

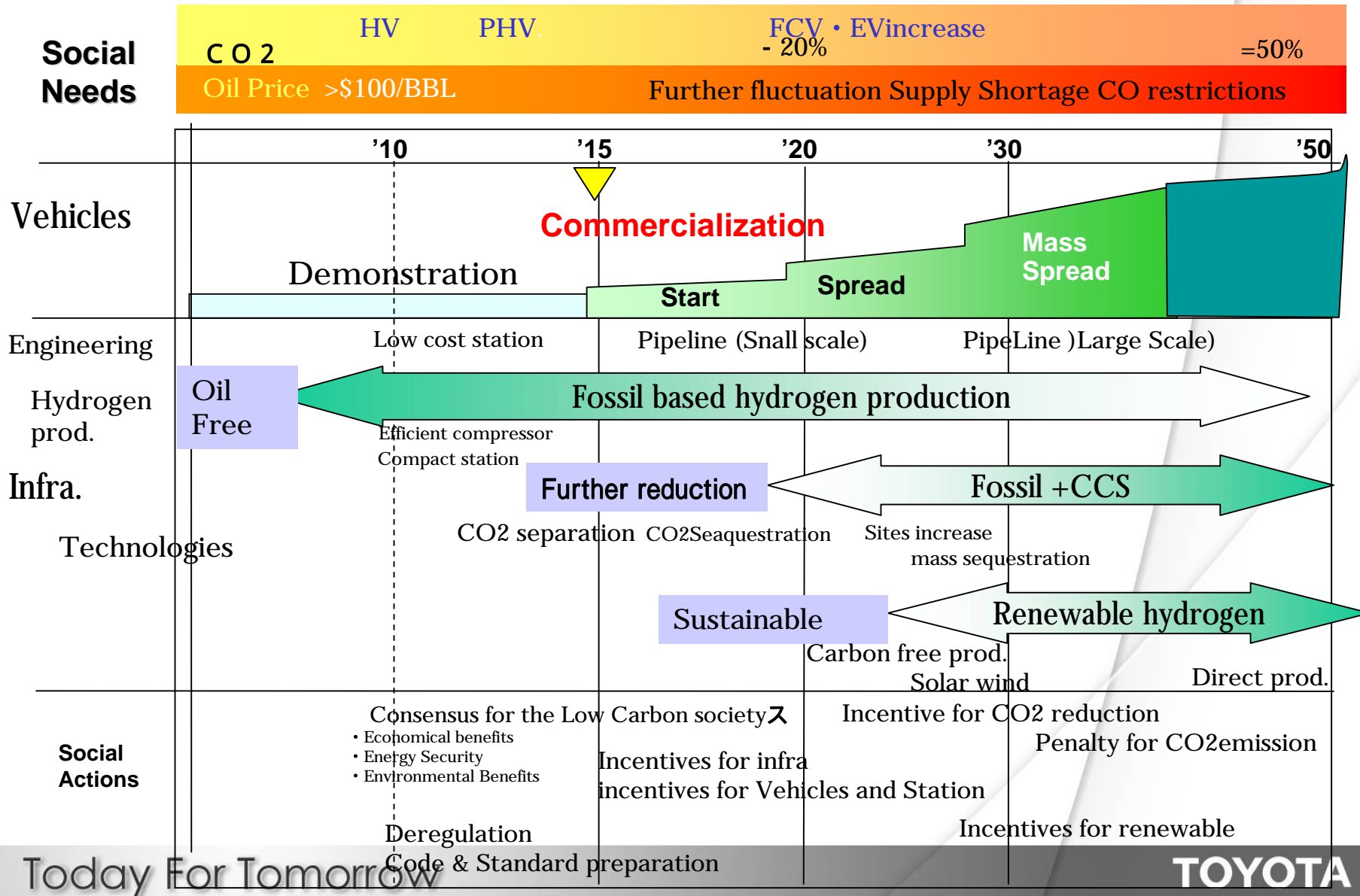
Hydrogen as Fuel for Today and Tomorrow

Progress and Challenges of Hydrogen Fuel Cell Vehicles for 2015 Commercialization

Katsuhiko HIROSE
Toyota Motor Corporation

Hydrogen vision

Key Words Energy security: Oil Free Electricity/Hydrogen Sustainable Society
 Global Warming: Carbon free



Today For Tomorrow

TOYOTA

What we learned from Prius

First Prius Oct1997



Today For Tomorrow

TOYOTA

First Official Prius Prototype did not work

- Predevelopment Small number of predevelopment
 - **Well Shared concept and language**
- Serial production prototype
 - Huge number of engineers from different division had to work together
 - Wording and concept are difficult to be shared
 - Share the terminology and concept
 - **Recognize**
 - **Human hybridization is the most important part**

Pre-Prius development

Engine development

Transmission development

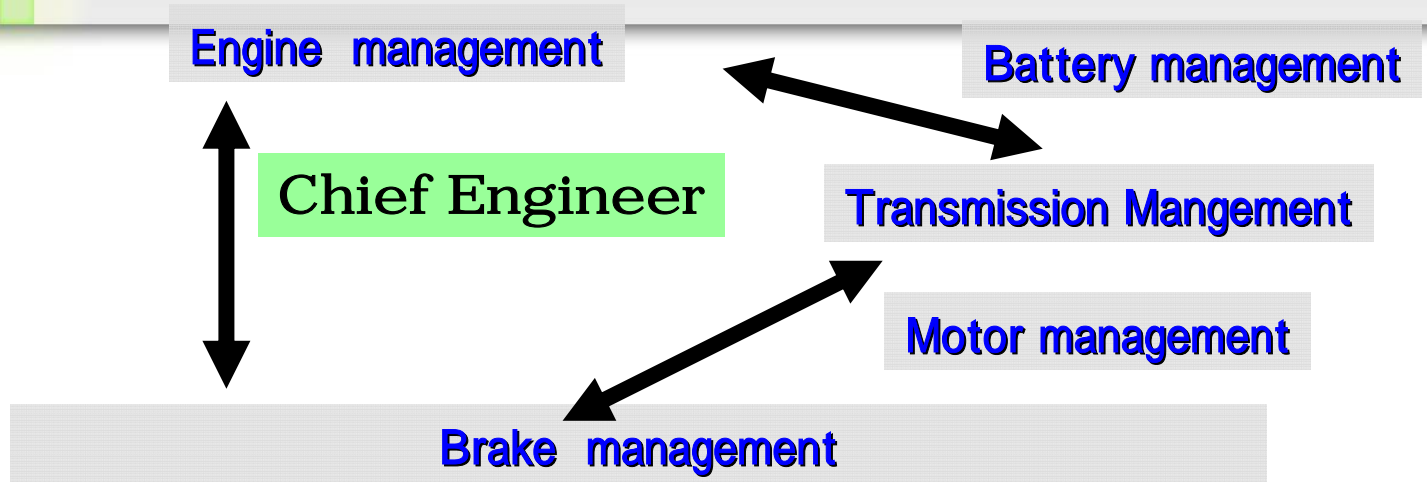
Brake development

Chief Engineer

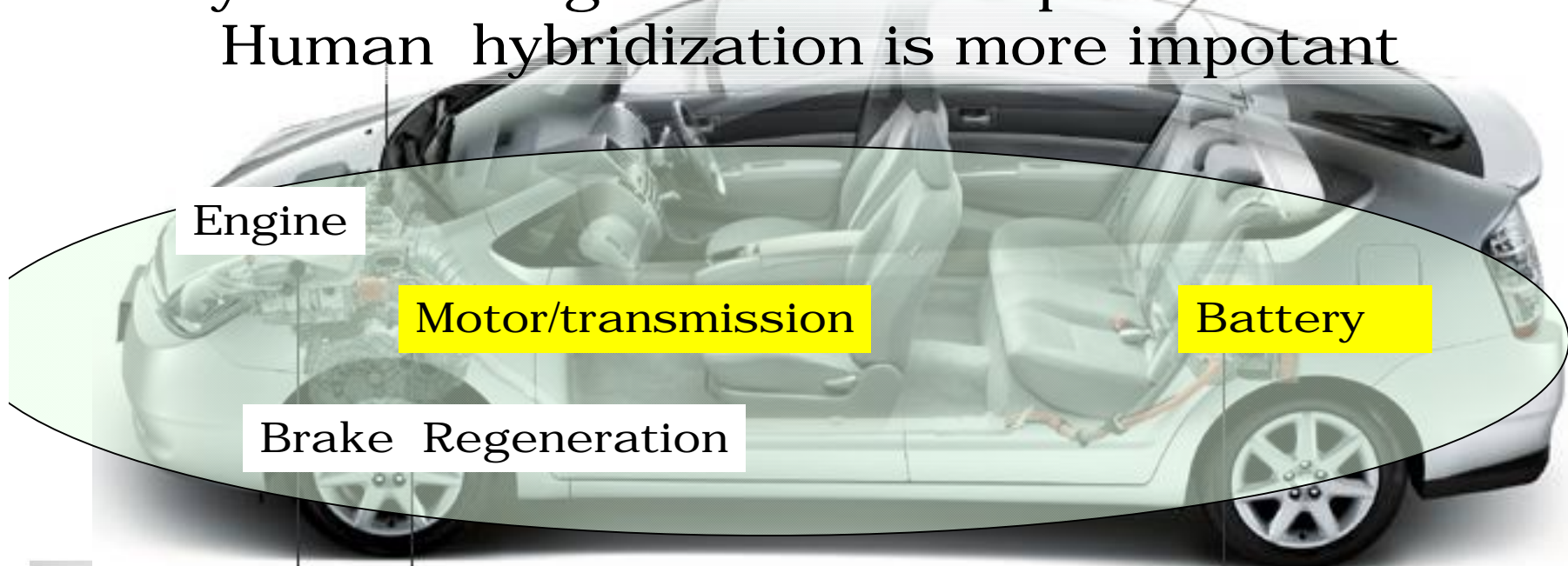
Interpretation among division



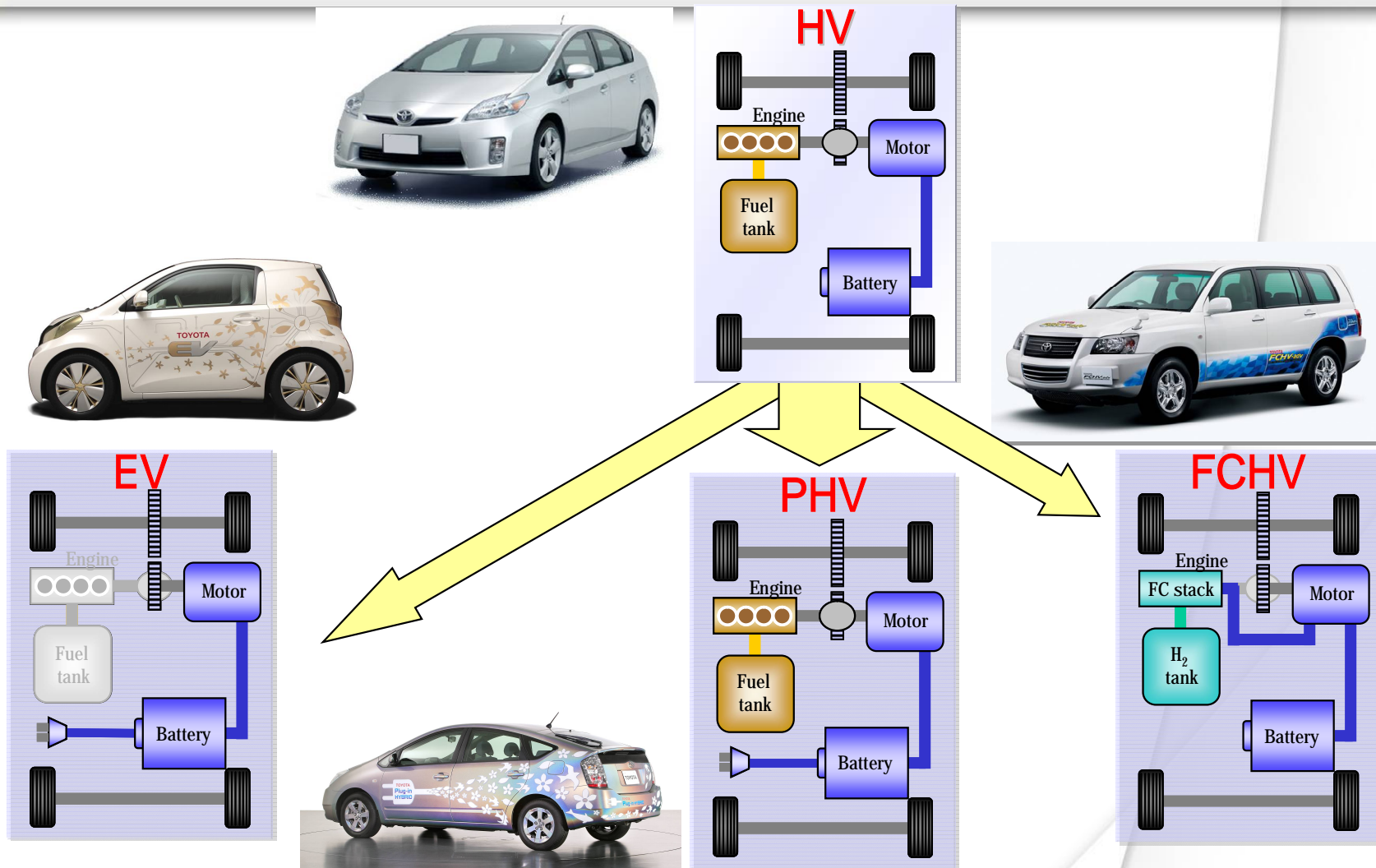
After-Prius



Hybrid Management Development
Human hybridization is more impotent



Response to Environmental and Energy Issues



Using hybrid technology for PHV, EV, and FCHV

What are created by Prius

- **Hybridization**

- Hybrid as a technology to extend to the new vehicles applications

+ Battery = PHV

– Engine + Large Battery = EV

– Engine + FuelCell + HydrogenTank = FCHV

What Prius Brought to US

Prius created a new idea of hybridization

New idea is created by the hybridization of the human being

What Prius Brought to me?

- **Small Dream's Realization is not easy.**
- **Big Dream is easier to make True**

Reason Why?

What Hydrogen Means to You?

Hydrogen from Economic Side

Global Automotive Value Chains 2004

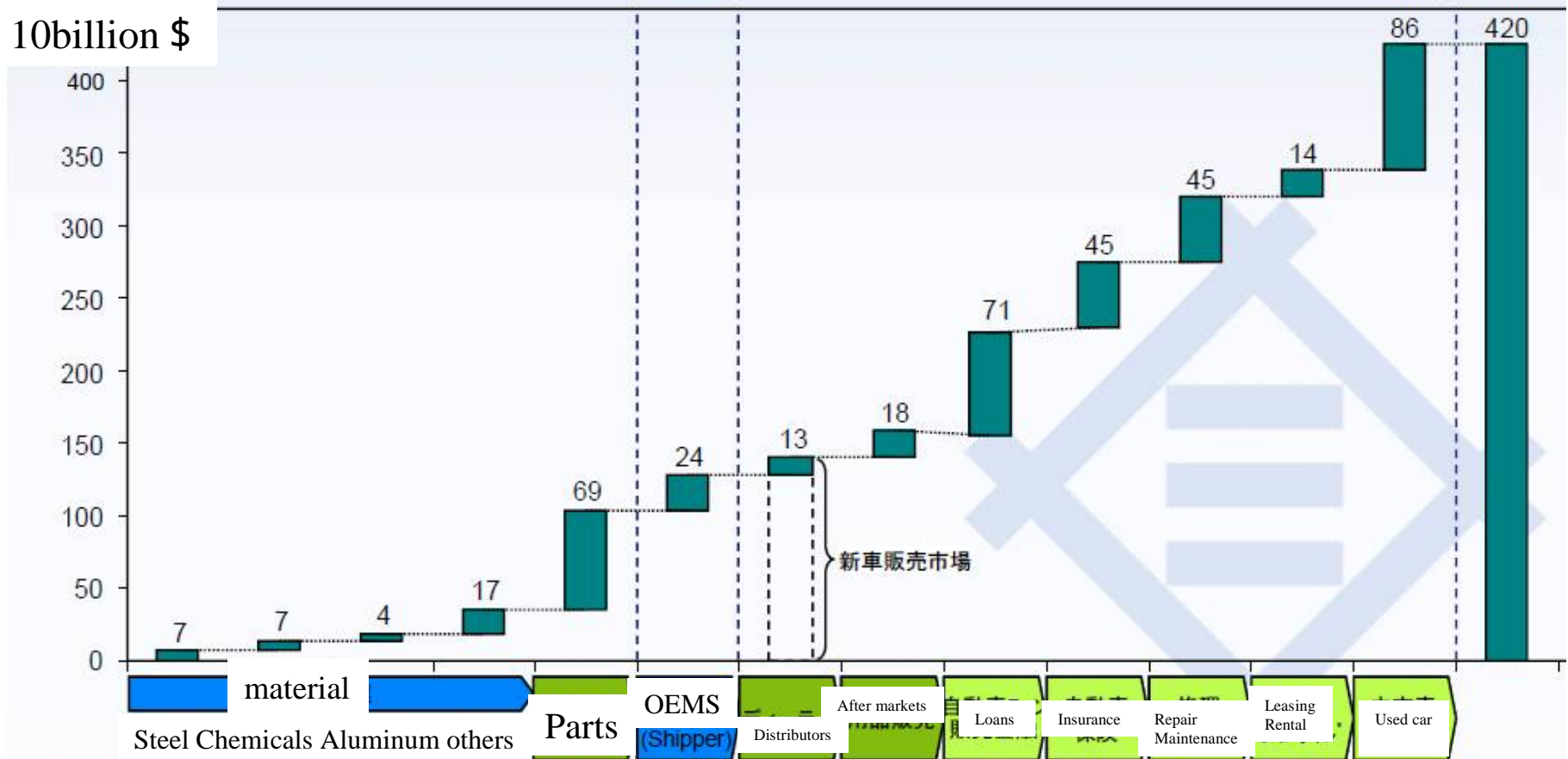
- 自動車産業バリューチェーン:自動車産業の市場配分構造(2004年度時点)

Upstream 1040B\$

川中
24兆円
(6%)

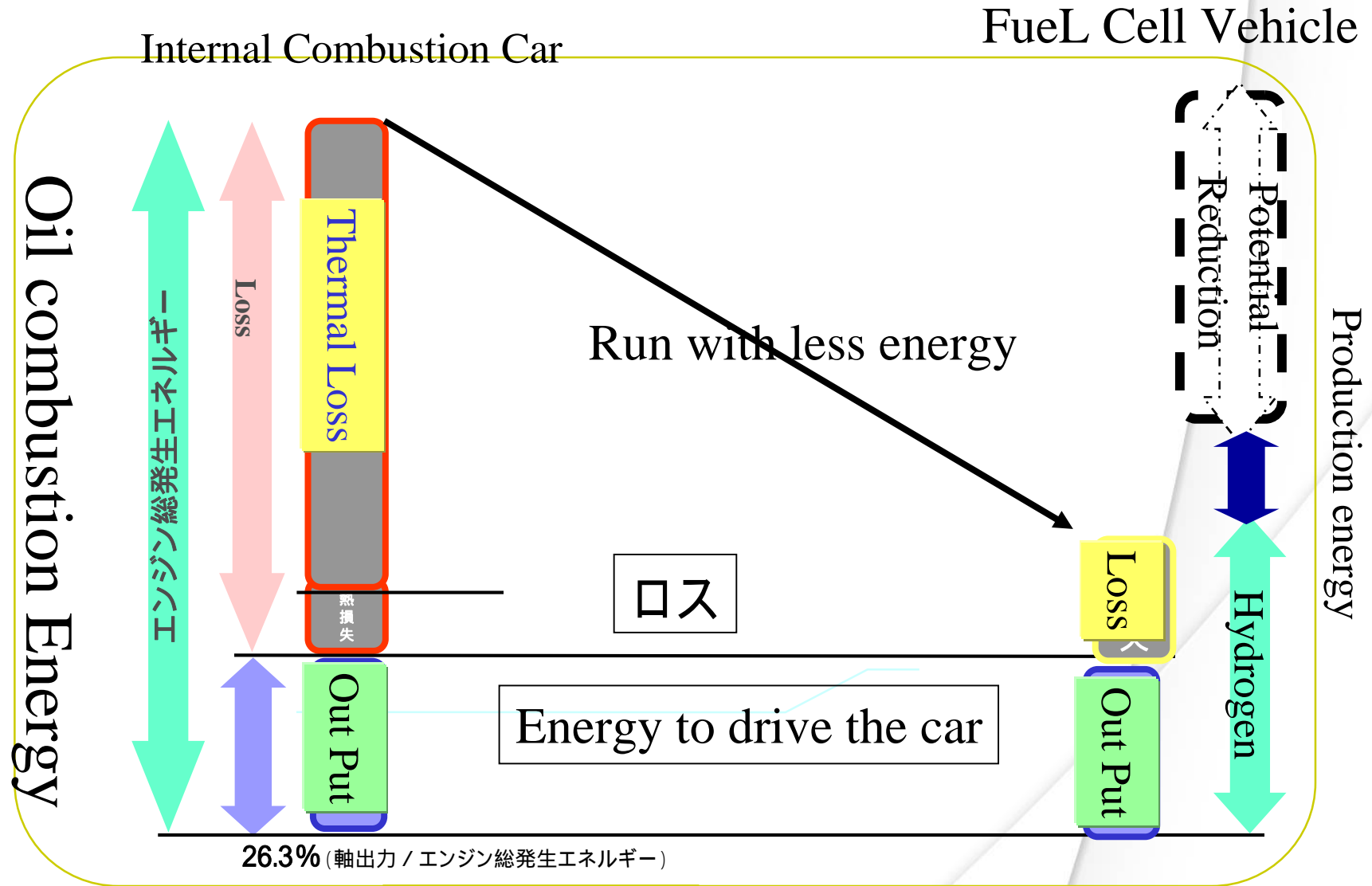
Down Stream 2090 B\$

10billion \$



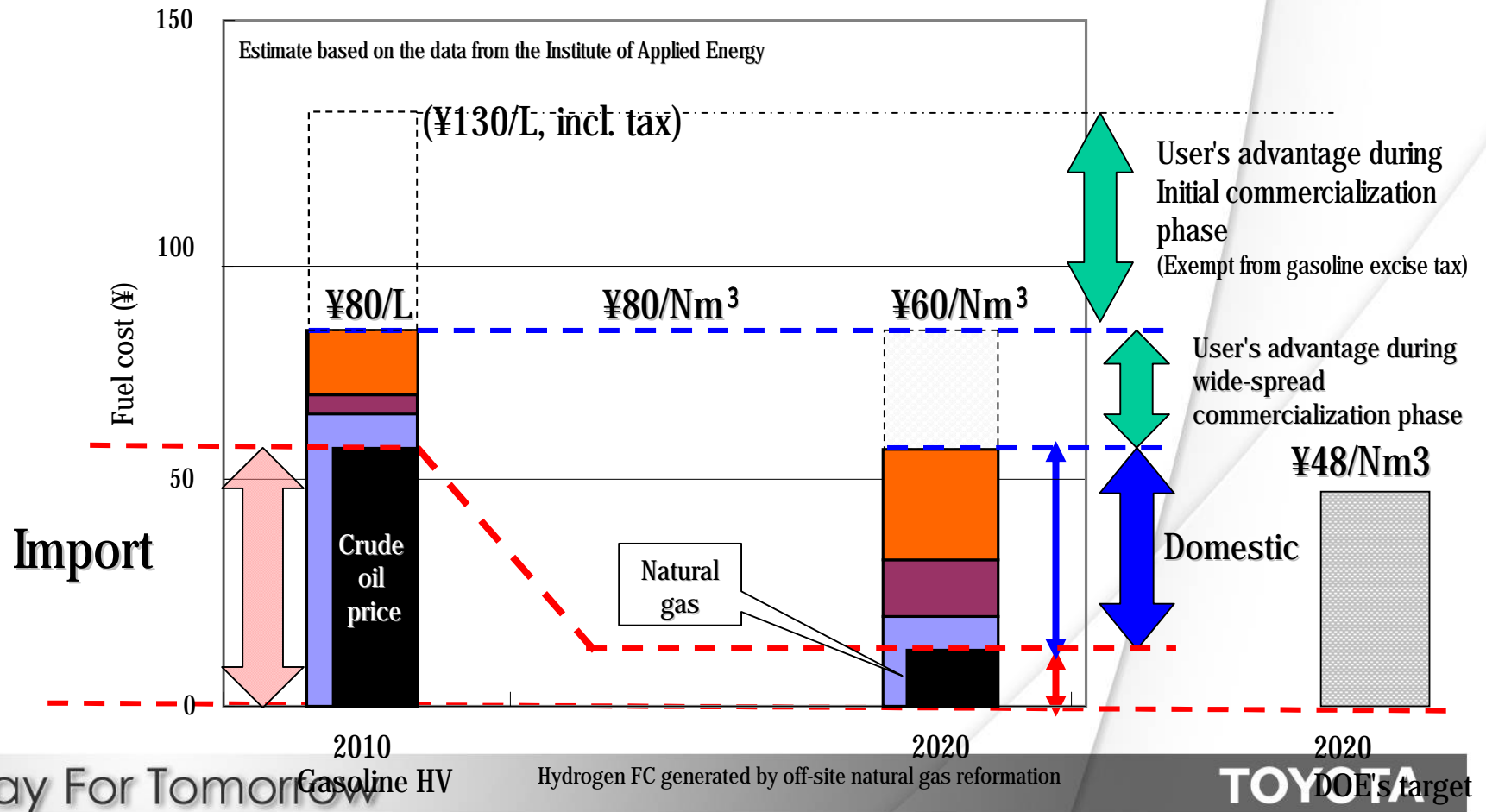
出典:BCG分析

High efficiency of Fuel Cell

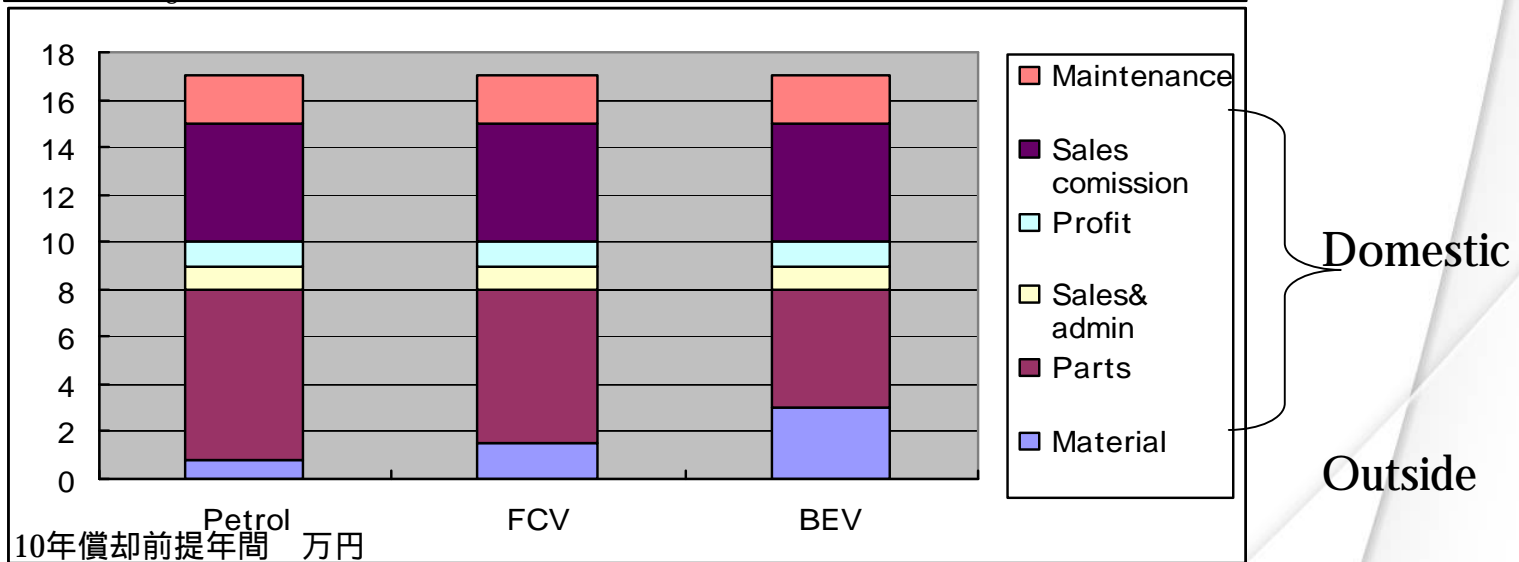
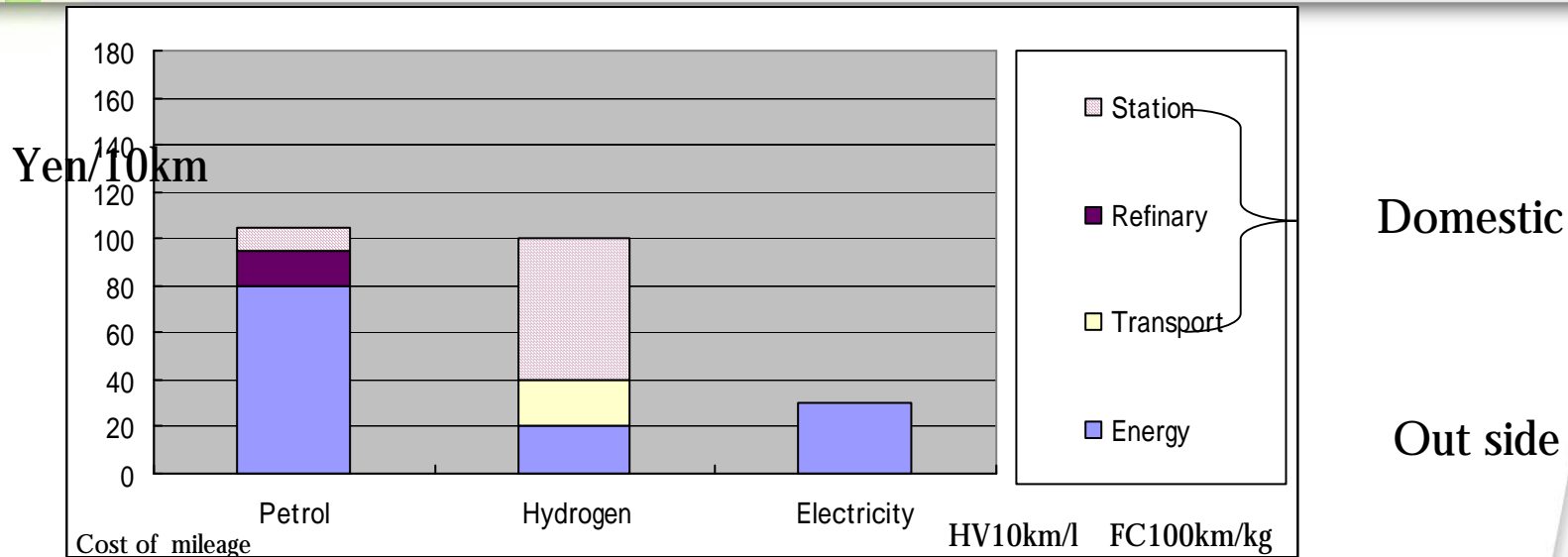


Compared to gasoline HV,
 1. Hydrogen price: **Advantageous for FCV users.**
 2. **Cash flow into foreign countries** in hydrogen: **Small**

Fuel cost to drive FCHV-adv for 10km (real world) (excluding tax)

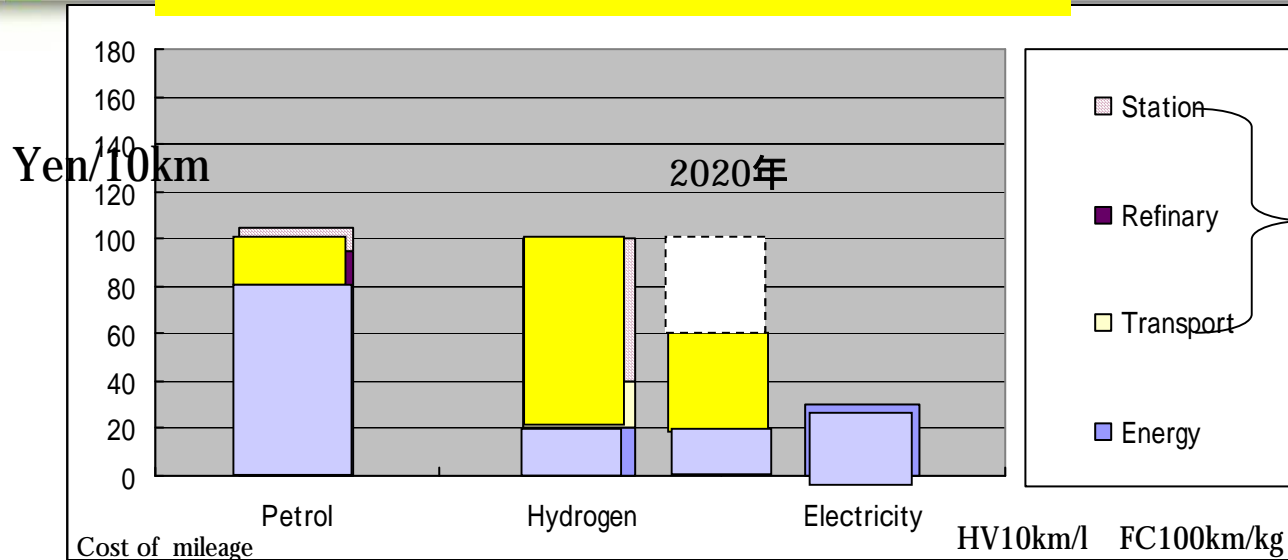


Value chain analysis



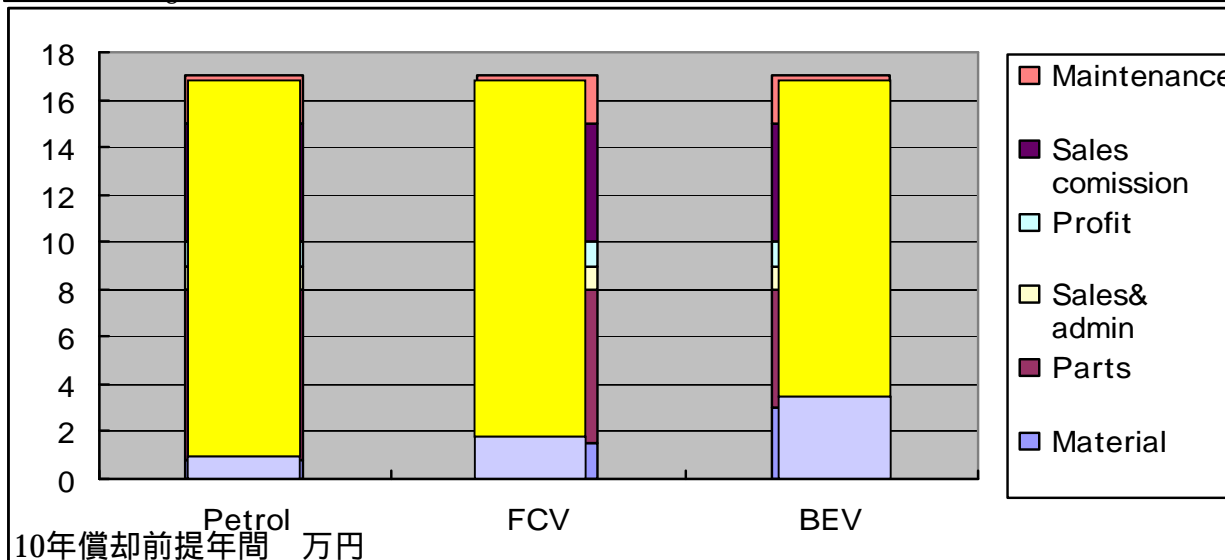
Condition Same price same total cost

Value chain analysis



Domestic

Out side

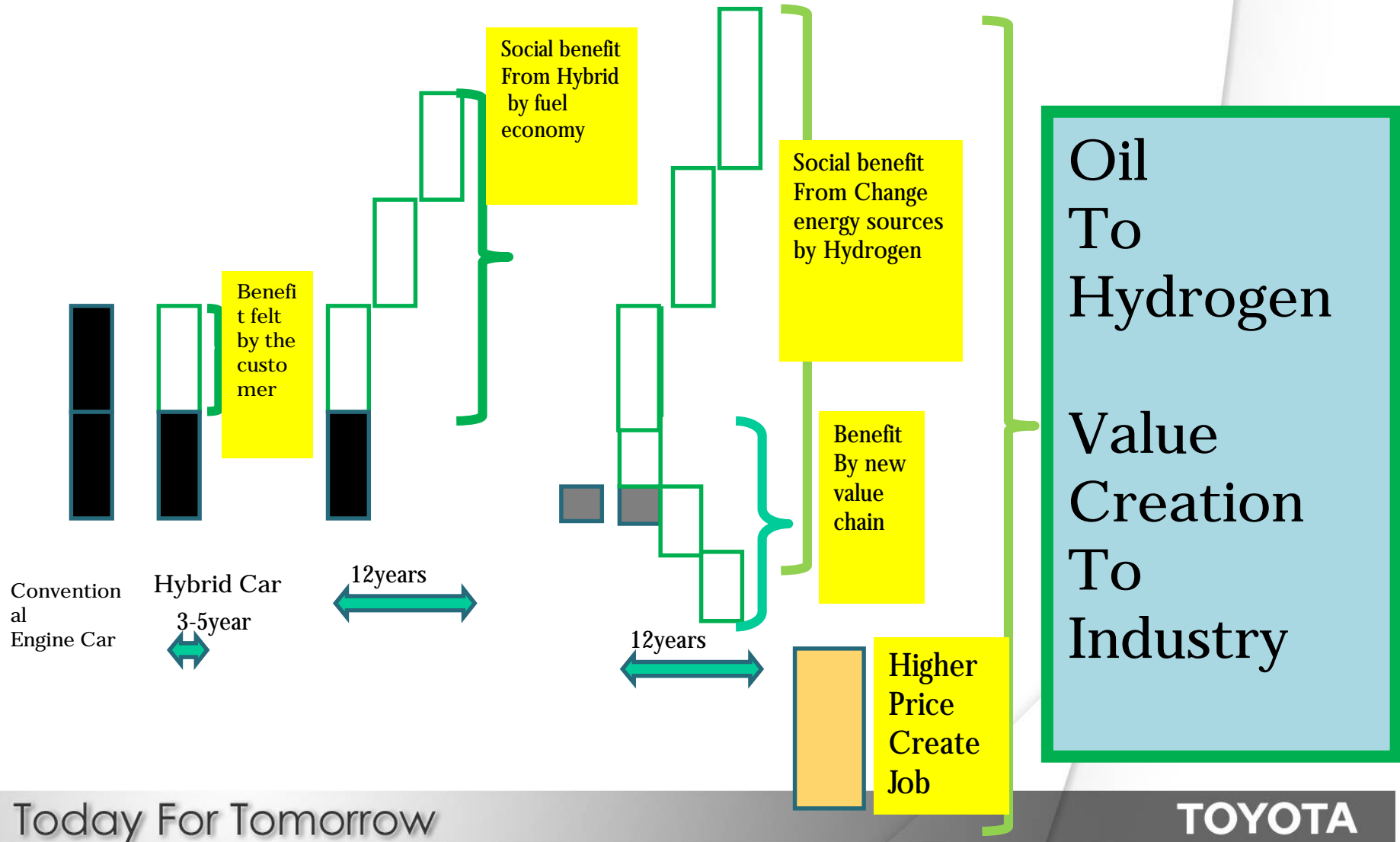


Domestic

Outside

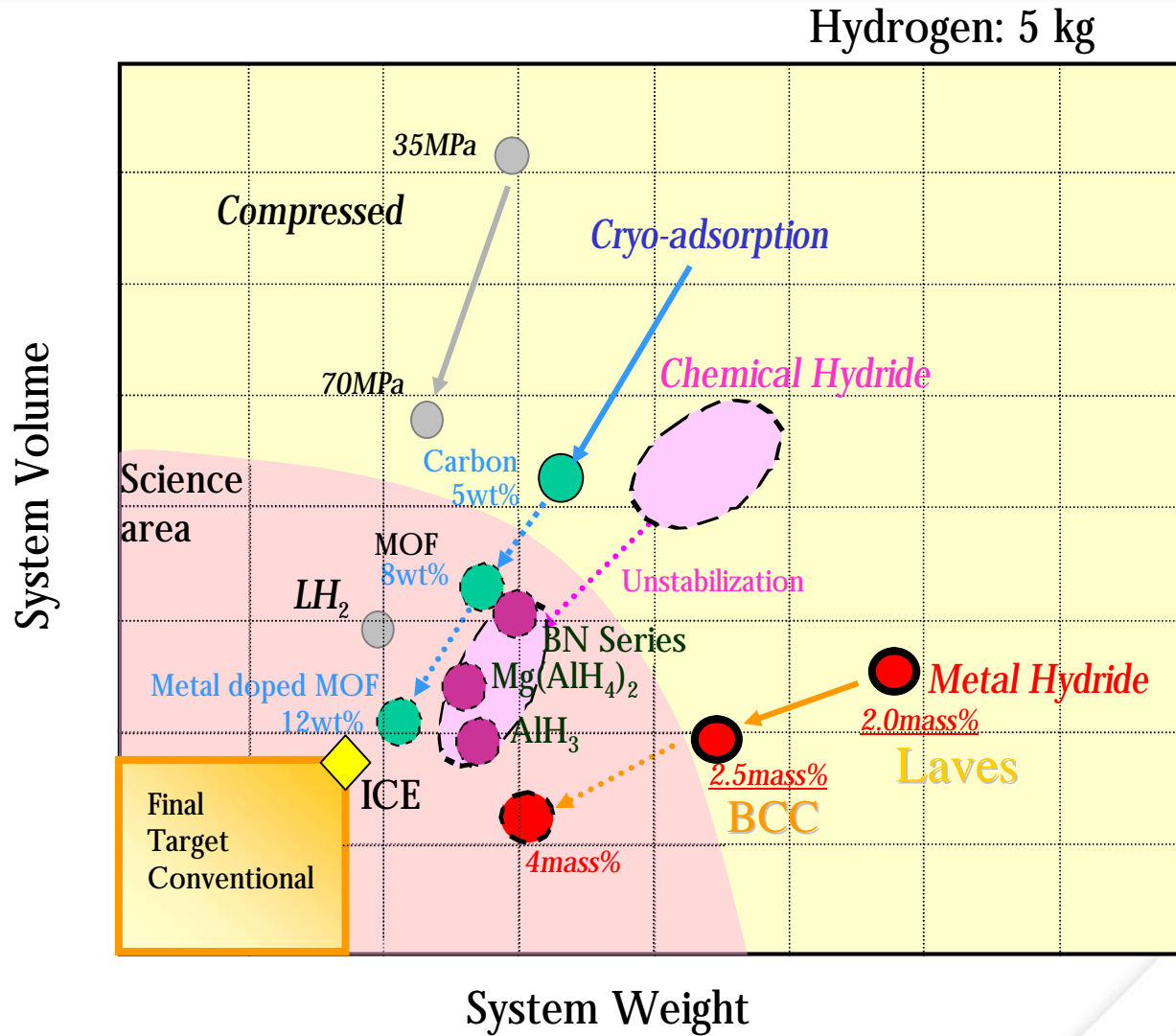
Condition Same price same total cost

Alternative Car in Economical View



- Hydrogen gives economical benefit.

Hydrogen Storage Technologies



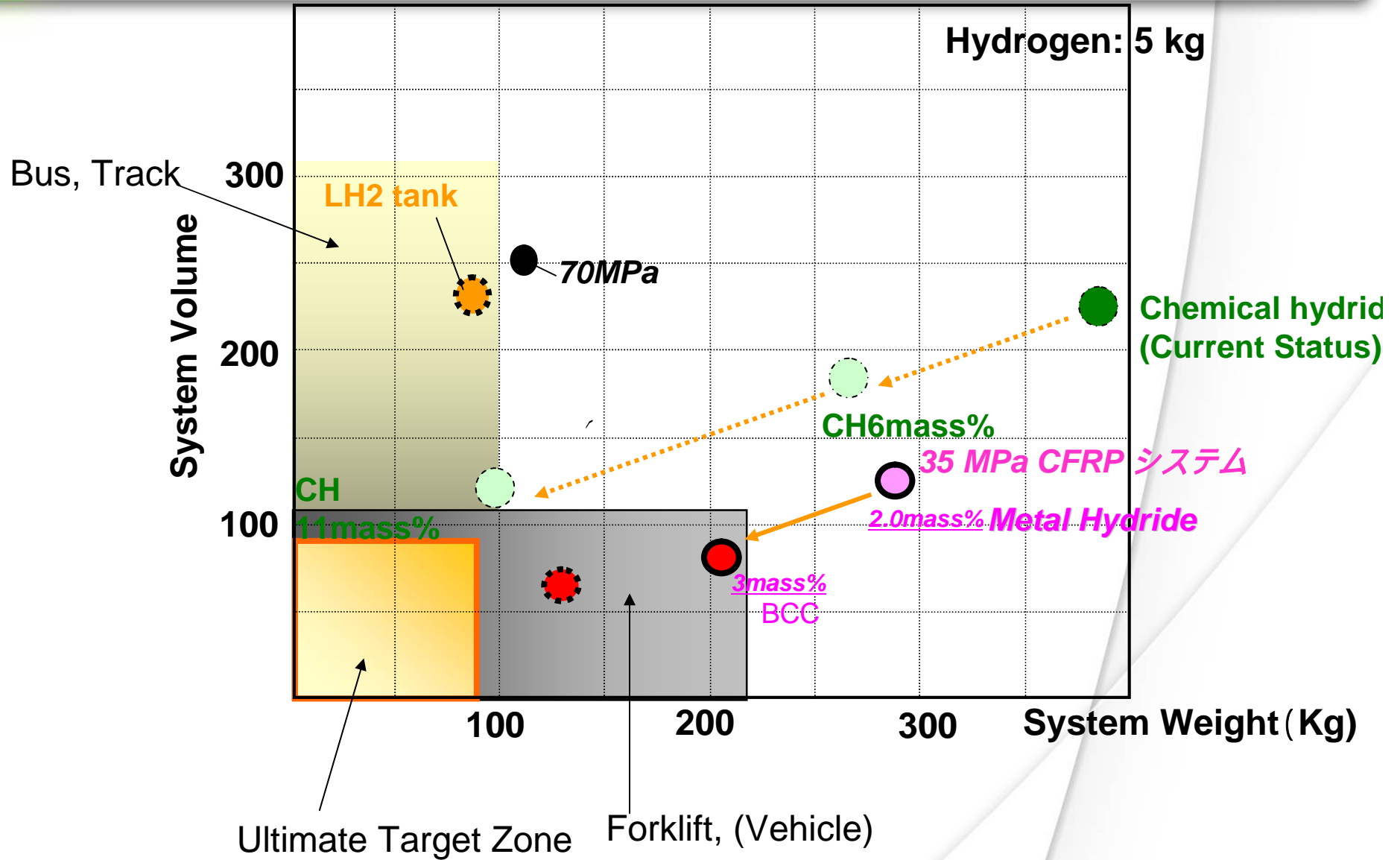
Important message

22

- Thank you for the effort on hydrogen storage works.
- Understanding and challenges have not reached the engineering stage.
- Car manufacturers decided to use 70MPa CFP tank for the 2015 commercialization.

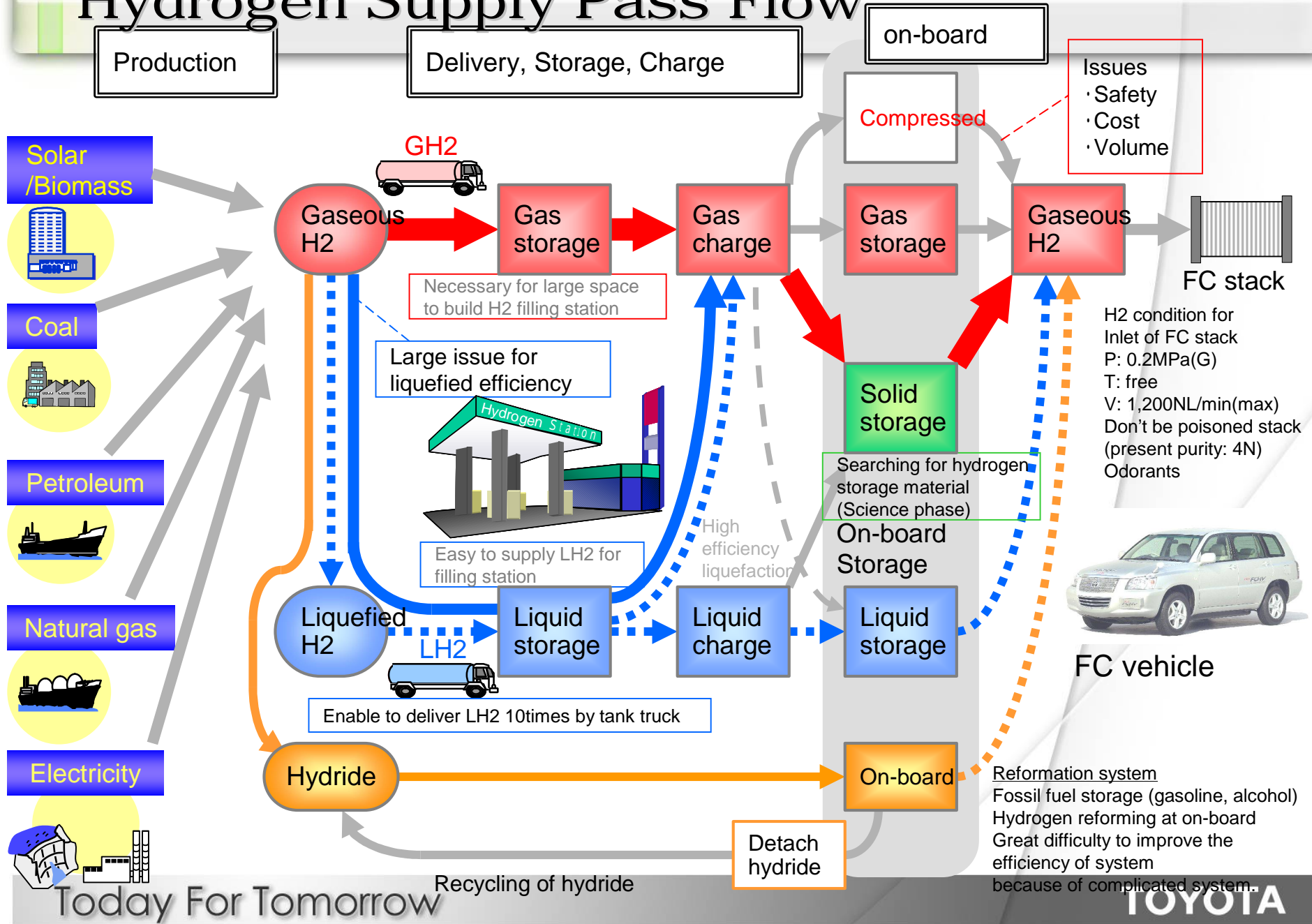
- Next step
- Scientists and Engineers must communicate to accelerate development into the right directions.

TMC Estimation of Hydrogen Storage System



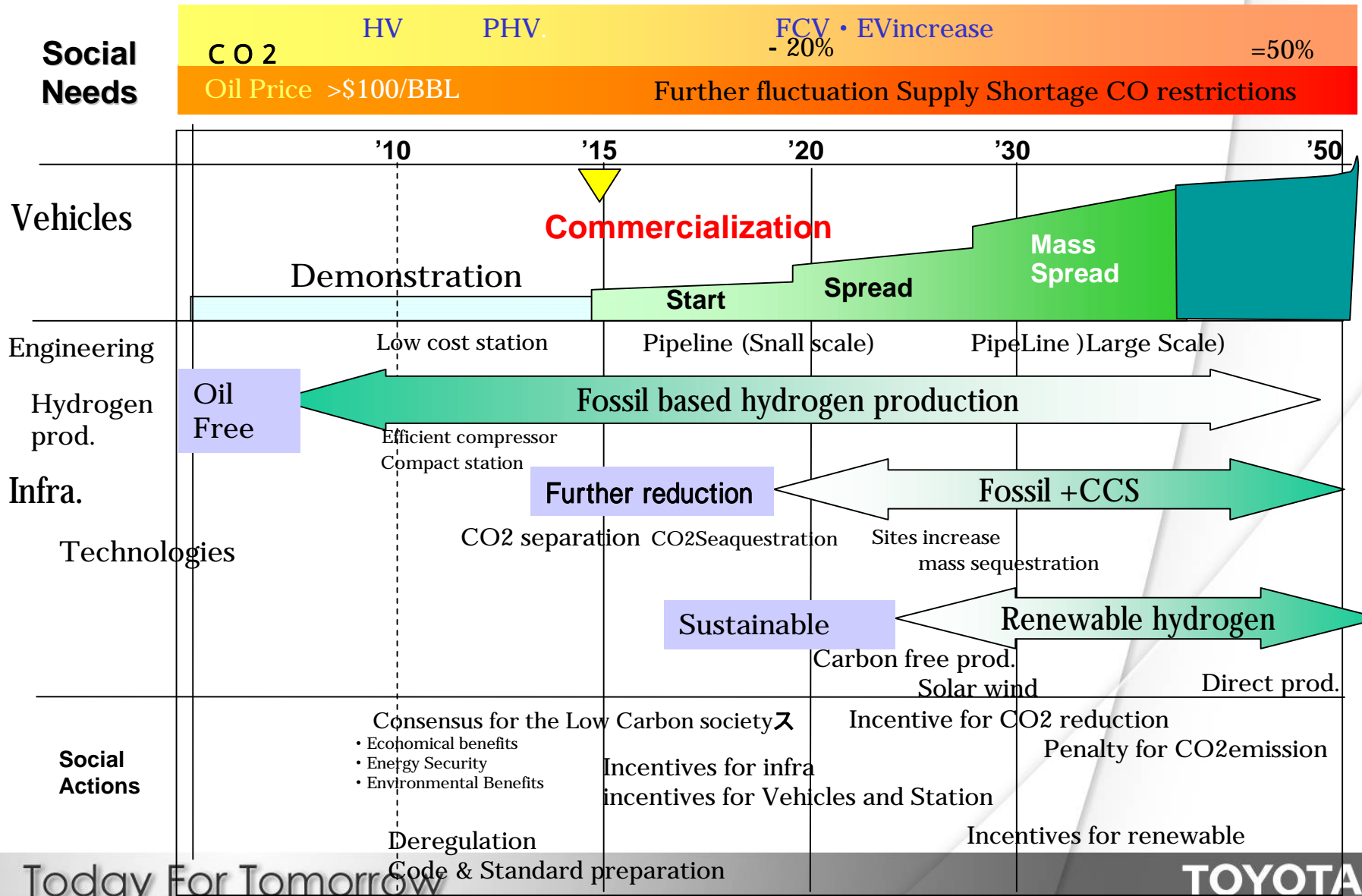
System estimation tools

Hydrogen Supply Pass Flow



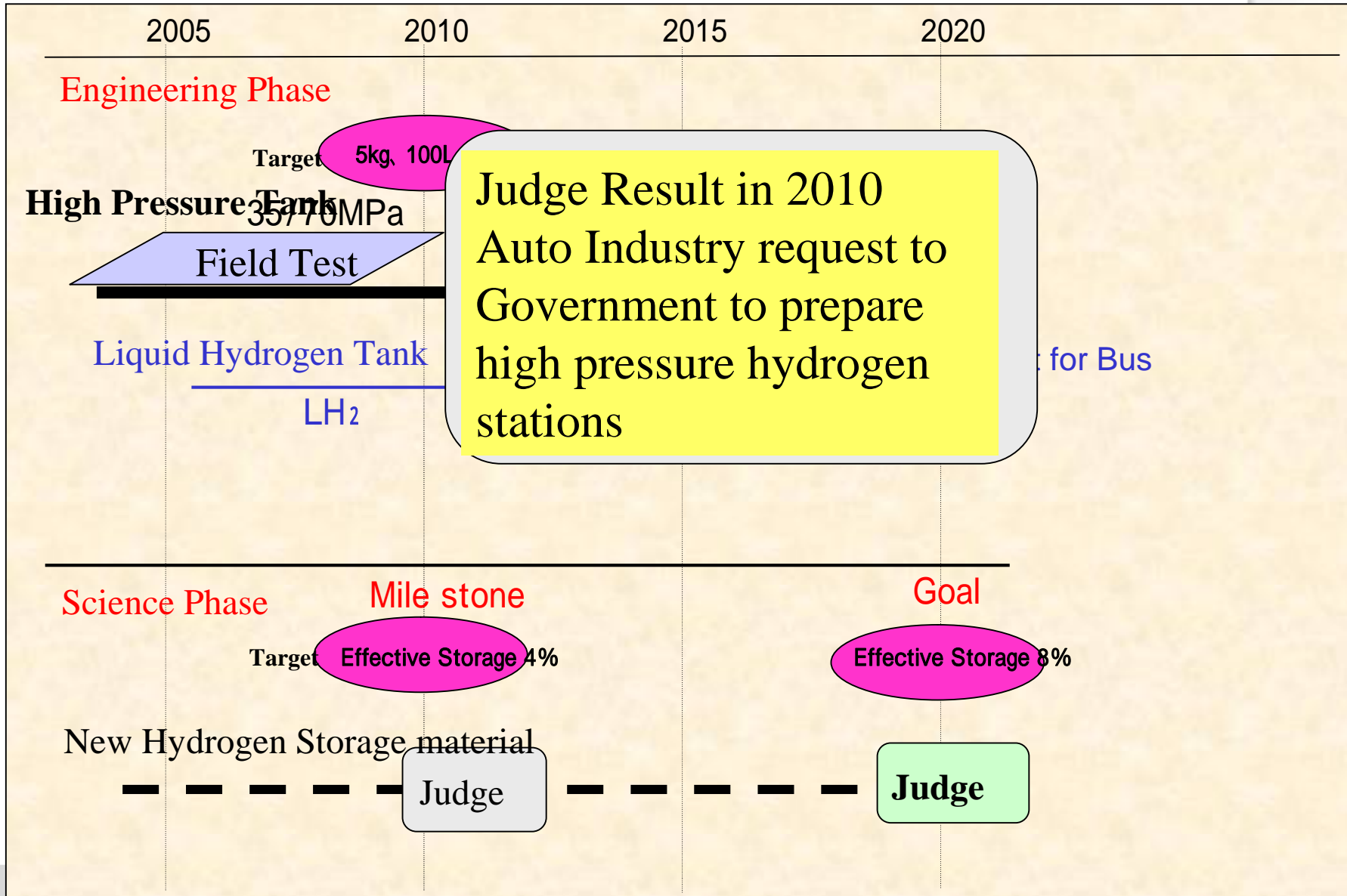
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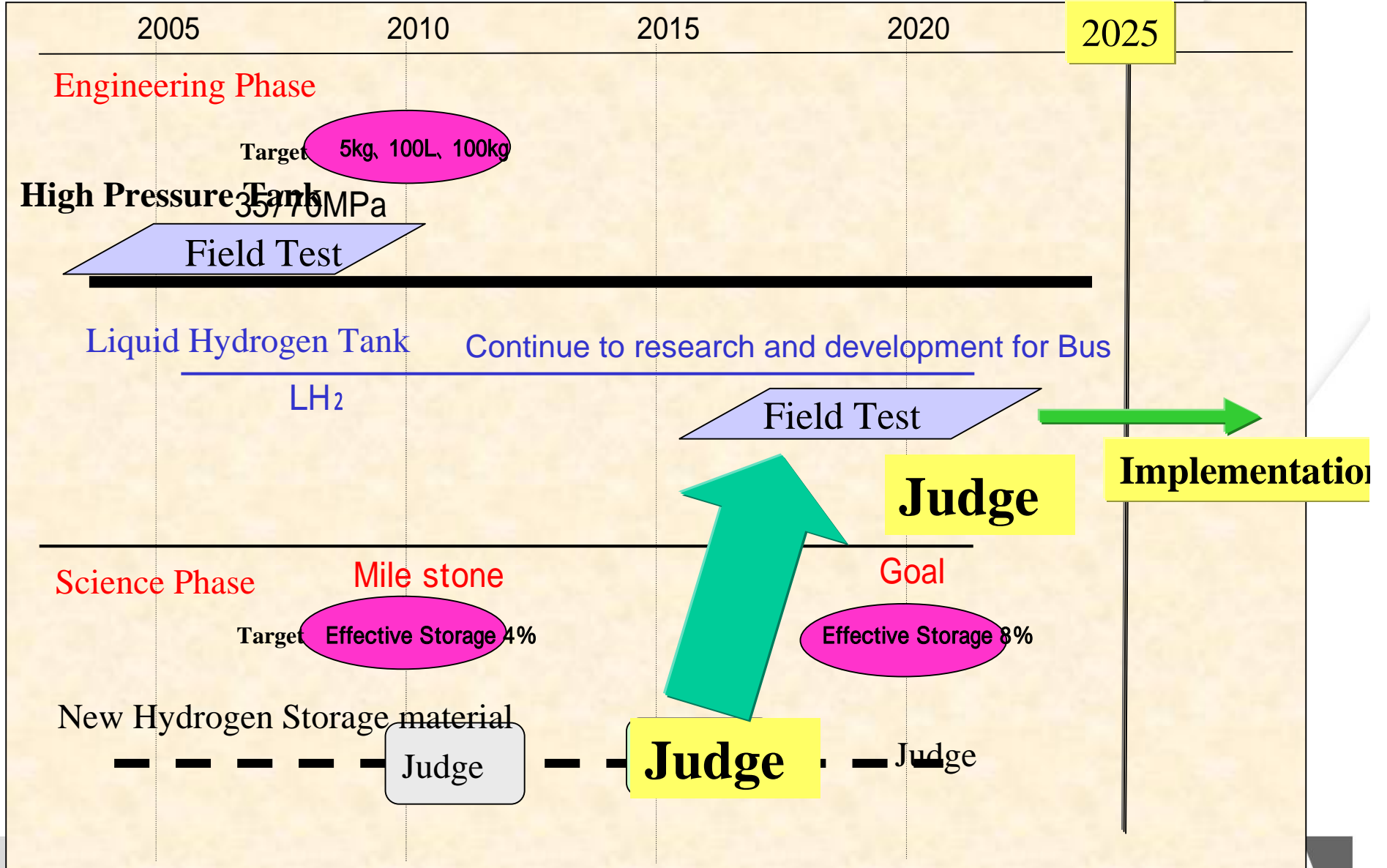


New Target and Collaboration

Hydrogen Storage Roadmap in 2011



New target for you is 2015 not 2020

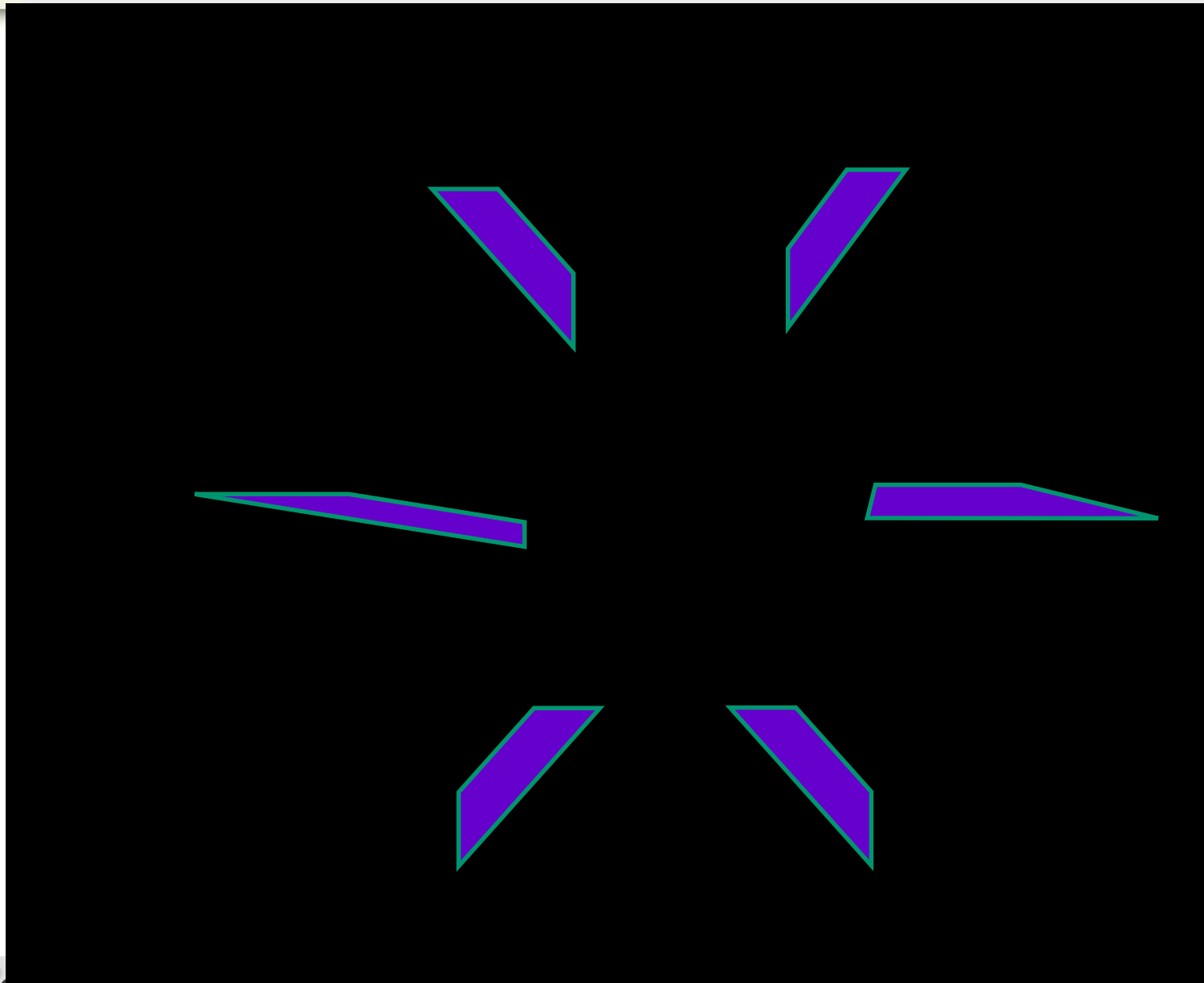


Material and Society

Societal Change and Material

Era	Society	Material	Mobility	Energy	Limitation
Stone age	Village	Stone, Bone tool	Foot	wood	food
Bronze age	City State	Bronze, Pottery	Foot, horse	wood	food
Iron age	nation	Iron, Porcelain	Horse, Carriage, Ship	wood	food
Industrial revolution	Urbanization	Steel	Railway Steam ship	coal	energy
20 century	Globalization	Steel, Copper aluminum	Automobile Airplane	oil nuclear	energy
21 Century	Sustainable	?	IT?	renewable	Earth

Material to Cut Connections



In the Past



Societal Change and Material

Era	Society	Material	Mobility	Energy	Limitation
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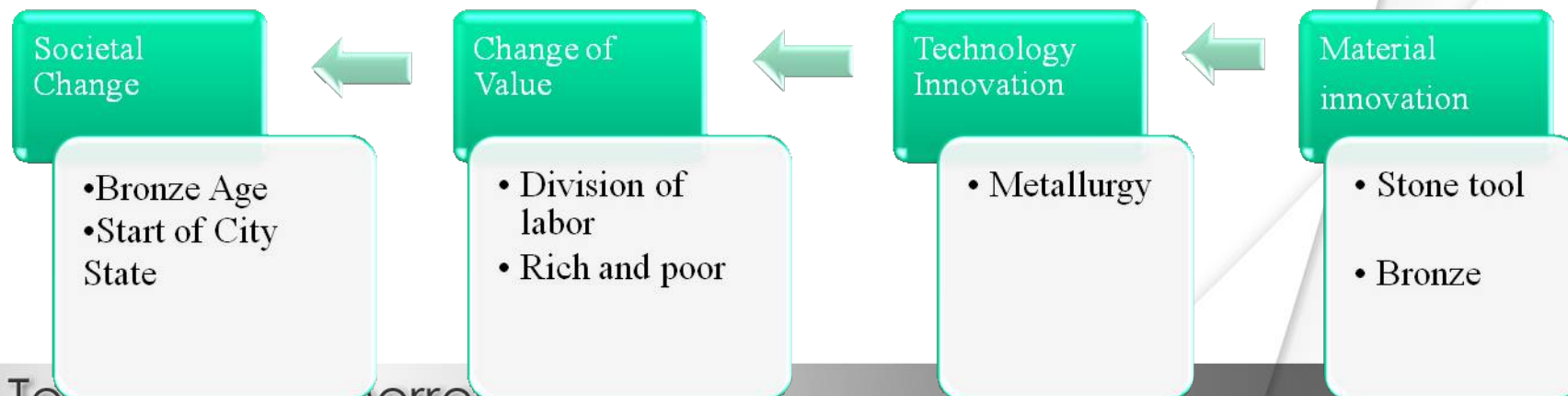
Material
innovation

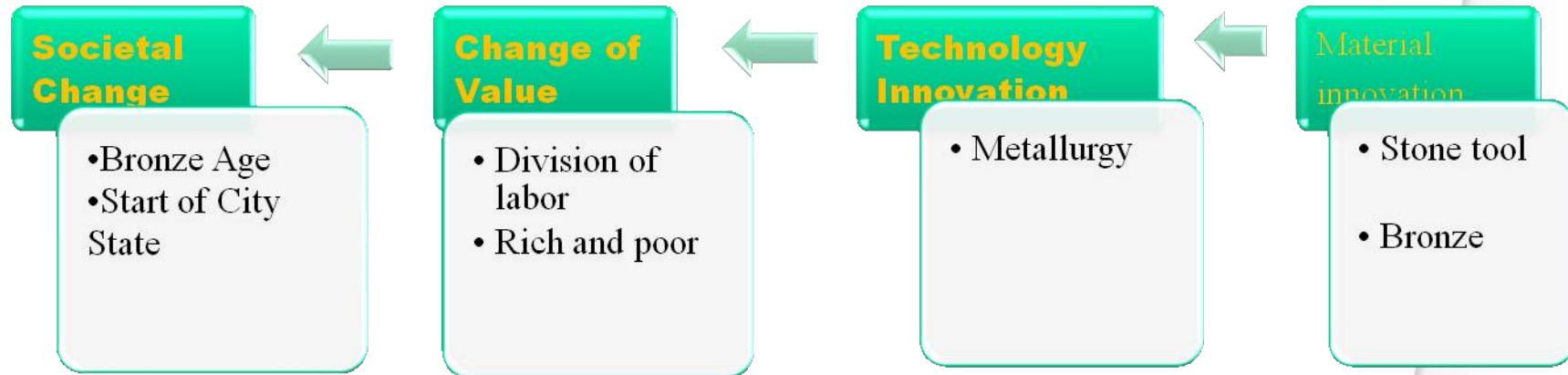
- Stone tool
- Bronze

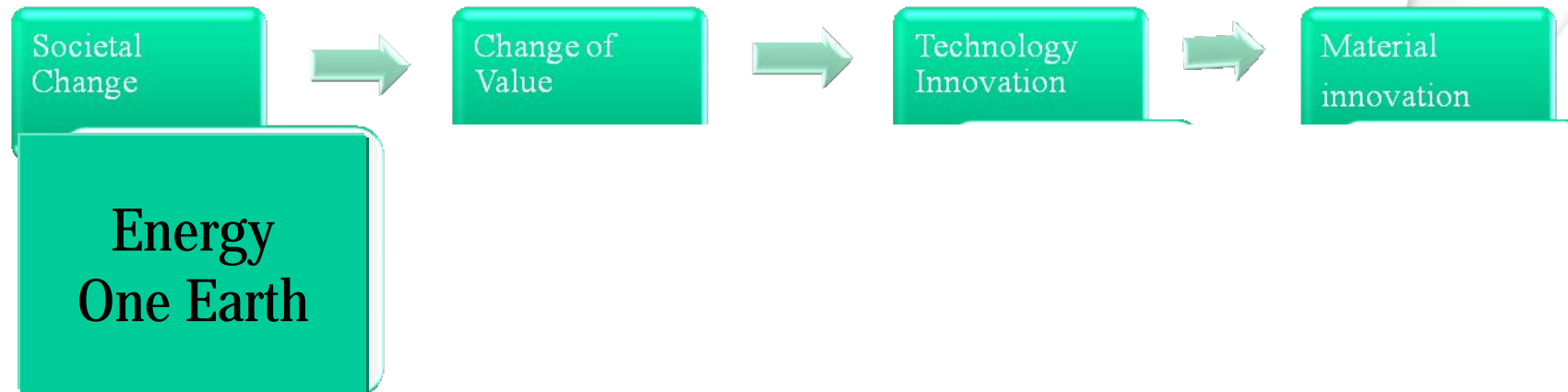
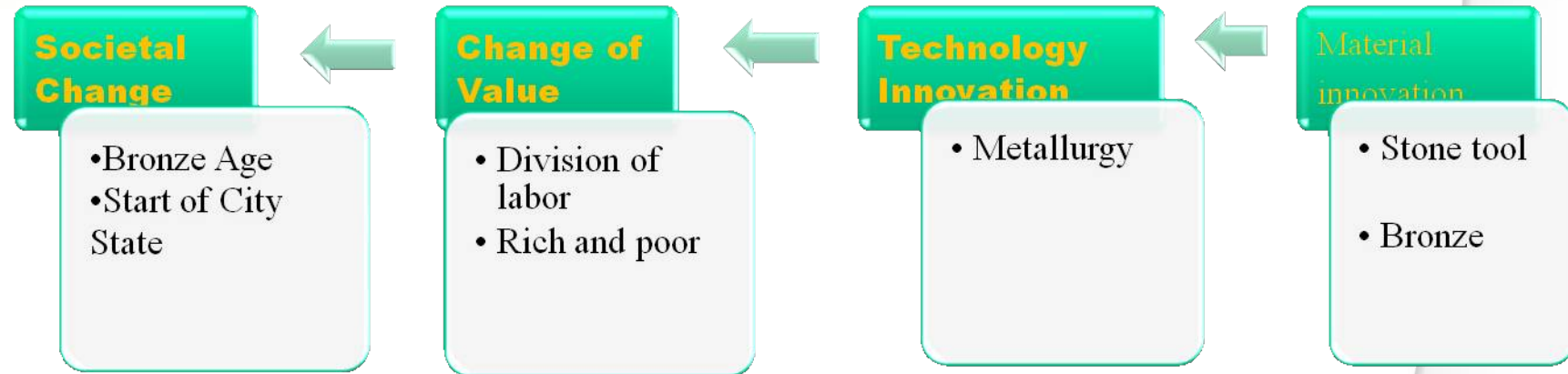
TOYOTA

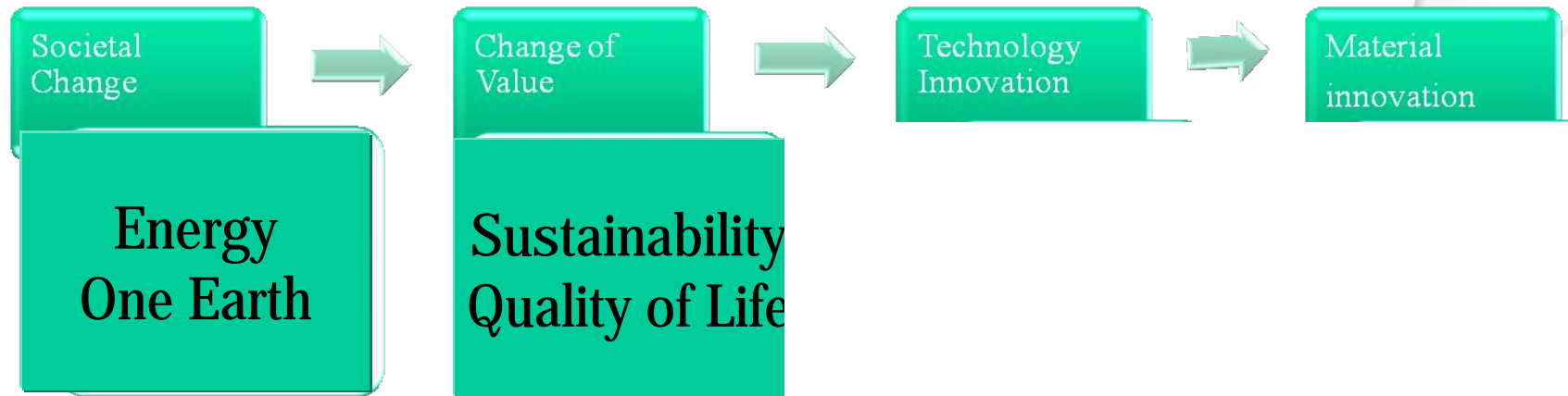
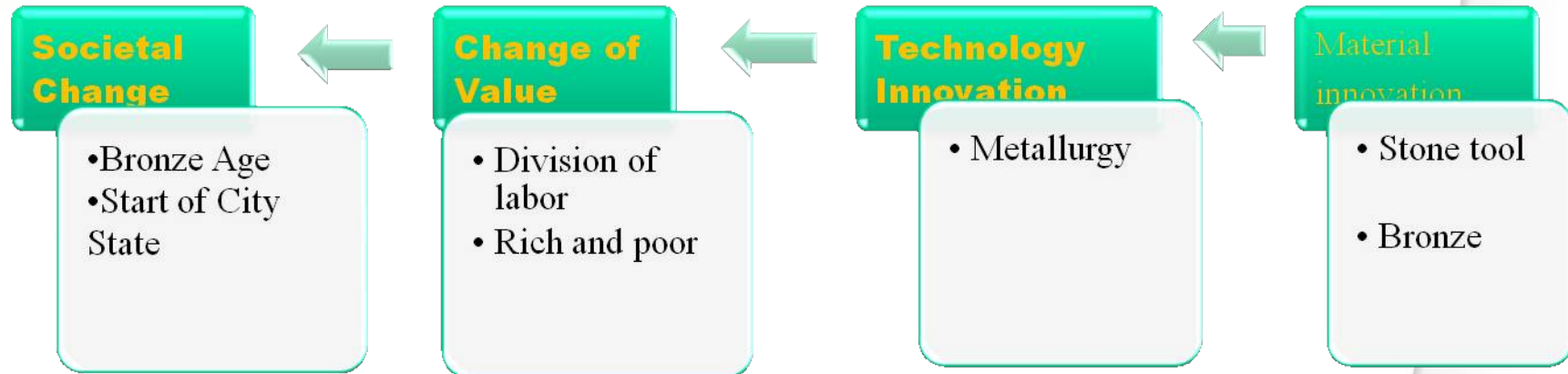
Societal Change and Material

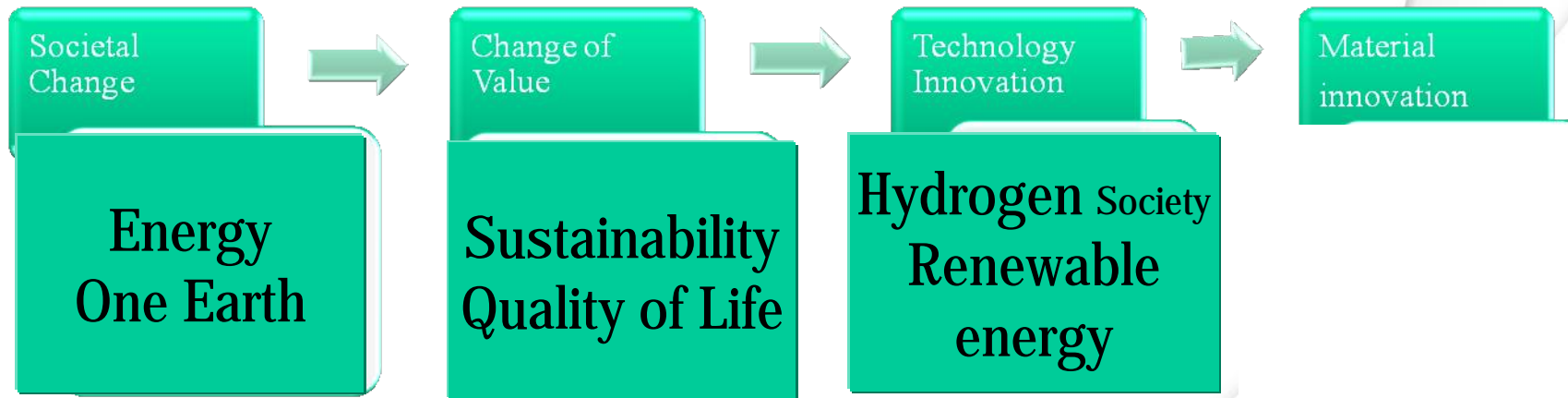
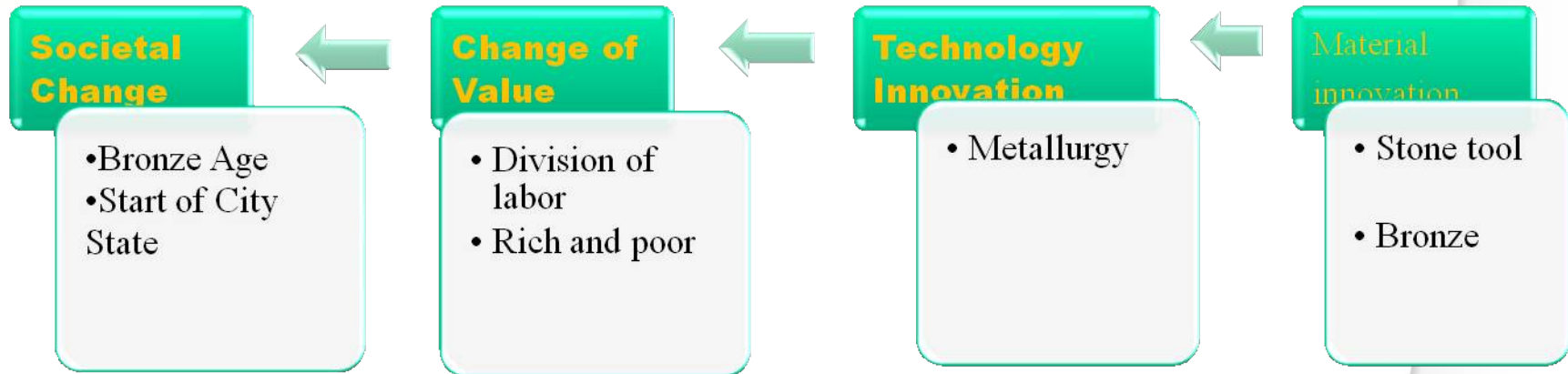
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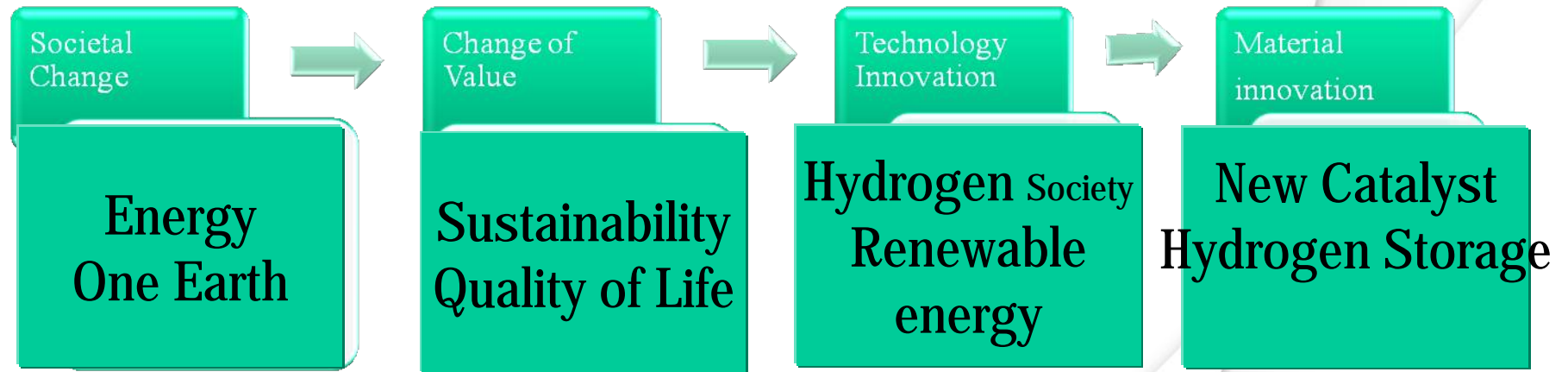
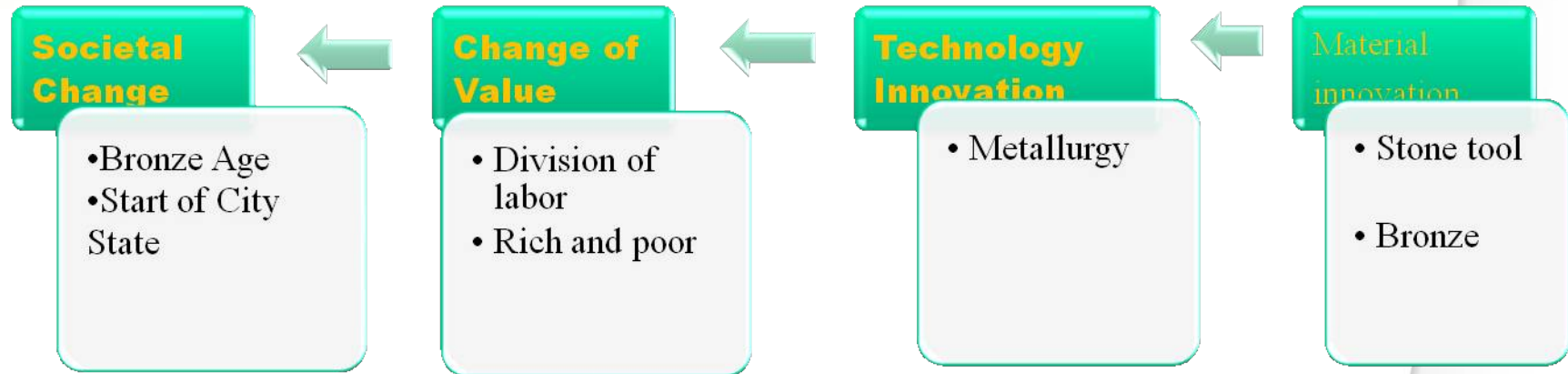












What is the new Axe material
for the sustainable world

“End of stone age was not due to the lack of stone”

New material lead the technological innovation and change the society.

Now environmental limitation forced to find new material and to change the society toward sustainable society

Towards the Sustainable Society

Sustainable Society
Peaceful
Healthy
Life for all

countries

Scientists

Engineers

Academies

Industries

Governments

support
for electricity
industry and household

Reason Why?

- Small dream is not easy to make.
- Small Dream shall be don by your self.
- This is not easy!

Reason Why?

- Big dream is easy to make it true.
- Everybody help you to make it true!

Evolution Continues

- Hybridization
 - Hybrid as a technology to extend to the new vehicles applications

+ Battery = PHV

– Engine + Large Battery = EV

– Engine + FuelCell + HydrogenTank = FCHV

What are created by Prius

- Hybridization
 - Hybrid as a technology to extend to the new vehicles applications

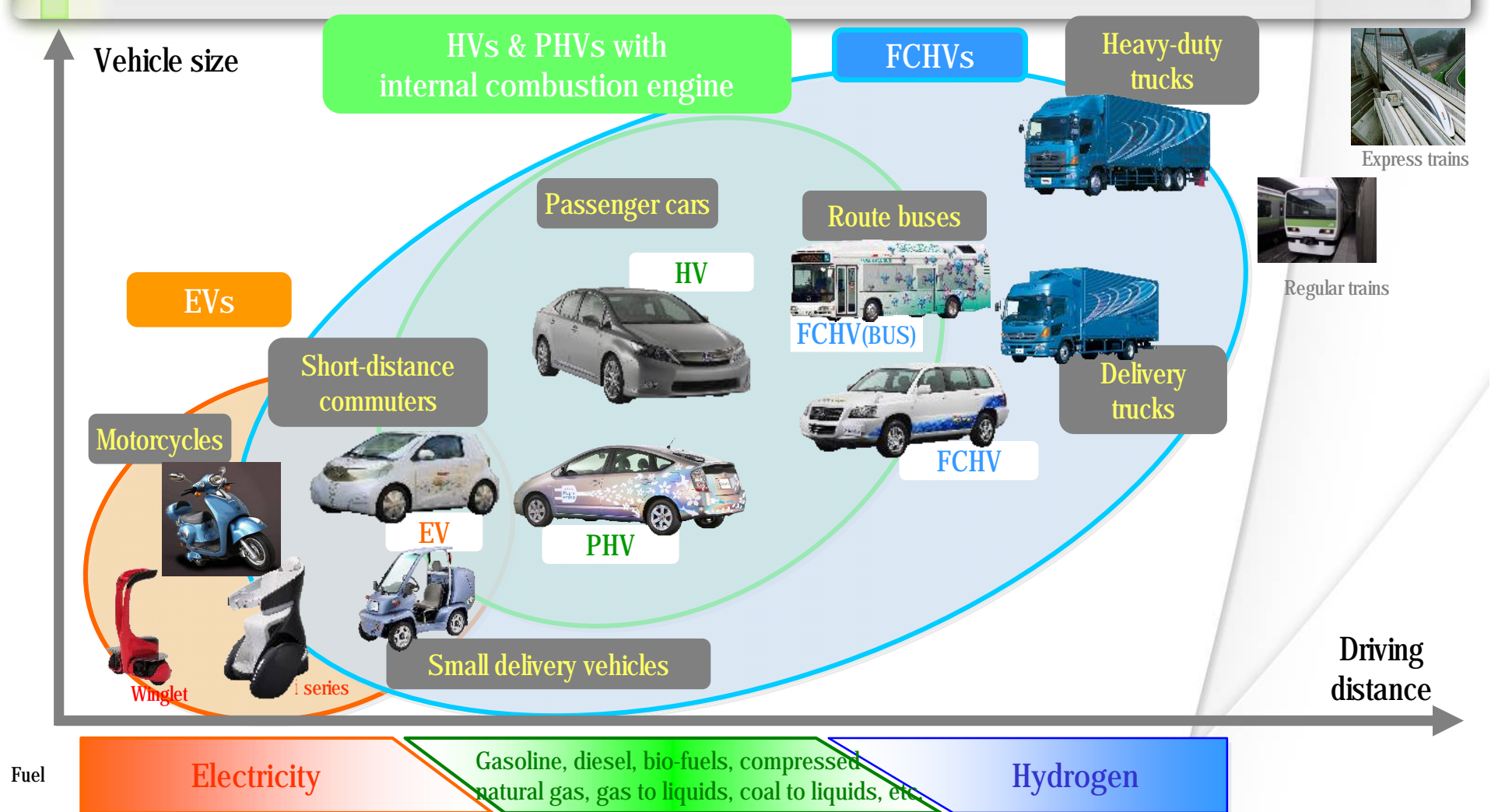
+ Battery = PHV

- Engine + Large Battery = EV

- Engine + FuelCell + HydrogenTank = FCHV

**- Engine + FuelCell + Hydrogen Storage =
Super FC**

Vision of Response to Environmental and Energy Issues



People choose vehicle according to the convenience but society choose fuels.

Ancient technologies at British Museum 2050

Once upon a time there burned the oil in the car to propel and emitted CO2 on road.



Extinct technology Oil burned Vehicle

As a engineer
Technology changes the world.

As a engineer
Technology changes the world.

As a personal
New world will be created by the
people's will to make it happen.

**Change the world
Toward
Safe and Healthy World
Together
With Hydrogen**