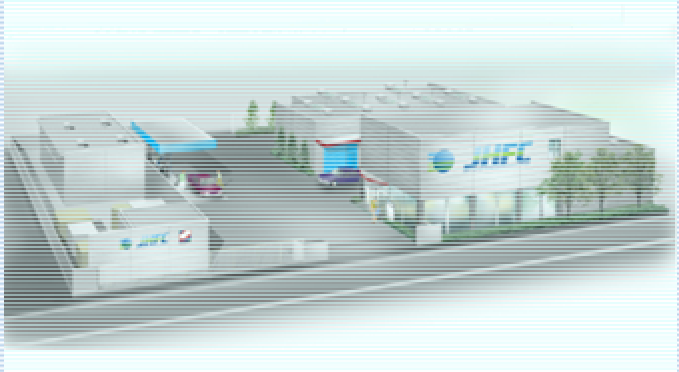
Hannover Fair 05:
International Conference
Hydrogen + Fuel Cells on their way to commercialisation

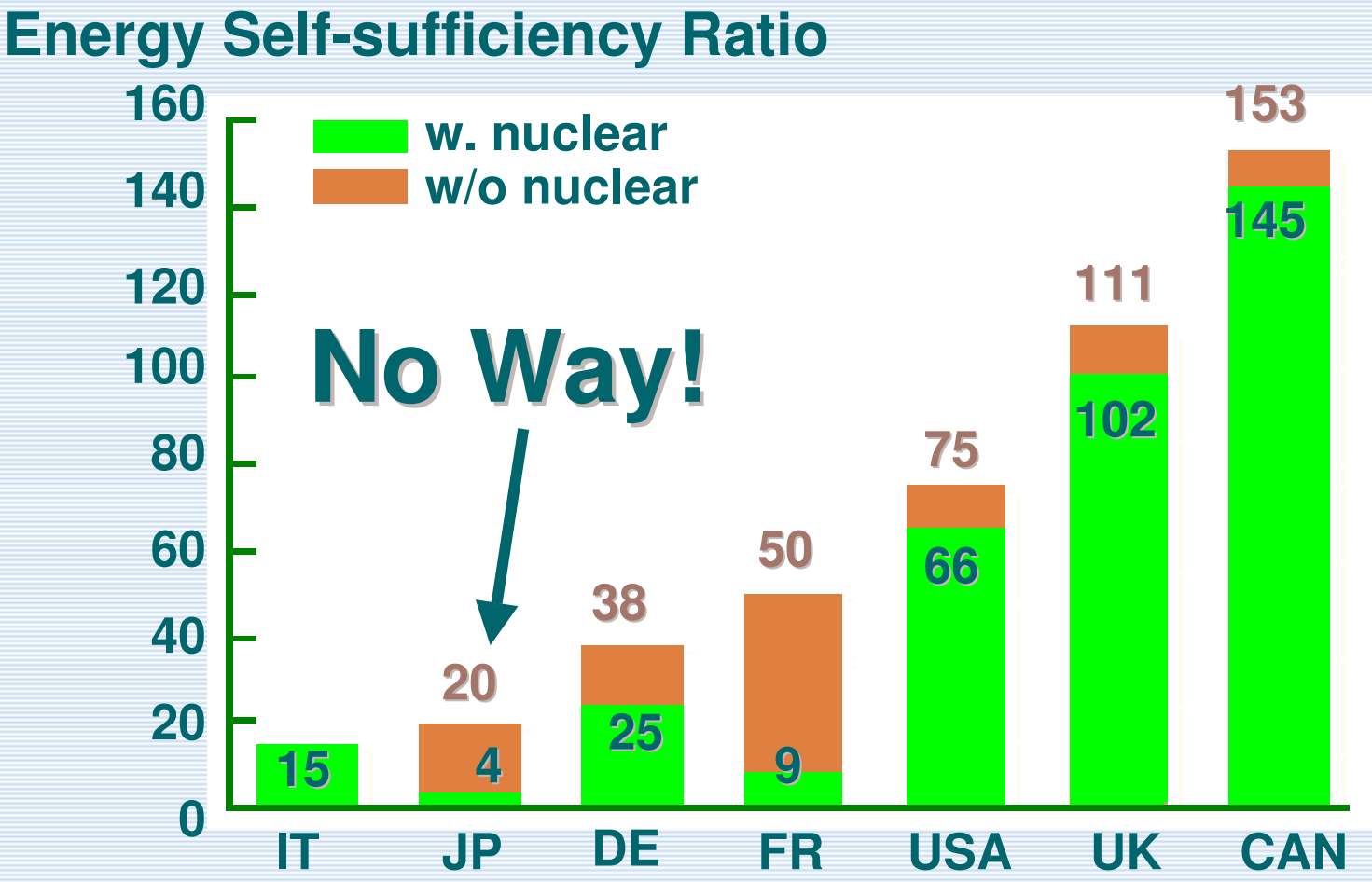
# Japan's Hydrogen and Fuel Cells Projects



Akiteru Maruta
TECHNOVA, Inc,
April 12, 2005

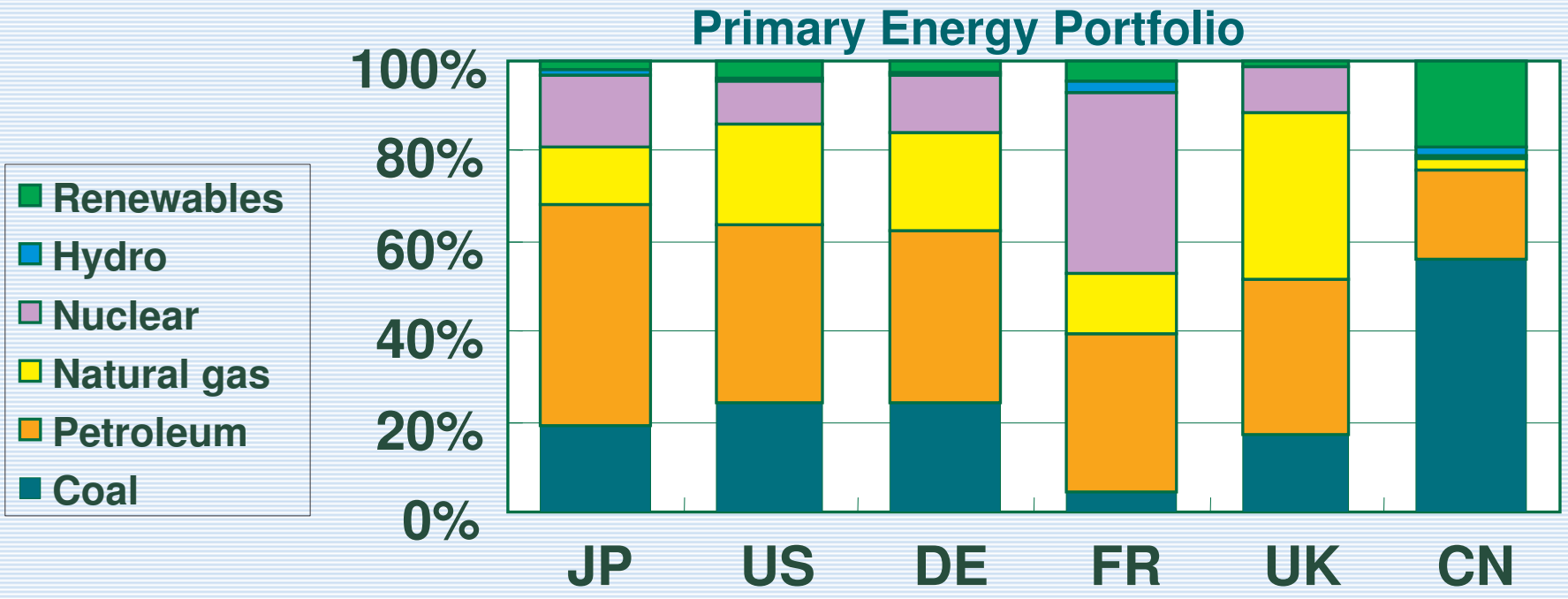
# 1. Why Japan Goes Hydrogen

# Energy Independence?




Source: IEA "Energy Balance of OECD Countries 2000-2001

# Oil Dependence?




| | JP | US | DE | FR | UK | CN |
|---|---|---|---|---|---|---|
| Foreign Oil Dependence | 99.7% | 59.8 % | 97.1 % | 98.1 % | - 49.4% | 28.1 % |
| ME. Dependence ratio | 85.7 % | 22.8 % | 10.7 % | 28.6 % | 5.6 % | 56.2 % |

**Japan needs energy diversity,**
**not energy independence.**

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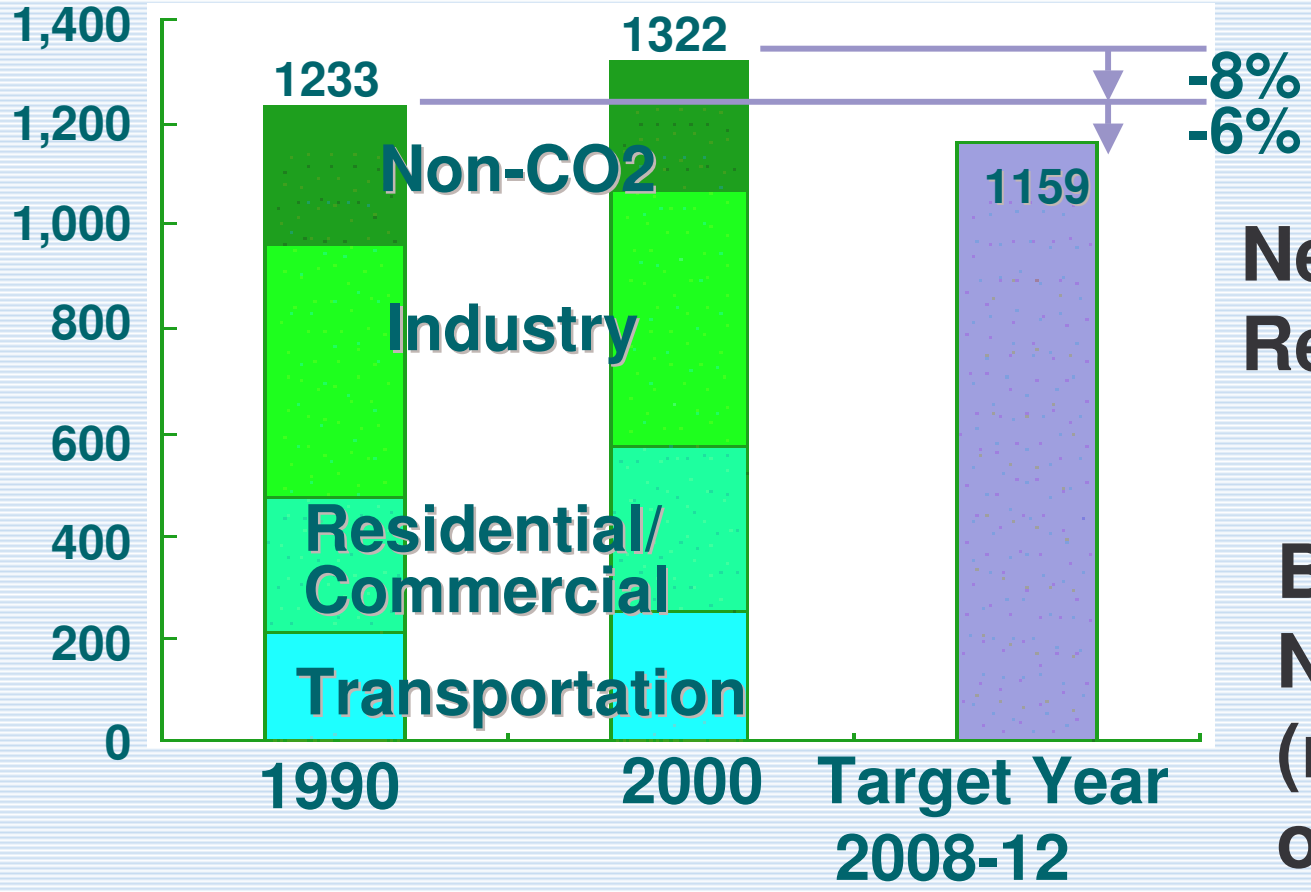
# Meet Kyoto Protocol Requirement

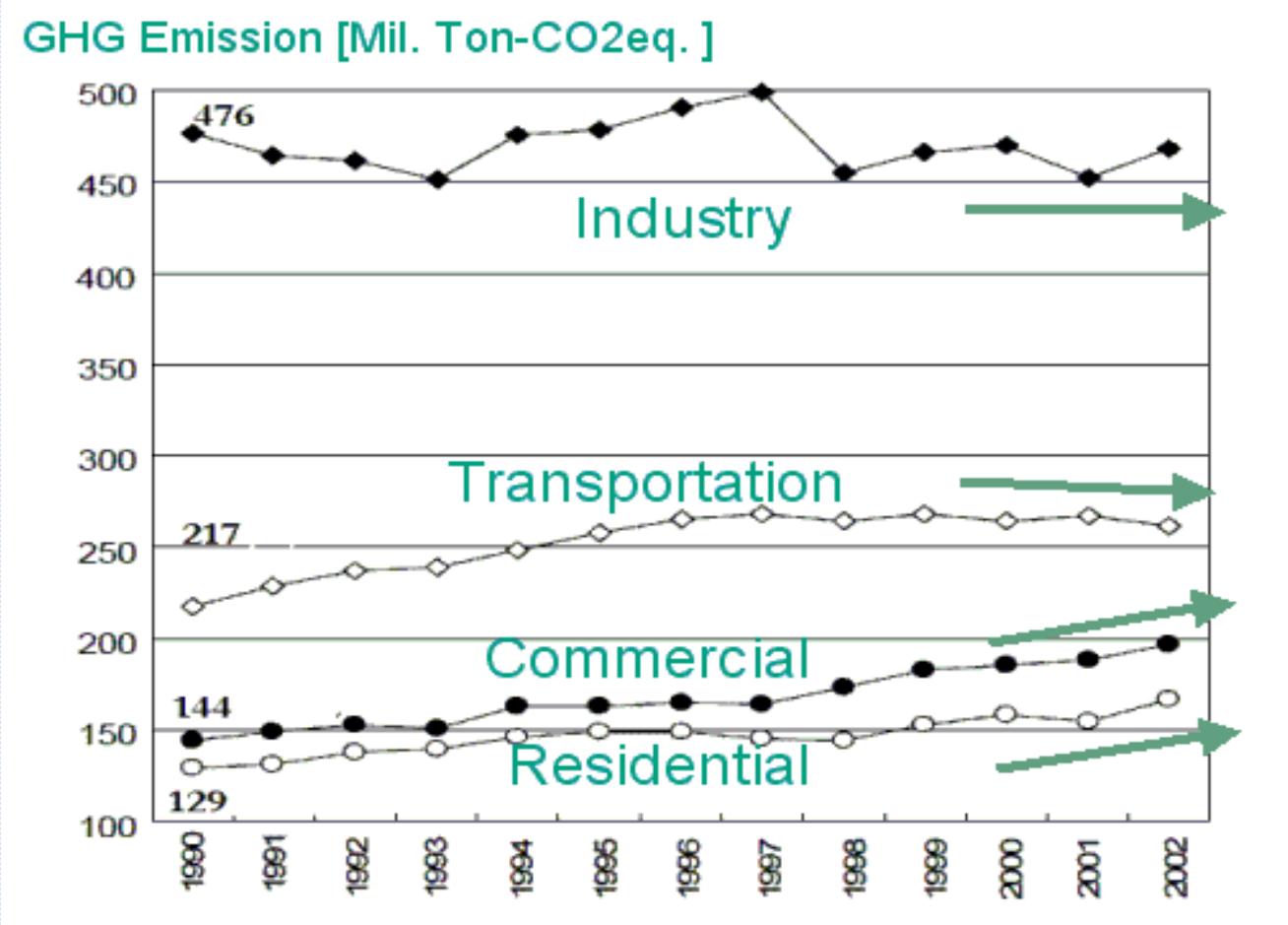
GHG Emission [Mil. Ton-CO2eq. ]




Need –14% Reduction

But how?
No work
(no TV, too)
on Monday?

# GHG: Which Sector is problem?




**Need measures for Residential / Commercial sectors**

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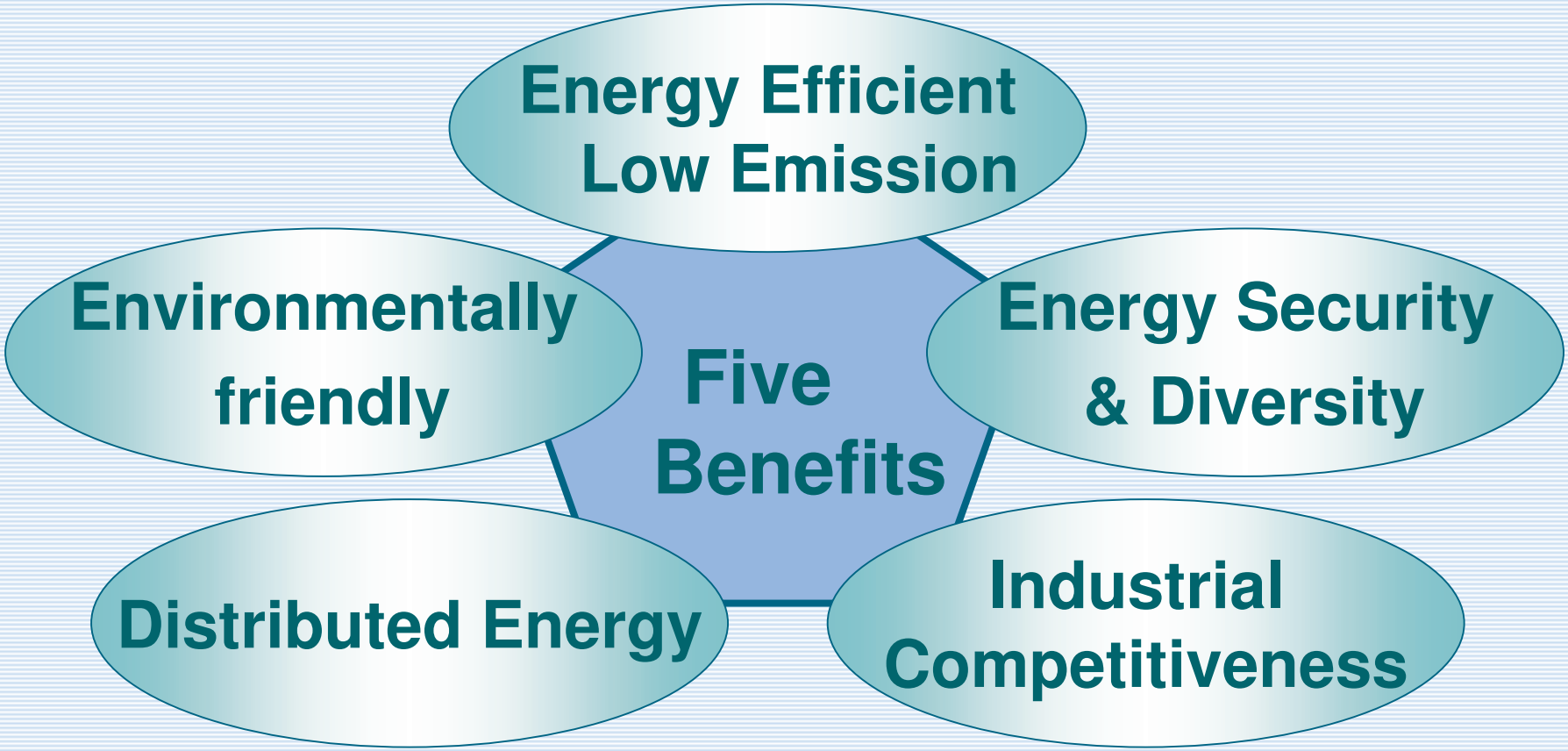
# Why Japan Goes Hydrogen

**METI Promotes Fuel Cells / Hydrogen ---- Five Benefits**

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# 2. Japan's Hydrogen Projects

# Japan's Policy on Fuel Cells

| | |
|---|---|
| 2001.1 | Policy Report by *Policy Study Group for Fuel Cell Commercialization*<br>- FC commercialization targets for 2010/2020 |
| 2001.3 | Establishment of *Fuel Cell Commercialization Conference of Japan* (FCCJ) |
| 2001.12 | FCVs test-ride at Diet |
| 2002.2 | Administrative policy speech by PM Koizumi<br>- Commercialization target: within 3 years<br>- Introduction of FCVs as gov. fleet |
| 2002.10 | Summary on review process on overall regulations toward FC commercialization |
| 2002.12 | FCVs were delivered to the Government |

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# Fuel Cells: Japan's target

## Target

| FCV | Stationary PEFC |
|---|---|
| 2010 50,000 FCVs | 2010 2.1GW |
| 2020 5 Mil. FCVs | 2020 10 GW |
| 2030 15 Mil. FCVs | 2030 12.5 GW |

## Policies

| | 2002 - | 2005- | 2010- |
|---|---|---|---|
| | R&D Stage | Introduction Stage | Diffusion Stage |
| Infra | Demonstration Project | Step by Step Construction | Grow Naturally |
| Codes | Review of Regulations | | |
| R&D | R&D on FC and $H_2$ | Further R&D | |

Source: METI

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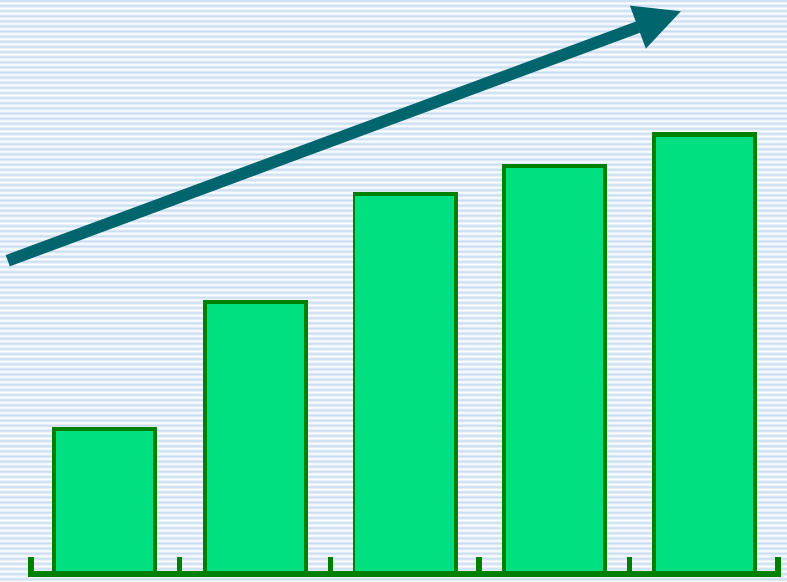
# METI's Budget for FC R&D

- 2001FY: 11.7 B yen
- 2002FY: 22.0 B yen
- 2003FY: 30.7 B yen
- 2004FY: 32.9 B yen
- 2005FY: 35.5 B yen

(requested)



Source: METI

**METI's budget for fuel cell R&D is increasing.**

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# Industry's Supports for Fuel Cells

## Keidanren (Japan Business Federation)

1,623 members

***FC supports from Keidanren***

**Chairman**

OKUDA Hiroshi (Toyota) ← FCVs / Stationary FC

**Vice Chairmen**

- Nippon Steel ← JHFC
- Toshiba Corporation ← UTC-FC
- Honda Motor ← FCVs / Stationary FC
- Canon
- NGK ← SOFC
- Bank of Tokyo-Mitsubishi
- Sumitomo Corp. ← SOFC
- Hitachi ← Stationary FC
- Mitsubishi Heavy Industries ← Stationary FC
- Sony
- Takeda Pharmaceutical
- NTT
- Sumitomo Chemical ← FC components
- NYK Line
- Tokyo Electric Power

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# Two Government Projects

## *"PEFC System Demonstration Project" by METI*

### < Stationary >

**Stationary FC Demonstration Study**

*Agency: New Energy Foundation (NEF)*

### < Automotive >

**JHFC Project**
(Japan Hydrogen & Fuel Cell Demonstration Project)

**FCV Demonstration Study**

*Agency: Japan Automotive Research Institute (JARI)*

**Demonstration Study of Hydrogen Station**

*Agency: Engineering Advancement Association of Japan (ENAA)*

**Source: METI/JARI**

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# Stationary FC Demo. Study
## - *Project Framework* -

- Agency: NEF (New Energy Foundation, Japan)
- 31 stationary PEFCs from 11 manufacturers
- Various conditions
- Various fuels (Natural Gas, LPG, Kerosene)
- Output level: 0.5-5 kW (mainly 1 kW)

**National Brands**

- Toyota / Aisin
- Sanyo
- Hitachi
- Fuji Electric
- Matsushita
- Nippon Oil
- IHI (Ishikawajima)
- Mitsubishi Heavy Ind.
- Mitsubishi Electric

**Int'l Alliances**

- Ebara-Ballard
- Kurita-Nuvera
- Toshiba-UTC-FC
- Marubeni-Plug Power

Source: METI/NEF

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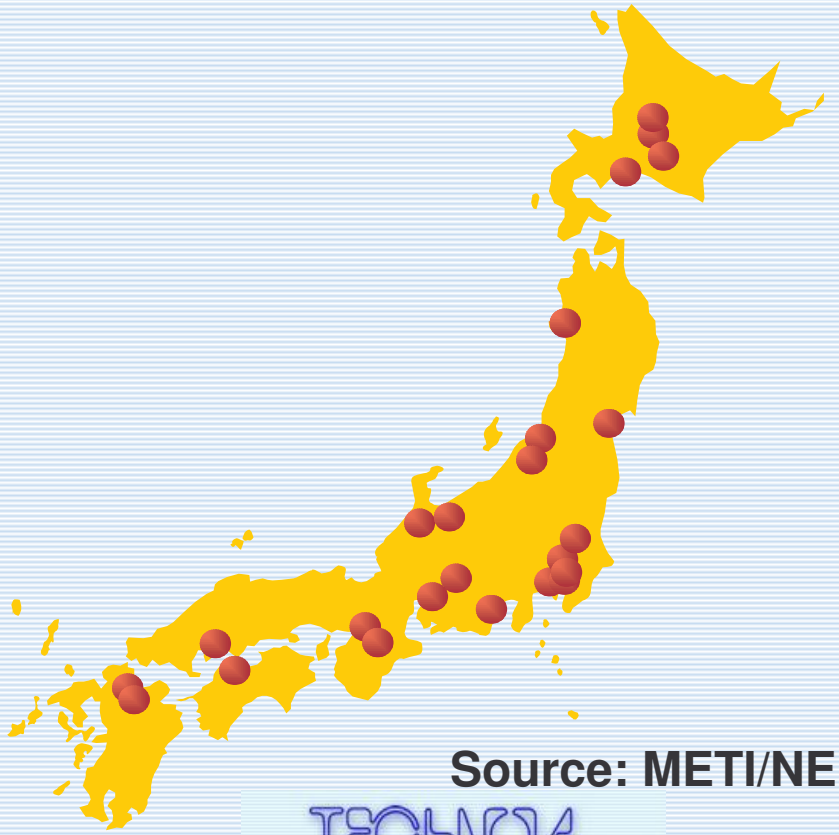
# Stationary FC Demo. Study
## - *System Requirements* -

<System Requirements>

- Gen. efficiency: 25%+ (HHV)
- Total efficiency: 60%+ (HHV)
- Heat temp: 55 C+
- Can be connected to grid
- Can supply hot water
- Easy operation
  (cf. air conditioner)
- Corporate support for FS

| 2002 | 2003 | 2004 |
|---|---|---|
| 12 sites | | |
| | 31 sites | |



Source: METI/NEF

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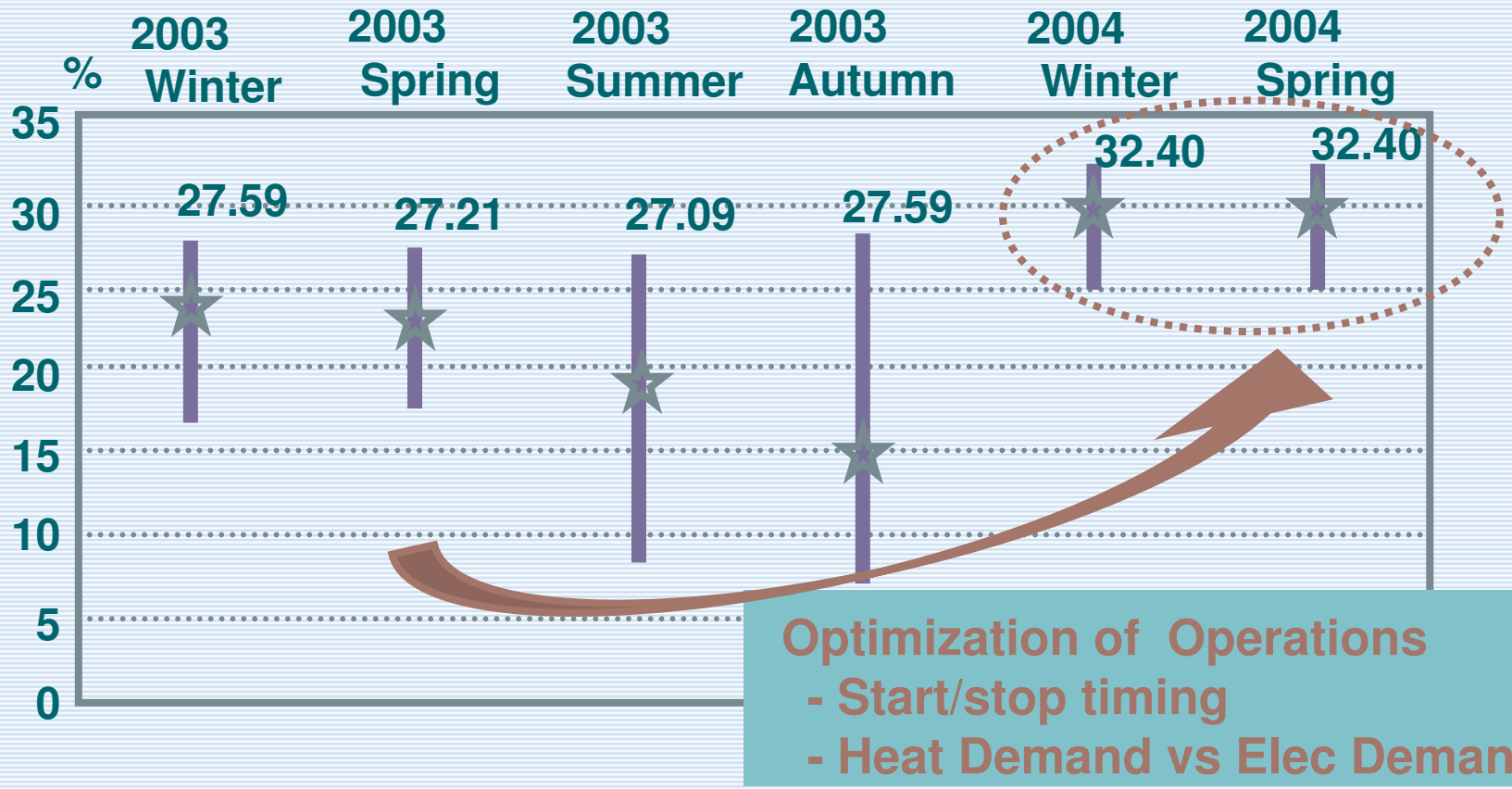
# Stationary FC Demo. Study
## - *Under the Real World* -

## Power Generation Efficiency




**32%+ efficiency under the Real World Conditions**

**"Learning by Doing"**

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# Stationary FC
## *- Next phase (FY 2005) -*

METI's New Stationary Project for 2005-2007

- Support for Mass Production (1 kW FCs)

| | Payback | Units | Cost Target |
|---|---|---|---|
| Today | | | 8~10 mil.yen |
| 2005 | 6 mil yen/unit X | 400 | ↓ |
| 2006 | 3 mil.yen/unit X | 1,000 | |
| 2007 | 2 mil.yen/unit X | 5,000 | <1 mil. yen (0.5 mil yen) |

**= METI's Success Story in New Energy Technology: Solar Panel**

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# Automobile: JHFC Project - Project Overview -

- **Test Vehicles**
  *Hydrogen FCVs*
- **Refueling Stations**
  *Hydrogen Stations (CH & LH)*
- **Period of Implementation**
  *2002 FY ~ 2005 FY (4 years)*
- **Amount of Subsidies**
  *2.0 Billion Yen ≒ $17 Million (2002 FY)*
  *2.5 Billion Yen ≒ $20 Million (2003 FY)*
  *2.0 Billion Yen ≒ $17 Million (2004 FY)*

**Source: JARI**

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# Automobile: JHFC Project - Project Partners (1) -

| | |
|---|---|
| TOYOTA | Toyota Motor Corporation |
| NISSAN | Nissan Motor Co., Ltd. |
| | Honda Motor Co., Ltd. |
| DAIMLERCHRYSLER | DaimlerChrysler Japan, Ltd. |
| GM | General Motors Asia Pacific Japan Ltd. |
| HINO | Hino Motors, Ltd. |
| MITSUBISHI MOTORS | Mitsubishi Motors Corporation |
| SUZUKI | Suzuki Motor Corporation |

Source: JARI

# Automobile: JHFC Project - Project Partners (2) -

| | |
|---|---|
| | Cosmo Oil Co., Ltd. |
| ENEOS | Nippon Oil Corporation |
| | Showa Shell Sekiyu K.K. |
| Iwatani | Iwatani International Corporation |
| TOKYO GAS | Tokyo Gas Co., Ltd. |
| NIPPON SANSO | Taiyo Nippon Sanso Corporation |
| JAPAN AIR GASES | Japan Air Gases, Ltd. |
| Nippon Steel Corporation | Nippon Steel Corporation |

Source: JARI

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# Automobile: JHFC Project - Project Partners (3) -

| | |
|---|---|
| KURITA | Kurita Water Industries Ltd. |
| SINANEN | Sinanen co., Ltd. |
| ITOCHU ENEX CO.,LTD. | Itochu Enex. co., Ltd. |
| IDEMITSU | Idemitsu Kosan co., Ltd. |
| BHK | Babcock-Hitachi K.K. |
| | Tsurumi Soda Co., Ltd. |
| TOHO GAS | Toho Gas Co., Ltd. |

**Source: JARI**

# Automobile: JHFC Project - Demonstration FCVs -

Nissan X-TRAIL

Honda FCX

Toyota FCHV

Toyota/Hino FCHV-BUS2

Suzuki wagon R-FCV

DaimlerChrysler F-Cell

General Motors Hydrogen3

MITSUBISHI FCV

Source: JARI

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# Automobile: JHFC Project - Demonstration FCVs -

| | Participated to Demo. Test | | Registered for Hydrogen Refueling |
|---|---|---|---|
| Passenger Car | Compressed Hydrogen | 10 | Factory Car<br>Leased Car to Gov. and private company |
| | Liquid Hydrogen | 1 | |
| | Sub total | 11 | |
| Bus | Event Operation | 1 | Factory Bus |
| | Normal Bus Service | 1 | |
| | Sub total | 2 | |
| Total | | 13 | 35-38 |

Source: JARI

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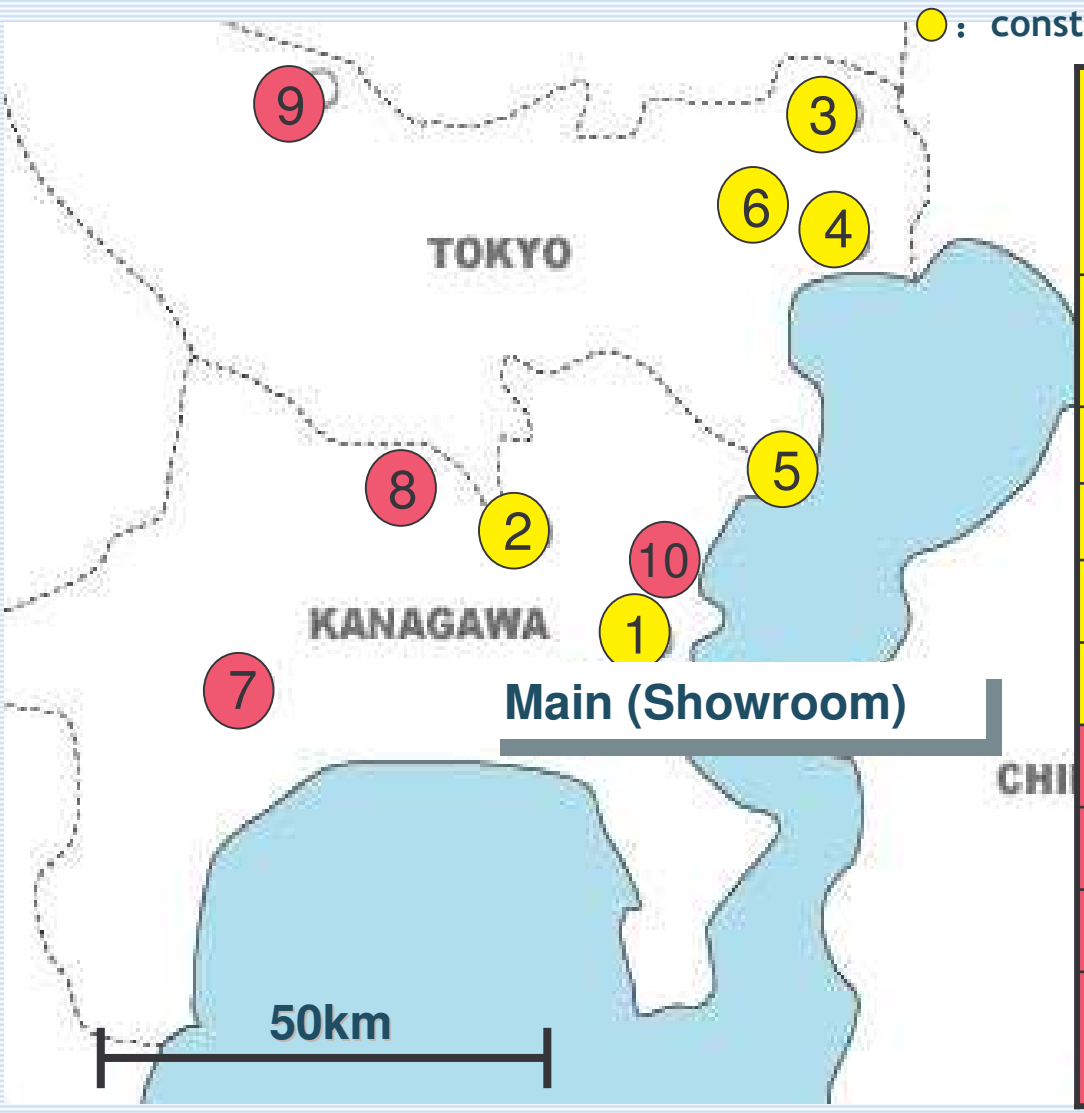
# Automobile: JHFC Project - Hydrogen Stations -




| | |
|---|---|
| 1 | Garage-Showroom |
| | Yokohama-Daikoku Hydrogen Station |
| 2 | Yokohama-Asahi Hydrogen Station |
| 3 | Senju Hydrogen Station |
| 4 | Ariake Hydrogen Station |
| 5 | Kawasaki Hydrogen Station |
| 6 | Relocatable Hydrogen Station |
| 7 | Hadano Hydrogen Station |
| 8 | Sagamihara Hydrogen Station |
| 9 | Ome Hydrogen Station |
| 10 | Yokohama-Tsurumi Hydrogen Station |

Source: JARI

# Automobile: JHFC Project - Hydrogen Sources -

| | LOCATION | SOURCE | OPERATOR |
|---|---|---|---|
| 1 | Yokohama-Daikoku | Desulfurized - Gasoline | Cosmo Oil Co., Ltd. |
| 2 | Yokohama-Asahi | Naphtha | Nippon Oil Corporation |
| 3 | Senju | LPG | Tokyo Gas Co., Ltd.<br>Nippon Sanso Corp. |
| 4 | Ariake | Liquid Hydrogen | Showa Shell Sekiyu K.K.<br>Iwatani International Corp. |
| 5 | Kawasaki | Methanol | Japan Air Gases, Ltd. |
| 6 | Kasumigaseki (mobile) | Compressed Hydrogen | Nippon Sanso Corporation |
| 7 | Hadano | Kerosene | Idemitsu Kosan co., Ltd. |
| 8 | Sagamihara | Electrolysis | Kurita Water Industries Ltd.<br>Sinanen co., LTD.<br>Itochu Enex. co., Ltd. |
| 9 | Ome | City Gas | Babcock-Hitachi K.K. |
| 10 | Yokohama-Tsurumi | By Product | Tsurumi Soda Co., ltd<br>Iwatani International Corp. |

**Various hydrogen sources are demonstrated.**

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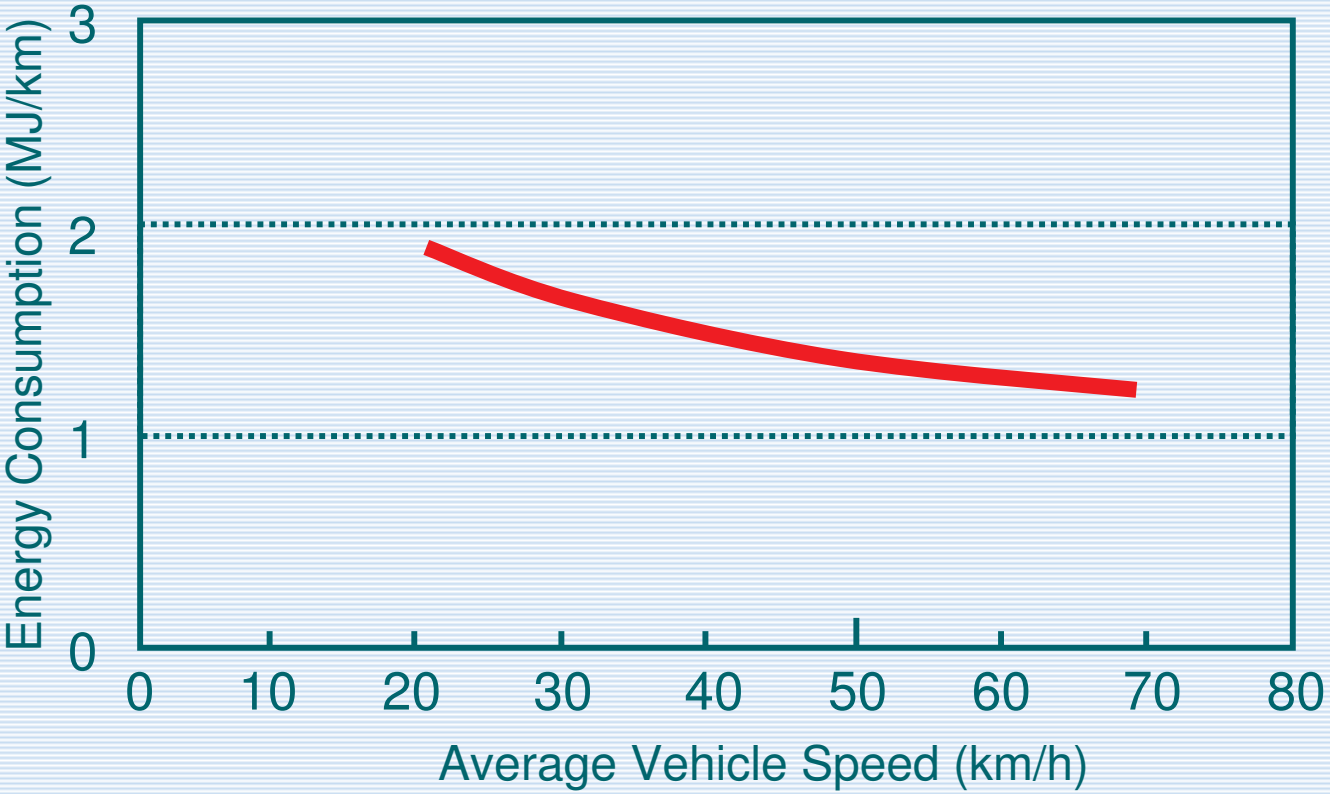
Source: JARI

# Automobile: JHFC Project
# - Route:Designated Routes -

# Automobile: JHFC Project - Results (Energy Efficiency) -

## Energy Consumption

**Route: Designated Route**




**2005 is the last year of the Project.**
**Let's see.**

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# 3. Into the Market

# Tokyo Gas Started FC Sales

- Tokyo Gas Started stationary FC sales.
- 200 units for 2005 (lease).

**- Efficiency: >31%(power) + >40% (heat)**
**- 1 mil. yen ($10,000) for 10 years**

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# Aichi Expo: SOFC works!

- Gas Pavilion
  CHPs supply 10 % of electricity demand.

**Desiccant air conditioner**

**Gas CHP (50 kW)**

**SOFC (1 kW)**

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# Today: On the Road

- Toyota
  - 16 FCVs
  - FCVs / Buses for Expo
  - Lease price 1.2 mil yen/month (=$11,000/month)

- Honda
  - 17 FCs (Japan:6 , USA:11)
  - Lease price 0.8 mil yen/month (=$7,600/month)

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# 4. You may ask..

# Hybrids killed FCVs?

Q:Today's Prius has better energy efficiency.
Does Prius kill FCVs?

| | Prius | FCHV |
|---|---|---|
| Well-to-Tank | 88% | 58% |
| Tank-to-Wheel | 37% | 50% |
| Overall | 32% | 29% |

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# Hybrids killed FCVs?

A:No, Two reasons.
(1) FCV has potential for higher energy performance.

| | Well-to-Tank | Tank-to-Wheel | Well-to-Wheel |
|---|---|---|---|
| Gasoline ICE | 88% | 16% | 14% |
| Gasoline HV | 88% | 37% | 32% |
| $CH_2$ FCV | 58% | 38% | 22% |
| $CH_2$ FCHV | | 50% | 29% |
| Future FCHV | 70% | 60% | 42% |

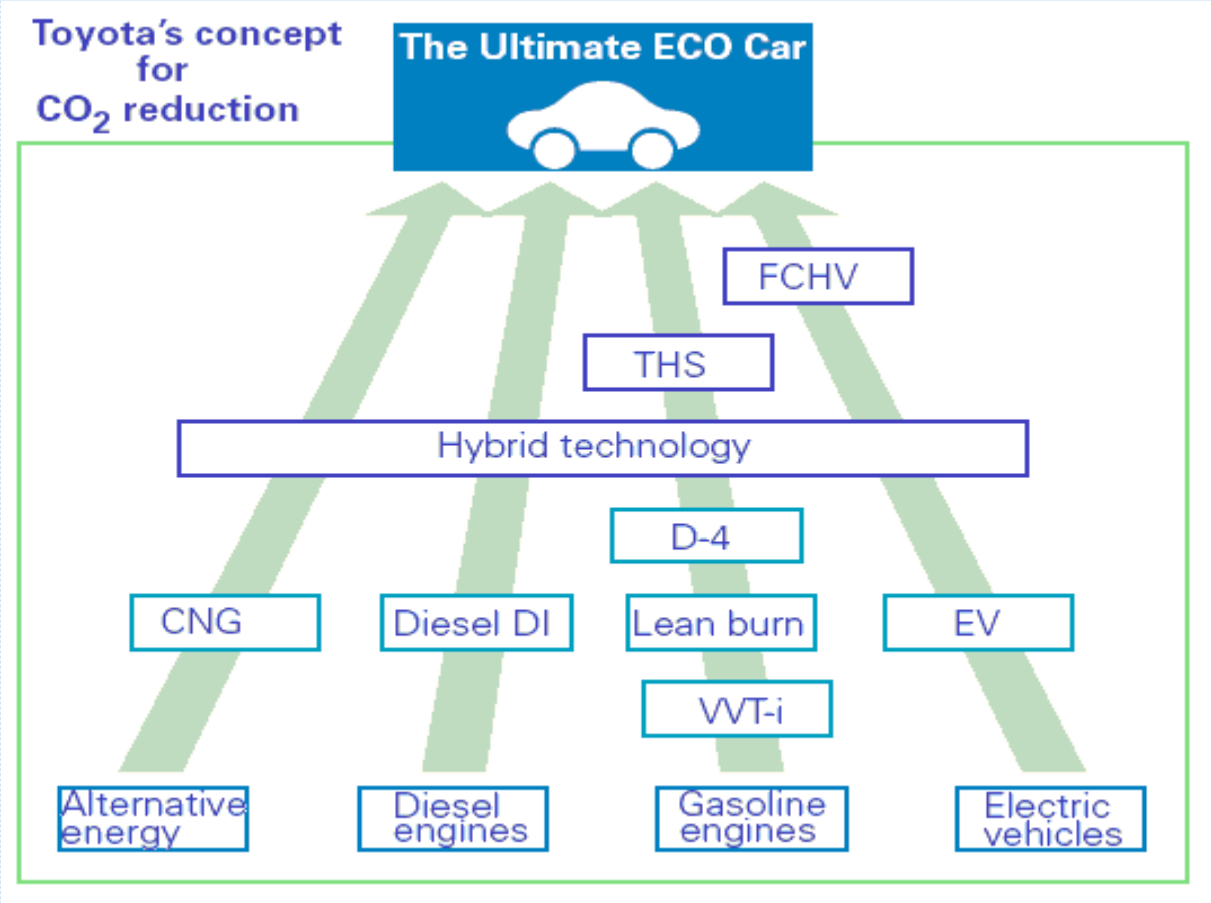
hybridization

hybridization

Source: Toyota

# Hybrids killed FCVs?

**(2) Hybrid technology can be used for all kinds of cars.**




**Source: Toyota**

# Japan's Targets: Too high? Too Low?

Q:Japanese government has very ambitious fuel cell targets. Can Japan achieve the targets? What is the status today?

## Japan's FC Target Today

| FCV targets | | Stationary FC targets | |
|---|---|---|---|
| 2010 | 50,000 FCVs | 2010 | 2.1GW |
| 2020 | 5 Mil. FCVs | 2020 | 10 GW |
| 2030 | 15 Mil. FCVs | 2030 | 12.5 GW |

## Failed Target

In 1991, METI (MITI) announced ambitious target of 200,000 EVs by 2000 (but, only 1300 EVs by 2000)

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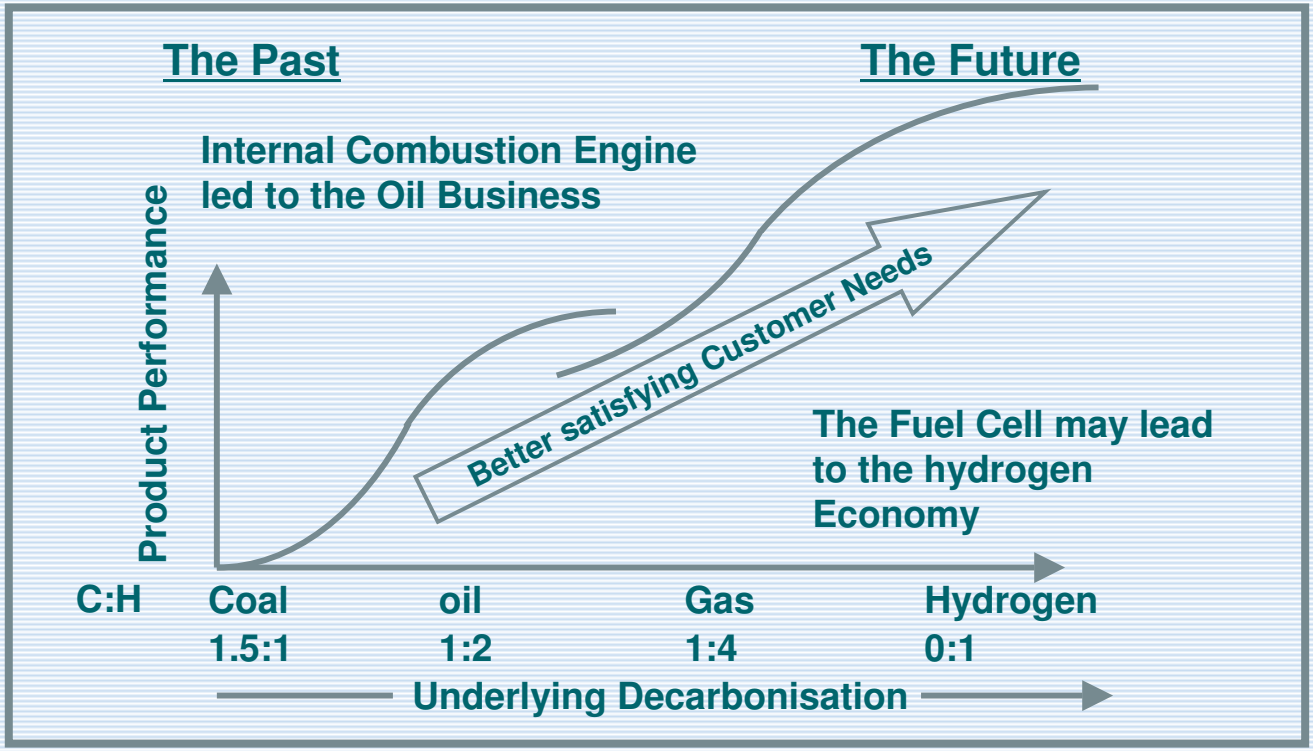
# Japan's Targets: Too high? Too Low?

OR

Q:We are moving toward low carbon-content energy. So, hydrogen is the future! Japan has to invest more resources into hydrogen R&D.




Source:
Shell Hydrogen

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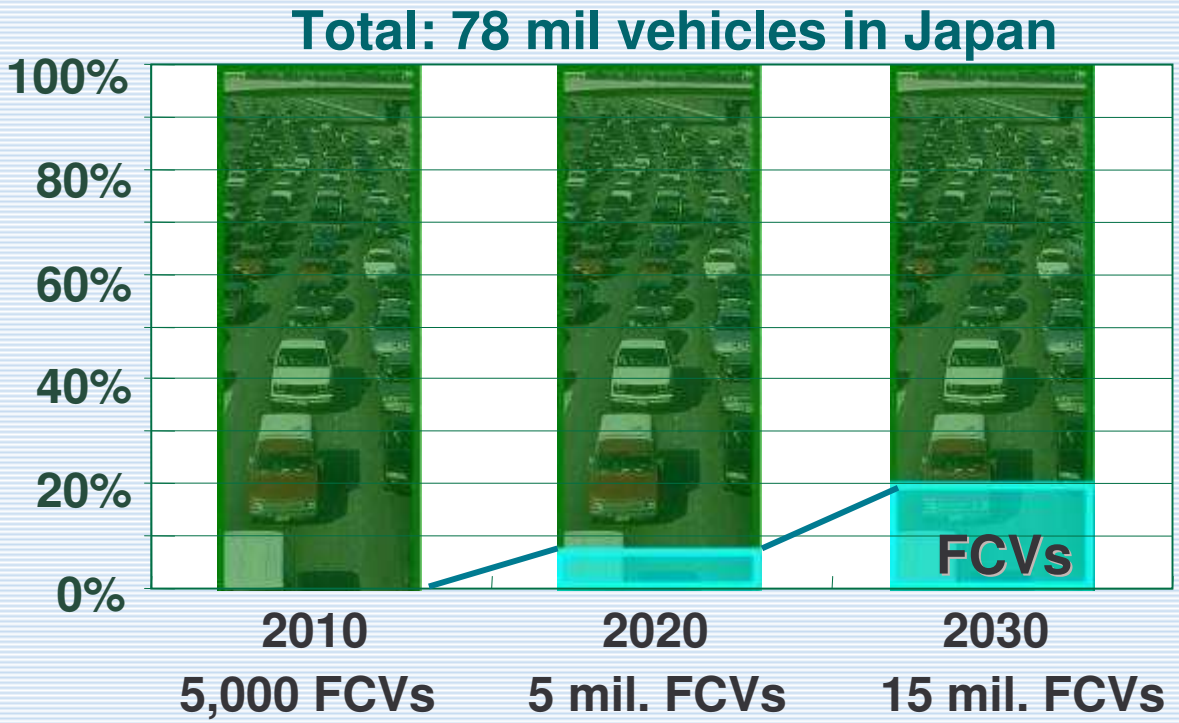
# Japan's Targets: Too high? Too Low?

**A:The Target is very challenging, but not wild.**




**15 mil FCVs in 2030**
**= 20 % of vehicle population in Japan (very challenging)**

# Japan's Targets: Too high? Too Low?

**Japan has 21 high power nuclear power plants (>1 GW)**

**Stationary FC Target**

| | | |
|---|---|---|
| 2010 | 2.1GW | (= 2 NPPs) |
| 2020 | 10 GW | (= 10 NPPs) |
| 2030 | 12.5 GW | (= 12 NPPs) |

**….And, FCs are distributed energy!**
**(socially, much easier for installation)**

**Stationary FC target is more achievable.**

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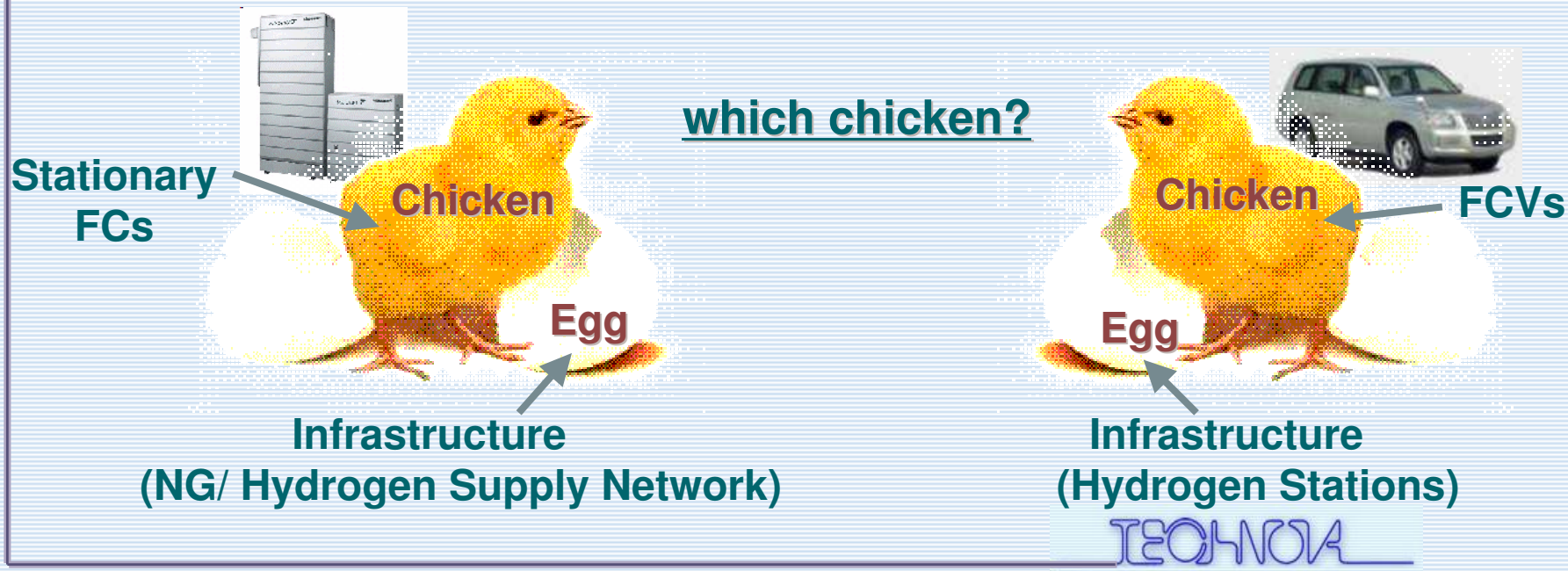
# Chicken and Egg…but which chicken?

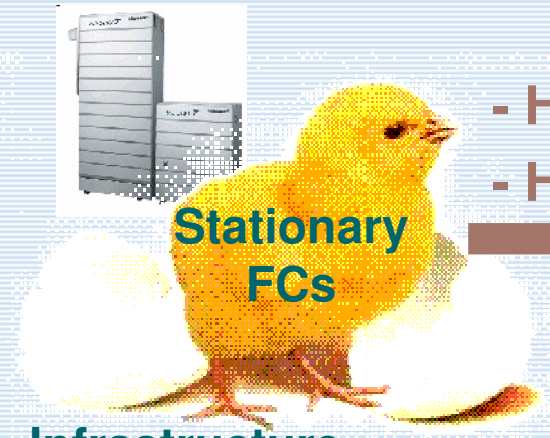
Q: Traditionally, fuel cell / hydrogen community believe that potable and stationary markets are the starters. But, because of slow growth of stationary market, more and more people believe the opposite; Auto-market comes first.
Which should come first?



# Chicken and Egg…but which chicken?

**A: Doesn't Matter.**
**But probably stationary FCs are closer to the market.**
**(with positive feedback to FCVs)**

- Cost reduction of FC components
- Higher durability
- Higher reliability



Stationary FCs

FCVs

Infrastructure
(NG/ Hydrogen Supply Network)

Infrastructure
(Hydrogen Stations)

- Support for Hydrogen infrastructure
- Hydrogen Codes & Standards

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# Thank you!

# Questions?

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