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Near-term Fuel Cell Applications in Japan

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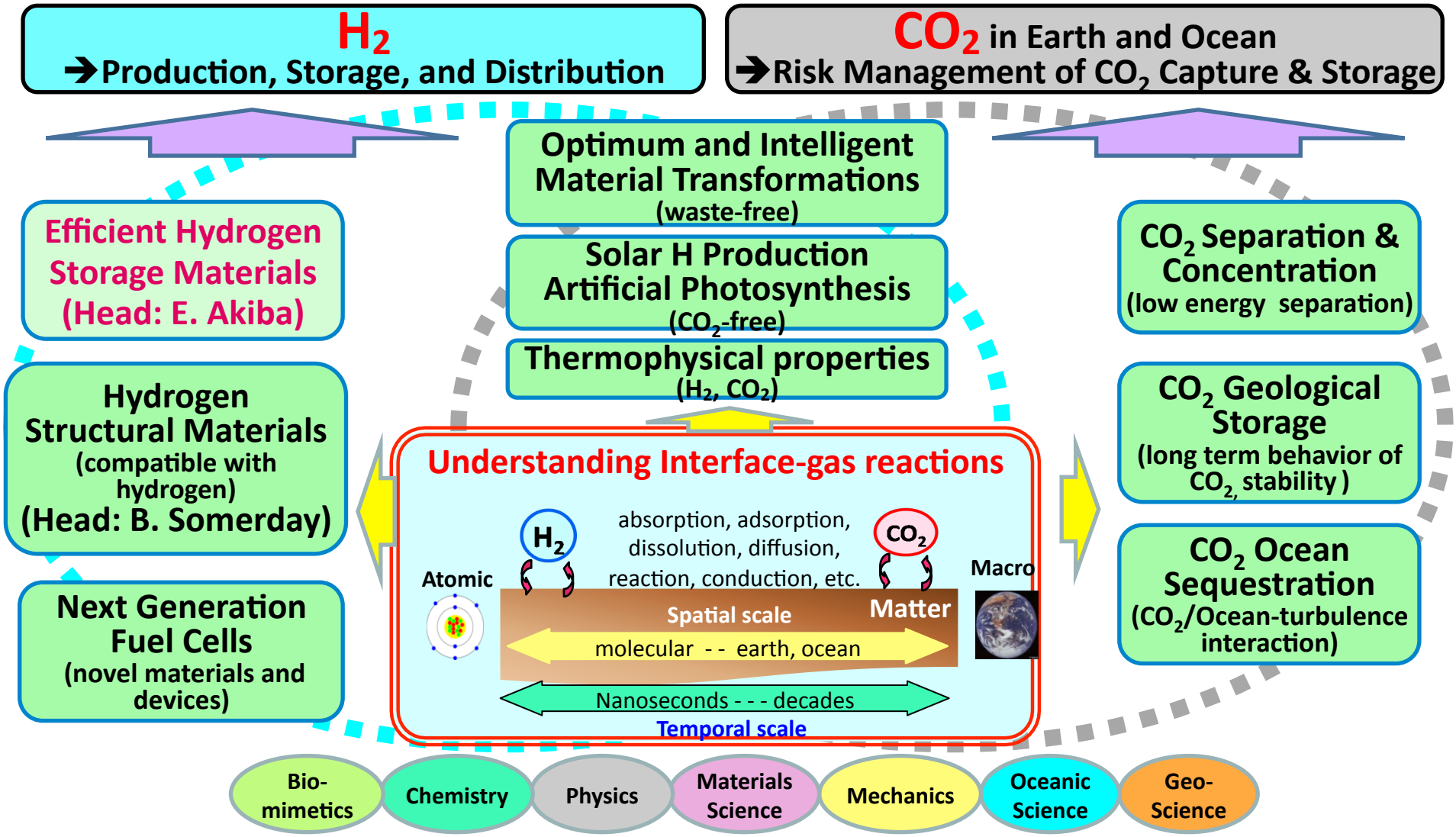
Kyushu University "Carbon-Neutral Energy Research Institute"

- Advance the fundamental science for a "Carbon-Neutral Energy Fueled World"
- Offer science-driven solutions for energy technologies that will enable environmentally friendly and sustainable development
- Reform the university research culture. Leadership by foreign director

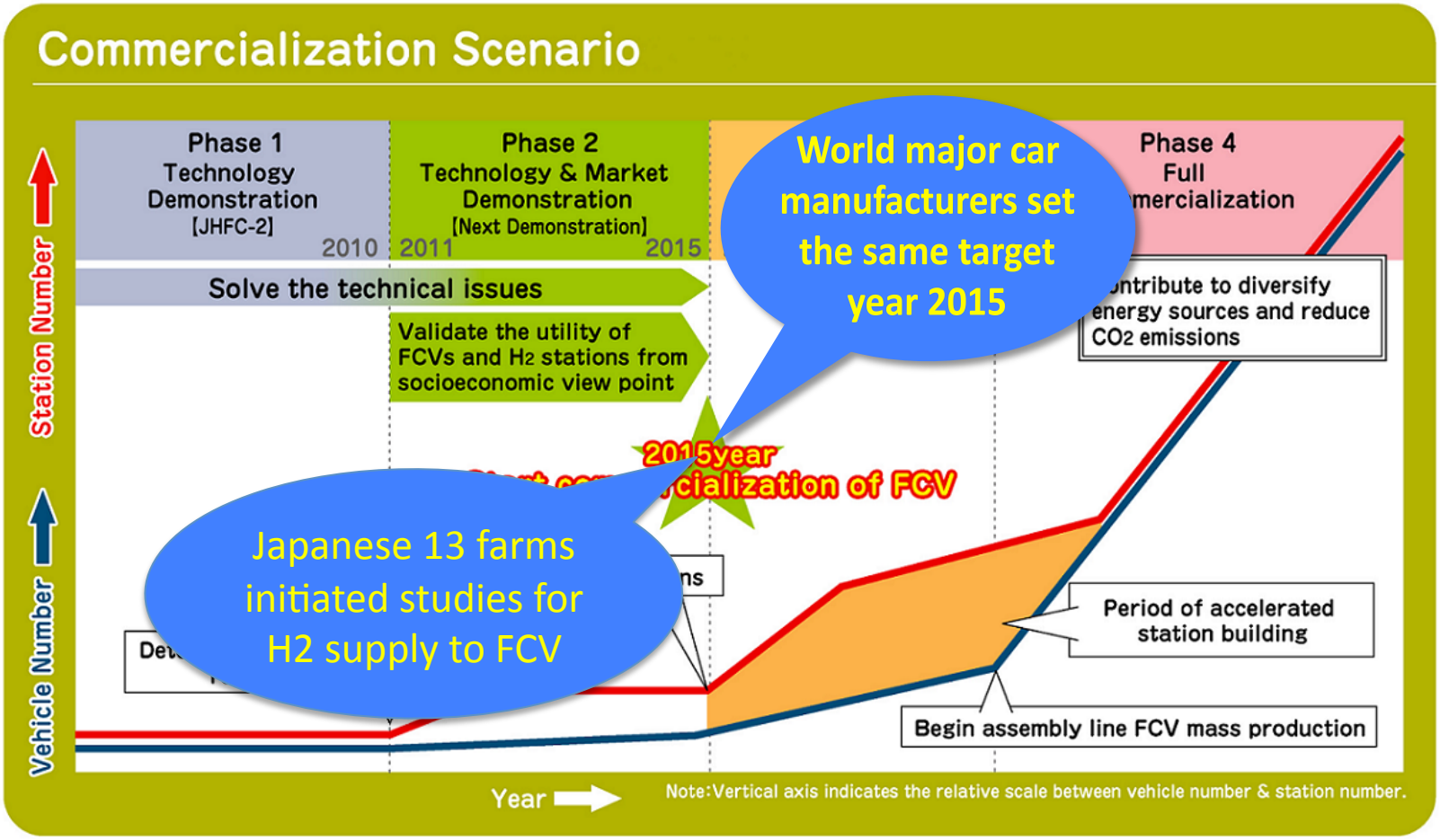


Content

- Japanese scenario for introduction of
- Fuel Cell Vehicles (FCV) and hydrogen refueling station
- Relaxation of regulations for hydrogen refueling stations is an very urgent task for the year of 2015
- Present and past activities for a near-term FC applications
- Hydrogen storage materials
- From our recent experience about a “soft material”

Fuel Cell Market Entry

Commercialization of FCV and hydrogen refueling stations

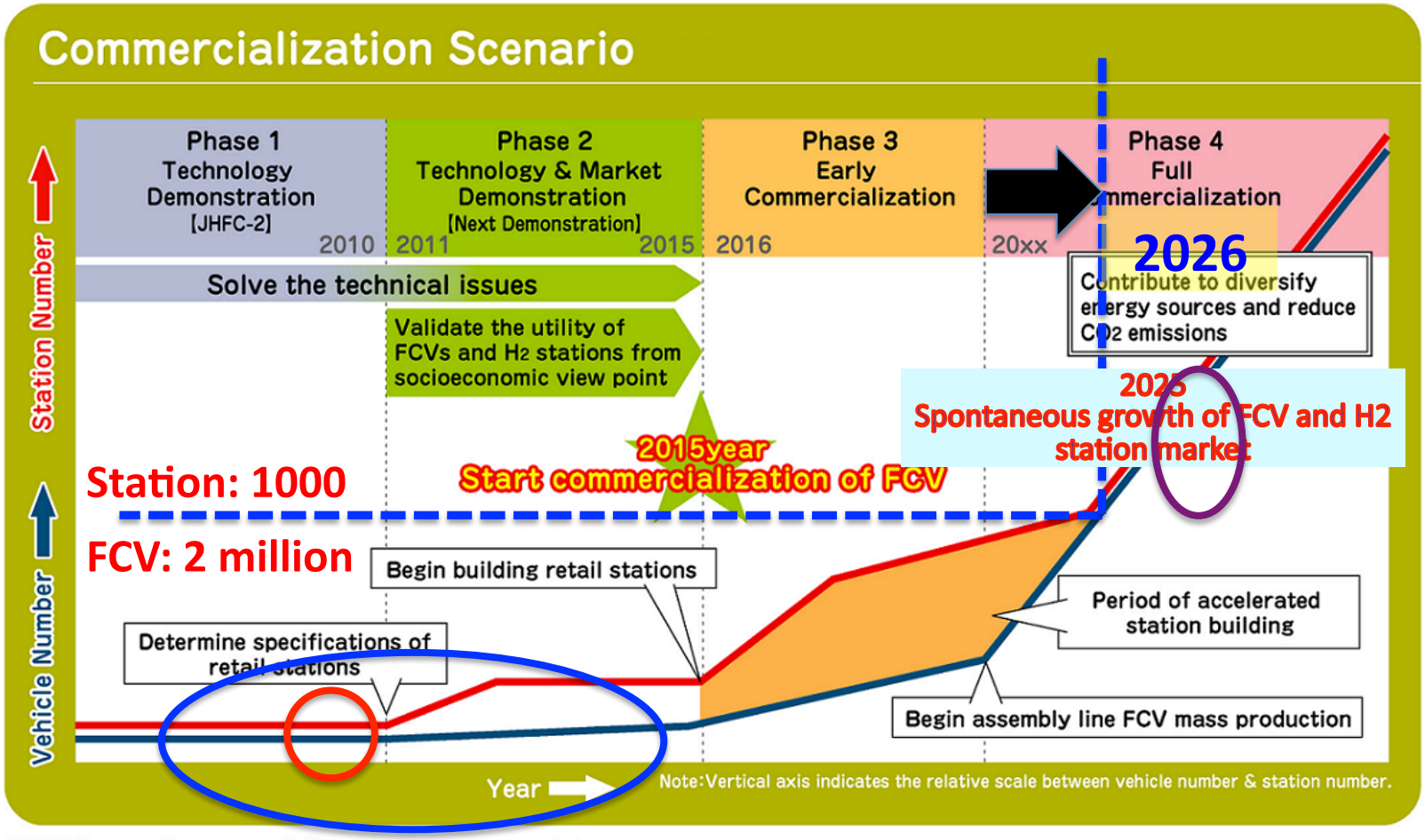


Leading automakers in and outside Japan and Japanese energy companies have agreed on a scenario which sees commercialization of fuel cell vehicles (FCVs) and hydrogen stations beginning in 2015.

Source : FCCJ, http://www.fccj.jp/pdf/20080704sks1e.pdf

Fuel Cell Market Entry revised March 2010

Commercialization of FCV and hydrogen refueling stations



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Modified by E.Akiba

FCV is a Long-term issue

- The expected number of FCV at 2025 in Japan is 2 million but that is **a few %** of passenger cars at present.
- Mass production of FCV will start **in 2030's at the earliest**.
- Near-term applications of fuel cell is significantly important but preparation for the year of 2015 should be started very soon.

Relaxation of Regulations by the end of FY 2012

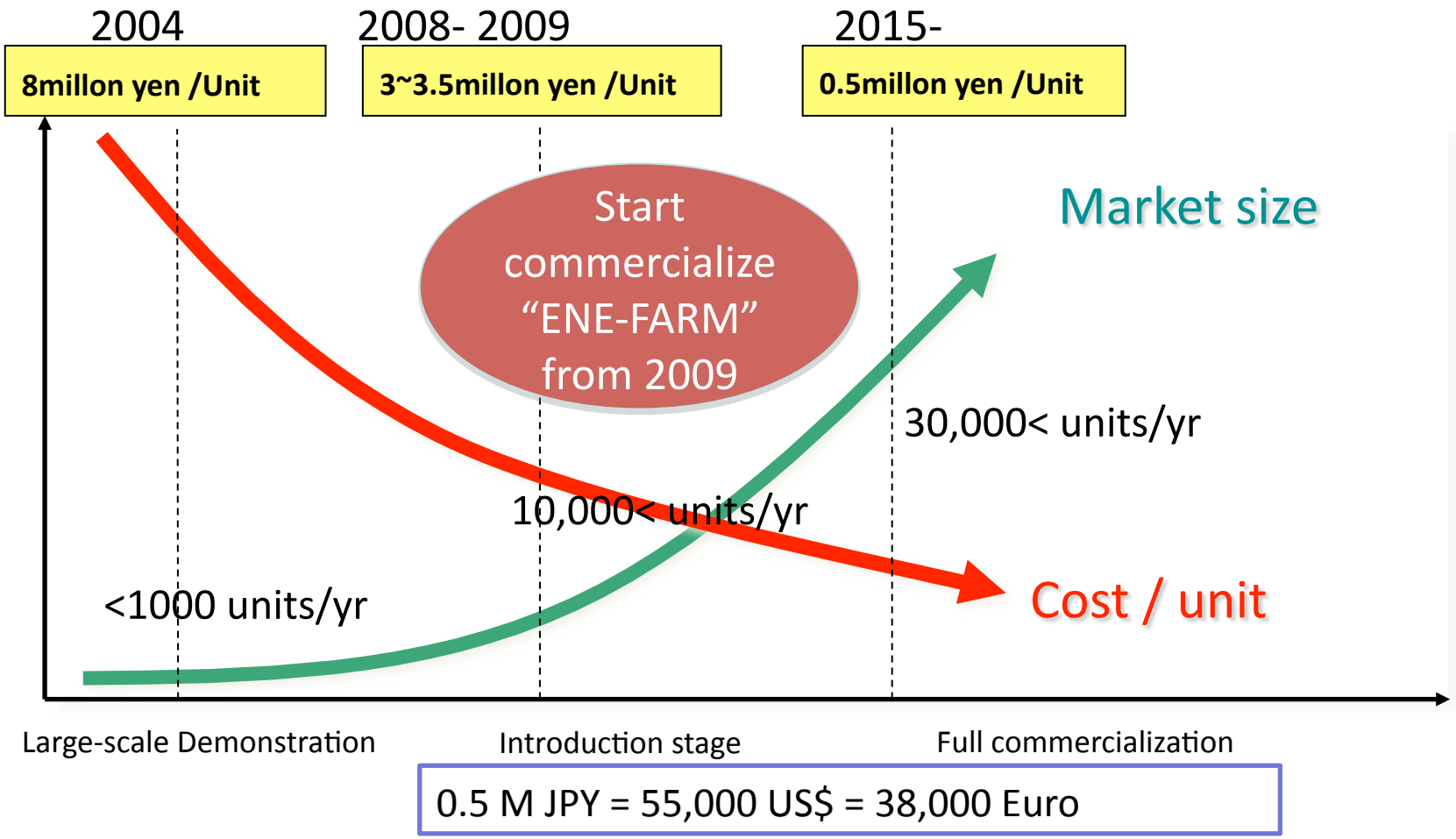
S-1	Establishment of Codes and Standards for 70 MPa station
S-2	Building H2 Station at the Same Place to CNG station
S-3	Simplification of Safety Inspection
S-4	Increase of Hydrogen Storage Capacity in Residential Area
S-5	Relaxation of Safety Factors
S-6	Expansion of Applicable Steel for Hydrogen Vessel
S-7	Application of Composite Tank for Delivering
S-8	Application of Composite Tank for Stationary Storage

Near-term applications of FC and Hydrogen in Japan

- Stationery Applications
- - Residential fuel cell
- - Energy storage
- Mobile Application but Niche Market?
- - Motorcycle
- - Train
- - Other special applications

Scenario of Market Creation for Residential Fuel Cell

Large-scale Demonstration Project → Market creation by government support → Full commercialization Self sustained and growing market



0.5 M JPY = 55,000 US$ = 38,000 Euro

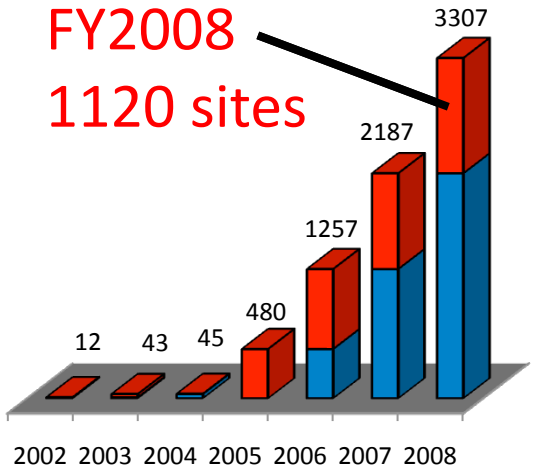
Large-Scale Stationary Fuel Cell Demonstration Project
- Experience of over 3,000 installations -

Residential FC 1 kW class

Reduction

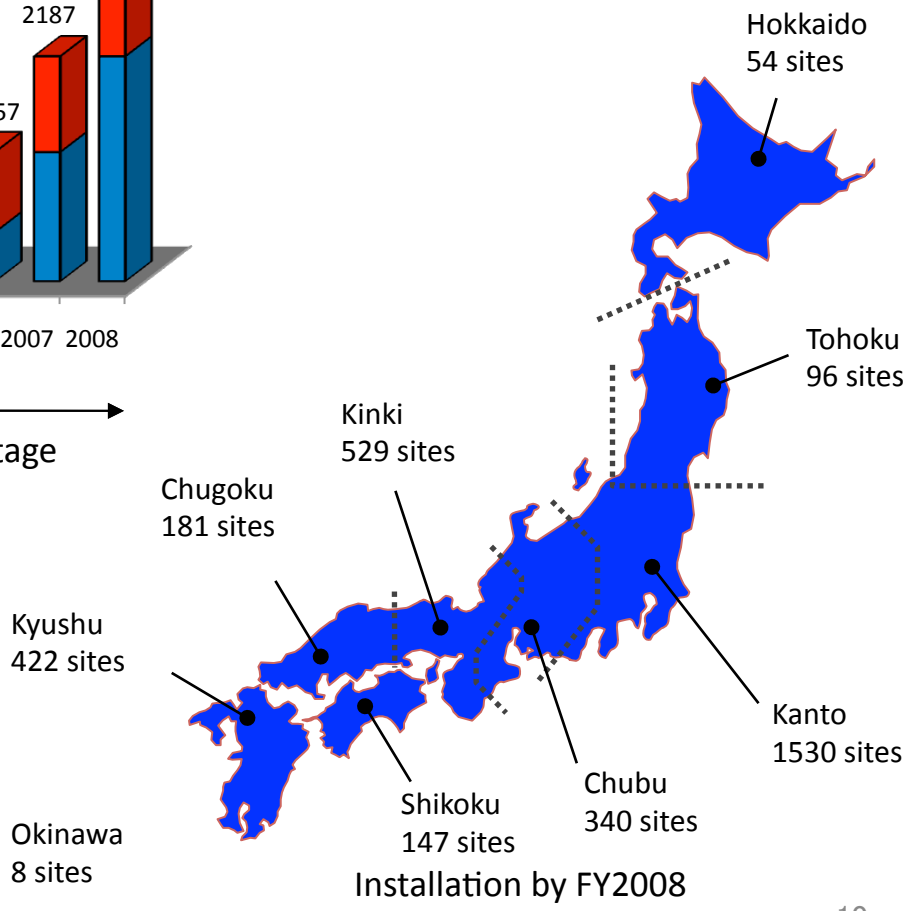
Energy Consumption : 24%
CO2 Emissions : 39%

※Based on data from 83 homes where top performing systems were installed in FY2006



Breakdown by Fuel

Fuel	Systems
LPG(Propane)	1,614
Natural Gas	1,379
Kerosene	314
Total	3,307



Installation by FY2008

Fuel Cell Market Entry
- Commercialization of Residential Fuel Cells -

“ENE-FARM” is the common name of the products

“The first shipping” ceremony of residential fuel cell

Over 2500 installations by December 11, 2009

Production capacity : 10,000 units/year
40,000 units/year by 2015

Stationary Fuel Cell Systems（1kW class）

ENEOS CELLTECH
Your Choice of Energy

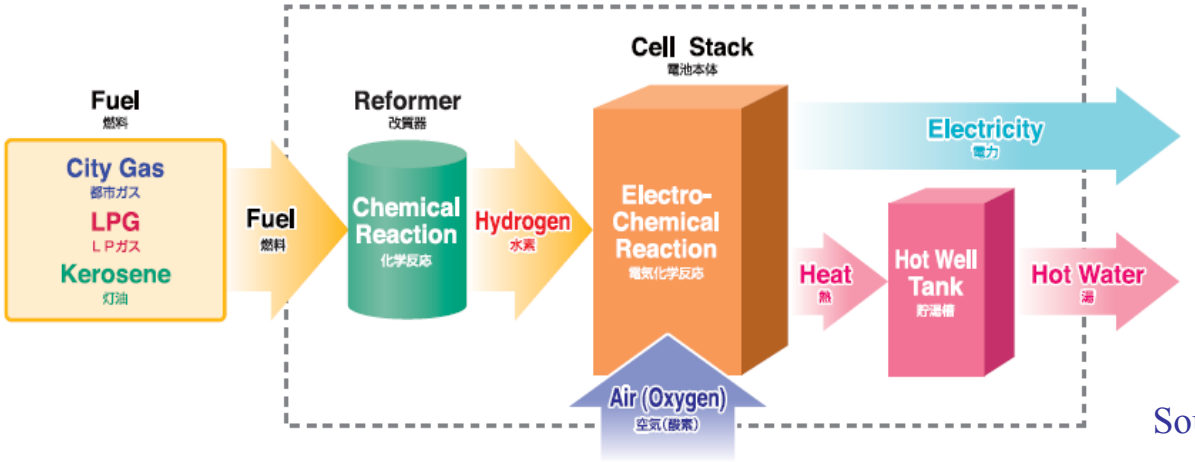
TOSHIBA
Leading Innovation

Panasonic
ideas for life

家庭用燃料電池コージェネレーションシステム
ENE・FARM
エネファーム

“ENE-FARM”
- The unified logo for Residential Fuel Cells

Market launch of “*ENE-FARM*” in 2009 following to Large-Scale Demonstration Project



Source : New Energy Foundation (NEF)

Subsidizing Policy for Residential Fuel Cells

Budget: 6.07 B JPY for FY2009 (FY2009-2013)

Subsidy for the purchase expanse to promote the introduction of Residential Fuel Cell co-generation system.

Summary

To stimulate the initial domestic market demand of the Residential Fuel Cells, "*ENE-FARM*", the subsidization program was started in April 2009.

5000 unites are installed every year from 2009.

Requirements , etc

Recipient of the subsidy

Who installs and uses the Residential FC co-generation system, or who leases out the system to the end-users.

The target system

- **System capacity : 0.5~1.5kW per unit**
- **Total energy efficiency : 80% or larger**
- **Hot-water tank : 150L or larger**

The minimum duration of the operation is six years

Amount of the subsidy

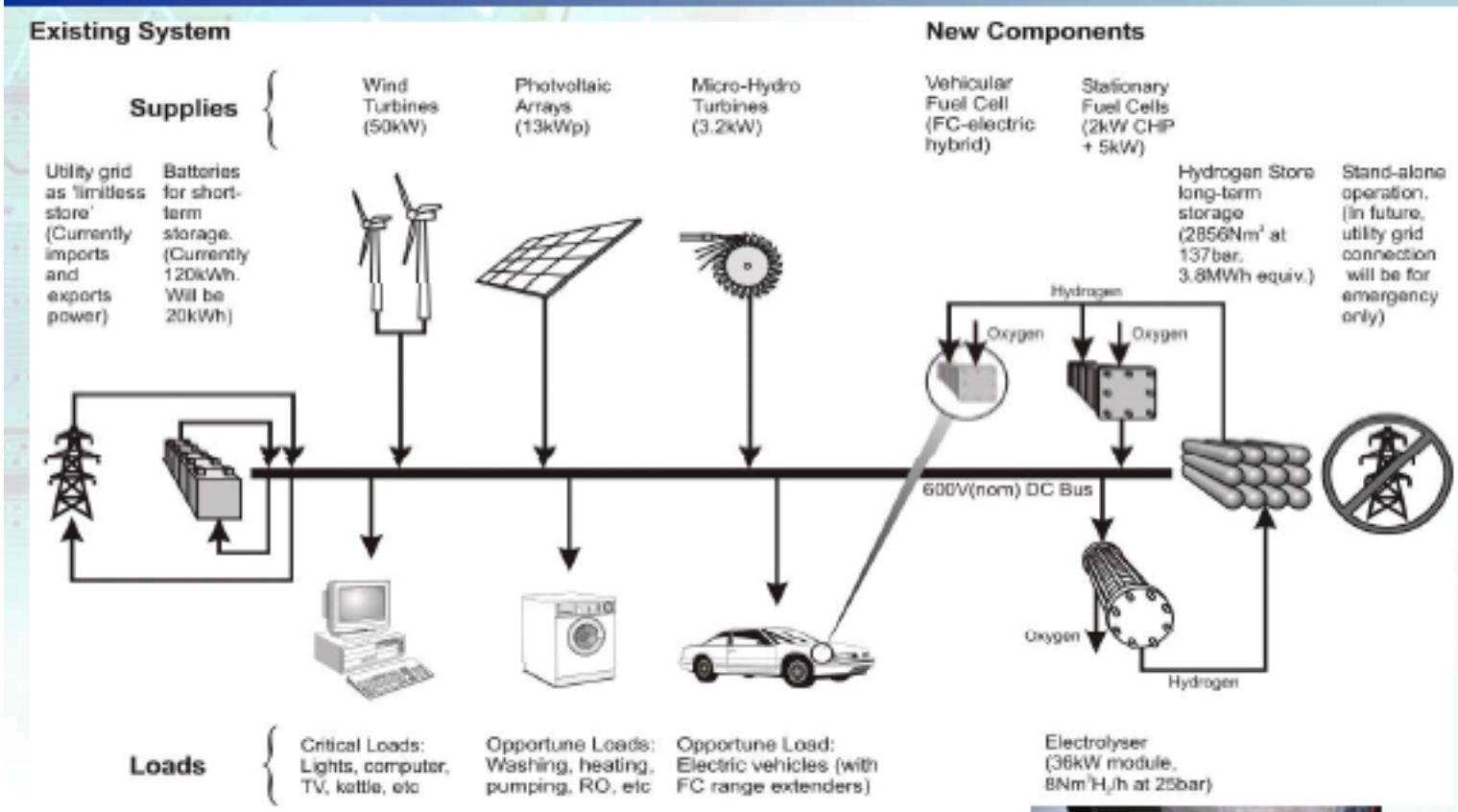
A half of the installation expense. (up to 1.4M JPY)

ENE·FARM エネファーム

National Institute of Advanced Industrial Science and Technology
AIST

HARI (Hydrogen and Renewable Integration)

R. Gammon at al. IEA/HIA Case studies (2006)
< http://www.ieahia.org/page.php?s=d&p=casestudies>




Electrolyzer


H_2 cylinders

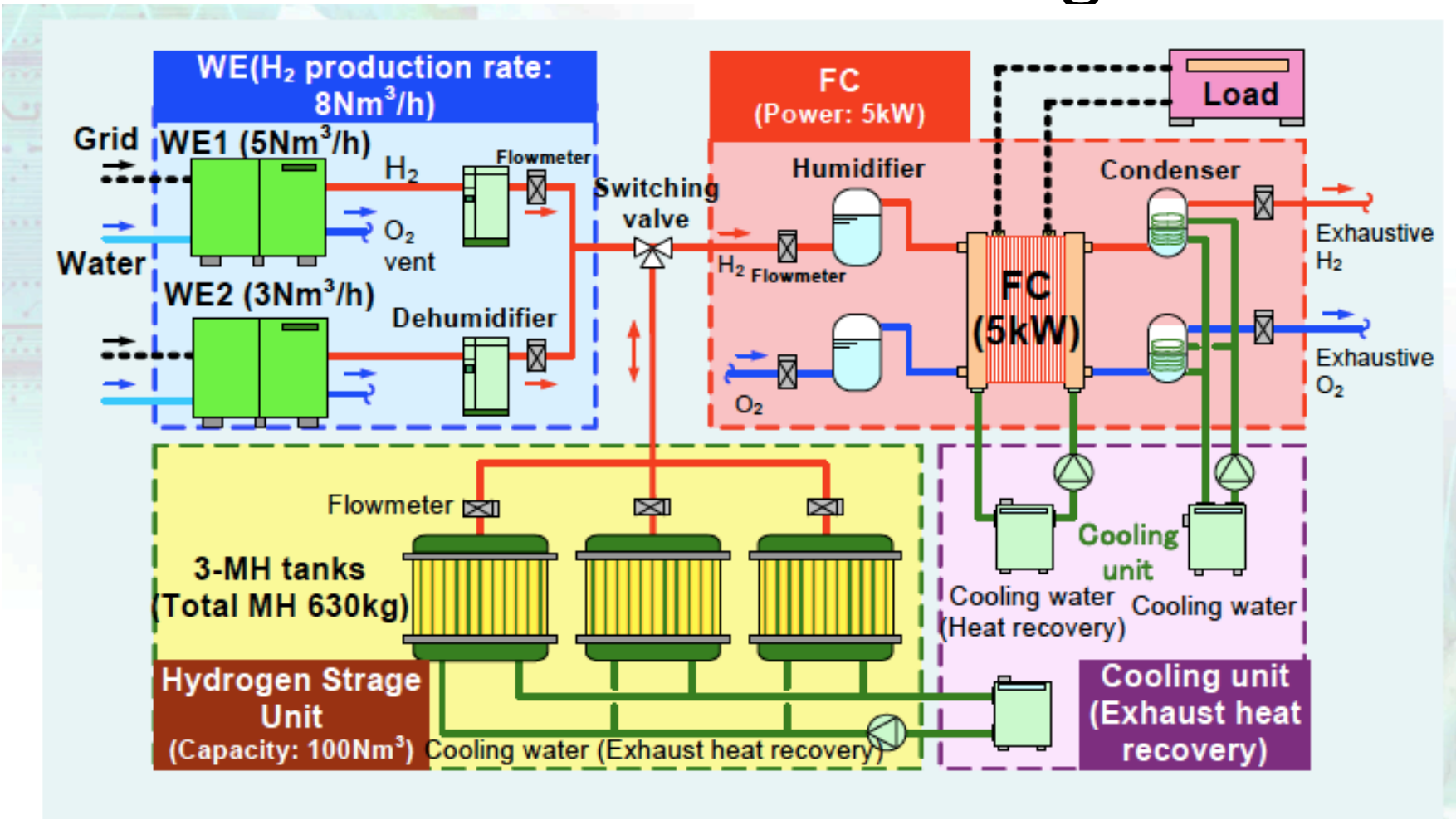

Photovoltaic arrays


Wind turbines


NiNaCl battery (Zebra, 2kW)


Fuel cell

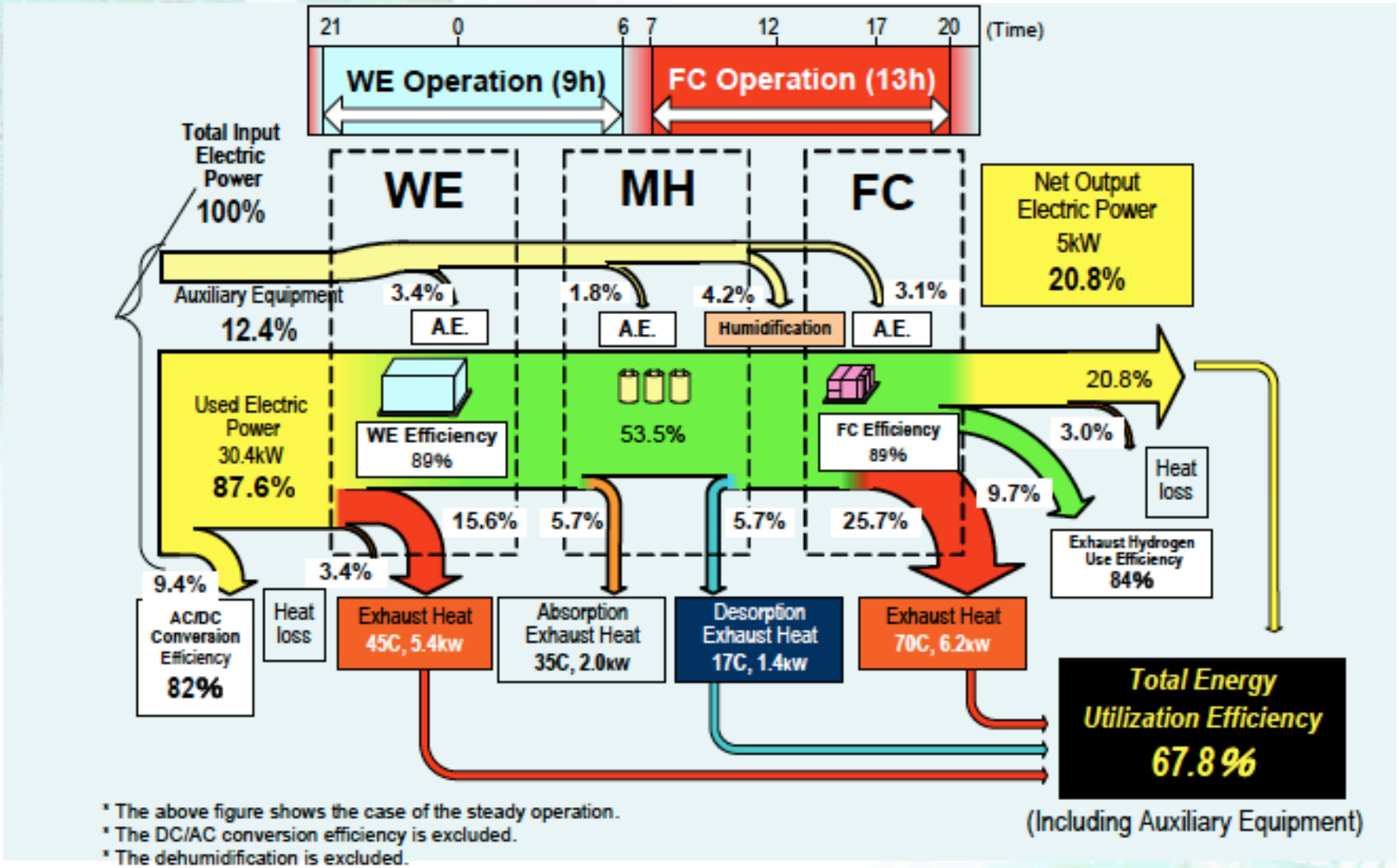
Energy storage using hydrogen storage materials for building



Courtesy to Dr. Hiroshi Ito of AIST

National Institute of Advanced Industrial Science and Technology
AIST

Results of operations



* The above figure shows the case of the steady operation.
* The DC/AC conversion efficiency is excluded.
* The dehumidification is excluded.

(Including Auxiliary Equipment)

Near-term applications of FC and Hydrogen in Japan

- Stationery Applications
- - Residential fuel cell
- - Energy storage
- Mobile Application but Niche Market?
- - Motorcycle
- - Train
- - Other special applications

Graph 1: Worldwide Motorcycle Production
(unit: 10,000 motorcycles)

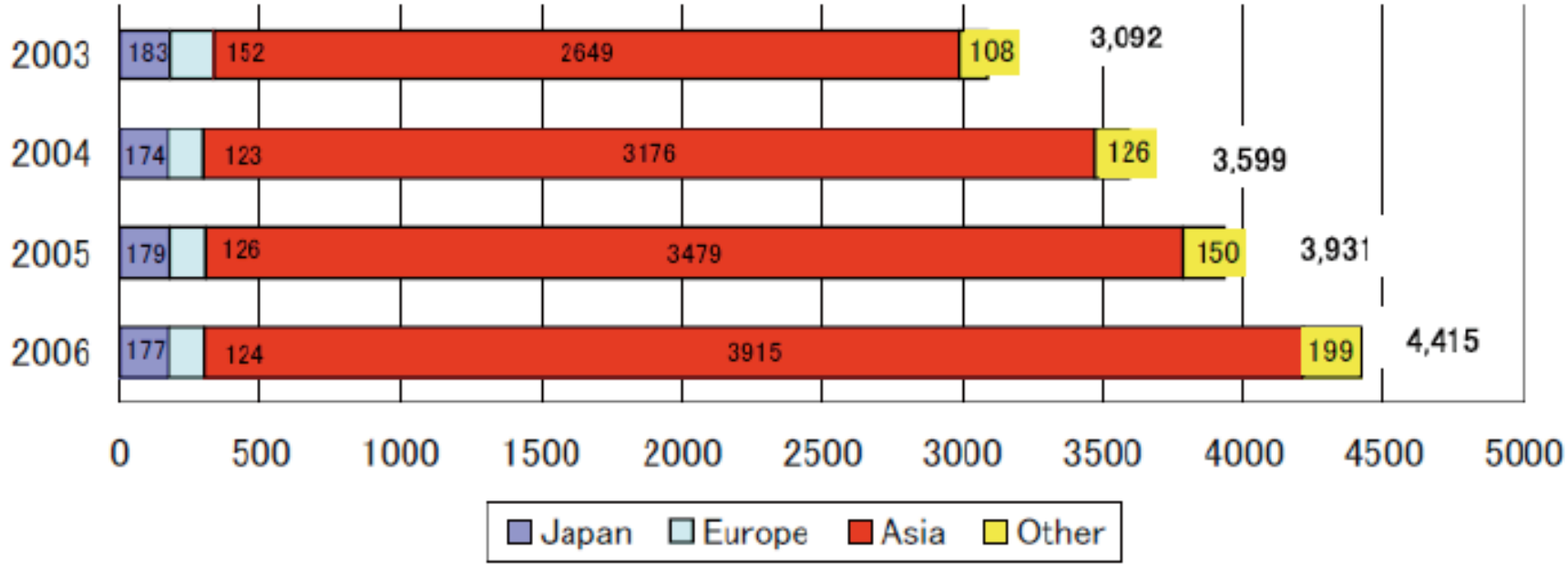


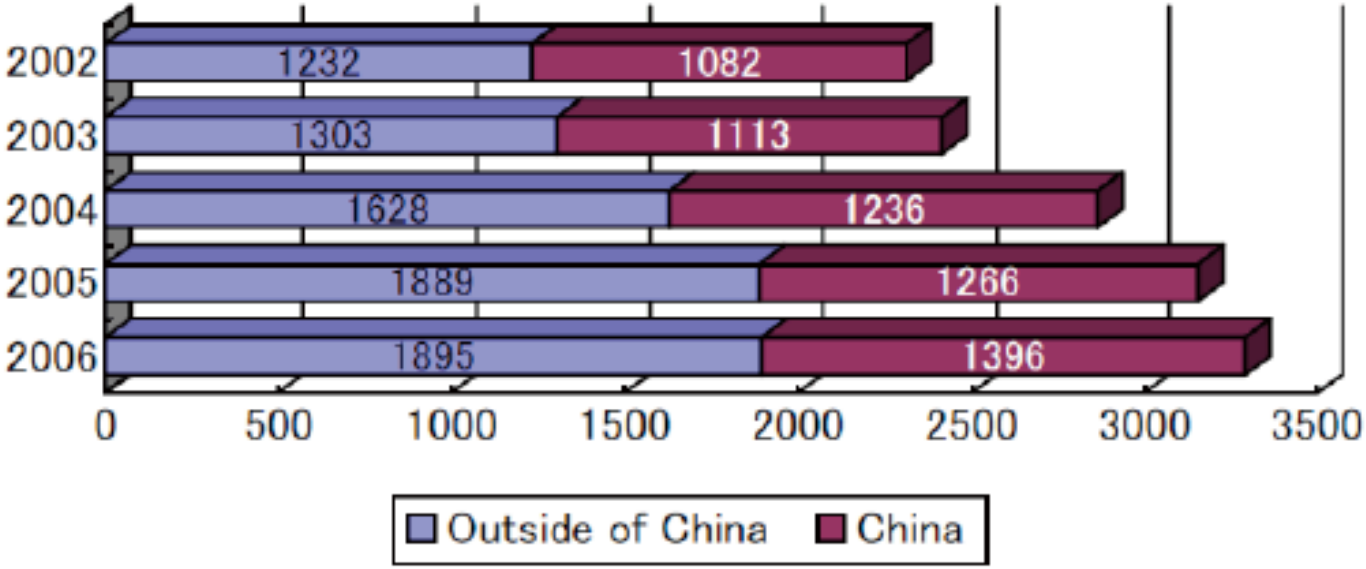
Table 1: Japanese Manufacturers' Share of Worldwide Production

Year	Worldwide unit production	Japanese maker unit production	Japanese maker share
2005	39.31 million	19.95 million	51%
2006	44.15 million	20.41 million	46%

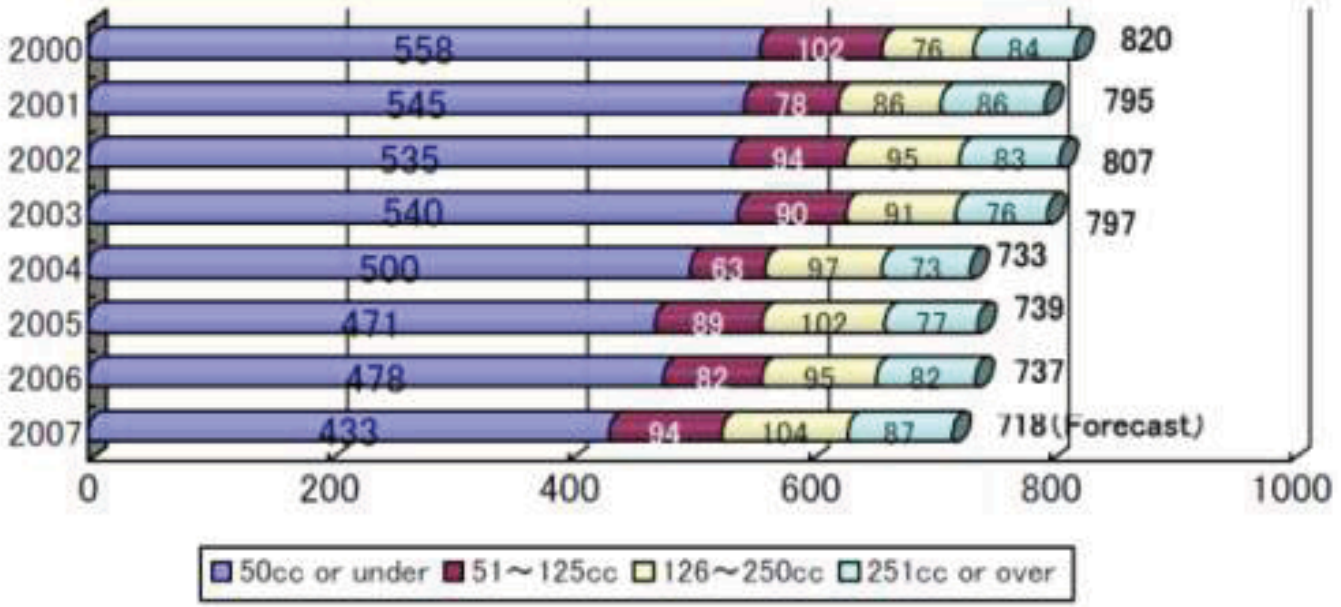
YAMAHA

資料:自工会

Graph 2: Motorcycle Sales in Asia[2] (unit: 10,000 motorcycles)



Graph 3: Japanese Domestic Sales (unit: 1,000)



YAMAHA

FC driven Motor Cycles

provided from YAMAHA Motor.

2005 2006 2007 **2008** 2009 2010 2011 2012

Direct methanol FC is appropriate for small mobile applications but the cost is too high.

ヤマハ㈱向け

PA電源

YMPC向け

汎用発電機

FC-me(05)

高性能
DMFCスタック

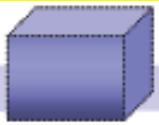
FC-Dii
(07)

FC-Dii
(08)

IMC向け

FC車椅子

Hydrogen FC is appropriate for larger mobile applications but hydrogen storage is an issue.



HFCスタック

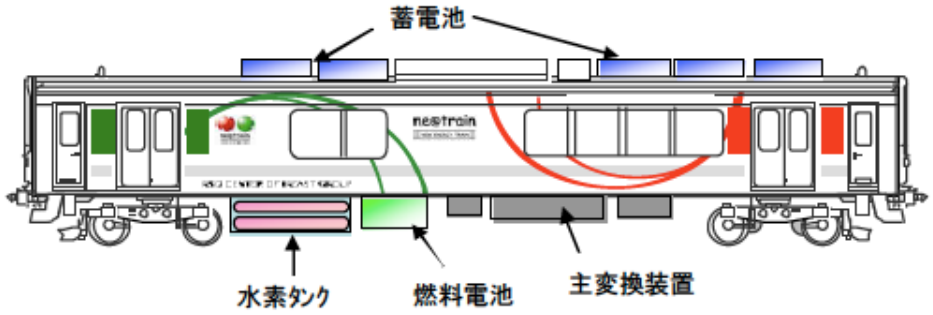
FC-AQEL
(06)

FC-AQEL (07)

三輪または四輪CV

FC train

- JR-East developed a FC
- train by the modification of
- Diesel hybrid train in 2006.
- The FC train was again
- modified to a battery train in 2009.



Cruising range and hydrogen infrastructure were issues.

Non-LDV applications under JHFC II

24V 250W PEFC ・Air cooling
H2 storage 180g / in 4 cylinders

Turret Truck

Turret Trucks are driven by battery power because they are used in fish market and/or inside of the building. Under a NEDO project, FC driven turret truck has been developed.

Battery driven

FC driven

ISO 16111:2008
Transportable gas storage devices -- Hydrogen absorbed in reversible metal hydride

- ISO 16111:2008 defines the requirements applicable to the material, design, construction, and testing of transportable hydrogen gas storage systems, referred to as “metal hydride assemblies” (MH assemblies) which utilize shells not exceeding 150 l internal volume and having a maximum developed pressure (MDP) not exceeding 25 MPa (250 bar).
- It only applies to refillable storage MH assemblies where hydrogen is the only transferred media. Storage MH assemblies intended to be used as fixed fuel-storage onboard hydrogen fuelled vehicles are excluded.
- ISO 16111:2008 is intended to be used for certification purposes.

Hydrogen storage materials

- provide higher volume density than compressed gas
- need not high pressure such as 70 MPa to store hydrogen
- possibly realize reasonable priced on board storage tank because expensive carbon fiber is not needed if the pressure is below 20 MPa. (Japanese ultimate cost target is 1000US$ for vehicle not a single tank)

From our recent experience about a "soft material"

Soft materials such as plastics, rubber and so on are used for static and "dynamic" parts of high pressure hydrogen system.

However, scientific studies of behaviors of soft materials under hydrogen atmosphere have not been carried out so far.

Especially, dynamic behaviors of soft materials that was found in a sealing part of valves is critical.

Summary

Japan has the scenario of commercialization of fuel cell vehicle and refueling station

To build hydrogen refueling station in 2015, relaxation of regulations is an very urgent task in Japan

Stationary fuel cell of 1 kW class has been installed more than 10,000 units

Near-term FC applications have been developed and demonstrated

Hydrogen storage materials possibly provide reasonable on board hydrogen storage tanks

Behaviors of non-metallic materials are one of critical issues

Acknowledgments

- Some of viewgraphs are provided from NEDO (New Energy Development Organization) and METI (Ministry of Economics, Trade and Industry)

- Special thanks to Mr. S. Adachi of YAMAHA Motor for providing some of viewgraphs.

- Dr. H. Ito of AIST also provides viewgraphs

Thank you