

November 18, 2010

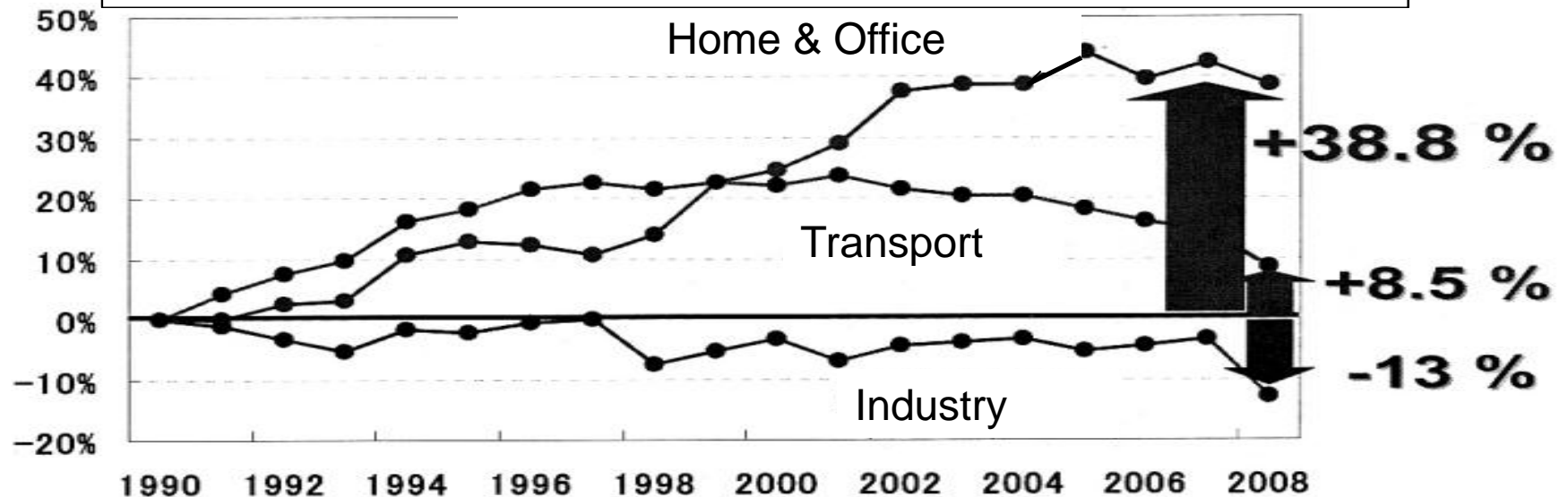
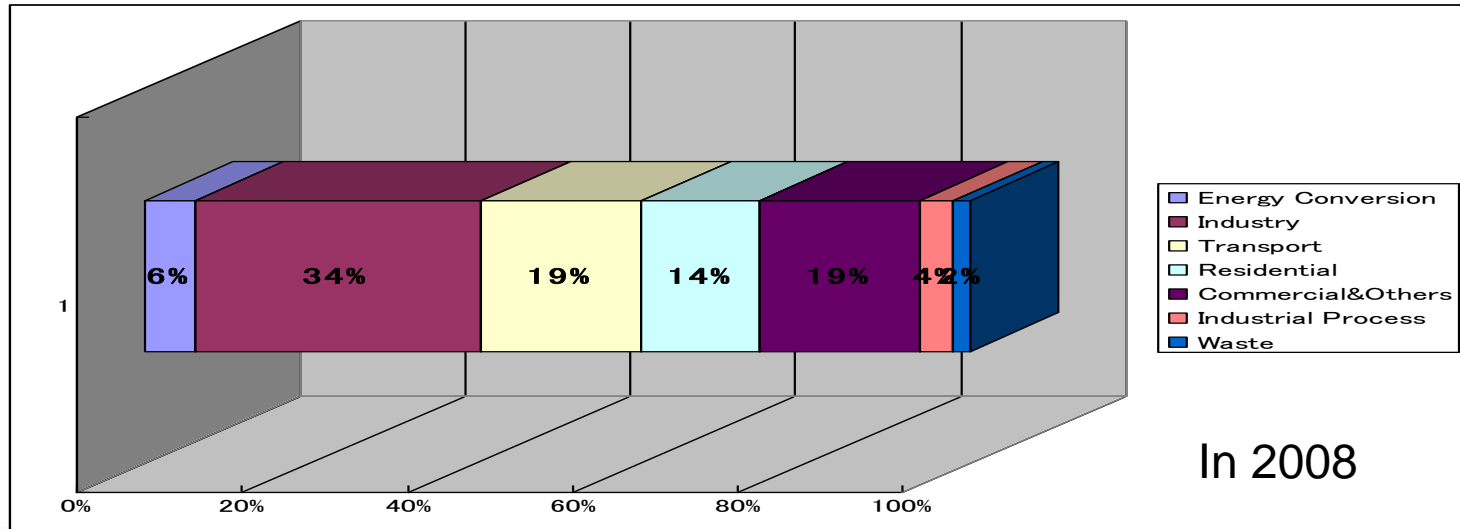
New S&T Foresight on Green Innovation in Japan

Tomoaki WADA
Affiliated Senior Fellow
National Institute of Science and Technology Policy
Professor
Tokyo University of Science

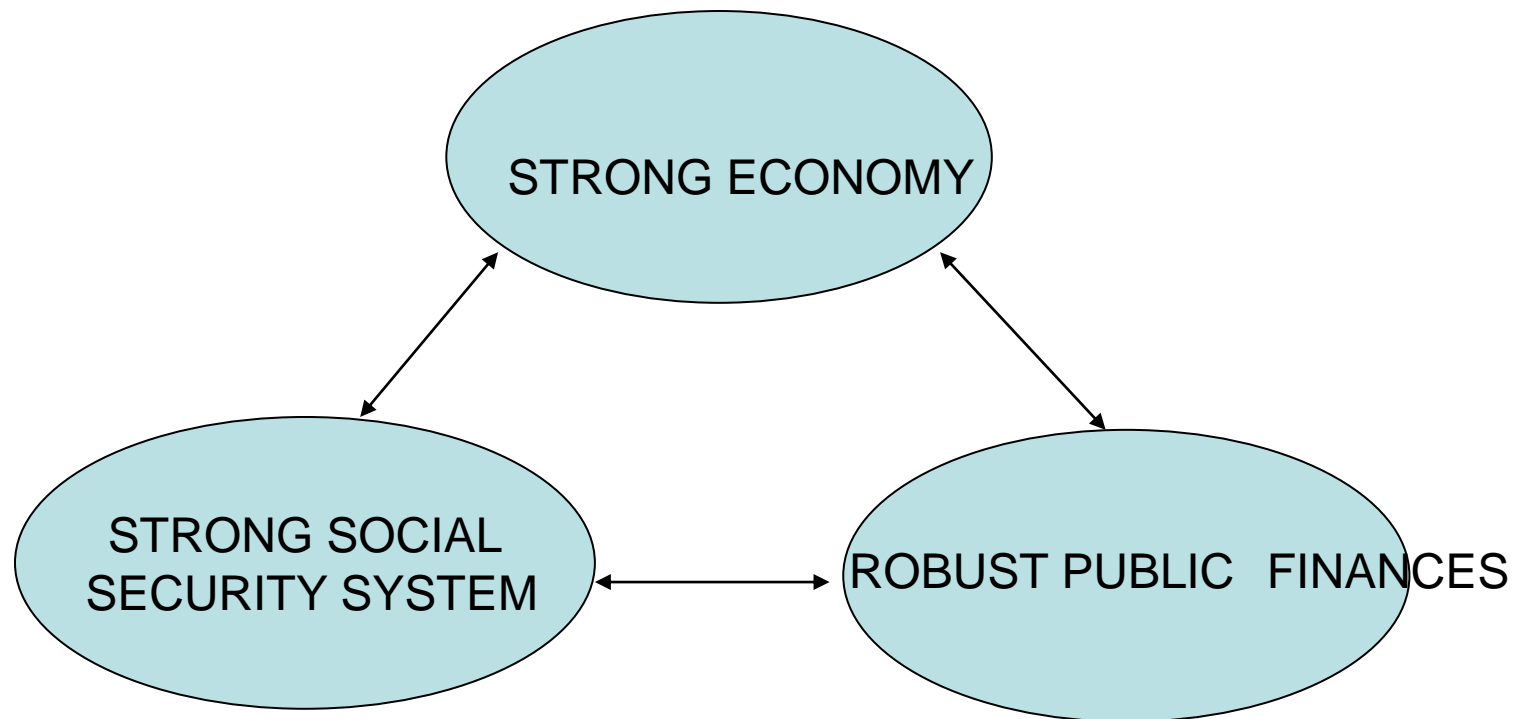
Contents

- Green Innovation in New Growth Strategy
- The 9th “Science and Technology Foresight on Green Innovation”

CO₂ Emissions in Japan



New Growth Strategy (June 2010)



TARGETS 2020

- Achieve nominal & real growth in excess of 3% and 2%, respectively
- Lower the unemployment rate to 3% - 4% at an early time.
- Return consumer prices to a positive increase in FY2011.

Growth Areas Driven by Japan's Strengths

- Green innovation (environment & energy)
- Life innovation

Green Innovation

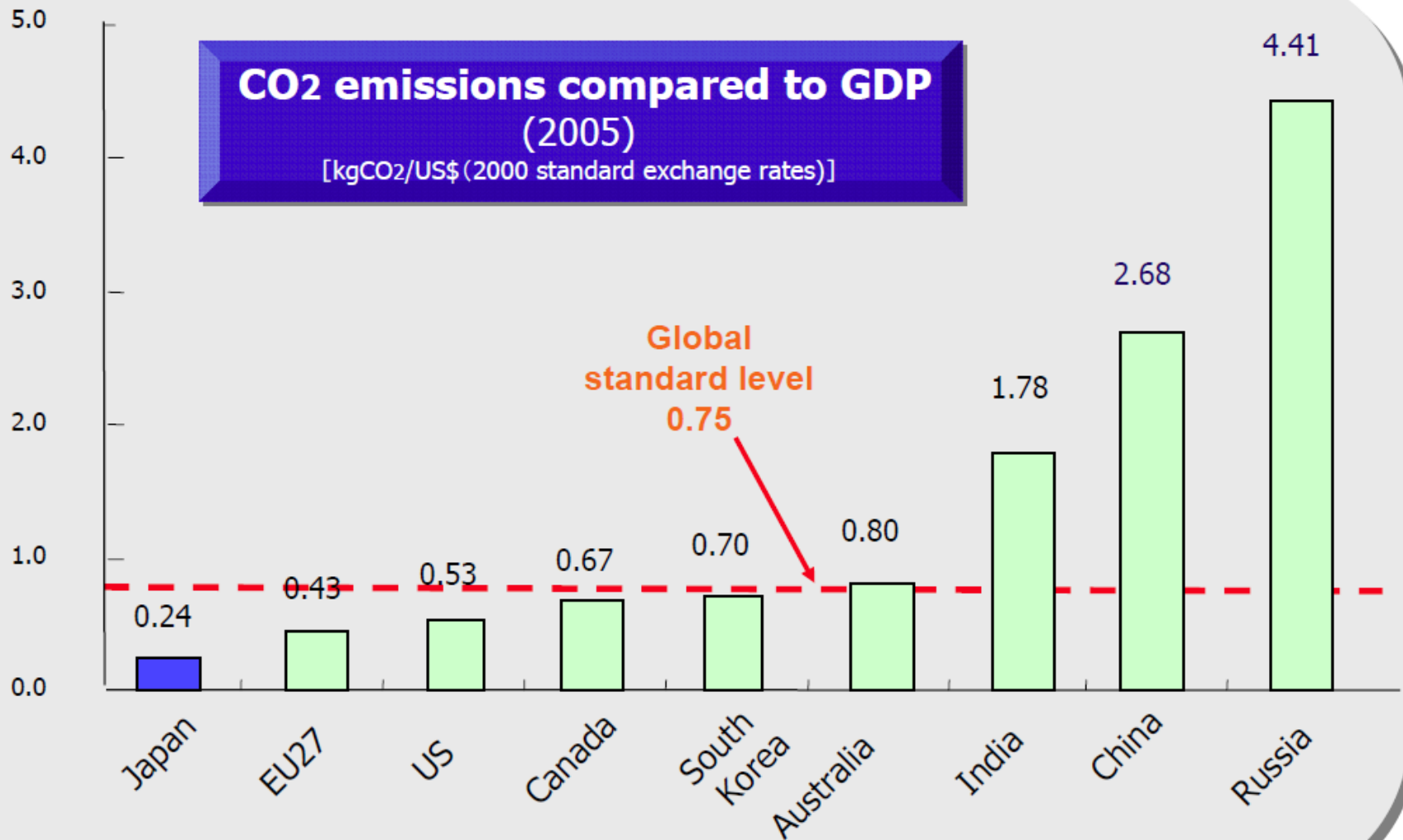
- **NEW MARKETS in Green Innovation**
 - Demand Creation by 2020: ¥50 trillion
 - Job Creation by 2020: 1.4 million Jobs
- **POLICY MEASURES**
 - Rapid increase in renewable energy by introducing feed-in tariff system
 - “Future City” initiative
 - Forest and forestry revitalization plan

Green Innovation Strategies

-General-

- Diffusing Japan's world-leading green technology globally
- Becoming the world's top environment and energy power through a comprehensive policy package
- Japan will play a leading role in a low-carbon society, having set a domestic target of reducing greenhouse gas emissions by 25% by 2020 compared to the 1990 level; this target is premised on the creation of 1) a fair and effective international framework that involves all major economies and 2) an agreement that includes ambitious targets and is created jointly by all those economies.

Expanding Advanced Technologies to Reduce Global Emissions



Source: IEA (2007), "CO₂ emissions from fuel combustion 1971-2005"

Green Innovation Strategies

*-Growth from green innovation
and securing support resources-*

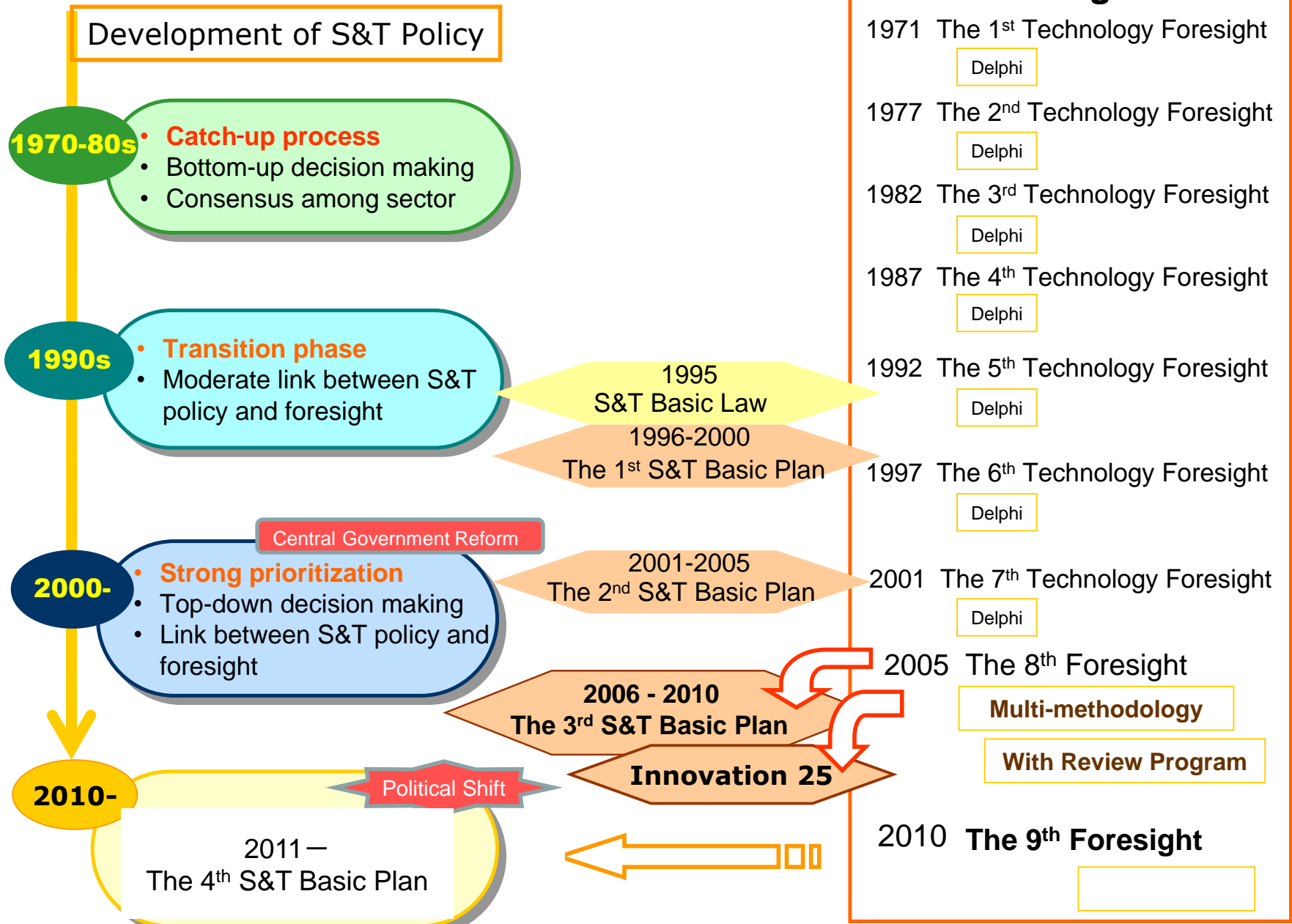
- The spread and expansion of renewable energies (solar, wind, small-scale hydroelectric, biomass, geothermal, etc.) by expanding the electric power feed-in tariff system
- The development of innovative technologies (storage batteries, next-generation vehicles, improved thermal power plant efficiency, and information and communications systems) with lower electric power consumption
- Comprehensive greenhouse gas emission reductions in the transportation and household sectors by promoting modal shifts and encouraging the use of energy-conserving consumer electronics

Green Innovation Strategies

*-Lifestyle reforms that improve
the comfort and quality of life-*

- Zero-emission homes, offices, and other facilities through the spread of eco-housing, and the expanded use of renewable energies
- Spread and expansion of heat pumps
- 100% adoption of LEDs, organic electroluminescent displays, and other forms of next-generation lighting

Development of National Foresight in Japan



What is Delphi?:

“Convergence of Expert Opinions”

- The name “Delphi” is taken from the location of the Temple of Apollo in ancient Greece, where the gods were said to visit the Oracle in order to have their futures told
- Originally developed by RAND corporation in the USA, in the 1950s
- Intuitive (qualitative) and quantitative data gathered: Opinion survey to a large number of experts repeated at least twice
- Encouraged exchange of opinions among experts with respect to convergence
- Useful for long-term foresight, where the opinions of experts are the only available source

The 9th Delphi Survey

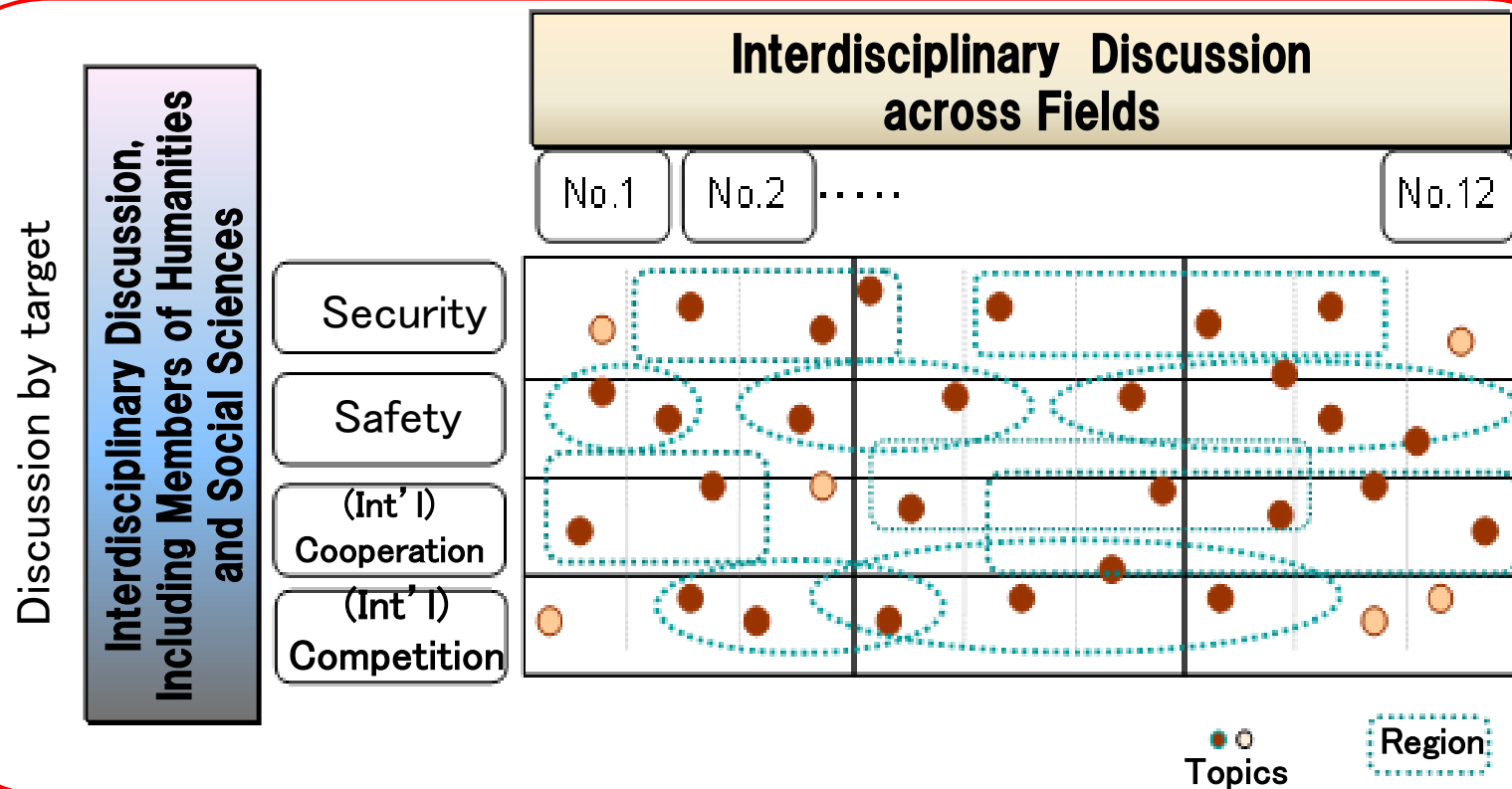
**Coupling and mixing two types of interdisciplinary subcommittees
that extend beyond existing fields**

Discussion by 4 Targets

+

12 Interdisciplinary Subcommittees

Cross-Field Discussion of Science and Technology



Delphi Survey - Targets and Technological Themes

No	Technological theme
1	Fully utilize electronics, communications technology, and nanotechnology in a ubiquitous society
2	Expand the scope of discussions on information processing technology to the media and contents
3	Link biotechnology and nanotechnology, to contribute to human quality of life
4	Make full use of IT to realize people's lives more healthy , with highly advanced medical technology
5	Use science and technology to help people understand the dynamism of space and the earth and expand the human sphere of activities
6	Make diversified changes in energy technology
7	Handle all kinds of necessary resources , including water, food, and minerals

Target

Safety

(Int'l) Cooperation

Security

(Int'l) Competition

8	Develop technology to preserve the environment and build a sustainable recycling society
9	Develop fundamental technology concerning substances, materials, nanosystems , processing and measurement
10	Develop manufacturing technology to comprehensively support the development of industry, society, and science and technology in general
11	Place overall subject matters under stricter management, due to advancements in science and technology
12	Create infrastructural technologies to support infrastructural and industrial bases

Key S&T Issues to Solve: Global and/or National Problems (Delphi Survey)

Issues related to “Green innovation”

Energy [No.1]
Industrial bio-nanotechnology related to energy and environment [No.3]
Space and ocean management technology (including observations) [No.5]
Nuclear energy [No.6]
Renewable energy [No.6]
Fossil energy [No.6]
Efficient power storage system [No.6]
Energy saving [No.6]
Agriculture, forestry, and fisheries resources [No.7]
Water resources [No.7]
Environment, recyclable resources, recycling, LCA [No.7]
Hydrocarbon resources, mineral resources, and CCS [No.7]
Lifestyle and environment [No.8]
Evaluation of and countermeasures to global warming [No.8]
Technology for urban waste minimization/material circulation for environmental conservation/resource- and energy- saving products [No.8]
Pollution prevention for atmosphere, water and soil / circulative use technology for water resources [No.8]
Energy, resources and environment [No.10]

Issues related to “Life innovation”

Applied bio-nanotechnology [No.3]
Healing (exogenous factors, metabolic disease, and psychiatric disease) [No.3]
Medical treatment aiming at safety and security [No.4]
Creation of new medical technology [No.4]
Development of predictive and preventive medicine [No.4]

Other issues

Socialization of information [No.2]
Cloud computing [No.2]
New principles for information and communication [No.2]
Space technologies [No.5]
Base materials for nanotechnology [No.9]
Output (device, systemization and applied technology) [No.9]
Globalization, value-adding and market creation [No.10]
Unpopularity of S&E, human resource problems, and the declining birth rate and aging population [No.10]
Management to prevent the decrease of competitiveness in the international market [No.11]
Service management, management in the education and research field, environment business management, and governmental institution management [No.11]
Framework for facilitation of social innovation [No.11]
Management of personnel, creation, and transfers of knowledge and education [No.11]
Strategy for maintenance of infrastructures [No.12]

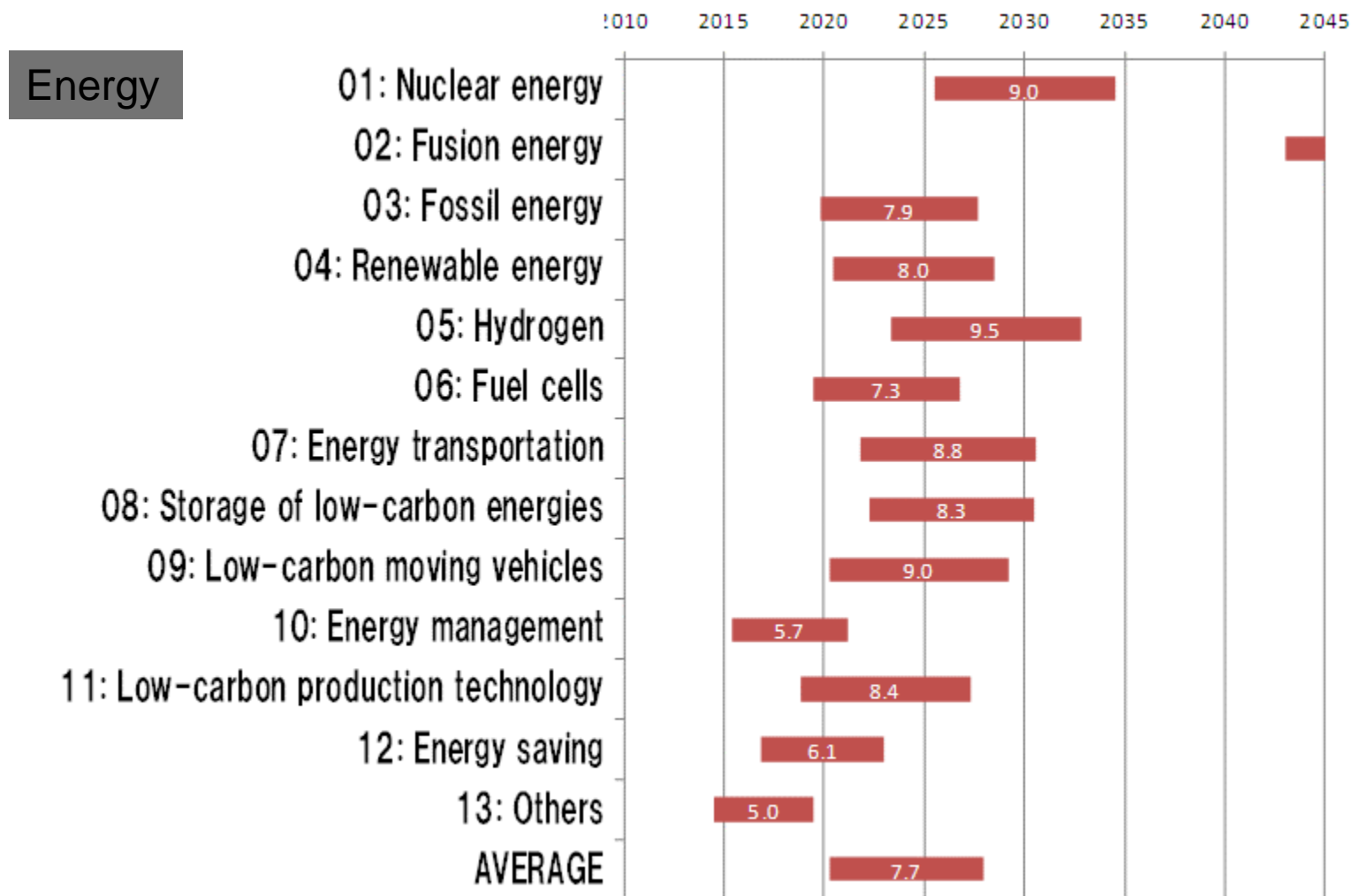
Number in brackets shows the sub-committee that give priority to the key issue .

Important R&D Items in Energy Field (Top 10)

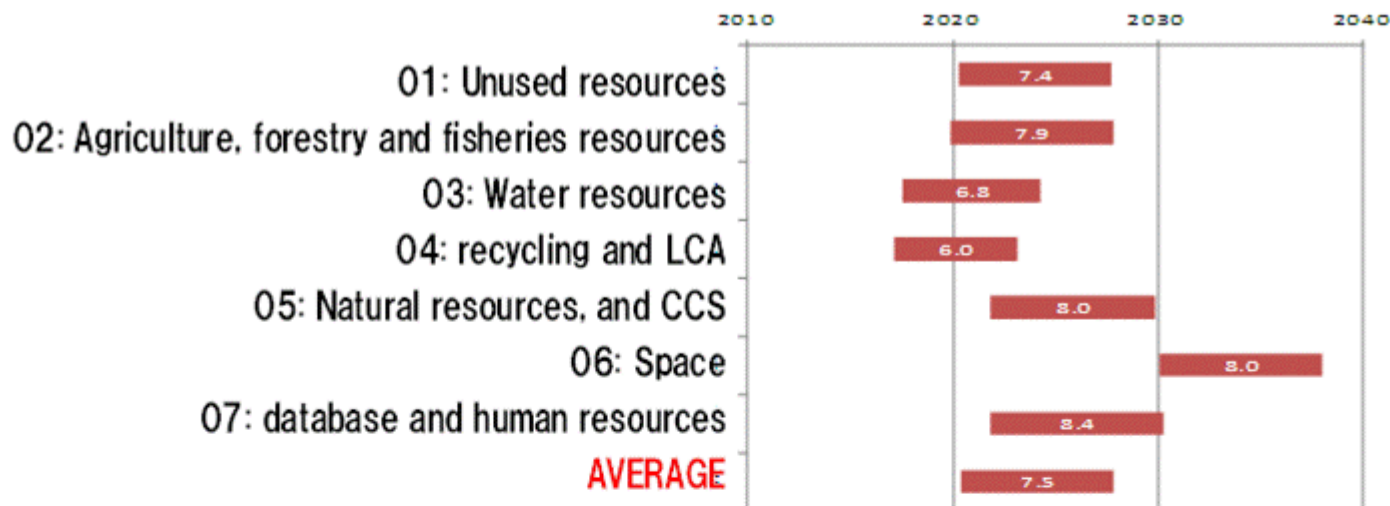
R&D Item	%	Technological Realization	Social Realization
Safe and rational decommissioning technology of commercial LWRs	100	2020	2028
Wide-area thin solar battery with more than 20% efficiency	98.9	2019	2027
Next-generation high-efficiency lighting with more than 150lm/W (LED, organic EL, etc.)	98.6	2018	2023
Fast-breeder reactor cycle technology	97.7	2029	2038
Low-cost secondary battery for automobiles (>100 Wh/kg, >2,000 W/kg, <¥30,000/kwh,)	97.7	2019	2025
Land-disposal technology of high-level radioactive waste	96.9	2022	2034
Super-high-efficiency heat pump for houses (COP > 8 for AC, COP > 6 for boiler)	96.9	2017	2022
Next-generation light water reactor technology (more than 5% LEU fuel, plant life of 80 years)	96.8	2026	2034
New material technology with higher energy conversion efficiency than Si/Ga-As batteries	96.8	2021	2029
Large-scale combined-cycle power generation using high-efficiency gas turbine (>1,700°C)	96.6	2018	2025

Results

Technological Realization Time and Social Realization Time



Resources



Environment

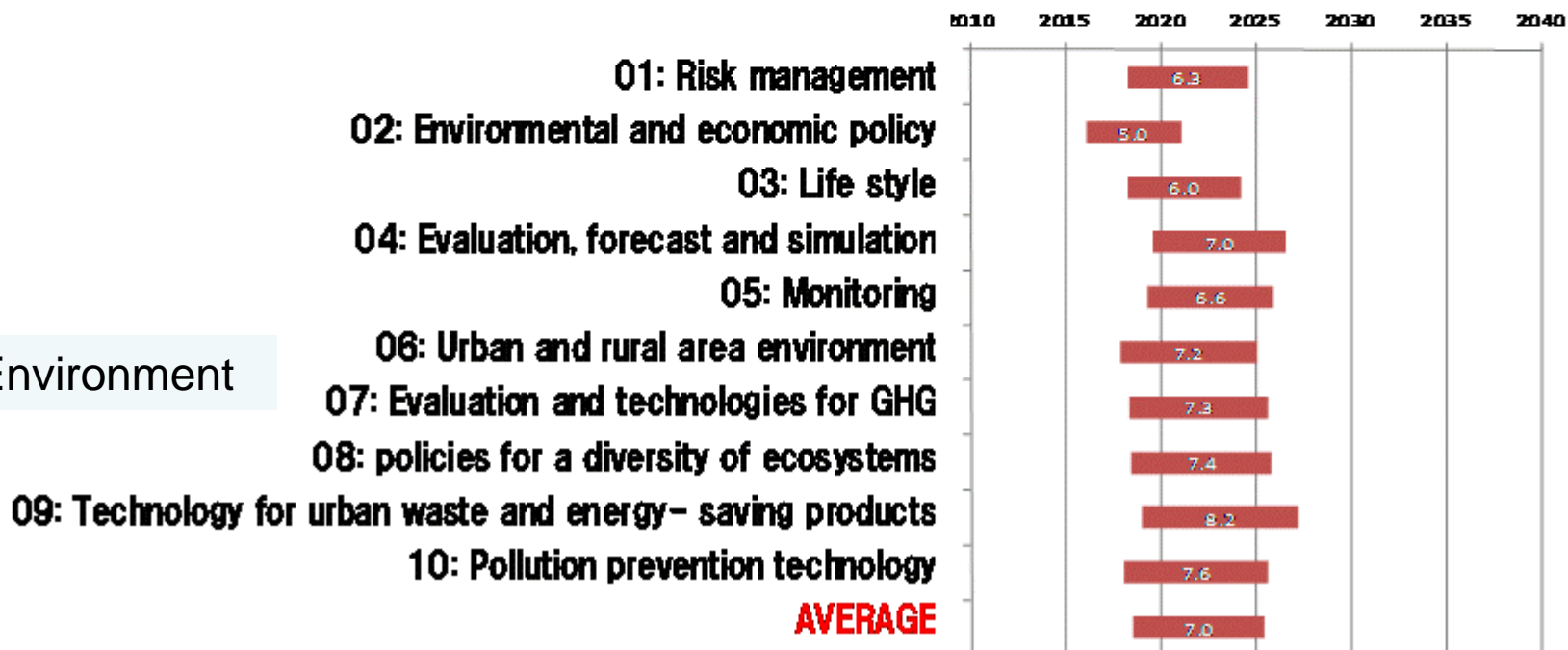


Illustration of Better Life around 2025, Based on the 9th Delphi Survey*

People will use a variety of energy sources selectively, based on their own values; they will actively participate in activities related to environmental protection and the prevention of global warming.

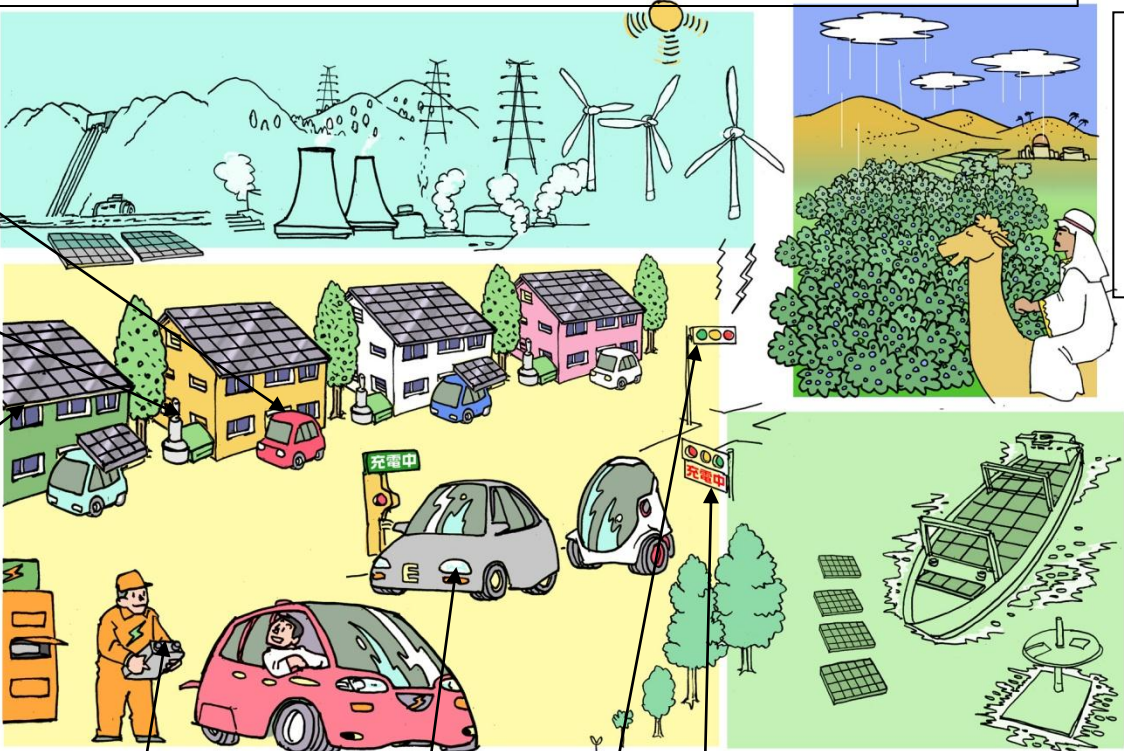
Microgrid technology that optimizes power supply through distribution power network communication, control and management technology, and telecommunications(2020)
Next generation energy transmission and distribution network technology enabling stable, low-cost and low-carbon power supplies, through the optimal management of the entire supply-and-demand balance of large power supplies, by utilizing information and communications technology (ICT).(2025)
A high-quality electricity supply system where natural energy sources are sufficiently utilized .(2026)

*Figures in parentheses show years when experts predict that technology will be applied in the real world.

A supply-and-demand control system for customers and a distribution system by using batteries for Plug-in Hybrid Electric Vehicles (V2G).(2022)

A micro turbine cogeneration system featuring ultra-lean combustion for high efficiency, enhanced pressure ratio for high power and downsizing, and low-NOx combustors.(2023)

Spread of a residential energy system integrating renewable energies such as solar cells and fuel cells.(2019)
Construction technology for energy-autonomous buildings enabling the use of natural energies, natural ventilation, natural lighting, rainwater, groundwater and other natural resources.(2020)



New technology for vegetation regeneration in deserts.(2029)
Improvement of quality of life for inhabitants of desert and semiarid areas based on the promotion of land use techniques that secure adequate food production.(2030)

A large-scale thin-film solar cell with a conversion efficiency of 20% or higher.(2027)
Power generation technology based on one of the ocean energy resources.(2030)

Low-cost secondary cells for vehicles (2025)

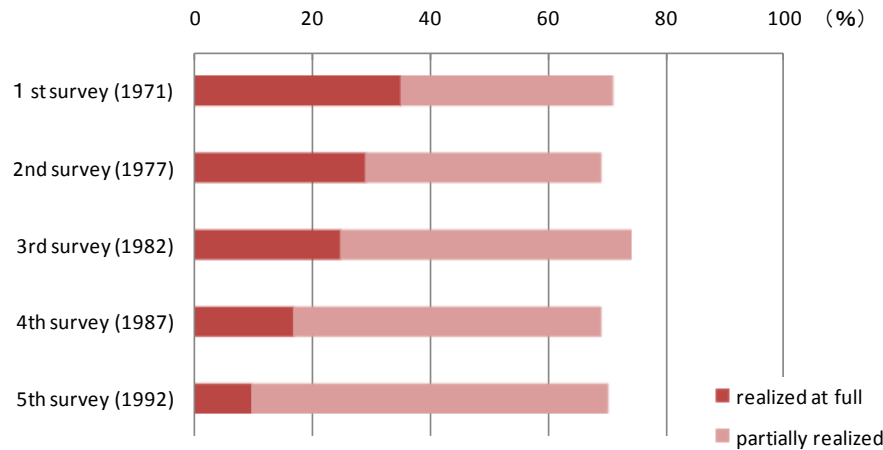
Electric vehicle battery technology with high energy (2025)

Successive contactless charging technology that charges electric vehicles and/or hybrid vehicles when they are parked at public parking lots and/or stopped on roads and at intersections.(2023)

Promotion of vehicles that control the speed and operation of the engine to minimize fuel consumption by detecting the timing of traffic signals, as well as a traffic control system enabling the operation of such vehicles.(2025)

(Reference) Evaluation of Past Delphi Surveys

Realization Rate of Past Delphi surveys, Conducted 20 Years or More Ago



Around 70% of the topics in past Delphi surveys conducted 20 or more years ago have been partially or fully realized.

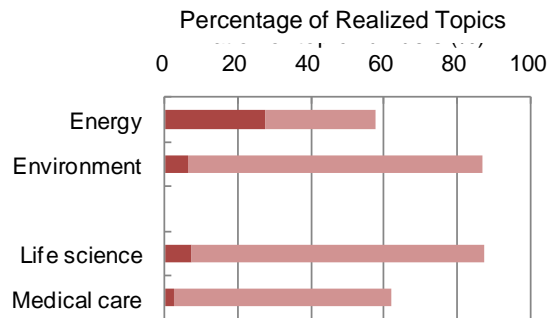
Examples of realized topics in the 5th survey (1992):

- ✓ Determination of the entire DNA base sequences of human chromosomes (2010)
- ✓ Widespread use of solar cells for residential power supply (2007)

Examples of unrealized topics in the 5th survey

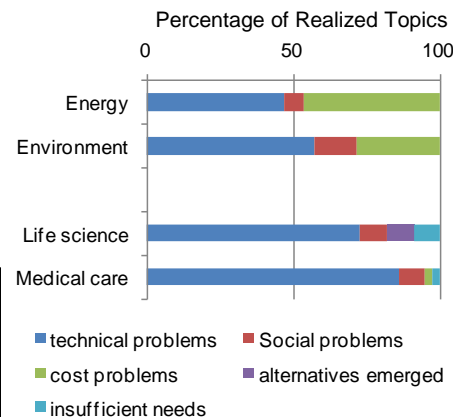
- ✓ Practical use of effective means to prevent cancer metastasis (2007)
- ✓ Practical use of economical techniques to recover deep-ocean metal resources (2006)

Realization Rate of Fields Related to Green/Life Innovation

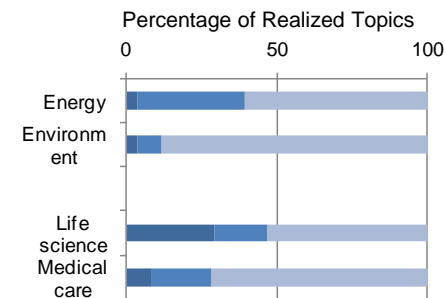


Evaluation of the 5th Survey (1992)

Why Haven't Topics Been Realized?



Ratio of Topics with Accelerated Realization



- Realized topics that were predicted to be realized after 2010
 - Unrealized topics that were predicted to be realized after 2010
 - Topics that were predicted to be realized in or before 2009
- ** "Realized" means "fully realized" or "partially realized."

- ✓ The energy field has more fully realized topics and more topics with accelerated realization than any other field, but the realization rate is relatively low. Energy and environment fields have cost problems that inhibit realization.
- ✓ Around half of the topics in life science and medical care fields were predicted to take a long time for realization; the goals of those fields were stable for a long time. In reality, about half of them were realized earlier than predicted.

Summary

- In New Growth Strategy of Japan, Green Innovation is the most important strategy in attaining targeted economic growth and lowering the unemployment rate.
- Japan will mainly contribute to the world by disseminating highly energy-efficient technology worldwide.
- In the new S&T forecast survey of NISTEP, Green Innovation was the respondent's greatest concern.
- In this report, the technological realization time and social realization time of each important technology in Green Innovation have been forecasted; this will lead to the setting of R&D and commercialization targets in each organization in Japan.