Constructing Hydrogen Supply Infrastructure for Promotion of Fuel Cell Vehicles

October 19, 2011

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R&D Planning Dept.
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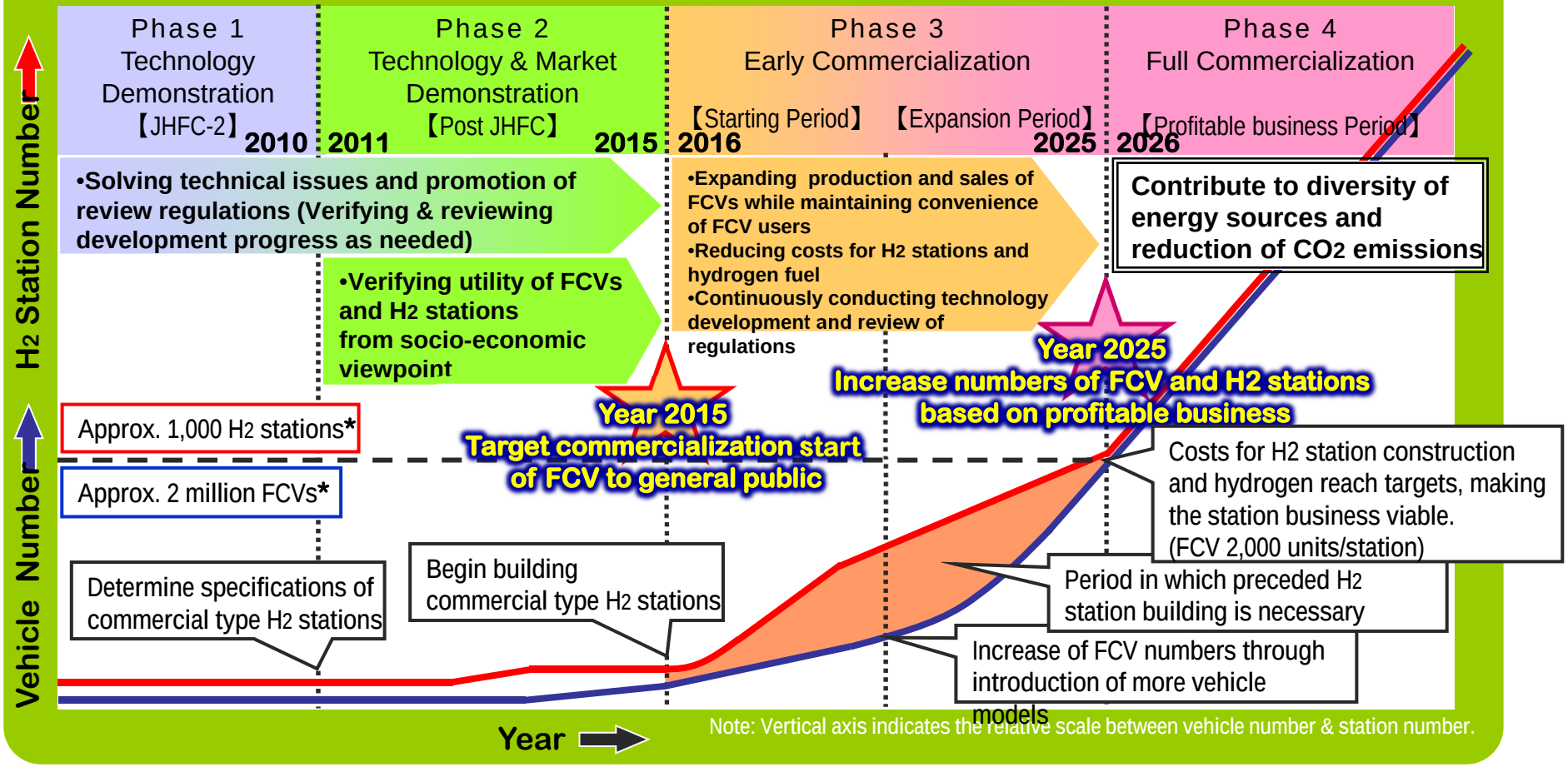
The Future of Energy, Resources and Materials
JX Nippon Oil & Energy Corporation

Scenario

Commercialization Scenario of FCV and Hydrogen Infrastructure

Commercialization Scenario for FCVs and H_2 Stations



* **Precondition: Benefit for FCV users (price/convenience etc.) are secured, and FCVs are widely and smoothly deployed**

Reference : FCCJ, July, 2010

FCV's Contribution to "3E" of Energy

Fuel cell vehicle (FCV) and hydrogen will contribute to 3E of energy by reduction of CO2, energy conservation and primary energy diversification.





CO2 reduction	Energy conservation	Energy diversification
FCV contribution▲45% (Economical effect \9trillion)	Reduction of energy import 50 million kl/y as petroleum (Economical effect 9trillion\/y)	Oil, Gas, Coal, Solar, Wind, Hydro, Biomass etc

Environment protection

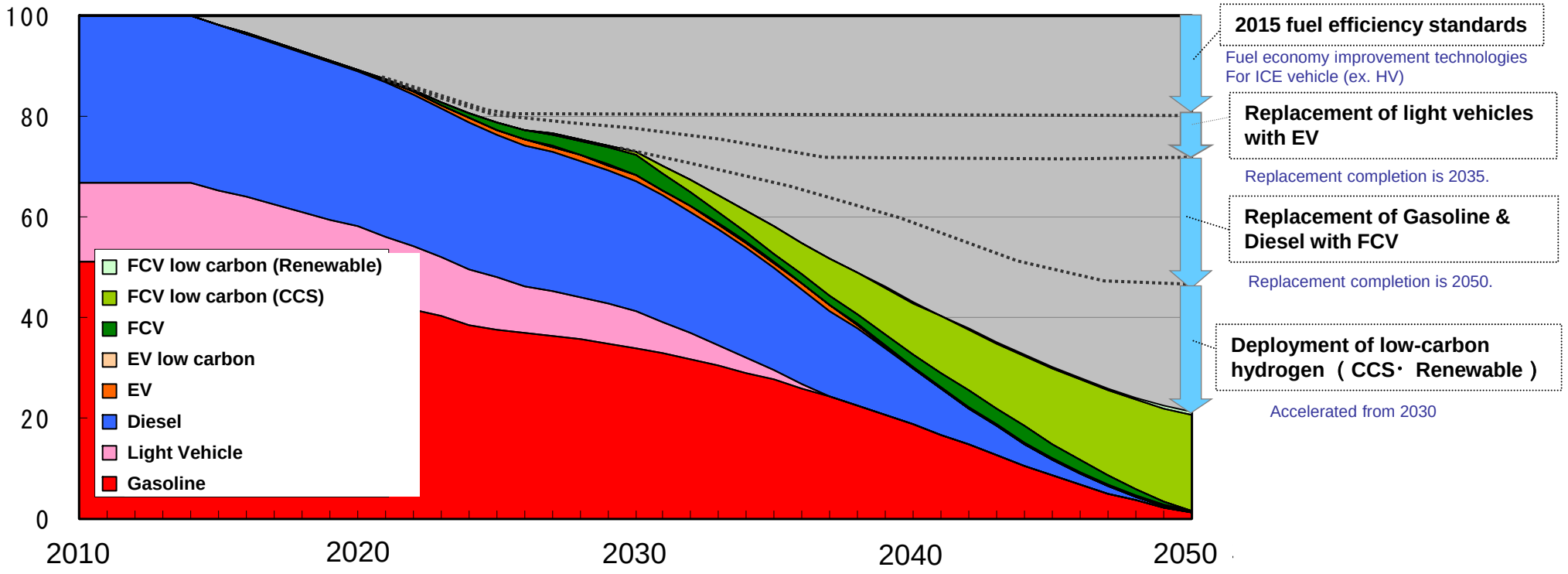
Economic efficiency

Energy security

Contribution to "3E" of energy

Estimate of CO2 emissions reduction with FCVs and the development of low-carbon hydrogen infrastructure

Low-carbon transportation system is necessary to achieve long-term CO2 reduction target. The deployment of FCV is highly promising measure for CO2reduction



Reference : Council on Competitiveness-Nippon (COCN) 2009.3

The Strategic Energy Plan of Japan
(Revised in June 2010 by METI)

Japanese government has revealed its intention for commercialization start of FCV in 2015 and hydrogen energy society creation.

The Strategic Energy Plan of Japan “Action plan of hydrogen energy society creation” summary

【Target】

- **We will create hydrogen energy society which emits no CO2 in utilizing stage.**
- **Hydrogen from fossil resources will be used in early deployment phase.**
- **In the future, hydrogen production from fossil resources with CCS* and/or non-fossil energy will be promoted.**
- **The government will support to hydrogen infrastructure construction which is prepared for 2015 FCV.**

【Action】

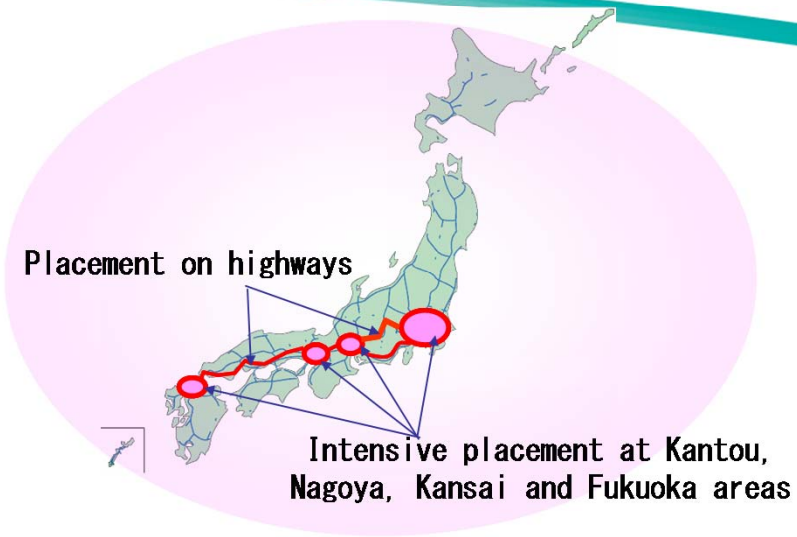
- **Support and regulation mitigation for cost down**
- **Promotion of demonstration test**

*Carbon Capture and Storage

Joint Announcement by 13 Japanese companies

January 13 2011

1.As development of fuel-cell systems progresses, Japanese automakers are continuing to drastically reduce the cost of manufacturing such systems and are aiming to launch FCVs in the Japanese market —mainly in the country's four largest cities—in 2015. The automobile industry hopes to popularize the use of FCVs after their initial introduction as a way of tackling energy and environmental issues.



2.Hydrogen fuel suppliers are aiming to construct approximately 100 hydrogen fueling stations by 2015, based on the number of FCVs expected to initially enter the market, to ensure a smooth launch and to create initial market.

3.With an aim to significantly reduce the amount of CO2 emitted by the transportation sector, automakers and hydrogen fuel suppliers will work together to expand the introduction of FCVs and develop the hydrogen supply network throughout Japan. The two groups are looking to the government to join them in forming various strategies to support their joint efforts and to gain greater public acceptance of the technology.

Supply Chain Business Model

Hydrogen Supply Scheme toward Low-carbon Society

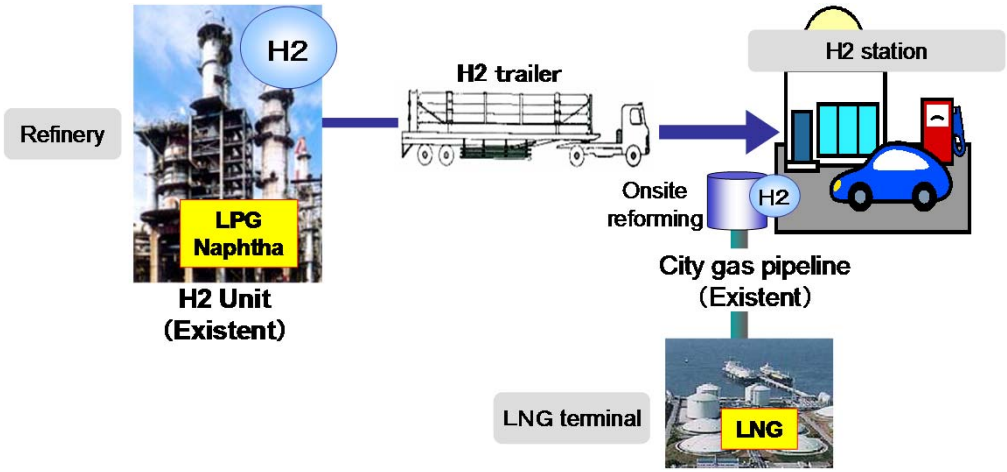
2015-2025

＜Initial Hydrogen Deployment ＞

①Supply by offsite reforming using existent oil refinery H2 unit

②Supply by onsite methane reforming using city gas pipeline

⇒Supply security and low-cost



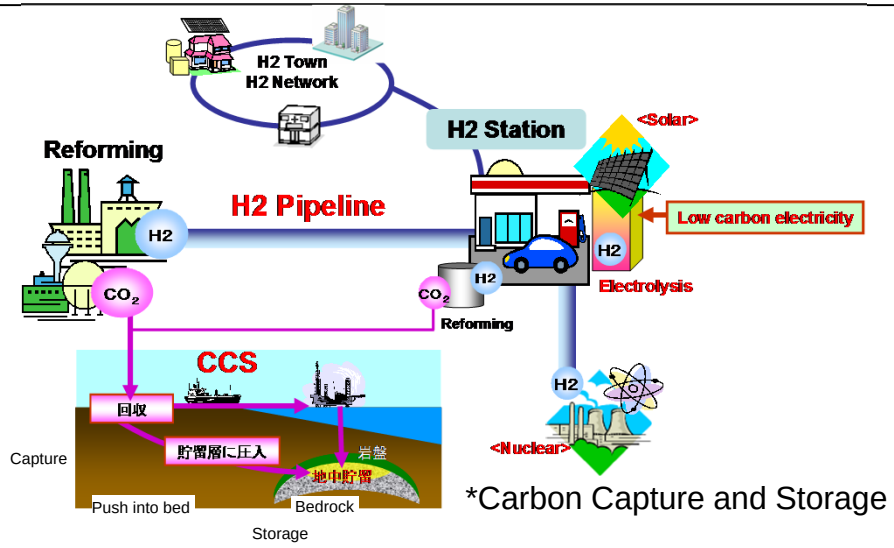
2025-2050

<Transition to low-carbon hydrogen＞

・Centralization of production, H2 pipeline and H2 network.

・”Low-Carbon” Hydrogen Supply

<Example>
①Oil/Gas Reforming with CCS*
②Electrolysis by Solar power

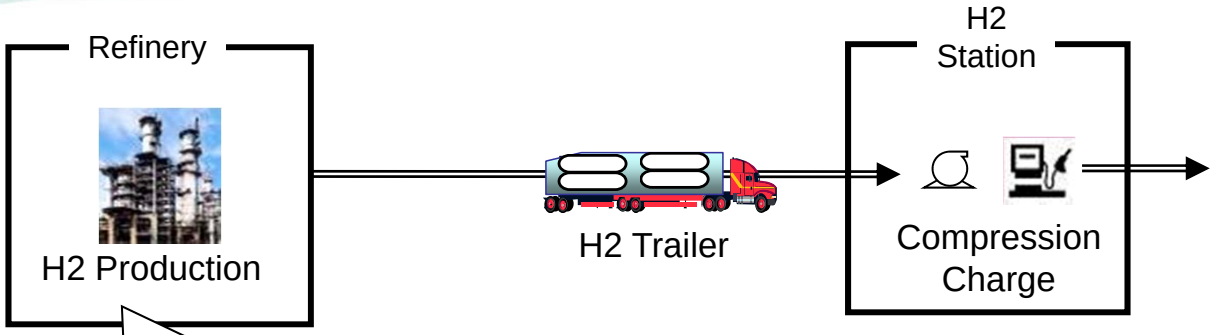


*Carbon Capture and Storage

Reference : COCN, March, 2009

Business Model of Oil Companies

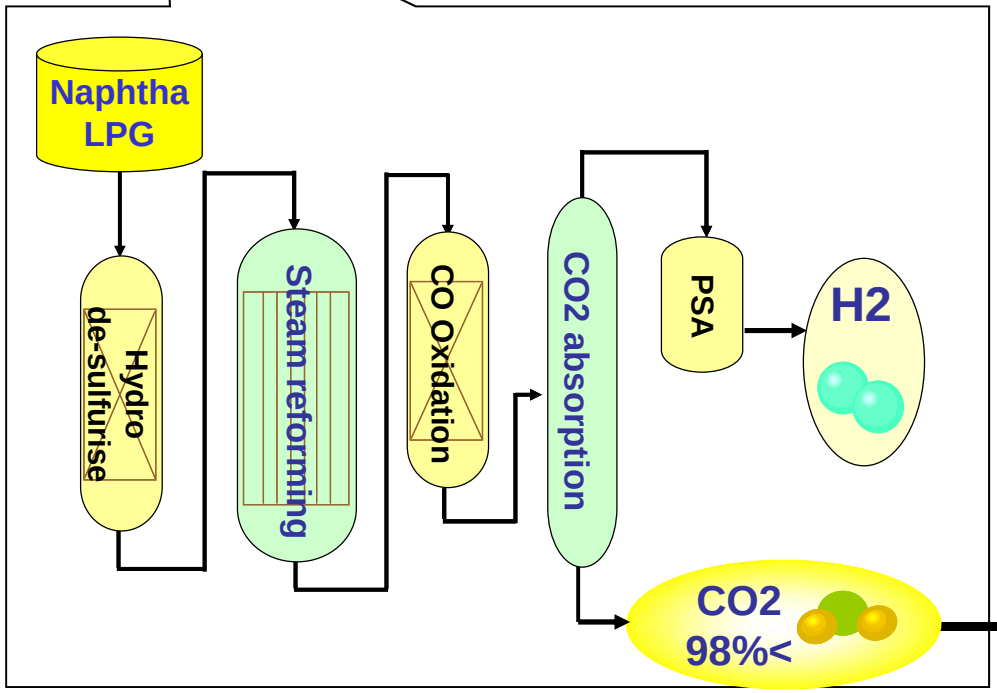
Supply Chain using Refinery Surplus Capacity



CO2 with hydrogen production has high purity.

=Easy for CCS application

H2 production with low CO2 emission will be achieved around 2020-2030 by CCS.



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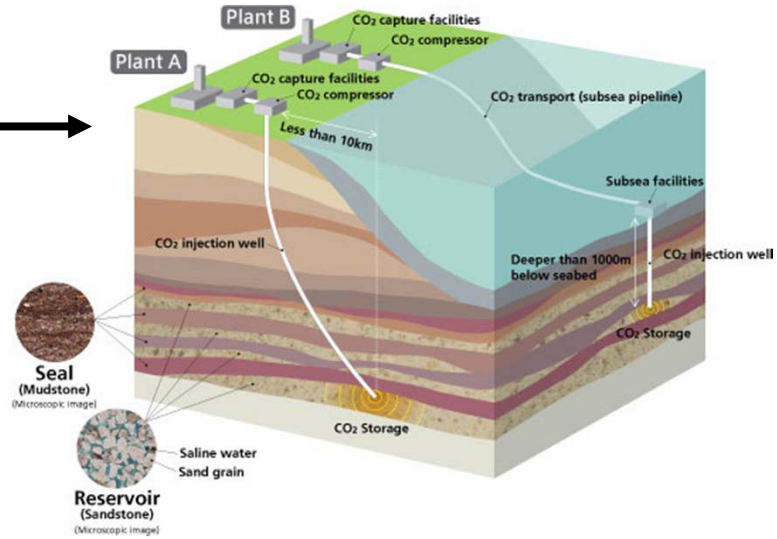


Business Model of Oil Companies

H2 Production Capacity in Japan

Japanese refineries has 4.7 billion Nm3* surplus and “on purpose” H2 production capacity.

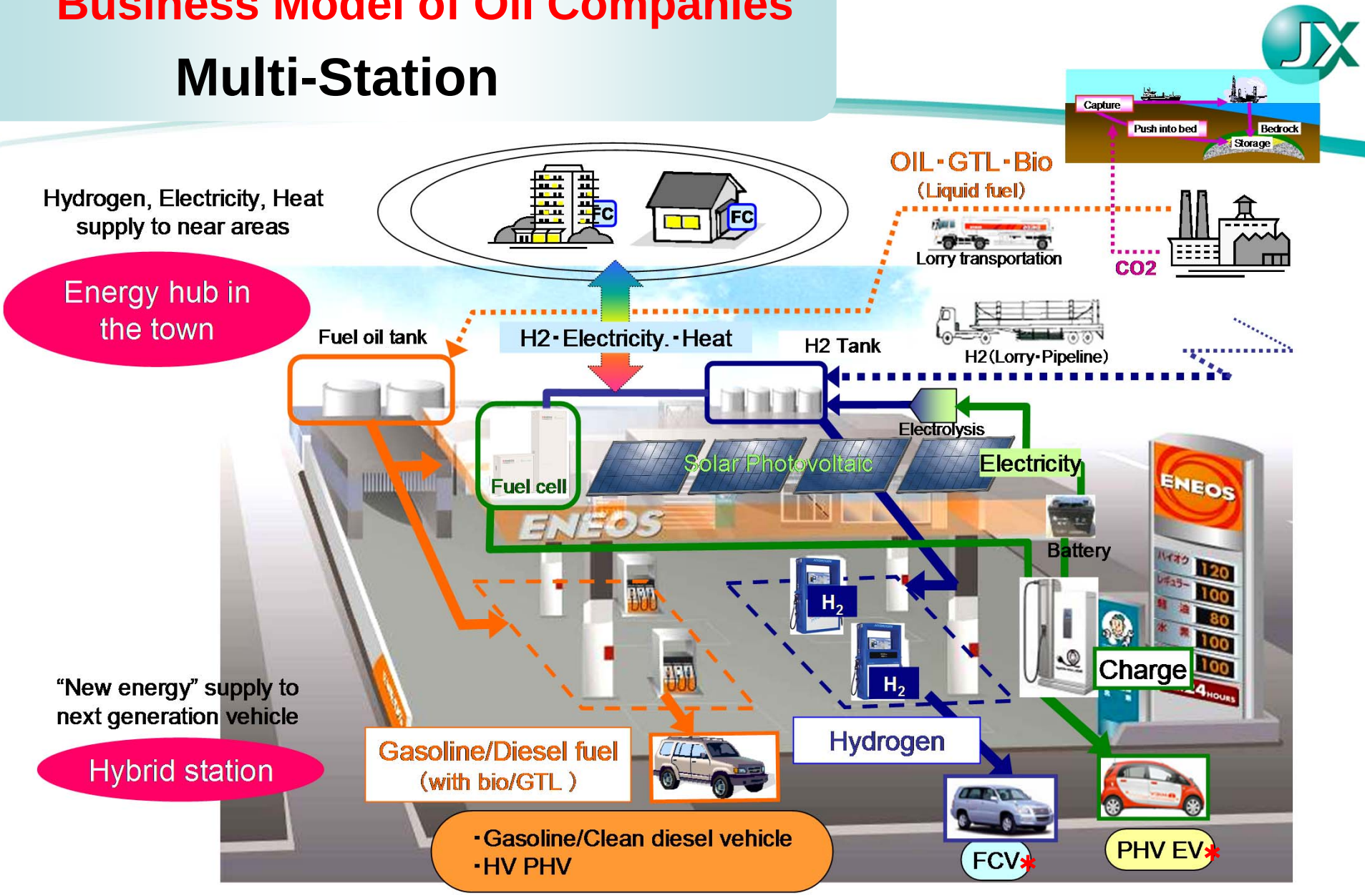
* Applicable to 5 million FCVs

Reference : JPEC Report

Industry	Production			Capacity		Main Product
	Stock	Input Energy	Process	Current Surpluss	By-product	
				Billion Nm3		
On Purpose Production						
Oil	Petroleum	Petroleum	Reforming	4.7	–	Hydrogen
Ammonia	Various			0.6		
City Gas	Natural Gas	Natural Gas	Reforming	–		
Electricity	Water	Nuclear	Pyrolysis			
–	Water	(Electricity)	Electrolysis			
By Production						
Steel	Coal	Coal	Dry Distillation	–	1.2	Cokes
Petro-Chemical	Petroleum	Petroleum	Pyrolysis		1	Ethylene
Soda	Water	(Electricity)	Electrolysis		0.6	NaOH

Business Model of Oil Companies

Multi-Station



* FCV: Fuel Cell Vehicle, PHV: Plug-in Hybrid Vehicle, EV; Electric Vehicle

Activities of “HySUT”

The Research Association of Hydrogen Supply/Utilization Technology

- Objective -

Contribution to preparing of circumstances toward the spread of FCV (Technology, Standard, Consumer acceptance, Social system) by operating "Demonstration Test".

(1) Members: 18 Companies

Energy Supplier:

JX Nippon Oil & Energy , IDEMITSU KOSAN ,COSMO OIL ,Showa Shell Sekiyu. K.K.,
TOKYO GAS, OSAKA GAS, TOHO GAS, Saibu Gas, IWATANI CORPORATION

Engineering Company, Device Company:

Air Liquid Japan, KAWASAKI HEAVY INDUSTRIES, MITSUBISHI KAKOKI, TAIYO NIPPON SANSO

Automakers:

TOYOTA, Nissan, HONDA

Others

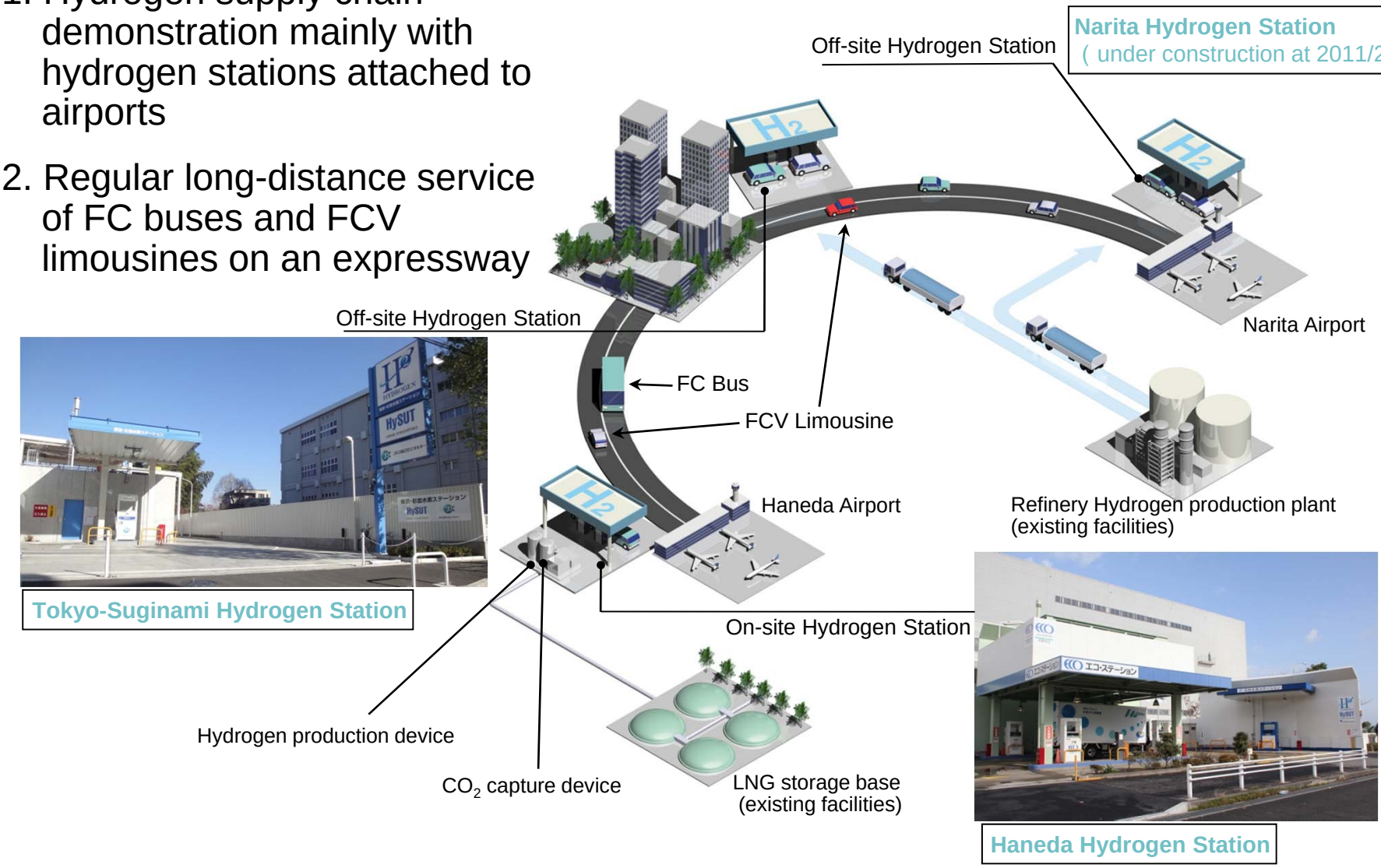
Japan petroleum energy center, Engineering Advancement Association of Japan

(2) Establishment： 2009.7.31

(3) Location: 2-10-5 Akasaka Minato-ku, Tokyo 107-0052

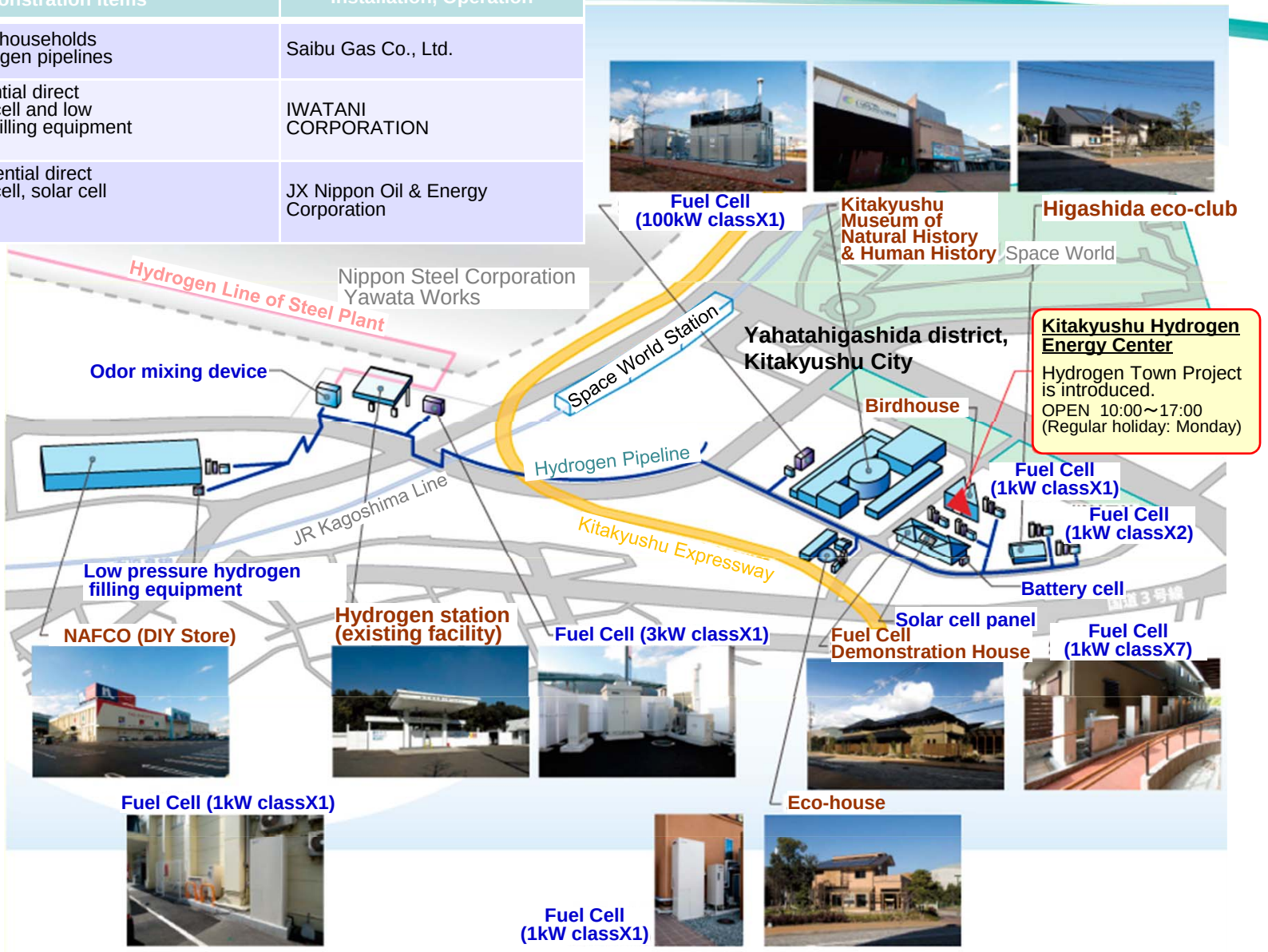
HySUT Hydrogen Highway Project

1. Hydrogen supply chain demonstration mainly with hydrogen stations attached to airports
2. Regular long-distance service of FC buses and FCV limousines on an expressway



Hydrogen Town Project

Demonstration items	Installation, Operation
Hydrogen supply to households through about hydrogen pipelines	Saibu Gas Co., Ltd.
Operation of residential direct hydrogen type fuel cell and low pressure hydrogen filling equipment	IWATANI CORPORATION
Parallel run of residential direct hydrogen type fuel cell, solar cell and battery cell	JX Nippon Oil & Energy Corporation



Technical Tasks in 2011-2015

（1）70MPa filling technology

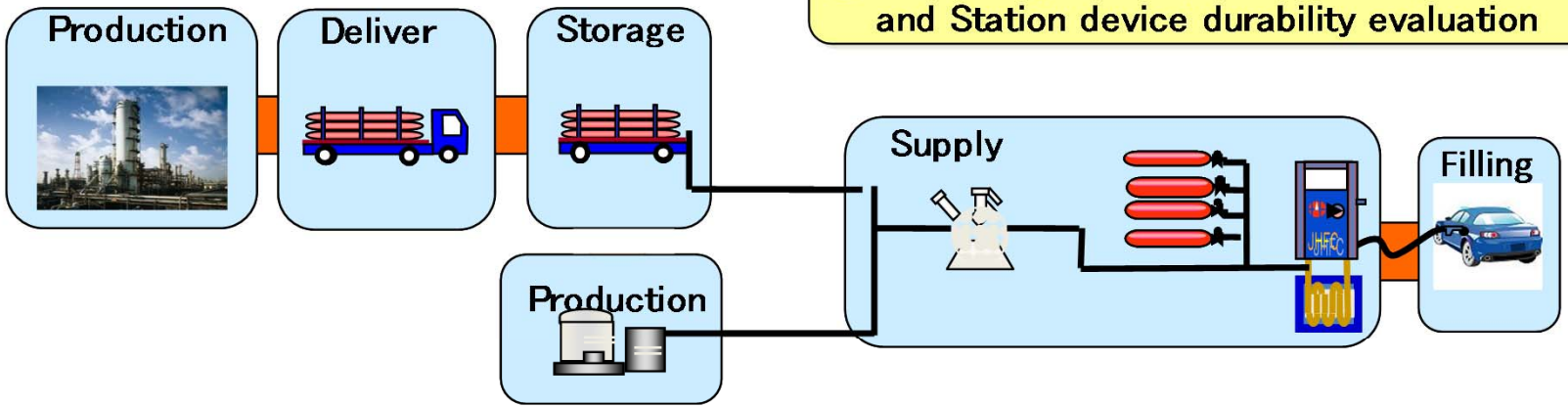
① Communication filling
② 3min. filling
③ −40℃ Pre−cooling realization
④ Breakaway ,Valve evaluation.
⑤ 70MPa full filling

Collaboration with other`s programs

- **Review of regulations**
- **International standardization**

（2）Low-cost H2 station technology

① Bank filling/Direct Filling evaluation
② H2 Storage Tank (included composite tank) and Station device durability evaluation



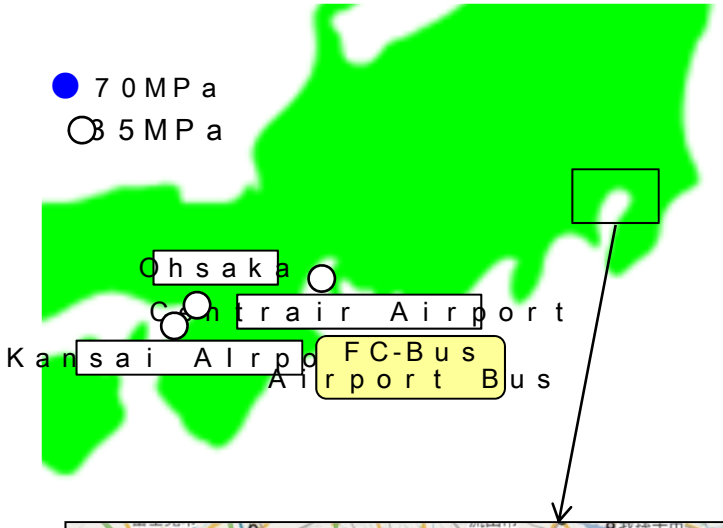
（3）High frequency operation

① Compressor durability evaluation
② Non−shut down inspection of H2 Storage Tank
③ Optimization of compressor operation
④ FCV Stack durability evaluation
⑤ High frequency Reformer operation

（4）Total system technology

① Filling to H2 Deliver Trailer
② Practicality and convenience evaluation of commercial H2 station model
③ Relapse prevention of breakdown and trouble study

HySUT FCV/Station Demonstration



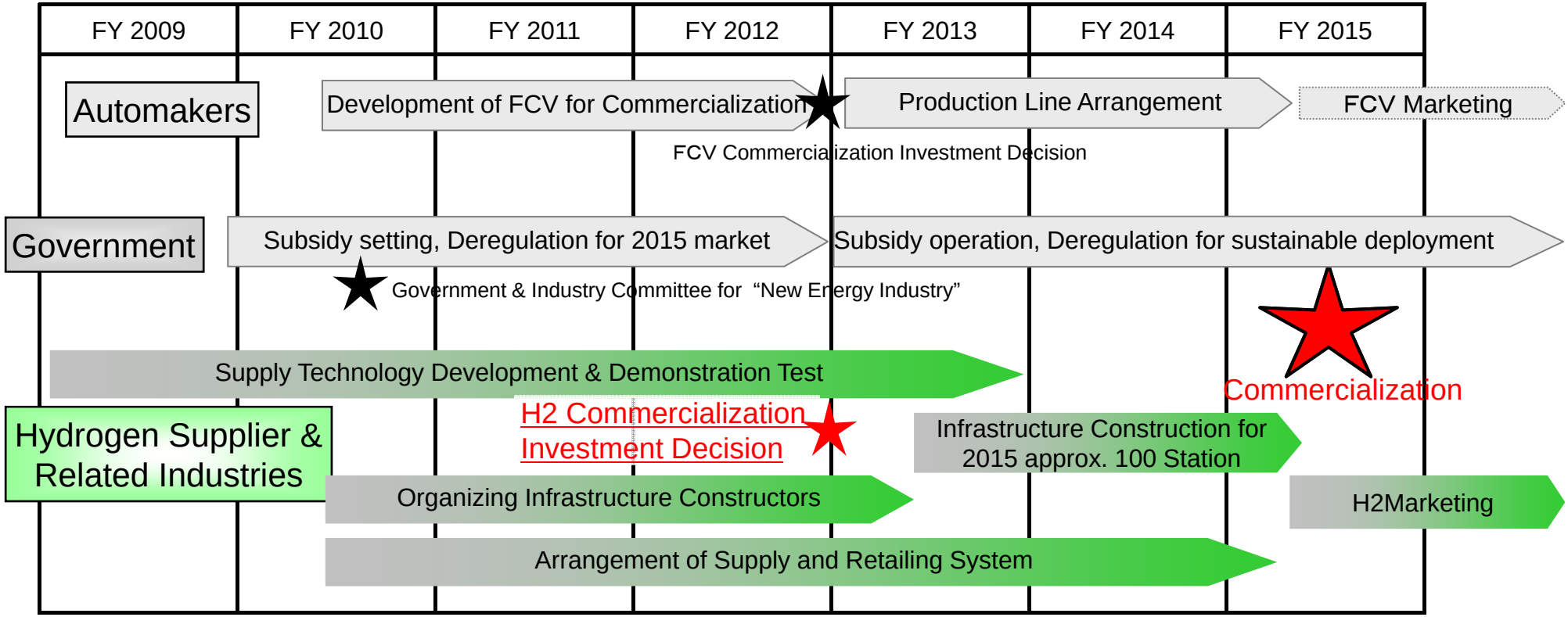
FCV / FC-Bus	Contents
FCHV-adv （ 3 ） (TOYOTA)	Fleet driving 1 , Program driving 1
	Test vehicle for charging system 1
X-TRAIL-FCV （ 3 ） (Nissan)	Fleet driving 1 , Program driving 1
	Test vehicle for charging system 1
FCX-CLARITY （ 2 ） (Honda)	Fleet driving 1 , Program driving 1
FCHV-BUS （ 3 ~ 4 ） (TOYOTA)	Fleet driving
Lease Vehicle	Cooperating to demonstration with free hydrogen from HySUT

Hydrogen Station （ 1 1 ）			Type
	70 MPa	Kasumigaseki	Mobile Off-site
		Yokohama Daikoku	Off-site
		Yokohama Asahi	Naphtha On-site
		Senju	City gas On-site
		Ariake	Liquefied Hydrogen
	35 MPa	Centrair	City gas On-site
		Osaka	City gas On-site
		Kansai Airport	Simplified Off-site
		Tokyo Suginami	Off-site
		Haneda Airport	City gas On-site
		Narita Airport	Off-site

Schedule for 2015

Schedule toward Commercialization

End of FY2012 : Investment Decision



Requirements of Investment Decision Making

National strategy must be fixed.

①Number and marketing area of FCV in short and long term.

②Number and placement area of H2 infrastructure which accommodates to FCV number

③Subsidy and back up system for deployment of FCV and H2

Circumstances around business must be cleared.

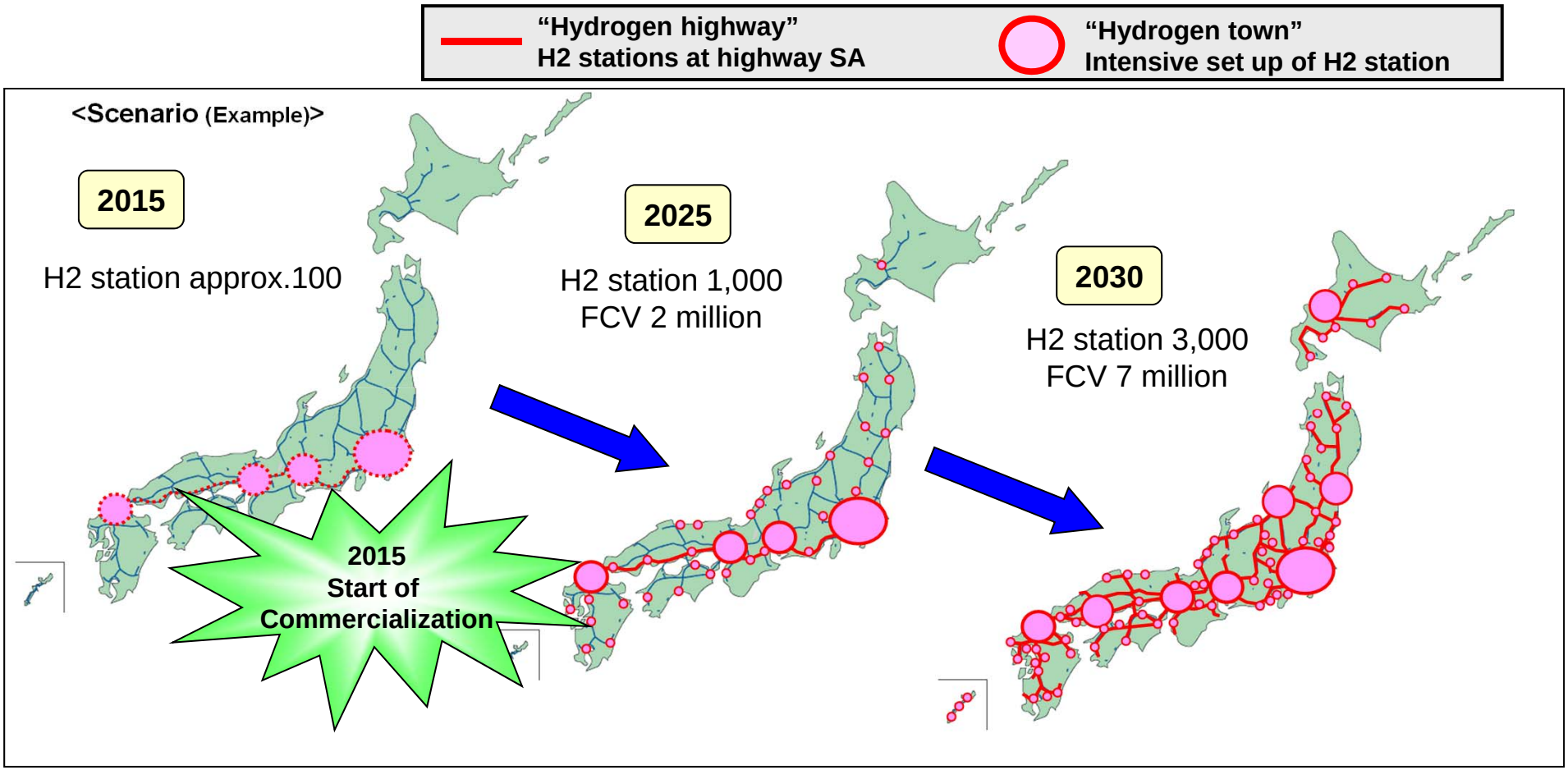
①Economical circumstances ; Technology development, Deregulation, Standardization, Subsidy and back up system for deployment

② Practical circumstances ; Organizing infrastructure constructors, Arrangement of supply and retailing system, Practice of operation

③ Social circumstances ; Public acceptance making through social demonstration, Dissolving of groundless fear

Deployment Strategy Discussion

Hydrogen Infrastructure Growing up Scenario (Example)

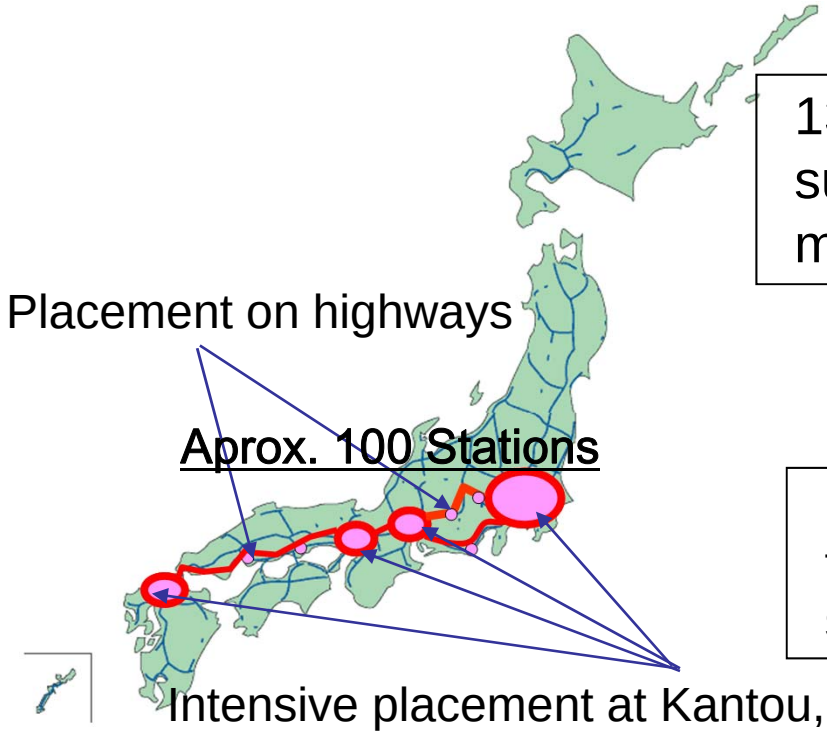


Joint Study on Preceded H2 Infrastructure Preparation

<The concept of preceded H2 infrastructure preparation>
Preparation of hydrogen station before 2015 FCV commercialization
Intensive placement in Kantou, Nagoya, Kansai and Fukuoka city area which may have big FCV market.
Placement on highways between 4 city areas.
Placement has to satisfy convenience of FCV users for FCV deployment.

13 companies (Automakers and energy suppliers) are discussing strategy for early market deployment.

Placement on highways



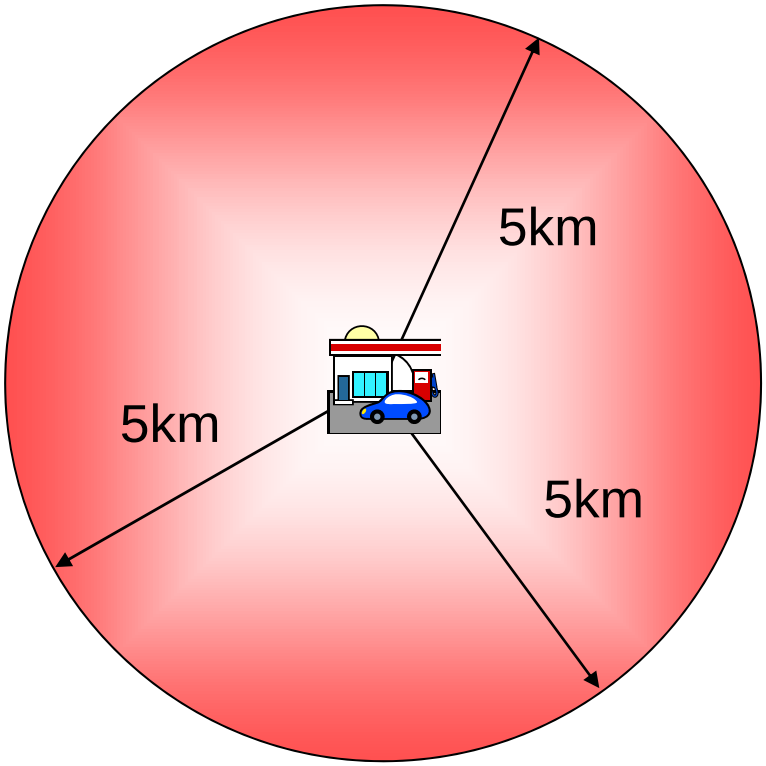
Aprox. 100 Stations

Local governments of 4 regions have started to discuss with automakers and energy suppliers

Intensive placement at Kantou, Nagoya, Kansai and Fukuoka areas

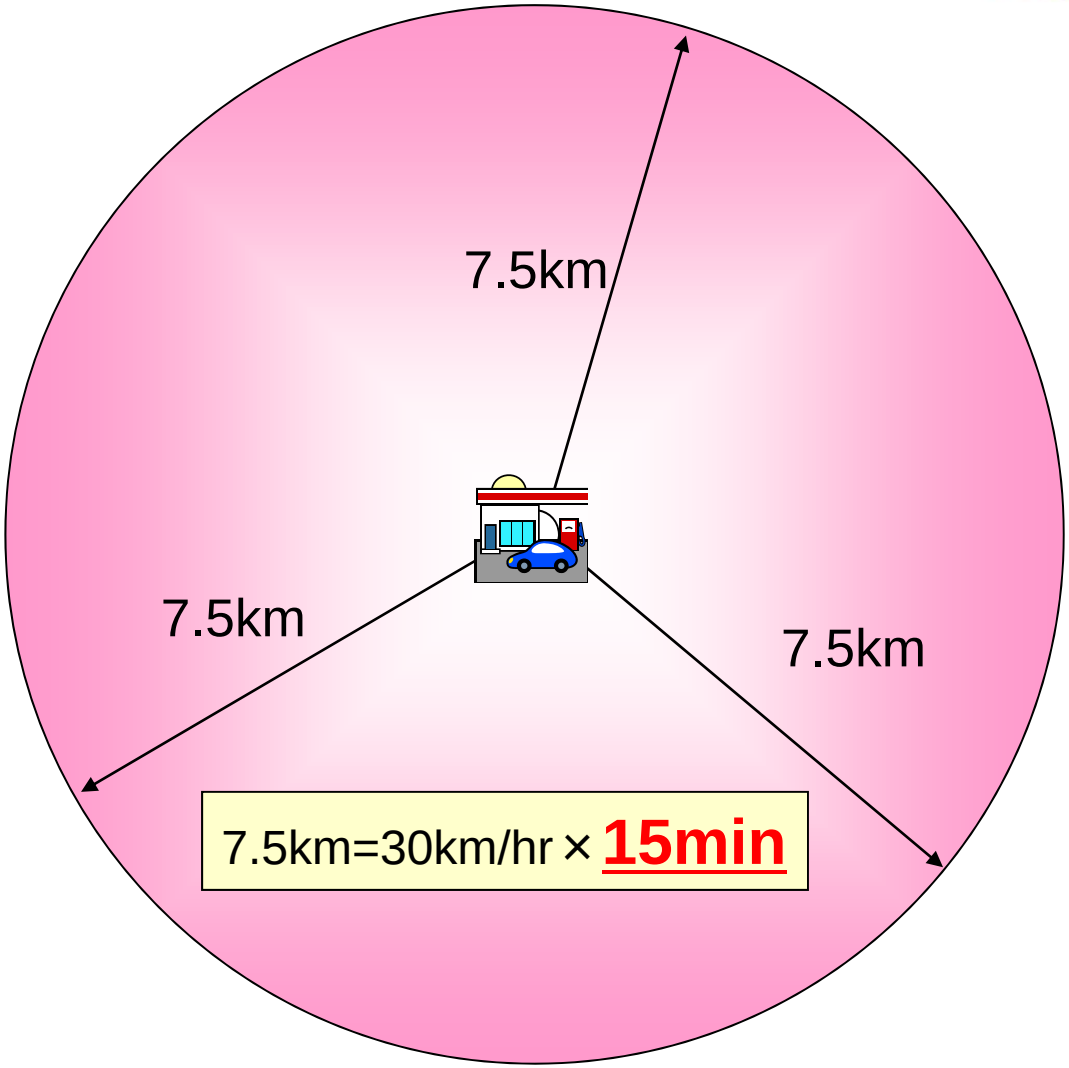
Basic Idea of Station Mapping

DID*(City) Area



5km=20km/hr × **15min**

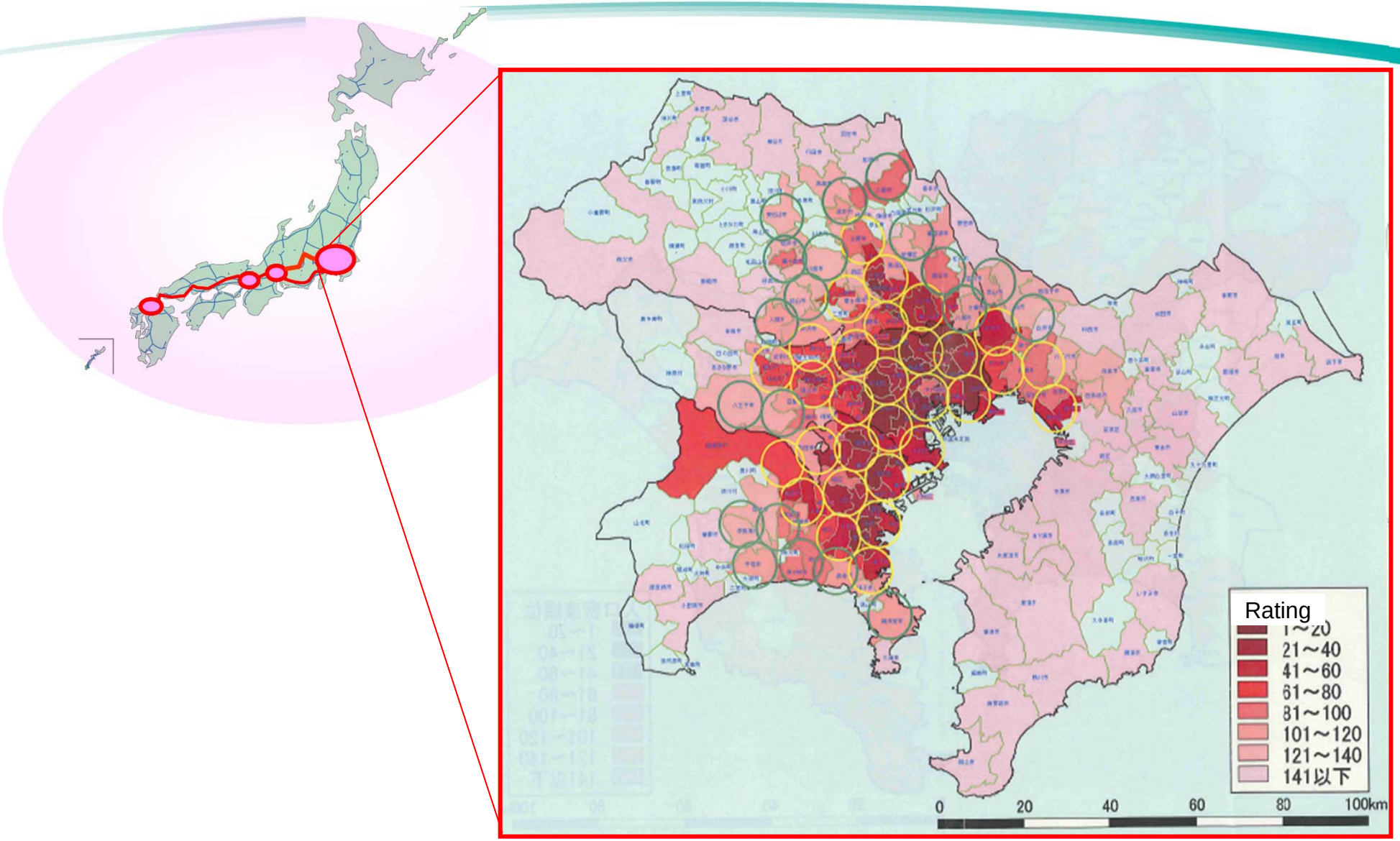
Other Area



7.5km=30km/hr × **15min**

*Densely Inhabited District

Study Image (Tentative) in Kantou Area

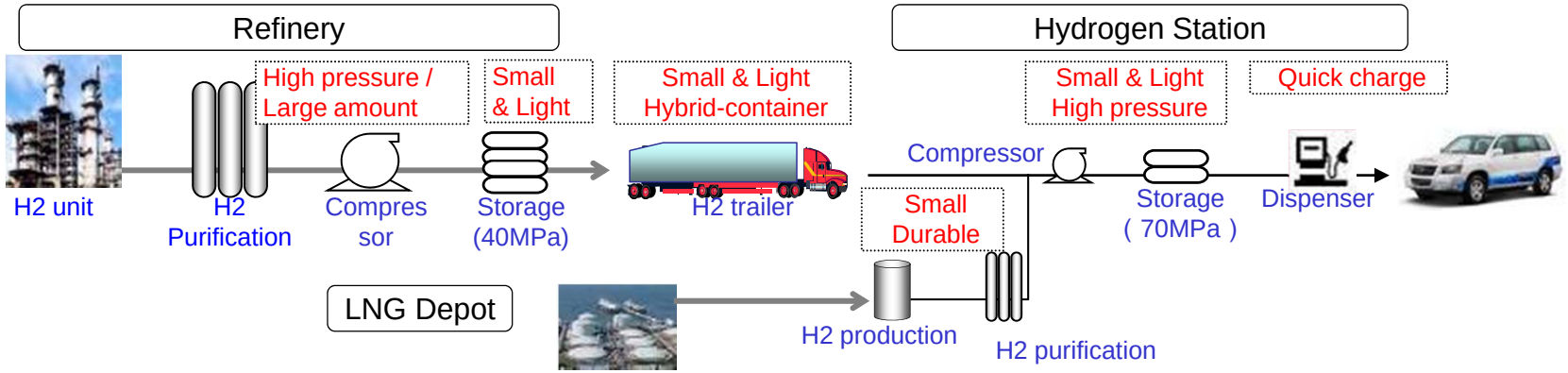


Issues

Cost-down through R/D and Regulation Relaxation

1．R/D cost-down

NEDO project etc：Fundamental/Elemental R/D

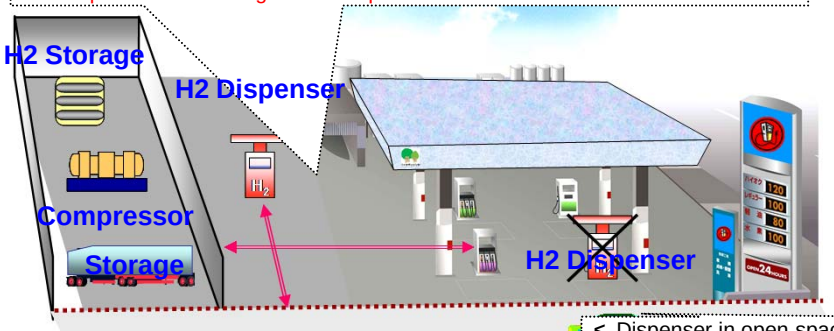


2．Regulation relaxation cost-down

< Example >

<Storage capacity limit>
Building Standards Law
Current:
Semi-factory area：3,500Nm³
(100FCV charge capa.)
Shop/Sales area：700Nm³
(20FCV charge capa.)
Semi-residence area：350Nm³
(10FCV charge capa.)
⇒Raising shop/sales area limit to the same as semi-factory area limit

< High pressure equipment in open space for refueling > Fire service law
Current：Prohibited
⇒Set up as an annex to gasoline dispenser



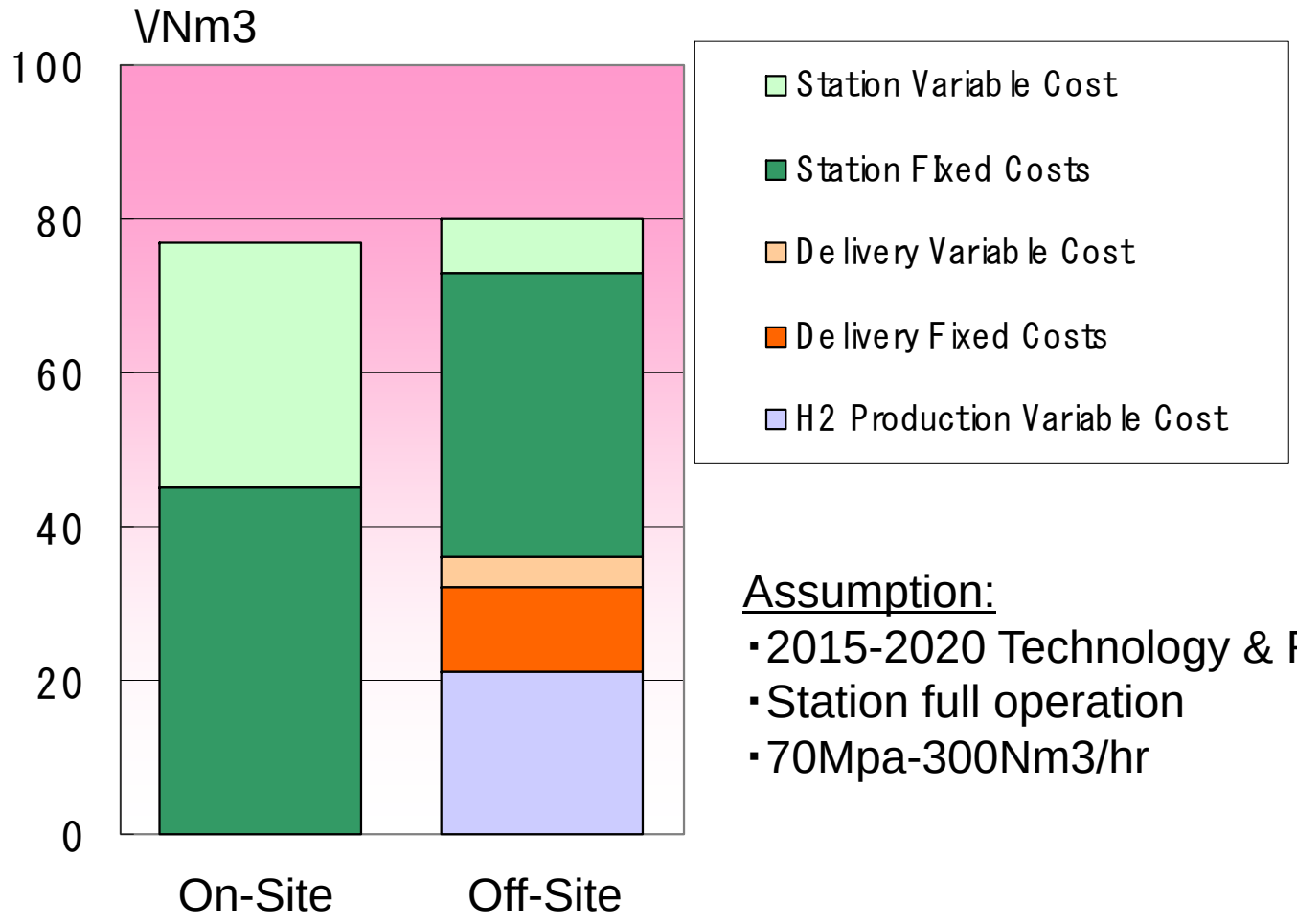
< Distance between H2 dispenser and road > High Pressure Gas Safety Act
Current：6m ⇒ 4m, same as gasoline dispenser

< Dispenser in open space for refueling > Fire service law
Current：Prohibited
⇒Set up as an annex to gasoline dispenser

Government, Automakers and energy suppliers are jointly working on regulation refining.

Future Cost Estimation by JHFC

Reference : JHFC 2011



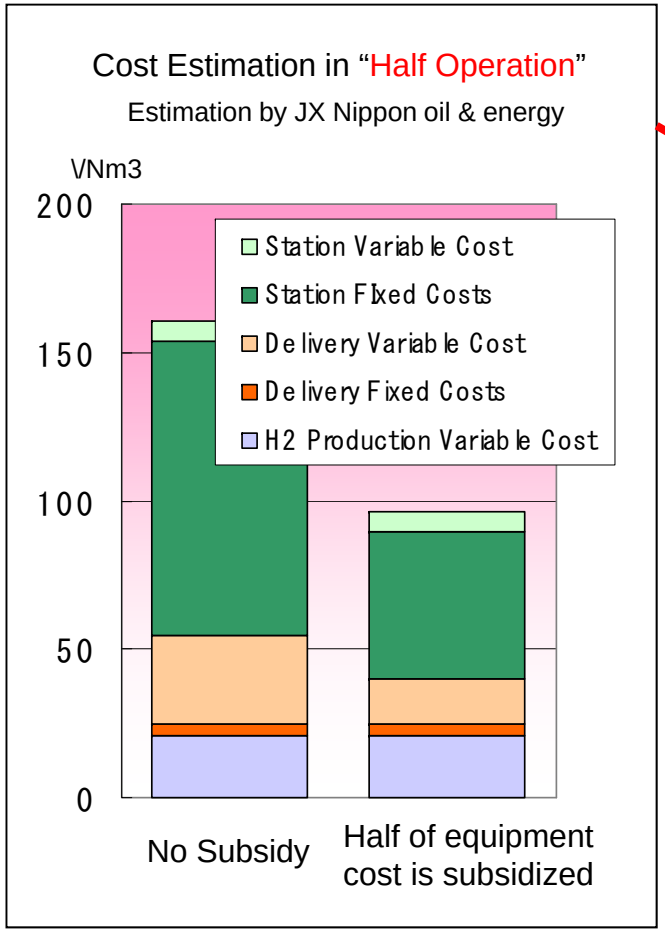
Assumption:

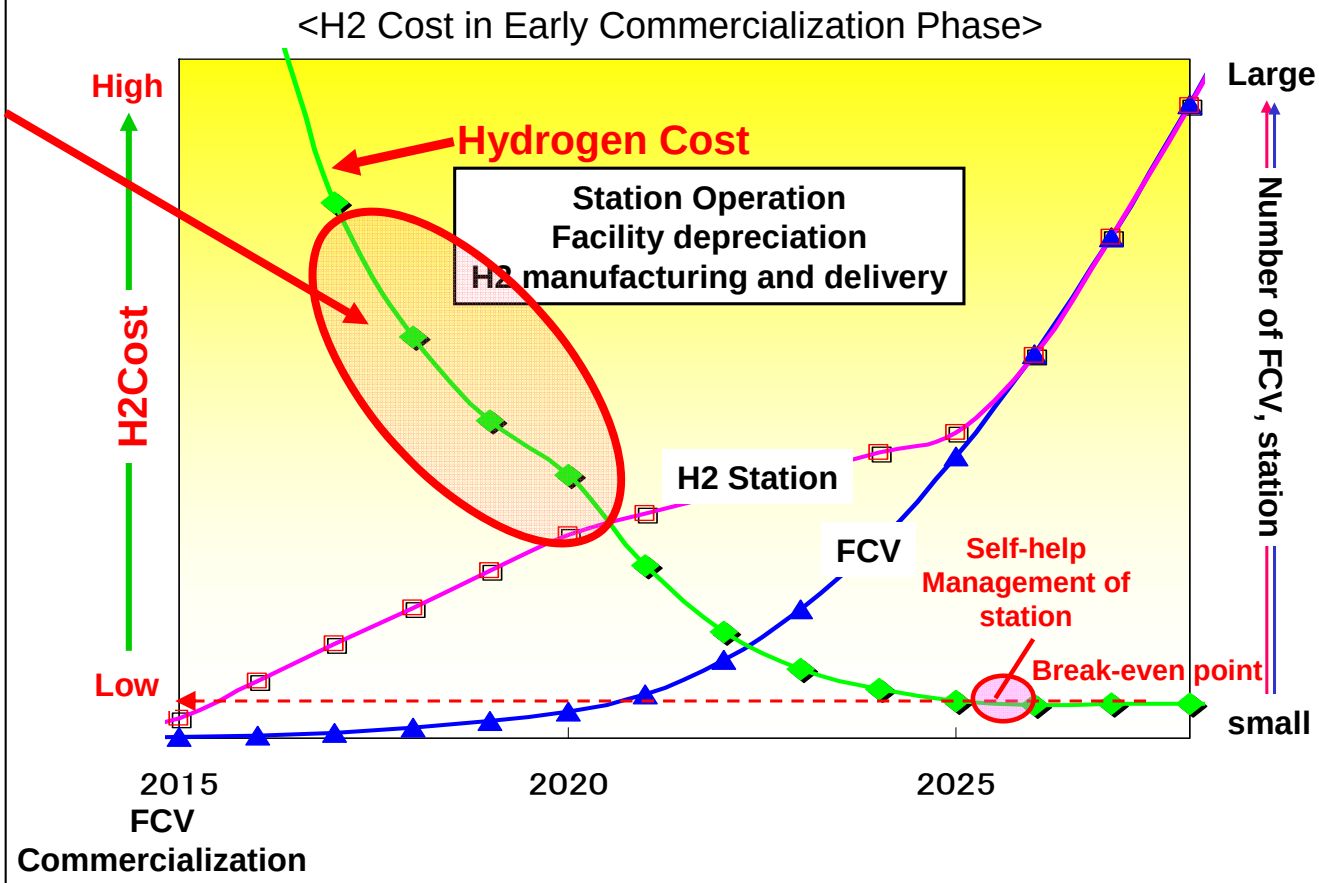
- 2015-2020 Technology & Regulation Estimation
- Station full operation
- 70Mpa-300Nm3/hr

“Cost” Issue during Early Commercialization Phase (2015-2025)

During early commercialization phase, hydrogen supply cost will be excessively high due to initial low sales numbers. Energy suppliers can not bear by themselves.

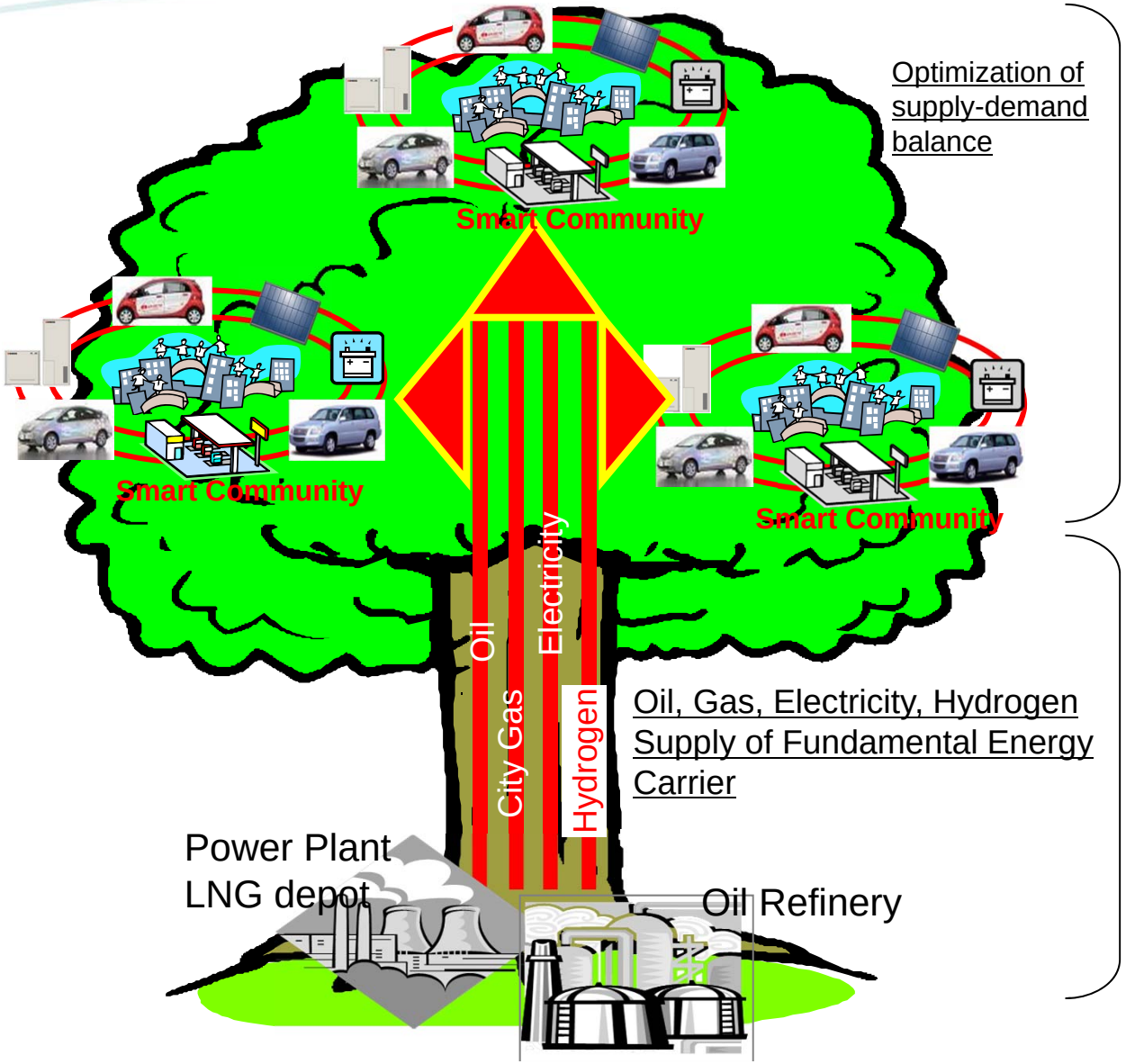
A system for cost-sharing (facility investment, subsidy/incentive for FCV/hydrogen purchase) by all Japan (government, makers, suppliers, consumers) is necessary.





Energy Innovation

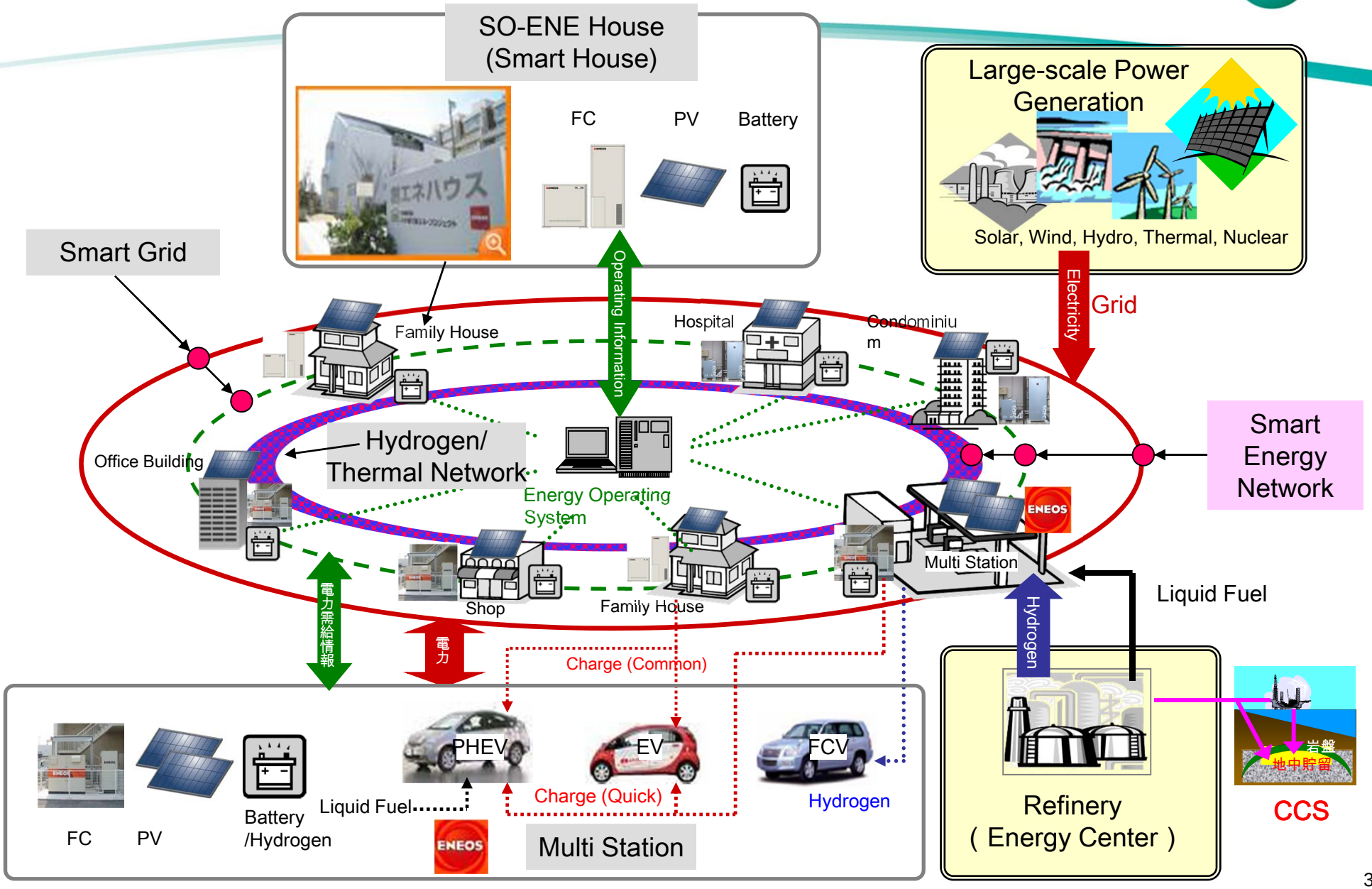
Hydrogen, The Forth Fundamental Energy Carrier



We will build hydrogen “The forth fundamental energy carrier” infrastructure for FCV deployment.

With hydrogen infrastructure, we will work on new society system creation by secure fundamental energy supply and optimization of supply-demand balance in “Smart Community”

Smart Energy Network



Thank you for your attention.