Analysis of government-sponsored energy R&D projects
− Lessons from Sunshine, Moonlight, and New-Sunshine Programs −

Background

Technology development plays a vital role in global climate strategy. It is essential to design effective policies to enhance technological innovation in the energy sector. In Japan, the government has been conducting various energy R&D projects since the 1970's. This experience should have important lessons for designing better energy technology policies.

Objectives

The research examines major R&D programs for energy efficiency and renewable energy technologies in Japan: the Sunshine, Moonlight, and New-Sunshine Programs, in order to assess the overall outcome and induce policy implications.

Principal Results

1. Trend of government-sponsored energy R&D projects in Japan.

Governmental investment in energy efficiency and renewable energy technologies has been substantial and stable for more than 30 years, which is in stark contrast with the declining trend of energy R&D budgets in other OECD countries (Fig.1).

2. Cost-effectiveness analysis (Table 1)

We conducted a cost-effectiveness analysis of the projects included in these programs, and found the followings:

(1) 10 out of the total 23 projects succeeded in commercialization. Cumulative energy savings and CO_2 emission reductions achieved by the commercialized technologies were estimated to be 23.3 Mtoe and 57.0 Mt-CO_2, respectively (cumulative savings from 1974 to 2002).

(2) The cost per unit energy saving and CO_2 reduction were calculated by dividing the cumulative governmental expenditures by the cumulative savings, which gives 57,791 JPY/toe (i.e. 70 US$/bbl *1) and 23,567 JPY/t-CO_2 (i.e. 196 US$/t-$CO_2$ *1), respectively. Although these figures are higher than the oil price and the carbon price in the Emission Trading System in recent years, the overall return on investment can be justified because the technologies commercialized through the governmental projects will continue to be deployed beyond 2002.

(3) The distribution of the benefits is highly skewed. 98% of the total cumulative energy savings and CO_2 reductions comes from only 4 projects: gas turbines, solar water heaters, heat pumps, and geothermal. These represent incremental innovations, and projects for radical innovations, such as photovoltaics and fuel cells, obtained small benefits so far. This implies the importance of having a portfolio of broad options.

3. Policy implications from 8 case studies

We conducted qualitative case studies on 8 selected projects, and found 2 critical factors for successful commercialization:

(1) Private investment after the government-sponsored project. Private entities that are highly committed to commercializing the technology are indispensable, because any technology developed by governmental project requires years of continuous investment after the project before coming onto the market.

(2) Early users and niche markets. Since there is a long lead time, sometimes a few decades, before new energy technology becomes fully competitive with existing technologies, developers need to find early users and niche markets in order to maintain long-term R&D investment into the technology. Thus they can continue to improve the technology and create larger markets.

Future Developments

Case studies will be elaborated to have deeper understanding of the role of the government in the innovation system.

Main Researcher: Osamu Kimura,
Research Scientist, Climate Policy Project, Socio-Economic Research Center

Reference

O. Kimura and M. Wakabayashi, 2007, "Assessing the effectiveness of climate policy instruments in Japan", presented at Workshop on Japanese Climate Policy - a power sector perspective, 23 April, Center for European Policy Studies, Brussels. [available at: http://www.ceps.be/files/ClimateDialogue/Kimura_Waka_CRIEPI.pps]

*1 : On the exchange rate of 120 JPY/US$

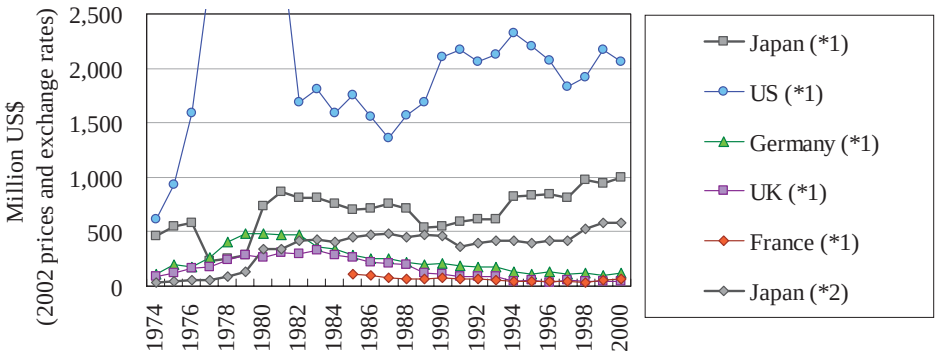

Fig.1 Energy R&D (excluding nuclear R&D) by major OECD countries, 1974-2000.

*1) Data based on "IEA Energy R&D Statistics 2003."
*2) Data based on author's estimation, including deployment subsidies.

Table 1 Cost and benefit of Sunshine, Moonlight, and New-Sunshine Programs, 1974-2002.

Project Name (Total 23 projects)	[a] Cumulative Gov. Fundings [Bil. JPY]	[b] Cumulative Energy and CO_2 Emission Savings *		[c] Cumulative Energy and CO_2 Savings attributable to the gov. investment (40% of [b]) *	
		Energy Savings [Mtoe]	CO2 Reduction [Mt-CO_2]	Energy Savings [Mtoe]	CO2 Reduction [Mt-CO_2]
Photovoltaics	315	0.47	0.10	0.19	0.44
Geothermal	222	4.33	10.06	1.73	4.02
Fuel Cells	103	0.32	0.93	0.13	0.37
Wind Turbines	72	0.42	0.96	0.17	0.38
Solar Water Heaters	34	16.2	43.7	6.50	17.5
Advanced Gas Turbines	31	29.7	61.5	11.90	24.6
Advanced Heat Pumps	11	0.0039	0.0072	0.0016	0.0029
Eco-Energy Network	9	0.0012	0.0040	0.0005	0.0016
Industrial Heat Pumps	4	6.59	24.3	2.64	9.74
Coal Liquefaction	269	(No commercialized technology so far.)			
Coal Gasification	118				
(Other 12 Projects)	155				
Total	1,344 Bil. JPY	58.1 Mtoe	142 Mt-CO_2	23.3 Mtoe	57.0 Mt-CO_2
[d] Cost per unit reduction ([a]/[c])				57,791 JPY/toe	23,567 JPY/t-CO_2

[a] Cumulative governmental expenditures in R&D, demonstration and deployment, from 1974 to 2002, at 2002 prices.
[b] Cumulative savings achieved by commercialized technologies from Sunshine, Moonlight and New-Sunshine Programs. These technologies are assumed to have replaced next-best existing technologies. Photovoltaics, geothermal, wind turbines are assumed to have replaced grid electricity; solar water heaters for gas water heaters; fuel cells for grid electricity and gas boilers; advanced gas turbines (combined cycle generation systems) for LNG steam power generation systems; and industrial heat pumps for fuel boilers. Grid electricity is assumed to be 39.98% energy efficiency, 0.5kg-CO_2/kWh carbon intensity, as average figures from 1970's to 1990's.
[c] Cumulative savings attributable to the governmental investment. It is estimated as 40% of [b]. The figure of 40% is an assumed contribution factor of the government, which is approximately the same as the governmental contribution in energy R&D expenditures (excluding nuclear) from 1970's to 1990's.
[d] Governmental expenditures [a] divided by cumulative savings attributable to the governmental sponsorship [c]. The cost per unit energy saving (57,791 JPY/toe) is equal to 70 US$/bbl on the exchange rate of 120 JPY/US$, which is a little higher than the oil price in recent years. The cost of 23,567JPY/t-CO_2 is also higher than the price of CO_2 in the EU Emission Trading System, which is between 1,000 to 10,000 JPY/t-CO_2.
*) Note that our estimation is conservative in three points: it does not include savings beyond 2002; projects without commercialization so far may do so in the future; and there are various benefits accrued from the government-sponsored R&D projects other than realized energy and CO_2 savings, such as knowledge basis and human resources.