Electrification and climate change mitigation
− A scenario analysis of Japanese energy systems in the 21st century −

Background

As seen in the governmental long-term outlook for energy supply and demand up to 2030, energy and environmental policies and economic activities are expected to have long-term visions of energy systems which address the issues of energy security, climate change mitigation, and sustainable economic development.

Objectives

To identify the possible development path of Japanese energy systems in the 21st century under the strong constraints of climate change mitigation, by the scenario analysis;

Principal Results

We have examined the causality pathway as to how the rapid progress of end-use technologies will have impacts on the structure of future energy systems, and found the following:

(1) Steady electrification in the building sector is expected driven by technological progress such as in information technologies and social changes such as aging, even in the absence of climate change policy. Electricity demand in the building sector will continue to increase particularly for the demand category of "power and others," as a result of the continuous creation of electric appliances or equipments.

(2) With strong greenhouse gas emission constraints, the combination of accelerated electrification across all sectors and decarbonization of power generation is most likely to evolve in the future ("Reference scenario" in Fig.1). In the Reference scenario, electrification will proceed extensively by the widespread use of all-electric homes, plug-in hybrid vehicles, or battery electric vehicles by the end of 2050.

(3) For realizing the Reference scenario, it is indispensable to accelerate the technological developments and diffusions of electric and electronic technologies. Technological innovations for climate change mitigation need energetic business activities of the world's leading clusters of manufacturing industries in Japan and appropriate policy inducements harmonized with those business activities. Attractive products for meeting market needs, such as mobile phones, will create many new technologies and new products, which will then be upgraded through competition and further applications, and will finally yield innovative climate technologies, such as battery electric vehicles with supports from appropriate policy inducements (Fig.2). Less innovation will interrupt the reduction of CO_2 emissions ("Sloth scenario" in Fig.1).

(4) "Shift-to-gas" strategy (Fig.1), which advances the utilization of natural gas instead of electricity, will reduce the CO_2 emissions to a certain extent; however, will not be able to stop the emission increase afterward due to the lack of additional measures for the emission reduction. "Shift-to-Gas" strategy also involves two big risks; 1) being locked-in to distributed gas combustion would disturb the long-term and deep CO_2 emission reduction, and 2) the energy system would become fragile against soaring natural gas prices.

Future Analysis

To examine the role of the electric and electronic technology innovations by world's leading clusters of manufacturing industries in Japan for the global efforts to mitigate climate change.

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Reference

Sugiyama and Imanaka, 2006, "Electrification and climate change mitigation -A scenario analysis of Japanese energy systems in the 21st century -", CRIEPI report Y06018 (in Japanese)

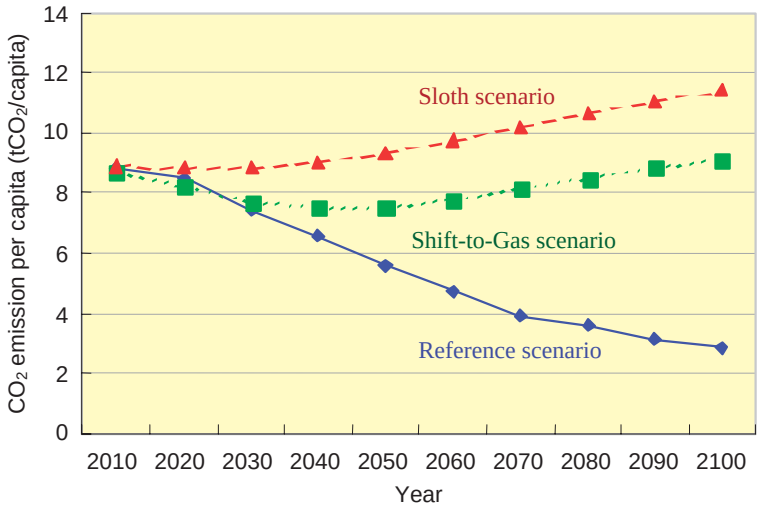

Fig.1 CO_2 emission per capita in scenarios

The CO_2 emission per capita will decrease significantly in the Reference scenario in contrast to the Sloth scenario where the emissions will increase gradually. In Shift to Gas scenario, per capita CO_2 emissions once decrease to a certain degree, however, will increase again due to the lack of additional measures for the emission reduction.

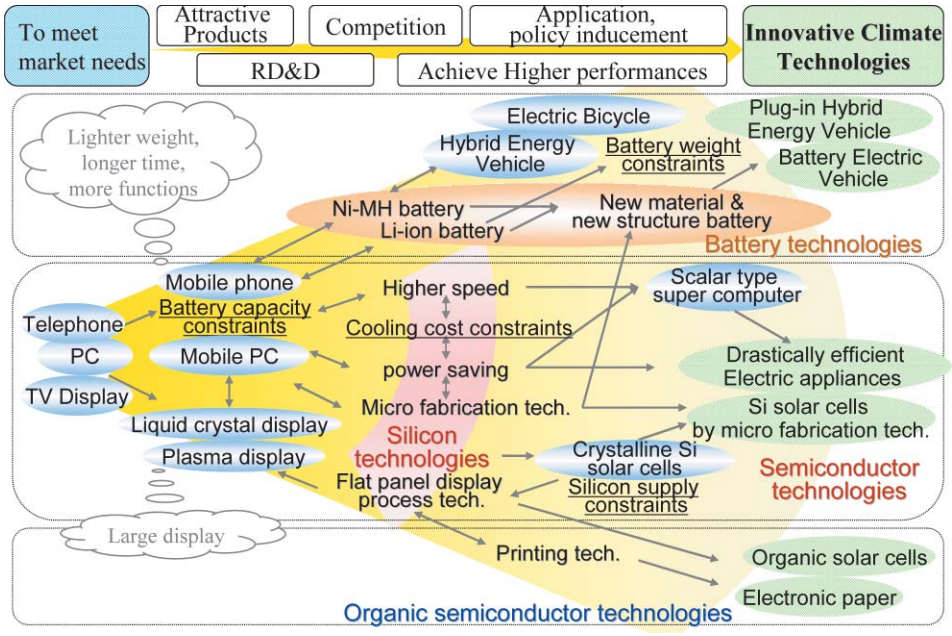

Fig.2 Inter-technology relationship between RD&D for attractive products for meeting market needs and RD&D for innovative climate technologies.

Attractive products for meeting market needs (mobile phones or mobile PCs) will create and upgrade many new technologies and new products (Ni-MH batteries or Silicon technologies). Those new technologies and products will be upgraded furthermore and finally yield the innovative climate change mitigation technologies (plug-in hybrid energy vehicles, battery electric vehicles, or organic solar cells) by energetic business activities for meeting market needs, with supports from appropriate policy inducements. (Underlines in the figure indicate the technical challenges for realizing the products.)