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PRIORITY-SETTING IN JAPANESE RESEARCH AND INNOVATION POLICY

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Priority-Setting in Japanese Research and Innovation Policy

by

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VINNOVA´s foreword

VINNOVA is the Swedish Governmental Agency for Innovation Systems and has a mission to promote sustainable growth by funding needs-driven research and developing effective innovation systems. The principles and institutional mechanisms utilized in setting priorities for public financing of research and development are crucial aspects of any country's research and innovation system. As an input to the development of its own strategies and positions, VINNOVA has decided to commission in-depth studies of the prioritization mechanisms in the USA, China and Japan and in the EU Framework Programmes. Welcoming open discussions on issues relating to priority-setting and hoping that the studies may also be of interest to other institutions in Sweden and internationally, these are published in English and made generally available. The project is managed by Göran Pagels-Fick at VINNOVA's Strategy Development Division.

This report covers priority-setting in Japanese research and innovation policy. It was written by Lennart Stenberg from VINNOVA and Professor Hiroshi Nagano, from the National Graduate Institute for Policy Studies (GRIPS). Both authors have extensive and long experience in the field of science, technology and innovation policy. Prior to GRIPS, Hiroshi Nagano headed up the National Institute of Science and Technology Policy (NISTEP) and then served as Executive Director at the Japan Science and Technology Agency (JST). He still serves as Principal Fellow at the Center for Research and Development Strategy of JST. After serving at two of the predecessor organizations of VINNOVA (STU and NUTEK), Lennart Stenberg held the post of Swedish science and technology counselor in Tokyo for six years. He continues to study developments in Japan as a part time visiting researcher at the University of Tokyo.

Although Sweden and Japan differ greatly in the structure and size of their research and innovation systems, VINNOVA finds that the evolution of priority-setting in Japan carries important lessons for Sweden as well. Although Sweden, with its small economy has a greater need to prioritize and co-ordinate its investment in research and innovation, Japan has so far made greater efforts towards developing government-wide priorities and strengthening co-ordination among ministries and agencies. It is also noteworthy that more emphasis has recently been put on linking research investment to the creation of innovation. Even in a large economy like Japan, attractiveness of its research and innovation environment on the global stage has come to be seen as essential.

VINNOVA, November 2009

Göran Marklund
Director and Head of Strategy Development Division

Authors´ foreword

This report attempts to provide an overview of the system for prioritizing government expenditure on science and technology in Japan. The main focus is on priority-setting for the government as a whole as reflected in the development of the Science and Technology Basic Plans and the activities of the Council for Science and Technology Policy.

Priority-setting is largely determined by the institutional framework in which priorities are deliberated and decided. This includes the system of organizations performing research such as universities and research institutes as well as that of ministries and special funding organizations used for channeling government resources. An important element of the priority-setting system is the concepts being used to characterize different types of research and development. A large part of this report is therefore devoted to introducing the relevant institutions and concepts.

Priority-setting is concerned with the allocation of resources. So the reader can judge the significance of individual priorities, there has been an effort to present actual resource allocation data for the priorities concerned and relate the scale of expenditure to overall government spending on science and technology. Since the aim has been to present budget data in a consistent framework, there has frequently been a need to go into technical details of the statistics used – details which many readers may wish to skip.

Many important aspects of the "real" priority-setting processes are not covered in the report. For example, under the rule of the Liberal Democratic Party (LDP), direct contacts between ministry officials and individual parliament members have been an important mechanism in building political support for specific policy measures.

One of the main conclusions emerging from this study is that the priority-setting system is continuously evolving in what appears to be a productive learning process. On 16th September 2009, a new government under Prime Minister Yukio Hatoyama of the Democratic Party of Japan took over stewardship of Japan. The extent to which the science, technology and innovation policies of the new government will represent a sharp break with, or further evolution of, recent policies still remains to be seen. In any case, priority-setting in Japan will warrant continued attention.

The authors would like to thank those persons who generously accepted to be interviewed for this study.

Stockholm and Tokyo, October 2009

Lennart Stenberg *Hiroshi Nagano*

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Summary

Until 1995, the mechanisms for prioritizing government expenditure on research and development remained weak in Japan. Through the enactment of the Science and Technology (S&T) Basic Law in that year, the development of an integrated government S&T policy began in earnest. The main instrument for this has been the development of successive five-year S&T Basic Plans, which have defined the main overall priorities for each period.

As part of a wide-ranging administrative reform in 2001, the Council for Science and Technology Policy (CSTP), chaired by the Prime Minister, was given a stronger mandate than before and has since had the leading role in developing overall S&T policy, including drafting and completing the S&T Basic Plans. The CSTP operates through a number of expert committees and working groups. The Bureau of Science, Technology and Innovation Policy in the Cabinet Office, with around 100 staff, serves as the CSTP's secretariat.

The Second Basic Plan, covering the period 2001-2005, defined four broad priority fields: Life Sciences, ICT, Nanotechnology/Materials and Environment. Comprehensive promotion strategies were developed for these and for four other broad fields; Energy, Manufacturing, Social Infrastructure, Frontiers (space and ocean). In the Third Basic Plan, based on an extensive planning process, 62 Strategic S&T Priorities were specified. Twenty-four of these – 14 in the energy field – fell outside the four broad priority fields defined in the Second Basic Plan. As a result, the start of new programs was no longer limited to the four broad priority fields defined in the Second Basic Plan.

The Strategic S&T Priorities were developed in relation to a hierarchy of S&T policy goals, oriented towards: a) strengthening Japan's scientific and technological capacity; b) advancing Japan's industrial competitiveness in its current or potential fields of strength, while responding to challenges posed by climate change and the need to increase resource-efficiency; c) contributing to meeting the needs of Japanese society, especially those linked to health and safety.

The Third Basic Plan explicitly distinguishes between two types of basic research: "Type-1 basic research that is conducted based on the free ideas of researchers in S&T, including human and social sciences; and Type-2 basic research that aims at future applications based on policies." The main significance of this distinction is that Type-1 basic research is considered to fall outside the system of thematic prioritization. In budgetary terms, 42 percent of government expenditure on S&T is categorized as Type-1 basic research. This primarily includes basic government funding of

universities and bottom-up, peer review-based research funding. Thematic prioritization applies to just under half of central government expenditure on S&T. This part of the budget is labeled “Policy mission-oriented R&D”. The remaining 10 percent concerns systems reform measures and other expenditure which cannot easily be thematically categorized.

For the fiscal year (FY) 2009, the 62 Strategic S&T Priorities are estimated to make up 28 percent of the total budget for Policy mission-oriented R&D. This is an increase from 16 percent in FY 2006. However, there are great differences in both the size and development over time of budgets for the individual Strategic S&T Priorities. Some have failed to secure any significant budgets. Five of what are known as National Critical Technologies in FY 2009 made up 35 percent of the budget for Strategic S&T Priorities and included such items as: fast breeder reactor; rocket; ocean and earth observation system; super-computer; and X-ray free-electron laser. Clinical and translational research and next-generation networks are other examples of priorities which have been allocated large budgets.

To date, the Basic Plans have not specified any budget allocations except for setting a target for total government S&T expenditure during the relevant five-year period. The target set for the First Basic Plan was reached, while expenditure during the Second Basic Plan was considerably below target. While the Third Basic Plan runs until the end of March 2010, it currently seems that expenditure will fall well short of the target this time too.

Budgets for government S&T expenditure are decided on an annual basis through negotiations between individual ministries and the Ministry of Finance. However, the CSTP does review part of the budget proposals from the individual ministries. The result of the reviews is openly published and CSTP’s opinions do seem to have some influence on the budget negotiations. From its establishment in 2001, the Council on Economic and Fiscal Policy (CEFP) played an important role in setting the overall framework and priorities for the annual budgets.

The politics of the annual budgetary process in Japan is complex. The Liberal Democratic Party, which until September 2009 had ruled Japan almost continuously for 50-plus years, has channeled its political influence in the budgetary process through a dual system. In addition to the expected influence through the cabinet and its individual ministers, the LDP has maintained a system of internal committees for different policy areas. Members of these committees have often exerted considerable influence on the budgetary process through direct contacts with ministry officials. The report does not attempt to analyze the relative importance of these different routes of political influence.

In September 2009, a historical shift of power made the Democratic Party of Japan (DPJ) the ruling party. The DPJ has placed strong emphasis on abolishing the dual system of exercising political power and moved to reduce the alleged power of ministerial bureaucrats. The CEFP has been abolished and a new Strategy Office established, headed by the Deputy Prime Minister, who is also the minister in charge of S&T policy. In terms of concrete priorities, the new government has so far put special emphasis on “green innovation”. This follows its pledge for Japan to effect a 25 percent reduction in greenhouse gas emissions by 2020, compared to 1990 levels. In other respects, it is not yet possible to judge the consequences of the power shift on the system for prioritizing S&T expenditure.

While the Basic Plans have served as the main framework for defining S&T policy in Japan since the mid 1990s, there has been a need to adjust priorities as conditions change over the five years covered by a Basic Plan. This has been especially noticeable during the most recent Basic Plan. As a result, the CSTP has recently defined a number of Top Priority Policy Issues, which can be said to serve as a new layer of priorities, overlapping with the Strategic S&T Priorities as well as introducing new elements. In the budget for FY 2009, the CSTP defined five Top Priority Policy Issues: transformative technologies, low-carbon technology, S&T diplomacy, regional empowerment through S&T, pioneering projects for accelerating social returns. The latter item reflects a growing concern with the need to convert investment in S&T into innovations that can contribute to solving important problems in society and generate economic growth.

Like governments in many other countries, the Japanese government responded to the financial and economic crisis which hit the world in 2008 by launching several major economic stimulus packages. The most recent, adopted in May 2009, included expenditure on science and technology equivalent to 38 percent of the regular FY 2009 S&T budget. After being reviewed by the new Cabinet the size of the budget has been somewhat reduced.

The report discusses the connections between priority-setting and coordination across ministries and provides examples of the efforts to strengthen coordination of investment in R&D and between such investment and regulatory and other policies. One long-standing instrument of coordination is the Special Coordination Funds for Promotion of S&T, which represents around one percent of total government S&T expenditure and 10 percent of all competitive funding of S&T. Especially in the health field, outdated regulatory practices have come to be seen as an undesirable impediment to innovation in Japan and special measures been taken to better adapt regulations to new developments in science and technology.

The development of more explicit priorities for S&T expenditure has been accompanied by a strengthening of the analytical basis for making informed judgments about the actual state of Japanese science and technology and its various institutions. The National Institute of Science and Technology Policy (NISTEP) has developed into a main analytical resource for CSTP and other actors. Technology Foresight continues to be carried out every five years. The Center for R&D Strategy established by JST has conducted extensive international benchmarking of Japan's scientific, technological and industrial capabilities in a large number of fields. The Ministry for Economy, Trade and Industry (METI) has developed a set of Strategic Technology Roadmaps which are regularly updated.

Preparations for formulating the Fourth S&T Basic Plan commenced during 2009. The report highlights some issues which are likely to be central in the new Basic Plan. The development of research environments in Japan capable of attracting leading scientists from abroad is one such issue and the creation of social and economic benefits from investment in science and technology through innovation is another. Japanese industrial organizations have advocated a stronger emphasis on "problems-to-be-solved" in defining thematic priorities.

Is there anything Sweden can learn from the Japanese system of prioritization? The difference in scale and structure of the research and innovation systems in Sweden and Japan makes comparisons difficult and few policies and measures in Japan should be expected to apply directly to Sweden.

With a much smaller system, there should be less of a need for coordination in Sweden, while the need for prioritization should be much greater. Until recently, overall government "research policy" in Sweden, as expressed in the research bills every four years, has focused on horizontal – "systemic" – issues, and especially those related to the conditions for research and PhD studies at universities. Priorities in terms of specific fields or themes have been treated only on a very general level. While research councils and agencies have been encouraged in general terms to cooperate and coordinate their activities, few specific mechanisms for realizing effective coordination have been established.

The introduction of 24 "Strategic Research Areas" in the most recent research bill from 2008 represents a new development in Swedish research policy. Unlike the Strategic S&T Priorities in the Japanese Third Basic Plan, the Strategic Research Areas are directly linked to allocation of resources. However, the function of the Strategic Research Areas is more specific in that they will serve primarily as a means to direct major new funding to selected universities. For some of the areas, additional resources are also channeled through research councils and R&D-funding agencies. In these cases, the impact will extend to larger parts of the Swedish research system. Thus, the situation is quite different from that of Japan, where only a smaller proportion (exact percentage unknown) of the resources for the Strategic S&T Priorities are being spent at universities with the greater proportion going to various types of research institutes or companies.

Unlike Japan, there is not yet an overall framework for prioritizing government R&D expenditure in Sweden in terms of scientific, technological or thematic fields. An important basis for developing such a framework would be extensive and systematic international benchmarking of research, innovation and industry in Sweden. Such activities appear more developed in Japan, where there is a wealth of quantitative and qualitative studies from both public and private think-tanks. Considering that Swedish industry is much more dependent on the global market than Japan, the need for global benchmarking is even greater in Sweden.

Although Sweden may need coordination less than Japan, the present situation would seem on the low side. A stronger basic infrastructure and incentives for coordination need to be developed. It is interesting that the role of the CSTP in creating platforms for coordination across ministries and agencies appears to be appreciated and welcomed. The function of the Coordination Funds for Promotion of S&T, as well as other efforts to improve coordination, warrants further study. The role of universities in Sweden as providing the research infrastructure for all sectors of society inherently makes the Swedish research system more integrated than the Japanese one, where most ministries have their own research institutes. On the other hand, this means that universities in Sweden are charged with wider responsibilities than those in Japan.

In Sweden, the development of research policy for the government as a whole is concentrated to the preparation of the research bills. One could argue that there is a need for government-wide policy development process on a more continuous basis. This should engage various actors in open and transparent processes.

Abbreviations

AIST: National Inst. of Advanced Industrial S&T

CEFP: Council on Economic and Fiscal Policy

COCN: The Council on Competitiveness - Nippon

COE: Center of Excellence

CSTP: Council for Science and Technology Policy

CRDS: Center for R&D Strategy

CREST: Core Research for Evolutional Science and Technology (research program)

DPJ: Democratic Party of Japan

FBR: Fast Breeder Reactor

FY: Fiscal Year

IAI: Independent Administrative Institution

iPS Cells: Induced Pluripotent Stem Cells

ICT: Information and Communications Technologies

IP: Intellectual Property

JAEA: Japan Atomic Energy Agency

JICA: Japan International Cooperation Agency

JAXA: Japan Aerospace Exploration Agency

JETRO: Japan External Trade Organization

JOGMEC: Japan Oil, Gas and Metals National Corporation

JPY: Japanese yen

JSPS: Japan Society for the Promotion of Science

JST: Japan Science and Technology Agency

LDP: Liberal Democratic Party

MAFF: Ministry of Agriculture, Fisheries and Forestry

MIC: Ministry of Internal Affairs and Communication

METI: Ministry for Economy, Trade and Industry

MEXT: Ministry of Education, Culture, Sports, Science and Technology

MHLW: Ministry of Health, Labor and Welfare

MLIT: Ministry of Land, Infrastructure and Transport

MOE: Ministry of Environment

Monbusho: (former) Ministry of Education, Sports and Science

NARO: National Agriculture and Food Research Organization

NEDO: New Energy and Industrial Technology Development Organization

NIBIO: National Institute of Biomedical Innovation

NICT: National Institute of ICT

Nippon Keidanren: Japanese Business Federation

NISTEP: National Institute of Science and Technology Policy

ODA: Official Development Aid

R&D: Research and Development

RIKEN (abbreviation for RIkagaku KENkyusho: Institute of Physical and Chemical Research; today, only the abbreviation is used in English)

SCF: Special Coordination Funds for Promotion of S&T

SCJ: Science Council of Japan

SME: Small and Medium Enterprises

STA: (former) Science and Technology Agency

S&T: Science and Technology

STR: Strategic Technology Roadmap

WPI Program: World Premier International Research Center Initiative

1 Priorities in the 2009 budget

1.1 Priorities according to the CSTP

Prioritization in Japanese government science and technology (S&T) policy has undergone radical changes during the last 10-15 years. The new S&T Basic Law in 1995 marked the beginning of a deliberate effort to integrate the policies of the different ministries into an overarching national S&T policy. The five-year S&T Basic Plans prescribed by the S&T Basic Law have been the most important instrument for developing an integrated policy.

A second crucial element for strengthening cross-ministerial policy development and coordination was the establishment in January 2001 of a new Council for Science and Technology Policy (CSTP). This was chaired by the Prime Minister, and given much more authority and room for initiative than the preceding council. With a secretariat of around 100 people, the CSTP has gradually developed its role as the top policy-setting and coordinating body in the field of S&T policy. During the last couple of years, innovation has been added as matter of specific concern for the Council as indicated by a change in the name of the relevant secretariat inside the Cabinet Office to the Bureau of Science, Technology and Innovation Policy.

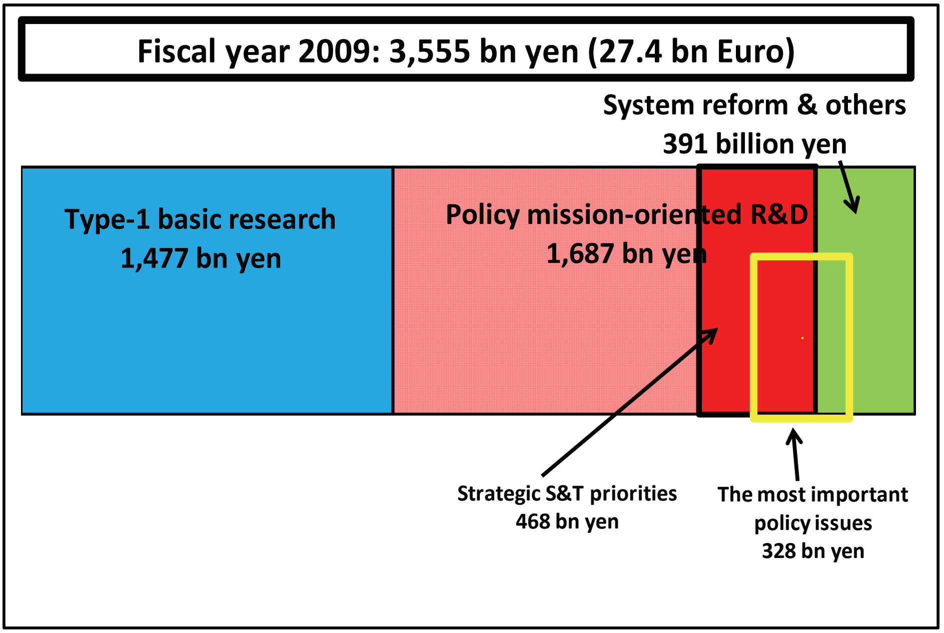
While the CSTP undoubtedly plays a central role in policymaking, it has little direct control over annual budgets. These are still basically negotiated between the individual ministries and the Ministry of Finance. However, the CSTP influences this process in a number of ways which will be further discussed later. These include evaluation of budget requests from the various ministries for major new S&T programs.

An important way in which the CSTP influences policy implementation is by continuously collecting and presenting information of overall government S&T expenditure and the extent to which it conforms to the policy objectives adopted by the CSTP.

Figure 1 shows some of the key categories most recently used by the CSTP in defining priorities for government S&T expenditure. These categories have changed over time and continue to evolve, as will be further explained.

The fiscal year 2009 covers the period 1st April 2009 to 31st March 2010. The government's proposal to the parliament (the Diet) for the FY 2009 budget was adopted by the Cabinet on 24th December 2008. As far as S&T-related expenditure was concerned, no changes were made in the version of the budget passed by the Diet in March 2009. This reflected the fact that the ruling coalition has a two-thirds majority in the Lower House.

Figure 1. Main components of the FY 2009 Government Science and Technology Related Budget in Japan.[1]



Source: CSTP (2009a); graph modified by authors

The total regular FY 2009 government budget for S&T adds up to JPY 3,555 billion. The framework defined in the Third S&T Basic Plan, and used by the CSTP for prioritization, recognizes a special category labeled "Type-1 basic research", the funding of which should be exempt as a matter of principle from prioritization according to societal objectives:

> *"Basic research consists of two types: Type-1 basic research that is conducted based on the free ideas of researchers in S&T, including human and social sciences; and Type-2 basic research that aims at future applications based on policies".*[2]

Around 83 percent of "Type-1 basic research concerns basic university funding, mainly national universities, whilst another 13 percent relates to so-called Grants-in-Aid (*kakenhi*). Altogether, this category of basic research makes up 41.5 percent of the total government S&T budget. Having sufficient total resources for basic research is a policy priority, but for "Type-1 basic research" there is deliberately no explicit government

[1] An exchange rate of 1 Euro = 130 yen is assumed throughout the report.
[2] Government of Japan (2006), page 16

policy for the distribution of funds between scientific fields or the like within this category.

Thus, the real target of the overall government prioritization process is the remaining 58.5 percent of government S&T expenditure. A majority of this, some 47.5 percent of total government S&T expenditure, falls under the category of "Policy mission-oriented research", while the final 11 percent is referred to as "System reform & others". The essential difference is that "Policy mission-oriented research" is prioritized according to its content in terms of scientific, technical or application field, while most initiatives in the "System reform & others" category are defined in "horizontal terms" not à priori limited to or specifying any particular field. The latter also includes items which for other reasons cannot be classified into the two first groups.

A subset of "Policy mission-oriented research" is characterized as "Strategic S&T Priorities" and makes up around 13 percent of total government S&T expenditure and 28 percent of all "Policy mission-oriented research". The Strategic S&T Priorities is a core element in the Third Basic Plan and a new development in comparison to the Second Basic Plan. Based on extensive preparatory work, involving a large number of experts from different sectors, 62 Strategic S&T Priorities were included in the Third Basic Plan. The CSTP is systematically monitoring the implementation of the 62 Priorities (see section 4.3).

Table 1. "Most important policy issues" in the S&T Budget for FY 2009

	FY 2008	**FY 2009**
	billion yen	
Transformative Technologies	40.5	52.3
Low-carbon Technology	140.8	164.0
S&T Diplomacy	45.0	46.7
Regional Empowerment through S&T	62.2	69.3
Pioneering Projects for Accelerating Social Return	16.6	19.5
Sum	305.1	351.8
Total excluding double-counting	**286.2**	**327.7**

Source: Same as Figure 1

Recently, the CSTP has taken a new step in its prioritization efforts and identified five "most important policy issues". In the budget for FY 2009 they occupy around nine percent of total S&T expenditure and 16 percent if expenditure for "Type-1 basic research" is excluded. Table 1 lists the five items determined as the "most important policy issues". There is some overlap between the different items. Some of the low-carbon technologies are also considered to be transformative technologies, for example.

As indicated in Figure 1, the most important issues are a mixture of specific technologies and system-reform oriented policies.

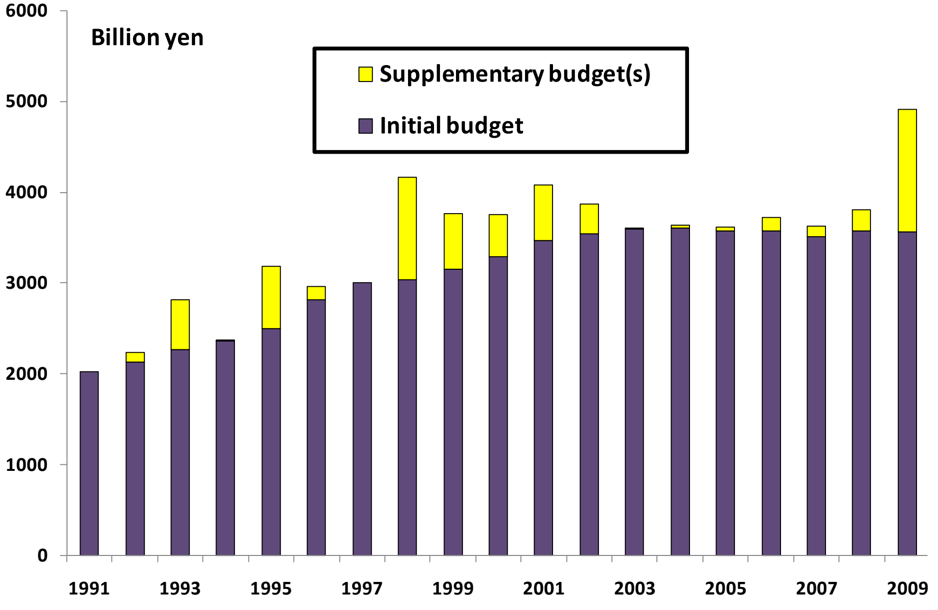
The designation of the five items as "most important policy issues" may be seen as a way for the CSTP to move its prioritization work forward during the Third Basic Plan without changing the latter, but adding additional specificity.

FY 2009 represents the fourth year of the Third Basic Plan's five-year period 2006-2010. During 2009, preparations have started in earnest for the Fourth Basic Plan.

1.2 Regular S&T budget stagnant since 2003

Figure 2 shows the development since 1991 of S&T-related expenditure in the budgets of the central government. Both regular (initial) budgets and supplementary budgets are shown. In certain years, the additional resources provided by the supplementary budgets are highly significant. This was particularly true for the period 1998-2002, when the Japanese economy was stagnant and showed strong deflationary tendencies.

Figure 2. S&T-related expenditure in central government budgets FY 1991-2009



Sources: MEXT (2009a) and MEXT (2009b)
Note: After the change of government in September 2009, the new Hatoyama Cabinet decided to reduce the FY 2009 supplementary budget by a total of some 20 percent. No updated estimate of S&T-related expenditure in the revised FY 2009 supplementary budget was available at the time of writing.

During the 1990s, the regular S&T budget grew fairly steadily with an annual growth rate of 4-6 percent for most years. Since the turn of the 21st Century, the picture has altered and the regular budget has stayed more or less unchanged.

The numbers in Figure 2 refer to current prices. There have of course been some changes in the price level, but as these changes have been small, current prices will be used throughout the report.[3]

The lack of growth in regular S&T budgets since 2003 and, until very recently, little if any additional resources from supplementary budgets reflect changes in overall fiscal policies. As the Japanese economy began to grow again, the need for an expansionary fiscal policy disappeared and the top priority became a rebalancing of the government budget. In this situation, only a few prioritized areas (S&T being one) have managed to escape budget cuts.

Once again, the global financial crisis has suddenly fundamentally changed the picture, as will be further discussed in Chapter 9.

[3] The GDP-deflator was 1.3 percent lower in 2000 than in 1991 after having increased by 2.7 percent between 1991 and 1995. From 2000 to 2005, the GDP-deflator decreased by 6.5 percent. However, during the same period the "overall deflator for R&D expenditure in Japan" decreased by only two percent.

2 Who is using government S&T funds and how are they distributed?

2.1 A research system very different from the Swedish one

Before proceeding to discuss different aspects of the prioritization process in more detail, it is necessary to describe the structure of the Japanese research system and the institutional mechanisms through which government S&T funds are being channeled to their ultimate use.

Each country tends to have its own unique ways of organizing and publicly funding research, and that is certainly true of Japan. The following are some of the main structural characteristics (as viewed from a contrasting Swedish perspective):

- Japan has a large sector of research institutes (outside the higher education sector), predominantly funded by the government. Most of these currently have a legal status known as Independent Administrative Institutions (IAI), while others remain a part of the ministry to which they belong. There are also quite a few prefectural and private non-profit institutes.
- Although private universities account for some 75 percent of all undergraduate students, government funding of universities is strongly concentrated on national universities. This applies to general university funds as well as for research grants.
- Private universities derive the largest part of their income from student tuition fees. National universities also charge tuition fees but at a much lower rate than private ones.
- Humanities and social sciences are by and large not dealt with in S&T policy, except where there is a link with science or technology.
- National universities as well as government research institutes still derive a very large portion of their funding from the government in the form of general funds rather than as competitive grants.
- Until recently, almost no work done by doctoral students was paid from funds considered part of government S&T expenditure; this also reduces the tendency to overestimate S&T expenditure discussed below. Through the Global Centers of Excellence program this situation has changed somewhat but funding of doctoral students still forms a very small part of total government S&T expenditure.
- Government project-based funding of R&D at universities, research institutes and companies is done through special funding agencies as well as directly from the ministries.

- Funding of research projects at universities and government research institutes does not usually include the salary costs of permanent employees. These costs are normally covered by general funding to the institutions; the same is true of most facilities costs. The only personnel costs covered by project funding are usually for post-docs. A system of indirect costs being covered by research grants began being introduced a few years back and, when fully implemented, should reach a maximum level of 30 percent.
- There has been a strong tendency for each ministry to build up its own research system centered on its own research institutes.
- Prior to 1995, virtually all the government funding of national universities came from the Ministry of Education (at that time Monbusho), but since then other ministries have gradually increased their funding of national universities (see further discussion in Chapter 5).

From the above it should be clear that one must be extremely careful when trying to compare data for the Japanese and the Swedish R&D systems. The systems are different enough for comparisons based on single indicators to be misleading in most cases.

It is particularly worth highlighting one effect of the Japanese system. With the high share of total costs covered by general funds at both national universities and government research institutes, the leverage of project-based research funding is usually much higher than in Sweden. In other words, a research grant of a certain size buys much more research in Japan than in Sweden. The difference may frequently be as large as a factor of two.

Table 2 shows the data from the official Japanese R&D statistics on the distribution of performance and financing of R&D among main types of organizations. According to these statistics, more than 90 percent of R&D funds from government sources are divided almost equally between “public organizations” and universities, with a somewhat higher share for the latter. “Public organizations” in this context correspond mainly to government research institutes or centers of one sort or another.

Japanese national R&D statistics differ significantly from the standards used by the OECD for comparing R&D expenditure in different countries (Table 3). The major difference concerns expenditure for R&D carried out in the higher education sector, which the OECD estimates at about 30 percent less than in the national Japanese R&D statistics in order to align the data for international comparison. This is mainly based on the adjustment of personnel costs made by the OECD, taking into account the ratio of effort devoted to research surveyed in Japan. So far, Japanese R&D statistics do not properly distinguish between research on the one hand and education on the other in the total efforts funded at universities, especially through general funds.

Table 2. Overview of performance and financing of R&D in Japan FY 2006 according to national Japanese R&D statistics

Fiscal year 2006, billion yen	R&D-performing organizations				
Source of funds	Business enterprises	Public organizations	Universities and colleges	Non-profit institutions	Total
Business enterprises	13126.7	9.6	96.2	111.8	**13344.3**
Central and local government	136.0	1411.6	1659.6	127.8	**3335.0**
Private universities and colleges	0.2	0.1	1594.1	0.0	**1594.4**
Non-profit institutions	11.5	4.2	31.1	81.1	**127.9**
Foreign countries	52.9	5.0	1.3	2.1	**61.3**
Total	**13327.4**	**1430.4**	**3382.4**	**322.9**	**18463.1**

Source: MEXT (2008a); based on the official R&D statistics compiled by Statistics Bureau Japan.

Table 3. Overview of performance and financing of R&D in Japan FY 2006, according to the OECD

Fiscal year 2006, billion yen	R&D-performing organizations				
Source of funds	Business enterprises	Public organizations	Universities and colleges	Non-profit institutions	Total
Business enterprises	13126.7	9.6	64.4	111.8	**13312.6**
Central and local government	135.1	1409.8	1123.5	127.4	**2795.7**
Private universities and colleges	1.2	1.8	983.0	0.5	**986.5**
Non-profit institutions	11.5	4.2	21.0	81.1	**117.8**
Foreign countries	52.9	5.0	0.9	2.1	**60.9**
Total	**13327.4**	**1430.4**	**2192.7**	**322.9**	**17273.5**

Source: OECD (2007).

Table 4. R&D expenditure, PhDs awarded and Grants-in-Aid by type of university

	National universities	Other public universities	Private universities	Other research organizations	All types of organizations
	Percent				
Share of R&D-expenditure in Higher Education Sector 2007	39.5	4.9	49.0	6.6	100.0
PhD-degrees awarded in 2005	75.5	5.2	19.3	0.0	100.0
Share of funds form Grants-in-Aid program 2007	68.5	4.6	14.4	12.5	100.0

Sources: a) Statistics Bureau of Japan (2009): R&D expenditure in HE sector; b) Bunkyo Kyokai (2007): PhDs; c) JSPS website: Grants-in-Aid.

Tables 2 and 3 both suggest that private universities make up a large part of the research carried out in the Japanese higher education sector. Although these tables do not provide a breakdown of the total research funding by type of university, they state that the self-financing of private universities represents 47 (Table 2) or 45 (Table 3) percent of total R&D funding of universities. Distribution of total R&D funding at higher education institutions in FY 2007, according to the official Japanese R&D

statistics, is shown in Table 4.[4] On the basis of this data, close to half of all research in the higher education sector in Japan would be carried out by private universities.

However, this picture is significantly at odds with the conditions suggested by other indicators, which tend to show university research in Japan as very strongly concentrated on national universities. In terms of the number of PhDs awarded – a measure which should be expected to have a high correlation with the volume of research activities in a university – national universities made up 75 per cent. This is almost four times the share for private universities and almost 15 times the share for municipal and prefectural universities (Table 4). The difference between national and private universities is similar in the case of funds obtained from the Grants-in-Aid scheme, the most broad-based program for peer-review-based research funding in Japan, covering all fields (Table 4). This divergence in the picture would suggest that in Japanese private universities, much effort is devoted not to research but to education and other functions.

In terms of policy in Japan, Science and Technology (S&T) rather than Research and Development (R&D) is the commonly used category. Most of budget-related data concerns "S&T-related expenditure", which is both broader and narrower than R&D expenditure. The former is broader in the sense that it contains some expenditure that would not be classified as R&D, such as the cost of running the Japan Patent Office. It is narrower in the sense that most of the expenditure for research in humanities and social science is excluded (see also Chapter 5). The net result is shown in Table 5. In 2006, government S&T-related expenditure in the regular budget was around 20 percent higher than recorded government R&D expenditure.[5] All levels of government are included.

Total government S&T-related expenditure in FY 2006 added up to JPY 3,992 billion, of which JPY 3,574 billion, or around 90 percent, came from the national government (Table 5). This report deals only with the S&T budget of the national government. The corresponding national government S&T-related budget for FY 2009 is JPY 3,555 billion which is the same as shown earlier in Figure 1.[6]

[4] In this case, "other research organizations" mainly refers to what are known as "inter-university research institutes", usually grouped with national universities.
[5] Supplementary budgets amounted to JPY 37.5 billion and JPY 145.1 billion in FY 2005 and 2006 respectively. Typically, parts of supplementary budgets are spent during the year in which they are adopted.
[6] This excludes JPY 240 billion for basic funding of humanities and social sciences in national universities (see Chapter 5).

Table 5. National and local/regional government S&T-related expenditure and comparison with data on total government R&D expenditure FY 2006

Fiscal year 2006, billion yen	Expenditure on R&D according to R&D-statistics (a)	S&T-related expenditure according to CSTP (b) (regular budget)
National government	(not available)	3574
Local and regional government	(not available)	418
Government, total	**3335**	**3992**

Sources: a) MEXT (2008a): R&D statistics; b) CSTP (2009b): S&T-related expenditure.

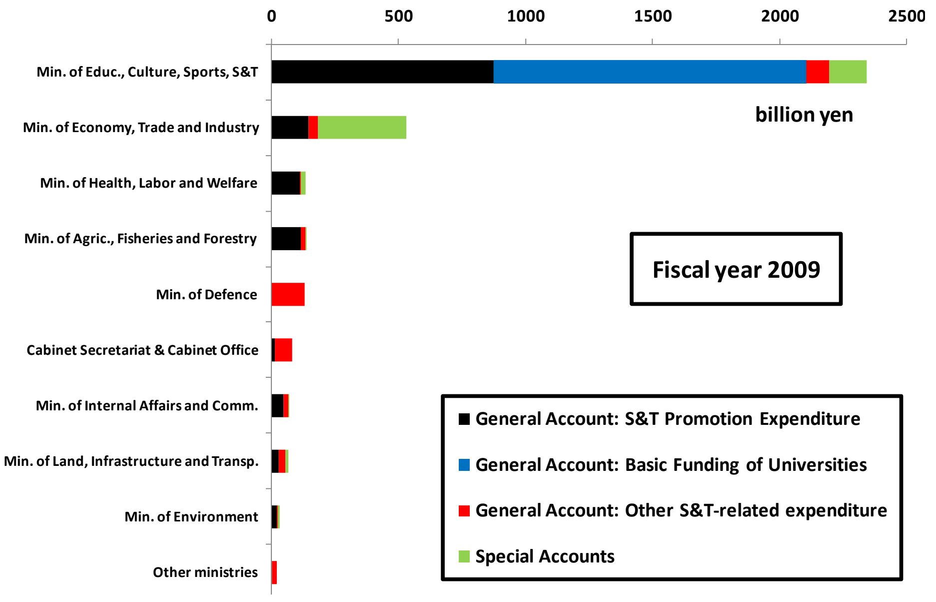
2.2 Ministries and Independent Administrative Institutions

In order to understand the nature of the prioritization process for S&T expenditure, it is necessary to introduce the main relevant actors in the government sector.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT), accounts for 66 percent of the total S&T-related expenditure in the FY 2009 regular budget. Just over half of this concerns basic university funding (see further discussion in Chapter 5). The second largest ministry in terms of S&T expenditure is the Ministry of Economy, Trade and Industry (METI), which makes up 15 percent of the total, a very large part of which is funded through special energy accounts.

Three other ministries each account for around four percent: the Ministry of Health, Labour and Welfare (MHLW); Ministry of Agriculture, Fisheries and Forestry (MAFF); Ministry of Defence. In FY 2009, about three percent is allocated directly via the Cabinet Secretariat or the Cabinet Office, but this percentage tends to vary considerably between years. Around 2 percent goes to each of Ministry of Internal Affairs and Communication (MIC) and the Ministry of Land, Infrastructure and Transport (MLIT). Most of MIC's spending on S&T is in the field of information and communication technologies. Finally, the Ministry of Environment accounts for one percent of total S&T expenditure.

Figure 3. S&T-related regular budget for FY 2009 by ministry and major type of account



Source: Cabinet Office (2008b).

Each ministry provides funding for S&T in basically four different ways:

- as basic university funding (MEXT only; see Chapter 5)
- as basic funding of R&D-performing organizations belonging to the respective ministry. Most of these now have a legal form known as Independent Administrative Institutions (IAIs)
- through special R&D-funding organizations; all the major ones are Independent Administrative Institutions (IAIs)
- through other direct funding of programs or projects from ministries; the extent to which open competitive call-for-proposals type funding mechanisms are being used in the direct support from ministries varies.

Table 6 provides an overview of the scale of activities and sources of funding in FY 2007 of 32 R&D-oriented Independent Administrative Institutions (IAIs), based on a special survey. Many of these IAIs are involved to some extent in activities other than R&D-related ones. An unknown but probably major part of these activities may still be included in the S&T-related budget.

Seven of the IAIs fund R&D, in FY 2007 amounting to JPY 364 billion in total. While the three largest - NEDO, JSPS and JST - basically do not carry any R&D themselves, four others - NIBIO, NARO, NICT and JOGMEC - combine funding and performance of R&D. Figure 4 shows who receives R&D funding from the respective IAI for some of their programs.

Table 6. Expenditure and sources of income for 32 R&D-oriented Independent Administrative Institutions in FY 2007

Fiscal Year 2007		Expenditure (billion yen)				Income (billion yen)			
Ministry	Independent Administrative Institutions (IAI)	Funding of R&D	Performing R&D	Other	Total	Basic Funding	Other Governm. funding	Other	Total
	R&D-performing IAIs								
MEXT	Japan Aerospace Exploration Agency (JAXA)		204.7	18.6	223.4	137.1	79.8	1.0	217.9
MEXT	Japan Atomic Energy Agency (JAEA)		147.0	66.4	213.4	186.6	14.9	18.0	219.6
MEXT	RIKEN		85.3	9.2	94.5	64.6	23.1	3.8	91.6
METI	National Inst. of Advanced Industrial S&T (AIST)		79.4	19.8	99.3	72.4	10.2	16.9	99.4
MEXT	Japan Agency for Marine-Earth S&T (JAMSTEC)		45.6	5.0	50.6	38.0	3.1	7.2	48.3
MAFF	Nat. Agriculture and Food Res. Org. (NARO)	7.4	45.0	9.2	61.6	50.4	8.0	4.4	62.8
MIC	National Inst. of ICT (NICT)	4.5	37.9	5.3	47.7	36.3	10.1	2.7	49.1
METI	Japan Oil, Gas and Metals National Corp. (JOGMEC)	0.4	30.8	5.6	36.8	33.3	144.4	1122.4	1300.1
MAFF	Fisheries Research Agency (FRA)		23.4	1.6	25.1	18.5	4.3	3.2	26.0
MEXT	National Inst. of Materials Science (NIMS)		18.7	1.8	20.5	16.1	2.8	1.8	20.7
MEXT	National Inst. of Radiological Sciences (NIRS)		14.3	4.2	18.5	14.5	1.3	2.8	18.6
MOE	National Inst. for Environmental Studies (NIE)		12.2	1.8	13.9	10.5	3.4	0.3	14.2
MAFF	Nat Inst of Agrobiol. Sciences		11.1	1.5	12.5	7.7	4.3	0.7	12.8
MAFF	Forestry and Forest Products Res. Inst.		8.9	3.9	12.8	10.9	1.3	0.7	12.9
MLIT	Public Works Research Inst. (PWRI)		8.5	1.6	10.1	6.9	3.0	0.3	10.2
MEXT	Nat. Res. Inst. for Earth Sc. and Disaster Prev. (NIED)		8.3	7.1	15.4	14.9	0.4	0.5	15.9
MHLW	National Institute of Biomedical Innovation (NIBIO)	10.1	2.1	1.4	13.5	11.6	1.2	0.9	13.7
various	12 other IAIs		27.8	11.8	39.7	32.1	5.7	2.7	40.5
	Total for 29 R&D-performing IAIs	**22.4**	**811.2**	**175.8**	**1009.4**	**762.6**	**321.3**	**1190.3**	**2274.2**
	Total (excl JOGMEC)	**22.0**	**780.3**	**170.2**	**972.6**	**729.3**	**176.9**	**67.9**	**974.1**
	Primarily R&D-funding IAIs								
METI	New Energy and Ind. Tech. Dev. Org (NEDO)	148.0	0.0	89.9	237.8	n.a.			
MEXT	Japan Society for the Promotion of Science (JSPS)	127.4	0.0	29.5	156.9	159.7			
MEXT	Japan Science and Technology Agency (JST)	65.8	0.9	42.9	109.5	104.3			
	Total NEDO, JSPS, JST	**341.1**	**0.9**	**162.3**	**504.3**				

Source: Cabinet Office (2008a).

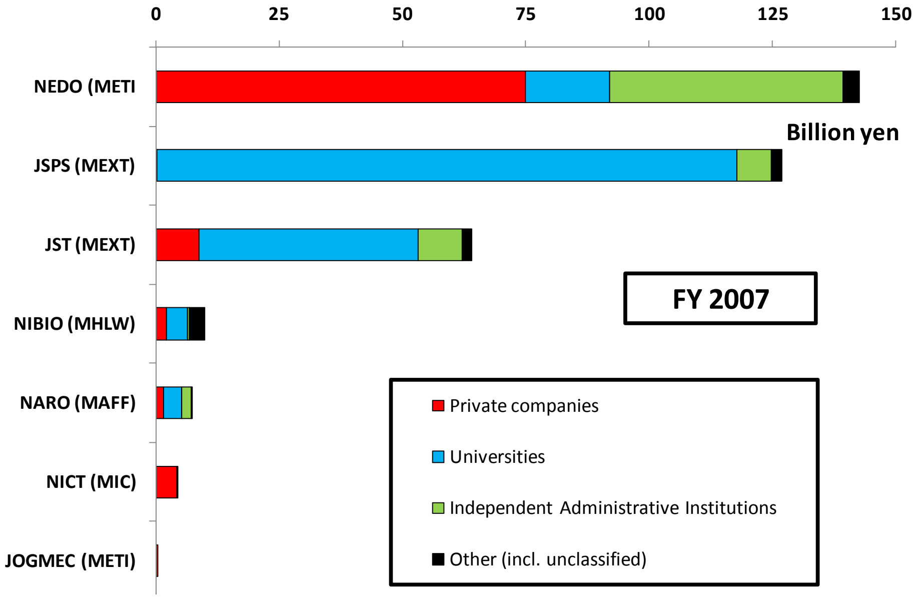
Note 1: Some part of the "Funding of R&D" may go to R&D-performing IAIs and thus be included under "Other Government Funding". All the "Funding of R&D" listed can be assumed to be based on government funds.

Note 2: Basic funding includes "uneihi-kofukin" as well as "funds for facilities".

Note3: The data on non-R&D-related expenditure of JOGMEC seems inconsistent with the data on income. The reason for this discrepancy has not been investigated for this report

29 R&D-performing IAIs spent a total of JPY 812 billion on carrying out R&D. The overwhelming part of this is covered by the basic funding from the government. Of other government funding to the R&D-performing IAIs, JPY 65 billion came from R&D-funding IAIs and the remaining JPY 122 billion direct from ministries.[7]

Figure 4. R&D funding from Independent Administrative Institutions by recipients of funding in FY 2007



Source: Cabinet Office (2008a).
Note: The funding shown does include all the funding by the NEDO, JSPS and JST. For example, in JST's case it appears that technology commercialization has been excluded.

There are additional government research institutes which are still part of their respective ministries and do not have independent legal status. The largest is the Technical Research and Development Institute of the Department of Defense with a budget of JPY 156 billion in FY 2009. With 1160 employees only 25 percent is spent internally, while the rest is used for "engineering model demonstration and prototyping".

[7] According to survey data. JOGMEC has been excluded in this estimate.

Table 7. Overview of the relative size of different routes for government funding of S&T-related expenditure in FY 2009

Route of funding	Approximate Government funding (billion yen)
Basic S&T-related funding of universities (FY 2009)	1245
29 R&D-performing IAIs (FY 2007)	940
NEDO, JSPS, JST funding other than to IAIs (FY 2007)	430
Technical R&D Institute of Department of Defense (FY 2009)	156
Non-IAI research institutes belonging to MHLW (FY 2009)	30
Total of above	**2801**
Other funding from ministries (calculated)	754
Total S&T-related budget (FY 2009)	**3555**

Sources: See text.

Only three of the research institutes which MHLW operates have the form of IAI. Most of the other institutes are attached to National Medical Centers, which carry out advanced medical care. The budget of non-IAI research institutes under MHLW can be estimated at roughly JPY 30 billion in 2007. There are a number of smaller institutes under other ministries.

It is not possible to give a comprehensive picture of direct ministerial funding other than that to IAIs or other national research institutes. A very rough estimate is that such funding amounts to JPY 750 billion in the combined categories of "policy-mission-oriented S&T" and "system reform and others". Table 7 shows how this estimate has been derived.[8]

According to the official R&D statistics, government funding of R&D in the business sector was around JPY 150 billion in FY 2007.[9] This included all levels of government. Funding to the business sector from the seven IAIs mentioned above amounted to JPY 92 billion in the same year. This leaves at most JPY 58 billion to direct funding from ministries to companies. This assumes of course that the R&D statistics gives a complete picture, which it may not, especially in the case of small firms.

Although some additional data will be presented in Chapter 5, there remains a lack of comprehensive data on the flows of S&T-related government funding, which can easily

[8] The survey data presented in Table 6 applies to FY 2007, while other data is for FY 2009. As the estimates are very rough in any case, FY 2007 data for IAIs is used as approximations of the conditions in FY 2009. Basic university funding is discussed in Chapter 5. Data for the 29 R&D-performing is the sum of basic government funding (JPY 762.6 bn) and other government funding with JOGMEC excluded (JPY 176.9 bn). Data on funding from government to JSPS and JST has been taken from the organizations self-presentations, while in the case of NEDO it has been assumed that all expenditure is cover by government funding. The funding from IAIs to other IAIs (JPY 65 bn) has been subtracted.

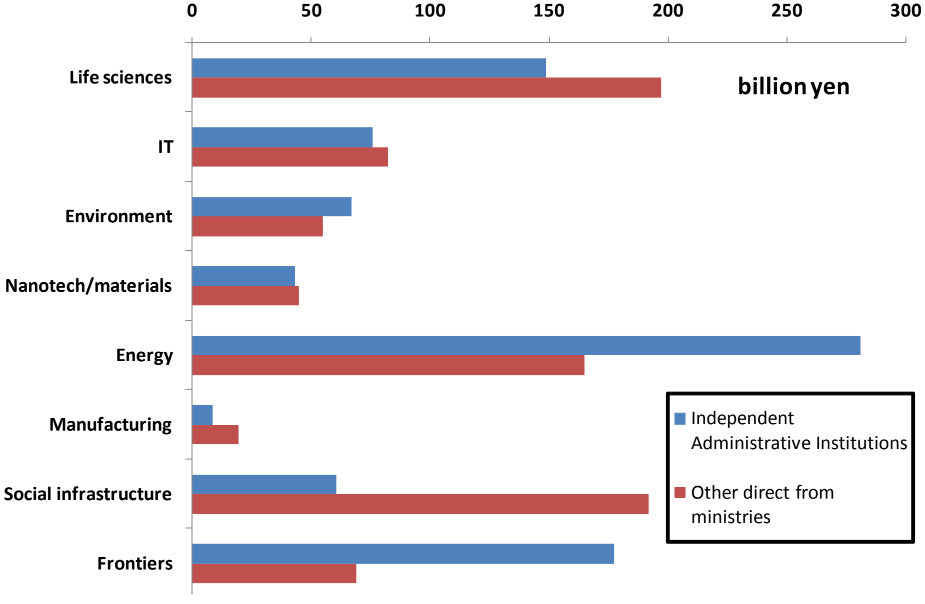
[9] MEXT (2009a).

be compared with generally used S&T budget data. The missing link is primarily direct funding from ministries.

The official R&D statistics supposedly provide comprehensive data for R&D activities but their usefulness is limited by the fact that the only breakdown of funding sources is between self-financing and receipt of external funds. The unclear relation between S&T-related expenditure in the S&T budget context and R&D also makes it difficult to combine budget data with official R&D statistics.

Figure 5 provides an overview of the relative importance of IAIs in the channelling of funds to Policy mission-oriented R&D as compared with funding directly from ministries to other performers of R&D than IAIs. As discussed above, the role of IAIs may be either performing R&D or funding of R&D.

Figure 5. Estimate of "Policy mission-oriented R&D" in FY 2009 for eight major fields carried out by or funded through IAIs and funded directly from ministries to other institutions



Source: CSTP (2009b).

The major funding to IAIs in the Energy and Frontiers field is mostly due to the large scale of JAEA and JAXA. "Other direct funding from ministries" in the field of Social Infrastructure is dominated by the Technical Research and Development Institute of the Department of Defense. The role of individual IAIs is discussed further in Chapter 5.

2.3 Council for Science and Technology Policy

The major administrative reform in Japan in 2001 strengthened the function of the Prime Minister as well as the Cabinet Office. The establishment of the Council for Economic and Fiscal Policy (CEFP) and Council for Science and Technology Policy (CSTP) were important components in this development. Both councils are chaired by the Prime Minister and include the most relevant ministers as well as outside experts. Ministers of State with special responsibilities for Economic and Fiscal Policy and Science and Technology Policy have also been appointed. The policies adopted by the CEFP provide the general economic and fiscal policy framework for the work of the CSTP. As well as the Prime Minister, the Minister of Finance, the Minister of Economy, Trade and Industry, the Minister of Internal Affairs and Communications and the Chief Cabinet Secretary are members of both councils. This means the policies of both councils are well harmonised.

The CSTP has 15 members, of whom seven are members of the Cabinet (Table 8). Four of the other members work full-time for the CSTP, while for the remaining four non-cabinet members the CSTP is only a part-time activity. The President of the Science Council of Japan (SCJ), which represents the scientific community, is an ex officio member of the CSTP.

During the period 2001-2006, the CSTP met at least nine times a year, but during FY 2007 and FY 2008, this was reduced to eight and six times respectively. The meetings typically last for an hour or less and focus on making policy decisions.

In order to deliberate the issues being dealt with by the CSTP in wider expert forums, various committees, working groups and project teams are established under the CSTP, usually for a limited period of time. In August 2009, the top tiers of these bodies were:

- Expert Panel on Basic Policy
- Expert Panel on Promotion Strategy for Prioritized Areas
- Expert Panel on Evaluation
- Expert Panel on Bioethics
- Expert Panel on the Management of Intellectual Properties

Of these, the Expert Panel on Basic Policy has the broadest mandate. It currently consists of all the non-cabinet members of the CSTP plus 22 expert members mainly from universities, research institutes or companies. A list of the current members of this Panel is presented in Appendix 1.

Table 8. Members of the CSTP

Members of the Council for Science and Technology Policy (as of August 11 2009)		
Chairperson	Taro ASO	Prime Minister
Cabinet Members	Seiko NODA	Minister of State for Science and Technology Policy
	Takeo KAWAMURA	Chief Cabinet Secretary
	Tsutomu SATO	Minister of Internal Affairs and Communications
	Kaoru YOSANO	Minister of Finance
	Ryu SHIONOYA	Minister of Education, Culture, Sports, Science and Technology
	Toshihiro NIKAI	Minister of Economy, Trade and Industry
Full-time Executive Members	Masuo AIZAWA	Former President, Tokyo Institute of Technology
	Tasuku HONJO	Visiting Professor, Kyoto University
	Naoki OKUMURA	Former Representative Director and Executive Vice President,Nippon Steel Corporation,Ltd
	Takashi SHIRAISHI	Former Vice President and Professor, National Graduate Institute For Policy Studies
Part-time Executive Members	Sadayuki SAKAKIBARA	President, Toray Industries, Inc.
	Toyoko IMAE	Professor Emeritus, Nagoya University
	Reiko AOKI	Professor, Institute of Economic Research, Hitotsubashi University
Science Council of Japan	Ichiro KANAZAWA	President of Science Council of Japan

Source: CSTP webpage.

3 S&T Basic Plans, National Strategies and Annual Budget Cycles

3.1 Science and Technology Basic Plans

Enacted in 1995, the new Science and Technology Basic Law stipulates that the government will prepare and implement Science and Technology Basic Plans and "annually submit a report on the policy measures implemented with regard to the promotion of S&T to the National Diet".

The First Basic Plan was adopted in July 1996 by the cabinet and covered the period 1996-2000. Subsequently, two more Basic Plans have been adopted for the periods 2001-2005 and 2006-2010. At the time of writing the first steps are being taken towards preparing the Fourth Basic Plan.

The organizational and other circumstances under which the Basic Plans have been produced and implemented have differed considerably. The First Basic Plan was drafted by the former Science and Technology Agency (STA) of the Prime Minister's Office and presented less than seven months after the Basic Law had been enacted. While the First Basic Plan mainly dealt with systemic issues, the Second Basic Plan added priorities expressed in terms of specific scientific and technical fields.[10] A new Council for Science and Technology Policy (CSTP) commenced activities in January 2001, only three months before the beginning of the Second Basic Plan. Most of the preparatory work was therefore also this time done by the STA, which from April 2001 was merged with the Ministry of Education, Sports and Science (Monbusho) to form the new Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Immediately upon its establishment, the CSTP set up expert committees for different issues

- Development of promotion strategies for priority fields
- Evaluation
- S&T system reform
- Bioethics
- Workings of the Science Council of Japan (SCJ)

[10] Government of Japan (2001). Some of the fields, especially "Environment", were defined in terms more of problems to be solved than of specific technologies to be promoted.

In September 2001, the CSTP decided on promotion strategies for four priority fields (Life Sciences, ICT, Nanotechnology/Materials, Environment) and four additional fields (Energy, Manufacturing, Societal Infrastructure, Frontiers). The strategies were presented in a 90-page document which specified in fairly much detail important problems and themes to be addressed.[11]

The preparation of the Third Basic Plan was done by the CSTP from the very beginning. A comprehensive review of government S&T policy, including the first three years of the Second Basic Plan, was made public in May 2004 and special “Project Teams” were set up in December 2005 for the four priority fields and the four “other fields to be promoted” in order to develop specific “strategic priorities” for the Third Basic Plan (discussed in the next chapter). The National Institute of Science and Technology Policy (NISTEP) was commissioned by the CSTP to carry out special studies, including a review of S&T policies since 1995.

The CSTP has recently started its work on developing the Fourth Basic Plan. Following up the implementation to date of the Third Basic Plan is an important activity. Chapter 8 mentions some of the studies produced with the aim of providing an input to the CSTP’s work. In Chapter 9 comments are made on some of the issues likely to be at the center of the Fourth Basic Plan.

3.2 National strategies

The S&T Basic Plans constitute comprehensive policies for government promotion of science and technology for all fields. For many individual fields, there are other separate policymaking processes which typically include many other aspects in addition to science and technology. Depending on the scope of the particular field, these policymaking processes may be confined to a single ministry or involve several. In certain cases, coordination is done through organizational units within the Cabinet Secretariat.[12] Examples of areas in which broad national strategies of great importance for science and technology policy have been developed are:

- Nuclear power (the Atomic Energy Commission and the Nuclear Safety Commission have been developing policies since they were established in 1956 and 1978 respectively; since 2001, both have been part of the Cabinet Office).
- Global warming prevention (various policies developed since the signing of the Kyoto Protocol in 1997; Action Plan for Achieving a Low-Carbon Society adopted in July 2008).

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[11] CSTP (2001).

[12] Currently, there are special headquarters for policy coordination within the Cabinet Secretariat for: Information and Communications Technology; Intellectual Property Strategic Promotion; Space Development and Strategy; and Ocean Policy.

- Information and communications technology (Basic Law on the Formation of an Advanced Information and Telecommunications Network Society enacted in November 2000; e-Japan Strategy adopted in January 2001; several revised strategies adopted, most recently the i-Japan Strategy 2015, in July 2009).
- Biotechnology (Biotechnology Strategy adopted in December 2002)
- Biomass utilisation (Biomass Nippon Strategy adopted in December 2002 and revised in March 2006).
- Intellectual property (IP Basic Law enacted in 2002; IP Strategy adopted in December 2004; IP Strategic Programs adopted annually since 2003).
- Ocean policy (Ocean Basic Law enacted in July 2007 and Ocean Basic Plan adopted in March 2008).
- Space development (Space Basic Law enacted in May 2008 and Space Basic Plan adopted in June 2009).

It is difficult to generalize about the relationship between the National Strategies and the priority-setting linked to the S&T Basic Plans. Timing will be an important factor in deciding in which direction the influence will be strongest. The basic stance should be an expectation that the National Strategies and the S&T Basic Plans will be harmonized. Neither the National Strategies nor the S&T Basic Plans directly determine budget allocations.

3.3 Annual budget cycle

The Basic Plan does not specify the size of the budget to be allocated to individual policy measures. It only provides a figure for the budget target for total government S&T expenditure to be achieved during the five-year period. The actual expenditure on the various S&T-related measures is adopted through the normal annual budgetary process. The major steps in this process are listed in Table 9 as regards preparation of the FY 2009 budget.

Each ministry submits its budget request to the Ministry of Finance on 31st August. Overall guidelines for formulation of the budget requests are issued, usually in June, by the Council for Economic and Fiscal Policy (CEFP), which is chaired by the Prime Minister. About the same time the CSTP issues guidelines specific to science and technology, based on the strategies and priorities of the Basic Plan, but taking into account the most recent changes in the socio-economic, political and budgetary context. Of course, there may also be unexpected changes in science and technology which require adjustments in strategies and policies.[13] During several months before the formal guidelines are issued, there are plenty of exploratory discussions in the two councils as well as in the ministries and their advisory bodies and in other organizations.

Table 9. Major steps in the annual budget cycle for S&T-related expenditure in the case of the budget for FY 2009

Time of decision	Content of decision	Decision-making body
June 2008	Report on Follow-up of prioritized activities during Fiscal year 2007	Expert groups and their Project teams under the CSTP
10 June 2008	Economic Growth Strategy	CEFP/Cabinet decision
19 June 2008	Basic policy for the overall configuration and resource allocation in S&T related FY 2009 budget	CSTP
27 June 2008	Overall framework and basic policies for the FY 2009 budget	CEFP/Cabinet decision
31 August 2008	Budget requests submitted by indiviual ministries to Ministry of Finance	Ministries
31 October 2008	Judgement of degree of priority for new S&T-related items in budget requests in terms of SABC and acceleration or deceleration for continuing programs	CSTP
26 December 2008	Government decides on budget proposal to be submitted to the parliament	Cabinet
March 2009	Budget decided by parliament	Parliament
1 April 2009	Fiscal year 2009 starts	

Sources: Webpages of the CSTP and CEFP

The CSTP's most concrete involvement in the budgetary process consists in evaluating specific measures proposed in the budget requests by the ministries. According to the current system, new programs are given marks of S, A, B or C which represent different degrees of priority[14]:

- S: Especially important, absolutely excellent in terms of the content, and with the potential to rapidly lead to the creation of innovation and development of society. It should be given especially high priority in resource allocation and be carried out aggressively.
- A: Important and, in terms of content, excellent activity which should be given high priority in resource allocation and be carried out steadily.

[13] Chapter 6 discusses how policies have recently been changed to meet new developments in various relevant spheres.

[14] Initially, the CSTP tried to review all proposals above a certain size, but the system was later changed. Initially also ongoing programs were graded.

- B: Necessary, but should be carried out effectively and efficiently with limited resources used effectively.
- C: Necessary, but the setting of goals, roadmaps, method of execution, etc., are partly inappropriate or the degree of priority for investing resources is low. It should not therefore be carried out.

Existing programs set to continue are separated into three categories:

- Activity should be steadily and effectively carried out (normal).
- Activity should be accelerated.
- Activity should be decelerated.

Reasons for the two last cases could either be that the R&D activity itself has progressed better or worse than planned or that changes in the context of that R&D have altered to provide more or less urgency in pursuing a certain program.

The CSTP does not review all programs. Some items, such as basic university funding and national research institutes, defense R&D and the basic funding of the Japan Patent Office, are mostly excluded. The selection criteria for items to be reviewed have changed somewhat over time. In reviewing budget proposals for FY 2009, in most cases the CSTP set a lower limit of JPY 100 million for new programs and JPY 1 billion for continued programs in selecting which budget proposals to evaluate. For items presented as falling under the category of ""62 Strategic Priorities" (discussed in the next chapter) and items argued as being closely related to innovation, the lower limits were reduced so that effectively all new programs and continuing programs with an annual budget of more than JPY 500 million would be evaluated. In total, the CSTP evaluated 85 new programs and 200 continuing ones. They represented budget requests amounting to JPY 764 billion.

The CSTP's evaluations of ministries' budget proposals are published openly immediately after being adopted by the CSTP and form an element of the budget negotiations between individual ministries and the Ministry of Finance. The CSTP's evaluations are reflected in the final budget in the sense that proposals for new programs marked S and A have tended to represent a larger share of the final budgets than of the budget requests. Of the total amount requested for new programs in FY 2009, four percent scored S from the CSTP. In the final budget they made up nine percent of the final budget for new programs. The corresponding figures for new A programs were 45 and 57 percent respectively.[15]

[15] Cabinet Office (2008b).

The CSTP has become increasingly restrictive in extending high priority grades which probably reflects increasingly tight budgetary conditions.[16]

An important part of the CSTP's activities in the annual budget cycle is following up R&D activities supported during the previous and current fiscal year. This follow-up focuses on "Strategic S&T Priorities" and "Most important policy issues".

3.4 Overall prioritization in ministries and independent administrative institutions

In the FY 2009 budgetary process, the CSTP engaged in a new type of dialogue with ministries and independent administrative institutions (IAIs). The CSTP's earlier focus on evaluating individual program proposals was seen as not having sufficient impact on ministries and IAIs which were developing their own priority-setting for their overall program portfolios. Thus, for the first time the CSTP held discussions with the relevant ministries and IAIs about their rationale for prioritization between different programs. The CSTP's conclusions from these discussions were briefly summarized and published with the evaluation of individual programs.

3.5 The politics of S&T budget allocations

The politics of the annual budgetary process in Japan is complex. The Liberal Democratic Party, which until September 2009 had ruled Japan for some 50 consecutive years, has channeled its political influence on the budgetary process through a dual system. In addition to the expected influence through the cabinet and its individual ministers, the LDP has maintained a system of internal committees for different policy areas, the members of which have often exerted considerable influence on the budgetary process through direct contact with ministry officials. This influence is described by one scholar as follows:

> *"It would be wrong to regard relations between civil servants and politicians as a one-way street. Since at least the 1970s groups of LDP parliamentarians, known collectively as 'tribes' (zoku), have coalesced around specific policy areas, such as education, defense, telecommunications, transport and construction, and operate in conjunction with their similarly interested counterparts in ministries, companies, think-tanks and so on. These may be regarded as 'iron triangles', in the sense that they seek to dominate a particular area of*

[16] Page 16 in CSTP (2009b).

policy in a way that cuts across political, bureaucratic and interest-group boundaries."[17]

One of the objectives of the administrative reform in 2001 was to strengthen the power of the Prime Minister and the Cabinet. The creation of the Council for Economic and Fiscal Policy (CEFP), the CSTP and the Cabinet Office were key measures in accomplishing this. The relative power of the Prime Minister is thought to have increased especially during the five-year tenure of Junichiro Koizumi (2001-2006), with the CEFP used as the main tool.[18]

In September 2009, the Democratic Party of Japan (DPJ) became the ruling party in a historical shift of power.[19] The DPJ has put strong emphasis on abolishing the dual system of exercising political power and towards reducing the alleged power of ministry bureaucrats. A new Strategy Office headed by the Deputy Prime Minister, who is currently also the minister in charge of economic and fiscal policy and the minister for S&T policy, has been established for the purpose of increasing political control of the budgetary process, including coordination between ministries.[20] At the same time, the CEFP has been abolished.[21] The new government has indicated its intention to transform the CSTP into the Headquarters for S&T Strategy during 2010. The first meeting with the CSTP under the new government was held on October 8th 2009.

The report does not attempt to analyze the internal workings of the political parties, nor any role played by 'tribes' in influencing budget decisions. Rather, the focus is on the "official" mechanisms of the CSTP and the extent to which actual budget allocations have conformed to the policies formulated by the CSTP.

The fact that for the last 50 years and until very recently, the power of government has rested almost exclusively with one party makes it very difficult to determine whether there are any important differences between the political parties in how they would prioritize investment in science, technology and innovation policy. With the change in government, it should become much clearer to what extent this is a divisive or consensus-prone policy area.

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[17] Stockwin (2008).
[18] In his book, Takenaka (2008), Professor Heizo Takenaka, serving in the Koizumi Cabinet as Minister of State for Economic and Fiscal Reform and in other capacities, gives a revealing personal account of the workings of Japanese politics.
[19] The new government is a coalition between DPJ and two other small parties, each with one minister in the Cabinet.
[20] The intention of establishing a Strategy Bureau, which would be more ambitious than the current Strategy Office, has been announced but not yet implemented.
[21] While Prime Minister Koizumi used the opinions of the private sector and other non-governmental members of the CEFP as a means of challenging entrenched policies, there are some indications that new DPJ government favours more direct political control of the policymaking process.

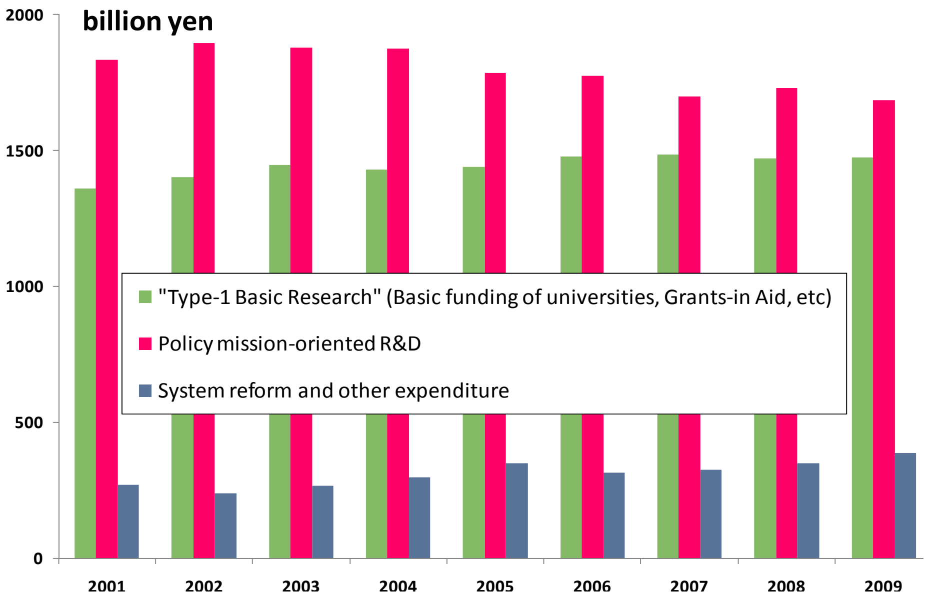
4 62 Strategic S&T Priorities

4.1 Four priority fields and four additional fields to be promoted

The First Basic Plan only discussed priorities in terms of scientific or technological fields in very general terms. This changed in the Second Basic Plan which identified four broad fields – Life Sciences, ICT, Nanotechnology/ Materials and Environment – to receive special priority in the allocation of resources. Another four broad fields – Energy, Manufacturing, Social Infrastructure and Frontiers (space, ocean) – would also be systematically promoted, but could not count on growing resources.

The total resources available for policy mission-oriented R&D in the regular budgets peaked in FY 2002 reaching JPY 1,900 billion and has since then gradually declined to JPY 1,690 billion in FY 2009, 11 percent lower than in FY 2002 (Figure 6). At the same time, the other two major categories of S&T-related expenditure increased so that the total S&T-related expenditure in the regular budget reached JPY 3.55 trillion in FY 2009, only 1.5 percent below the peak level of FY 2004 and 2.5 percent higher than in FY 2001.

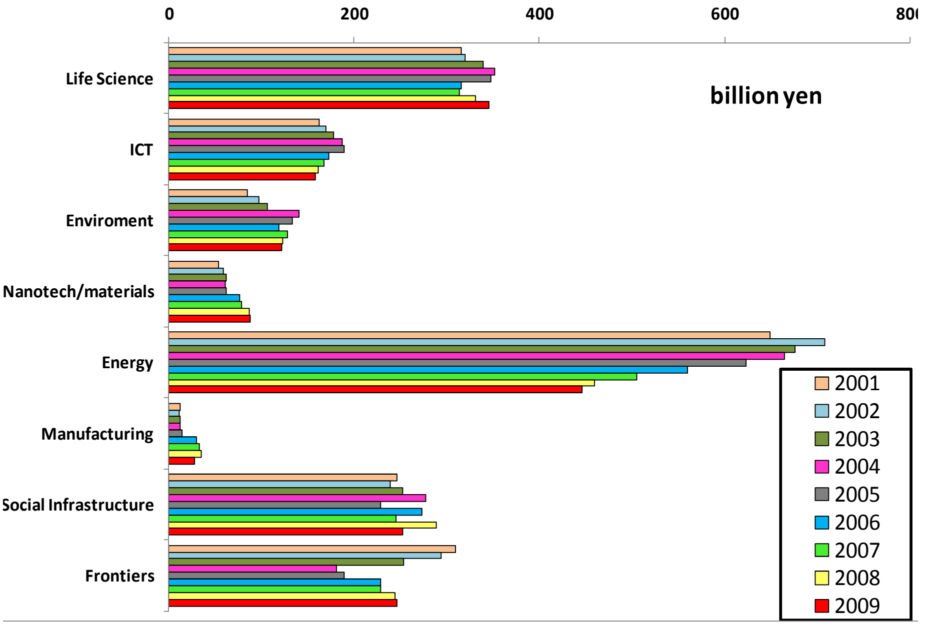
Figure 6. S&T-related expenditure in the regular budgets FY 2001-2009 by major categories



Source: CSTP (2009b).

During the Second Basic Plan (2001-2005) the four priority fields all expanded their budgets, while the budgets for three of the other four fields decreased, the biggest decrease being in the Frontiers field (Figure 7). Manufacturing increased somewhat, but from a very low level compared to the other fields. Environment experienced the largest relative increase.

Figure 7. Policy-mission-oriented R&D expenditure in regular budgets FY 2001-2009 by four broad priority fields and four additional fields



Source: CSTP (2009b).

The development pattern during the first four years of the Third Basic Plan has been different. Among the four priority fields, only Nanotechnology/ Materials has seen an increase. Frontiers (space and ocean) R&D has seen the largest increase in absolute terms regaining about half of the ground lost during the Second Basic Plan. Energy shows by far the biggest decrease in both absolute and relative terms.

4.2 Connecting S&T Priorities with policy objectives

One of the experiences from the priority-setting system of the Second Basic Plan was that it had proven very difficult to obtain resources for any new initiatives outside the four broad priority fields. As a consequence, a larger number of more focused priorities were developed for the Third Basic Plan, which in practice meant that the 4+4 fields ceased to have any significant effect on the budgetary process. However, these fields continued to be used as the basis for organizing the development of strategies.

An important part of the Third Basic Plan is thus a 400-page document, “Area-specific Promotion Strategies”, which was adopted with the main text of the Third Basic Plan. The first document justifies and describes promotional strategies in considerable detail for each of the eight broad fields. The main text of the Basic Plan devotes a chapter to “Strategic Priority-Setting in S&T”. It describes the general philosophy and criteria used in priority-setting.

The central body in charge of drafting the Third Basic Plan was the Expert Committee for Basic Policy established under the CSTP in December 2004. During its 15 month tenure, this committee was quite active and held no fewer than 18 meetings. These typically lasted two and-a-half hours according to the minutes of the meetings.[22]

The chairman of the committee was the leading full-time executive member of the CSTP, Professor Hiroyuki Abe. All the seven other expert (non-cabinet) members of the CSTP were also members of the Expert Committee for Basic Policy along with 20 external experts, of whom eight came from universities, four from companies, four from research institutes and the remaining four from the Bank of Japan, the Industrial and Economic Newspaper, the National Museum of Emerging Science and Innovation, and the Consultative Group on International Agricultural Research (CGIAR). In total, 14 of the Committee’s 27 members came from academia and six from industry.

The Expert Committee for Basic Policy dealt with all aspects of the Basic Plan. This included various aspects of “system reform”, which will be discussed later as well as creating the overall framework and principles for the formulation of area-specific priorities. For the latter, the Committee developed a hierarchy of “policy goals”. These goals, together with other principles and criteria for priority-setting, then formed the basis for work by specially appointed “Project Teams”, one for each of the eight broad fields, which were charged with developing promotion strategies for their respective fields. However, the Project Teams did not start work until December 2005 and thus had only three months to develop the “Area-specific Promotion Strategies”.

Table 10 shows the relation between three “ideas”, six “main goals” and 12 “intermediate goals” in the hierarchy of goals developed by the Expert Committee for Basic Policy. Sixty-three “individual policy objectives” were defined (Appendix 2) in a further, finer level of detail. The tables largely speak for themselves, but a couple of comments may be in order.

The policy goals cover a wide range, including open-ended knowledge creation, solving environmental problems, strengthening industrial competitiveness, curing diseases and protecting against natural disasters.

[22] A new Expert Committee for Basic Policy was appointed in June 2006, with a majority of the members the same as in the previous Committee.

The Third Basic Plan explicitly distinguishes between two types of “basic research”: “Type-1 basic research that is conducted based on the free ideas of researchers in S&T, including human and social sciences; and Type-2 basic research that aims at future application based on policies. In principle, the framework of policy goals applies only to Type-2 basic research and not to Type-1 basic research, which is primarily promoted through basic university funding and through the Grants-in-Aid scheme.[23]

Table 10. Hierarchy of policy goals in Third S&T Basic Plan (for individual policy goals see Appendix 2)

"Ideas"	**Major Policy Goal** (number of individual policy goals in parenthesis)	**Sub-goals**
Idea 1 Create Human Wisdom	**Goal 1** Quantum Jump in Knowledge Discovery & Creation (5)	1. Discover and clarify new principles and phenomenon
		2. Create knowledge as a basis of discontinuous technical innovation
	Goal 2 Breakthroughs in Advanced S&T (6)	3. Bolster S&T by conducting the world’s most advanced projects
Idea 2 Maximize National Potential	**Goal 3** Sustainable Development - Economic growth & environmental Protection (12)	4. Overcome global warming and energy problems
		5. Realize an environmentally harmonized, recycling-oriented society
	Goal 4 Innovator Japan - Strength in economy & industry (22)	6. Realize a ubiquitous Internet society that attracts global interest
		7. Become the world’s top manufacturing nation
		8. Enhance industrial competitiveness to win in global S&T competition
Idea 3 Protect Nation's Health & Security	**Goal 5** Nation's Good Health over Lifetime (8)	9. Overcome diseases afflicting the public
		10. Realize a society where everyone can stay healthy
	Goal 6 The World's Safest Nation (10)	11. Secure national, social safety
		12.Ensure safety in life

Source: Government of Japan (2006).

An important function of the hierarchy of policy goals is to describe the objectives of government investment in science and technology in generally understandable and not overly technical terms and in a framework which makes it possible to consider the balance between different types of objectives in the overall portfolio.

[23] The first major policy goal, “Quantum jump in Knowledge Discovery and Creation” and the corresponding specific policy objectives (Appendix 2) are expressed in such general terms that they are also compatible with the idea of Type-1 basic research.

There are many signs that those who prepared the Third Basic Plan felt a strong need to ascertain that it would actually lead to benefits for society commensurate with the resources being expended. Ten years had passed with the two first Basic Plans and questions would increasingly be asked about what the outcomes had been. Thus the Third Basic Plan had to show a real commitment to achieve demonstrable results.

When the eight (4+4) Project Teams started their work, they were furnished with a preliminary list of policy goals. However, the final version of this was developed significantly over the succeeding months, supposedly as a result of the work in the Project Teams.

Each Project Team developed a list of "important R&D themes". For all eight fields, 273 "important R&D themes" were identified. Several ministries are involved under most of the themes. For each theme and respective ministry both the R&D goals and the intended impact of the R&D results on society briefly described. A distinction is made between the ultimate R&D goals and impacts and those to be achieved by 2010, the final year of the Third Basic Plan.

Based on the "important R&D themes", the Project Teams defined 62 Strategic S&T Priorities (Appendix 3). It appears that Strategic R&D Priorities are defined on a higher level of abstraction and not merely as a selection of some of the important R&D themes. The thinking behind the identification of the Strategic S&T Priorities is described for each of them in the 400-page report mentioned earlier. For each of the eight broad fields, there is also a description of the overall conditions for research and innovation in Japan as well as directions for the design of promotion measures.

As shown in Appendix 3, there is no one-to-one correspondence between the 63 "individual policy objectives" and the 62 "Strategic S&T Priorities".[24] Some Strategic S&T Priorities aim at several policy objectives and some policy objectives provide the rationale for several Strategic S&T Priorities.

4.3 Follow-up of the Strategic S&T Priorities

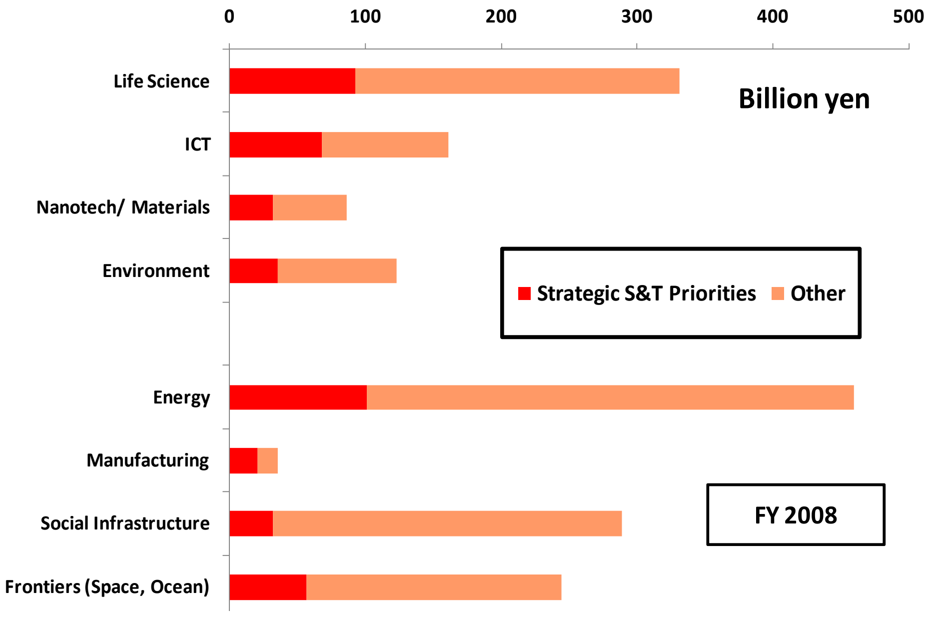
The area-specific promotion strategy is systematically followed up by the CSTP. Information is gathered from each ministry and annually compiled by one of the CSTP's subcommittees and expert groups for each field. A more in-depth review covering the first three years of the Third Basic Plan was completed in mid-2009. This will serve as input for the preparation of the Fourth Basic.

The follow up focuses on the 62 "Strategic S&T Priorities" and the 273 "important R&D themes". The progress on each item and data on the sources and size of budgets

[24] It may be confusing that the number of "individual policy objectives" and "Strategic S&T Priorities" is almost the same!

allocated are reported. There are significant differences among the eight major fields in terms of the funding provided for the "Strategic S&T Priorities" in each field. Energy and Life Sciences are the largest, with roughly JPY 100 billion each in FY 2008 for "Strategic S&T Priorities" (Figure 8). This is more than double the level for Nanotech/ Materials, Environment and Social Infrastructure, which are each of similar size. ICT and Frontiers fall somewhere in between, while Manufacturing is by far the smallest. Around 25 percent of total funding for "Policy mission-oriented S&T" goes into "Strategic S&T Priorities". The share is highest for Manufacturing (57 %), ICT (42 %), Nanotech/Materials (37 %), and lowest for Social Infrastructure (11 %). Contributing to the latter low level is the fact that all S&T expenditure by the Ministry of Defense is included under the label of Social infrastructure, but none of defense R&D is included as Strategic S&T Priorities.

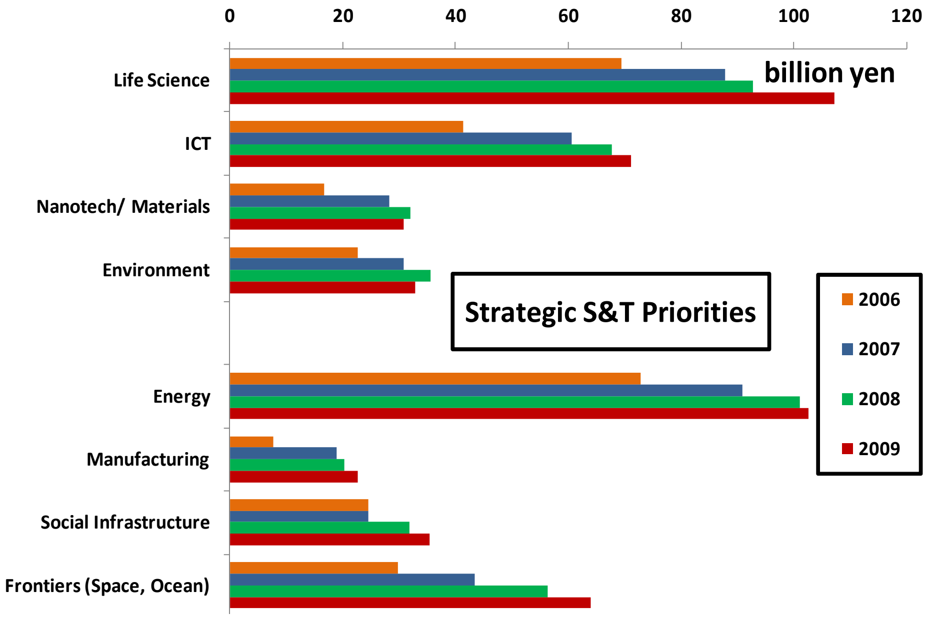
Figure 8. Estimated government S&T-related expenditure in eight broad fields and share going to Strategic S&T Priorities in FY 2008



Source: CSTP (2009d).

The meaning of "Strategic S&T Priorities" seems to be primarily a matter of the development over time of the allocated budget. According to estimates by the CSTP, the share of "Strategic S&T Priorities" of total spending on "Policy mission-oriented S&T" increased from 16 percent in FY 2006 to 23 percent in FY 2007 and 25 percent in FY 2008. Preliminary data for FY 2009 further increases the share to 28 percent.[25] Viewed over the first four years of the Third Basic Plan, the budgets for Strategic S&T Priorities have increased very significantly in all of the eight broad fields (Figure 9).

Figure 9. Development of budgets for 62 Strategic S&T Priorities during the first four years of the Third Basic Plan



Source: CSTP (2009b).

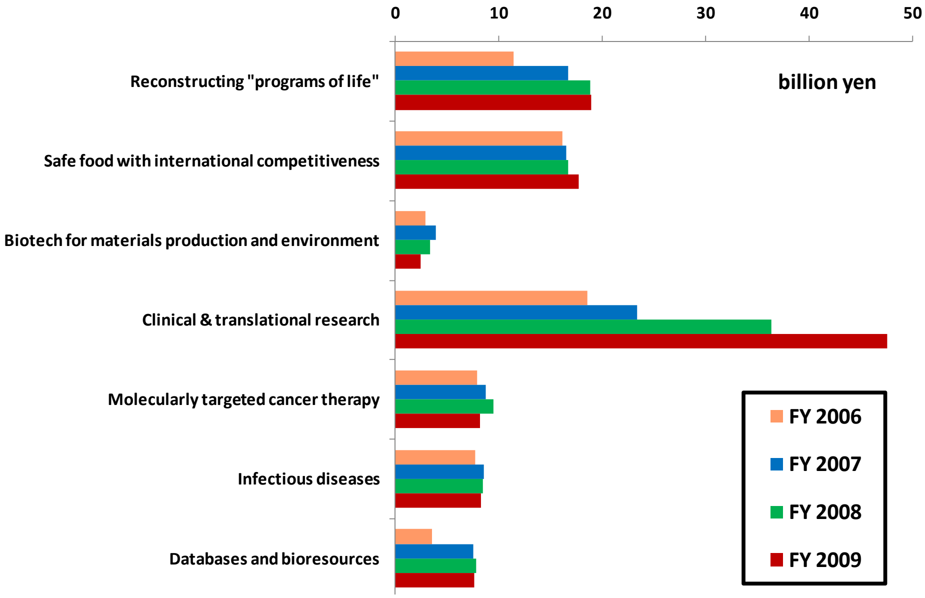
The size of the budget for each individual "Strategic S&T Priority" varies greatly as does the extent of increase. Figure 10 shows the budget development for each of the seven Strategic S&T Priorities in Life Sciences. The biggest and most consistent increase has been for "Clinical and Translational Research", which is also clearly the top priority issue in Life Sciences identified in the prioritization process leading up to the Third Basic Plan.[26]

The development of the budgets for the Strategic S&T Priorities in all eight major fields is shown in Appendix 4. Several priorities have very limited budgets, suggesting that the number of priorities has either been too large or that the priorities should have been implemented more forcefully.

[25] CSTP (2009b).

[26] Several R&D programs can be categorized under more than one Strategic S&T Priority, but in Figure 9 each R&D program has been assigned to only one "main" Priority.

Figure 10. Government expenditure on Strategic S&T Priorities in the field of Life Sciences 2006-2008



Source: CSTP (2009b).

Among the Strategic Priorities are five of what are known as National Critical Technologies:

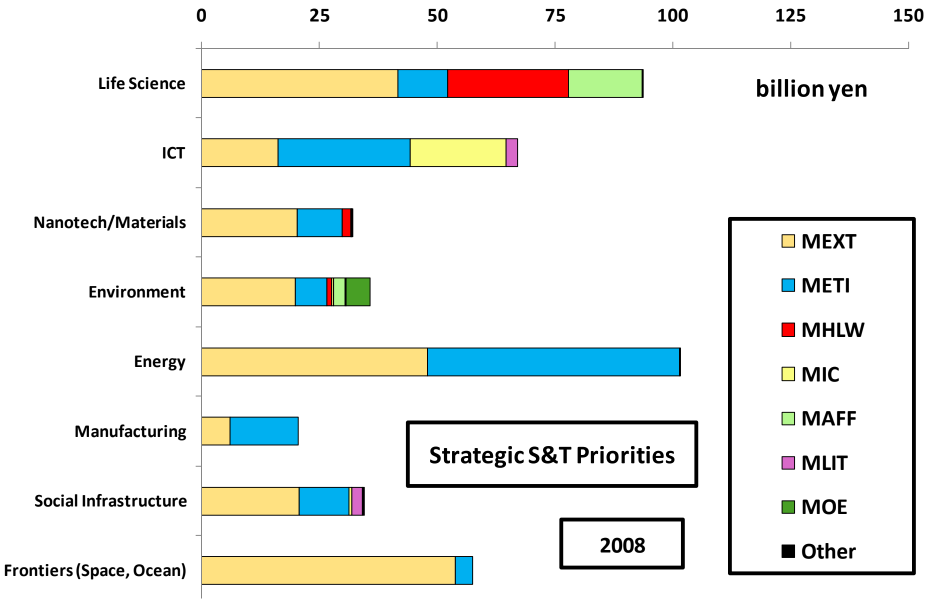
- Next-Generation Super Computer (ICT).
- Ocean and Earth Observation System (Environment; Social Infrastructure; Frontiers).
- Space Transportation System (Frontiers).
- X-Ray Free-Electron Laser (Nanotechnology/Materials).
- Fast Breeder Reactor (FBR) cycle technologies (Energy).

These are distributed among six of the broad fields (other than Life Sciences and Manufacturing). In FY 2008, the budget for the National Critical Technologies represented as much as 48 percent of the total budget for these six broad fields.

The total expenditure on Strategic S&T Priorities in FY 2008 is estimated at around JPY 442 billion. Part of this sum relates to funding of projects at universities. In such projects, the specific project funding does not usually include salaries for permanent employees of the universities and other costs covered through basic university funding. Another part concerns activities at IAI-type of government research institutes mentioned earlier in this report. According to a special survey done for the CSTP, the Strategic Priorities made up around one third of "research expenses" at the 29 R&D-

performing IAIs, corresponding to JPY 200 billion in FY 2008. However, this sum probably does not include salaries for permanent employees. Adding in those government research institutes which have not been made into IAIs but remain part of their respective ministries, it seems likely that around half of the budget for Strategic Priorities is spent at government research institutes of one form or another. Some of this may be further subcontracted to companies, especially in the space and nuclear fields and for supercomputer development.

Figure 11. Expenditure on Strategic S&T Priorities by Ministry in FY 2008



Source: CSTP (2008d).

As might be expected, the mix of ministries in implementing the Strategic S&T Priorities varies between fields (Figure 11). In the fields of Energy and Manufacturing, more or less all the funding is provided by MEXT or METI and in the field of Frontiers MEXT dominates almost totally. It would be natural to conclude that there is little need for coordination in these fields. This may be true, but it should not be forgotten that there are also connections between the different broad fields. Thus, for example, satellite-based observation systems are used in both the Environment and the Social Infrastructure fields.

5 Priorities for structural reform of the research and innovation system

5.1 The agenda for structural reform

When discussing prioritization of S&T expenditure, the focus is usually on the distribution of funds between different thematic areas defined in terms of scientific or technological fields, or problems to be addressed. Issues of “S&T System Reform” are also high on the agenda in Japanese S&T policy, but in this case the connection with the allocation of budgetary resources is less clear. In this chapter, we will briefly discuss some of the connections that can be made.

The following are major issues of “S&T System Reform”, which have been addressed in varying degrees and in various ways in all three Basic Plans launched so far:

- Securing the long-term supply of highly qualified scientists and engineers as well as research support staff.
- Strengthening the independence of young researchers.
- Enabling female and foreign researchers to make a research career in Japan.
- Increasing the mobility of scientists.
- Upgrading research facilities at national universities and government research institutes as well as developing the research infrastructure in terms of databases, bio-resources, etc.
- Creating a sufficient number of world-leading universities in Japan.
- Promoting each university to develop its own unique character in education and research according to its potential.
- Creating a more competitive R&D environment for universities and research institutes.
- Facilitating and strengthening exchange and cooperation between different sectors (industry, universities, government research institutes, etc.)
- Increasing the utilization by private industry of the outcome of publically funded R&D.
- Creation of R&D-type ventures based on technological seeds from public research.
- Promotion of R&D in the private sector.
- Developing appropriate policies and human and organizational capabilities for management of intellectual property at universities and research institutes.

- Promotion of S&T for regional development.
- Promotion of international cooperation.
- Promoting public understanding of and interest in, S&T.
- Creating a fair, transparent and effective evaluation system.

Together, these issues reflect a comprehensive set of reforms which have been, and largely remain, necessary in the Japanese research and innovation system.[27] Progress has varied among the issues but, viewed over the whole period since the enactment of the S&T Basic Law in 1995, in many areas the changes have been impressive and sometimes profound.

In some cases, numerical targets have been set for system reform. In the First Basic Plan, one target was to expand funding of post-doctoral positions to 10,000 positions. This target was reached and has contributed to a larger degree of mobility in the Japanese research system, whilst creating new problems such as uncertainty as to future career paths among young researchers. These continue to be important areas of concern.

In the Second Basic Plan, another target was to double the funding provided under competitive funding schemes, whilst setting higher standards for and otherwise changing the operation of such schemes. Although competitive funding has increased, growth has fallen far short of the target set in the Second Basic Plan. A principal reason is the stagnation in the development of the overall S&T budget.

Quantitatively, the largest increase in competitive funding took place during the period when the total S&T budget was growing. In recent years, the increase has been much more modest.

The system for funding universities and research institutes is a fundamental aspect of the science and technology policy and an important basis for the design of priority-setting mechanisms. We will therefore devote much of this chapter to discussing the system for funding research organizations, with special emphasis on national universities.

Before proceeding to discuss university funding, it would be appropriate to comment on the connection between "System Reform" and the three major divisions of the S&T-related budget in Figure 1 (Chapter 1). "System Reform" is pursued within all the three major budget categories. Of the JPY 391 billion shown to be spent on "System Reform and Other", JPY 179 billion is specified under various headings (Table 11).

[27] In its mid-term follow-up of the Third Basic Plan, the CSTP reviews progress being made on most of the above issues. This is based primarily on material provided by ministries and special studies by bodies such as NISTEP.

Table 11. Major categories of "S&T System Reform" and "Other" in FY 2009 Budget

	billion yen
Special Coordination Funds for Promotion of S&T	36.3
Competence development	48.9
Industry-University-Government Cooperation	37.2
Regional S&T	26.2
International activities	30.4
Other	212.0
Total	**391.0**

Source: CSTP (2009b).

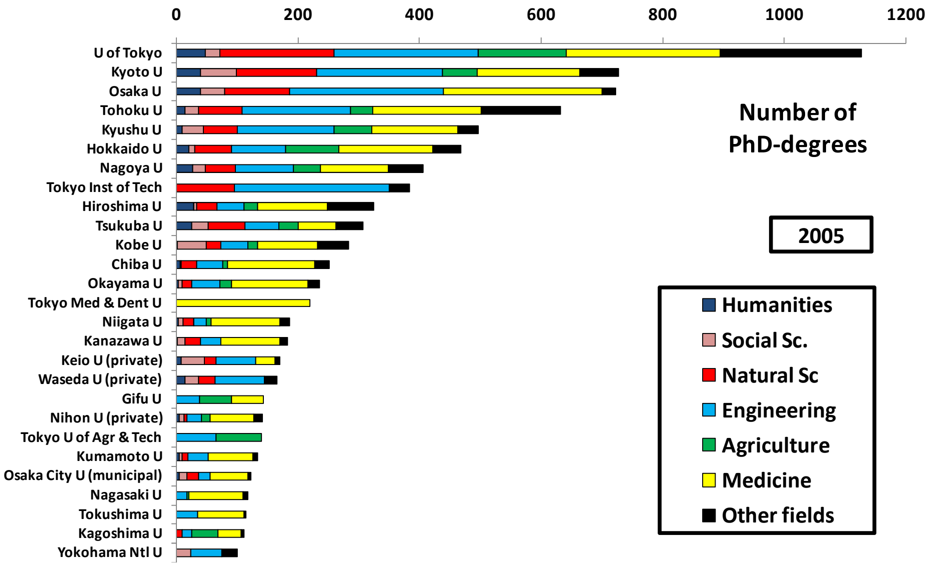
The role and content of the Special Coordination Funds are dealt with in considerable detail in Chapter 7. The budgets for "Competence development" and "Industry-University-Government Cooperation" shown in Table 11 represent only a small fraction of the total budgets for activities which might appropriately be labeled in this way. "Regional S&T" covers a number of well-defined programs, including a ""Knowledge Cluster" program run by MEXT and S&T-related expenditure of METI's "Industrial Cluster" program. Part of "International activities" represents programs making up the "S&T Diplomacy" initiative.

5.2 Expanding competitive funding of universities

As universities have increasingly come to be seen as central to the future development of the Japanese economy, efforts to strengthen the university system have intensified. With as many as 750 universities, it is recognized that the desirable development and support policies will have to differ between universities. The need for each university to develop its unique role and characteristics has become a major theme. In terms of science and technology policy (which naturally does not cover the full range of policies towards universities), much of the focus has been on creating a limited number of truly internationally attractive and competitive universities, primarily in terms of research and graduate education. The number 30 has often been mentioned.

Research activity is highly concentrated in national universities. Among the top 27 universities reckoned by number of PhDs granted in 2005, all were national except three private universities and one municipal (Figure 12).

Figure 12. Top-ranking Japanese universities by number of PhDs granted in 2005



Source: Based on data from Bunkyo Kyokai (2007).

National universities also receive by far the largest proportion of government university funding. Basic funding of the operational costs of national universities (*uneihikofukin*), in FY 2009 amounts to JPY 1,170 bn (Table 12). National universities include 90 different institutions, of which four are designated as Inter-university Research Institutes. The size of the basic funding varies from JPY 1.3 bn for the smallest to JPY 87.9 bn for the largest which is the University of Tokyo. Government contributions to the basic funding of private universities reached JPY 322 bn distributed amongst some 580 universities. There is some additional basic funding of national universities for research facilities, including some very large ones at the institutes mentioned above. The establishment of a new graduate school university at Okinawa is a special budget item.

Tuition fees from students are another important source of basic income for universities. For private universities, it is the dominant source. In the FY 2009 budget for national universities, tuition fees represent JPY 354.2 bn. The operation of university hospitals is also part of the host universities' budgets. The FY 2009 budget for costs and income from operating hospitals at national universities were almost the same at JPY 654.9 bn and JPY 634.2 bn respectively.

Table 12. FY 2009 Budget for "Type-1 Basic Research" which is not policy mission-oriented

	S&T-related "Type-1 Basic Research"	Not included in S&T-related budget	Total
	billion yen		
Basic funding of universities			
Basic funding of National univ.	995.8	173.7	1169.5
Support to Private univ.	172.6	149.2	321.8
Okinawa Graduate School University	11.2	(unknown)	
Basic funding of facilities at National univ.	49.9	(unknown)	
Large facilities (J-PARC, Spring-8, RIBFI)	16.2	(unknown)	
Competitive funding			
Grants-in-Aid ("Kakenhi")	197.0	0	
Global COEs	34.2	0	
Total	**1476.9**	(unknown)	

Source: CSTP (2009b).

Not all the basic university funding is included in what is counted as the S&T-related budget. Humanities and social sciences are excluded and expenditure for education is also excluded. The details surrounding the calculation of the S&T-related part of basic university funding has not been investigated, but the end result is shown in Table 12. It provides the breakdown of the budget for “Type-1Basic Research” (Figure 1), that is basic research but excluding that part which is policy mission-oriented. In total, JPY 1,477 billion was allocated to Type-1Basic Research in FY 2009. It represents 41.5 percent of the total S&T-related budget this year. In addition to the basic funding, this sum also includes two competitive funding schemes.

In FY 2009, JPY 197 billion was allocated to the largest source of competitive research grants, entitled the Grants-in-Aid scheme; this is managed by JSPS and in part directly by MEXT.[28] Roughly 70 percent went to national universities and another 15 and five percent respectively to private and prefectural or municipal universities. Another competitive funding scheme, also counted as Type-1 Basic Research, is the Global COE program amounting to JPY 34 billion in FY 2009, all of which goes to universities.

Prior to 1995, almost all government funding of national universities took the form of either basic funding or Grants-in-Aid. These two sources still dominate government funding of national universities, but significant funding is now provided through other channels as well.

Other competitive funding schemes, which fall under the category of either “policy mission-oriented” or “system reform” in FY 2008 amounted to around JPY 250 billion

[28] This includes humanities and social sciences.

(Table 13).[29] These include around 40 different funding schemes of greatly varying size. The funding is both directly from ministries and via Independent Administrative Institutions IAIs). Data is available on the distribution of funds between major categories of R&D-conducting organisations for some of the latter and for the scheme run directly by MHLW (Health and Labour Sciences Research Grants). A very rough estimate based on this is that JPY 100-150 billion goes to national universities.

Table 13. FY 2008 budgets of competitive funding schemes other than Grants-in-Aid and Global COEs

Ministry	From ministry directly	From agency		Total
	Amount (billion JPY)	Name of agency	Amount (billion JPY)	Amount (billion JPY)
MEXT	68.4	Japan Science and Technology Agency (JST)	79.3	147.7
MHLW	40.7	New Institute of Biomedical Innovation (NIBIO)	7.5	48.2
METI	9.9	New Energy and Ind. Techn. Dev. Org. (NEDO)	13.8	24.2
		Japan Oil, Gas and Metals National Corp. (JOGMEC)	0.5	
MAFF	5.6	National Food and Agricultural Research Org. (NARO)	6.8	12.4
MIC	3.0	National Inst. of Inform. and Communication Technologies (NICT)	4.7	8.0
		Fire & Disaster Management Agency	0.3	
MLIT	0.5	Japan Railway Construction, Transport and Technology Agency	0.3	0.8
MOE	8.9		-	8.9
Cabinet Office	0.4		-	0.4
Total	**137.3**		**113.3**	**250.6**

Source: Based on data from MEXT (2009c).

There is additional (direct or indirect) government funding of national universities from ministries and agencies, which is neither basic funding nor funding through competitive schemes. Available statistics do not allow the total size of such funding to be estimated.

A major policy towards national universities has been to gradually change the balance between basic funding and competitive funding towards an increasing share for the latter, while at the same time improving the system for competitive funding. To implement this policy, in recent years the government has been reducing basic university funding by one percent per year, while increasing funds for the Grants-in-Aid scheme. The aim is to maintain total funding of Type-1 Basic Research. According to data from the CSTP, the total funding of Type-1 Basic Research in the regular budget grew in nominal terms by 8.3 percent from 2001 to 2009, but was down by 0.6 percent in 2009 as compared to the peak year 2007.[30]

One effect of the reduction in basic funding has been that national universities have had to reduce the number of permanently employed professors, usually with the greatest

[29] Of the JPY 68.4 billion going directly from MEXT, JPY 33.8 billion represents funding from the Special Coordination Funds. The competitive funding schemes included in Table 11 cover less than 10 percent of NEDO's total R&D-funding.

[30] A major change that has occurred in recent years is the introduction of overhead charges on external funding of universities. While not yet fully implemented, the overhead rate is set to reach 30 percent in the near future for all external funding. The use of income from overhead charges is an important factor in the overall funding system of universities.

impact on the number of positions as assistant professors. For this and other reasons, many representatives of universities have criticized the steady decrease in basic funding. At the same time, the freedom of national universities in managing their economic and personnel affairs has increased dramatically as a result of their corporatization in 2004. Prior to corporatization, making changes to personnel was extremely involved. Every change in position had to be negotiated not only between the university and MEXT, but also with the Ministry of Internal Affairs and the Ministry of Finance. Today, such decisions are internal matters for the universities. Another effect of corporatization is that universities can now employ professors on fixed-term contracts using project-based funding. The number of such appointments has increased rapidly. One of the basic elements the corporatization of national universities was to introduce more businesslike management methods into universities. To this end, university presidents have been given considerable power under the new legal framework. Naturally, the degree to which university presidents have chosen to make active use of their new prerogatives has varied. The introduction of the new system of indirect costs paid to universities on competitive grants and other external funding has been useful in providing presidents with significant resources for university headquarters that can be employed strategically to develop their universities. The utilization of indirect costs may vary among universities but at the University of Tokyo for example, the university headquarters take 50 percent, the schools 25 percent and the departments 25 percent.

While universities have been given much freedom in managing both their finances and their personnel affairs, they cannot start educational programs without permission from MEXT. In fact, MEXT determines a fixed number of students by discipline and educational level for each national and each private university. MEXT also decides on the size of tuition fees that national universities can charge, although the individual university may deviate from this by up to 10 percent.

The development of truly internationally competitive and attractive universities, or parts of universities, has been a key objective of government policy. A higher degree of concentration of research funds through more emphasis on competitive funding, plus promotion of the formation of Centers of Excellence (COEs) have been seen as means of achieving this. There are various types of programs to nurture the development of COEs, with the Global COE program mentioned earlier as the largest. This represents roughly 1.5 percent of total government funding of universities, including education and research and around seven percent of total competitive government funding. How strong a structuring effect this has on Japanese universities is hard to tell. It should also to be noted that, while the selection of the Global COEs is largely based on the strengths of the professorial research forming a particular COE, the Global COE grants themselves are primarily aimed at supporting the development of graduate education.

So far, the World Premier International Research Center Initiative, another COE program, has been limited to only five Centers but with a total budget of JPY 7.1 bn. The budget of each of these Centers is much larger than for the Global COEs, of which there are 140.

The overwhelming majority of competitive funding is directed towards individual researchers and their groups. (In some cases, especially with funding from METI or NEDO, cooperation with companies or other partners may also be involved). This funding is concerned with the research itself and usually blind to the development of the institutions in which the research is being conducted. Naturally, it still has an effect on the institutions, even if unintentional. The question is whether this condition will persist or whether there may be future attempts to combine assessment of the thematic content and quality of the research being supported with consideration of the development of the institutional context in which that research is conducted. Inasmuch as universities are becoming more strategic in the use of their own resources, negotiations concerning project-based research funding between funding ministries or agencies and the universities as institutions may become more attractive to both sides.

In considering the effects of competitive grants on Japanese universities, a distinction needs to be made between the Grants-in-Aid program and other competitive funding programs. As already indicated, the Grants-in-Aid program is purely bottom-up and not influenced by any thematic priorities. The Grants-in-Aid program is divided into a very large number of relatively small grants and thus involves a large number of researchers. There are several different types of grants varying in size, but most are relatively small. The unique nature of the grants is suggested by the fact that they are not included in official accounting of universities, but are deemed to be grants to the professors as individuals.[31]

Other competitive grants also vary in size, but they are much larger on average than those of the Grants-in-Aid program. This is especially true of projects funded by JST under the CREST and other programs. In contrast to the Grants-in-Aid, these are decidedly strategic. Their thematic content is decided in a two-stage process with MEXT defining “strategic sectors” in line with the current Basic Plan and JST identifying more specific “research areas” within these.

There are currently major differences in the funding picture between individual institutions and individual researchers. This has largely been a desired development in line with calls for higher selectivity, competition and concentration in the allocation of research resources. However, some questions have recently been raised as to whether this development may have gone too far in certain respects.

[31] However, the indirect costs of the grants are given to the universities of the professors as institutions.

While the development of stronger universities is still a fundamental objective, comparisons between Japan and the United Kingdom have shown that, measured in terms of scientific publications, research capacity is more highly concentrated on fewer universities in Japan than in the UK.[32] An emerging issue therefore seems to be what policies are needed to strengthen some of those universities, which currently rank below the top 15 in terms of publication performance among all Japanese universities. The point is that current policies do not seem to allow these universities to strengthen their relative positions. There is a fear that the base of competitive universities is currently too narrow and needs broadening.

Regarding individual Principal Investigators (PI), there is some concern that certain researchers have collected so many large grants that their ability to spend sufficient time on managing the research under each one may be questioned. To deal with this, more attention will be paid to the "effort" (time) budgeted by PIs to each of their projects and to the monitoring of the total effort claimed by each PI. The latter is one purpose in establishing a central database for all R&D projects funded by the government.

5.3 Towards performance-based basic funding of universities and research institutes?

Arguably the most fundamental reform in the Japanese S&T system in recent years concerns the change in legal status and governance of most government research institutes in January 2001 and of national universities in April 2004. Research institutes became Independent Administrative Agencies (IAIs), while national universities became known as National University Corporations. In October 2003, a number of funding agencies - such as NEDO, JSPS and JST - also became Independent Administrative Agencies.

One of the main objectives of the changes in legal status has been to increase the independence and accountability of the organizations in question. While ministries previously engaged in very detailed micro-management of these organizations, they are now expected to have a more strategic and hands-off relationship to them. In principle, ministries will now control these organizations by agreeing mid-term objectives and strategies for them which are developed through dialogue. For the IAIs, these midterm strategies are set for five years[33] at a time, while the corresponding period for universities is six years.

[32] NISTEP (2009).
[33] The first period was less than five years, covering the period January 2001 to March 2005.

The new system of more independent organizations is supposed to make room for resource allocation to be influenced by the outcome of evaluations of how well each organization has performed in relation to its mid-term objectives and strategies. The research institute IAIs have already seen their mid-term strategies evaluated once, and a second round of objectives and strategies was adopted for the period April 2005 to March 2010. However, it seems there have not so far been any dramatic changes in funding of individual institutes resulting from the performance evaluations. For national universities, the first period of the new system expires in March 2010. A first interim evaluation was done after four years.

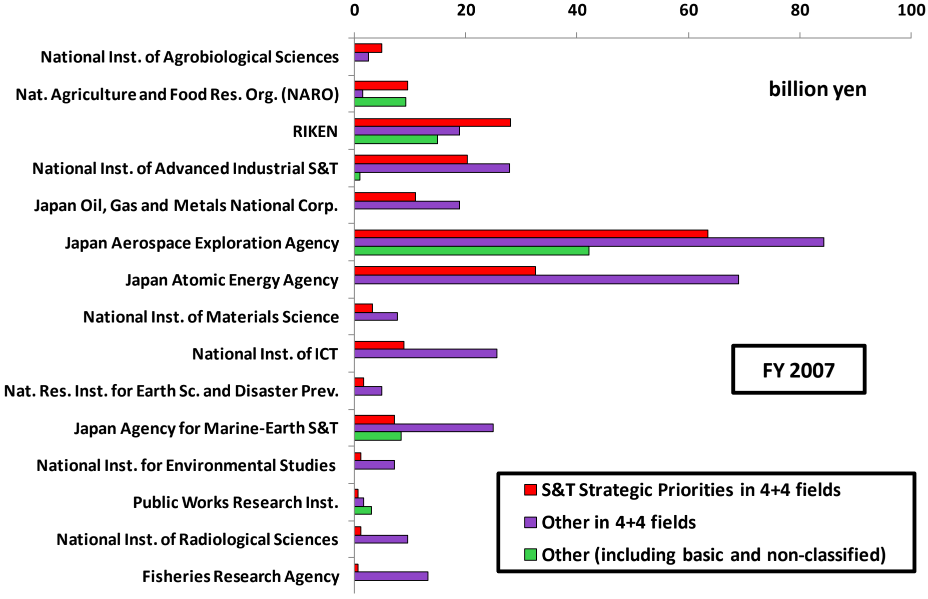
Comparing the mid-term objectives and strategies formulated by research institute IAIs and national universities, a major difference is that IAIs define concrete R&D plans in terms of specific themes, while such details on the content of research are largely absent from the objectives and strategies of national universities.

The second mid-term strategies of the research institutes were adopted a year before the start of the Third Basic Plan. The fact the R&D plans of the institutes are updated annually would still leave some room for the institutes to adjust their plans to the Strategic S&T Priorities of the Third Basic Plan. Figure 13 shows the extent to which the 15 largest R&D-performing IAIs (by research expenses) focused on R&D topics defined as S&T Strategic Priorities in the Third Basic Plan in FY 2007. Figure 14 shows similar data for total research expenses of 29 R&D-performing IAIs according to major field. In both cases, the order of presentation is according to the share occupied by S&T Strategic Priorities among total research expenses.

On average, 33 percent of the Research expenses at 29 R&D-performing IAIs were devoted to the S&T Strategic Priorities, as compared to 23 percent for all Policy mission-oriented S&T expenditure during the same year.[34] The share was 40-45 percent for the two large research institutes, RIKEN and AIST and around 32-33 percent for JAXA and JAEA, the leading aerospace and atomic energy agencies. For two other institutes, NIMS in the field of materials and NICT in the field of ICT, the shares were 30 and 26 percent respectively while the share in some other institutes was considerably lower.

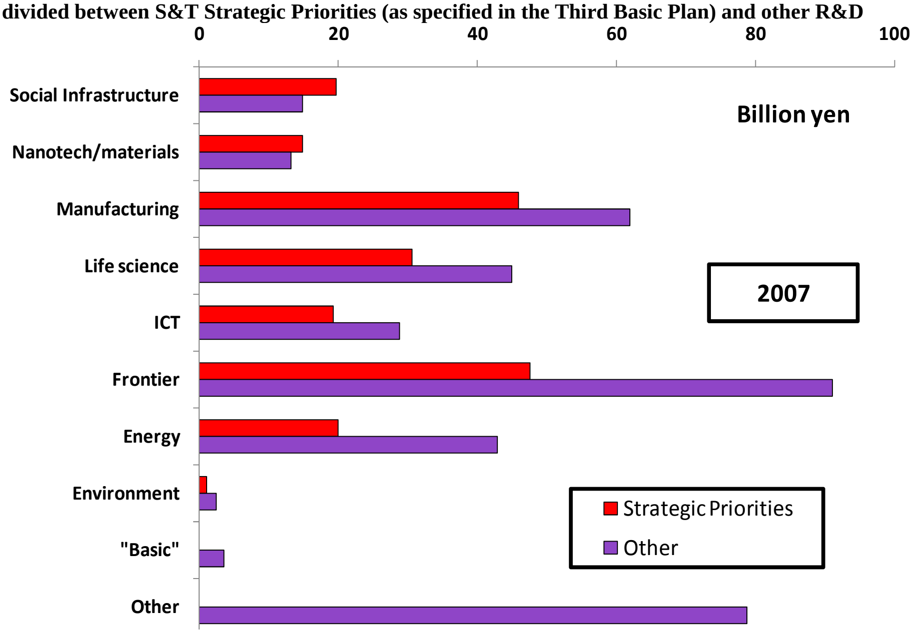
[34] As shown in Figure 13, around JPY 80 billion, or 16 percent, of research expenses at the 29 R&D-performing IAIs fall outside the 4+4 fields. If the 4+4 fields are considered in isolation, the share of S&T Strategic Priorities increases from 33 to 44 percent.

Figure 13. Research expenses (excl. personnel costs) at 15 R&D-performing IAIs for S&T Strategic Priorities (as specified in the Third Basic Plan) and other R&D



Source: Cabinet Office (2008a).

Figure 14. Total research expenses (excl. personnel costs) at 29 R&D-performing IAIs by field and divided between S&T Strategic Priorities (as specified in the Third Basic Plan) and other R&D



Source: Cabinet Office (2008a).

On the level of the R&D-performing IAIs, the prioritization capacity has changed significantly in recent years. More independence from the ministries combined with more power given to the top management of the IAIs is basic factor. Another factor is the merger in several cases of institutions working in related areas. Some of the restructuring occurred as early as the establishment of the new system of IAIs in 2001, but in other cases this has happened more recently. One more factor is the change in employment conditions that has gradually been introduced, with an increase in fixed-term employment.

An example is AIST, the predecessor of which was made up of 15 different institutes each operating with a high degree of independence, organizational inertia and very limited cooperation across institutes. In 2001, these were all combined into one new organization and the new leadership given the power to establish a suitable organization. A new system with a larger number of organizational units of varying size and anticipated longevity was introduced. This allowed for much more frequent and adaptive changes in the organizational set-up as a response to performance and changes in the AIST environment.

RIKEN is the most notable example of extensive use of a fixed-term employment system. This has actually been a prerequisite for its remarkable expansion in the Life Sciences field which took place especially during the period 1997-2003.

6 Timely and flexible response to change: “Top Priority Policy Issues”

Changes in the real world constantly influence the context of priority-setting. The following are examples from recent years of important new developments which have influenced S&T policymaking in Japan:

- “Innovation 25” initiative by the Prime Minister at the time, Shinzo Abe; the first meeting of the Innovation 25 Strategy Council took place in October 2006.[35]
- Breakthrough by Japanese (and American) researchers in iPS cell[36] research opening up new possibilities of reprogramming cells; the most important breakthrough reported in November 2007.
- Soaring prices of oil, minerals and food, especially during 2007 and the first half of 2008, and concern over security of long-term supply; prices have come down at least temporarily as an effect of the global financial crisis.
- Japan as host of the G8 meeting in summer 2008 chooses to focus the meeting on measures to counter global warming, especially the development of new technologies.
- Intensification of the global financial crisis in September 2008 as Lehman Brothers files for Chapter 11 bankruptcy protection.
- Obama administration takes over in the United States in January 2009 and announces very large increases in federal R&D spending, including areas of energy and environment considered particular Japanese strengths.

These developments have put new demands on S&T policy, but also provided new opportunities for S&T policy to gain visibility and political attention. In responding to these demands and opportunities, the CSTP has created frameworks for policy and prioritization that are new at least in part and go beyond those of the Third Basic Plan. While the Strategic S&T Priorities of the Third Basic Plan have not officially been changed, the CSTP has introduced a set of “Top Priority Policy Issues”, which may be seen as a new top layer of priorities (as listed in Table 1, Chapter 1).

The Innovation 25 initiative had close political ties with Shinzo Abe’s short-lived premiership and its direct influence largely disappeared when Abe resigned in September 2007 after only a year as Prime Minister. The most visible result is six

[35] Government of Japan (2007).
[36] Induced Pluripotent Stem Cell.

“Pioneering Projects for Accelerating Social Return” (Appendix 5), which in FY 2009 has a total modest budget of JPY 19 billion. However, some of the ideas introduced during the preparation of the Innovation 25 report, published in May 2007, may turn out to have more of a long-term impact. One central theme dealt with the need for fundamental changes in the Japanese research system, especially a radical increase in the degree of its internationalization. A second theme concerned the close connection between innovation and changes in social values and systems. The report argued that an effective innovation policy should start from a vision of how innovations could contribute towards solving problems and meeting the needs of Japan’s citizens as well as globally within the timeframe up to 2025. It further argued that the following three elements all need to be included in order to realize significant innovations:

- Development of various technological elements and their integration.
- Verification of effectiveness as a social system through verification studies on integrated technology.
- Establishment of a framework necessary for putting the technology firmly in place.

The breakthrough in iPS cell research has received enormous attention in Japanese society and created high hopes in terms of both new medical therapies and business opportunities for Japanese industry. The CSTP and affected ministries reacted swiftly and managed to secure funding to expand research in the field. It became very clear to everyone in the process that there were almost insurmountable constraints in the Japanese budget system against the quick reallocation of funds in response to new opportunities. Difficulties of combining and coordinating funding from different government sources also became apparent. Finally, in the realm of innovation, discussions of the possibilities for commercializing the iPS cell technology highlighted the already well-known problems with the Japanese system of regulatory approval for new therapies.

These experiences from iPS cell research were a major factor behind the creation of the “Transformative Technologies Plan” adopted by the CSTP in May 2008.[37] This Plan identifies 23 “transformative technologies”, which have the potential to either reinforce the growth of industries that are already strong in Japan or provide the basis for creation of new industries (see Appendix 6 for a list of the 23 technologies). Some of the technologies are also expected to contribute to “building a healthy society” or to “safety and security of Japan and the world”. In addition to the 23 technologies listed, special reference is made to the five National Critical Technologies. It appears that the selection of the 23 technologies was made by the expert members of the CSTP. It is

[37] CSTP (2008c). CSTP initially used the term “Innovative Technologies” in an English translation, but later changed this to “Transformative Technologies”).

unclear what kinds of consultations were involved in the selection. Frequent updates of the list are expected.

Based on the argument that the government must be able to respond with sufficient agility to new opportunities, the CSTP has managed to obtain funding for a new Transformative Technologies Fund with a budget of JPY 6 billion in FY 2009, which will be managed under the guidance of the CSTP. The details of the operation of the Fund remain to be worked out, but it has already been reported that applications will be accepted several times during a year, which is a big difference from normal procedures in Japan. An important issue is how support from the Fund will be combined with funding from other sources, as the latter must still be expected to bear the main part of the costs. An initial call for proposals was issued in June 2009 and was limited to three fields: 1) Self-support technology for elderly/disabled people based on brain-machine interface; 2) Regenerative medicine and toxicological evaluation technology using iPS cells; 3) Spintronics technology. In each of these three fields, Japanese scientists have recently reported results which have received worldwide attention.[38]

The experiences from iPS cell research have also been a factor in launching other initiatives. One of them is the "Super Special Consortia for supporting the development of cutting-edge medical care". The decision to establish this system was made in the Council on Economic and Fiscal Policy (CEFP) as a measure for facilitating the development and practical implementation of transformative technologies. The basic idea is to overcome the negative effects of the fragmentation of government policies on the development of a particular technology as described above for iPS cell technology. After an open call for proposals for "all-Japan efforts" in the fields of regenerative, medicine, pharmaceuticals and medical technology, 24 out of 143 proposals were selected and assigned as "Super Special Consortia". The latter will receive fast-track treatment in regulatory processes and the opportunity to side-step some of the normal constraints on combining funding from different sources etc. Each of the selected consortia is typically centered on a research group at a university or research institute and involves companies as well as other research groups in Japan and sometimes also abroad. The selection itself did not initially provide any new funding but could be expected to increase the chances of funding in other contexts. In fact, as early as the FY 2009 supplementary budget, JPY 5.6 billion in new funding had been earmarked for the medical Super Special Consortia. The plan for this was worked out jointly by the MHLW, MEXT, METI and the Minister in charge of S&T policy, leaving the administration of the funding to MHLW.

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[38] Table 1 shows the total budget for "Transformative Technologies" in FY 2009 reaching JPY 52.3 billion. This can be assumed to include funding under a variety of programs for all 23 Transformative Technologies identified in CSTP's report from 2008, including the JPY 6 billion under the new Transformative Technologies Fund for the three selected fields.

The intention is clearly to extend the system of Super Special Consortia to other fields. The field of environment and energy technologies appears next in line.

Another measure to improve coordination among ministries in the medical field is the creation of a joint Health Research Committee by the Minister in charge of S&T policy, MEXT, MHLW and METI in June 2008. Through work in this committee, the ministries developed an integrated program to support translational and clinical research and related competence development, plus innovation support measures. This program was reflected in the respective ministry's budget request for FY 2009 and resulted in a total budget of JPY 14.8 billion for the program in FY 2009.[39] Such coordination of budget requests is unusual but strongly urged by the CSTP.

As a resource-poor country, Japan is sensitive to changes in international natural resource markets. As in many other places, recent shortages and price increases were interpreted in Japan as a sign of a long-term shift towards a resource-constrained world economy in which competition for natural resources would take on new intensity. This caused METI to revise its growth strategy to include a stronger emphasis on reducing Japan's very high degree of dependence on imports of fossil fuels, rare metals and other resources.[40] This dependence could be reduced by:

- increased resource efficiency (e.g. fuel-efficient vehicles, energy-efficient buildings and household appliances)
- substitution of scarce resources through innovation (e.g. new energy sources)
- better utilization of resources available in Japan (e.g. recycling of rare metals ("urban mining") and biomass utilization).

Efforts to reduce dependence on imported resources would often also have beneficial effects on the environment, including greenhouse gas emissions. Japan considers itself a world leader in many areas of environmental and energy technologies. As prices and availability of resources became matters of increasing concern, it therefore seemed reasonable for Japan to put even stronger emphasis on investment in such technologies. In preparing the G8 meeting that it hosted in July 2008, Japan decided early on to put special emphasis on the contribution of science, technology and innovation for solving global problems, with global warming being seen as the most important.

The CSTP's deliberations on "Low Carbon Technology" and "S&T Diplomacy" both served as inputs to Japan's initiatives at the G8 meeting. Like the "Transformative Technology Plan", the "Low Carbon Technology Plan" identifies a number of

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[39] The total budget for the Strategic S&T Priority "Translational and Clinical Research" amounts to JPY 47.6 billion in FY 2009.
[40] METI (2008).

technologies, which Japan may be able to lead the world in developing. The Plan formulates three pillars of the strategy underlying the Plan:

- Japan will lead the world in the development of low carbon technologies and associated international cooperation and proactively disseminate their achievements to the international society.
- The main actors to transfer Environment and Energy technologies will be private companies while the government provides indirect support.
- International cooperation in environmental model cities will be used as the effective method of transferring technology in the commercial/ residential sector.

Although there is some overlap with the Transformative Technology Plan, the scope of the Low Carbon Technology Plan is wider in several regards: the type and range of technologies; the time horizons covered; the detailed discussion of how Japan could transfer its technologies abroad, especially to developing countries.

Transfer of technology to developing countries in the environmental field is also a central topic in the CSTP's proposals regarding S&T Diplomacy, but they also include other technical fields and other aspects. One of the new programs coming out of the S&T Diplomacy initiative combines resources from JST for S&T activities in Japan and official development aid (ODA) from Japan International Cooperation Agency (JICA).

What triggered the CSTP to develop a "Strategy for Revitalization of Regions based on S&T" is less clear. Developing the regional aspects of S&T policy is likely to attract political interest. It is also one of the "systemic" policies in the Third Basic Plan and there is a need for coordination among ministries as well as between the national and regional levels. The strategy adopted by the CSTP in May 2008 argues that regional S&T initiatives should put more emphasis on developing and exploiting each region's unique characteristics and resources. It also urges the regions to be more active in developing their role and links in the national system and not unduly limit themselves to the actors within each region.

The global financial crisis and change of administration in the United States have once again drastically changed the context of Japanese S&T policy. As will be described in Chapter 9, the FY 2009 Supplementary Budget passed by the Diet in May 2009, gives some indications of new adjustments of S&T policy in Japan in response to this new context.

Another new and very significant development is the recent change of government in Japan itself, the effects of which on science, technology and innovation policy are yet to be seen.

7 Coordination across ministries and policy domains

The focus in this report is on the overall prioritization of government expenditure on S&T. There is a close connection between such prioritization and coordination across ministries. Establishing common priorities is a necessary basis for achieving coordination among different actors. Special measures for coordination are often needed for effective implementation of priorities. Common objectives of these two linked processes include:

- Increasing the impact by combining investment from several sources.
- Increasing the impact by combining different types of R&D and different types of R&D-performing actors.
- Increasing effectiveness in the use of resources by allocating R&D tasks in each case to the most competent R&D-performing organization.
- Avoiding unproductive duplication.
- Developing the research and innovation system in such a way that bottlenecks are removed and overall efficiency and effectiveness are improved.
- Ensuring that promotion of R&D and innovation is harmonized with policies in other areas, such as education, regulatory affairs, intellectual property polices and public procurement.

To the extent that innovation and the utilization and diffusion through society of the fruits of research and development are considered important – and this does increasingly seem to be the case – the need for coordination goes beyond the science and technology domain itself, and includes other aspects and policy domains, such as regulatory systems and measures, tax policies, subsidies and other measures for promoting early adoption or diffusion of new socially beneficial innovations.

It could be argued that strengthening the coordination of S&T policies across ministries could have the effect of pulling those policies out of their specific contexts (as defined by the policy portfolios of each ministry) in which S&T represents only one element. Some may view this as a possible justification for the strong tendency in Japan for each ministry to develop its own research system. However, such a system has not proven very effective in practice. The enactment of the Basic Law for S&T in 1995 clearly articulated the ambition to develop a more integrated system in which S&T resources would be shared across sectors and ministries. Since then, various measures have been taken but integration is still rather limited. The following are some of the basic factors working towards increased integration in the Japanese research and innovation system:

- Increasing recognition that resources have to be combined across ministries in order to effectively solve real problems.
- Increased reliance on public research infrastructure by Japanese companies, partly due to secular trends in this direction by companies worldwide and partly Japanese companies being forced to reduce their own long-term research after bursting of economic bubble in early 1990s.
- Criticism from industry of duplication and lack of coordination among ministries.
- A generally stronger role for universities in the Japanese research system; this has co-evolved with increased use of universities as a resource also by other ministries than Monbusho (previously)/ MEXT (today). Prior to 1995, universities were in practice not open to grants from other ministries.
- Growing need to utilize the competence built up through basic research at universities to meet the mission objectives of various ministries.
- The major administrative reform of 2001, resulting in fewer ministries (including the merger of Monbusho and the STA) and a stronger position of the Prime Minister and the Cabinet Office
- Increased interdependence between missions of the different ministries.
- Increased independence of universities, research institutes and agencies in relation to ministries.

7.1 Special Coordination Funds for Promoting S&T

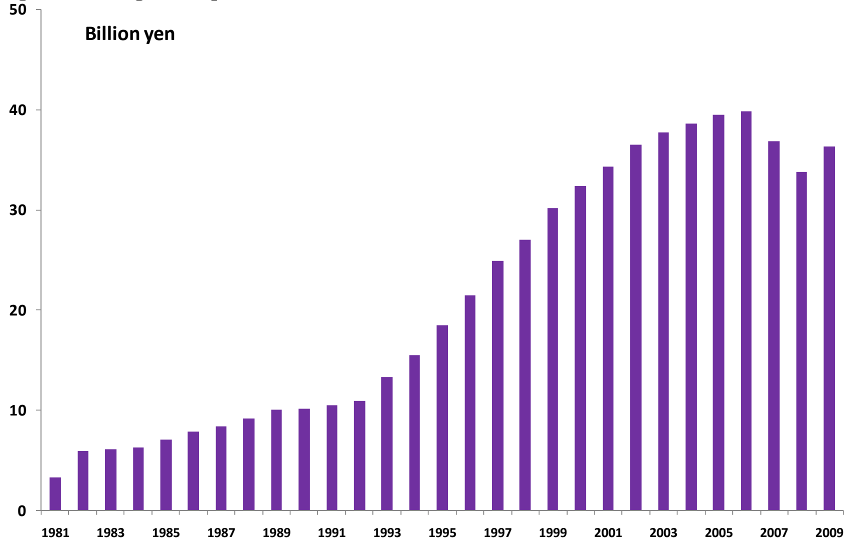
The need for coordination across ministries and sectors has long been recognized as demonstrated by the fact that the Special Coordination Funds (SCF) for Promoting S&T was already established back in 1979. The SCF is today used as “policy-guided competitive funds” based on policies adopted by the CSTP. The management of the call for proposals is the responsibility of MEXT, which has commissioned the actual handling to JST.

The budget for the SCF grew very rapidly during the 1990s but has declined in recent years. The addition of a new program for “transformative technologies”, with a budget of JPY 6 billion, reversed the earlier declining trend in FY 2009.

From the start, the basic idea of the SCF has been to fund high-priority activities which cannot effectively be dealt with by individual ministries or which require cooperation between sectors (companies, universities, government research institutes). In recent years, the focus has been on promoting high-priority “structural reforms in the S&T

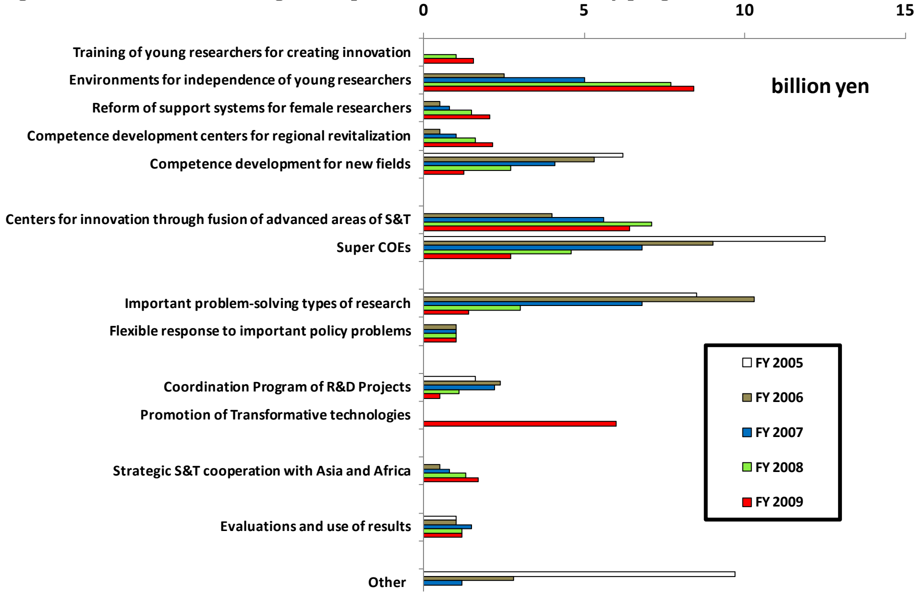
system". An intention is that the high visibility and prestige of reform efforts funded by the SCF will serve catalytically as models for more broadly based reforms.

Figure 15. Budget for Special Coordination Funds for Promotion of S&T



Sources: a) data for 1982-2006: MEXT (undated); data for 2007-2009: CSTP (2008a) and CSTP (2009c).

Figure 16. Distribution of Budget for Special Coordination Funds by programs 2005-2009



Source: CSTP (Annually published overviews of the distribution of funds from SCF by program)

As early as the 1990s, the Special Coordination Funds were being used for limited support of Centers of Excellence programs on a limited scale. At about the same time as the 21st Century Centers of Excellence Program was launched by MEXT in 2002, resources under the SCF were redirected towards something entitled the Super COE Program. This aimed to support deep organizational reforms in a limited number of leading universities or research institutes. A total of 13 Super COE grants were given during 2001-2005, based on annual calls for proposals. Each (quite large) grant runs for five years and totals on average JPY 1 billion per year. The type of reform being aimed at differs greatly between individual cases. About half relate to new structures for developing interdisciplinary research, four involving medicine in combination with other fields. Others concern such things as creation of spin-off companies from an institute, new forms of interaction with industry, arranging attractive conditions for top young scientists from abroad, organizing a system of “solution-oriented” research and the introduction on a large scale of fixed-term contracts for faculty members. In most cases, it appears that the reforms tried during the grant period have later been institutionalized on a more permanent basis.

The Super COE Program is gradually giving way to a new COE program focusing on strategic research cooperation between universities – research institutes in a few cases – and companies. The new program, “Centers for Creating Innovation through Fusion of Advanced Areas of Science and Technology”, reflects some of the priorities of structural reform under the Third Basic Plan. So far, 21 centers have been granted funding for an initial three-year period through three rounds of calls for proposals.[41] The first nine centers that started in 2006 have recently been evaluated and four selected for further funding.[42] Successful centers are expected to receive funding over 10 years. With its basis in large-scale, joint government-industry funding for industry-linked university research centers, the program is breaking new ground.

Securing talented researchers in fields appropriate for the future is another area in which SCF has been put to use. During the Second Basic Plan, the focus was on developing educational programs in new fields such as bioinformatics and other “fusion fields” involving life sciences, basic software, intellectual property management, etc. Reflecting the system reform priorities in the Third Basic Plan, the focus has shifted towards developing better conditions for young researchers and female researchers. The largest program currently funded by SCF supports the development of recruitment, promotion and other organizational practices which would give more and earlier independence to young researchers. Another program is funding

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[41] Compared with Sweden, the closest counterpart is the VINN Excellence Centers program run by VINNOVA.
[42] Four of the five centers denied continued funding have a chance to reapply in 2010 along with the second round of nine centers.

the development of best practice models in support of female researchers, making it easier for them to combine research with childbirth and motherhood.

The SCF is also used for funding R&D defined thematically in terms of certain fields of science and technology, or particular problems facing society. Support of R&D for solving important problems, which made up a large part of SCF's budget a few years ago, has recently decreased and changed character. The importance of "problem-solving" types of R&D was emphasized in Innovation 25 and six examples of important areas for such R&D were suggested: "Pioneering Projects for Accelerating Social Return" (see Appendix 5). These areas have since been given high priority by the CSTP in the annual budgetary process. The CSTP's role has here been to highlight the importance of activities by different ministries in the six areas and to provide some degree of coordination. However, no special funding has been provided from the SCF.[43]

7.2 Coordination Program of R&D Projects

One of the programs supported by the Special Coordination Funds is the "Coordination Program of R&D Projects". This program was started in 2005 based on the idea that in certain areas, R&D projects with similar objectives were being supported by different ministries. Thus, improving the connections between these projects would increase their overall effectiveness.

A special temporary organization for managing the program was created under the JST. The program, which started in 2005 and ends during 2009, supports coordination in 14 different areas. The coordination effort has consisted in identifying relevant projects, organizing meetings and working groups for exploring the possible connections projects, and some funding from the Special Coordination Funds to "fill in gaps". A list of areas supported is shown in Appendix 7.

The extra funding provided by the SCF will total some JPY 5.5 billion for 25 projects, each running for three years. This translates into an average of JPY 74 million per project and year.

7.3 A More Proactive Coordination Role for the CSTP?

As discussed in the previous chapter, the CSTP recently began to take coordination initiatives which were in some sense more proactive than before. It is too early to say how sustainable this more proactive role will be. The CSTP describes its desire role as that of a "control tower". In order to succeed it, will need to offer value to the

[43] Some of the areas overlap with those of the "Coordination Program of R&D Projects" discussed below, and the latter program has received funding from the SCF.

ministries in return for the “intrusion” into their affairs. Merely serving in a support function to the Ministry of Finance in the annual budget negotiations is unlikely to be appreciated. Acceptance of the CSTP would definitely increase if it were proved able to influence the size of the total budget available for S&T. Given the severe constraints on public finance in Japan, this has so far proven impossible and the future prospect is not very encouraging either, unless a convincing case can be made that increased S&T investment is essential for sustainable economic recovery and growth.

A likely role of growing importance for the CSTP lies in coordinating S&T policy with policies in other domains. Many of the “systemic” policy issues require such coordination. A stronger emphasis on innovation would also increase the need for coordination with other policy areas.

8 Evidence-base for policy and strategy development

The knowledge base for the development of science and technology policy has been markedly strengthened in Japan in recent years. It seems clear that this has come in response to the increased need for comprehensive and reliable information about the status of the Japanese research and innovation system accompanying the development and follow-up of the S&T Basic Plans. As increasing emphasis has been put on prioritization of S&T expenditure among different fields and themes, the demand for information allowing comparisons among specific fields has grown.

8.1 Long history of technology foresight and industrial structure analysis

Certain types of S&T-related information which combines a comprehensive coverage and high degree of detail have long been in ample supply in Japan. This is especially true of:

- Science and technology foresight surveys.
- Data and analysis of industrial structure and dynamics.

Large-scale S&T foresight studies have been carried out in Japan about every five years since the early 1970s. Initially, these studies were primarily Delphi surveys attempting to identify likely consensus amongst experts as to when certain specific technologies would be developed and utilized in society. Delphi surveys have also continued as an essential part in recent surveys, but the range of methodologies has been expanded. The Eight Foresight Survey, conducted under the leadership of the National Institute of Science and Technology Policy (NISTEP) and published in 2005, thus included a socio-economic needs analysis, scenario analysis and bibliometric analysis of fast-growing scientific fields.

The Ministry of Industry, Trade and Economy (METI), through its predecessor MITI (The Ministry of International Trade and Industry), has a long history of detailed and continuous analysis of structural changes in Japanese industry in a global context. These analyses have been closely linked with METI's/MITI's own R&D programs and have consequently included in-depth studies of technological aspects of industrial development. METI combines a multitude of resources in its efforts to comprehend the structural dynamics of Japanese industry:

- Its own staff, including those at METI's regional bureaus.

- Staff at organizations under the supervision of METI, such as NEDO, AIST, JETRO and the SME Agency.
- Experts from industry, academia, etc. in numerous councils, subcommittees and working groups.
- Studies commissioned to private think-tanks (of which there are a large number in Japan) and other organizations.

A major challenge for METI is how to continuously integrate all the perspectives and viewpoints from its various parts. This is of course a problem for any ministry, but may be especially demanding for METI with its broad coverage of very diverse industries and technologies, many of which must be viewed in their global context and in a long-term perspective. METI's most recent attempt at grasping the growth prospects of Japanese industry in a comprehensive way is its "New Economic Growth Strategy". A first version of this was adopted through a Cabinet decision in June 2006. The rapid increase in the prices of petroleum, raw materials and food during 2007 and the first half of 2008, plus growing concerns about persistent future supply constraints, prompted METI to revise the strategy and place resource efficiency at its heart. This strategy was adopted by the Cabinet in September 2008 at the very moment the world entered its present economic crisis. This had the effect of at least temporarily easing raw material supply problems while exposing the weaknesses of the export-driven Japanese growth model. This is not to suggest that large parts of the revised New Economic Growth Strategy may not still be relevant, but further revisions of it should be expected once the implications of the economic crisis can be fully comprehended.

8.2 Building a knowledge platform for national policy

The establishment of the new framework for the development of an integrated national S&T policy in the form of the S&T Basic Plans has produced a demand for new types of information and information which is structured in new ways. Previously, each ministry basically sought information that would inform its own policymaking and be useful in convincing the Ministry of Finance of the importance of its proposals.

Through the Basic Plans and the creation of a stronger CSTP, a new arena for exchange of information and arguments has been created. In principle, every activity should now be viewed in the national context as a whole, not just that of the individual ministry. This has probably had a significant effect on the collection and analysis of S&T-related information, not only in the relevant ministries but in many other organizations as well. The following are just a few prominent examples of new analytical capabilities that are of definite value for nationwide prioritization efforts:

- The CSTP and its secretariat as an integrator of information.
- Input from NISTEP to the S&T Basic Plans

- International benchmarking conducted by the Center for R&D Strategy (CRDS) of JST.
- Strategic Technology Roadmaps developed by METI.

8.3 The CSTP and its secretariat as an integrator of information

As already discussed, the CSTP serves as a clearing house for information from different ministries. This function is of course not conducted by the CSTP itself, but by its various committees and working groups and its secretariat which forms part of the Cabinet Office; the Bureau of Science, Technology and Innovation Policy. The CSTP relies heavily on the information provided by the individual ministries.

On the CSTP's initiative, a central database is being established of all government-funded R&D projects. The argument for this has been that coordination among ministries needs to be strengthened. When a ministry, or its agencies, makes a decision about funding a project they should know about similar activities already funded by other parts of the government in order to avoid duplication, avoid unhealthy concentration of research funds on individual principal investigators and discover opportunities for collaboration with other ministries.

Through the establishment of the central database, the CSTP will also have its own direct access to information about the S&T-related activities of each ministry. In some future cases it will therefore supposedly be able to perform its own analyses without having to ask specifically for information from the ministries. The database is on the verge of completion, but it is still too early to say what effects it will have as a basis for new types of analysis of government-supported S&T.

8.4 Input from NISTEP to Third and Fourth Basic Plan

The National Institute of Science and Technology Policy (NISTEP) was established back in 1988 under the Science and Technology Agency (STA). As part of the fundamental reorganization of government ministries and agencies in January 2001, the STA was merged with Ministry of Education, Science and Culture (Monbusho) to form the new Ministry of Education, Sports, Science, Culture and Technology (MEXT) and at the same time a new strengthened CSTP was established. As a result, MEXT and the CSTP became the two main clients of NISTEP. Unlike the STA, MEXT has a major responsibility for university affairs, which made it necessary for NISTEP to develop its research on universities. Furthermore, in January 2001, NISTEP's capability for analyzing issues that needed expertise in science and technology was drastically increased through the establishment of the Science and Technology Foresight Center. Most of the staff in the new Center were dispatched from companies or research organizations on a temporary basis. As a result, NISTEP almost doubled its staff to its current strength of around 100 persons. The Center also built a large contact network with science and technology specialists in companies, universities and research institutes.

In 2003, NISTEP was asked by the CSTP to produce a wide range of studies intended as an input in the preparation of the Third S&T Basic Plan. Over two years, NISTEP focused a large part of its efforts on this work. Major funding from the Special Coordination Funds for S&T Promotion allowed NISTEP to complement its own staff with consultants from various think-tanks. In the spring of 2005, NISTEP reported the results of its research in an abundance of reports on different subjects.

- Government S&T budget and its use.
- Analysis of the degree of achievement of policy objectives in the Third Basic Plan for which numerical targets had been set or which otherwise lent themselves to quantitative analysis.
- Various aspects of human resource development such as career opportunities for doctorates, conditions for young, female and foreign researchers and mobility of researchers.
- Industry-academia-government cooperation and regional innovation.
- The quantity and quality of Japan's publication of scientific papers in international comparison.
- Socio-economic impact analysis of 16 cases of already implemented technologies and 16 cases of technologies still under development.

Studies of these and other topics were published in separate reports and the most important findings summarized in one report which was then translated into English.[44] In most of the studies, an attempt is made to structure the data according to the 4+4 major fields introduced in the Second Basic Plan.

The Foresight studies mentioned earlier were another input from NISTEP to the preparation of the Third Basic Plan.[45] Among these, a pioneering study of "hot research areas" deserves special mention.[46]

Similarly, NISTEP is heavily involved in collecting and analyzing data as input also for the development of the Fourth Basic Plan. In 2008, 12 different projects were commissioned by the CSTP, once again using the Special Coordination Funds. The

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[44] NISTEP (2005a). A *summary of some of the international comparisons is also available in English in* NISTEP (200b).

[45] These studies are summarized in NISTEP (2005c). A separate English translation of the Delhi Survey is also available in NISTEP (2005D).

[46] An updated version of the study of hot research areas is available in English in NISTEP (2008).

first reports from these studies started to appear in March 2009. From a cursory look at them, it appears that NISTEP has continued to develop its methodologies and been able to increase the depth of its studies. For example, interviews with 50 leading scientists in Japan, 50 in USA and Europe and 20 in Asian countries do provide important insights into the actual conditions for conducting research in Japan as experienced by both Japanese and foreign scientists. In another example, a comparison of research productivity between Japanese and British universities is carried out at individual university level, but the analysis considers how these are positioned within the national systems of higher education as a whole.

The policy-relevant analytical capability built up at NISTEP – including its ability to subcontract work to think-tanks – seems quite impressive, and is probably currently one of the leading in the world. In addition to its long tradition of Foresight studies, particular strong points relate to quantitative analysis of the research system in Japan and its international position. Studies of innovation and industry seem less developed.

8.5 International benchmarking conducted by the CRDS

The Center for Research and Development Strategy (CRDS), which was established in July 2003 as a part the Japan Science and Technology Agency (JST), provides the CSTP, JST and others with qualitative benchmarking studies covering a wide range of science, technology and industry. This is not the only activity of the CRDS but makes an interesting example of an activity which will serve as a direct input to the preparation of the Fourth Basic Plan and in which the CSTP has already expressed keen interest.[47]

In February 2008, the CRDS published very detailed benchmarking studies for five major fields, subdivided further into areas and subareas. In April 2009 a summary of a revised and updated version of this benchmarking was published[48], with Clinical Medicine added as a new major field, the total set of major fields becoming:

- Electronics, Information and Communication.
- Nanotechnology & Materials.
- Life Sciences.
- Clinical Medicine.
- Environment.

[47] The CRDS describes its main activity as “making ‘Strategic Proposals’ on R&D and present them to JST and the relevant government ministries of Japan”. Strategic Proposals are said to consist of two main elements: a) Identifying R&D areas and subjects to be funded by the Japanese Government (“Research Priority-Setting”); b) Proposing how to implement this R&D.
[48] CRDS (2009b).

- Advanced Measurement Technology.

Except for Advanced Measurement Technologies and the treatment of Clinical Medicine as a separate field from the rest of Life Sciences, the benchmarked fields are identical with the four Priority Fields introduced in the Second Basic Plan and kept as such in the Third Basic Plan. The major fields were structured into 45 areas (see Appendix 8), and further divided into 274 subareas.

Using the knowledge of 356 external experts distributed across the six major fields, the CRDS carried out international benchmarking of Japan's position for each of the 274 subareas. In most of the cases the following three aspects were considered:

- Level of research activities.
- Level of technological development activities.
- Level of the technology implemented in actual manufacturing.

For each of these three aspects, the current level is determined according to a four point scale for each of five countries/regions: Japan, the USA, Europe, China and South Korea. Other countries are sometimes added depending on the subarea, usually Asian countries or Australia. Recent trends in relation to the current level are also indicated in terms of: "strengthened", "unchanged" or "weakened". The results are summarized and visualized in tables, which allow the reader to quickly identify relative strengths and weaknesses for each country/region in the various subareas. In addition qualitative information for each subarea is provided in text form. For Europe, individual countries are sometimes highlighted.

The benchmarking reports contain a wealth of detail presented in a highly systematic and easily understood structure. Like any expert judgment, the evaluations on which the benchmarking are based are subjective and reflect the bias of participating experts. In some cases, the experts have made site visits to leading laboratories abroad to improve the basis of their evaluations. In the Life Sciences field, the CRDS is also experimenting with novel bibliometric methods which may help make the benchmarking more objective, especially when evaluating the relative level of research activities.

As already mentioned, the CRDS' activities are not limited to benchmarking. Amongst other things, it is also trying to identify important new fields or aspects of the Japanese research and innovation system which need reform. A recent report discusses problems of effectively organizing the interdisciplinary research often needed when addressing important societal problems.[49] This topic seems to fit well with issues expected to be central in preparation of the Fourth Basic Plan.

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[49] CRDS (2009a).

8.6 Strategic Technology Roadmaps developed by METI

The Strategic Technology Roadmaps (STR) developed by METI in recent years represent one more important instrument in the development of national research and innovation policy.

Technology roadmaps have been used in industry since at least the 1980s when they formed a basis for development of joint R&D programs in the US semiconductor industry. METI's broad effort to introduce Strategic Technology Roadmaps (STR) as a tool for its development of R&D policy and programs and for communication with different stakeholders started in 2003.[50] The first set of STRs covering 20 areas of technology was published in 2005. The roadmaps have been updated annually and the number of areas expanded. The 2009 STR report includes 30 areas grouped into eight major fields. The fields and areas are listed in Appendix 9. Four of the major fields, including 19 of the 30 areas, are more or less the same as the four Priority Fields in the Second and Third Basic Plans, while some of the remaining four fields and 11 areas reflect METI-specific policies and programs.

Compared to most of the analysis discussed earlier in this chapter, the STR treats technology in much greater detail and perhaps more in the manner of an engineer. METI's STR consist of three major elements:

- Dissemination Scenarios, which identify factors influencing the path towards actual use of a technology, including regulatory aspects, need for standardization, etc.
- Technology Overviews, which logically demonstrate the relationship between different technologies.
- Technology Roadmaps, which identify the consensus view of when certain milestones of technological performance will be achieved.

One criticism directed at the use of STR is that it is primarily applicable to fields where incremental innovation dominates and that it cannot deal with disruptive innovations. METI seems to acknowledge this problem and emphasizes that the STR should not be allowed to become a straightjacket but be used in a pragmatic and flexible way. It claims that the STR has great merits as a communication device and can be useful as a platform in seeking to combine different technologies or industrial fields.

Clearly, METI and NEDO have adopted STR in their policy and program development. It is still not clear how much STR will be used in the development of national policy.

[50] Three of the originators of the STRM work at METI have described the background, implementation and some issues concerning this work in Yasunaga (2009).

9 Looking ahead to the Fourth Basic Plan

As a way of reflecting on the current status of the prioritization process for government S&T expenditure in Japan, we will briefly discuss what are likely to become some of the key issues in the Fourth Basic Plan. Work to prepare the Fourth Basic Plan has started very recently and the plan will be formally adopted in early 2011. Discussion of the plan's possible content of course therefore remains speculative at the present time.

9.1 New hope of achieving one percent of GDP for S&T

Until very recently, there seemed little political interest in significantly increasing government expenditure on S&T. The pressure to reduce the large budget deficit, a lack of enthusiasm over the results from the investment made since the system of S&T Basic Plans was introduced and a highly unstable political situation combined with an increasingly prosperous business sector all favoured a restrictive attitude towards increasing spending.

The global financial crisis, its severe effects on Japanese exports combined with a new US administration committing itself to aggressive S&T investment have suddenly and dramatically changed the picture. The fact that the Obama administration has set ambitious goals to strengthen the US position in energy technologies, an area in which Japan prides itself as having particular strengths, has amplified the sense of vulnerability and need to act in Japan.

A clear sign of change can be seen in the FY 2009 supplementary budget, which added no less than 38 percent to the regular government S&T budget. Including local and regional governments, this will bring total government S&T expenditure for FY 2009 close to the one percent of GDP which was a target for the Third Basic Plan.

This may of course be only a temporary, one-off increase. The fiscal deficit is still there and even larger than before, so the pressure to keep expenditure down is at least as strong as earlier. What has changed is that there is now definitely a sense of crisis and an acutely felt need to develop a new basis for sustainable growth in Japan. Judging from deliberations in various advisory councils to the government in recent months, the belief that investment in S&T should play a central role in laying the ground for medium and long-term growth seems strong. This belief seems to be shared by the business sector.

9.2 Changing the rules of the game for R&D funding

A purpose in prioritization of government S&T funds is to increase the effect of their use. As discussed earlier, there is a close connection between prioritization and coordination. The creation of a stronger CSTP in 2001 was aimed at strengthening the government-wide prioritization and coordination function. With limited direct influence on budgetary matters, the CSTP has been fighting an uphill battle to live up to these expectations. Increasingly frequent calls have been heard recently for "all-Japan efforts", combining financial and human resources from different ministries and from public and private sectors. Some of the CSTP's initiatives (described earlier) have attempted to achieve this within the present framework or with only marginal adjustments.

Despite these efforts, it appears that present administrative structures make it very difficult to effectively muster resources on a significant scale for integrated national initiatives.[51] It would therefore be no surprise if the Fourth Basic Plan contained more radical measures for achieving "all-Japan efforts". In fact, there is already an example in the FY 2009 supplementary budget, the proposal for which was submitted to the Diet on 24 April. The most noteworthy S&T-related measure in this budget proposal is the "Program for Strengthening Support of World Class Research". With its budget of JPY 270 billion over five years, this program will support research on around 30 different themes, each led by a principal investigator (PI) (or "central researcher").[52] The PIs and themes will be selected together and a key criterion will be that the research conducted should achieve a leading position in the world. The research will cover "from basic research to R&D close to 'exit'" and gather researchers from different organizations. A new fund has been created under the Japan Society for the Promotion of Science (JSPS) to administer the allocated budget.[53] The substantive management of the R&D itself will be contracted to various organizations based on calls for proposals for each theme. R&D-funding organizations, universities, research institutes and companies, and other organizations will be invited to make proposals.

In announcements of the program, it is emphasised that "the highest priority" is being put on the PIs. One might say that the funding system has been turned upside down.

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[51] The Special Coordination Funds is an interesting device designed to work across the whole government. However, its budget is limited to around JY 36 billion per year equivalent to one percent of total government S&T expenditure.

[52] The new DPJ-led government which came to power in September 2009 has decided to revise the FY 2009 Supplementary Budget adopted by the previous government. According to Mainichi Shinbun (2009), through a decision on 17th October the budget for the 30 PIs has been reduced to JPY 100 billion. Another JPY 50 billion will be reallocated to a new call for proposals aimed at young and female researchers. The program will thus be reduced by JPY 120 billion compared to the original budget.

[53] The new fund will also manage JY 30 billion for another program, which will finance the sending of 15-30,000 researchers to leading foreign R&D organizations over five years. The law under which JSPS is established had to be amended to establish the new fund.

Instead of trying to coordinate the funding streams from different government R&D-funding sources, there is the intention to give major powers to a small number of PIs to organize big "projects", assisted by organizations funding or conducting R&D. Whether this radically new approach will prove effective in cutting the Gordian knot of cross-ministerial prioritization and coordination remains to be seen, but no doubt it will be fascinating to see how the initiative unfolds.[54]

9.3 Engaging the business sector strategically

During the last year, Nippon Keidanren has made a number of statements regarding government policy for science, technology and innovation. The most comprehensive one appeared in May 2008 under the heading "Regarding the promotion of problem-solving type of innovation, which will contribute to strengthening international competitiveness". In February 2009, Nippon Keidanren published "A Call for a Japanese New Deal: Promoting National Projects to Ensure Employment Security, Create Jobs, and Enhance Japan's Growth Potential". It urged that:

> *"The public and private sectors should join hands at the economic situation such as today, and launch and vigorously promote national projects such as a Japanese New Deal that will lead to the creation of new jobs and strengthen Japan's mid- to long-term growth potential to be ready for the future. Through these national projects, Japan must strive to quickly emerge from the current tunnel of economic stagnation and lead the world economy in the 21st Century."*

In the statement, Nippon Keidanren underlines the importance of implementing the Third Basic Plan and laments the fact "that governmental R&D investment has fallen substantially below the initial plan". Among S&T-related measures, special attention is given to "creating a low-carbon, recycling-oriented society" and to the need to "accelerate human resources development and advanced R&D in the field of information and communications technology (ICT) which has major ripple effects on other industries as basic technology".

In connection with preparing the FY 2009 Supplementary Budget, Nippon Keidanren publically stated its views on two occasions in April on the principles that it thought should guide the new "Program for Strengthening Support of World Class Research"

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[54] On its official website the CSTP reports, in its English summary of the meeting on 21st April 2009: "After the discussion, Prime Minister Taro Aso commented as follows: "In order to implement an R&D system that gives the highest priority to researchers, I hope that efforts will be made to create a completely new scheme, free from conventional mannerisms and constrains, that will become a good example. I will make the final decision myself when it comes to choosing the central researchers and core research themes."." This indeed suggests that the new scheme is attracting great political interest.

discussed above. It appears those principles are largely the same as those adopted in the new program.

While the business sector appears to have had considerable influence on drawing up the recent supplementary budgets, it is far from clear to what extent the views of the business sector will be reflected in the Fourth Basic Plan. The influence of the business sector on government science and technology policy has so far primarily been channeled through METI. As Japanese industry has come to view universities as having an increasingly important role, it may also need to use other channels to influence policy. Although the direct funding of universities from METI (mainly through NEDO) has increased during the last decade, especially in the biotechnology field, it still is marginal in universities' total research budgets. Industry is clearly in a minority n the government's main advisory councils on university matters. Only four out of 30 members of MEXT's Council for Science and Technology are from industry. Two of the eight non-Cabinet members of the CSTP are from industry. The proportion is the same for the four full-time members among the eight.

Insofar as industry can speak with one voice, its views are likely to carry great weight even with few representatives on the relevant councils. As indicated by the various statements by the Nippon Keidanren, industry seems able to agree in expressing rather detailed demands on government policy. Its weakness is a difficulty agreeing what it is prepared to offer in return for its demands being met. Naturally, a wish-list from industry with no undertakings is politically much less attractive than proposals with both elements.

An interesting example is the program supporting industry-linked Centers of Excellence, "Centers for Creating Innovation through Fusion of Advanced Areas of Science and Technology" mentioned earlier (Section 7.1). Since the start of the program in 2006, 21 centers – all but two at universities – have been selected for funding; half come from the Special Coordination Funds and half from the partner companies in the respective center. Those centers showing the best prospects after the first three years are expected to receive larger funding for an additional seven years. Of the nine centers started in 2006, four were recently selected for continued funding.

What is perhaps most surprising about the program is that it is the first large-scale joint government-industry funding of industry-linked COEs at universities in Japan.[55] [56]The

[55] The National Science Foundation (NSF) started a corresponding program, Engineering Research Centers (ERC), as early as 1985. Its Swedish counterpart is the Competence Centers started in 1994 by NUTEK and continued today in somewhat revised forms by VINNOVA and the Swedish Energy Agency.

[56] It is sometimes claimed (in Japan too) that contacts between industry and universities are much less developed than, say, the US. Empirical studies do not seem to support this generalization. See Baba (2007) for example. Still, in terms of strategic alliances between universities and firms the situation in Japan may still be undeveloped.

fact that it is funded by Special Coordination Funds rather than through any regular programs of MEXT or METI might be interpreted as reflecting the difficulty of effectively handling university-industry cooperation within the current administrative framework in Japan.[57] This in turn may explain why establishment of the program required a proposal from the Nippon Keidanren. While the initiative came from the business sector, Nippon Keidanren has expressed misgivings about the funding model adopted. In particular, the demand on the partner companies to commit resources over a long time period has been criticized in favor of a more flexible model.[58] The example indicates that the process of engaging the business sector in cooperation with universities in a strategic way is still at a fairly early stage.

For the reader not to draw the wrong conclusions, it must be emphasized that there is by no means a lack of research capability or appreciation of the importance of long-term scientific research in the majority of technologically advanced companies in Japan. The problem is rather that the companies have tended to rely more heavily on their internal R&D capacity and been rather late in embracing the concept of "open innovation".[59] However, this now seems to have taken root in Japanese firms.

From a Swedish perspective, it is interesting to note that business sector representatives frequently express a high regard for the Technology Platform-related activities in Europe and would like to see a counterpart activity established in Japan. One perceived attractive feature of the Technology Platform activities is that they allow open and forward-looking discussion among leading experts from companies, academia and other organizations. Discussion which connects the identification of problems in society which need solving with the required innovations, new technologies and scientific knowledge. Such platforms for creation of visions and exchange of knowledge and opinions are seen as missing in Japan and their establishment is strongly urged by Nippon Keidanren.

Industry also emphasizes the need for universities to better adapt their educational programs, including graduate studies, to the competence requirements of industry. A concern is expressed that too high a priority may be placed on the scientifically most prestigious fields and that industrially important fields may be neglected in the process.

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[57] However, it should be noted that although the policy for the use of the Special Coordination Funds is decided by the CSTP, MEXT is in charge of its budget and operation.

[58] See Nippon Keidanren (2008) for example.

[59] The willingness of Japanese firms to invest in long-term, in-house research has varied over time and was probably at its peak during the latter half of the 1980s. After the bursting of the financial bubble in the early 1990s, many Japanese firms significantly reduced their long-term exploratory research although it still remained sizeable in many firms. During the last five years, the interest of firms in entering new business fields has once again been revived and as a consequence also the willingness to invest in exploratory research. It is still too early to judge the effects of the recent financial crisis on the research strategy of Japanese firms.

Generally speaking, Nippon Keidanren argues for more power to the CSTP, including in budgetary matters, and a greater ability to organize "all-Japan efforts".

Among other organizations active in developing and articulating broad-based industrial views on government S&T&I policies, The Council on Competitiveness – Nippon (COCN) deserves special mention. Discussions in subcommittees of METI's Industrial Structure Council, supported by the analytical capabilities of METI and its networks – including the capacity to make surveys of industrial opinions, also contribute to honing the input from industry in the policy formation process. Glancing over documents from the sources just mentioned gives the impression that highly nuanced opinions are being formed. It remains to be seen whether and how they find their way to influencing the Fourth Basic Plan.

9.4 Moving from S&T fields to problems-to-be-solved as a basis for defining priorities?

A major challenge in preparing the Fourth Basic Plan will be to specify priority "areas" for government support of R&D. The Third Basic Plan developed a whole new system, as described earlier in this report. There are some indications that this system may be changed in important ways.

One question is the basis for defining the areas. Some, especially those from industry as discussed in the previous section, have argued that the organizing principle should be the needs or societal problems to be solved rather than technologies or scientific fields, which are seen as characterizing the Strategic S&T Priorities in the Third Basic Plan too much.[60]

A similar argument was a central theme in Innovation 25. Generally, the need to connect investment in S&T to the realization of problem-solving and value-creating innovation seems to have become widely shared. It is recognized that unless results of investment in S&T in terms of innovation can be demonstrated, it will be difficult to find political support for maintaining or increasing such investment. For each Basic Plan, the urgency grows to demonstrate the effects of past investment in terms of innovation. It is noteworthy that JST reorganized itself from 1st April 2009 and placed its support for "Basic research" and "Technology Transfer" under a common umbrella named "Innovation Headquarters". During 2009, METI is establishing a new Industrial Innovation Organization aimed at co-investing together with the private sector in

[60] The extent to which Strategic S&T Priorities in the Third Basic Plan can be said to be connected with solving socio-economic problems is of course a matter of degree. By looking at the list of priorities in Appendix 3, the reader can make their own judgement.

innovation projects in high-growth fields such as environment and energy and medicine.[61]

Once innovation is placed at the center it becomes clear that R&D in itself is not always sufficient. This is well recognized as witness the creation of the system with "super-special zones for medical technology" and plans to create a similar system in the environment and energy field.

During the Third Basic Plan, the importance of the distinction between the four priority broad fields and the other four promoted broad fields introduced in the Second Basic Plan as a basis for prioritization almost disappeared. It was replaced by the 62 Strategic S&T Priorities distributed across all eight broad fields. However, the eight fields remain the basis for structuring and organizing follow-up to the Third Basic Plan.

An additional argument presented for questioning the suitability of the broad S&T fields as a basis for organizing the priority-setting process, has been that it tends to pay insufficient attention to the potential and need for combining competences from different fields.

In order to organize the work of defining priorities for the Fourth Basic Plan, a subdivision will probably be needed on approximately the same level of detail as the eight broad fields. It would be surprising if no change were made in selection of broad fields for organizing the work, but it is still impossible to say what a new or modified structure might look like.

9.5 Attracting international talent

It must be expected that the Fourth Basic Plan will also contain a number of priorities expressed in terms of changes in the "S&T system". The themes of systemic changes have shown considerable continuity since the First Basic Plan with emphasis on increasing the degree of concentration, competition, and intersectoral cooperation and mobility. These themes are likely to continue receiving attention. The conditions for young researchers are far from satisfactory. A broadening of the career options for PhD-holders and the need to change graduate programs accordingly is one important issue in this regard. The ambition to create a limited number of universities – 30 is often mentioned – which can compete internationally will probably remain. Some of the data presented by NISTEP and others suggest that the concentration of resources to the top universities is much higher in Japan than in the US or several of the large

[61] In the initial budget for FY 2009, JPY 40 billion is allocated as capital for the new organization, which is incorporated as a company. An additional JPY 42 billion is made available through the FY 2009 supplementary budget.

European countries and that Japan may need to make special efforts towards broadening its base of strong universities.

International issues have received growing attention but are still a rather marginal aspect of Japanese S&T policy. S&T Diplomacy is a recent example of a new initiative. There seems to be real concern that Japanese research institutions, especially universities, will continue to have difficulty attracting leading scientists to work in Japan. The launching of the World Premier International Research Center Initiative (WPI Program) in 2007 is an attempt to develop new models for globally attractive research organizations in Japan. The Global COE Program, which focuses on strengthening PhD programs at universities, is likely to contribute towards building a broader base of internationally oriented research environments. In order to internationalize the Japanese scientific community it is also seen as necessary to give a larger number of Japanese scientists the experience of working of abroad. The FY 2009 supplementary budget allocates JPY 30 billion to a new program for sending young researchers to leading foreign R&D organizations. This money will be spent over five years and is expected to allow 15-30,000 researchers to go abroad. These and other initiatives[62] show that integrating Japanese research organizations more strongly into global networks is becoming increasingly prioritized and further actions may be expected during the Fourth Basic Plan.

[62] In another new initiative, "Global 30" started in FY 2009 around 12 universities will be granted JPY100-200 million per year over five years to develop their educational programs so that they become more attractive to foreign students.

10 Conclusions

The system of government policymaking has traditionally had a very strong bottom-up character in Japan. There has been strong segmentation of policies between and often even within ministries. This is not only the case for science and technology policy but also a general phenomenon. However, the need for more integrated government-wide policies has increasingly been recognized and reducing segmentation was an important objective of the major administrative reform implemented in 2001.

Science, technology and innovation represent an area in which there has been a definite movement from a highly segmented system towards a more integrated one, although segmentation still remains strong. As early as 1995, the enactment of the Basic Law for S&T in represented an important turning point. Key instruments in the development towards an increasing degree of integration have been the drafting of S&T Basic Plans prescribed in the Basic Law and the CSTP, in its new form since 2001.

The system for prioritizing government S&T expenditure has evolved gradually with the development and implementation of each the three Basic Plans that have appeared so far. The system continues to evolve in what seems to be a healthy learning process leading to continuous adjustments of organization, methods and routines.

Thematic prioritization has been given much more attention in the Third Basic Plan than earlier. Priorities are formulated in terms of “62 S&T Strategic Priorities” and “273 important R&D tasks”. Objectives to be achieved during the Plan’s five-year period are specified for the latter. However, the resources needed to achieve these objectives are not specified in the Basic Plan, but negotiated on an annual basis between the individual ministries and the Ministry of Finance.

Resources have indeed been increasingly concentrated to the Strategic S&T Priorities. Their share of total government S&T expenditure for “Policy mission-oriented R&D” is estimated to have increased from 16 percent in FY 2006 to 28 percent in FY 2009. The biggest increase occurred between 2006 and 2007 when several new initiatives were started.

Budget development has differed greatly among the 62 S&T Strategic Priorities. For some, the budget allocation during the first four years of the Third Basic Plan was so small that it must be concluded that actually prioritize the theme in question was impossible. This may be understandable considering that the total S&T budget for the five-year period has fallen far short of the targeted budget. It does, however, raise questions regarding the influence of the CSTP on the budgetary process and how meaningful it is to establish objectives without explicitly linking them to resource requirements. One might also argue that there are simply too many Strategic S&T Priorities.

The CSTP does play some role in the budgetary process. Through its SABC evaluation of proposed new program it can influence the fate of initiatives by the ministries. However, if initiatives are lacking it is much more difficult for the CSTP to act. The CSTP also makes major efforts through various subcommittees and expert working groups to follow up activities corresponding to the S&T Strategic Priorities and the Important R&D tasks. The results of this follow-up are published annually and may have significant indirect influence on prioritization within the ministries.

The strengths and weaknesses of the thematic prioritization process utilized during the Third Basic Plan should become clearer as its accomplishments are reviewed after its completion.

The system for development and follow-up of Strategic S&T Priorities and Important R&D tasks has other functions in addition to that of influencing the allocation of resources among fields. It helps all the actors in the Japanese research and innovation system to obtain an overview of ongoing R&D activities in Japan. In many cases, it also provides information concerning the position of these activities in the global context.

The various processes of strategy development, planning, coordination and follow-up managed by the CSTP create many opportunities for actors from different parts of the Japanese research and innovation system to meet, exchange views, identify common interests and sometimes coordinate their activities.

Leading representatives of the scientific community seem to recognize that there has to be some visible output from government investment in S&T in order to build political support for increased funding. However, scientists have shown mixed feelings about the perceived increasing concentration of government S&T funding to certain fields. As in Sweden and in many other countries, the scientific community in Japan tends to argue in favor of protecting “basic research”. The Third Basic Plan explicitly distinguishes between diverse (Type-1) basic research driven by the interests and curiosity of the individual scientist and policy-driven (Type-2) basic research and considers both important.

Basic university funding is by and large distributed without reference to any priorities among fields. Indirectly however, the use of the resources provided through the basic funding (teachers’ time, buildings etc) will largely be influenced by external funding from the government and from other sources. Roughly one third of such funding is provided through the Grants-in-Aid program, the distribution of which is based in principal purely on scientific quality. The remainder comes from sources which are policy-driven and influenced by field prioritization. The nature of this latter influence on universities does not seem to be well analyzed despite the mass of data provided in different reports.

More generally, there seems to be a lack of data showing how government resources in particular fields are being distributed among different types of R&D-performing organizations. Presumably, this will change as a result of the central database set up by the CSTP for all government funding of R&D projects. Such data would be an important input towards the further development of policies aimed at reforming the "S&T system".

The focus on "Strategic S&T Priorities" during the Third Basic Plan has had as one side-effect in that much less information is now available on overall government support for research outside these priorities. The transparency of the funding system as a whole has thus been reduced. Whether this remains the case will depend on how comprehensive the data in the new project database will be and how its content will be made available.

During the Third Basic Plan there have been some notable new policy developments, which are likely to significantly affect the further evolution of S&T prioritization in Japan:

- A new emphasis on "innovation" and a recognition that successful innovation often requires results from R&D to be combined with institutional and organizational change, including development of new regulatory regimes.
- Intensified efforts to achieve coordination across ministries and experimentation with new organizational mechanisms for this.
- Increasingly frequent calls for "all-Japan-efforts", that combining the most capable actors from different sectors and parts of Japan in order to be able to address major problems in an internationally competitive way.

Some recent initiatives by the CSTP point in the direction of a growing role for the CSTP in providing platforms for coordination among ministries and other actors. The "Coordination Program of S&T Projects" carried out during 2005-2009 are of particular interest in this context. While most of the work is conducted by the various actors themselves, the specially assigned and highly respected coordinators appointed by the CSTP, experts and administrative staff supporting the coordinators and some amount of extra funding through the Special Coordination Funds have provided an important infrastructure for the coordination activities.

As shown by the creation of "Super Special Consortia" in the medical field, coordination of S&T policies with policies in other domains, especially regulatory policies, is a central concern. This was also an important point in Innovation 25. Such coordination typically crosses the boundaries of several ministries giving the Cabinet

Office and the CSTP a crucial role. There are plans to extend the system of Super Special Consortia to the environment and energy field. More generally, this movement is in line with an increased emphasis on producing innovation or other tangible results in society.

Humanities and social sciences seem conspicuously absent from S&T policy discussions in Japan. There is reason to believe that this is a serious weakness, as Japanese society will be increasingly dependent on service-related innovations.

The global financial crisis and subsequent severe economic downturn have recently motivated the Japanese government to inject very large extra resources to S&T, especially through a supplementary budget approved in May 2009. This large "Program for Strengthening Support of World Class Research" introduces a totally new approach towards the prioritization of government spending on S&T, with the explicit aim of radically breaking through the segmentation in the Japanese system. Its implementation will be very interesting to follow.

*

Is there anything Sweden can learn from the Japanese system of prioritization? The difference in scale and structure of the research and innovation systems in Sweden and Japan makes comparisons difficult and few policies and measures in Japan should be expected to apply directly to Sweden.

We have seen that big and increasing efforts are made in Japan to prioritize and coordinate S&T expenditure across the whole government, with the exception of the defense area, which is usually treated separately. With a much smaller system there should be less of a need for coordination in Sweden, while the need for prioritization should be much greater. Until recently, overall government "research policy" in Sweden, as expressed in the research bills every four years, has focused on horizontal – "systemic" – issues, and especially those related to the conditions for research and PhD studies at universities. Priorities in terms of specific fields or themes have been treated only on a very general level. While research councils and agencies have been encouraged in general terms to cooperate and coordinate their activities, few specific mechanisms for realizing effective coordination have been established.

The introduction of 24 "Strategic Research Areas" in the most recent research bill from 2008 represents a new development in Swedish research policy. Unlike the Strategic S&T Priorities in the Japanese Third Basic Plan, the Strategic Research Areas are directly linked to allocation of resources. However, the function of the "Strategic Research Areas" is more specific in that they will serve primarily as a means to direct large new funding to selected universities. For some of the areas, additional resources are also channeled through research councils and R&D-funding agencies, in which case their impact will extend to larger parts of the Swedish research system. The situation is thus quite different from Japan, where only a smaller part (unknown exactly what percentage) of the resources for the Strategic S&T Priorities are being spent at universities and the main part goes to various types of research institutes or companies.

The resources set aside especially for the Strategic Research Areas represent around seven percent of the projected total government R&D budget in Sweden for 2012. The total government budget for Strategic S&T Priorities in Japan is 12 percent in FY 2009. These figures are not directly comparable and further study is needed to compare the systemic impact of the prioritization in the two countries.

The processes behind identifying the Strategic Research Areas and Strategic S&T Priorities were very different. In Sweden, the selection of the 24 areas was basically a political decision based on "strategies delivered by agencies, industrial associations and companies", consultations with the Swedish National Research Council (VR) and the Swedish Governmental Agency for Innovation Systems (VINNOVA) and a report from VR describing Sweden's position in a number of scientific fields. The fields are defined in very general terms, such as cancer, transportation technology, etc. The thematic content of the research to be supported in each Strategic Research Area is mostly decided through competitive calls for proposals among universities. The emphasis is thus primarily on further strengthening areas which are already academically strong in Sweden and which in addition are seen as being of strategic importance.

Unlike Japan, there is thus not yet an overall framework for prioritizing government R&D expenditure in Sweden in terms of scientific, technological or thematic fields. An important basis for developing such a framework would be extensive and systematic international benchmarking of research, innovation and industry in Sweden. Such activities appear to be more developed in Japan, where there is a wealth of both quantitative and qualitative studies from public as well as private think-tanks. Considering that Swedish industry is much more dependent on the global market than Japan, the need for global benchmarking is even greater in Sweden.

Although Sweden may need coordination to a lesser degree than Japan, the present situation would seem on the weak side. A stronger basic infrastructure and incentives for coordination need to be developed. It is interesting that the role of the CSTP in creating platforms for coordination across ministries and agencies appears to be appreciated and welcomed. The function of the Coordination Funds for Promotion of S&T, representing about one percent of total government S&T expenditure is worth studying further. The role of universities in Sweden as providing the research infrastructure for all sectors of society inherently makes the Swedish research system more integrated than the Japanese one where most ministries have their own research institutes. On the other hand, this means that universities in Sweden are charged with wider responsibilities than universities in Japan. It goes without saying that in the current Swedish research system no other type of institution will, within a reasonable timeframe, be able to take on the work if universities do not take up the challenges with sufficient vigor.

In Sweden the development of research policy for the government as a whole is concentrated to the preparation of the research bills. One could argue a need for a government-wide policy development process on a more continuous basis. This should engage various actors in open and transparent processes.

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Appendix 1: Members of the CSTP's Expert Panel on Basic Policy

Members of CSTP's Expert Panel on Basic Policy (as of August 11 2009)		
Executive Members of CSTP	Masuo AIZAWA (Chair)	Former President, Tokyo Institute of Technology
	Tasuku HONJO	Visiting Professor, Kyoto University
	Naoki OKUMURA	Former Representative Director and Executive Vice President,Nippon Steel Corporation,Ltd
	Takashi SHIRAISHI	Former Vice President and Professor, National Graduate Institute For Policy Studies
	Sadayuki SAKAKIBARA	President, Toray Industries, Inc.
	Toyoko IMAE	Professor Emeritus, Nagoya University
	Reiko AOKI	Professor, Institute of Economic Research, Hitotsubashi University
Science Council of Japan	Ichiro KANAZAWA	President of Science Council of Japan
Expert Members	Kutsuo Aoki	Adviser, Astellas Pharma Inc.; former Chairman of Japan Pharmaceutical Manufacturers Association
	Yasuhiko Arakawa	Professor, Institute of Industrial Science (IIS), University of Tokyo
	Keiji Kainuma	Former Member of Agriculture, Forestry and Fisheries Research Council; Former Member of the CGIAR Science Council
	Tadao Kakizoe	President Emeritus, National Cancer Center
	Kakutaro Kitashiro	Senior Adviser, IBM Japan
	Kashiko Kodate	Professor and Special Adviser to the President, Japan Women's University
	Hiroshi Komiyama	Chairman of the Institute, Mitsubishi Research Institute
	Masamitsu Sakurai	Chairman, Ricoh; Chairman, Japan Association of Corporate Executives
	Hiroko Sumita	Lawyer
	Sawako Takeuchi	Visiting Professor, Graduate School of Engineering, Kyoto University
	Akihiko Tanaka	Professor, Graduate School of Interdisciplinary Information Studies and Institute of Oriental Culture, University of Tokyo
	Koichi Tanaka	Fellow, Shimadzu Corp. and Director, Koichi Tanaka Mass Spectrometry Research Laboratory
	Ichiro Taniguchi	Adviser, Mitsubishi Electric
	Shigetada Nakanishi	Director, Osaka Bioscience Institute
	Junko Nakanishi	Director, Research Center for Chemical Risk Management, National Institute of Advanced Industrial Science and Technology (AIST)
	Tomoko Nakanishi	Professor, Graduate School of Agricultural and Life Sciences, University of Tokyo
	Sanae Hara	Visiting Lecturer, Faculty of Economics, Saitama University, Faculty of Economics, Sophia University; Researcher of consumer issues
	Koichi Hosokawa	Vice Chairman, Japan Finance Corporation; Visiting Professor, National Defense Academy in Japan
	Mamoru Mohri	Director, The National Museum of Emerging Science and Innovation
	Shigefumi Mori	Professor, Research Institute for Mathematical Sciences, Kyoto University
	Shunji Yanai	Judge, International Tribunal for the Law of the Sea
	Ryuhei Wakasugi	Professor, Institute of Economic Research, Kyoto University; Visiting Professor, Keio University

Source: CSTP Webpage.

Appendix 2: Individual policy goals for area-specific promotion in Third S&T Basic Plan

	Individual policy goals
1-1	Accumulate knowledge as a source for wisdom and innovation, and increase the international recognition of our country in creating quantum jumps in knowledge
1-2	Form world top-class centers, which lead the world in S&T
1-3	Produce a great many talented researchers which receive international recognition
1-4	Lead the world in establishing a new body of knowledge for understanding the workings of life
1-5	Create new functions based on new operating principles, using the special properties and phenomena in the nano domain
2-1	Pursue the outer boundaries of the universe
2-2	Acquire totally new knowledge about the early phases of the earth and life of the origin of matter
2-3	Realize the world's highest performance supercomputer
2-4	Develop measurement systems, based on the world's highest power laser beam, that can measure the physical state at molecular and atomic level at ultrahigh speed and in ultrahigh detail by 2010
2-5	Verify the scientific and technical feasibility of fusion energy, which is hoped to become a future energy source
2-6	Build a world top class infrastructure for life science
3-1	Carry out earth observation globally and realize accurate forecasts and impact evaluations of climate change
3-2	Continue to be the world's most energy efficient country
3-3	Realize new energy supply in harmony with the environment and which is used worldwide
3-4	Realize the wide use of fuel cells in households and neighborhoodss ahead of the world
3-5	Utilize nuclear energy safely for generations
3-6	Supply in a stable and efficient way the fuels and electricity which the nation needs
3-7	Realize an efficient use of biological resources based on biomass utilization technology developed by our country
3-8	Realize efficient use of resources and reduction of waste thorugh 3R (reduce, reuse, recycle) and substitution technnology for scarce resources
3-9	Realize risk and safety management of chemicals which contributes to a virtuous cycle for the environment and the economy
3-10	Realize the sustainable conservation and use of the ecosystem
3-11	Realize a healthy water circulation and sustainable water use
3-12	Realize a reduction in the emission of greenhouse gases and of air and water pollution
4-1	Realize the world's most convenient and easy-to-use information network
4-2	Realize a network infrastructure and technology for ubiquitous terminals (such as smart electronic tags) which allow any product to be easily connected with information
4-3	Realize wide-spread use in households and society of next generation information and communication systems, which allow everyone to communcate easily and without feeling any stress
4-4	Create in Japan highly innovative information applicances which can achieve wide-spread use in the world
4-5	Realize innovative devices which eliminate present operating limits of semiconductors
4-6	Realize wide-spread use of in households and neighborhoods of robots which are useful in everyday life
4-7	Disseminate digital contents create in Japan throughout the world
4-8	Create value based on internationally competitive software
4-9	Train IT professionals who can work effectively throughout the world
4-10	Lead the way in the material's revolution of this century and make full use of nanaotechnology and innovative materials and components
4-11	Develop advanced manufacturing technology which creates maximum value added with a minimum burden on resources, environment and labor

	Individual policy goals
4-12	Nurture and reinforce the competence of personnel playing the key role on the actual manufacturing sites
4-13	Spread the use on manufacturing sites of robots which can performy out diverse functions in collaboration with people
4-14	With the aim of building a recycling-oriented society, utilizing biotechnology to realize advanced manufacturing in harmony with the environment
4-15	Strengthen industrial competitiveness in pharmaceuticals and medical equipment and services and by effective use of biotechnology
4-16	Develop new medicines, catalysts and substances for cleaning up the environment by using bioorganisms from extreme environments
4-17	Offer safe and high quality foods with high international competitive power while aiming to increase in selfsufficiency and stability in food supply
4-18	Launch a world top-class rocket and establish technology for utilization of space
4-19	Establish technology for utilization of the ocean with power to compete internationally
4-20	Establish aeronautical technology with power to compete internationally
4-21	Nurture and reinforce the competence, in a wide range of fields, of personnel playing key roles in innovation, including technology management staff
4-22	Seek to promote the public acceptance and diffusion of nanotechnology
5-1	Cure life-style and hard-to-cure deseases, such as cancer, and extend the healthy life expectancy based on an understanding of biological functions which utilizes genome information
5-2	Cure immunonologic and allergic diseases, such as pollen allergies, based on an understanding of the mechanisms of immunity
5-3	Develop new medical therapies which combine different fields such as biotechnology, IT and nanotechnology
5-4	Realize life-long health through the full use of preventive medicine and the functionality of foods
5-5	Based on the progress in brain science, allow people to maintain the health of of mind and body and the ability to live independent and vigourous lives
5-6	Support the independence of disabled persons by developing medical therapies for assisting, replacing or regenerating body functions which have been lost
5-7	Create social well-being by fully grasping the impact of life sciences on society
5-8	Build a universal living space and social environment which everyone can enjoy regardless of age or disability
6-1	Put into practical use new highly resistant technologies for mitigating and preventing disasters
6-2	Develop land and city areas so that they are safe and in harmony with each other and make good use of existing infrastructure
6-3	Build a new traffic and transportation system which is safe and convenient
6-4	Establish technology for gaining access to space which is secures the citizen's safety and national autonomy
6-5	Secure natural resources by opening up new frontiers in the oceans
6-6	Put into practical use new countermeasure technologies for preventing or controlling terrorism and crime which are becoming increasingly serious
6-7	Overcoming infectious diseases, such as avian influenza, which are becoming a threat to humanity
6-8	Secure the trust of consumers by developing food safety
6-9	Improve safety standards and health crisis management actions for medicines, medical equipment, medical therapies, daily life and work environments
6-10	Protect the safety of the internet society through strong information security

Source: CSTP (2006).

Appendix 3: Strategic S&T Priorities in Third S&T Basic Plan

Broad field		Strategic S&T Priorities
Life science	1	S&T for reconstructing "programs of life"
	2	Clinical research and translational research towards the clinic
	3	Cutting-edge medical treatment technologies for molecularly targeted cancer therapy
	4	S&T against the threat of emerging and reemerging infectious diseases
	5	S&T enabling safe production and distribution of food with increased international competitiveness
	6	S&T enabling biotechnology-based material production and cleaning up of the environment
	7	Provison of a world-class infrastucture for life sciences
Information and communication technologies	1	Development of a world-leading "Next Generation Super Computer" [★] with the capacity to propel S&T forward
	2	Develop highly talented IT professionals who can play a key role in next generation ICT
	3	Design and processing technologies for ultra-small and low-energy-consuming devices which can prevail in the global competition of next generation semiconductor development
	4	Core technologies of displays, storages and super-high-speed devices for maintaining world leadership
	5	Core technologies for world-leading robots which are useful in the daily life in households and neighbourhoods
	6	Software development technologies aiming at reaching world standards
	7	Next generation network technologies which can transmit huge amounts of information instantaneously and be used easily and usefully by everyone
	8	Ubiqitous network utlization technologies that supplement human capabilities and provide support in daily life
	9	Content creation technologies that enable us to share emotions with people all over the world and technologies for utlizing information
	10	Security technologies that realize the world's most safe and secure IT society
Environment	1	"Ocean and Earth Observation System" [★] (incl. S&T for real-time satellite observation of CO2 and global warming related conditions)
	2	S&T for accurately forecasting climate change in the 21st century, using super computer simulations and aiming at post-Kyoto agreements
	3	S&T enabling timely forecasts of the risks caused by global warming and design of countermeasures against global warming
	4	Technology for risk assessment and management of chemical substances which, by being able to handle new substances and aiming at contributing to developments internationally, can lead the world
	5	Technology for utilization of valuable materials and control of harmful substances suitable for the international circulation of waste materials
	6	Biomass utilization technology which is adapted to regional needs and allows efficient conversion to energy
	7	S&T for drawing up scenarios of a society which works in symbiosis with nature and preserves a wholesome circulation of water
	8	S&T for conserving and restoring ecosystems based on understanding the role of biodiversity in their development
	9	Human and social sciences for chemical risk management
	10	S&T for design of production and consumption systems which are suitable for 3R (Reduce, Reuse, Recycle) and which appropriately evaluate the whole lifecycle of products
	11	Competence development for environmental research which integrates human and social sciences

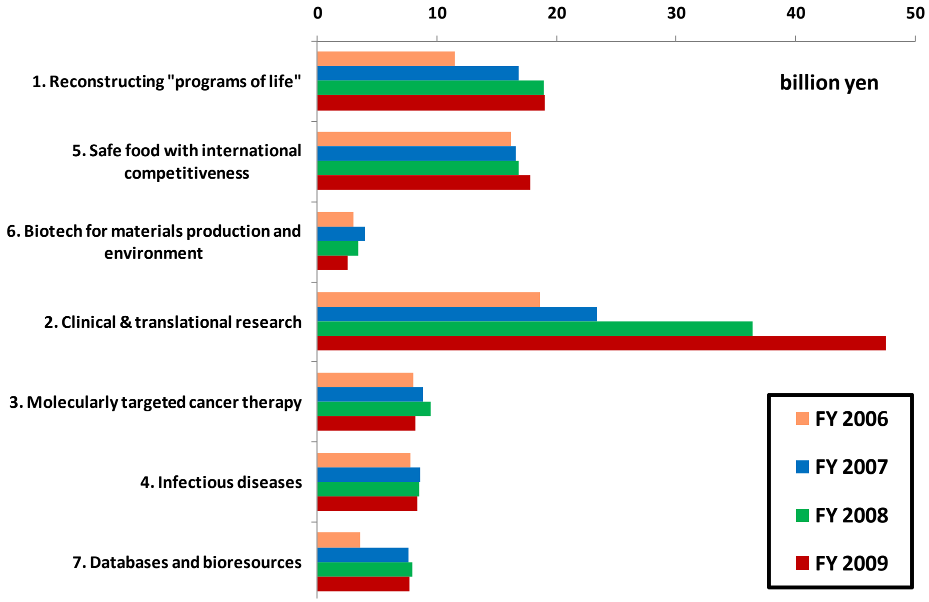
Broad field		Strategic S&T Priorities
Nanotech/ materials	**1**	Advanced materials and process technology which can play a key role for bringing about innovation
	2	Advanced materials technology which can drastically reduce the costs of clean energy
	3	Advanced materials technology for substituting rare or scarce materials as an important means of solving resource problems
	4	Advanced nano- & materials technologies which support people's health and the safety and security of daily lives
	5	Advanced electronics which breaks through the functional limits of devices
	6	Advanced nano-biotechnology and nano-medical technology aiming at the realization and integration of very early-stage diagnosis and minimally invasive medical therapies
	7	R&D for social acceptance of nanotechnology
	8	Advanced R&D aiming at practical use of nanotechnology at COEs established for the purpose of creating innovations
	9	Cutting-edge nano-scale measurement and processing technologies
	10	Development and shared-use of an "X-Ray Free Electron Laser" [★]
Energy	**1**	Urban systems technologies which realize a drastic reduction in energy use by wide-area use of energy
	2	Advanced technologies for houses and buildings which enable both energy-saving and efficient daily life
	3	Technologies for advanced high performance general-purpose devices which enable a comfortable and affluent energy-efficient society
	4	Advanced materials manufacturing and processing technologies for the ultimate energy-saving factory
	5	Advanced core technologies for next generation vehicles which do not require petroleum
	6	Advanced manufacturing technologies for Gas-to-liquid (GTL) fuels for vehicles substituting for petroluem
	7	Clean and efficient world-leading coal gasification technologies
	8	Advanced fuel cell systems and technologies for safe hydrogen storage and transportation
	9	Technologies for achieving high efficiency and low cost in photovoltaic power generation allowing for its world-wide use
	10	High performance electric power storage technologies which can overcome the limitations imposed by the configuration of power sources and use
	11	Technology for practical use of next generation light water reactors which, by being superior in terms of safety and economy, will achieve world-wide use
	12	Geological disposal and processing technology indispensable for disposal of high-level radioactive wastes
	13	"Fast Breeder Reactor (FBR) cycle technologies" [★], which secures long-term and stable energy supply
	14	Open the possibility for nuclear fusion energy through international cooperation - ITER (International Thermonuclear Experimental Reactor)
Manufacturing technology	**1**	Science-based manufacturing "vizualization" technology (development pf advanced measurement technology and equipment) which will further develop Japanese-style manufacturing technology
	2	Manufacturing process innovation which can overcome constraints imposed by natural resources, the environment and population and become the flagship of Japan

Broad field		Strategic S&T Priorities
Social infrastructure	**1**	Land monitoring and management technology for disaster mitigation ("Ocean and Earth Observation and Exploration System"[★])(incl. disaster observation sattelite and high-precision seismometry technology)
	2	New technology for lifesaving by support at disaster sites and for prevention of damage expansion (such as technology for on-site detection of dangerous materials)
	3	Technology for renewal of social infrastructure and urban spaces which meets the needs of the "great rebuilding age" and the society of declining birth rate and aging population
	4	New technology for traffic and transportation systems adequate for the society of tomorrow (such as technology for domestic production of aircraft responding to new demand)
Frontiers	**1**	High reliability "Space Transportation System" [★] (H-II A rocket and its derivatives)
	2	"Ocean and Earth Observation and Exploration System" [★](such as new generation ocean exploration system (deep riser etc))
	3	Technology for high reliability and high performance satellite (disaster countermeasure and crisis management; remote sensing; improvement of reliability)
	4	Technology for building and maintaining platforms in the open sea
		[★] marks "National Critical Technologies"

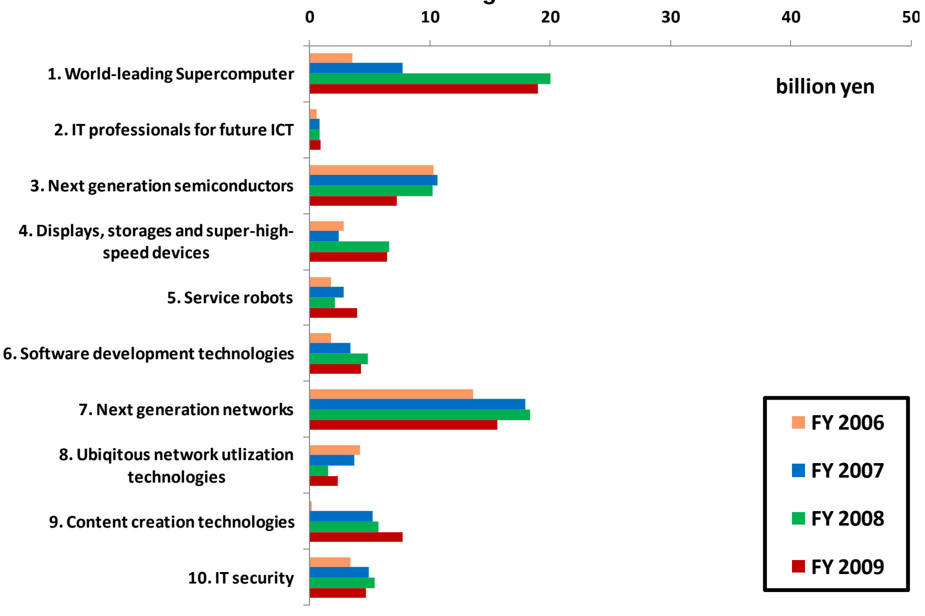
Source: CSTP (2006).

Appendix 4:
Government expenditure on Strategic S&T Priorities 2006-2009

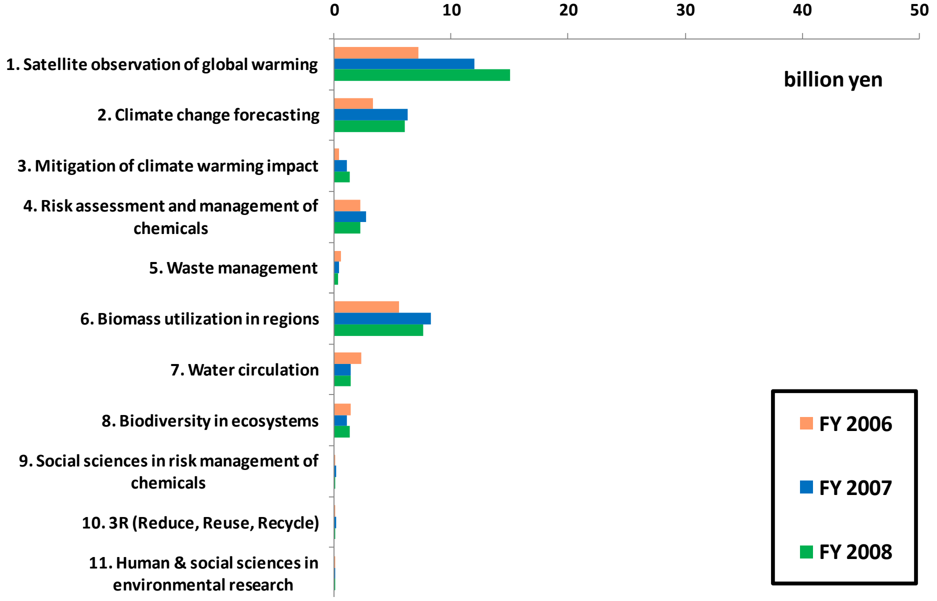
Life Sciences



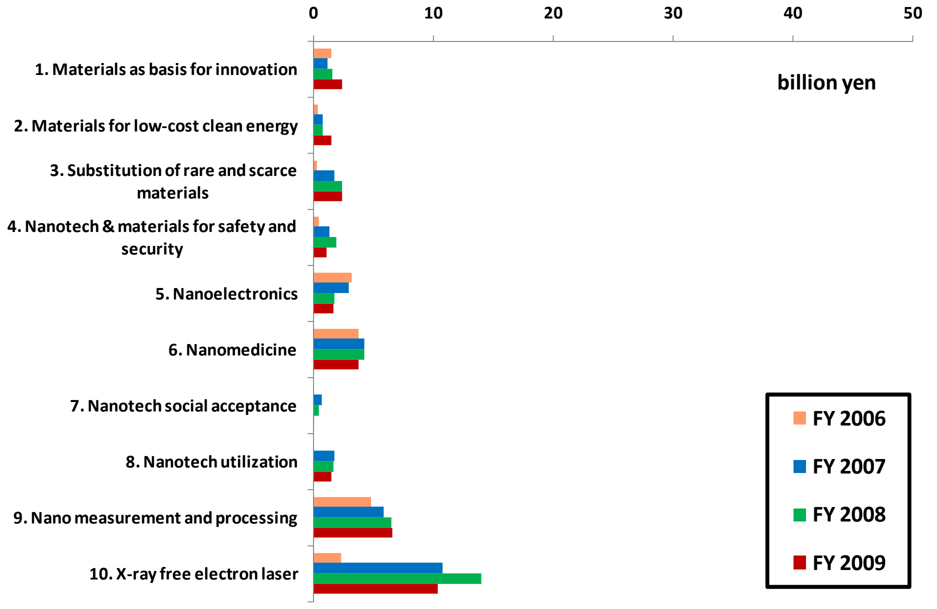
Information and Communication Technologies



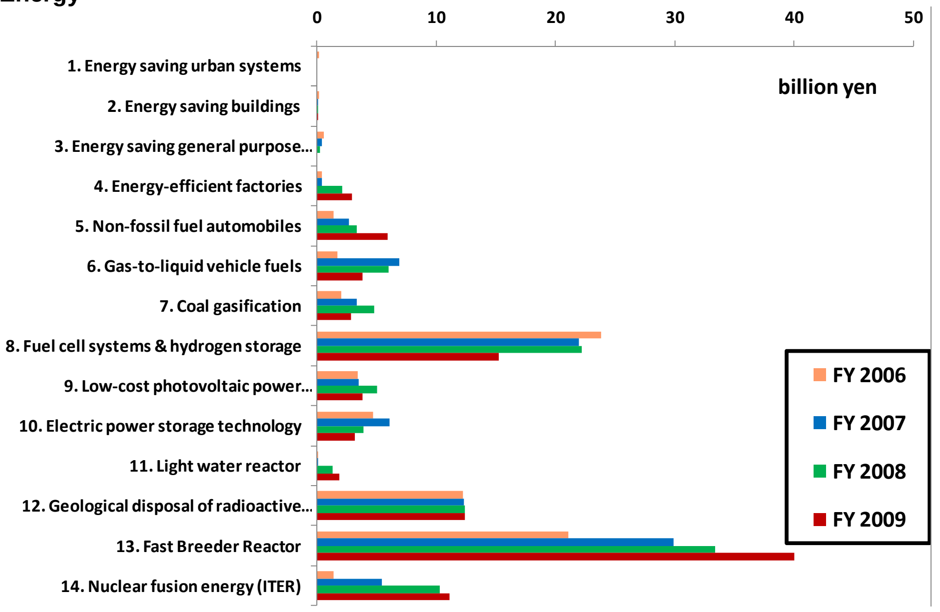
Environment



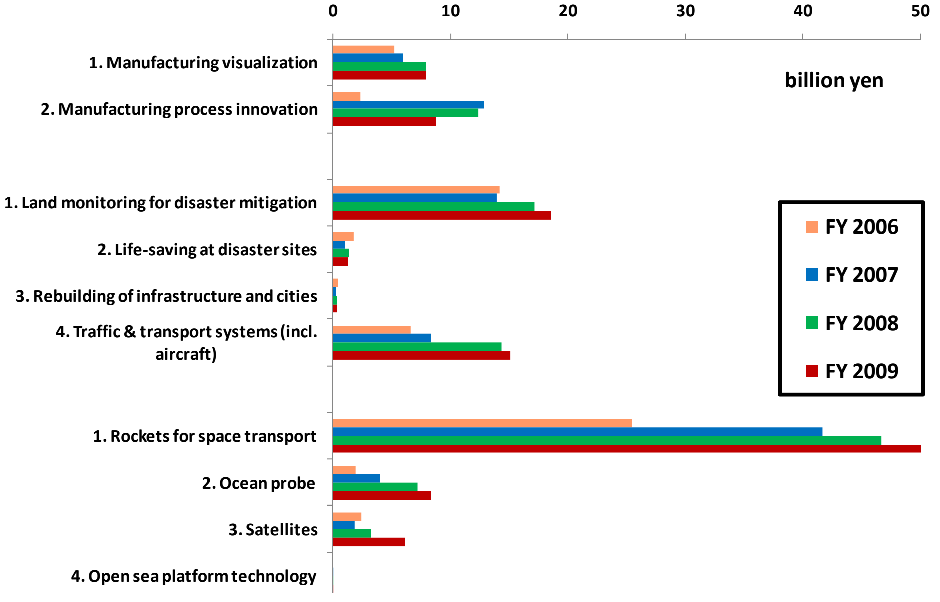
Nanotechnology and Materials



Energy



Manufacturing, Social Infrastructure and Frontiers



Source: CSTP (2009d)

Appendix 5:
Themes suggested in Innovation 25 for "Pioneering Projects for Accelerating Social Return"

- Aiming for a "society where all can stay healthy throughout life"
  - Realization of medical care that replaces and restores a lost function
- Aiming for "a safe and secure society"
  - Construction of the information and communication system which gives detailed disaster information to each resident, and helps disaster countermeasures
  - Realization of a safe and effective road and traffic system using information and telecommunications technology
- Aiming for "a society with diversified lifestyles"
  - Realization of advanced home medicine and home care
- Aiming for "a society contributing to solution of the global issues"
  - Comprehensive use of biomass resources which is contributed to addressing the environment and energy issues
- Aiming for "a society open to the world"
  - Realization of audio communication technologies that overcome language barriers

Source: Government of Japan (2007).

Appendix 6:
Technologies listed in the CSTP's Transformative Technologies Plan adopted in May 2008

Goal		Innovative Technology	
Enhancement of international competitiveness of industry		High Speed Large Capacity Communication Network	All-Optical Networking Technology
		Electronic Device Technology	Spintronics Technology
			3-Dimensional Semiconductor Technology
			Carbon Nanotube Technology (Capacitor Development)
			Integrated MEMS Technology (Micro Electro-Mechanical System)
		Advanced Image Technology	3-Dimensional Image Technology
		Embedded Software Technology	Highly Reliable/Productive Software Development Technology
		Global Warming Countermeasure Technology	Highly Efficiency Photovoltaic Power Generation Technology
			Hydrogen Energy System Technology
	Building of a healthy society	Intelligent Robot Technology	Life Support Robot Technology
		Medical Engineering Technology	Self-Support Technology for Elderly/Handicapped People (Brain Machine Interface)
			Low Invasive Medical Device Technology (Built-in Touch Sensor Endoscopes)
			Heart Function Prosthetic Device Technology
		Regenerative Medical Technology	iPS Cell Regeneration Medical Technology
		Drug Discovery Technology	Toxicological Evaluation Technology using iPS cells
	Safety and Security of Japan and the world		Vaccine Development Technology for Infectious Disease (Malaria)
		Detection Technology	Noncontact Visualizing Analysis Technology (Terahertz)
		Food Production Technology	Environmental Tolerance/High Yielding Technology for Chief Crop (wheat and soybeans)
			Complete Cultured Technology for Wide-Area Migratory Fish (Eel and Tuna)
		Technology for Scarce Resources	Rare Metals - Alternative Materials/Recovery Technologies
		Green Chemical Technology	Production Technology by Using Genetic Recombination Microbial (Energy/Chemical Engineering Material)
			New Catalyst Chemical Manufacturing Process Technology (Underwater Function Catalyst)
		New Material Technology	New Superconducting Materials Technology (Superconductors incorporating Magnetic Element etc.)

Source: CSTP (2008b)

Appendix 7:
Content of “Coordination Program of R&D Projects” and data on extra funding provided by Special Coordination Funds

Area	Extra funding from Special Coordination funds			
	Period	**Focus**	**Number of projects**	**Total Budget (JPY Million)**
Clinical and translational research (focus on	2007-2009	Training of clinical researchers for gene and cell therapy	1	251
Emerging and reemerging infectious dieseases	2005-2008	a) Ecological and genome analysis of viruses from wild birds; b) Study of need for Biosafety-level- 4 facilty	2	629
Life science infrastructure (focus on integration of databases)	2005-2007	Integration of databases	1	285
Nanobiotechnology	2005-2008	a) Quantum Dot imaging and therapy; b) biosensors; c) molecular imaging; d) creation of gene vectors	5	640
Food and bioproduction research	2007-2009	Genome interaction in the symbiosis between plants and bacteria	1	244
Biomass utilization	2005-2008	a) Design and evaluation methods for biomass utilization systems; b) local fuel systems	2	636
Ubiquitous networks (focus on electronic tags)	2005-2008	Use of electronic tags for in medical field and for safe and secure positioning	2	633
Basic technology for large scale integration and utilization of information	2007-2009	Contents for social use of sensor information	1	264
Next generation robots	2005-2008	Platform technologies for use of robots in "town environment"	4	634
Infrastructure development for social acceptance and R&D promotion of nanotechnology	2007-2009	Knowledge base supporting the development of nanotechnology and materials aimed at public acceptance	1	219
Hydrogen utilization and fuel cells	2005-2007	a) Regional systems for utilizing hydrogen energy; c) Hydrogen gas measurement systems for consumers	2	284
R&D for safe management and use of chemicals based on comprehensive risk assessment	2007-2009	Information base for self-imposed control by businessmen of chemical risks	1	244
R&D for countermeasures against terrorism	2007-2009	Detection systems for nuclear materials hidden in hand luggage	1	275
Regional S&T clusters	2005-2007	Structual analysis of regional innovation and policy effects	1	287
		All projects (2005-2009)	**25**	**5525**

Source: Data from CSTP (2009e).

Appendix 8:
Areas included in international benchmarking conducted by the CRDS

Major Field		Area
Electronics, Infromation and Communication		Electronics
		Photonics
		Computing
		Information Security
		Network
		Robotics
Nanotechnology & Materials	Nanotechnology& materials	Nanomaterials & New Functional Materials
		Nanoprocessing Technology
	Applications of Nanotechnology& materials	Nanoelectronics
		Bio & Medicine
		Energy & Environment
		Structural Materials for Use in Industry (transportation, construction)
		Daily Life related Materials
	Basic S&T	Nanoscience
		Materials Measurement & Probing
		Nano Measurement & Evaluation Technology
	Related Common Themes	Common Use R&D Centers (promotion of multidisciplinary research and cooperation)
		Education & Competence Development (including nanotech literacy)
		International Standards & Manufacturing Standards
		Social Acceptance, EHS, ELSI
		International programs
Life Science		Genome & Functional Molecules
		Neuroscience
		Developmental Biology & Regenerative Medicine
		Immunity
		Cancer
		Plant Science
		Multidisciplinary Areas
Clinical Medicine		Pharmaceutical Development
		Medical Equipment Development
		Regenerative Medicine
		Gene Therapy
		Imaging
		Regulatory Science
Environment		Global Warming
		Environmental Pollution & Damage
		Resource Recycling
		Ecosystem Management
Advanced Measurement Technology		Separation & Purification Methods
		Spectroscopy
		Structure Analys
		Sensors & Detection
		Imaging
		Reagents & Probes
		Composite Analysis

Source: CRDS (2009b).

Appendix 9:
Areas included in METI's Strategic Technology Roadmaps 2009

Major field	Technology Area
Information and Communications	1. Semi-conductors
	2. Storage and non-volatile memory
	3. Computers
	4. Networks
	5. Usability
	6. Software
Nanotechnology and Components	7. Nanotechnology
	8. Materials and components
	9. Fiber technology
	10. Green sustainable chemistry
Integrated System and New-Manufacturing	11. Robots
	12. Micro-electro mechanical system
	13. Design and production
	14. Aircrafts
	15. Space
Biotechnology	16. Drug discovery
	17. Diagnostic and treatment equipment
	18. Regenerative medicine
	19. Investment in anti-cancer technology
	19. Industrial bio
Environment	20. CO2 capture and storage
	21. Reduction of fluorocarbon and development of fluorocarbon substitutes
	22. Reduce, reuse and recycle
	23. Comprehensive control of chemical substances
Energy	24. Energy
	25. Superconducting technology
Soft Power	26. Human life technology
	27. Services
	28. Contents
Strategic Crossover	29. Sustainable monodzukuri technology
	30. Metrology and measurement system

Source: METI (2009).

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