Arbetsrapport

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Environmental driver as a driver of technology and business development in Japan

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Preface

This study has been initiated upon a request from The Swedish Agency of Innovation System as a part of their governmental assignment to develop a national R&D and innovation strategy for environmentally driven technology development.

Our task has been to describe the most important driving forces (governmental policy, environmental legislation business practices, and customer demand) for environmentally driven technology and business development in Japan, and to compare them with the situation in Sweden.

The report has been written as a part of the program "Discovering Sustainable Japan", which is conducted by The Swedish Agency for Growth Policy Studies at the Swedish Embassy in Tokyo, in cooperation with The Swedish Agency for Innovation System, The Swedish Business development Agency, The Swedish Environmental Protection Agency, The Swedish Energy Agency, and the Swedish Research Agency for Environment, Agricultural Sciences and Spatial Planning.

Most of the figures in the report are expressed in yen. At current exchange rates, 1 SEK ≈ 14.03 yen.

We would like to thank everyone that has contributed to this study. Of special importance has been the information and insight provided by Prof. Yamamoto at Tokyo University, Prof. Mizuguchi and his colleagues at CSTP, The Ministry of Environment, The Ministry of Economy, Industry and Trade. We would also like to thank Toshiba Corporation, and especially Dr. Minagawa for a good cooperation.

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Eva Ahlner and Izumi Tanaka

Summary

The driving forces for environmental technology and business development in Japan are to a large extent similar to in Sweden. But a high population density, limited space, and a strong dependence of imported energy even more stress the need to develop more sustainable products and systems in Japan.

The environmental quality is a clear driver for extensive investments in governmental R&D. Technology development to reduce GHG emissions are of high importance. Examples are improved automobile fuel economy, fuel-cell technology, solar power generation, nuclear power generation, housing and construction technology and recycling technology and systems.

Many of the environmental policy measures and trends are similar to in Europe. Examples are the Kyoto agreement, new legislation on waste management and recycling, extended producer responsibility, green procurement, and requirements on more extensive environmental reporting from companies. One of the key drivers for environmentally driven technology and business development in Japan is the Green Procurement Law followed by an increased use of green procurement/purchasing by both the government and large companies.

Sweden is ahead of Japan in implementing recycling systems for household waste, design and recycling of packages. Due to new recycling laws there is currently a rapid development of technology and systems for increased reuse and recycling of packages, electronic appliances, construction materials, food waste and cars.

Sweden also seems to be ahead of Japan when it comes to the understanding of consumer preferences and behaviors related to environmental issues as well as the structural barriers towards sustainable development. Sweden is often viewed as a model country for sustainable development in Japan.

There are about 2.5 million companies in Japan and the national competition is very high. Although national environmental legislation is an important driver, in many cases the Japanese company's in-house standards are found to be more progressive. This is due to several reasons such as for example a stricter European legislation, which is the case with the EU WEEE/ROHS Directives, voluntary action plans, or compliance with green procurement criteria. About 73 % of the total R&D in Japan is carried out by industry. At Toshiba Corp., which is part of this study, an Environmental Technology Laboratory recently has been established within the Corporate R&D center in order to generate environmental technology and tools for the development of environmentally sound products.

Investments in environmental related technology are viewed as an important growth factor in Japan. To provide unique solutions to future green markets is regarded as a competitive factor of increasingly importance. A large export industry recognizes new opportunities in environmentally driven markets.

Content

1 Introduction

On the 22nd of September 2003, Ms.Yuriko Koike was appointed a new Environmental Minister of Japan. She is the fourth in a row, since the Ministry of Environment was established in 2001.[1] She stresses that the environment will play a key role in reviving the nation's economy, which is now undergoing structural upheavals. Prime Minister Junichi Koizumi has earlier stated the importance of technological breakthroughs to attain both environmental protection and economic development.[2]

Japan, the 2nd largest economy, is producing one fifth of the world production of goods and services, and stands behind about 60 percent of Asia's GDP. Japan is with its 126 million inhabitants a great purchasing power due to large personal savings. The nation is however facing a strong competition by other Asian countries, especially China. A key strategy to enhance the increasing competition is to develop from an economic superpower into an "environmental superpower". By providing unique environmental solutions Japan will increase its ability to compete with countries like China and India.[3] The new vision is now communicated among stakeholders in the Japanese society with increased acceptance.

During the 1960´s to the early 1970´s, Japan went through a period of rapid economic growth dominated by heavy industry and chemical industry, coupled with a wide-spread use of motor vehicles, which gave rise to serious pollution problems. In order to solve the bad situation, 14 new or revised pollution control laws to control various forms of pollution, including air pollution, soil contamination, water pollution, noise, vibrations, and odors, were enacted. Within a remarkable short period of time, the legislation was implemented and the pollution crises abated.

The air quality in mega-cities such as Tokyo and Osaka is still however a big problem leading to for example an increased number of cases of air-pollution-related diseases. Diesel vehicles emit the vast majority of air pollutants from exhaust. In order to improve the difficult situation the Tokyo Metropolitan government is now preceding the national government by the introduction of a new stricter diesel vehicle emission control regulation. For the same purpose, a National Strategy for the development and dissemination of environmentally friendly vehicles was introduced in 2001.

[1] *The Environmental Protection Agency, which was initiated in 1970, was upgraded to the Ministry of Environment in 2001*
[2] *Governmental declaration January 2003*
[3] *Prof. Yamamoto, Centre of Collaborative Research at Tokyo University*

The acute shortage of final disposal sites for handling the growing volume of solid wastes has lead to the development of a new Basic Environmental Plan and set of new laws to lead the way from mass consumption, and mass disposal into an economic system based on recycling. The legislation was developed during the economic stagnation in the 1990´s and enacted in 2001. By that the Japan took a first step towards new environmental policy to increase eco-efficiency throughout the whole society.

In June 2002 the Japanese government ratified the Kyoto protocol, which means a reduction of green-house gas emissions with -6 % 2008-2012 compared with 1990. Since the GHG emissions have increased with 8 percent since 1990, the required reduction is -14 %. Japan has one of the lowest levels of CO_2 emissions per GDP unit in the world-even when developing countries are included. On the other hand, in terms of absolute green house gas emissions Japan ranks fourth in the world. The country also has a very high level of GHG emissions per head of population.

The temperature increase predicted by the IPPC for 2100 is considered a serious threat to Japan. Nature catastrophes such as some of the predicted effects from global warming, rise of the sea level, heat stress, impact on food production etc., feels more real in Japan than in Sweden. It may be explained by the daily presence of risks connected to nature phenomena such as earthquakes, typhoons, and heat stress during summer, especially in a mega-city like Tokyo. People now seem to, deep down, accept climate change as a fact in Japan.[4]

Even if Japan is Japan is the most energy efficient nation in terms of final energy consumption per unit of GDP, the energy demand is continuing to rise and has increased significantly during the past 20 years.[5] The energy situation in Japan is insecure due to a heavy dependence of imported oil from the Middle East. Despite being promoted for decades, alternative energy sources such as wind and solar power, have yet to become mainstream energy sources. Today renewable energies (photovoltaic, wind, waste, biomass, solar thermal, black liquor, others) account for less than 1.5 percent of the total energy supply to be compared with about 16 % in Sweden. An increase to 3 % is targeted for 2010. Oil is currently the major energy supply, about 50 percent followed by coal 18, nuclear power 17, and natural gas 13 percent. Nuclear power is despite a significant negative opinion, continues to be an important pillar in the Japanese power industry with a planned increase in the number of nuclear plants from 51 units to 70 in 2010. The supplier of nuclear energy TEPCO, has during 2002-2003 been heavily criticized for neglecting to officially report several incidents at nuclear power plants. The open mistrust forced the company to a close down of as many as 17 plants, which caused a temporary electric power shortage.

[4] *Foresight study by NISTEP in 2002, the chapter on Environment.*
[5] *Quality of the Environment in Japan 2001, Ministry of the Environment.*

Japan spent 3, 1 percent of GDP, on research and development during 2001, which is recognized as being the highest level among the large OECD countries. Despite the bad economic development the governmental R&D budget has increased with 60 percent 1993-2003.

A large portion of the R&D carried out, 73 %, is undertaken by industry. In total Japanese companies account for approximately 20 % of the total industrial R&D spending within OECD.

Reforms of the science and technology systems are currently being undertaken striving to "achieve a nation advancing with international competitiveness and sustainable progress". Recently, in 2001, the central organization of S&T has been reformed by the establishment of the Council of Science and Technology Policy with the Prime Minister as the chairman. Its purpose is to assist in policy making of the Cabinet and to plan and coordinate science and technology development from a position above the ministries, and to evaluate R&D. The initiative in managing R&D funding, including submitting budget proposals, remain at the individual Ministries. Some of the Japanese research facilitates and research programs are ranked highest in the world. One example in the environmental field is the Front Research System for Global Changes in Yokohama, including the Earth Simulator, which is the most powerful computer worldwide, about 5 times more powerful than the second most powerful located in the U.S.

Government R&D funding in the environmental field, one out of 4 fields given special priority, has increased with about 20 percent during the past 3 years. In the environmental field, research initially only tackled local environmental problems, such as air pollution and water pollution, but the rise of global-scale environmental problems such as global warming and the spreading of environmental hormones such as endocrine disruptors, has turned it into a major research field. The top 20 topics in terms of degree of importance and forecasted realization time in the field of environment are listed in the figure 1.1 below. The table is part of a comprehensive foresight study by the National Institute of Science and Technology Policy (NISTEP). It is based on an expert survey performed by the use of the Delphi method.[6] While the topic rated most important related to motor vehicle emissions control technology, those relating to industrial waste and greenhouse effects also featured relatively high on the list. Technology and services to decrease the amount of waste by 90 % in 2015 is ranked as one of the five most important subjects overall.

[6] *The Science and Technology Foresight Center http://www.nistep.go.jp/index-e.html, was established as a part of National Institute of Science and Technology Policy (NISTEP) in January 2001 with the aim to strengthen survey functions about trends of important science and technology field*

FIGURE 1.1

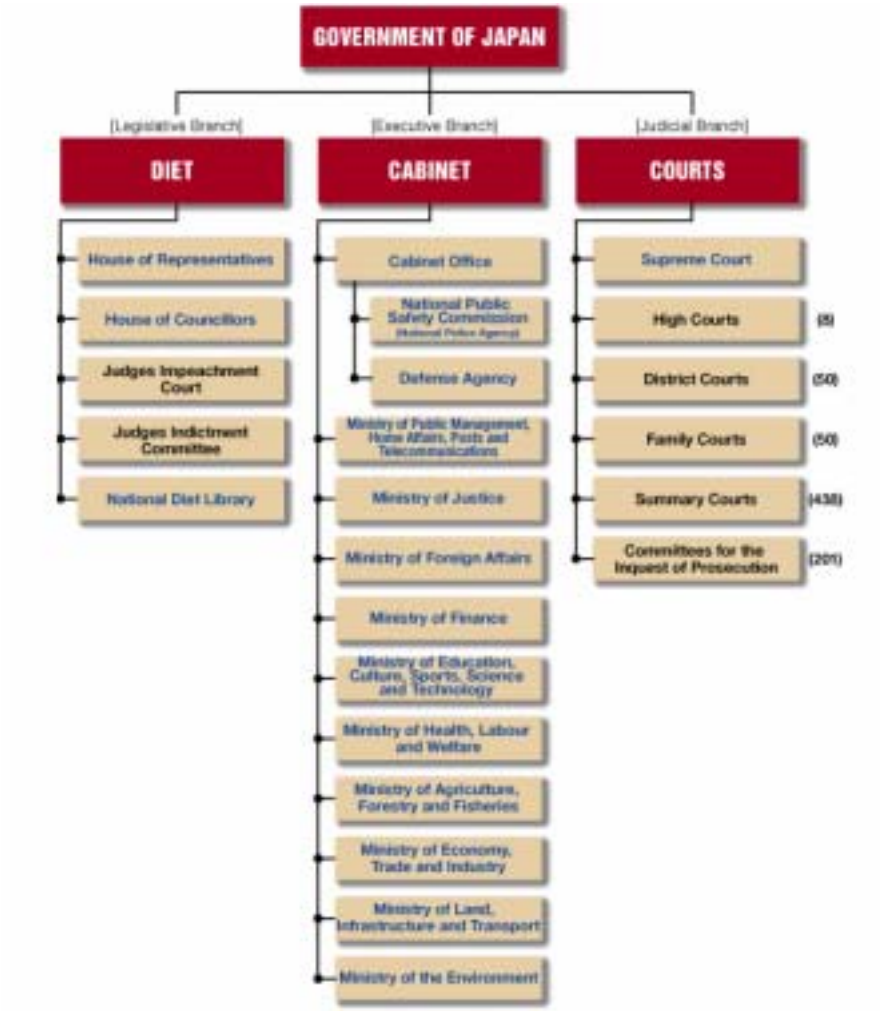
Top 20 topics in terms of degree of their importance to solve environmental problems forecasted realization time by the Japanese Science & Technology Foresight Center 2001

Topic	Importance index	Forecasted realization time
21: Widespread use in virtually all types of automobiles of a technique capable of meeting an emission control standard that specifies a nitrogen oxide emission limit of 0.1 to 0.2 g/km. (Current emissions from heavy diesel motorcars are about 4 to 5 g/km, and the 1978 standard value for gasoline passenger cars is 0.25 g/km.)	90	2011
22: Practical use of technology capable of reducing particulate matter emissions from diesel vehicles to 10% of current levels (fiscal 1999 standard value for vehicles weighing more than 2.5t is 0.25g/kWh (average value)).	90	2011
38: Large reduction of the amount of buried industrial waste as a result of advances in the reorganization and integration of industrial technology aimed at reducing waste emissions to zero.	89	2018
40: Introduction of an environmental tax in Japan with the aim of preserving the global environment	84	2009
39:Reduction of global carbon dioxide emissions to 20% below the 1990 level	84	2027
29: Widespread use of products based on LCA (life cycle assessment) concepts that facilitate recycling and reuse	82	2012
34: Widespread use up to at least 20% throughout the world of low-polluting vehicles that do not cause air or noise pollution for urban transportation (e.g., electric vehicles).	81	2018
30: Elucidation of health disturbances caused by long-term exposure to low concentrations of endocrine-disrupting chemicals (so-called environmental hormones).	77	2015
37: Widespread use of technology for removing POPs (persistent organic pollutants) such as dioxin from soil and sediment.	75	2017
31: Establishment of a technique to predict the fate of newly discovered chemical substances through the accumulation of knowledge on matters such as the behavior of persistent chemical substances in the environment.	73	2018
13: Elucidation of the impact of marine pollutants on marine ecosystems on a global scale.	73	2018
23: Widespread use of high-efficiency processes for treating refractory and hazardous materials using biotechnology-based waste water processing systems.	71	2015
27: Widespread use of biodegradable plastics that can be fully decomposed by microorganisms, as material for containers and packaging with short service lives.	71	2014
09: Widespread use of alternative substances or processes for the three gases — SF6, HFC and PFC — that were added to the list of gases subject to control in the Kyoto Protocol.	69	2012
36: Large reduction of the number of allergy-sufferers as a result of elucidation of the relationship between environmental pollutants and allergies.	68	2019
14: Practical use of effective technologies for restoring ocean areas contaminated by tanker accidents, etc. (e.g., oil pollution control technologies utilizing marine microorganisms).	68	2014
04: Elucidation to a high degree of accuracy of the mechanism of generation, absorption and fixation of carbon dioxide.	67	2015
35: Widespread use of methods for on-site detoxification of soil over limited areas contaminated with heavy metals or chemicals.	67	2015
32: Development of a bio-monitoring system effective for almost all chemicals that are considered to be endocrine disrupters.	67	2018
20: Widespread practice of global-scale monitoring of various factors causing air, water or other pollution, leading to realization of an international information system that integrates environmental data.	66	2017

2 Governmental measures to reduce environmental impact and to promote environmentally driven business

In Japan, there are ten ministries. (Figure 2.1) Of them Ministries of 1. Environment (MOE) and 2. Economics, Trade and Industries (METI) are main players in promotion of environmentally driven technologies and businesses. Perhaps a situation not so unique to Japan, environment and economics has seen as not a complementary quality and it has put a challenge for MOE and METI to work together in the interest.

FIGURE 2.1
Structure of Japanese Government as of 2003



Prime Minister's Office

2.1 Legislations

Legislation imposes challenges on private and public sectors, sometimes resulting in increased burden in their businesses and/or activities. However, it can also lead to elicitation of underlying opportunity for technology advancement and increased competitiveness. Results seen are of following characteristics: 1) creation of new businesses, 2) creation of new products and 3) reduced environmental burden on existing products. Some of the examples can be seen in the following cases:

2.1.1 Recycling laws

Japan has enacted a series of laws in resource utilization, including a series of laws in recycling, since the establishment of Basic Law for Promoting the Creation of a Recycling-Oriented Society in January 2001 (Figure 2.2)[7].

For example, Home Appliance Recycling Law, enacted in April 2001. The targeted products and the recycling rate (not including heat recovery) are as follows: air conditioner 60 percent, television 55 percent, washer 50 percent and refrigerator 50 percent [8]. Now, two years after establishment of the law, the projected reexamination of the law in 2006 is keeping the manufacturing companies involved in research and development of new recycling technologies and systems. Currently, the recycling rate can be accomplished by recycling of glass and metal, which already have well-established technologies. However, when higher rates are proposed, recycling of other materials, such as plastics, will be called for. For example, the recycling requirement of 60 percent for air conditioner is easily achieved by recycling of iron and copper, which composes 64.4 percent of the product. (Figure 2.3)

[7] *Basic Law for Promoting the Creation of a Recycling-Oriented Society http://www.env.go.jp/recycle/circul/kihonho/law-e.html*

[8] *Home Appliances Recycling Law http://www.meti.go.jp/english/information/data/cReHAppre.html*

FIGURE 2.2
Laws to promote the creation of a recycling-oriented society

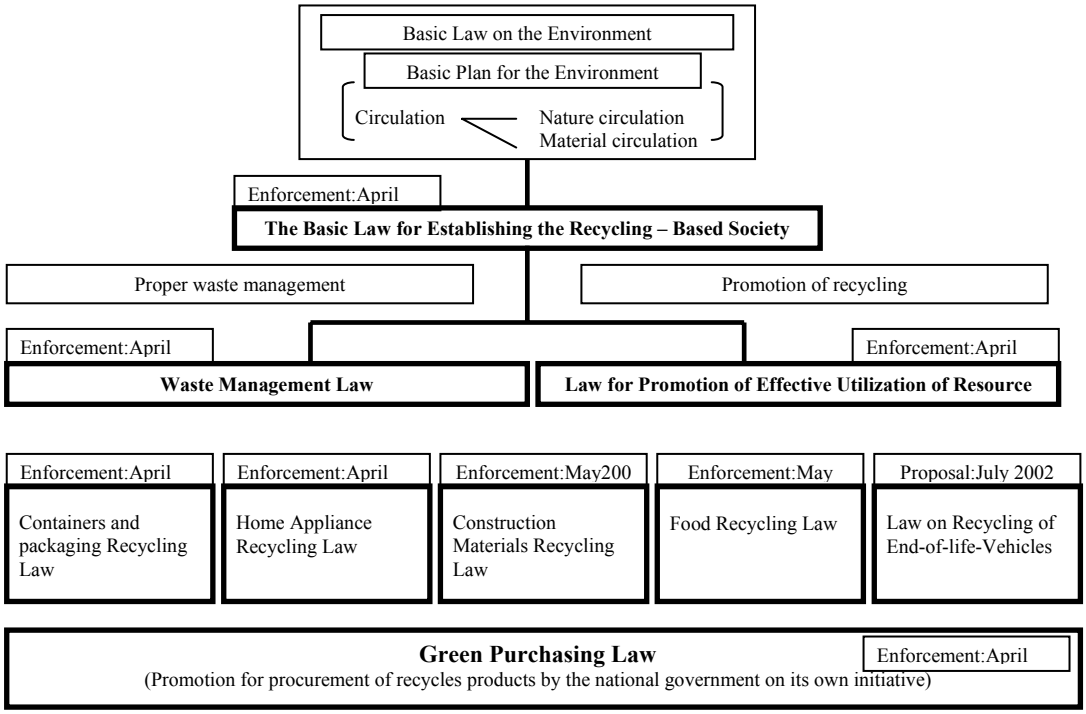


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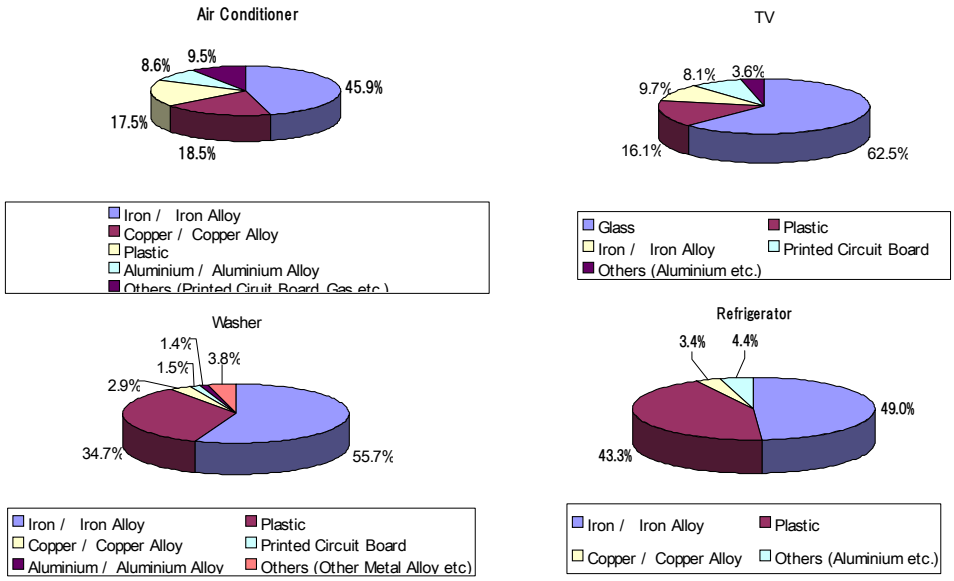
FIGURE 2.3
The composition of the materials for the four targeted product groups



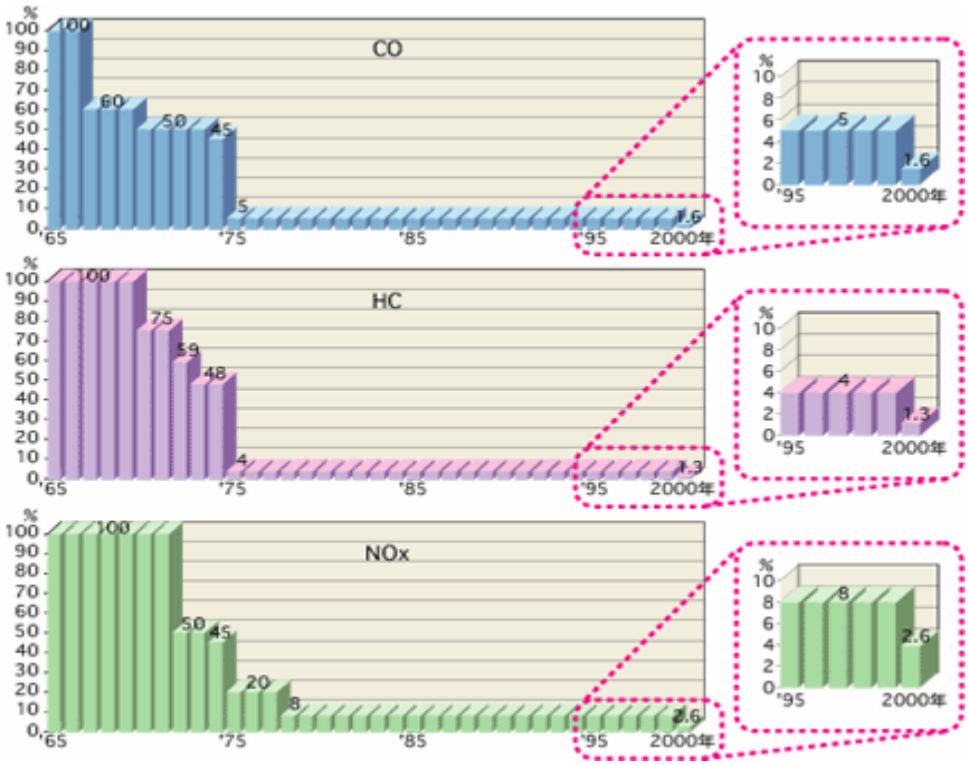
Anticipation for new requirements has lead the industry to look into recycling of more complex materials, such as urethane insulation in refrigerator. Not only are companies driven to meet the higher recycling rate, R&D in raising efficiency in recycling, making products which are more easily processed for recycling, making products with the materials recovered and tools to aid designing of such products are also driven by this law. As an example, at Panasonic, research laboratories located on the same premise as the recycling facilities are seen in Japan, to maximize the utilization of experiences from disassembling and recycling in the product development phases.

2.1.2 Regulations on vehicle emission

Learning from the US experience with chemical smog in the 60's, Japan established its first regulation on motor vehicle emission in the early 70's when it saw its first chemical smog. Introduction of a regulation similar to the Clean Air Amendment Act of 1970 of US first met much resistance, saying that the technology was not available yet to meet such standard and that it would strip competitiveness of Japanese auto makers in the world market. While US delayed enforcement, Japan enforced the law and saw all domestic car manufacturers meet the standard by technology development[9]. This trend still holds true in the recent years, and Japan remains one of the countries with the highest emission standard. (Figure 2.4)

[9] *Quality of the Environment in Japan 2002, Ministry of the Environment (translated from Japanese version)*

FIGURE 2.4
Trend of gas emission regulations in Japan (1965= 100%)



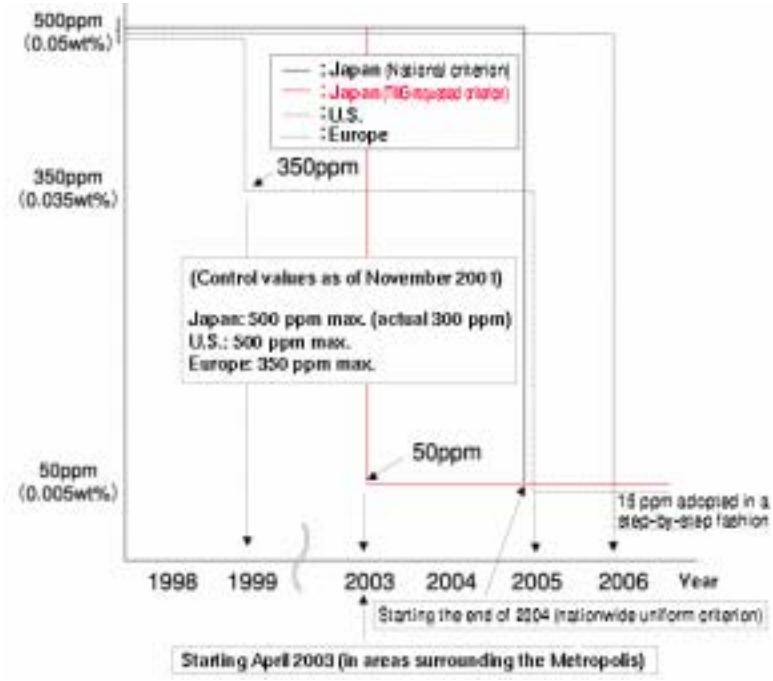
Tokyo Metropolitan Government

This has had impacts on Swedish car import into Japan, to the point that some of the manufacturing processes had to be revised to meet the standard. On October 1, 2003, the Tokyo Metropolitan Government introduced a strict diesel vehicle emission control regulation for vehicles operated by businesses located in and driving through its jurisdiction (excluding passenger cars). The number of diesel vehicles to which the regulation is applied are: 420,000 vehicles registered in Tokyo (as the end of FY2000) and the about 180,000 per day that drive into Tokyo (investigated by the Bureau of the Environment in 1999)[10]. Specifically, this regulation calls for replacement with a more low-pollution vehicle for diesel fueled vehicles older than seven years, or equip the vehicle with a diesel particulate matter reduction system. This decision by the largest regional government in Japan has encouraged involved parties to speed up the process of researches of low-pollution diesel vehicles and low-sulfur diesel fuel. Currently, the criteria for sulfur content in diesel fuel is 500 ppm in Japan, compared to 350ppm in Europe. The government has decided to reduce it to 50 ppm by the end of 2004. In November 2001, however, Tokyo Metropolitan Government requested the Petroleum Association of Japan to supply low-sulfur diesel fuel as soon as feasible. In response to this

[10] *Stop Global Warming! Tokyo Strategy*
http://www.kankyo.metro.tokyo.jp/kouhou/english2002/index.html

request, the Petroleum Association of Japan has decided to start supplying low-sulfur diesel fuel for the Metropolitan Tokyo area from April 2003. (Figure 2.4) The national government is planning to introduce legislation with a similar standard by the end of 2004.

FIGURE 2.4
Current status of sulfur content of light oil in Japan, Europe and US



Tokyo Metropolitan Government

2.2 Promotion of environmental technologies by means other than legislations

2.2.1 Initiatives taken by Ministry of Economy, Trade and Industry

Ministry of Economy, Trade and Industry (METI) plays a role in the promotion of eco-businesses. Their activities are engaged in the strategic investment in new technologies to build a sustainable society. Activities they are engaged in supporting companies to execute environmentally sound management and technology include, establishment of the Environmental Reporting Guidelines and a workbook on environmental accounting, study conducted on the introduction and promotion of environmentally conscious business activities (DfE), development of LCA method and system through the LCA-National Project and assistance in establishment of

environmental management system (EMS). Especially in the area of EMS, there is a budget specifically set aside for small and medium sized enterprises (SMEs); 52 million yen for the establishment of environmentally conscious operation system and 21 million yen for conducting lectures for ISO 14001 certification. In addition, there are funds available from METI specifically targeted for technology development in recycling field for SMEs (max of 3.5 million yen per project). Development of human resources in the field is highlighted in the budget newly proposed by METI. There is 1 billion yen allocated for the development of curriculum and educational material to gain knowledge and skill in environmental management to create a basic infrastructure for development of human resources in environmental business operation[11].

The Ecotown Project is an effort undertaken in cooperation between METI and MOE. In 2002, total of about 8.1 billion yen was budgeted to aid ecotown activities. As of May 2002, there were 16 ecotowns approved and supported by the government. City of Kitakyushu fosters one of the first ecotowns approved (in 1997) with participation by 18 industries in plastic bottle, home appliances, automobile and fluorescent tubes recycling and disposal of polychlorinated biphenyl to start soon.[12]

Another example of METI's effort in promoting eco-businesses by supporting regional industrial cluster area. 24.7 billion yen (18.7 billion yen in 2003) is requested for fiscal year 2004 to aid the generation of new business/industry at a regional level to rejuvenate regional economic activities. This funding supports the establishment of strong academic-industrial-governmental tie, promotion of development of ready-to-market technology and establishment of the infrastructure for the nurturing of entrepreneurs to promote the formulation and operation of industrial clusters. Currently, there are 19 projects with approximately 5000 companies and 200 universities engaged; of which five are in the environment and energy areas[13]. One of the five industrial clusters in the environmental field is the Kyushu Recycle and Environmental Industry Plaza (K-RIP) in the Kyushu Region established in November 1999. Their activities include a "need-seed matching," which is construction of database system for retrieving technological information provided by the universities and sponsor industry-academia interaction meetings, funding for projects involving both academia and industry and sponsor of a four-day "Eco-Town College," which classes are conducted in cooperation with the ecotown in Kitakyushu[14].

[11] *Budget proposal for fiscal year 2004, submitted by METI to the Ministry of Finance*
[12] *Documents from Environemental Industries Office of METI (in Japanese only)*
[13] *"Industrial Cluster Plan" by METI (in Japanese only)*
[14] *K-RIP http://www.k-rip.gr.jp/index_e.html*

2.2.2 Initiatives taken by Ministry of Environment

In 2002, a research group consisting of experts from the academia and the industry, was created to exchange information with high-level government officials. The research group was aimed at government official to gain understanding of how eco-business can realize a sustainable society and at the same time vitalize technological advancement and creation of employment opportunities. The group has identified the following as tasks to consider; development and exchange of information, creation and promotion of eco-product market, active expansion of eco-business abroad and promotion of eco-business utilizing regional resources. The research group also gives suggestion in deployment of the tasks mentioned above.

In September 2003, MOE has announced a new environmental policy/strategy to be ”integrating environment and economy.” This strategy is in discussion in the largest committee of MOE with 300 members, the Central National Committee for Environment. It has formulated a national committee on “promotion of environmental management in companies.” This newly launched committee will provide important input to the formation of law on promoting environmental management, expected to come in approximately six month. One of the aspects to the law anticipated is the mandate of environmental reporting by big enterprises (2700 companies defined by the Japanese standard). Based on the search conducted about market size for eco-business by categorization established by OECD, the market is expected to be 47.2 trillion yen in 2010 compared to 29.9 trillion yen in 1999 (Figure 2.5)[15].

[15] *Quality of the Environment in Japan 2001, Ministry of the Environment.*

FIGURE 2.5

Current and future forecast of market of eco-business in Japan

Eco-business	**Market scale (100 million Yen)**			**Employment scale (person**		
	2000	2010	2020	2000	2010	2020
A. Prevention of environmental pollution	95,936	179,432	237,064	296,570	460,479	522,201
Manufacturing of equipment and pollution prevention material for:	20,030	54,606	73,168	27,785	61,501	68,684
1. Air pollution preventing	5,798	31,660	51,694	8,154	39,306	53,579
2. Waste water treatment	7,297	14,627	14,728	9,607	13,562	9,696
3. Waste treatment	6,514	7,037	5,329	8,751	6,676	3,646
4. Soil and water purification (incl ground water)	95	855	855	124	785	551
5. Prevention of noise and vibration	94	100	100	168	122	88
6. Environment measurement, analysis and assessment	232	327	462	981	1,050	1,124
7. Others	-	-	-	-	-	-
Provision of service for:	39,513	87,841	126,911	238,989	374,439	433,406
8. Air pollution prevention	-	-	-	-	-	-
9. Waste water treatment	6,792	7,747	7,747	21,970	25,059	25,059
10. Waste treatment	29,134	69,981	105,586	202,607	323,059	374,186
11. Soil and water purification (incl ground water)	753	4,973	5,918	1,856	4,218	4,169
12. Prevention of noise and vibration	-	-	-	-	-	-
13. Environmental research and development	-	-	-	-	-	-
14. Environmental Engineering	-	-	-	-	-	-
15. Analysis, data collection, measurement and assessment	2,566	3,280	4,371	10,960	14,068	17,617
16. Education, training and providing info	218	1,341	2,303	1,264	5,548	8,894
17. Others	50	519	987	332	2,487	3,481
Construction and installation for:	36,393	36,985	36,985	29,796	24,539	20,111
18. Air pollution prevention	625	0	0	817	0	0
19. Waste water treatment	34,093	35,837	35,837	27,522	23,732	19,469
20. Waste treatment	490	340	340	501	271	203
21. Soil and water purification	-	-	-	-	-	-
22. Noise and vibration prevention	1,185	809	809	956	536	439
23. Environment measurement, analysis and assessment	-	-	-	-	-	-
24. Others	-	-	-	-	-	-
B: Technology and products for reduction of environmental burden (Manufacturing equipment and providing technology, material and services)	1,742	4,530	6,095	3,108	10,821	13,340
1. Technology of abating environmental burden and resource conservation technology and process	83	1,380	2,677	552	6,762	9,667
2. Technology of abating environmental burden and resource conservation products	1,659	3,150	3,408	2,556	4,059	3,673
C. Efficient use of resources	201,765	288,304	340,613	468,917	648,043	700,898
(Manufacturing equipment, provision of technology, material, services, construction and installation of equipment)						
1. Prevention of indoor air pollution	5,665	4,600	4,600	28,890	23,461	23,461
2. Water supply	475	945	1,250	1,040	2,329	2,439
3. Renewable energy facility	78,778	87,437	94,039	201,691	211,939	219,061
4. renewable energy facility	1,637	9,293	9,293	5,799	30,449	28,581
5. Energy saving and energy management	7,274	48,829	78,684	13,061	160,806	231,701
6. Sustainable agriculture and fishery	-	-	-	-	-	-
7. Sustainable forestry	-	-	-	-	-	-
8. Prevention of natural disaster	-	-	-	-	-	-
9. Eco.tourism	-	-	-	-	-	-
10.Others	107,940	137,201	152,474	218,436	219,059	195,655
Repairing machinery and furniture	19,612	31,827	31,827	93,512	90,805	66,915
Renovation and repair of house	73,374	89,700	104,542	59,233	59,403	56,794
Urban greening etx	14,955	15,674	16,379	65,691	68,851	71,946
TOTAL	299,444	472,266	583,762	768,595	1.119,343	1.236,439

Note 1. "-" indicates there is no number due to lack of suffient data
2. Date of the market scale 2000 is used for some of the market scale of 1999 etc
3. Total of the market scale may not add up due to rounding

Ministry of Environment

2.2.3 Voluntary agreements

Although not mandated by the Government, voluntary agreements/commitments declared by the Nippon Keidanren (or the Japan Business Federation) play a crucial role for management and technology development for businesses in relation to the governmental activities. For example, in the "Guideline for Measures to Prevent Global Warming," published by the Global Warming Prevention Headquarter on the order of the Cabinet, the step-by-step approach is introduced. (Figure 2.6)

FIGURE 2.6
The Step-by-Step approach introduced in the Guideline for Measures to Prevent Global Warming

First Step **2002-2004** (Evaluation in 2004)	**Second Step** **2005-2007** (Evaluation 2007)	**Third Step** **2008-2010** (Evaluation in 2012)
	ENERGY RELATED	
• Implementation of voluntary action plans • New energy and energy conservation measures • Fuel switching • Promotion of nuclear power	• - Implementations of policy measures based on the evaluation of the First Step	• Implementations of policy measures based on the evaluation of the Second Step
	NON- ENERGY RELATED	
• Promotion of CFC substitution measures • Strengthening R&D innovative technologies • Promotion of awareness among the public • Promotion of measures involving sinks of green house gas	• - Implementations of policy measures based on the evaluation of the First Step	• Implementations of policy measures based on the evaluation of the Second Step
	KYOTO MECHANISM RELATED	
• Implementation of CDM/JI • Setting up infrastructure for implementation of national registry and CDM/JI	• - Consideration for domestic system to prepare for utilization of the Kyoto Mechanism	• - Enforcement of domestic system for full utilization of the Kyoto Mechanism

Guideline for Measures to Prevent Global Warming

In the Approach, it states voluntary actions are to be implemented and to be reviewed in 2004, when policy and measures by the government will be considered. Clearly, it is for the benefit of the businesses to comply with the voluntary action plans than to be bound by laws and regulations. Nippon Keidanren, under such documents as Keidanren Voluntary Action Plan on the Environment, works with 36 industries and 137 organizations, which establishes quantitative targets for the measures that they have adopted.

One of the measures being considered as an action to be taken beyond 2004 is environmental taxation. Under the leadership of Ministry of Environment, this matter is researched carefully, including socio-economic effect it may have. The business sector, including the Nippon Keidanren, expressing the fears for decrease of international competitiveness and double taxing with the already existing taxation schemes. MOE is in process of formulating the evaluation criteria for the coming evaluation of the First Step in 2004.

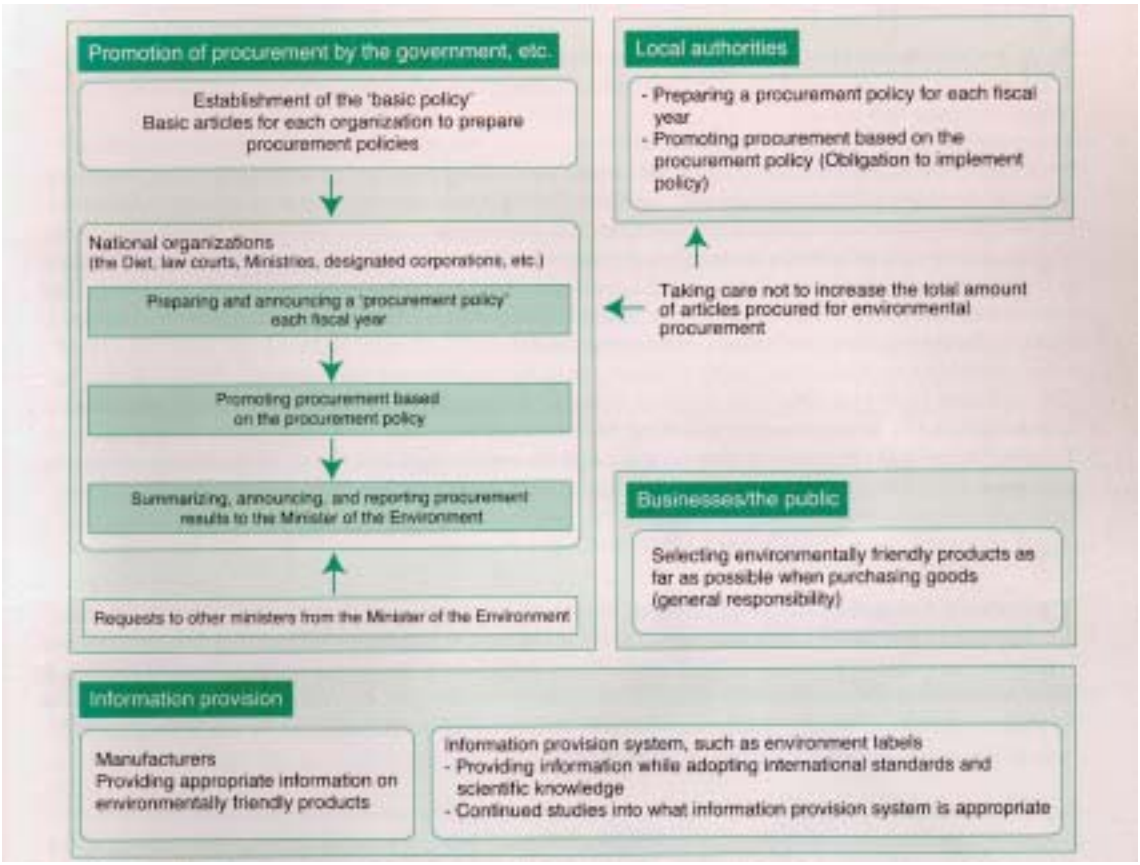
3 Customer demand

Consumption by both the public and private sectors are important drivers in the technology development. In this chapter, green procurement in both entities are introduced.

3.1 Green procurement by the government

The Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (referred to as Law on Promoting Green Purchasing) has taken effect in 2001 (Figure 3.1).

FIGURE 3.1
Framework of Law on Promoting Green Purchasing by the government



Ministry of Environment

The number of products covered, 101 items, is significantly fewer than the system for green procurement introduced in Sweden. It includes such products as stationeries, computers and automobile. In the case of automobile, along with the Green Purchasing Law, the Prime Minister Junichi Koizumi has announced the action plan to promote development of low-pollution cars including the plans to change all public cars (owned by Ministries, the Court and the Diet) into low-pollution vehicles by fiscal year 2004. (Figure 3.2)[16]

FIGURE 3.2

The numbers of low-pollution vehicle procured and projected to procure by the government

Fiscal Year	Until 2000	2001	2002	2003	2004	Total
Newly Acquired (or will acquire)	316	1013	1860	1931	1901	7021
Electric Powered	8	0	0	0	0	8
Natural gas	57	26	59	58	52	252
Methanol	0	0	0	0	0	0
Hybrid	251	689	1039	1101	1100	4180
High fuel efficiency/ Superior emissions	0	298	762	772	749	2581
Total number of Cars	316	1329	3189	5120	7021	
Percentage	4	19	45	73	100	

Ministry of Environment

FIGURE 3.3

The greenest vehicle ranking of 2003

Make & Model	Specifications	Emission Standard	Mile Per Gallon: City	Mile Per Gallon: Hwy	Green Score
HONDA INSIGHT	1.0 l 3 auto CVT [a]	SULEV	57	56	57
HONDA CICIC GX	1.7 l auto CVT (CNG) [b]	SULEV	30	34	53
TOYOTA RAV4 EV	Electric [c]	ZEV	37	29	52
TOYOTA PRIUS	1.5 l 4 auto CVT [a]	SULEV	52	45	52
HONDA CIVIC HYBRID	1,7 l 4 auto CVT [a]	SULEV	48	47	51
HONDA CIVIC HX	1,7 l 4 manual [a]	ULEV	36	44	43
NISSAN SENTRA	1,8 l 4 manual [a]	SULEV	28	36	42
TOYOTA ECHO	1,5 l 4 manual [a]	LEV	35	43	42
TOYOTA COROLLA	1,8 l 4 manual [a]	ULEV	32	40	41
HONDA CIVIC	1,7 l 4 manual [a]	ULEV	32	38	40
FORD FOCUS	2,3 l 4 manual	SULEV	25	33	39
FORD FOCUS WAGON	2,3 l 4 manual	SULEV	25	33	39

[a] Configurations of these models with other transmissions and emission standards score nearly as well

[b] Compression natural gas (CNG) vehicle fuel economy given in gasoline-equivalent miles per gallon

[c] Electric vehicle fuel economy given in miles per kilowatt-hour

American Council for an Energy-Efficient Economy

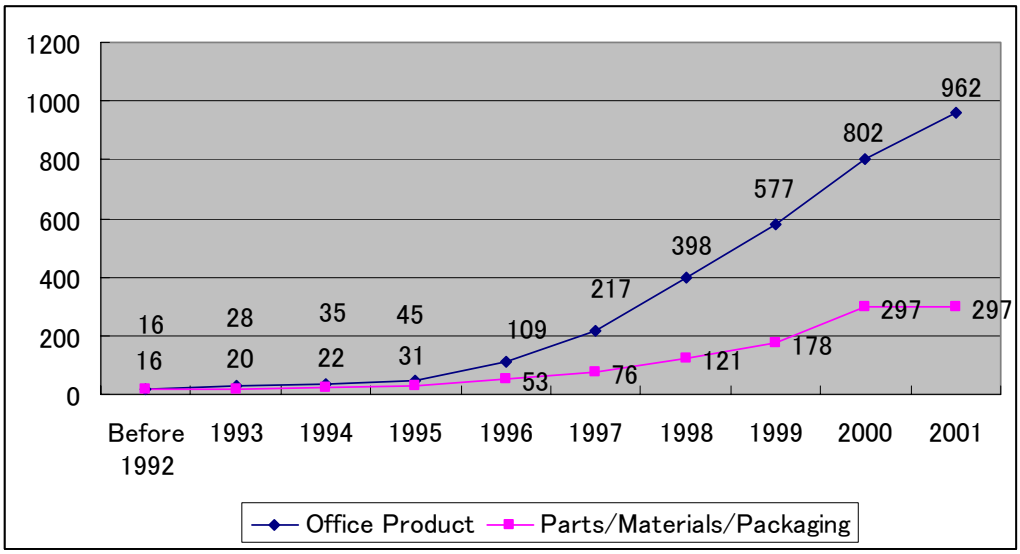
[16] *Quality of the Environment in Japan 2002, Ministry of the Environment (translated from Japanese version)*

At the same time, the ambition to have 10 million low-pollution vehicles on the street by 2010 was announced. Such collective government effort has been and continues to be a driver for Japanese companies to manufacture low-pollution vehicles. The American Council for an Energy-Efficient Economy (ACEEE), a nonprofit organization, rated ten vehicles from Japan in the top twelve listed. (Figure 3.3)[17]

3.2 Green procurement by the companies and consumers

In the recent years, along with green procurement by the government, green procurement by the private companies and consumers has attracted much attention. Organizations and companies with ISO 14001certification are committed to the greening of the supply chain and conducting green procurement is one of the ways to meet this challenge. An increasing trend is clearly seen in the number of companies with green procurement and establishment of guidelines of green purchasing. (Figure 3.4)[18]

FIGURE 3.4
Number of companies practicing green procurement



N=1409

Green Purchasing Network

A case study of green procurement by an electronic company is introduced in Chapter 4.

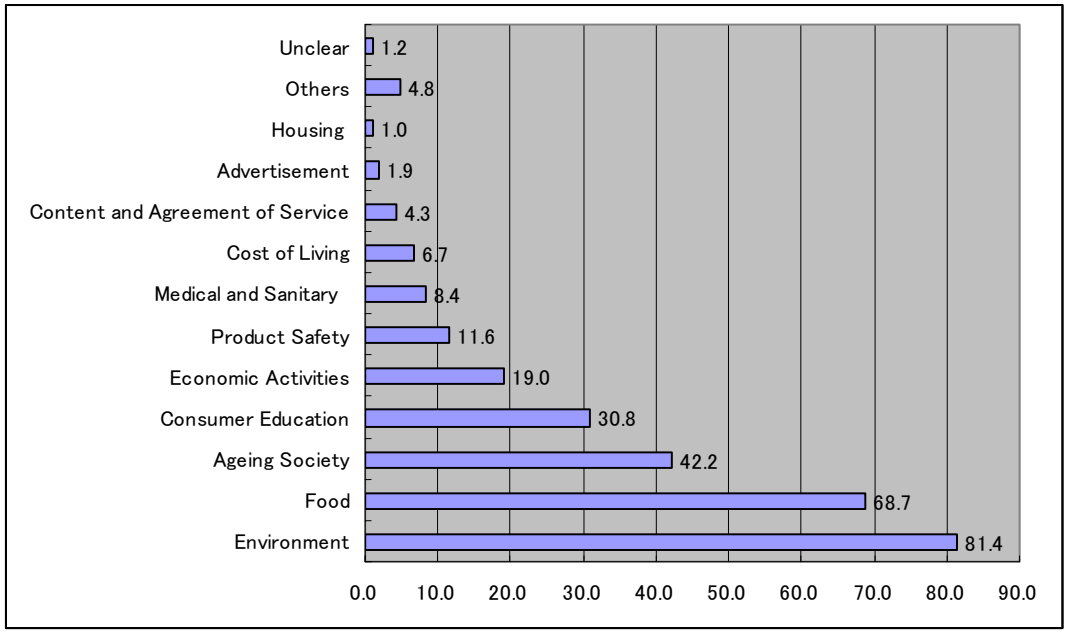
The consumer interest in environmental performance is increasing, as "environment" tops "safety" and "economic activities" in the survey of concerned topics. (Figure 3.5) There are green purchasing networks created to aid companies/organi-

[17] *American Council for an Energy-Efficient Economy http://www.aceee.org/*
[18] *Green Purchasing Network http://eco.goo.ne.jp/gpn/files/gpne/index.html*

zation and individual consumer to be environmentally conscious in their purchasing. The Green Purchasing Network (GPN) was established in 1996 and holds membership of approximately 2500. According to the survey taken among the 2500 members of GPN, for fiscal year 2001, 5.3 trillion yen was spent to purchase green procurement items. This is a 15% increase since the previous fiscal year. Although the force by the consumer to lead the companies is not the largest at this moment, the growing trend in effort to educate and give opportunities for consumers to choose green items is a hopeful trend in becoming a bigger force.

FIGURE 3.5

Graph of topics of interest of consumer organization



N= 459 consumer organizations, three answers allowed per group

Survey conducted by the Cabinet Office

3.3 Eco-fund

Financial investment in eco-funds often seen in Europe is also available in Japan. The market is said to be 200 billion yen. There are currently seven companies operating such investment funds in Japan. The 90% of the money invested comes from personal investors. The screening is done on companies' environmental management, environmental technologies, environmentally-conscious products/services, along with analysis on their financial status. However, all seven funds' screening processes are very similar and all value the overall performance of the company, rather than the one outstanding factor such as unique environmental business or specialization in environmental technologies the company may have.[19] Similarly, the Development Bank of Japan (a governmental financial institution) will provide, starting fiscal year 2004, a low-interest loan to companies with good environmental management. However, just as the eco-funds are, it will not provide money on the basis of providing new and/or unique environmental technologies.

[19] *"Sustainable Companies," by Professor Ryoichi Yamamoto (in Japanese only)*

4 Role of private industry and business

For the reasons, including those mentioned in previous chapters such as legislations and voluntary agreements, extensive researches and activities are undertaken in the sustainable development field in the industries. This is especially true in the electronics and automobile industries, in which some technologies are known to be of world-top-class such as energy efficient consumer goods and low-pollution vehicles.

4.1 Case Study - Toshiba Corporation

In order to better understand the role of private industry and business, a case-study was conducted. An extensive communication with an electronics company, Toshiba Corporation (Toshiba, hereafter), is used here to gain better understanding of the research and innovation in the environmental field in the private sector. Toshiba is a 128-year old company and a diversified manufacturer and marketer of advanced electronic and electrical products, information & communications equipment and systems, internet-based solutions and services, electronic components and materials, power systems, industrial and social infrastructure systems, and household appliances. Its business activities include in both environmental technology developed with the purpose to reduce environmental impact and products/services with environmental issues are one of many competing requirements in the product development.[20]

As well as providing products and services that create a higher quality of life, the company's commitment to corporate social responsibility is visible in establishment of Corporate Social Responsibility Division in July 2003 group involved in other activities beneficial to society, including environmental protection, contributions to society, promotion of human rights, and compliance with laws and regulations. Toshiba is included in the Dow Jones Sustainability Index (DJSI).

Toshiba has a central research center, Corporate Research and Development Center (R&D Center, hereafter), development laboratories located in the nine in-house companies and five research facilities overseas. The mission of the R&D Center is to produce new business, advanced and innovative R&D in their existing business fields and conduct fundamental research to benefit the Toshiba group. Departments other than the R&D Center also involved in the environmental aspects of the operation are the Environmental Protection Planning Division located in the Headquarter and the Environmental Protection Offices located within each of the operational facility located throughout Japan. The Division located at the headquarters also oversees environmental management operations overseas.

[20] *Toshiba Corporation www.toshiba.co.jp*

The case-study was conducted by first visiting the R&D Center, to start discussion on their activitities, our aim and goal in this study and a facility visit to interact with the researchers engaged in the researches in the environmental field. Then, a follow-up meeting was conducted. We had communication with the following members of Toshiba:

- Laboratory Strategic Manager (Systems and Environmental Fields), R&D Center
- Senior Manager, Facilities Maintenance & Environmental Protection Division, R&D Center
- Chief Specialist, Facilities Maintenance & Environmental Protection Division, R&D Center
- Chief Specialist, Environmental Protection Planning Division, Headquarter

4.2 Outcome of the study

4.2.1 Drivers

Legislations

The domestic legislations, such as mentioned in the previous chapters, are of course a driver for technology development, however, a company facing international market such as Toshiba is very sensitive to laws and regulations abroad, as well. EU WEEE/ROHS directives have great impact on the direction of the technology to be implemented in products. The sales offices located throughout the world serve important roles in collecting information about the relevant issues. In addition to meeting the imposed legislations, there is a set of voluntary measures indicated by the company. The Third Voluntary Action Plan of Toshiba covers the period 2000-2005 with quantitative goals to be accomplished (Figure 4.1)[21]. The goal on lead-free soldering is an example in which calls for the research and development of new technologies. Researches in tin-zinc and tin-silver solders and the software to project the durability of the lead-free soldering joints have been undergoing to fulfill the goal. The alternative for lead in soldering is not yet standardized in Japan and the competition is very close between different materials and companies using different materials. However, at this point, Toshiba is confident in their strategy to use the above-mentioned alternatives.

[21] *Toshiba Environmental Report http://www.toshiba.co.jp/env/english/pdf/report03e.pdf*

FIGURE 4.1
Third Voluntary Action Plan of Toshiba group

	Items	Target	Result for fiscal 2002
1	Zero emission of waste	Step-by-step implementation and the quantity of final disposal to be 1% or less of total discharge in fiscal 2003	0.7% in fiscal 2002. The target was achieved.
2	Reduce release of chemical substances	30% reduction in fiscal 2005 compared with fiscal 2000	40% reduction compared with fiscal 2000
3	Reduce CO2 release	25% reduction in fiscal 2010 compared with fiscal 1990	22% reduction compared with fiscal 1990
4	Green procurement	Set the target green procurement ratios for years up to fiscal 2005 with fiscal 2000 as a benchmark	Green procurement ratio of 75.4%
5	Provide product information	50% of products to be in compliance with the voluntary environmental standards by fiscal 2005	52.2% of products are in compliance with the voluntary environmental standards on a monetary value basis.
6	Reduce electricity consumed per product function	30% reduction in fiscal 2005 compared with fiscal 2000	23.2% reduction compared with fiscal 2000
7	Apply lead-free soldering	Application of lead-free soldering to all products by fiscal 2003	37.3% of products use lead-free soldering.
8	Abolish HCFCs	Abolition by December 2004	64.2% of products do not use HCFCs.

Toshiba Corporation

Corporate social responsibility

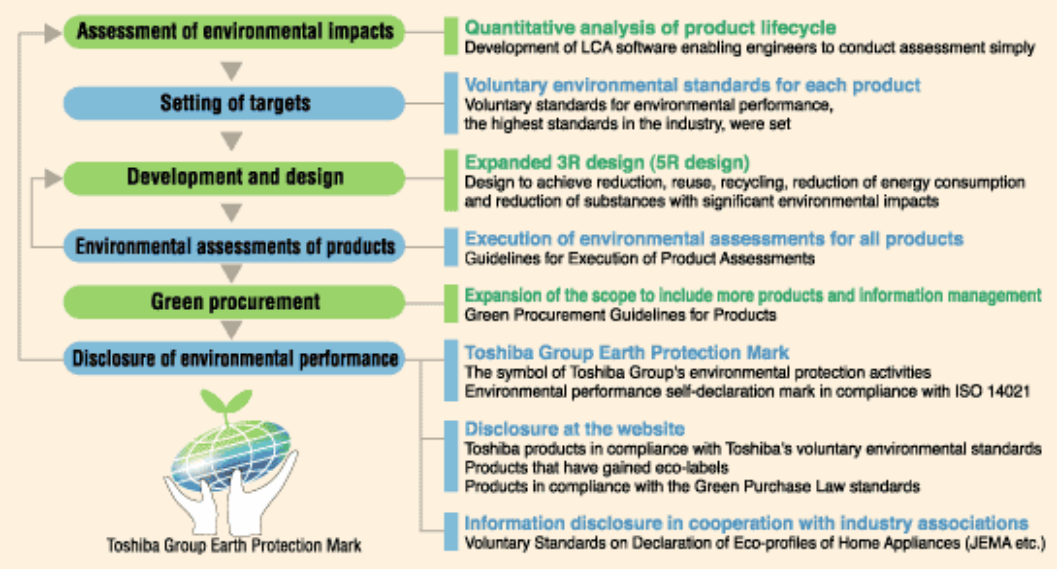
As mentioned in the section above, the consideration for CSR is important in every phase, such as product development, manufacturing, usage and recycling phases. There also is an interest to minimize the risk of possibility of harming its name value, when considering sustainability. In order to communicate its activities, the Toshiba Environmental Report is published since 1998 in guidance with international and domestic standards as GRI Sustainability Reporting Guidelines and the Guidelines for Environmental Performance Indicators for Business (fiscal year 2002 version), published by the Ministry of Environment. Although the reports have mainly reported on the Toshiba group's environmental protection activities, a continuing effort is being made to include more attributes required for a sustainability report, by including financial performance and social activities

Consumer demand

Consumer demand is a big factor in making environmental decisions. The market is a strong driving force in reduction of size and weight and low energy consumption during usage phase. They are viewed as one of the key competition factor. For products such as laptop PCs and cellular phones, good fundamental technologies to produce low-power semiconductor chips and tunnels, for example, are called for. Although the so-called “green consumers” are not so plenty in Japan, still it is seen as a market. In order for the product to sell, cost performance is still the dominating factor in consumer decision and the environmental performance (excluding energy consumption) is still secondary. For that reason, it is a challenge to provide product at a competitive price, as well.

Toshiba has set a voluntary standard for environmentally conscious products (ECPs): that is, products whose eco-efficiency and resource recyclability are enhanced at every stage of their entire life cycles-from materials procurement, manufacturing and distribution, through to consumption and eventual disposal. All Toshiba products are subjected to environmental assessments, mandated by the Product Assessment Guidelines established in April 1992, and those satisfying the assessment criteria are deemed to be ECPs (Figure 4.2)[22]. In order to create excellent ECPs, Toshiba has also established a system for assessing the compliance of products with voluntary standards. Standards are stringent and life cycle assessment (LCA) is mandatory. It uses its own developed software called EasyLCA, which is also available commercially. 52.2% of consumer products and office automation equipment covered by the third voluntary environmental action plan were in compliance with the voluntary standards in fiscal 2002. In order to promote ECPs, the disclosure of environmental performance of products is important.

FIGURE 4.2
The ECP creation process flow



Toshiba Corporation

Information on Toshiba products in compliance with the voluntary environmental standards, products that have gained eco-labels, and products in compliance with the evaluation criteria of the Green Purchase Law, mentioned in the previous chapter, is available at Toshiba Eco Products homepage. http://www.toshiba.co.jp/env/ecp/index_j.htm Unfortunately, currently it is only available in Japanese.

[22] *Toshiba Environmental Report http://www.toshiba.co.jp/env/english/pdf/report03e.pdf*

To aid in developing ECP's, a lifecycle planning tool named LCPlanner® is available to formulate of a concept for an environmentally conscious product at the planning stage that satisfies the quality and cost requirements while at the same time achieving effective reduction in environmental impacts throughout the lifecycle. Cleaner using this tool is already out on the martket[23].

The competence to use the available tools, including LCPlanner® and EasyLCA®, and about environmental management issues and product environmental aspects are emanated by providing classes at the in-house human resource development center.

There are no systematic and direct methods to capture the environmental trends. But in general, market and trend search is done at well-known electronic goods sales district and by attending conferences, seminars and exhibitions. Bench-marking with other competitive companies can be done by analysis conducted on the already available evaluations of companies provided by other parties.

Although not a direct disclosure of environmental performance of product, Toshiba offers classes at elementary to high schools to teach them about what companies are doing for the environment. These classes have been conducted in conjunction with the newly established slot of class time in school called "comprehensive studies." With the facilities located throughout Japan, Toshiba feels it is important to be in communication with the local community and in particular, with those members that of younger generation. For that reason, most of the facilities publish an environmental report/brochure of their own to disclose their business activities, including environmental management.

Green procurement

As a part of the effort to create environmentally conscious products, promotion of products, parts and components, materials and raw materials that have less environmental impact in cooperation with the suppliers are practiced. A thorough communication to the suppliers is done in the Green Procurement Guidelines[24]. The suppliers are to report about the chemical content of supplies they provide as well as an evaluation of their environmental protection activities, which Toshiba trusts and bases the evaluation on. This is quite different from the Sony's way of conducting green procurement. At Sony, 600 employers are utilized to inspect the suppliers. This very strict and probably more costly operation is perhaps in the result of the experience of cadmium content in the parts of Play Station in Europe. At Toshiba, any parts/material/unit planned to procure containing any substances prohibited in their control rank, it will not be procured. A supplier can and has been excluded to do business with, if their environmental management system is not up to par, however, Toshiba is ready to consult and advice those suppliers needing improvement in their system. Yet, in the previously mentioned Voluntary Plan, it plans to increase the ratio of suppliers with S or A ranks on their environmental protection activities to 100 percent from the current ratio of 75.4 percent.

[23] *Toshiba Environmental Report http://www.toshiba.co.jp/env/english/pdf/report03e.pdf*
[24] *Green Procurement Guidelines http://www.toshiba.co.jp/procure/english/pdf/green_e.pdf*

4.2.2 Innovation System

The consumer demand, or the voice of customer, is very seriously taken and systematically integrated into its innovation system by utilizing a tool called Quality Function Deployment. Also, a relation with the academic arena is encouraged as a part of the innovation system. However the relation Toshiba is aiming for is quite different from, for example, that of Hitachi; which recently announced its agreement with Hokkaido University. Hitachi's strategy is to have fundamental research done at the University to reduce the cost and human resources needed to do it in-house. Although Toshiba feels it is an efficient alternative, it faces some doubts in being able to maintain the quality in the needed research, therefore cannot judge it as an effective measure. To this reason, the management of Toshiba has called for an active search for knowledgeable and potent professors to cooperate, worldwide. In particular to the conducting research and development with a system perspective, the international academic society, including that of Europe is highly regarded. Government support from METI and an independent administrative institution under METI called New Energy and Industrial Technology Development Organization (NEDO) and international networks are valued as a part of their innovation system.

The strategic challenge of Toshiba in environmental research is evident in the establishment of Environmental Technology Laboratory located within the Corporate R&D Center. Researches in decolorable ink, carbon dioxide absorbing technology and tools to aid ecodesign and inverse manufacturing are just some of the researches conducted in the laboratory. It is a challenge to return the investment into the lab and to conduct research and development in what it would be profitable. Moreover, there are researches conducted in other laboratories, which result in the betterment of the environment, including Bluetooth technology and on-demand bus system. In order to manage those researches that are environmentally beneficial, an environmental evaluation is performed on all researches conducted in the R&D Center. Also in managing the researches, new ideas are processed through four phases; idea scouting, feasibility study, prototyping and business developing phases. Especially in the latter two phases, the impact of the research, including on environment and on sustainable business strategy, is considered. The Laboratory Strategic Manager maps the research topic's existing market value against its sustainable characteristics in order to make the process systematic. A similar matrix to map reliability is under development to map the characteristics.

5 Governmental strategies to promote Environmental R&D and innovation

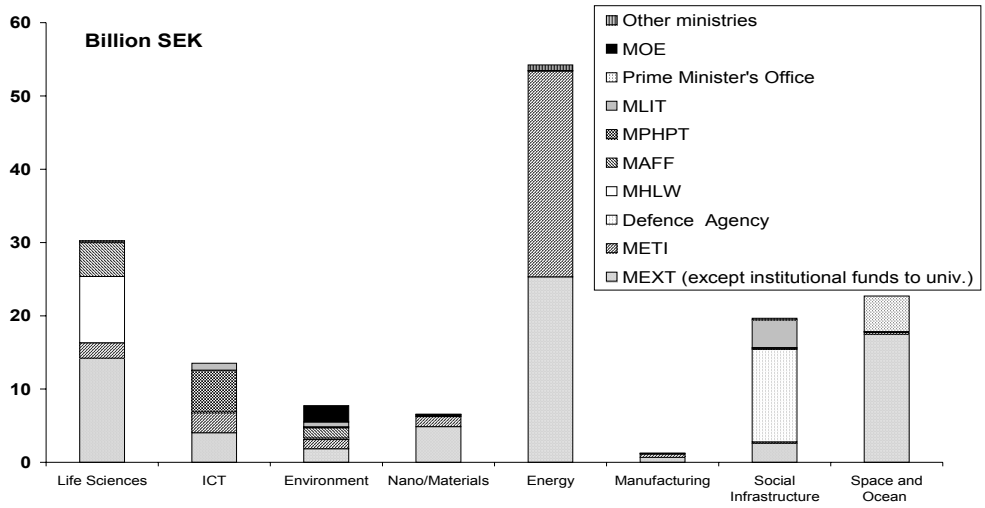
As being a country without a lot of space and possessing few natural resources and a bad economic situation, increases the pressure on Japan to demonstrate its originality and create high-value-added products and services through sustainable innovation that is driven at its core by technology. Systems capable of effectively generating such innovations are currently being developed and strengthened.

5.1 S&T policy in the Environmental field

The second Science and Technology Basic plan 2001-2005 for promotion of science and technology based on the Basic Law for S&T from 1995, places particular priority to four broad fields: Life sciences, IT, **Environmental science and technology** and Nanotechnology/materials.

R&D in the environment field is, as can be viewed in figure 5.1, funded through the Ministry of Environment (MoE), Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Economy, Trade and Industry (METI), Ministry of Agriculture Forestry and Food (MAFF) and the Ministry of Land Infrastructure and Transportation (MLIT). Thus in Japan as well as in Sweden the financial contribution to research in the environmental field is coming from a number of different governmental sources.

FIGURE 5.1
Government R&D-funding in Japan f.y. 2002 in 8 fields by Ministry. Institutional funds to universities are not included in this figure.



In 2001 Council of Science and Technology Policy (CSTP)[25] has drawn a strategy for promotion of S&T in the Environmental Sector. The five-year strategy includes five priority research areas, so called R&D Initiatives:

1. Global warming
2. Zero-garbage and recycling technologies
3. Drainage basin and urban renewal technologies for co-existence with nature
4. Technologies for comprehensive risk management of chemical substances
5. Research into global scales changes in the water cycle

The total budget for Environmental Science and Technology was about 5 billion SEK in 2002. The budget for 2003 has increased with about 22 % compared to 2001. In addition of the 5 initiatives above, CSTP has just started to discuss two new topics; biological ecosystems and earth observation. The outcome of the discussions will be presented in September 2003.

[25] *CSTP, which was established in 2001, is a new body equivalent to the Executive Office of the President in the U.S. The mission of CSTP is to give assistance to the Prime Minister and his cabinet in the planning and overall coordination of R&D from a position above the ministries.*

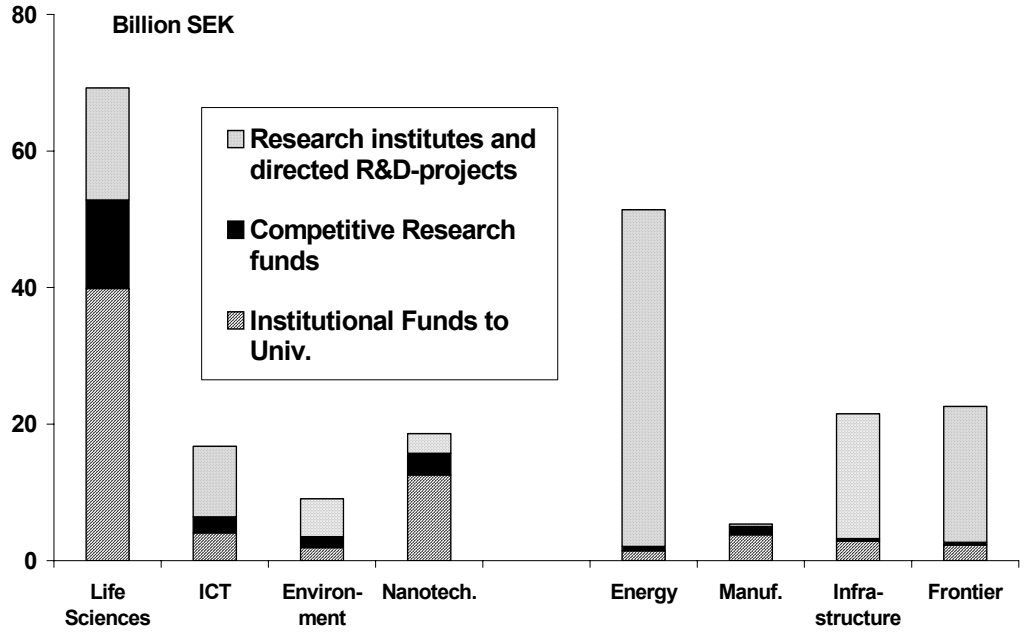
5.2 Where is the governmentally funded R&D performed?

Attached to the different ministries are national R&D institutes. Compared to Sweden research institutes represent a much larger component of research financed by the government. Figure 5.2 illustrates how the governmental R&D expenditure is distributed between major R&D performers for the current 4 priority areas (Life Sciences, ICT, Environment, Nanotech), and the 4 areas given special recognition (Energy, Manufacturing, Infrastructure, Frontier). Noteworthy is that the picture looks very different depending on the field analyzed. In the field of Environment and Energy most of the R&D is being carried out at research institutes and directed R&D projects compared to for example in the fields of Life Sciences and Nanotechnology, where most of the research money goes into institutional funds at the universities.

The most important national institutes in the field of environmental research are Institute for Global Environmental Strategies IGES-www.iges.or.jp (MoE), National Institute of Environmental Studies – www.nies.go.jp (MoE) , Research Institute of Innovative Technology for the Earth-RITE-www.rite.or.jp (METI), National Institute of Advanced Industrial Science-AIST-www-aist.go.jp (METI), Yokohama Earth Science Institute-YES-www.jamstec.go.jp (MEXT), National Traffic Safety and Environmental Laboratory-NTSEL-www.ntwel.go.jp (MLIT), National Institute for Agro-Environmental Sciences-NIAES-www.niaes.affrc.go.jp (MAFF).

In FY 2001 the majority of the national institutes saw a change in their legal status to “Independent Administrative Institutions”. Compared to before they are less dependent of their ministries in terms of use of financial resources, cooperation with companies and other external parties nationally and internationally, and in personnel matters. It is too early to judge the results of the transformation, but already some of the institutes have undergone significant restructuring, such as for example, The National Institute of Advanced Industrial Science and Technology (new AIST). From April 2004, National Universities are also scheduled to become IAIs. The new legal status of the national universities has, however already set in motion initiatives in each university to define and develop their unique strengths.

FIGURE 6.2
Distribution of governmental R&D funding in Japan 2002.



5.3 Research into global warming – an example of a the new strategic R&D coordination by CSTP

So far research on global warming has been given the highest priority among the five key initiatives presented in 5.1. At the UPDATE seminar on climate change held in Stockholm last May, Prof. Mizoguchi from CSTP laid out how S&T is the field of global warming is organized and promoted by the government.[26] The global warming framework scenario has been built-up around the key question derived from the UN Framework Convention on Climate Change:

- How can we define a greenhouse gas emission scenario that will not cause adverse effects on human beings and our ecosystem on the Earth?

The overall image diagram figure 5.3 of the global warming research initiative illustrates how different R&D topics are contributing to solve the key question. Since as much as 80 % of greenhouse gas emissions in Japan are CO_2 derived from energy consumption environment and energy issues needs to be addressed together.

5.3.1 Promotion strategy for technologies to prevent global warming

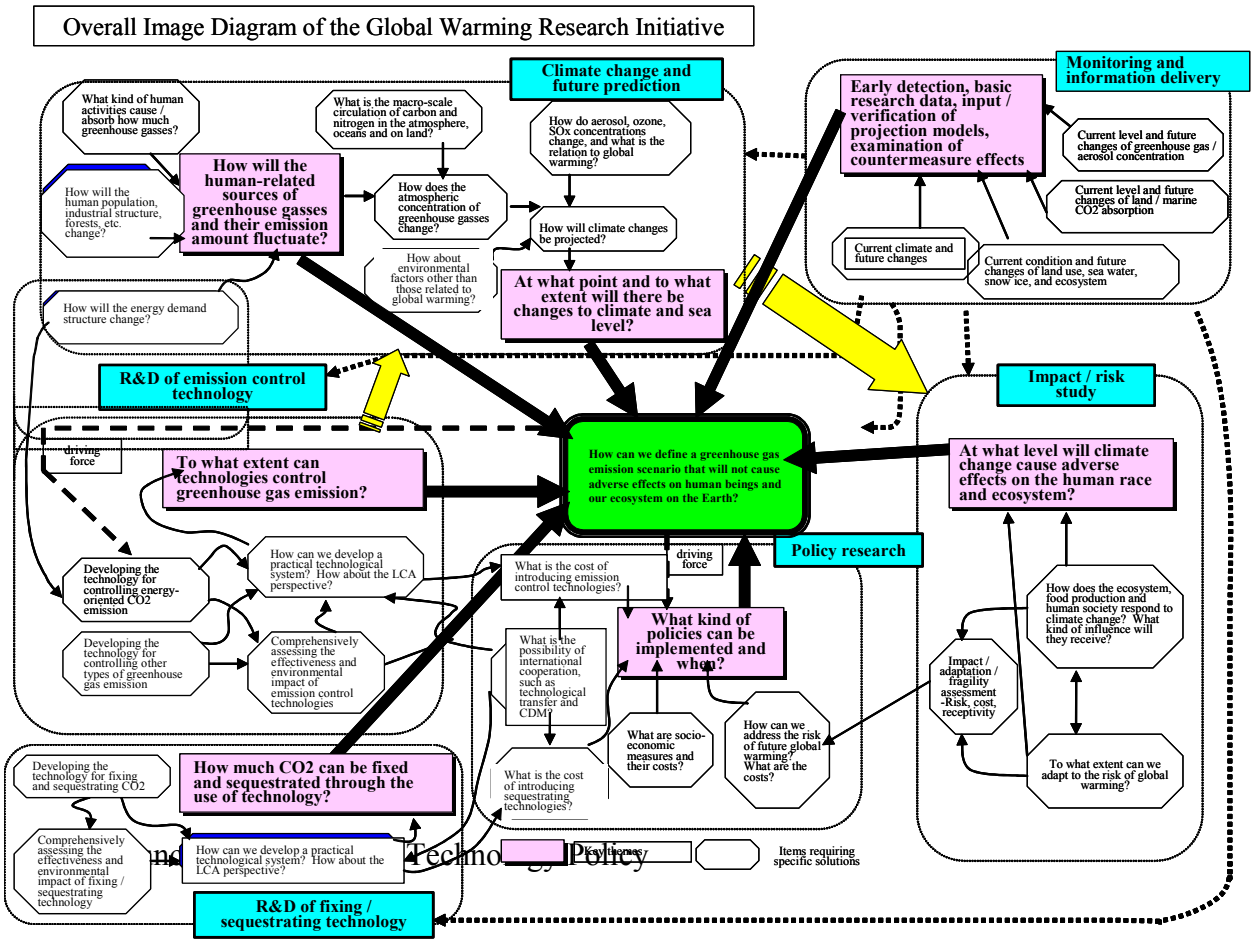
In order to get a common view CSTP has appointed a project team for Technology to Prevent Global Warming in June 2002. The team was composed by distinguished members from industry such as for example Toyota, Hitachi, Sekusui House, Nippon Steel, NEC and academia such as for example Tokyo Institute of Technology, Tokyo University, Keio University etc. It was investigating the status of re-

[26] *The slides are available at www.itps.se*

search and development in the energy conservation, new energy, and innovative environmental and energy technologies specified in the new Guideline of Measures to prevent Global Warming issued by the Government in March 2002. As a result the team, in April 2003, presented a research and promotion strategy for each R&D issue by analyzing its priority as a;

- technology for prevention of global warming in terms of its green-house gas reduction potential,
- taking feasibility into consideration,
- the necessity for research and development,
- the necessity for measures to introduce the technology and promote its diffusion,
- the ripple effect on global warming prevention measures.

FIGURE 5.3
Overall image of the Global Warming Research initiative coordinated by CSTP.



The main conclusions are summarized in figure 5.4 below. R&D development issues that are considered to be of great significance in the move to build environmentally harmonious social systems (infrastructure development) are further identified as:

- development of hydrogen manufacturing and supply systems for the hydrogen society
- development of high-efficiency secondary batteries for fixed installation
- technology for increased sophistication and recycling in waste treatment

Although not being in the focus of the analysis, the report clearly states that the expansion and construction of new nuclear power plants will be essential if Japan is to meet its reduction target according to the Kyoto agreement. Continuous research and development for this purpose is asked for. This report was guiding the budgeting process and planning for 2003 as well as other initiatives in the 2004-budgeting guideline.

FIGURE 5.4
Need for support within major technologies to prevent global warming in Japan 2003

Technologies that should get high-priority treatment because of their great potential for greenhouse gas reduction	**Technology development topics that in particular require more work on adoption and diffusion**
Improved automobile fuel economy	Energy-saving housing and construction technology
Energy-effective CO2-separation, recovery and sequestration	High-efficiency heat pumps
Carbon dioxide storage	Solar power generation
Fuel cell technology	Collaborative Industrial-consumer recycling systems with effective energy utilization
High-efficient coal gasification power generation	Biomass utilization
Forest management for CO2-fixation	Chlorofluorcarbon replacement

5.4 Research into waste-free and recycling technologies

Research into waste-free and recycling technologies is the second largest of the five R&D initiatives within the Environmental field. The overall five-year target is to develop technologies and systems for reducing waste, boosting the resource recycling rate and lowering environmental risks caused by hazardous waste. The program is closely linked to the Japanese waste policy and consists of four major programs:

1. Development of recycling technologies and systems (targets individual recycling resources)
2. Development of support system for creating a recycling-based society (LCA methods etc for proper evaluation)

3. Development of recycling-based design and production (3R into design and production)
4. Development of technologies and systems for appropriate waste processing and disposal

5.5 Environmental quality as a driver in other priority R&D areas

When investigating the environmental quality as a driver for innovation, research and technology development, it is of course not possible to limit the scope to R&D in the field defined as environmental R&D. In Japan it is obvious that environmental aspects are considered to be important drivers for the development in other research areas. For example in the **Nanotechnology/Materials** field *"materials for environmental preservation and upgraded use of energy"* is one of five areas given special priority.

Japan is either equal or leading the development in the field of nanotechnology R&D. Wide-range industry sectors is expected to achieve innovative developments, such as improving functionality and characteristics of materials, saving energy and reducing environmental burdens by the use of nano-level control. Mass syntheses of carbon nanotubes are one example. Of high interest in this context is the research being performed at the National Institute for Materials Science (www.nims.go.jp), which belongs to MEXT.

In the area of Manufacturing **technology**, which in the White Paper on S&T 2002 is referred to "the source of Japan's economic power","*technologies for minimizing environmental burdens"* is mentioned as one of eight areas meriting special priority. A program on "Circular Industrial Systems" including the R&D topics Environmental conscious production processes and Management of biological and genetic resources is now given increased priority within METI´s **Biotechnology Program** for fiscal year 2003.

5.6 Promoting exploitation of research results

In Japan the achievements as innovations are small in relation to the amount of R&D expenses invested, compared to for example the U.S. The Ministry of Economy and Trade (METI) has taken the lead in trying to promote closer ties between industry and academia, and stimulating entrepreneurial inclinations in different areas. Last April a new tax reform was introduced which allows private companies to deduct 10-12 % of their R&D expenses.

Although relatively low when compared with other major countries, the number of ventures established originating from Japanese universities are increasing. One initiative taken by MEXT to catalyze the process is the establishment of Venture Business Laboratories (VBLs) at 45 Japanese universities. The purpose is to promote original and cutting-edge research that should become buds of venture business and to develop creative human resources possessing advanced specialized vocational skills. Of relevance for this study is the EcoTechnology System Laboratory, which is a VBL focusing on Environmentally Conscious Technology at Yokohama National University.

A new program to promote regional innovative clusters by MEXT, the program on Industrial clusters by METI (chapter 2.2.1), are other governmental initiatives to promote exploitation through business-academic-public cooperation.

5.7 Centers of Excellences

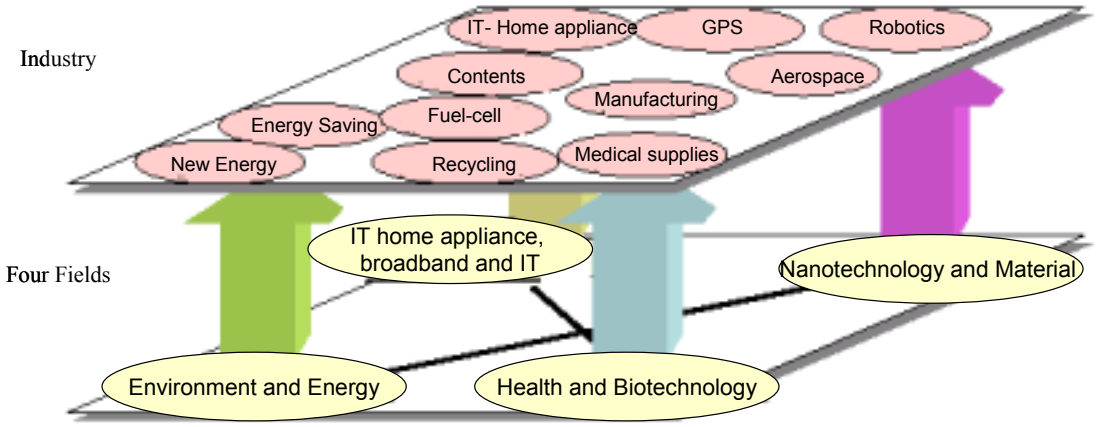
In 2002 the Ministry of Education, Culture, Sports, Science & Technology (MEXT) started a program named the "Centre of Excellence (COE) program for 21st Century". The focus is to strengthen doctoral programs in universities. The provided amount per center is 100-500 million yen per year during five years. Approximately 10-20 percent of the centers selected so far are related to the environmental field.

5.8 New Industry Development Strategy for economic revitalization

There is a good promise for creation of new markets and business and an expansion of the environmental and energy industries. This is stated by the Strategy for Industrial Development-Technical Development. As a part of the Basic Policies for Economic and Fiscal Policy Management and Structural Reform of 2002, New Industry Development Strategy was introduced as one of the six strategies for economic revitalization. This strategy called for relevant ministries/agencies to give input to the Cabinet Secretariat in formulating strategies in technology development, intellectual property/standardization and commercialization.

The four designated areas of interest are 1. environment and energy, 2. IT home appliance, broadband and IT, 3. health and biotechnology and 4. nanotechnology and material. The four were chosen because it is promising that, based on fundamental technologies, they can create an innovative demand. Note that the areas coincide very well with the four areas defined in the second Science and Technology Basic plan 2001-2005. The technology development and the fusion and synergy created among the four emphasized areas are promising to create new industries and products. (Figure 5.6) The strategies were drawn from a demand perspective, rather than the technology development, and by building an image of an ideal society. Then strategic goals are established to realize the ideal society envisioned and then issues to be overcome and the method to do so is stated.

FIGURE 6.6
Technology developments in four areas for the creation of new industries and products



In the environment and energy field the overall goal is defined as making "made in Japan" internationally recognized as an environmental brand and an adjective for environmentally conscious product/service. Then the following strategic goals were established; greening of technology, industry and the market. A plan is stated for the realization of each of the three goals. For example in solar energy, a quantitative goal of 482 million kilowatt generated in 2010 is stated. This is to be realized by research and development for lower cost electricity (as low as current electricity supply) in the greening of technology, promotion in creating the infrastructure for the surrounding industry in the greening of industry and promotion of use in private houses for the greening of the market. The above three strategic goals are to be the basis for creating and structuring specific measures by the government.

5.9 National strategy for Environmental Friendly Vehicles (EFV)

The Research and Development Program of the next-generation environmentally friendly vehicles (EFV) is one example of an extensive development project being performed by the National Traffic Safety and Environment Laboratory together with industry. The Japanese government is promoting the next generation EFV:s to replace current heavy duty diesel trucks and buses. The emission targets are to lower NOx emissions to 1/10 of those stipulated for 2005 and to reduce the emissions of particulate matters to virtually zero.

This is part of the National strategy to promote development and dissemination of EFVs launched in 2001. Except for supporting the development, the government also promotes the dissemination of EFV:s by tax reductions, subsidies, information centres., free parking etc. including public procurement of EFV:s as described in 3.1.

5.10 Nippon strategy for utilization of Biomass

In December 2002 the Japanese government decided about a national strategy to promote the use of biomass for energy and product utilization. A special plan has been adopted by the government to facilitate the development and dissemination of biomass technology. Among others the plan includes:

- Increase public understanding and awareness of the resource biomass
- Evaluate new biomass technologies and present successful case stories to the public
- Demonstrate biomass recycling systems at the World Expo 2005 in Aichi in Japan. Food and other organic waste will be collected and used for methane fermentation. The gas obtained will be used for electricity generation. Biodegradable plastics will be promoted at the EXPO.
- The development of regional models for increased utilization of biomass will be supported. Bio-diesel fuels will be evaluated. Efficient collection systems for farming and food waste will be investigated. High performance forestry machines will be developed etc

5.11 Building academic competence in Environmental Sciences and Environmental Technology

Although the necessity of human resource development in the field of environmental sciences is repeatedly mentioned by documents produced by the government, including in the Initiatives by CSTP and the report on Promotion of Environmental Research and Technology Development by the Central Environment Council of Ministry of Environment, no specific measures are visible in the higher education. There has been increase in number of academic departments, including at graduate level, in the field of environmental studies, however, the content is still at its developing stage. Professors engaged in the research and teaching in the environmental studies at universities are now bringing up the question of systemization of research and education in the field. This was a concern brought up in result of the following two phenomena. One is that the “environmental researchers,” who are already expertise in another field of study and nurtured by funding through special topic-based fundings are often running out of ideas for new research topics. Although there are needs for researchers with a comprehensive perspective to tackle the existing problems, they are not growing. Also, if the recognition by the general public of environmental sciences does not increase, the departments/divisions with the name “environmental sciences” may face extinction. Since the name value in academic record is very highly regarded in Japan, for example in attaining a job, institution and discipline of study one took a part in is a very important factor. In order to make a degree in the environmental field of study more recognizable and well-regarded, awareness by the general public must be raised. The concerned professors are in search for ways to structure environmental sciences and are in process of collecting successful experiences from abroad.

6 Discussion and comparisons

In order to overcome the initial cost barriers for greener technology the Japanese government has introduced specific measures to promote the development and dissemination of new technology such as for example solar panels and environmentally friendly vehicles. Experiences however indicate that more support is needed to make environmentally sound alternatives competitive. The environment ministry's draft of a carbon tax would indeed increase the drive, but it has so far received a stiff opposition from industry, and is not yet supported by Prime Minister Koizumi due to its estimated socio-economic consequences.

Climate Policy

The climate policy in Japan shows similarities with the Swedish. Both Japan and Sweden have ratified the Kyoto agreement. So far voluntary actions by industry, an extensive R&D package and efforts to raise the consumer awareness are the dominating policy measures in Japan. Beyond 2004, after progress has been evaluated, stronger measures like the proposed environmental taxation may be enforced. Although experiments of emission trading are being performed, it is less developed in Japan then in Europe. The use of the Clean Development Mechanism (CDM) and Joint Implementation (JI) are considered as key instruments to reach the Kyoto target in Japan. The Swedish policy that states that the Swedish reduction target (-4 %) should be met without the use of the flexible mechanisms. The absence of strong commitments from the U.S and major developing countries to reduce green-house-gas emissions is a great concern in Japan.

A resource effective and nontoxic society

Considering that an average Japanese person generates approximately the same amount waste as a Swede, but also that 126 million Japanese people are sharing a living area smaller than Sweden, explains the urgent need for new innovations to reuse, recycling, incinerate and dispose of the end products.

The Japanese environmental policy for increases eco-efficiency has been strengthened lately through the introduction of extended producer responsibility and recycling laws for individual product groups. The introduction of the new regulation put Japan on the same level as Europe.

Recent evaluations in Japan show that the recycling rates for many products have increased due to the introduction of the recycling legislation. Clear dematerialization can not however be observed so far. Virgin materials production is still high, and recycling rates of post consumer materials are rather low. In order to address the material input three additional objectives for resource productivity, material circulation rate and final disposal (see table) were adopted in March 2003 (se below).

Final disposal	50 % reduction in 2010 (compared to 2000)
Material circulation rate: recycled and re-used material/(domestic material input (DMI) + recycled and reused material)	14 % increase 2010 (2000)
Resource productivity: GDP/DMI	40 % increase 2010 (2000)

Key drivers

One of the most important drivers for environmentally driven technology and business development in Japan seems to be the increasing use of green procurement/purchasing (GPP) by the government and companies. One reason behind its effectiveness may be connected to the Japanese culture of shame. If a Japanese company would not be able to comply with environmental criteria set by the government or a large company, it will lose face. The greening of the supply chains was dramatically accelerated by the enforcement of the Law on Promoting Green Purchasing in 2001. Green purchasing is now becoming as basic as recycling or energy savings in Japan. Domestic and Asian networks are in place to exchange experiences and give support. Sweden leads the implementation of GPP in Europe. There is a common interest for Sweden and Japan to promote an expansion of green purchasing and green markets on a global level.

There are about 2.5 million companies in Japan and the national competition is very high. National environmental legislation is an important driver, but in many cases the Japanese company's in-house standards are more progressive than the national regulation due to several reasons such as:

- stricter European legislation, which is the case with the WEEE/ROHS Directives,
- environmental performance is identified as one of the key competitive factors
- a risk of harming the name value if actions are not taken
- green purchasing criteria

The usage of LCA thinking is increasing, but instead of making full LCA:s, an extensive development of performance indicators based on LCA. Companies like Hitachi, National Pansonic and Mistubushi Electric Co, Canon Inc, NTT (about 47 companies altogether) are, as a part of a 4 year national project, developing indicators to measure their products eco-efficiency (performance /environmental impact) and factor X improvements (eco-efficiency new model /eco-efficiency old model) of new products.

Environmental Product Declarations type III, which are based on LCA, is increasingly used between business and business. The Japanese Green Leaf system has been developed in parallel and partly in cooperation with the Swedish EPD system.

Sustainable consumption

Lately there is an increasing awareness that it is not sufficient to address only the production side. Efforts are therefore taken to understand how to promote sustainable consumption. In March 2003 the Ministry of Environment presented the public how to contribute to the reduction of carbon dioxide emissions as a part of the national Guidelines for Measures to prevent Global Warming. At the LCA centre at AIST in Tsukuba there is an extensive development of consumer performance indicators for GHG emissions to catalyze new consumption practice. Surveys are pointing at the importance of properly communicating the effects of taken measures to the citizens. If effects are known the willingness to act seems to be quite high. The individual consumer demand as well as the awareness of the average Swedish consumer is felt to be relatively higher in Sweden compared to Japan.

Environmental related R&D funded by government

R&D investments by the government during the past years show an increasing priority of the environmental fields. The majority of the funding goes into R&D to understand and solve identified environmental problems such as these given by priority by CSTP. More and more though, environmental applications are also targeted in other main R&D areas such as for example nano/ material technology.

During the last years important initiatives have been taken to increase the funding for preventive solutions before end-of-pipe solutions. Good examples are seen in industrial design (eco-design, development of LCA), materials development (bio-based materials), biotechnology program (bio-processing) and nanotechnology (energy efficiency), but the ratio is still comparably small.

Compared with Sweden it seems to be a stronger coordination between the environmental policy agenda and the R&D spending. This is especially true when looking at the role of R&D as one of the key components to prevent global warming. The appointed academia-business-government team is forming an important link between the climate policy and the R&D initiative on global warming.

When it comes to R&D of socio-economic aspects such as the understanding of consumer behavior, economic and structural barriers towards sustainable development on system level, Sweden seem to be ahead of Japan.

7 Conclusions

Investments in environmentally driven technology and business development are an important growth factor in Japan. Providing unique solutions to meet future green market demand is viewed as an important competitive factor.

The environmental quality is a strong driver for governmental R&D investments at research institutes and universities. The government annually spends approximately 5 billion SEK on research and development to address important environmental problems such as green-house gas emissions, increasing waste volumes and poor air-quality in urban areas. The amount has increased with 22 % the past three years.

There is a clear trend towards increased coordination and strategic planning of the governmental R&D investments. Technology R&D to prevent global warming is carefully analyzed from a strategic perspective in cooperation between academia, government and business. Environmental applications are being targeted in other R&D priority areas such as bio-technology, nanotechnology, IT and manufacturing technology.

The Japanese innovation system is currently under going a transformation to more effectively contribute to economic growth. Among the reforms are tax reductions for R&D performed by industry, creation of regional clusters, and increased support to entrepreneurs.

The Environmental Policy has been strengthened during the past years. New legislation is being implemented such as new recycling laws and stricter emission requirements for motor vehicles. A carbon tax and a new bill on environmentally sound business performance are being considered.

Integration of environmental aspects into industrial policy is being done by METI through for example the promotion of industrial clusters with an environmental profile. Cooperation between MoE and METI is still a challenge.

The government plays an active role as a buyer of green product alternatives both for demonstration of new technology and its daily operation. The Environmental Ministry is certified by 14 001. The number of regional governments certified according to 14 001 is the highest in the world. The introduction of environmental friendly vehicles has been catalyzed by a successful cooperation between government and car companies.

Green Procurement Law and green purchasing performed by companies seem to be the most important driver for a general greening of products and markets in Japan. An increasing number of companies are implementing green procurement into their supply chains.

Japanese companies such as Toshiba are investing in in-house development and effective use of LCA and other assessment methods and related competence building.

The consumer demand for environmentally sound products is weak. Still companies like Toshiba and National Panasonic are offering an increasingly amount of environmentally conscious products. One of their biggest challenges is to overcome cost barriers connected with the introduction of environmentally sound alternatives. Environmental performance is not yet a competitive factor. The risk for harming the name value by not considering corporate social responsibility is viewed as one of the strongest driver for taking actions.

Japan R&D holds a top position in fuel-cell technology, utilization of semi-conductor technology to increase energy efficiency, climate research, recycling technology, solar energy and power generation, nanotechnology and biotechnology. Ongoing reforms of the academic system open up for increased co-operations.

Sweden is often viewed as a model country towards Sustainable Development in Japan. Swedish environmental policy and Swedish environmental technology are strong trademarks in Japan.

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