Table paper 2 (Selected)

Hydrogen and Fuel Cells save the Earth

July 22, 2008
Cabinet Office, Japan
University of Electro-Communications
Haruhiko ANDO

"*L'Île mystérieuse*" (Jules Verne, 1874)

- "One day all the coal will be used up. Without coal, no more progress for modern life." "What will they burn in the place of coal?"
- "**Water**," replied Cyrus Smith. "but decomposed into its basic elements. **water** will one day be employed as a fuel, **hydrogen** and oxygen will furnish **an inexhaustible source of heat and light**. Then there will be nothing to fear. As long as this earth is inhabited, it will provide for the needs of its inhabitants. I believe that when the coalmines have been exhausted, they will heat and be heated with **water**. **Water is the coal of the future**."
- "I would like to see that," said the sailor.

Structure of air

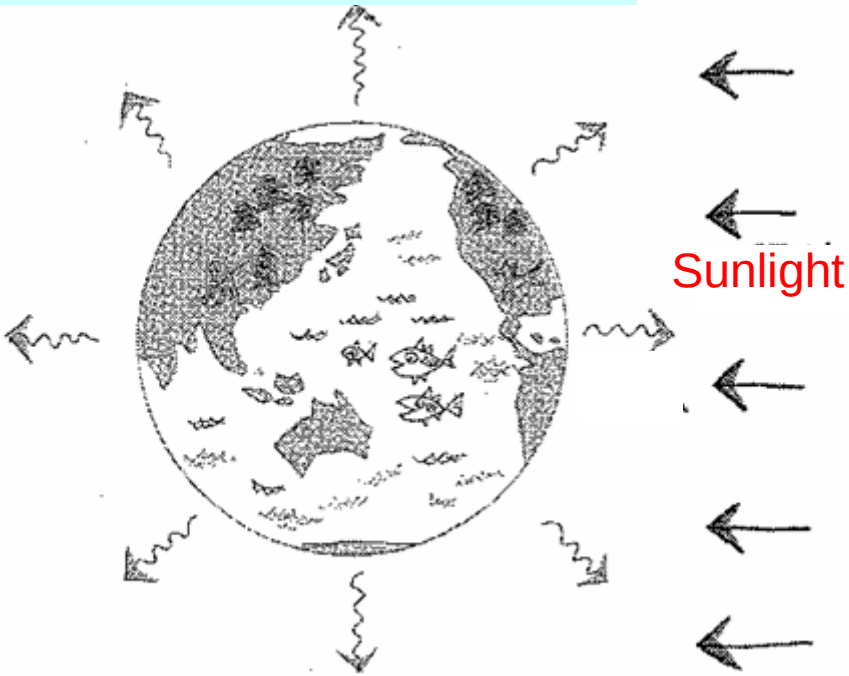
Thermosphere	80-800km	2000℃
Mesosphere	50-80km	0→-92.5℃
Stratosphere	11-50km	-70→0℃
Troposphere	**0-11km**	**15→-70℃** **80% of Air**

The radius of Earth = 6,400 km

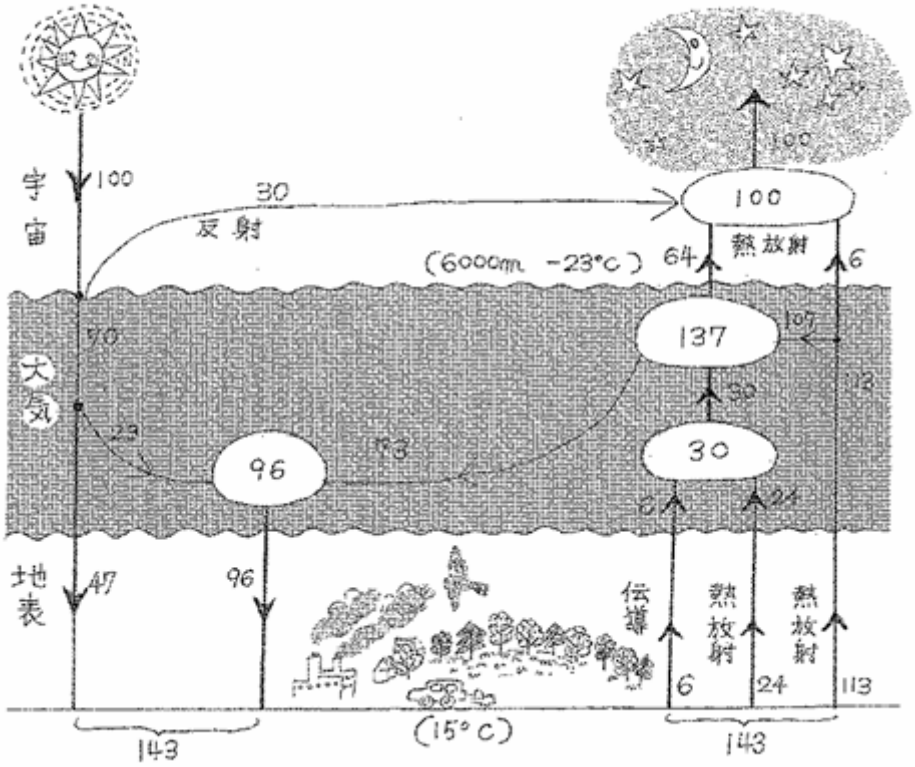
Fierce Hurricanes, Typhoons occur inside Troposphere and surface of sea.

Inside “thin film” of the Earth

heat absorption and release

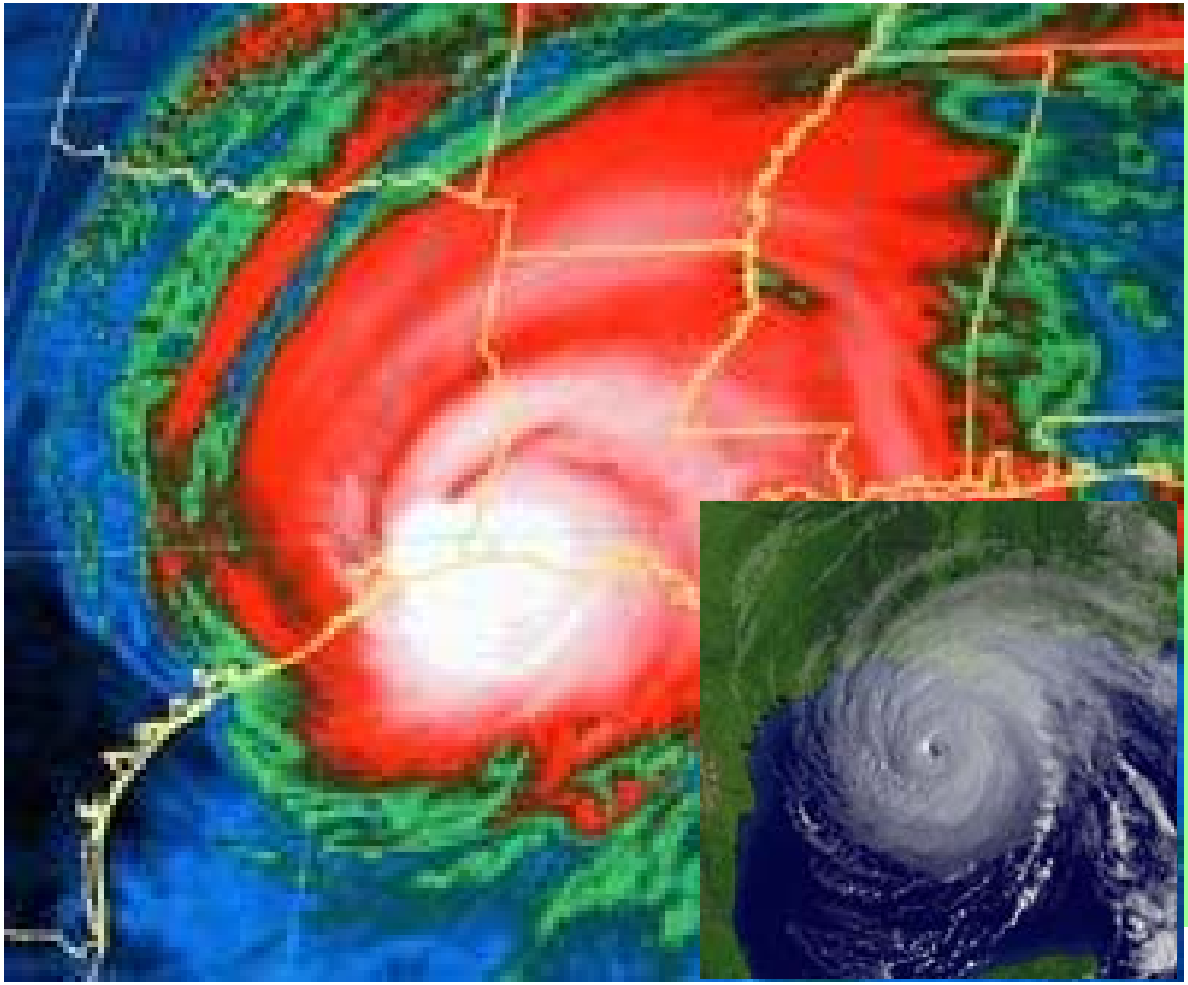


Thermal balance of GHG effect



Source: Prof. Tatsunari Hirose

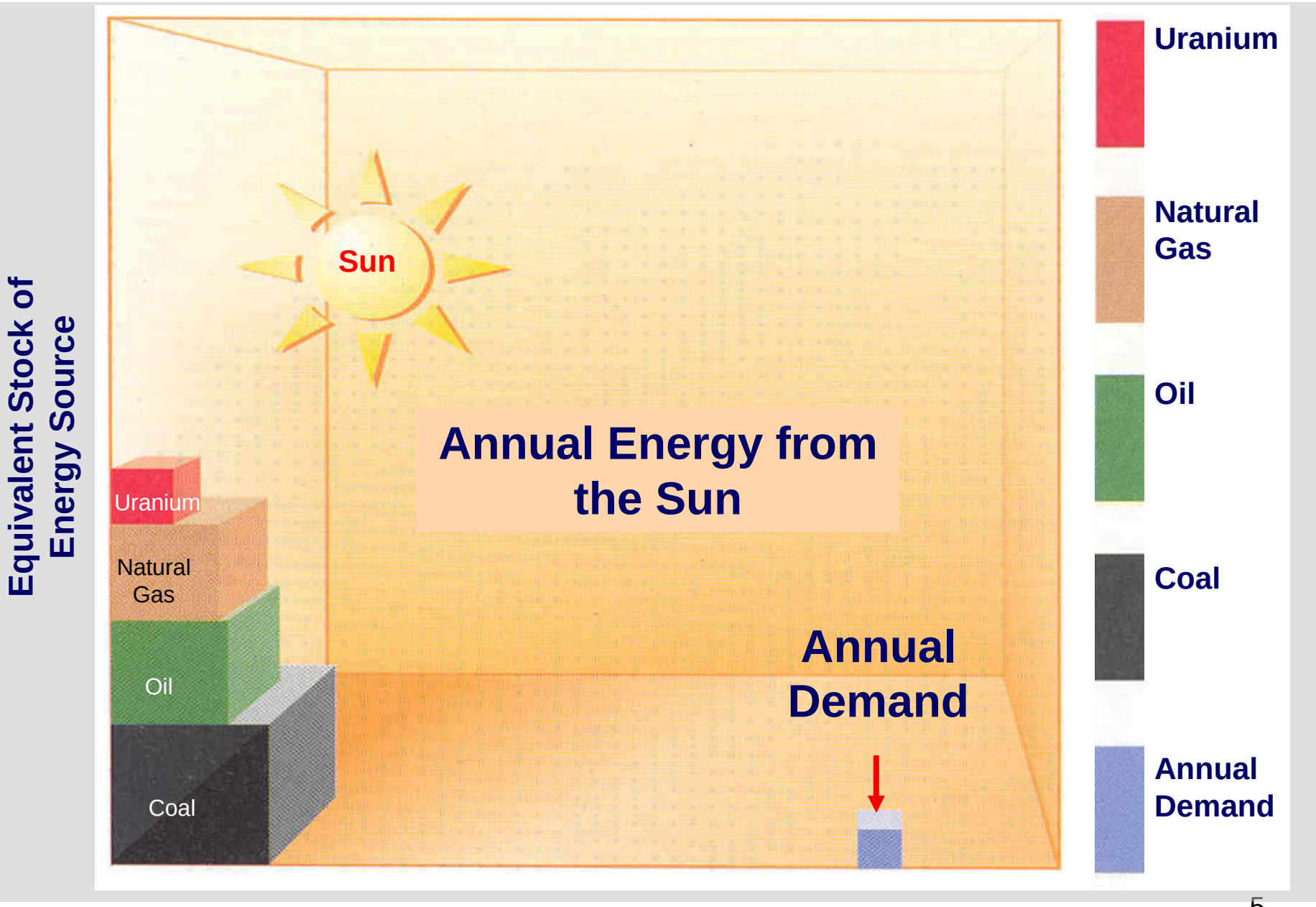
National Oceanic & Atmospheric Administration
U.S. Department of Commerce



Hurricane Rita

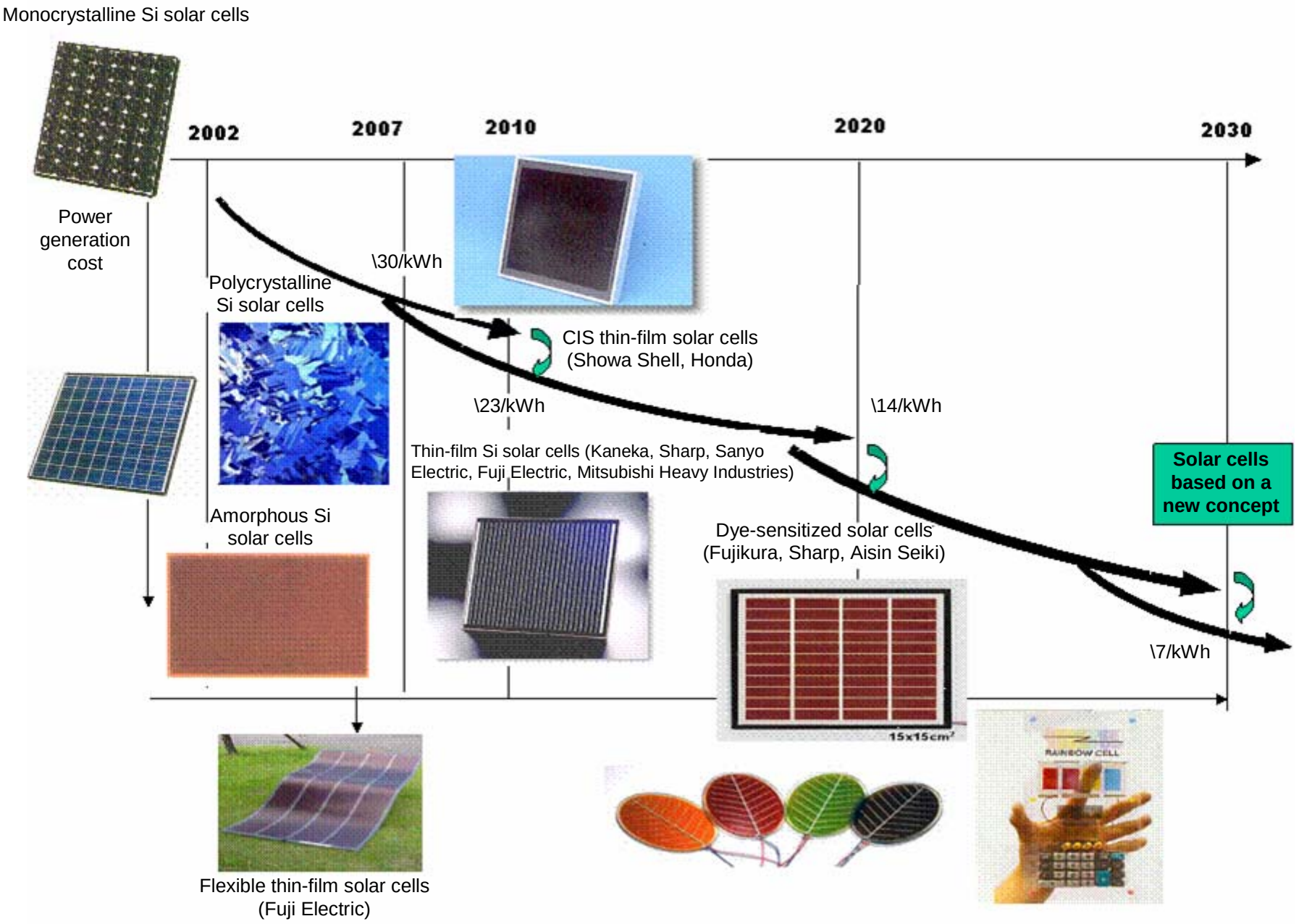
"The **global warming** influence provides a new background level that increases the risk of future enhancements in **hurricane** activity,

Dr. Kevin E. Trenberth is Head of the Climate Analysis Section at the National Center for Atmospheric Research

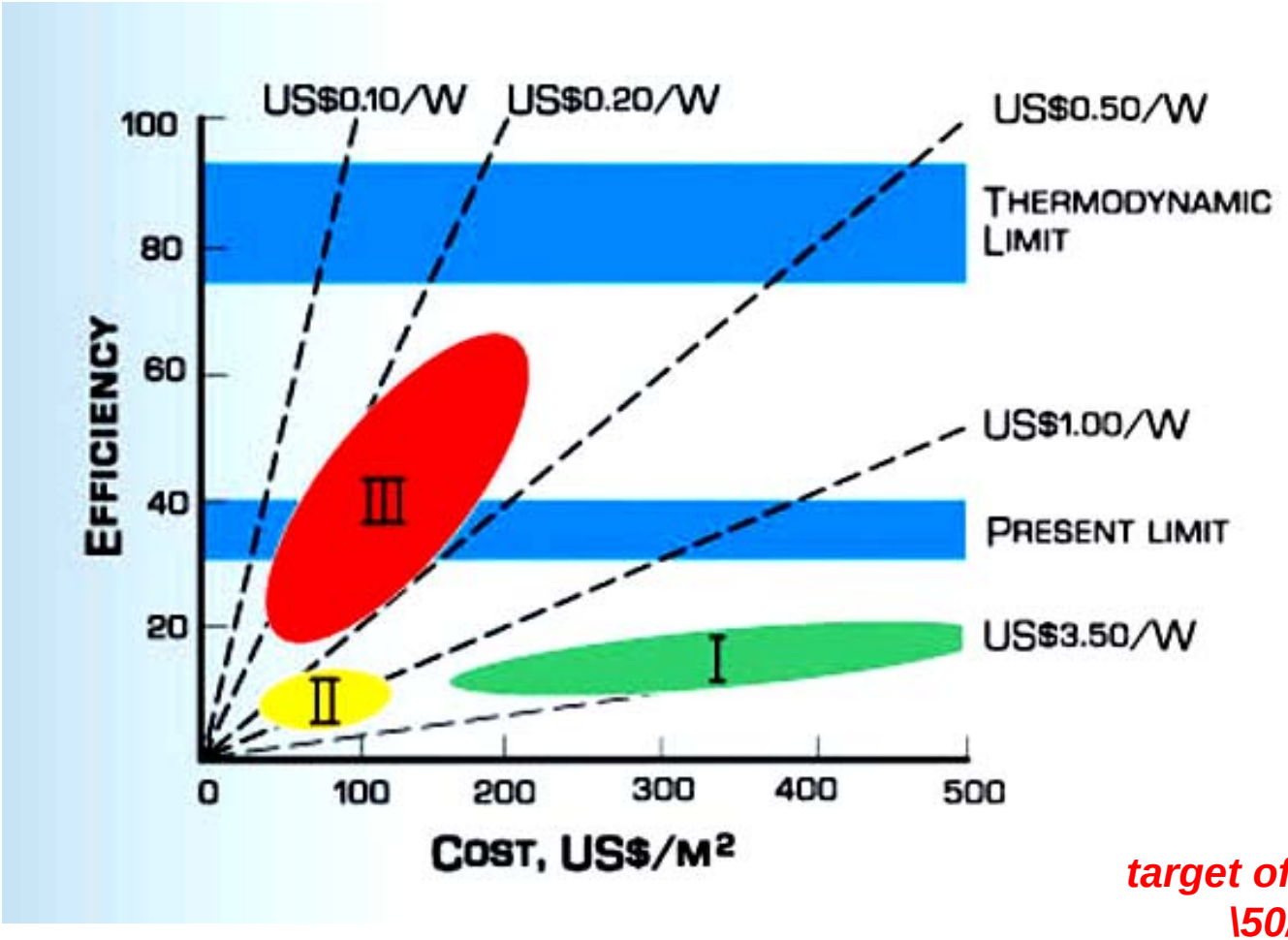


Source: Kyocera based on Dr.Bjorseth's data

Scenario for the Development of PV Modules toward 2030

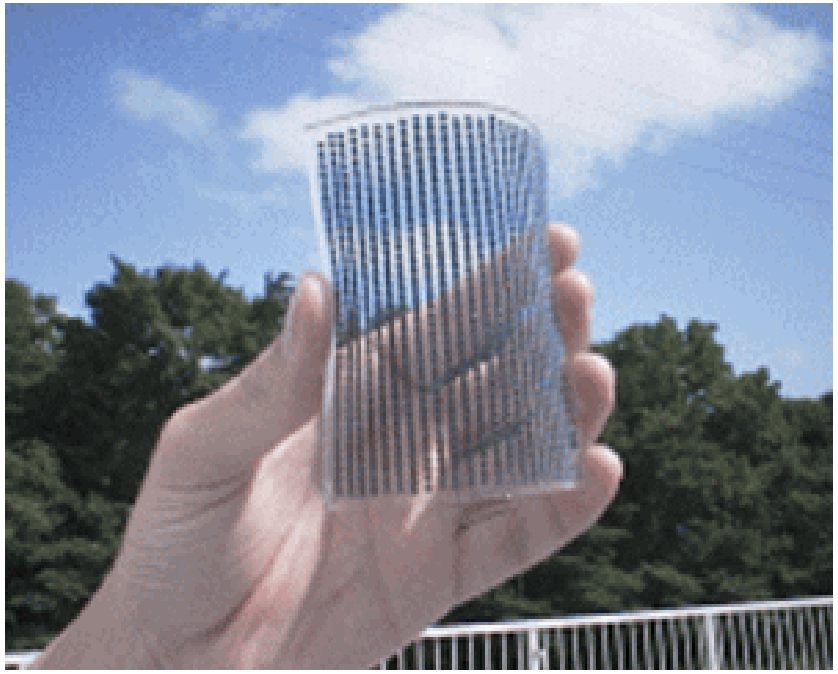


Third Generation Solar Cell and plan 2020



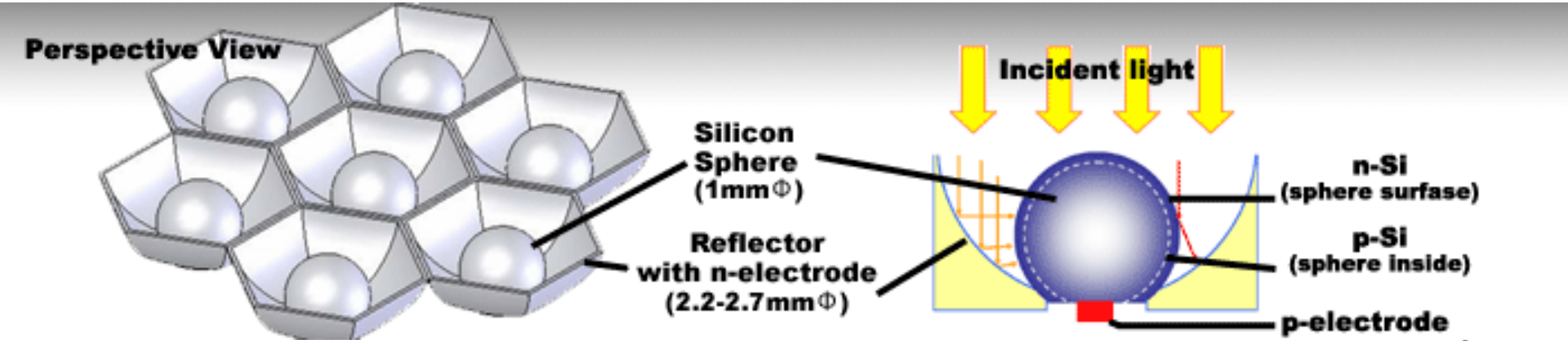
target of cost reduction: \50/W by 2020

Silicon-Sphere Solar Module by Japanese small Ventures



Kyosemi

Clean Venture 21



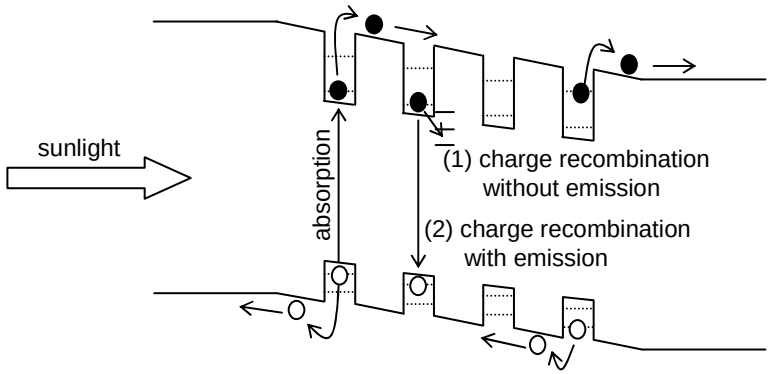
Daibutsu, Big Budda is named for infinite amount of lightning (अमिताभ, amitaabha).

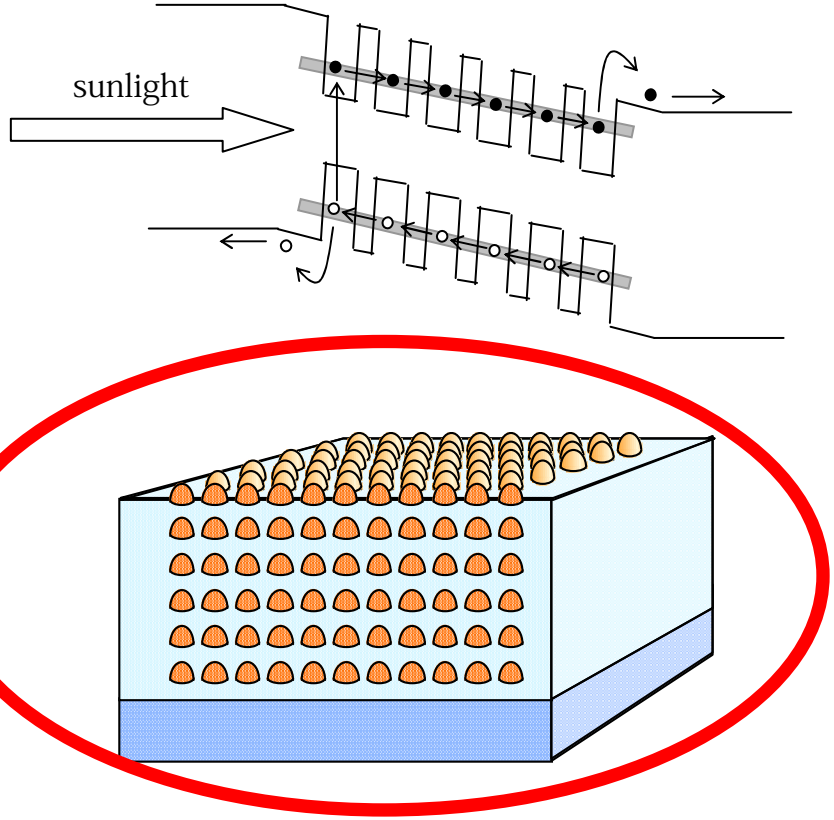
Promising Quantum-dot Photovoltaic

Conventional

Well Potential

Next-Gen Type





Source: Dr. Yoshitaka Okada

3D-Quantum dot superlattice

The Championships for newer Photovoltaic cells, "Wimbledon" in Japan

- 9 countries, 10 types, 26 different modules severely compete in Hokuto (west of Tokyo)

Samurai: ancient noble warrior?

"Innovation Samurai" today is defined here for prepared, decided, devoted, high-minded scientist or engineer who tackles difficult breakthrough targets with bravery, deepest spirits, calm passion and robust personal commitment under empowerment.

侍

Personal computer: crazy or not? How about Personal Generator?

Gates said on starting Microsoft:

"Microsoft is one of the few companies you can say it just started with a dream. A dream that software would be important. A dream that there would be a computer that was affordable on a personal level. That's a dream that Paul Allen and I had, which at the time seemed very crazy."

Next-Generation Vehicle Fuel Initiative

1. Biofuel | **2. Clean diesel** | **3. Next-generation batteries** | **4. Fuel cells/hydrogen Economy**

1. Biofuel

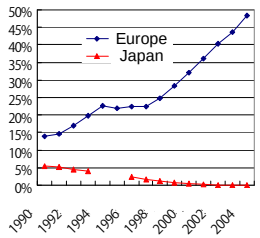
- Bioethanol blended with gasoline, and
- Biodiesel blended with diesel oil

Cellulose-derived biofuel

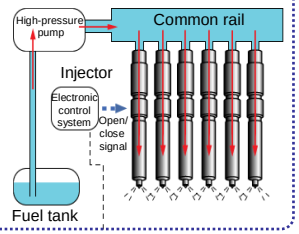
Waste wood → • Conversion into sugar using enzymes • Fermentation using yeast → **Ethanol**


2. Clean diesel

Share of diesel vehicles

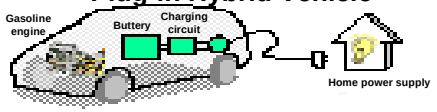


Common rail system



3. Next-generation batteries

Next-Generation Vehicle Battery Development Project
Budget (07FY): $ 50 Million



Electricity for daily commuting
(Huge cnt cut of oil consumption)
Gasoline for long drives

	Improved battery (2010)	Advanced battery (2015)		Innovative battery (2030)
	Compact EV	Compact EV	PHV	Standard-sized EV
Targeted battery performance	1	1.5		7
Targeted battery cost	1/2	1/7		1/40

R&D of next-gen batteries (improvement in performance)

4. Fuel cells/hydrogen Economy

Hydrogen Economy: transition from "carbon cycle" to "water cycle"

Hydrogen station

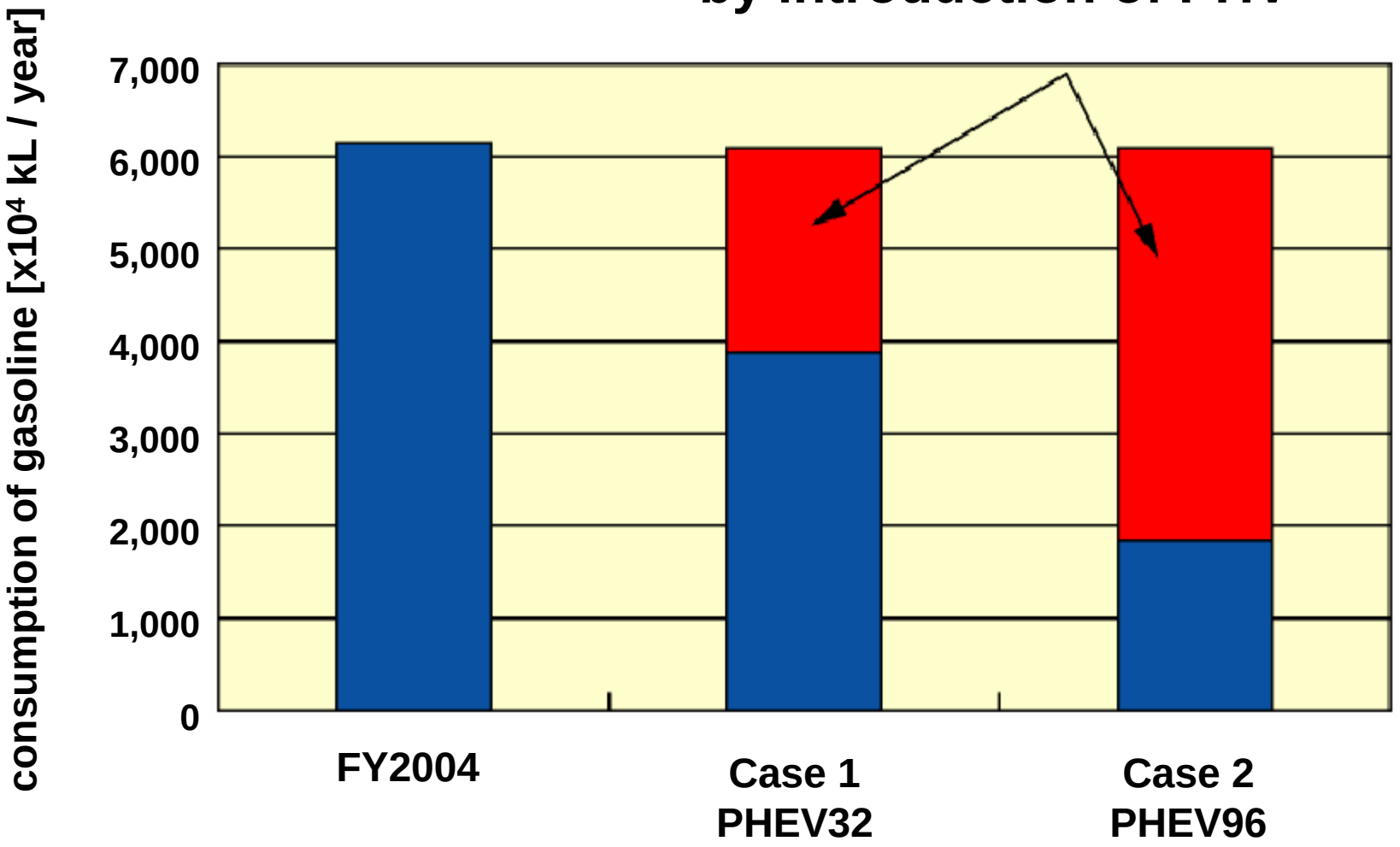
Hydrogen supply

Fuel cell vehicle

Hydrogen vehicles

- Powered by way of the combustion of hydrogen instead of fossil fuel (e.g. gasoline)
- Producing very clean exhaust that contains almost nothing but water

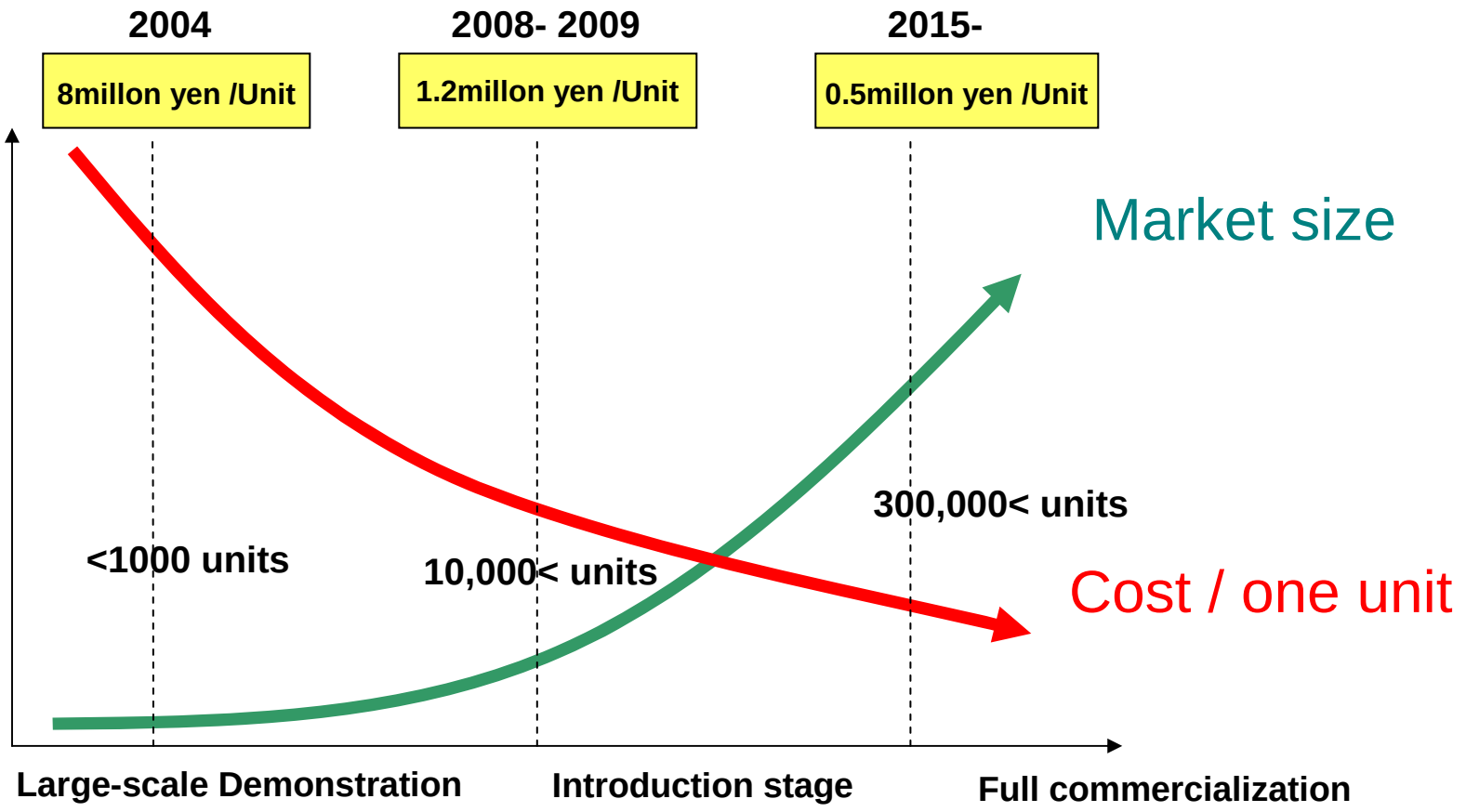
Reduction in gasoline consumption by introduction of PHV



Source: http://criepi.denken.or.jp/en/e_publication/pdf/den433.pdf

Scenario of Market Creation for Residential Fuel Cell

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

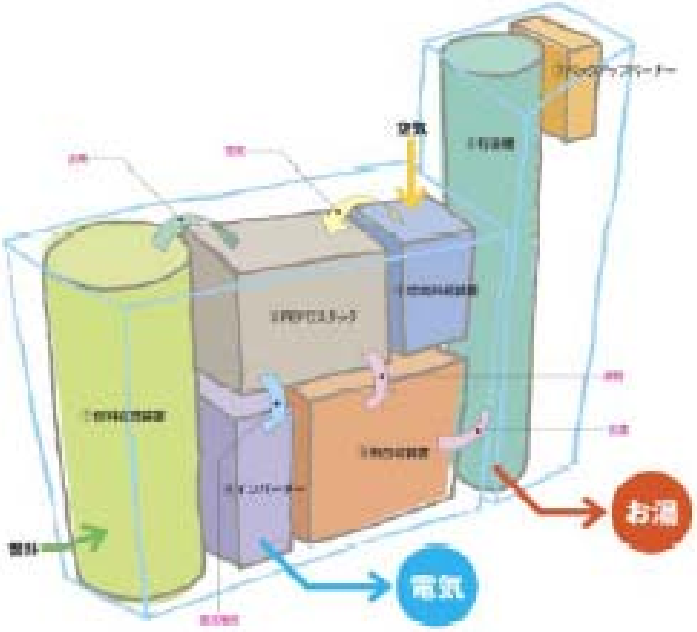


Note: * means annual production rate

Wanted!!: New Entries in R&D Competition ！ for BOP ｓ of Stationary FC Cogeneration System

Specifications of BOPs required for stationary FC system can be seen at the website (http://meti.go.jp/press/20051227004/20051227/004.html)

Solenoid valves



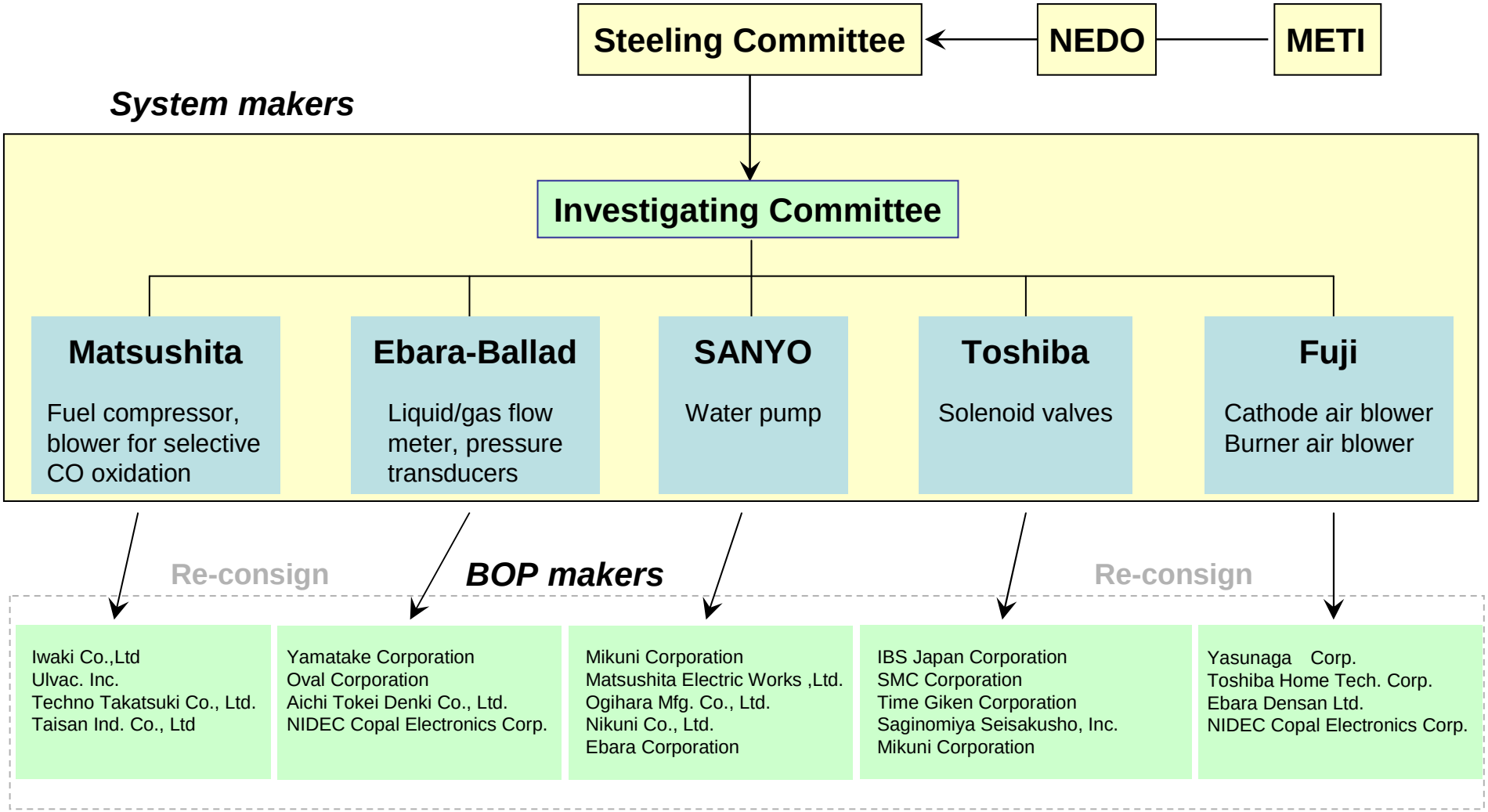
Precise pumps

Blowers

Pressure transducers

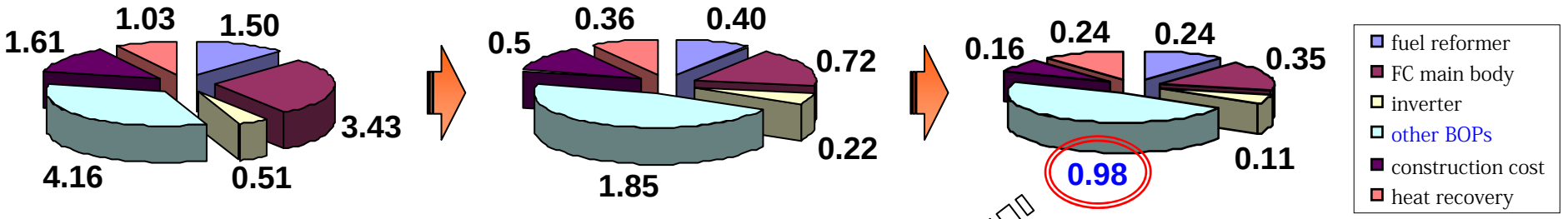
Flow meters

R&D organization for harmonization of BOP of stationary FC cogeneration system



Strategy for Further Cost Reduction of BOP

Forecast of cost of 1kW PEFC system based on mass production (by major system makers)

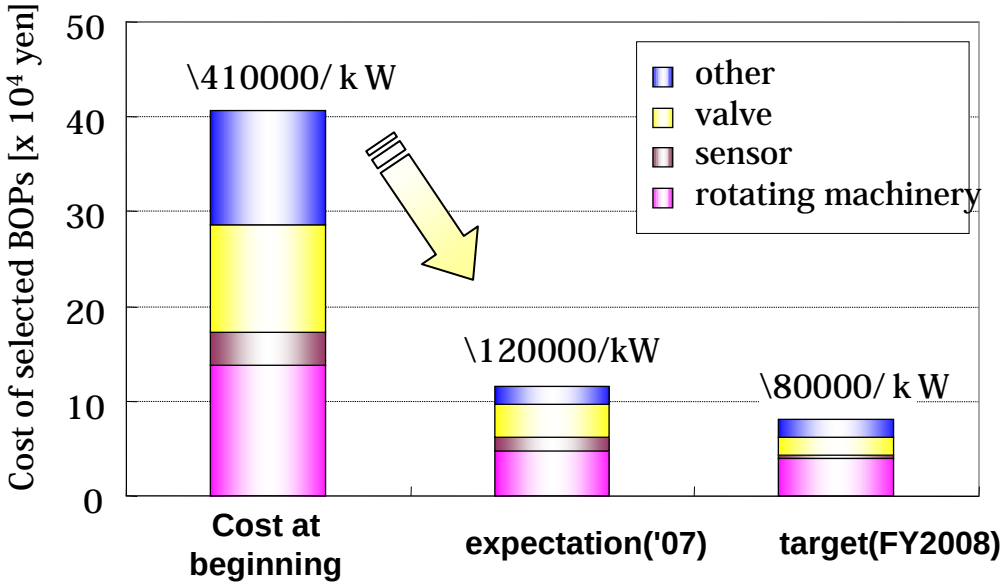


12.24 million yen (present)

4.04 million yen (1,000systems/year)

2.08 million yen (10,000 systems/year)

- System manufacturers selected some BOP devices (0.41million yen/kW) which specification can be harmonized among the participating system manufacturers.
- Concentrated R&D for the selected BOPs to satisfy durability, performance and cost.

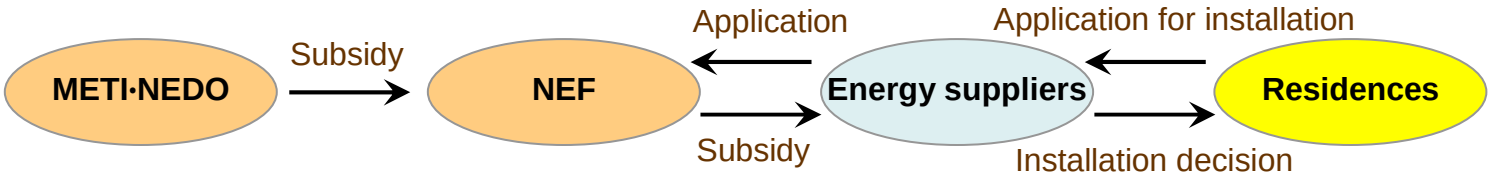


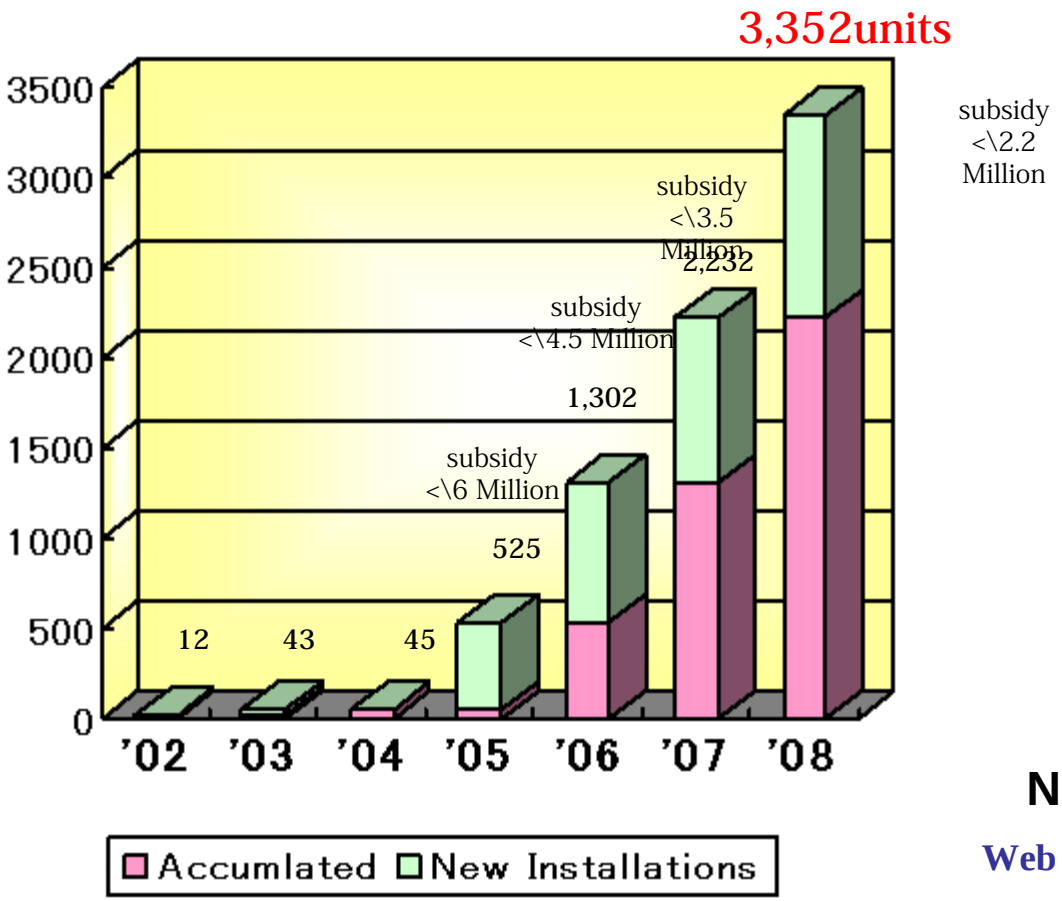
○ **As a consequence of the effort in this R&D (’06～’07), drastic cost reduction has been achieved:**
￥410,000/kw ⇒ ￥120,000/kw

○ **By concentrated and continuous R&D, improvement of BOPs as well as the further cost reduction will be achieved**
\80,000/kw by FY2008

Large-Scale Stationary Fuel Cell Demonstration Project

Provide feedback on various demonstration data, for research and development
Step up to mass production and inspection of learning curve
Price target: 1.2 million yen/system (in 2008)

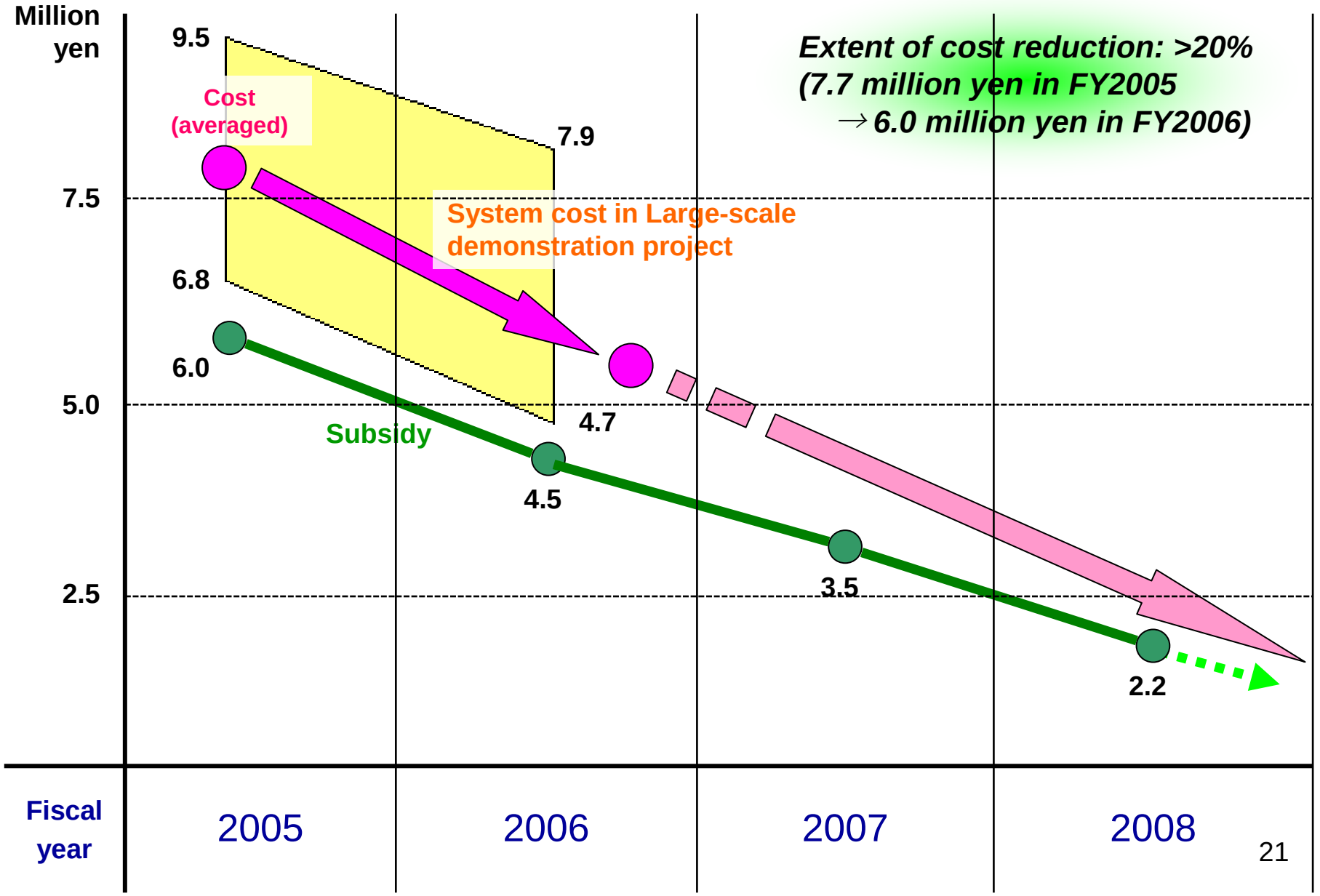




Number of installation

Web site: http://happyfc.nef.or.jp

Trend of Cost of Fuel Cell Co-generation System (1kW-PEFC)

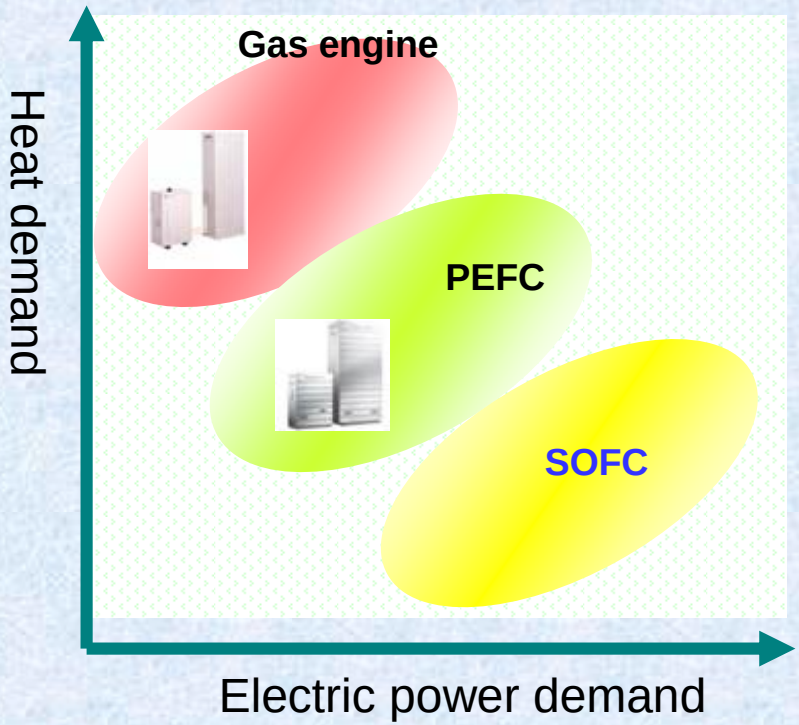


Extent of cost reduction: >20%
(7.7 million yen in FY2005
→ 6.0 million yen in FY2006)

Solid Oxide Fuel Cell (SOFC) Demonstration Project

Aiming at commercialization of residential SOFC co-generation system, demonstration project is started from FY2007 to accumulate our experience of practical operation of SOFC and extract technical subjects to be undertaken for further development of SOFC.

Characteristic of co-generation system for household



- **Budget: 0.77 billion yen for FY 2007**

Objectives

- **clarification of degradation of stack caused by high temperature operation**

(ca. 90 ℃ for PEFC, ca. 1000 ℃ for SOFC)

- **Accumulation of experience of practical operation of residential SOFC system**

Characteristic of SOFC

- **High efficiency of electric power generation**
- **No expensive catalysts (Pt etc.) needed**
- **Mature ceramic technology applicable**
- **Scale-up**

Ceremony for installation at PM's Residence

PM is turning a key to open "Hydrogen Economy"

Ebara=Ballard

Panasonic

Demonstration of FCVs and H_2 Station (JHFC-2)

Identifying Issues and Improving Public Acceptance for Hydrogen Society

Hydrogen Infrastructure

H_2

FCEV Demonstration Project

Kansai Area

- New applications and hydrogen station demonstration (Wheelchairs, FC motor-cycles)
- Emergency power source applications
- Hydrogen station suitable for cities
- Conventional hydrogen supply (Satellite stations)
- H_2 stations are under construction

Common

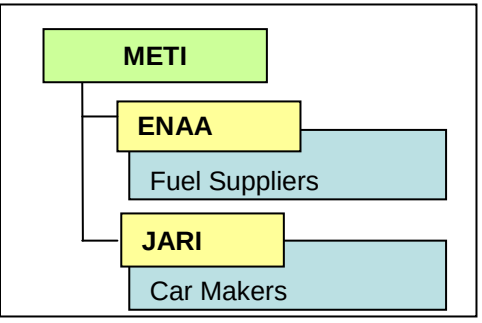
- PR・Educational activities
  Initiate and join events
  JHFC park event
- PR・Long-term strategy
  Proposal for educational curriculums in school and social education

Chubu Area

- Fuel cell bus demonstration
- Hydrogen station test
- Natural gas reforming and off-site hybrid hydrogen station
- Two H_2 stations and three FCV

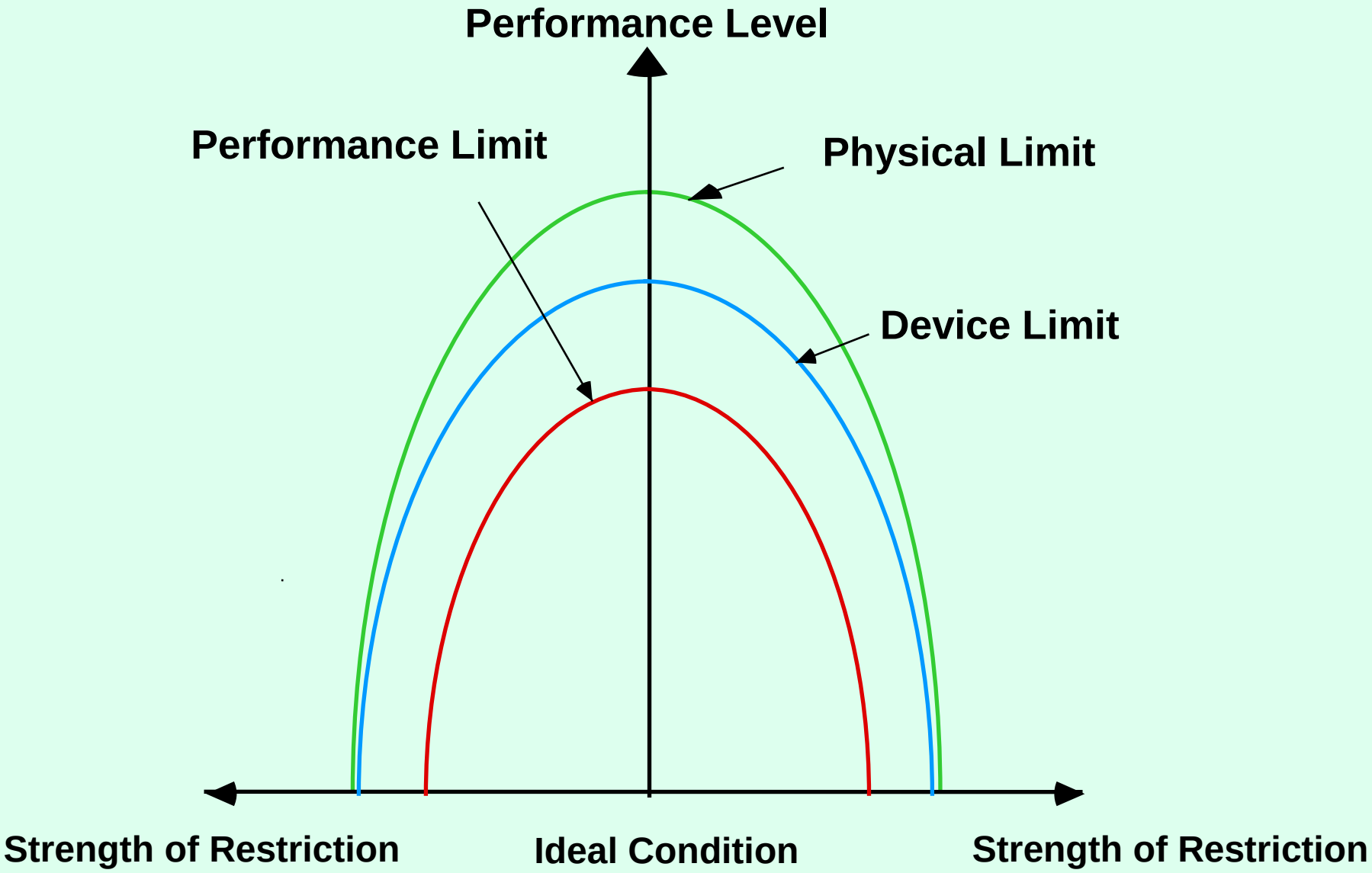
Tokyo Metropolitan Area

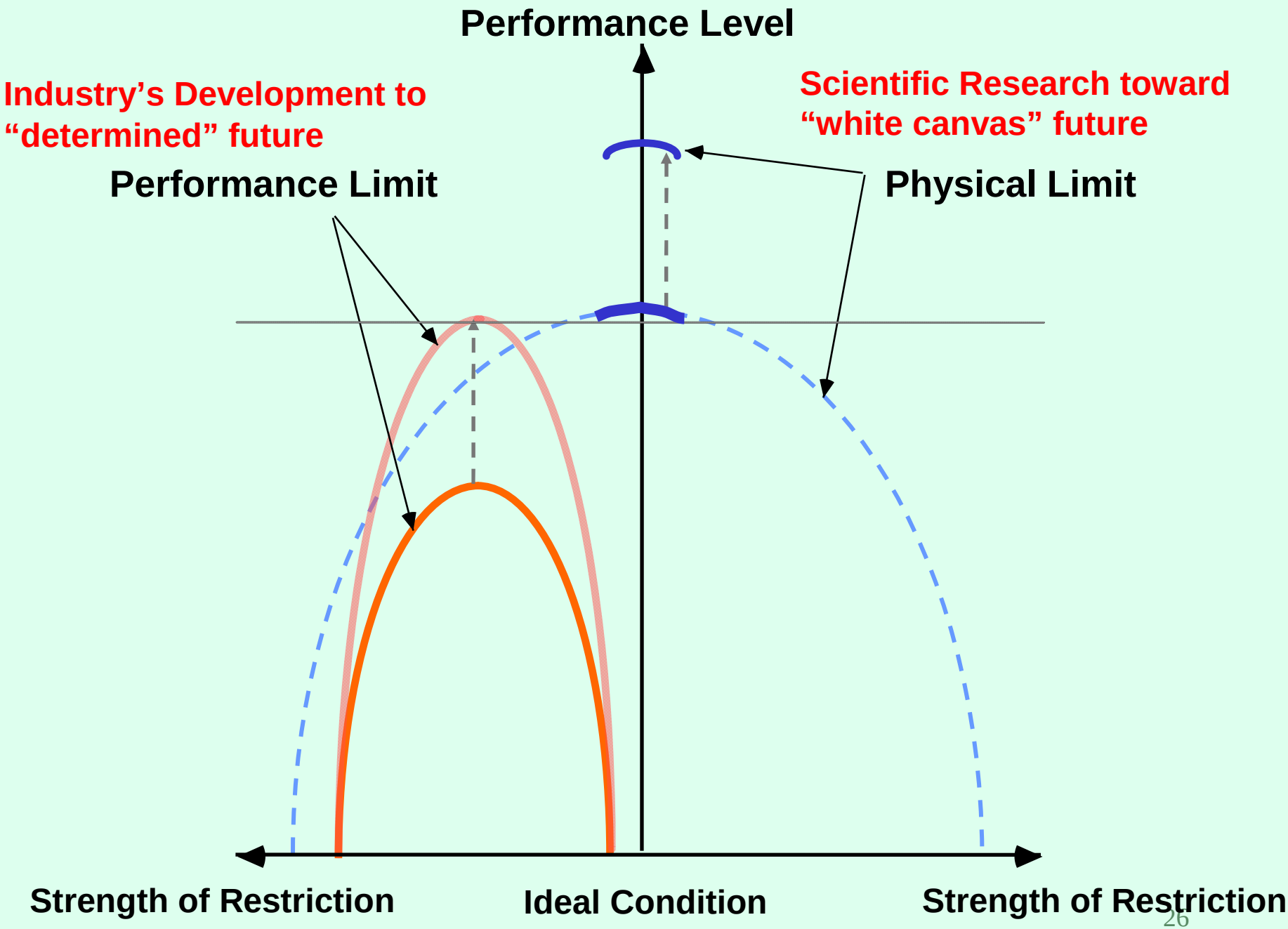
- Fleet demonstration by third party
- Verification of safety, reliability and performance improvements for various hydrogen sources and production methods
- Nine H_2 stations and fifty FCVs



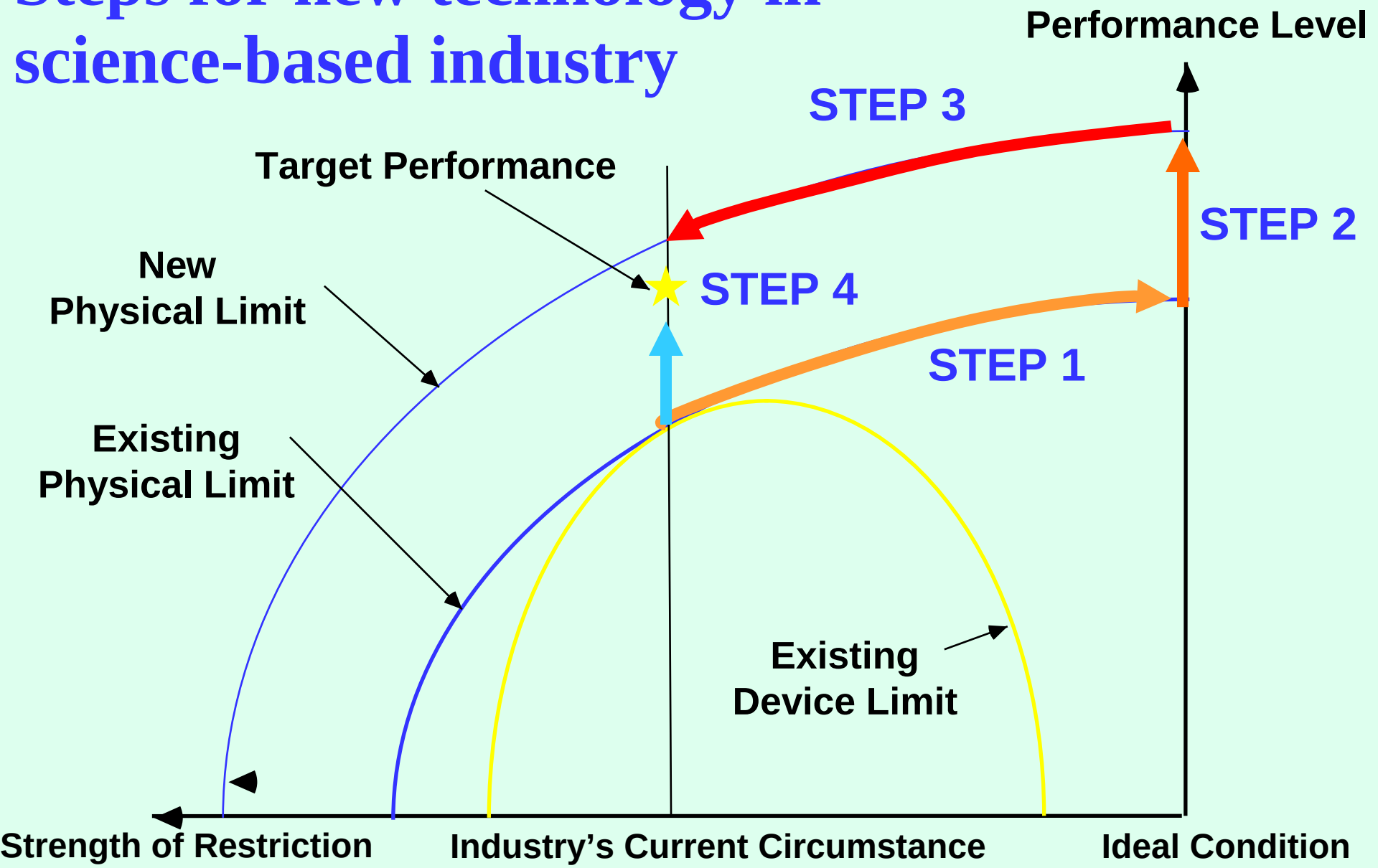
ENAA: Engineering Advancement Association of Japan
JARI:: Japan Automobile Research Institute

Three layers of Technology




Performance Level
Industry's Development to "determined" future
Scientific Research toward "white canvas" future
Performance Limit
Physical Limit
Strength of Restriction
Ideal Condition
Strength of Restriction

Steps for new technology in science-based industry

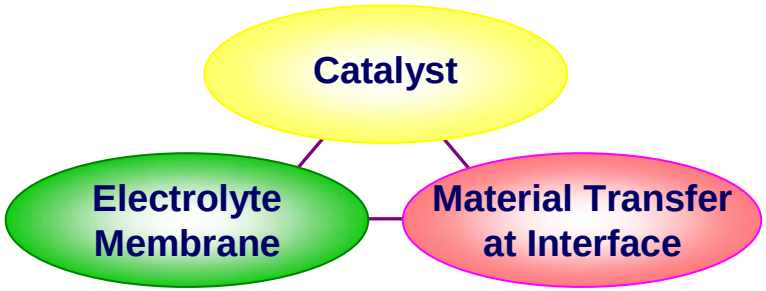


(Restriction on cost, durability..)

A National Lab. for Basic FC R&D

Polymer Electrolyte Fuel Cell Cutting-Edge Research Center (FC^3 = FC-cubic)

- *Established on April 1, 2005*
- *Director of FC-cubic: Dr. Hiroshi HASEGAWA*
- *Budget: 1.0 billion yen for FY2007(1.2 billion yen for FY2006)*



AIST Depts.

METI

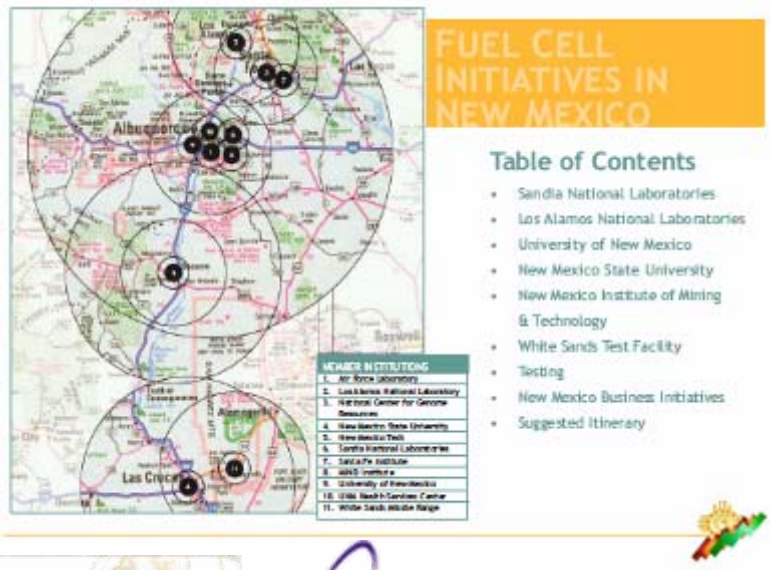
Close collaboration

Basic Scientific Knowledge
↓
Innovation in R&D

Industry, Public, Academia

Collaboration with First class Labs in NM

Fusion between top science and Japan's fabrication



Sandia National Laboratories

Los Alamos NATIONAL LABORATORY

White Sands Test Facility

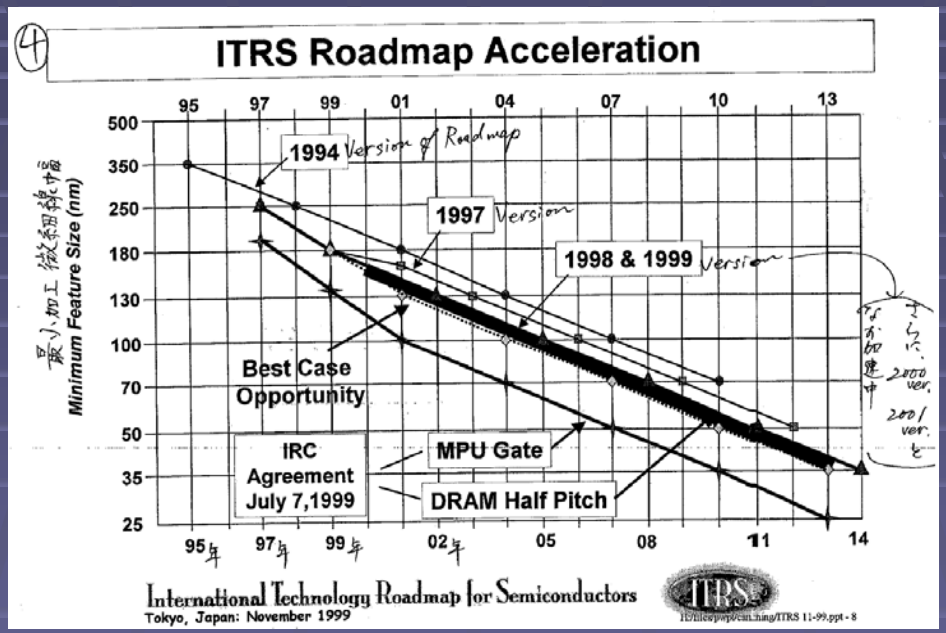
The University of New Mexico

NEW MEXICO TECH
SCIENCE · ENGINEERING · RESEARCH · UNIVERSITY

NEW MEXICO STATE UNIVERSITY

The world's Greatest Science Protecting America

One aspect of ITRS



http://www.itrs.net/Links/2007ITRS/Home2007.htm

http://www.itrs.net/Links/2007ITRS/2007_Chapters/2007_Lithography.pdf

Updated target, time limit and problems are open to everybody alluring investment

Top mode; Open Innovation

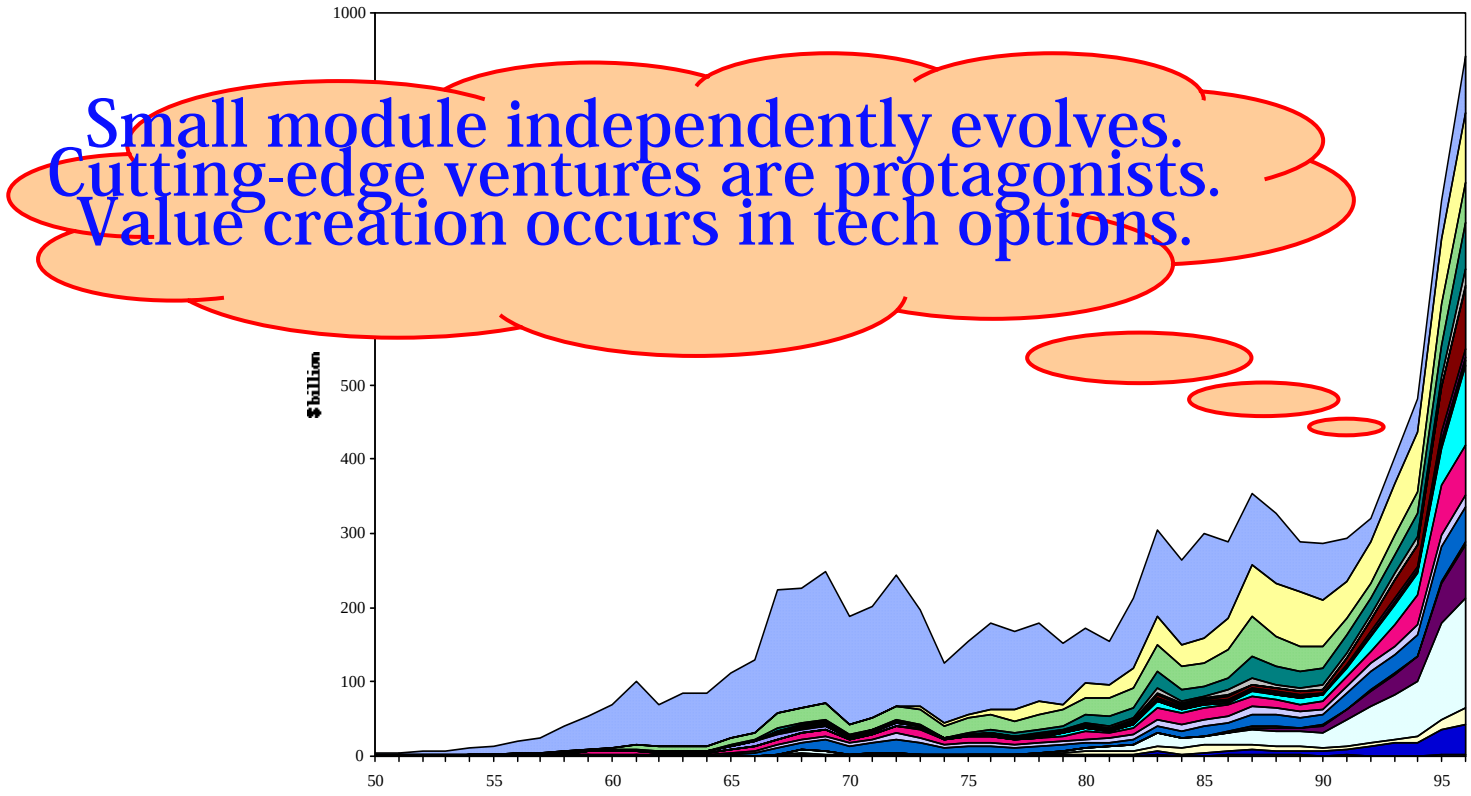
"Open Innovation: Renewing Topline Growth"

Henry Chesbrough
Executive Director, Center for Technology Management
Haas Business School, UC Berkeley

http://cpd.ogi.edu/MST/capstoneWIN2006/ToplineGrowth.pdf

Value Creation in Modular Industry

IBM's blue days



"***Design Rules: Power of Modularity***" **(C. Baldwin et al., MIT Press, 2000)**

Venture Capital Firms Specializing in Fuel Cell Industry

Targets	Outline
EXIT PEMEAS Fuel Cell Technologies	Polymer electrolyte membrane for high-temperature operation A spin-off from Hoechst AG
P21 power for the 21st century	Fuel cells for emergency power supply A spin-off from Vodafone
EXIT CELLEXPOWER	Fuel cells for fork lifts
EXIT Protonex The Next Generation of Portable Power	Fuel cells for compact mobiles
EXIT PolyFuel	DMFC (a spin-off from SRI)
EXIT CMR FUEL CELLS LTD	New-type membrane for DMFC
NFT NANO FUSION TECHNOLOGIES, INC.	Japanese university venture (Micropump)
CONDUIT VENTURES LIMITED	Shell Hydrogen, Mitsubishi Corp., Johnson Matthey, Danfoss, Solvay

New Funds Investing

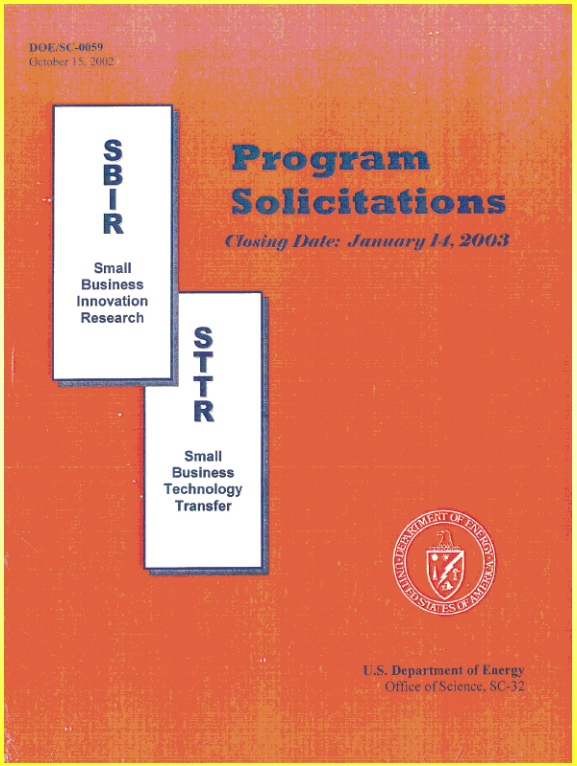
Recently launched funds	Geography		Currenc	Size	Tech scope	Lead investor
Zouk Ventures	UK	Apr-06	EUR	25	Energy	N/A
LSP BioVentures (Syngenta fund)	US	Q1 06	USD	100	Biofuel	Syngenta
Dexion Alpha (fund of funds)	UK	Q1 06	GBP	130	New energy	IPO
Impax Environment Markets	UK	Q1 06	GBP	20	New energy	New share issues
CorStone Capital	US	Mar-06	USD	100	Tech in China	N/A
NW Brown	UK	Q1 06	GBP	25	SMEs in UK	UK government
DFJ Element	US	Q1 06	USD	270	Green tech	Calpers
Hydro	Norway	Feb-06	NOK	400	Energy	Hydro
Kleiner Perkins	US	Q1 06	USD	100	Green tech	N/A
Conduit Ventures	UK	Q2 06	EUR	100	H2 & FC	Shanghai etc

USDOE's SBIR R&D Topics

- In Program Solicitations annually published, the DOE indicates R&D topics eligible for grants by each DOE office.
- For the 2006 version, refer to:

http://www.science.doe.gov/sbir/solicitations/fy%202006/table_of_contents_sub.htm

Front cover of Program Solicitations



(Source) http://www.science.doe.gov/sbir/Solicitations/FY%202003/contents.htm

New attempt: Strategic Promotion of R&D for Renewable Energy Introduction through Small Business Innovation Research Program

[What's SBIR and why?]

SBIR is a highly competitive program which encourages small business to explore their technological potential and provides the incentive to profit from its commercialization. By including qualified small businesses in the nation's R&D arena, high-tech innovation is stimulated and Japan gains entrepreneurial spirit as it meets its specific research and development needs.

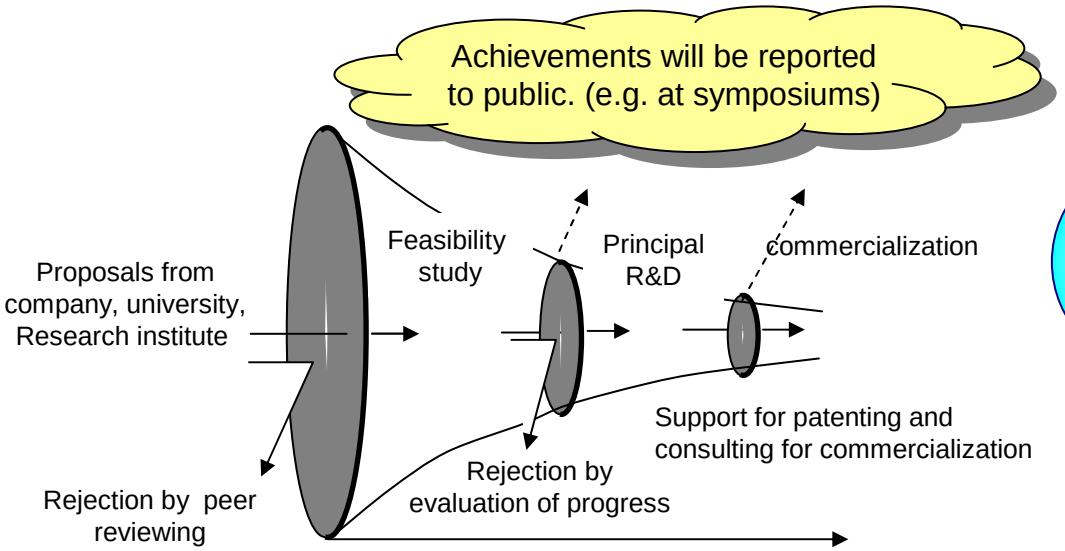
[Target and areas]

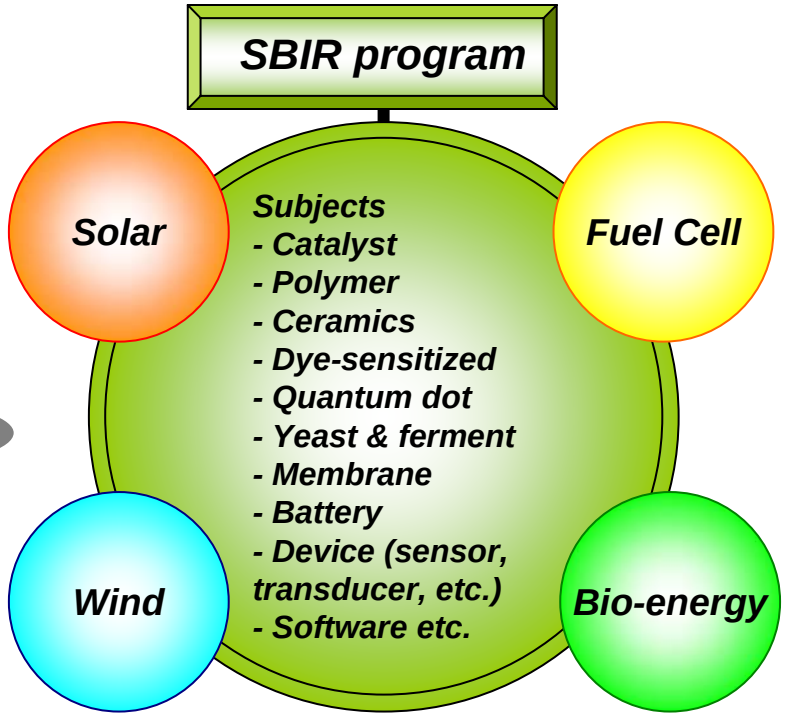
Small and medium companies, universities, and research group that which have a strong venture-capitalism in the new energy businesses such as solar energy, wind energy, tidal energy, geo-thermal, biomass energy as well as other related technologies for reliable and efficient utilization of new energy such as fuel cell and battery.

[Scheme]

Phase 1 (Feasibility study) [up to $90,000]
Phase 2 (Principal R&D) [up to $900,000]
Phase 3 (Commercialization)

- ○ Private sector funding
- ○ Government continue R&D as main project





These subjects are complementary to main R&D projects for new energy introduction but crucial for innovation and breakthrough for existing status of technology.

US Top 10 Biopharmaceutical Companies in Sales in 2000 used SBIR in their early stage

Rank	Company name	Sales ($ million)	With/ without grants	Established in:	Phase I	Phase II	Title
1	Amgen			80	86	88	RECOMBINANT DNA-DERIVED PERTUSSIS SUBUNIT VACCINE
					89		EXPRESSION
2	Genentech			76	—		
3	Serono			06	—		
4	Chiron			81	83	84	FEEDBACK CONTROLLED OLIGONUCLEOTIDE SYNTHESIZER PHASE I
					85		
					85	87	GENETIC ENGINEERING APPROACHES FOR AIDS VACCINES (MICE, RABB
					85		
					86	88	GENETIC ENGINEERING APPROACHES FOR MALARIA VACCINES
					90		CYTOMEGALOVIRUS GLYCOPROTEIN B RECOMBINANT ANTIGENS
					90		DEVELOPMENT OF A CYTOMEGALOVIRUS SUBUNIT VACCINE
					90		DEVELOPMENT OF A DEFECTIVE HEPATITIS
5	Biogen			78	86		
					86	87	MULLERIAN INHIBITING SUBSTANCE
					87		SOLUBLE MHC MOLECULES TO INDUCE ALLOGRAFT TOLERANCE
					87		PRODUCTION OF RECOMBINANT PROTEINS IN MILK
					96	97	High Numerical Aperture Scintillating Fibers
6	Genzyme General			81	83		
					84		
					85		
					86		
					88	89	PURIFICATION OF HIGH MANNOSE OLIGOSACCHARIDES
					97		EMBRYONIC STEM CELLS
7	Immunex			81	86		
					86		
					88		MOLICULAR CLONING
8	MedImmune			88	—		
9	Millennium Pharmaceuticals			91	97	98	NOVEL DRUGS FROM UNCULTURABLE FUNGI
					97		IDENTIFICATION OF FUNGAL DERIVED IMMUNOSUPPRESANTS
					98		GENETIC ENGINEERING OF FUNGAL POLYKETIDES
10	Gilead Sciences			87	89		RIBOZYME-LIKE ANALOGUES OF OLIGORIBONUCLEOTIDES
					92	94	OLIGONUCLEOTIDES BEARING FORMACETAL LINKAGES AGAINST HIV
					92		PERMEATION-ENHANCED PRIMER-DISRUPTING ANTIVIRAL AGENTS
					92	93	NOVEL INHIBITORS OF THROMBIN

Source:
The ranking in sales was compiled by NRI based on the data available on Contract Pharma and Hoovers Online.
The use of SBIR grants was confirmed on Tech NET, SBA.

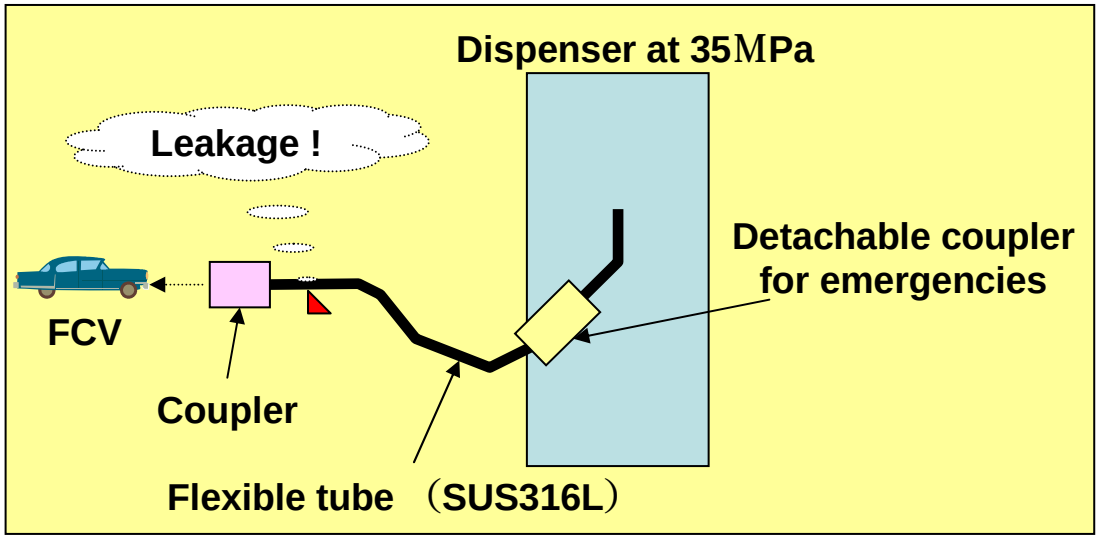
Trouble in Flexible Tube of H_2 Station during EXPO 2006 in Aichi

H_2 leakage due to crack in flexible tube of H_2 dispenser (the material lasted only 1/10 of its stated lifespan)

⇩

Leakage attributable to H_2 embrittlement.

H_2 station at Seto-minami (EXPO 2005)



A New National Lab. for Hydrogen Material R&D

HYDROGENIUS
Hydrogen saves the Earth

In order to realize a hydrogen energy society, a new laboratory "HYDROGENIUS" was founded last June, which aims to establish basic technologies to use hydrogen more safely and conveniently.

- HYDROGENIUS was established on June 1, 2006.

- Budget: 1.67 billion yen for FY2007

Organization of HYDROGENIUS

Director
Dr. Murakami, Y.

Deputy Director
Dr. Sasaki, K. (Research)
Mr. Ogata, T (General Affairs)
Dr. Yotsumoto, H. (Planning)

Research teams

Leader
Dr. Fukuyama

Hydrogen Dynamics in Metal Research Team

Leader
Dr. Matsuoka

Leader
Dr. Fujii

Hydrogen Fatigue and Fracture Team

Hydrogen Thermophysical Properties Team

Hydrogen Simulation Team

Hydrogen Tribology Team

Leader
Dr. Murakami

Leader
Dr. Sugimura

HYDROGENIUS: Top Scientists from Overseas

Prof. R.O. Ritchie
University of California, USA (2007～)

Dr. Jean-Marc Olive
University of Bordeaux I, FRANCE (2006.8.16～)

Dr. Veronique Doquet
Ecole Polytechnique, FRANCE (2007～)

Prof. Dan Eliezer
Ben Gurion University of The Negev, ISRAEL (2006.10.5～10.15)

Prof. Petros Sofronis
University of Illinois at Urbana-Champaign, USA (2006.6, 2007.1～2)

Prof. Richard P. Gangloff
University of Virginia, USA (2007.1～2)

Dr. Sergiy M. Stepanyuk
Paton Electric Welding Institute of National Academy of Sciences UKRAINE (2007.2.1～)

Dr. Brian P. Somerday
Sandia National Laboratories, USA (2007.1～2)

Advanced Basic Technology for Hydrogen Storage Materials

Budget: 0.76 billion yen (FY2007)
Project year: FY2007-FY2011

Establish compact and highly-efficient hydrogen storage/delivery technology through revolutionary performance improvements of hydrogen storage materials

Background

○ Key for Hydrogen Society
= Establish of compact and high efficient hydrogen storage and delivery technology

○ Technology of “hydrogen storage material (metal hydride)” as promising candidate
Japan has world-leading technology

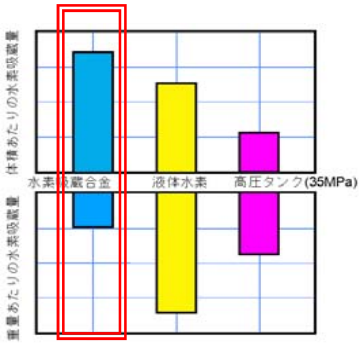
○ Key issue is to attain a significant increase of adsorption capacity in hydrogen storage material

Project Policy

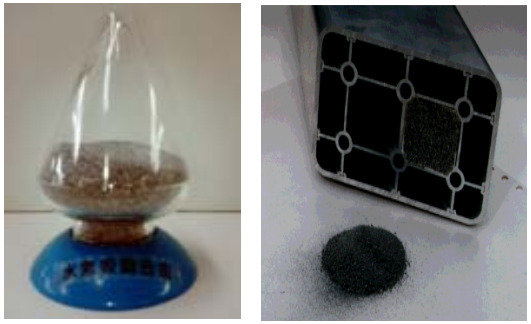
○ Intensive R&D through close and flexible network of national laboratories

○ Open the rise of new talent or new comers from different fields

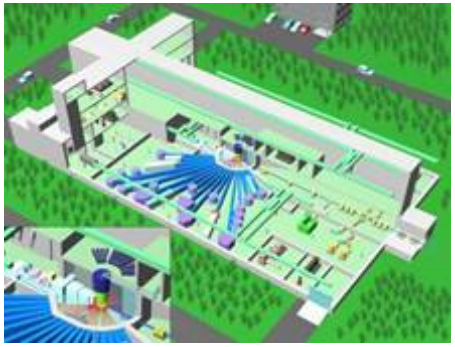
○ Collaboration with top class laboratories outside of Japan (ex. Los Alamos National Laboratory) in simulation technology
（High Energy Accelerator such as “J-PARC Project” would be used to analyze the structure of hydrogen storage materials）



〔**ability of hydrogen storage materials**〕



［**hydrogen storage alloy**］



〔**quantum beam lab. image**〕

Mr. Nikai, Ex-Minister of METI Visited to LANL (2006.8)

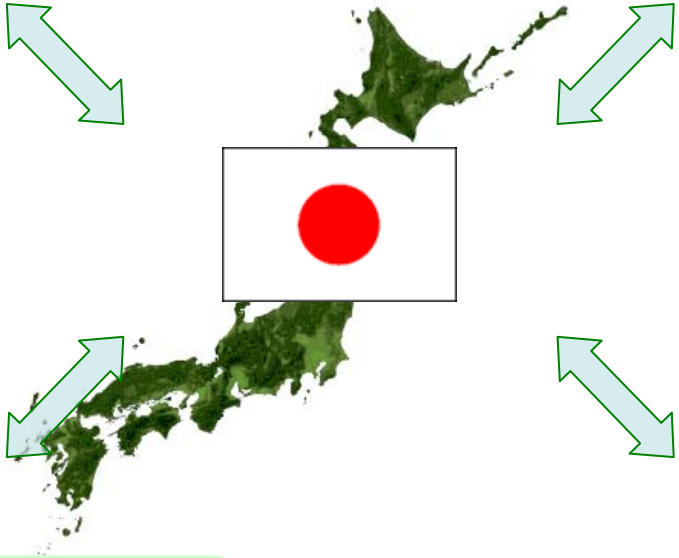
Global-Scale Collaboration for the Development of Fuel Cells

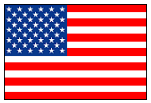
International Partnership for the Hydrogen Economy (IPHE)

・International cooperative framework for promoting technology development, standardization, and exchange of information concerning hydrogen and fuel cells
・Members: 17 countries/organizations, including Japan

Research Center for Hydrogen Industrial Use and Storage (HYDROGENIUS)

・Researchers get together from countries around the world, including the US, France, Ukraine, and Israel



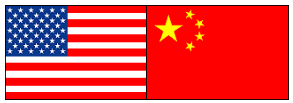


Polymer Electorolyte Fuel Cell Cutting-Edge Research Center (FC-Cubic)

・Exchange information with the Los Alamos National Laboratory

High-Performance Fuel Cell Project

・Inviting foreign researchers



Advanced Research Project for Hydrogen Storage Materials

・Joint research with the Los Alamos National Laboratory
・Hold Japan-China Seminar on Hydrogen Storage Materials

The World's Largest FCEXPO

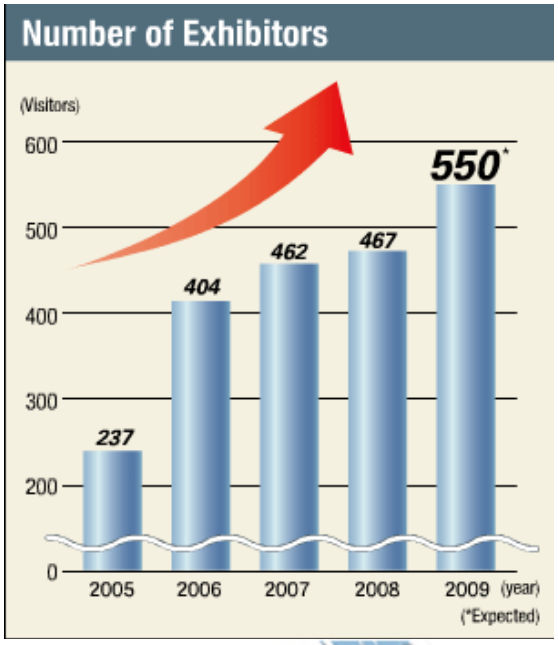
February 25 [Wed] - 27 [Fri], 2009

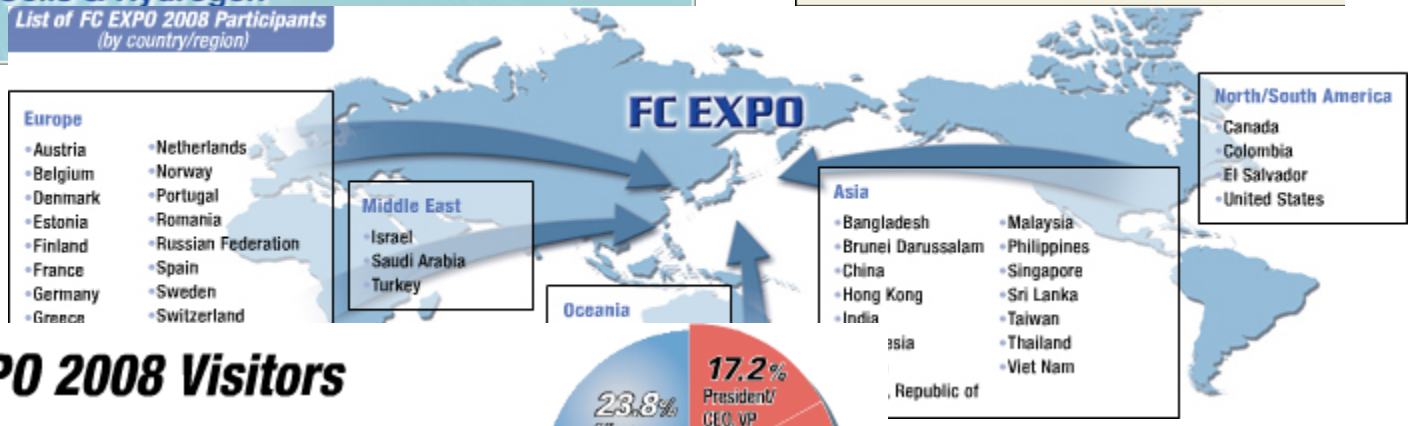
5th Int'l Hydrogen & Fuel Cell Expo

FC EXPO 2009

第5回 国際水素・燃料電池展

International Exhibition & Conference
featuring all kinds of technologies,
equipment and products related
to the R&D and manufacturing of
Fuel Cells & Hydrogen

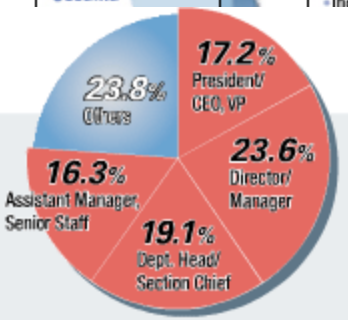




Breakdown of FC EXPO 2008 Visitors

76.2% *of total visitors were decision makers with purchasing authority.*

A large number of specialists including CEOs/Presidents, Directors, Managers and Cheif Engineers of fuel cell related companies visit FC EXPO every year. Exhibit at FC EXPO 2009 to conduct face-to-face business meetings with key buyers!



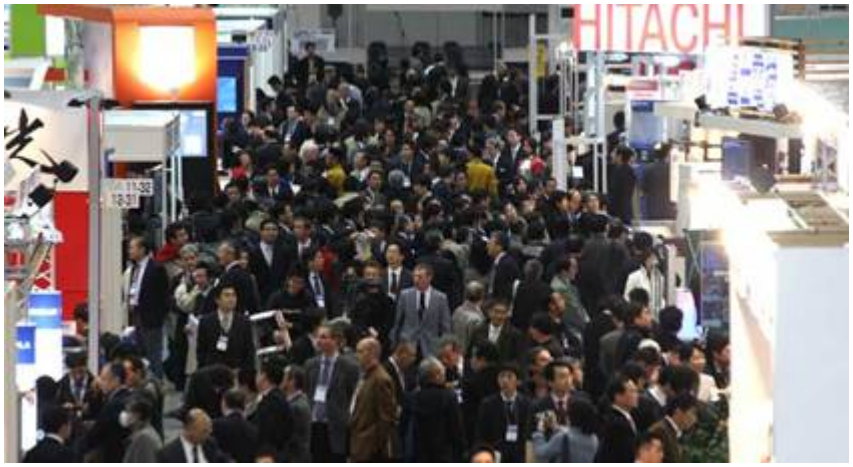
http://www.fcexpo.jp/

Numbers of visitors:

2005 : 20,037
2006 : 23,039
2007 : 24,494
2008 : 24,617

Numbers of exhibitors:

2005 : 237
2006 : 404
2007 : 462
2008 : 467



Exhibitions of leading companies from Japan and abroad

Serious business discussions and technical consultations

JHFC Demonstration Project (Fuel Cell Vehicle)

FC EXPO Keynote session

"Samurais" have just begun battles toward the Hydrogen Economy

Big challenges to overcome

Limit of known methods:

Foreseeable innovations as "kaizen," "kanban," etc.

Closed, self-supporting innovation style

Huge amount of R&D costs

Circumstances:

Rapid innovations in competing technologies like hybrid-cars, heat pump systems

Uncertainty of new infrastructure

R&D challenges:

Drastic cost reductions

Degradation factors

Hydrogen storage

Durability, etc.

Self-sustaining innovations in integral architecture

- Collaborative activities in non- & pre-competitive areas
- Alliances with external enterprises
- Robust engineeringtechnology in manufacturing arena

Scientific breakthroughs and industrial application

- Basic mechanism
- Degradation factors
- Accumulations of scientific knowledge
- Fusing disparate knowledge (Schumpeter's principles)

	2005	2010	2020
FCVs			
Cruise range [km]	300	400	800
Price compared to ICVs	x 20	x 3-5	x 1.2
Stationary FC			
Efficiency [HHV, %]	30	32	37
Durability [hour]	20,000	6-70,000	90,000
H_2 price [Y/Mm^3]	150	80	40

FCV: 5 million

Stationary FC: 10GW

H_2: \40/Nm^3

Expansion from realistic niches

- Tech. marketing
- Mix & match of best modules
- Inversion of modules
- DC applications

"Destructive" innovation by ventures

- Unprecedented modules
- Unexpected synergies
- Bridge to integrated architecture

Outline of the Latest Document of the Industrial Structure Council ① METI

○ Resource constraints are internationally becoming severer
(Demand growth, drastic rise in prices, conservatism in resource trading)

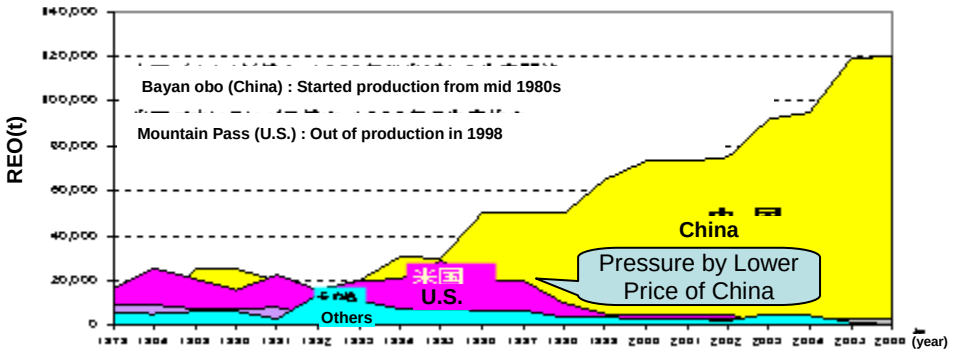
*The risk is eminent in **"rare metal supply"** which is indispensable with the production process of "High-Tech" commodities such as automobile, digital home appliance and other electronic devices

*Academic reports suggests the possibilities in the shortage of metal source by the year 2050.

●Escalating Price of Natural Resources
(Indium, Neodymium, dysprosium, etc) Compared the figures of 2002's to 2007's, prices are escalating by 4 to 8 times.

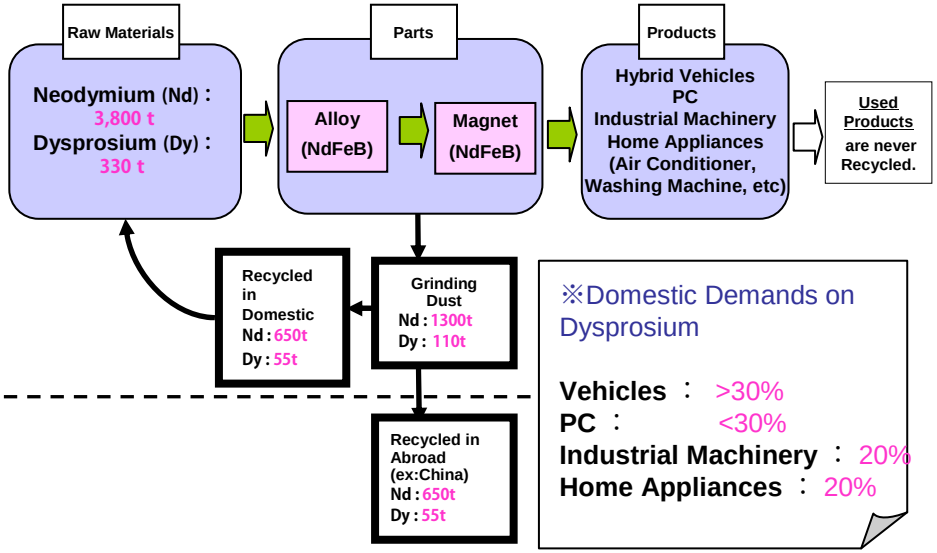
		Mar/2007	May/2007	%
Iron Scrap	US$/t	73.9	273.3	370%
Aluminum	US$/kg	1.4	2.7	196%
Copper	US$/kg	1.6	7.4	459%
Lead	US$/kg	0.5	2.2	441%
Indium	US$/kg	85.0	710.0	835%
Nickel	US$/kg	6.5	52.2	798%
Rare Earth (Neodymium)	US$/kg	7.3	44.0	603%
Tungsten (Ore)	US$/MTU(*)	35.3	165.0	467%
Rare Earth (Dysprosium)	US$/kg	34.0	120.0	353%
Platinum	US$/kg	16,517.7	41,465.5	251%

●Total Amount of Production of Rare Earth by Country



Source：Mineral Commodity Summaries

●Material Flow of Neodymium/Dysprosium



※Domestic Demands on Dysprosium

Vehicles ： >30%
PC ： <30%
Industrial Machinery ： 20%
Home Appliances ： 20%

The Industrial Structure Council is…

An official organization that responds to inquiries from the Minister of Economy, Trade and Industry on important topics relating to METI's policy, particularly improving the economic strength of the private sector and promotion of good international economic relations.

Outline of the Latest Document of the Industrial Structure Council ② METI

Minimization of input by the reduction of production loss and consumption loss

Maximization of the output from natural resources

Ultimate utilization and reduction in the consumption of natural resources

Achievement of "Most resource-efficient society in the world"

- **Promoting the cooperation among whole industrial sectors in product life cycle**
- **Paradigm shift into "Green" production and social system reducing resources**

"Green Supply-Chain"

- **Integrated approaches with the national policies of stable Rare Metal supply, carbon reduction, and enhancement of industrial competitiveness**

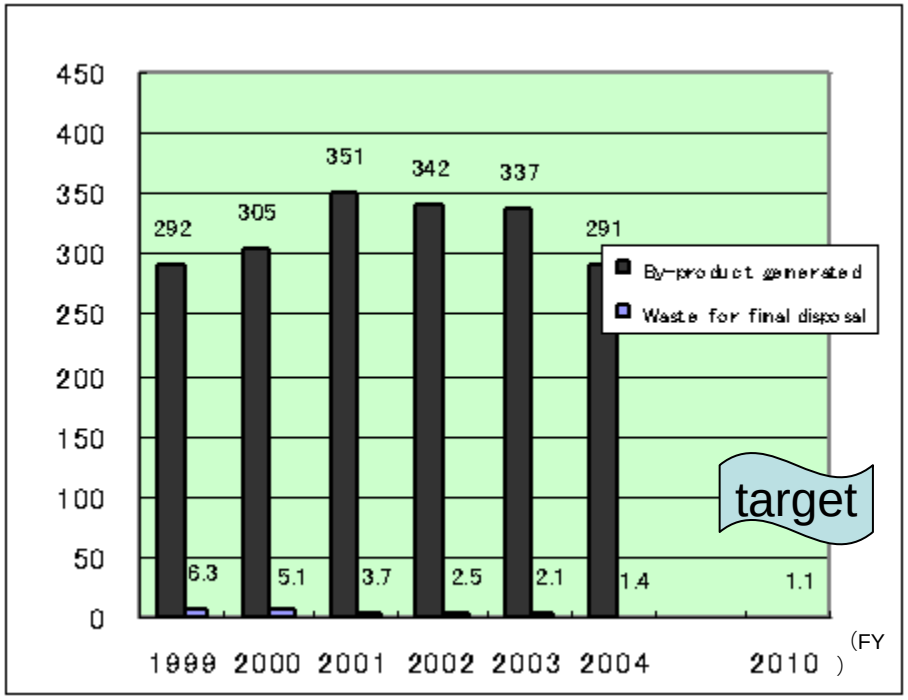
Generation of wastes in Automobile manufacturing / Car parts manufacturing

METI

In the car part manufacturing (which is the middle-stream industry) as well as in the automobile manufacturing, promotion of the 3Rs contributes to the reduction in the amount of final disposal. But generation of wastes are bigger than that of the automobile manufacturing, and going sideways in recent years.

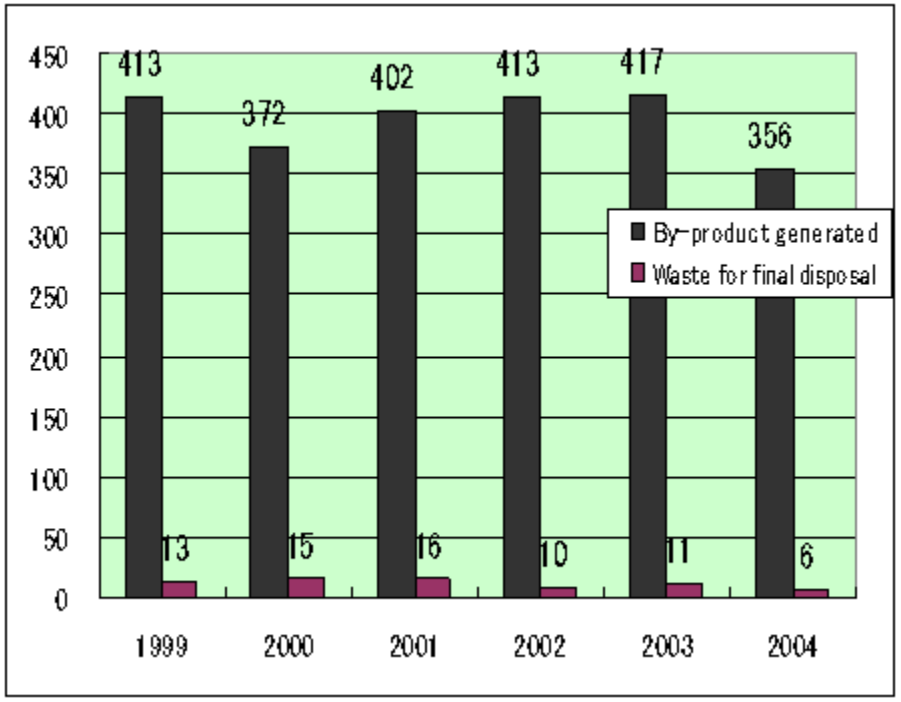
The amount of wastes and their final disposal generated in ***automobile manufacturing***

(Unit：10 thousand ton)



The amount of wastes and their final disposal generated in ***Car parts manufacturing***

(Unit：10 thousand ton)



○According to estimates of the amount of direct and induced generation of industrial by-products using the input-output table, **the transportation equipment (automobiles, etc.) manufacturers and electrical /electronic (home appliances/PCs, etc.) manufacturers produce a larger amount of induced generation of by-products than direct generation, as well as a large total amount of direct and induced by-products**.

○It is assumed that **there is much room to further curtail the generation of by-products in the process of production of products with a large supply chains through full optimization in collaboration between upstream/mid-stream firms and downstream firms.**

Amount of direct generation・・・ Amount of by-products generated by downstream firms

Amount of induced generation・・・ Amount of by-products generated in the supply chain of the production of final goods, or in the process of raw materials and parts (upstream/mid-stream)

●Amount of direct/induced generation of by-products in different industries (FY2005)

	Induced (1) (Unit: ton)	Direct (2) (Unit: ton)	(1) / (2)
Precious machinery manufacturers	225,024	48,000	4.69
Other manufacturers	344,547	102,000	3.38
General machinery manufacturers (copier, etc.)	**2,831,032**	**1,331,000**	**2.13**
Electrical/electronic (home appliances/PCs etc.) (*)	**4,423,768**	**2,706,000**	**1.63**
Transportation equipment (automobiles, etc.) (*)	**7,211,252**	**5,422,000**	**1.33**
Rubber products manufacturers	299,757	293,000	1.02
Printing/related businesses	541,445	536,000	1.01
Textile industry (dye/sorting)	192,994	195,000	0.99
Furniture/accessory manufacturers (metallic furniture/others)	71,443	102,000	0.70
Chemical industry	3,549,650	8,416,000	0.42
Ceramic/clay product manufacturers	321,296	772,000	0.42
Non-steel metal manufacturers	242,466	757,000	0.32
Plastic product manufacturers	585,150	1,843,000	0.32
Petroleum & coal product manufacturers	131,785	449,000	0.29
Steel industry	853,498	4,198,000	0.20
Pulp/paper/paper product manufacturers	748,714	5,796,000	0.13

Source: Estimates based on the survey on industrial waste and by-products with value (FY2005) and the 2005 Input-Output Table (Simple Extended Table/2000 Fixed Price)

“Greenising” of the Procurement Strategy （Reducing / Cost Down） and Strategy for next-gen. Automobiles

Reduce

Cost Reduction

Evolution of Japan’s favorite Procurement

Further “Kaizen”

＜**Possible Case**＞

・Transforming manufacturer's recent experiences to supplier's

・ 3R and CO2 Optimization of materials / process （cutting, forging, casting, sinter, Molding, near-shape etc.）

・**”Greenising” may become key point for further VA/VE activities and cost reduction**

Next-gen. Strategy

＜**Linkage to Rare Metal Strategy**＞

・High performance magnet contained Nd/Dy and alternative materials

・lithium battery electrode contained Li, Co, Mn/Fe related and alternatives

・ Reduction/ Substitute (Pt/Rh/Pd/Ru)

＜**Fuel Cell**＞

Material-flow Management

＜**Successful Experiences in other industries**＞

Canon: reduce of glass sludge by 80%

NITTO DENKO: reduce the negative product by 2/3

Tanabe Pharma: change sludge treatment which contributes to decrease maintenance fee, energy saving, CO2 reduction.

・**These successful MFCA experiences of other industries may contributes to further cost reduction.**

Cost Reduction / Future Strategy / International Competitiveness

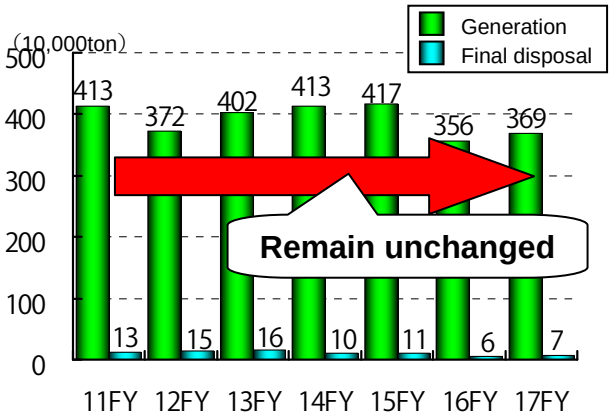
"Greenising"

Strengthen industrial competitiveness by resource-saving design & manufacturing (”New *Suriawase version 2.0*”)

- There are much resource losses in the integral manufacturing industry where Japan has competitiveness. The tough industrial structure is necessary that is not negatively affected by price rises of resources like the rare metals which are indispensable for next-gen. cars (plug-in-hybrids etc.).
- The actions of Japanese companies who seek high qualities promote more generation of resources losses as a result.
  （The reduction of losses is limited by the designs and specs of downstream companies / Process yield becomes unintentionally lower by severe demand of quality）
- Fourfold effect of resource saving / energy saving / CO2 saving / workload reduction (= cost cut) can be realized by downstream companies' considering resource losses in all stages of supply-chain including the upper stage thorough resource conserving manufacturing.
- Only several pioneering companies have begun to tackle with these resource conserving manufacturing, which does not be generally done by Japanese companies because it may not lead to short-term profit of them.
- By improving related systems, competitiveness of Japanese industry should be increased by “Power of New Integration (Suriawase version 2.0)“ again through resource conserving.

○ Examination of a legal system to obligate downstream companies to design and procure with consideration of loss reduction in the process of the upstream and mid-stream companies. （For example : cars, home appliances, copying machines）
○” Visualization ” of the outputs by the creation of excellent examples.

●Resource losses in upstream and mid-stream



●Examples of pioneering companies

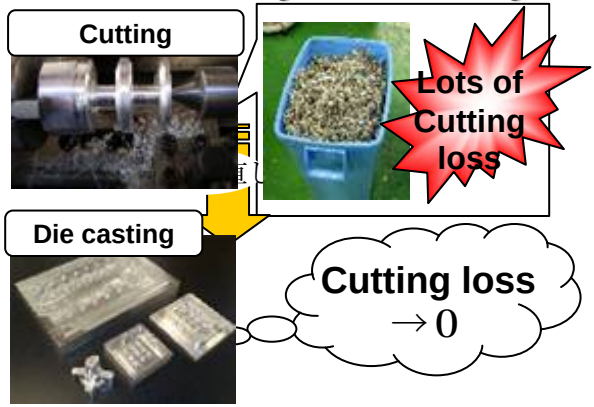
TOYOTA

○ Promoting lightweighting by review of the raw materials and part designs in cooperation with makers of materials and parts. Realizing improvement of the mileage and CO2 saving by the lightweighting.

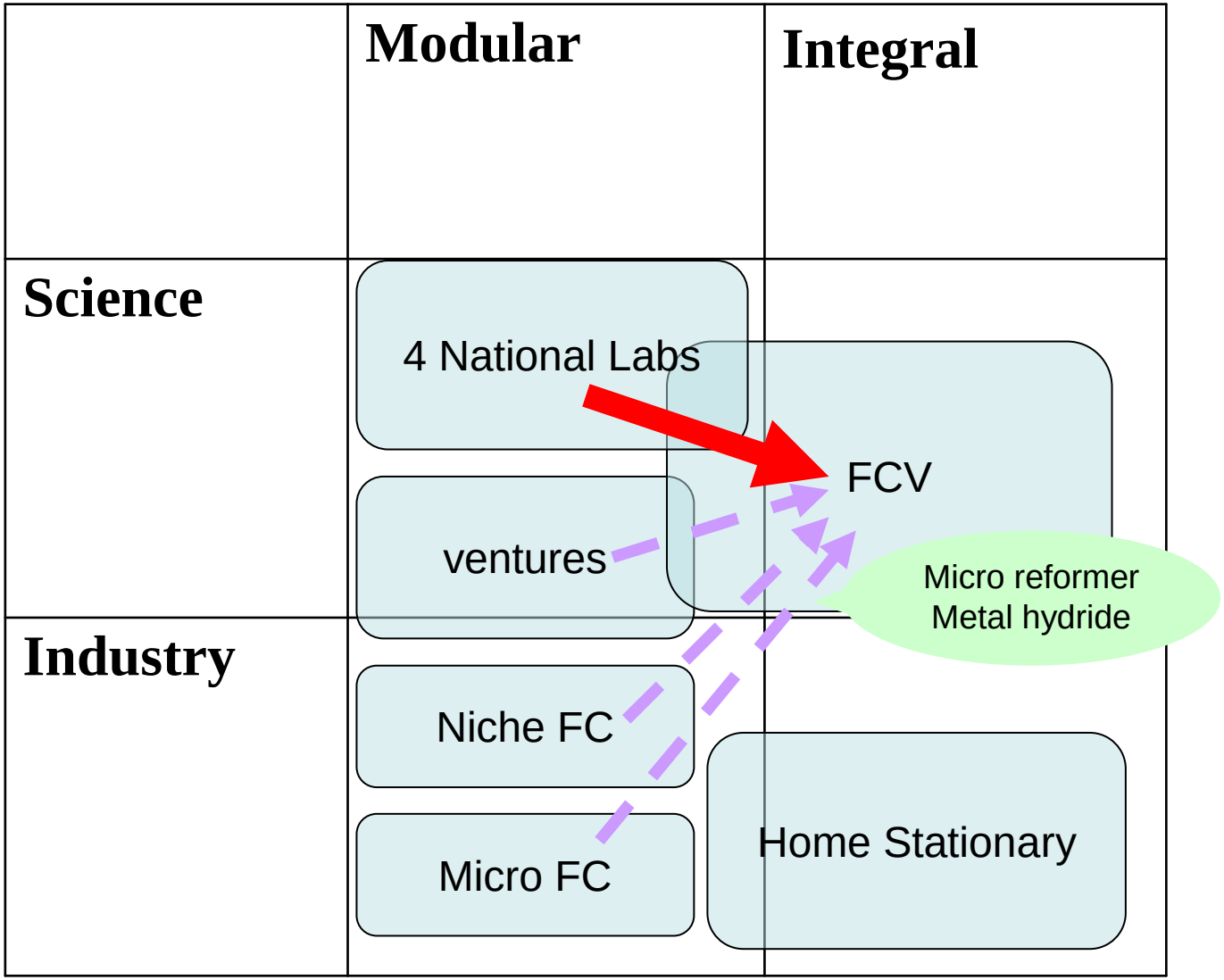
Ricoh

○ Reviewing the product designs which promote environmental load reduction in the part production. (carrying it out in 50 companies, spreading it in about 200 companies in the future).

●Examples of reducing losses with resource-conserving manufacturing



Architecture and Innovation phase



Options and Progress so far

HYDROGENIUS	AAA+	Superb
Home PEFC	AAA	Very Excellent
Home SOFC	AA+	Promising
FCV	AA	Good; To be improved
Hydrostar	AA	Just started
HiPerFC	AA	Just started
FC-Cubic	A+	Last spurt?
Micro FC	A+	When Products?
Ventures	A-	Waiting new star…
RMFC	B	New team?
Niche	B	New team?

Innovation management

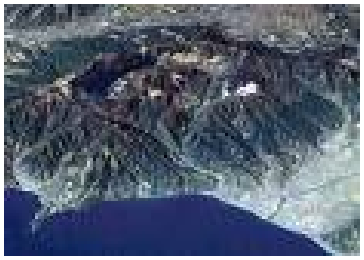
Key words

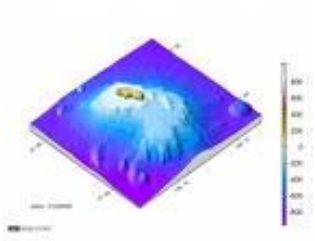
- Passion
- Mission
- Options
- Competition
- Persistency
- Architectural Design
- Open Innovation
- Science-Industry Bridge
- Tangible target
- Samurai Spirit

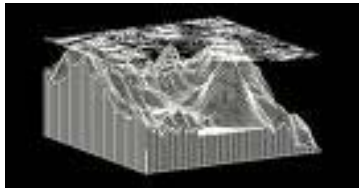
Role of Government

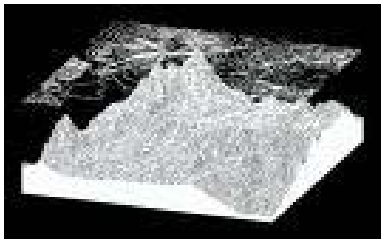
- National Focus
- Super neutrality
- Encouragement
- Stubborn support
- Empowerment
- Fair Battle field for competition
- Salon for exchange of information and passion
- Budget allocation (inferior)

Value Landscape incessantly changes under modular economy









"Der Tag ist Schön auf jenen Höhen."

"*Design Rules: Power of Modularity*" (C. Baldwin et al., MIT Press, 2000)

References

"*Design Rules: Power of Modularity*" (C. Baldwin et al., MIT Press, 2000)

"*Mojuru-ka*" (Modularity: the Nature of New Industrial Architecture) (M. Aoki, H. Ando et al,. Toyokeizaishinposha, 2002)

"*Nihonkeizai Kyosoryoku no koso*" (Japan's Economy and vision for competitiveness: Modular architectural strategy to challenge in new era of speed) (H. Ando et al,. Nihonkeizaishinbunsha, 2002)

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"Nenryodenchi Kaihatsu to Architecture (R&D of Fuel Cells and Architecture)", *Nenryodenchi Jituyoka heno Chosen* (Fuel Cells: Challange for Commercialization) (A. Tsutsumi et al,. Kogyochosakai, 2007)