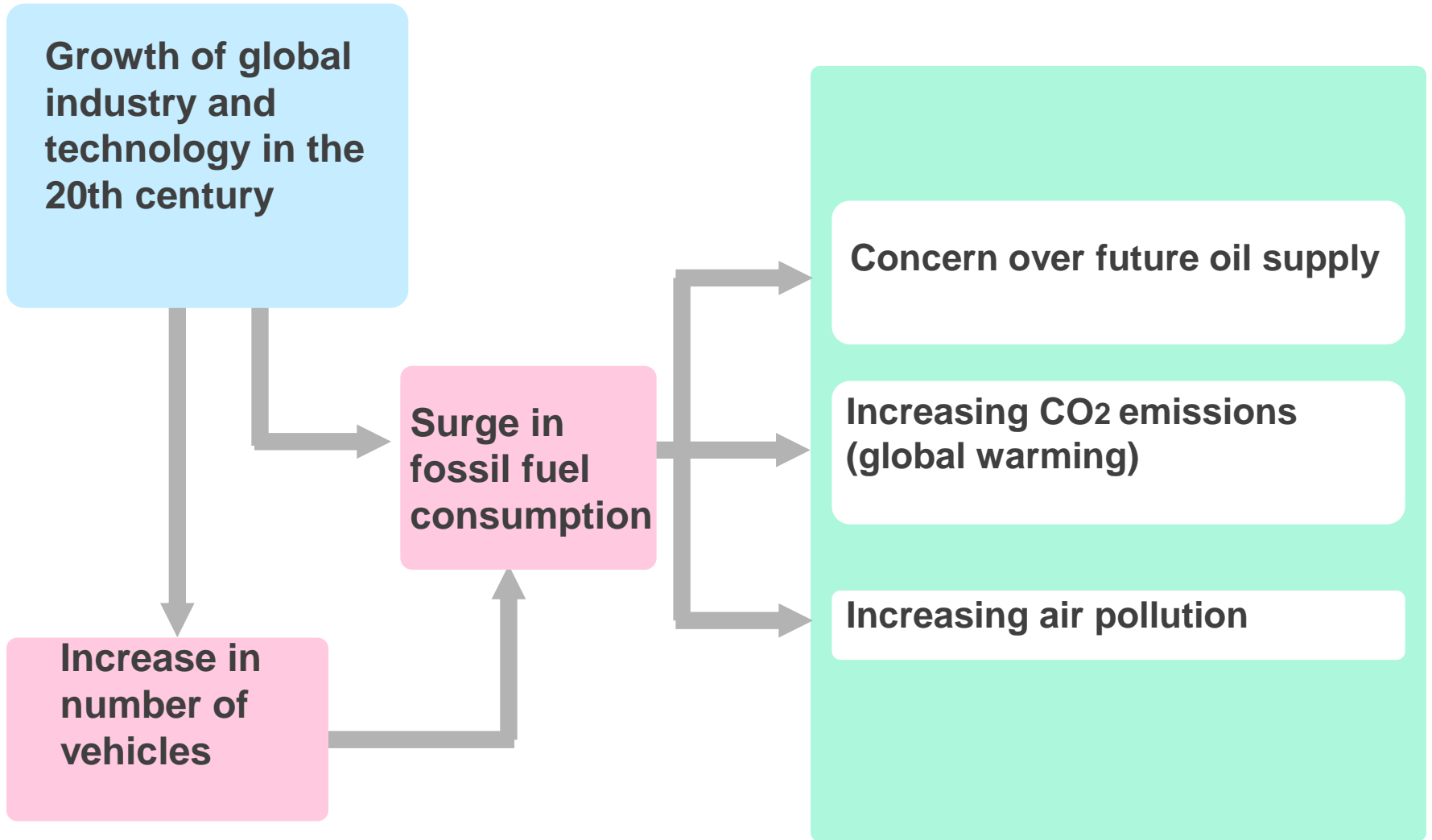
Global GDP



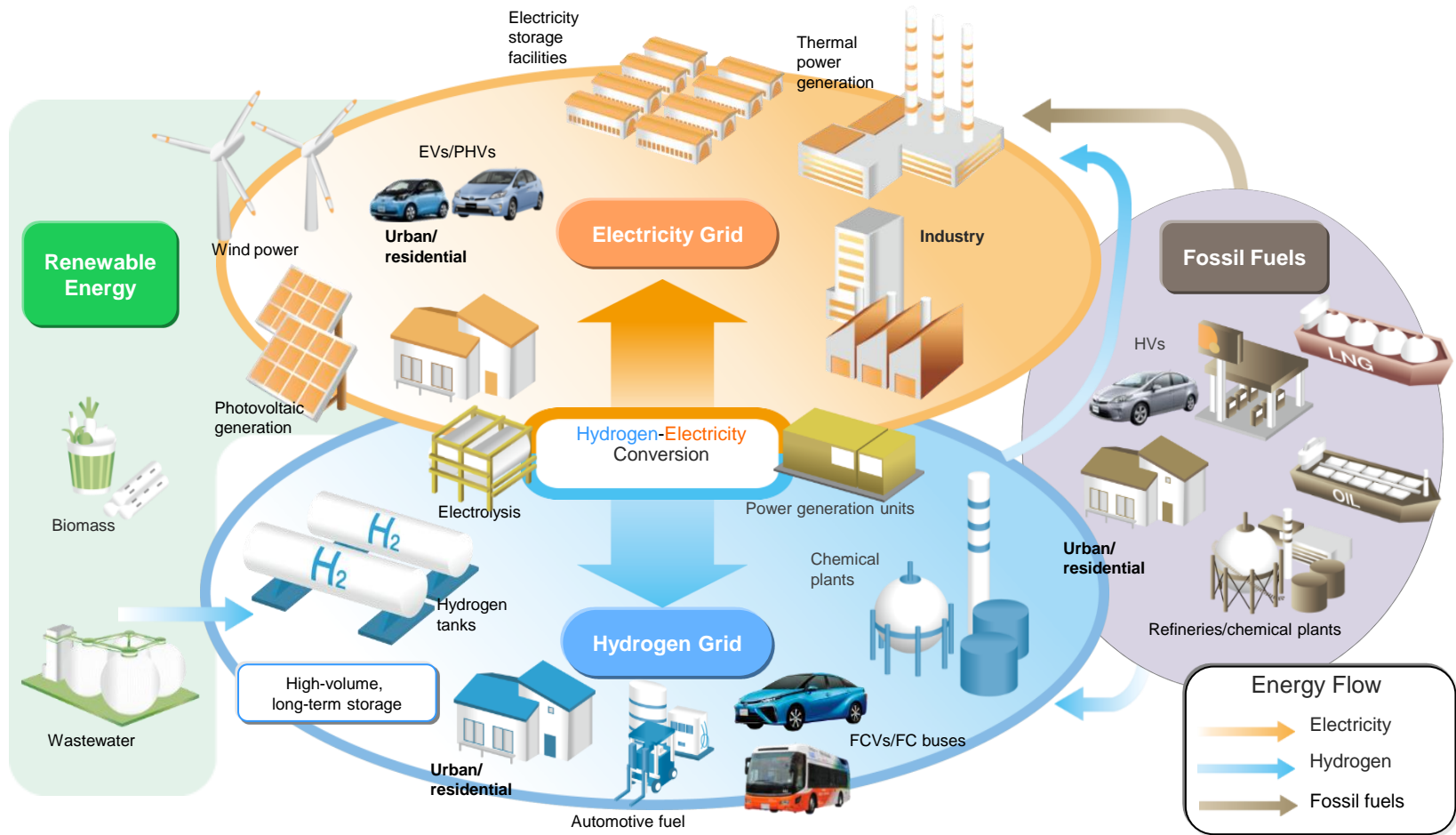
- Global population of 9.6 billion
- 70% of the world's population living in cities
- Global GDP to increase more than threefold

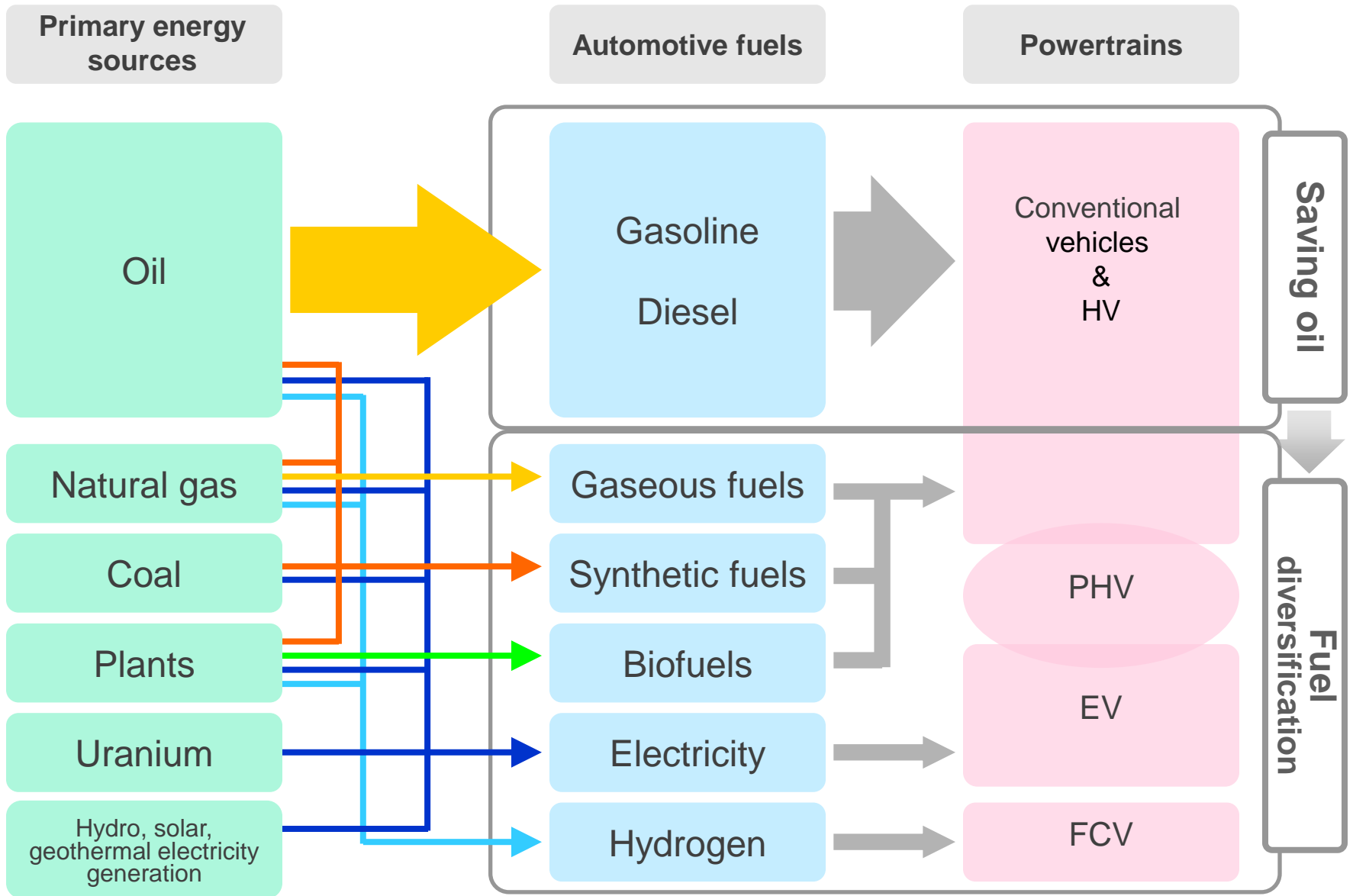
- Developing non-conventional resources will increase the global oil supply

- Rapid increase in overall/urban population and economy leading to Intensified environmental problems (climate change, global warming, air pollution)



A society which uses diverse energy sources, with electricity and hydrogen infrastructures







Dec. '97 : sales started
“In time for the 21st century”



Compact



Medium



Large



SUV



Minivan

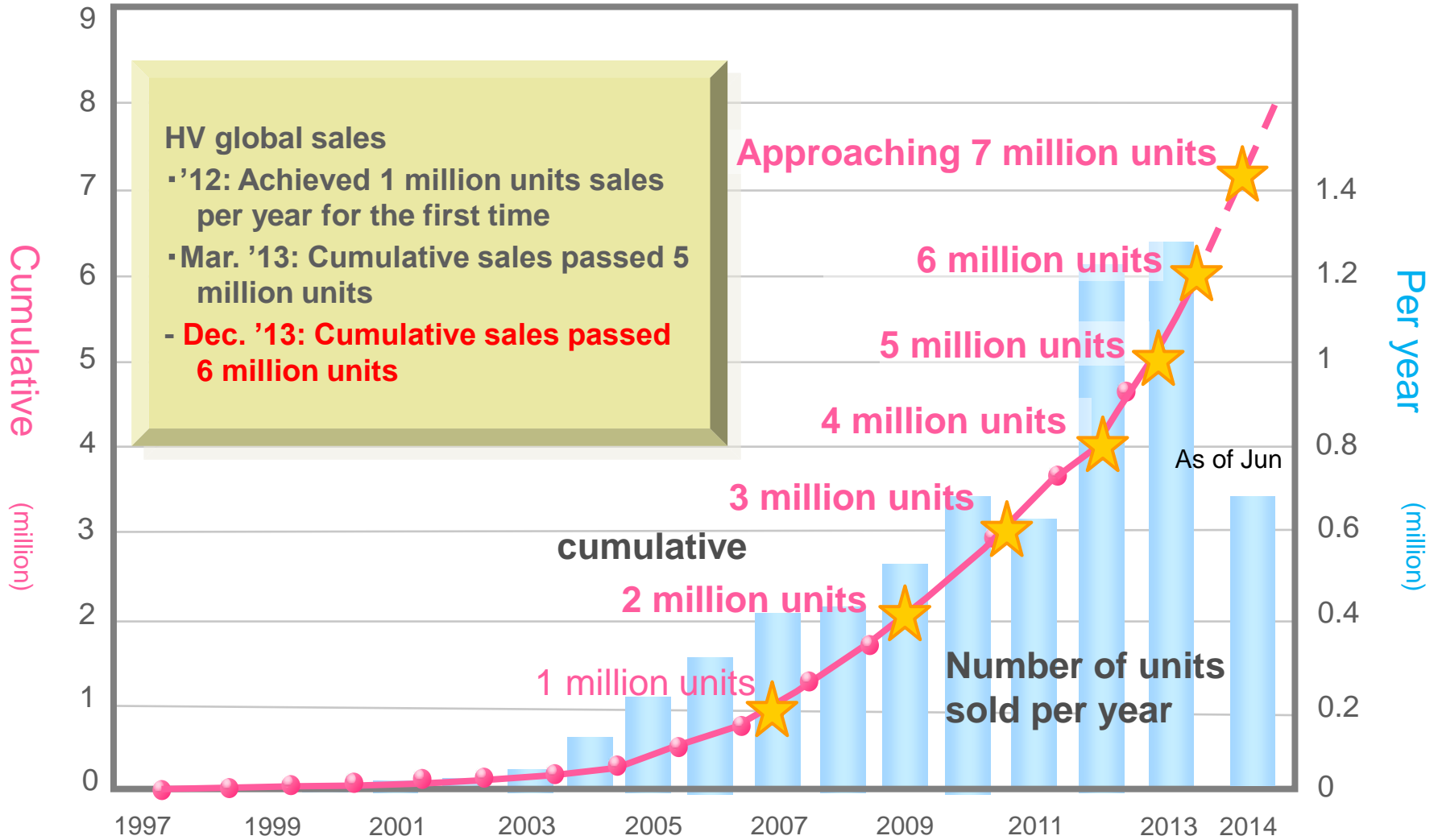


Commercial



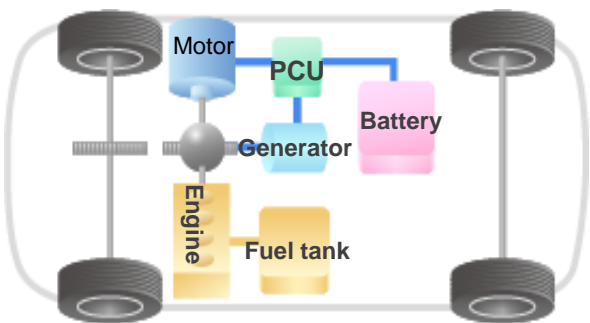
As of Jan. 2014

Toyota has introduced hybrid models to all the vehicle categories

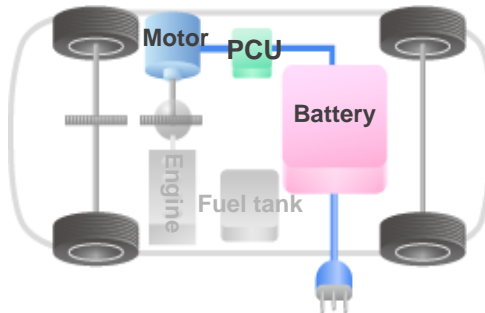




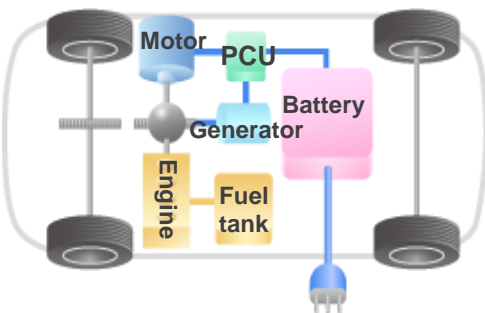
HV



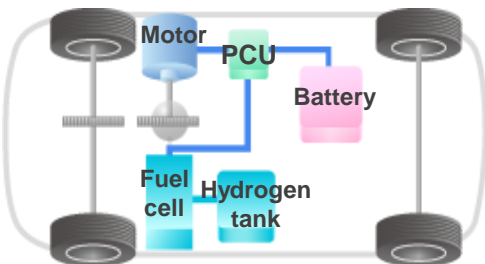
EV



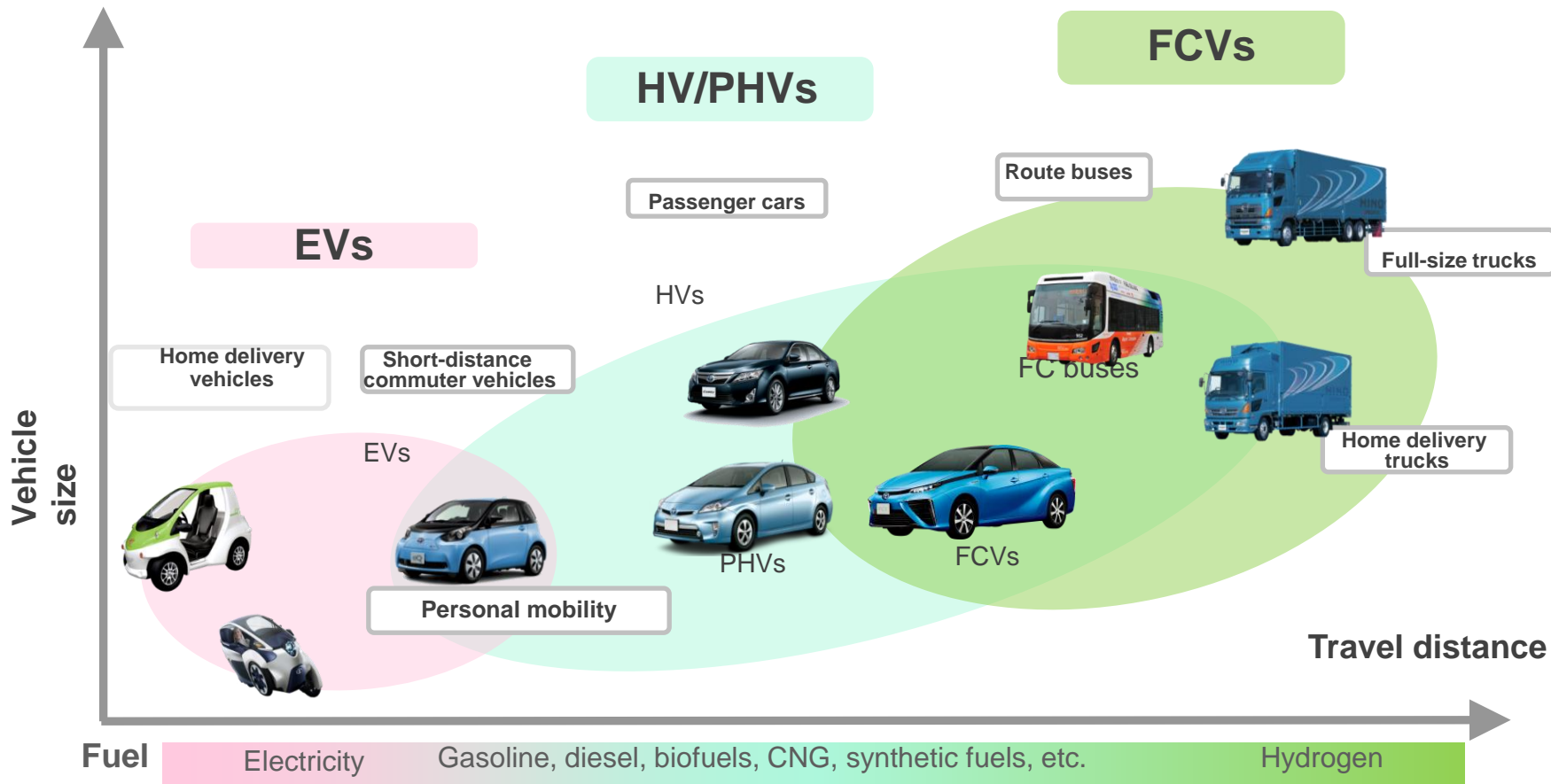
PHV



FCV



Hybrid technology as core technology including PHV, EV, FCV elements

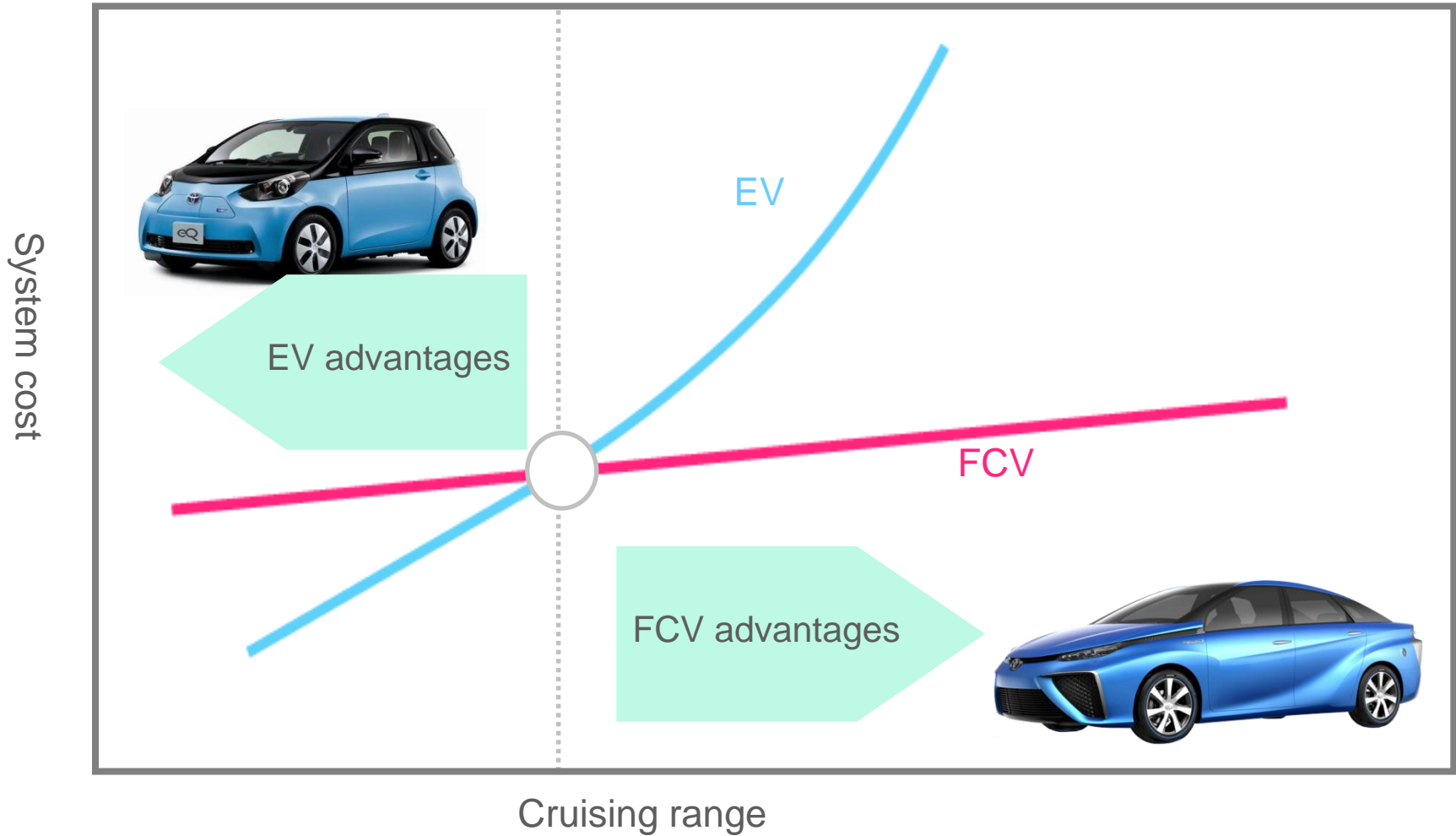


EVs: Short-distance, HVs & PHVs: Wide-use, FCVs: Medium-to-long distance



	Electricity EV	Hydrogen FCV	Biofuel Internal combustion engines	Natural gas Internal combustion engines
Well-to-wheel CO ₂	Poor to Excellent	Poor to Excellent	Poor to Excellent	Good
Supply volume	Excellent	Excellent	Poor	Good
Cruising range	Poor	Excellent	Excellent	Good
Fueling/charging time	Poor	Excellent	Excellent	Excellent
Dedicated infrastructure	Good	Poor	Excellent	Good

The strengths of individual alternative fuels
EVs are appropriate for short-distance commuting and fleet use
FCVs are for future zero emission main stream



FCV system's cost increase over long cruising ranges is rather small ➔ **Has advantages in mid-to-long ranges**



Energy diversification

- Hydrogen can be produced from various primary energy sources

Zero emissions

- Zero CO₂ emissions during driving

Driving pleasure

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



Performance

- Practical cruising range (Similar to conventional sized vehicle)
- Refueling time (approx. 3 min.)
- Cold-start capability (-30°C)

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

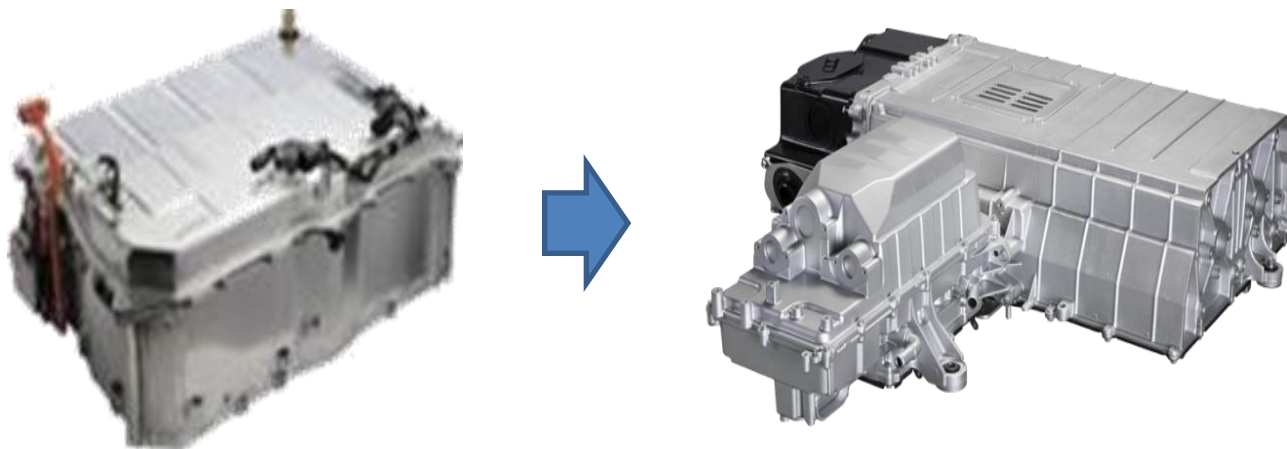


- Output power density:
Improved more than double
(Compared to TOYOTA FCHV-adv)

Top-level
Achieved 3.0kW/L

- Output power → More than 100kW

- Size reduction → Enabled under-seats layout



Realized performance improvement and size reduction of fuel cell system



- Tank storage density:[※]
Improved approx. 20%
(Compared to TOYOTA FCHV-adv)

※hydrogen storage per unit tank mass

Top-level!
Achieved 5.7wt%

- Decrease in number of tanks per vehicle from four to two

Reduced costs

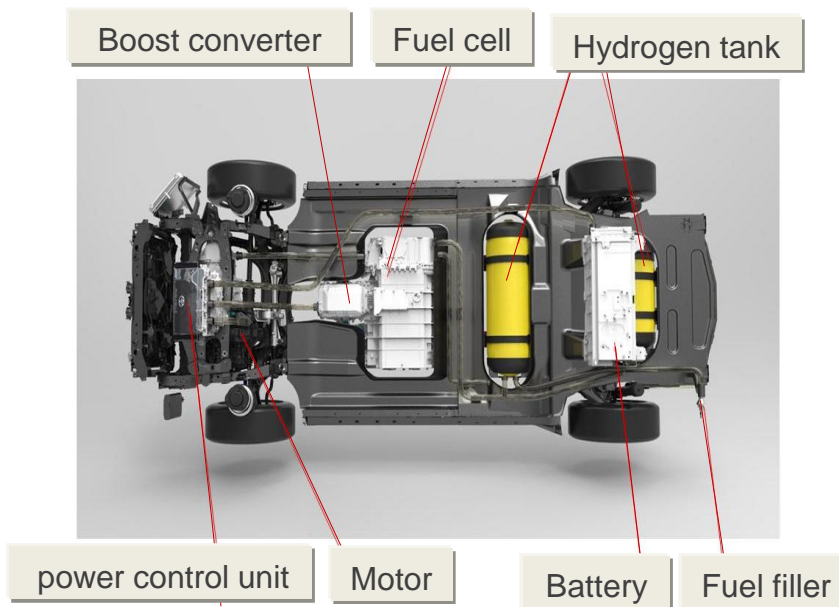
- Re-examination of material used and manufacturing process



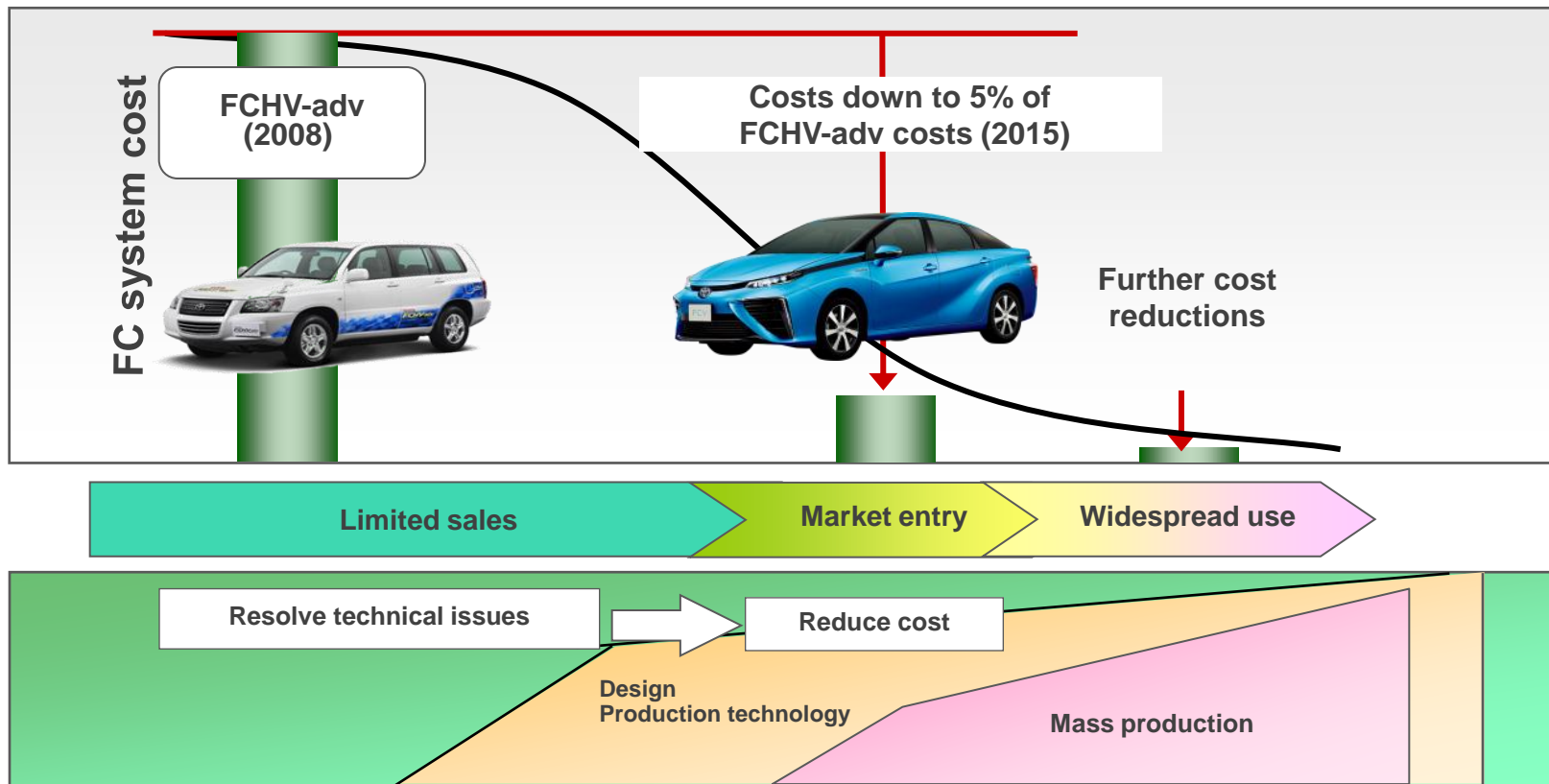
Realized performance improvement and cost reduction of high-pressure hydrogen tank



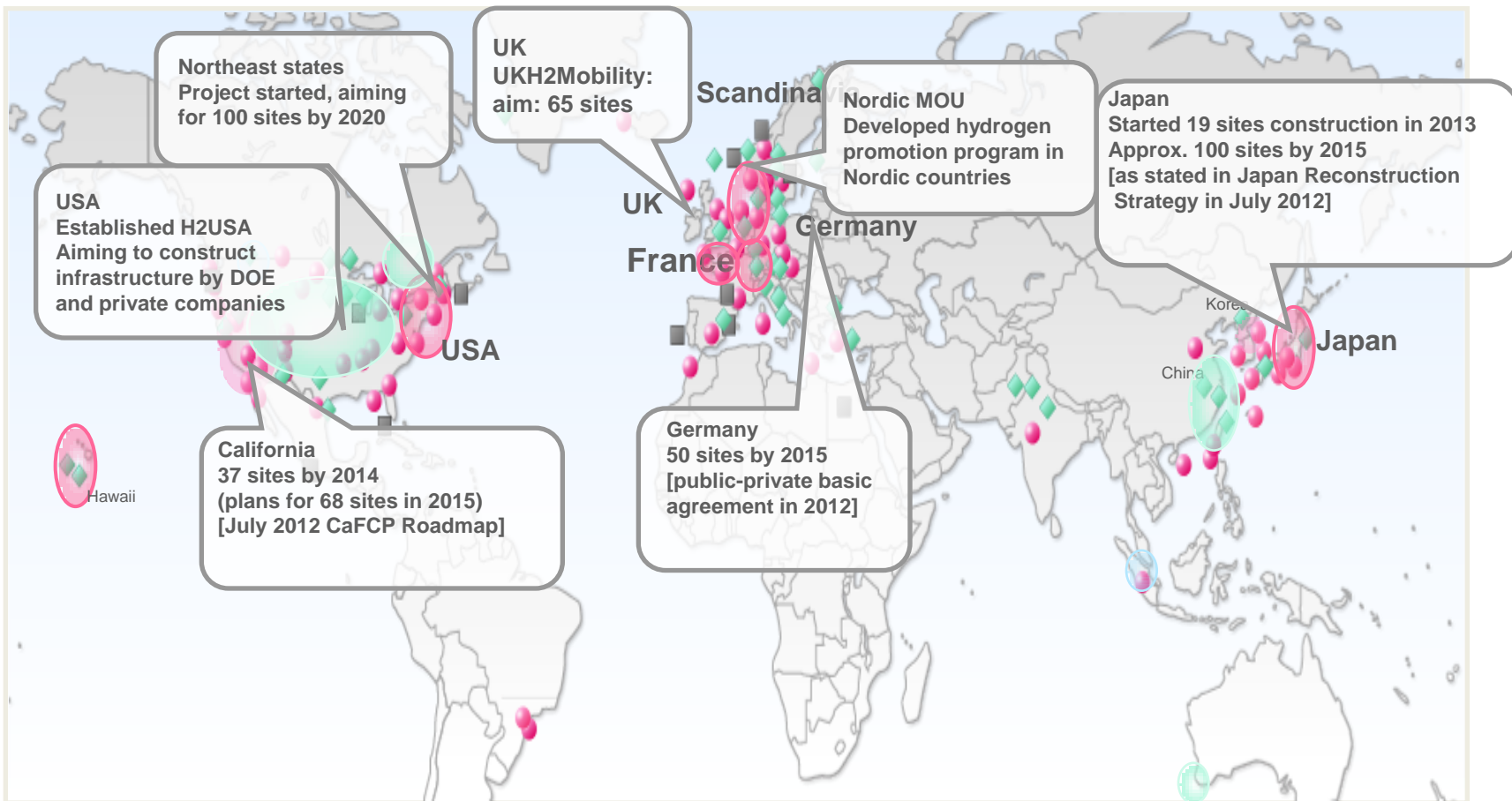
- Vehicle system efficiency 60% ➔ 65%
(Compared to TOYOTA FCHV-adv., LA#4 mode, Toyota measurement)
- No humidifier ➔ Enhanced reliability, reduced size, weight, and cost
- Adoption of boost converter ➔ Fewer number of cells, smaller motor



Aiming for further improvement toward its market introduction

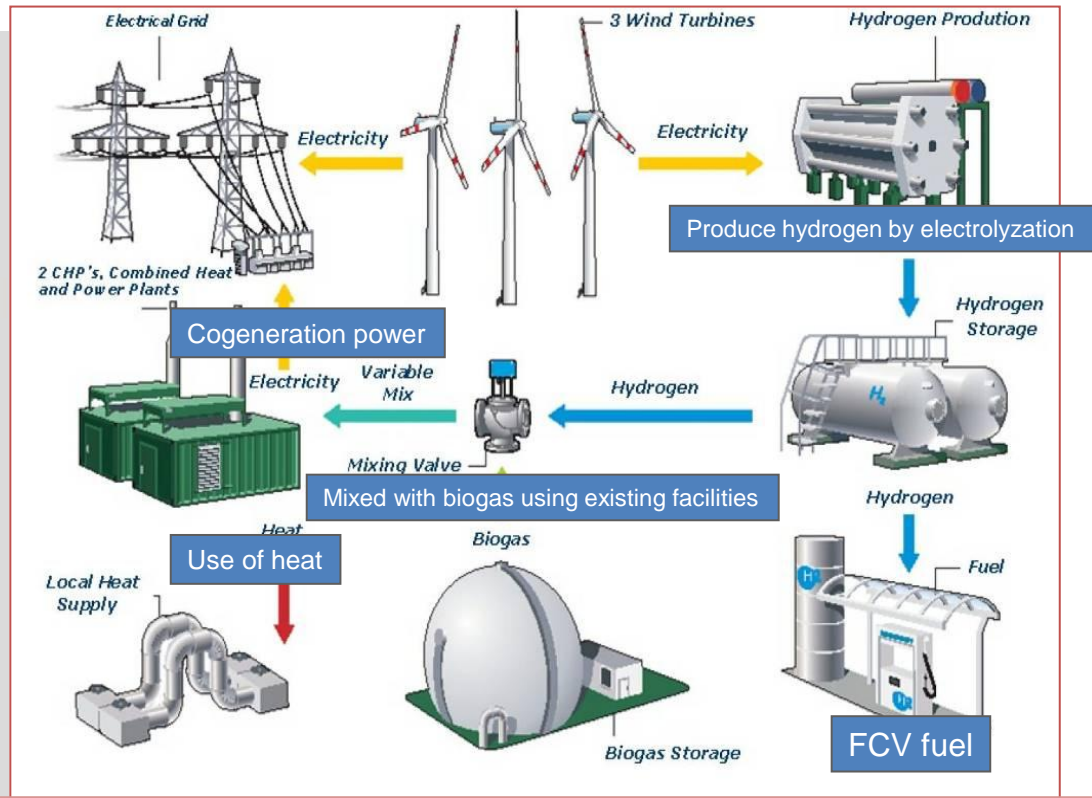
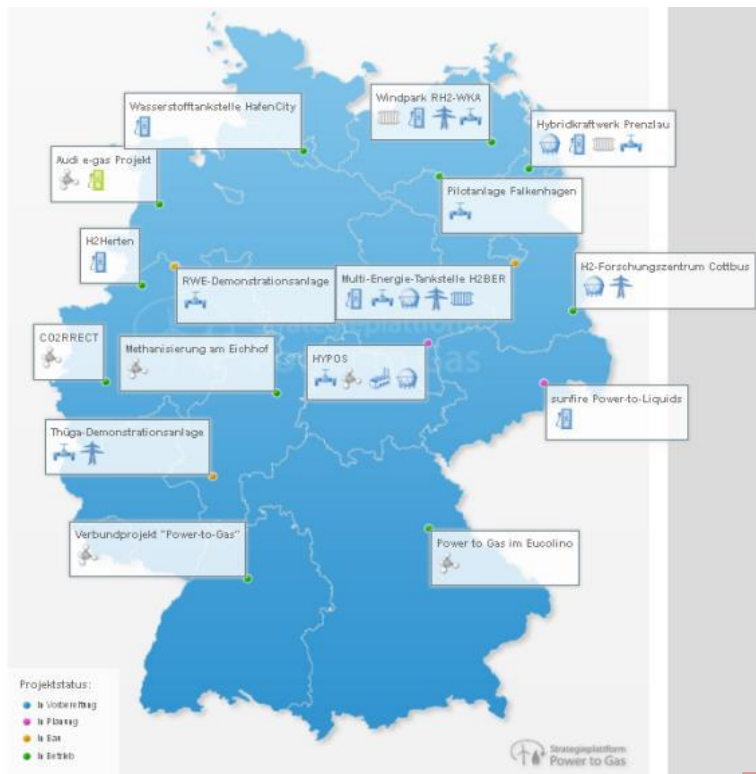


Fuel cell system costs have decreased significantly, and will continue to decrease.



- In operation
- Planned
- Areas where infrastructure development can be expected from early 2015
- Areas where infrastructure development can be expected after 2015
- Not in operation

Few hundreds of hydrogen stations are planned by 2015



i.e. Hydrogen made from wind power used for power generation and FCV fuel (Enertrag HP)

10 sites in operation, 6 sites under construction, 30 sites under planning (Based on CEP data)

Siemens focuses post nuclear power business.

It conducts as part of its approach to ex-electric power company shifting to general energy company.

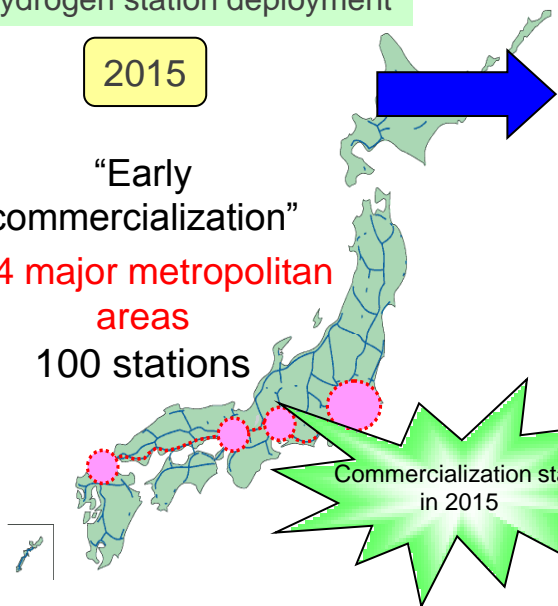
Germany has already started test programs using hydrogen combined to other renewable energies



1. Hydrogen station deployment

2015

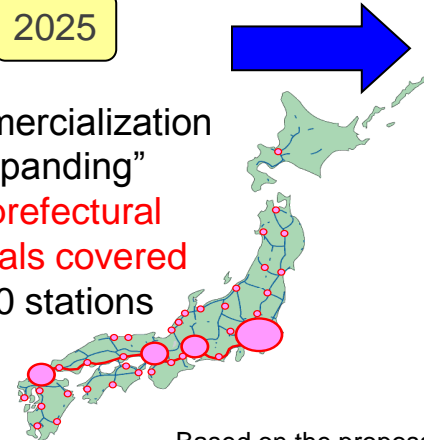
“Early commercialization”
In 4 major metropolitan areas
100 stations



Commercialization start in 2015

2025

“Commercialization expanding”
47 prefectural capitals covered
800 stations



from 2030 onward

“Mass commercialization”
Nation-wide hydrogen net established
5,000 stations



Based on the proposal of Council of Competitiveness-Nippon (COCN)

2. Station technology development



Example of container-type low cost station (Linde, Germany)

3. Regulation review

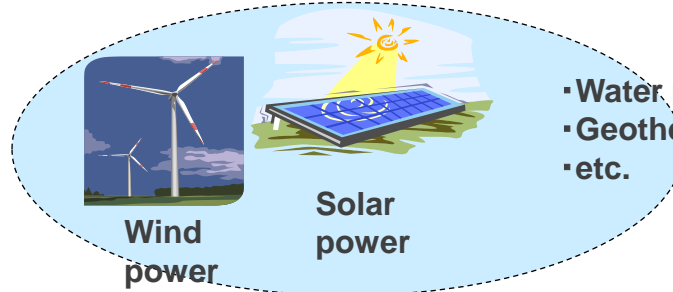
“Action plan for regulation review” was announced in Dec 2010.



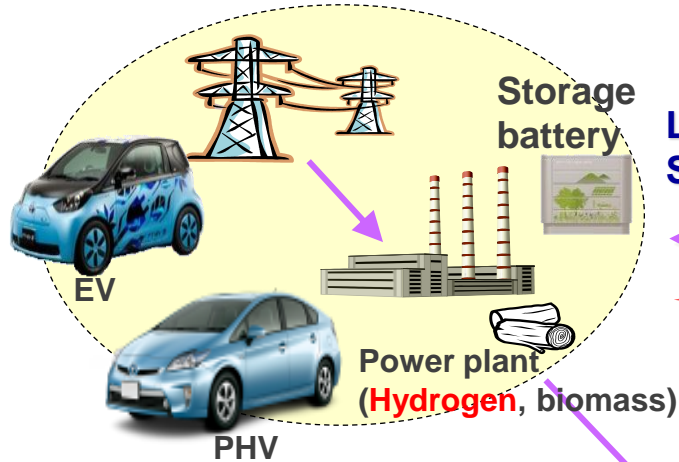
- Material standards
- Pressure standards
- Accumulator structure
- Adjacent stations
- Periodic inspection method
- Self-service stations, etc.

It is necessary to solve these three issues for hydrogen station establishment.

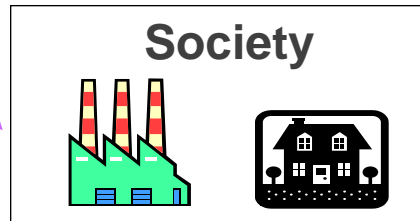
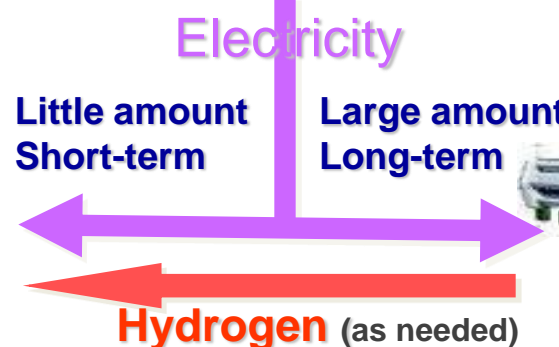
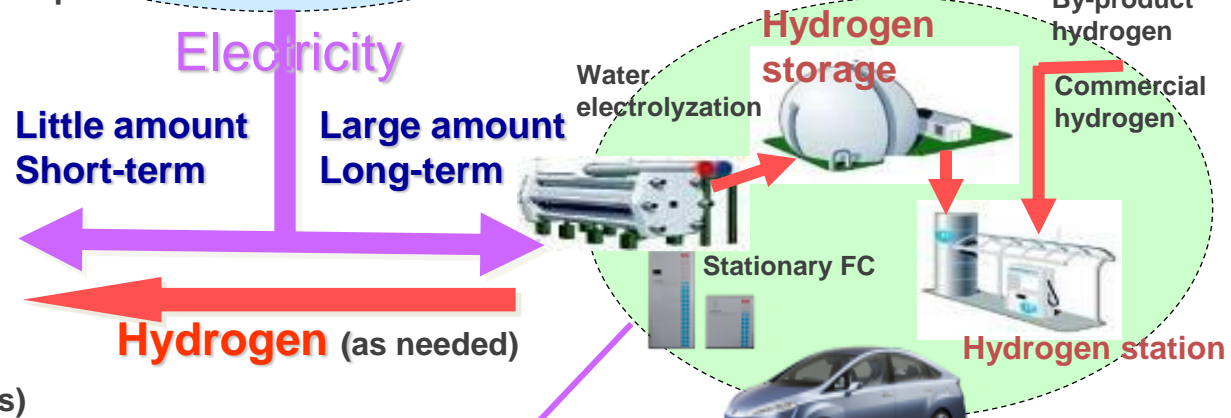
Renewable energies



Electricity grid



Hydrogen grid



Hydrogen grid: Store or transfer hydrogen derived from renewable energies
 → Utilization of "HyGrid", integration of electricity grid and hydrogen grid, enables optimization of total energy use for society.





Timing

<Japan> Sales start before April 2015

<US & EU> Preparations are underway for launches in 2015

Sales Channel

**<Japan> Through Toyota dealers and Toyopet dealers in Japan
(Deploy where hydrogen stations are expected to deploy)**

<US & EU> Have not yet been decided

Price

<Japan> Around 7M yen in Japan

<US & EU> Have not yet been decided



Hybrid technology as core technology to correspond energy saving and fuel diversification

Next-generation eco-friendly cars should be used depending on its powertrain and fuel characteristics

Combine next-generation eco-friendly cars and electricity and hydrogen grid enables efficient use of renewable energies



- Hybrids have paved the way for electrified powertrains. Hybrid technology will continue to play a key role in electrified powertrains.



- FCV represents Toyota's long-term goal of fostering a sustainable mobility society.

Toyota has always pushed boundaries.

Our ideas are revolutionary at the time,
but eventually they become “the norm”.



TOYOTA