Local energy planning for Japanese municipalities

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ABSTRACT

Promoting renewable energy and rational energy use at local level is one of most urgent subjects in Japan. This study demonstrates the local energy planning with MARKAL model and evaluates the energy demand and supply system for 2030 in Tokyo Metropolitan Government, Hachinohe City, and Kuzumaki Town. Focusing on the size of renewable energy use, the business as usual scenario and CO2 reduction scenario are discussed. The optimization is performed considering future economic growth, energy intensity, energy cost, and advancement of energy technologies. It will be indicated from this study that the implementation of renewable energy at local level contributes to mitigate CO2 emission, but without incentives, the capacity is not sufficient to satisfy the future energy demand. The sustainability of local energy system should be realized by cooperation between local government and the national government.

INTRODUCTION

Since around the mid-1990s, some of the Japanese local governments have launched rather advanced policies in order to introduce renewable energy. Given the long-term predominance of the central government in the energy policy area, the commitment of local government is of importance and what promote it should be explored. The local energy planning which shows the scenarios of energy demand and supply linkage at local scale on a medium-long-time horizon is a suitable method in promoting energy policy. Thus, in this sturdy, we shed light on the most notable local initiatives with different types of Tokyo Metropolitan Government, Hachinohe City, and Kuzumaki Town.

CASES

Tokyo Metropolitan Government:

Tokyo is capital of Japan having a population of 12.65 million with an annual mean temperature of 17.3 degrees. Gross production is 84,762 billion yen that is about one sixth of the entire Japan. The total energy demand is 830,000TJ in 2001. In Tokyo, Governor Shintaro Ishihara's top-down decision-making system makes them as a policy maker by setting ambitious and, to some extent, regulatory targets and rules in energy plans: reducing GHG by 6% until 2010, raising the rate of renewable energy in the final energy consumption to 20% by 2020.

Hachinohe City:

Hachinohe is an industrial city of Aomori Prefecture in northern part of Japan. The total energy demand in 2001 is 71.43TJ. The current population is 247 thousand and the annual mean temperature is 10.1 degrees. Hachinohe launched microgrid project in 2003 trying to build small-scale (610kW) decentralized green electricity network system in the city. In 2004, Hachinohe decided the energy vision including renewable energy target to be 6% in the final energy consumption in 2010. For this ambitious, establishing the "Citizens energy company" and expanding microgrid system with various sources of large-scale PV systems, biomass generations, the incinerator, fuel cells, offshore wind system are being examined in the city.

Kuzumaki Town:

Kuzumaki is a mountainous town in Iwate Prefecture having a population of 8.37 thousand. The altitude 400 meters or more accounts 95% of the entire town, and the farming and forestry are key industries. In 1999, the current mayor Tetsuo Nakamura, paying attention to strong wind, woody and livestock waste, started to use these "negative resources" for renewable energy. Since then, "Be top of Japan in the use of renewable energy" has become their policy slogan. In present, about 56 million kWh accounting 185% of total annual electricity supply is from renewable sources such as wind power generation, solar PV, biomass generation, livestock methane gasification.

METHODOLOGY

The ALEP:

In the regional study, many have already discussed about the introduction of renewable energy, but the studies of two or more renewable energies and the attempt to the linkage between the energy demand and supply have not appeared until recently. One of most interest researches is Advanced Local Energy Planning (ALEP) initiated by International

Energy Agency (IEA). Some of the European cities such as Göteborg/Sweden undertake the project in accordance with ALEP methodology. The ALEP process is divided into 5 phases: assessment of the present situation; main study with energy modeling; evaluation and decision; implementation; and improvement and monitoring. Many of the Japanese local governments are in assessment phase and it will be necessary to show the way for promoting the next main study. Fundamental steps of the main study are: defining reference energy system (RES) with the energy balance table, optimizing the scenarios running the model, investigating the steadiness of the solutions, and assessing the robustness of the selected measures.

MARKAL model:

MARKAL (Market Allocation) is an engineering bottom-up model that has been developed by Energy Technology Systems Analysis Program (ETSAP) of IEA since the late 1970's. Using linear programming structure, MARKAL allows users to optimize energy and material flows under the various constraints such as decreasing oil dependence, mitigating environmental effect, and maximizing energy saving. MARKAL represents energy flows from supply to demand with various components of resources, energy carriers, conversion technology, process technology, demand-side technologies, and demand sectors. MARKAL has 6 time slices by indication of seasons and day-night. In Japan, the Japanese MARKAL has been developed by Japan Atomic Energy Agency, assuming energy demand and supply composition from 1990 to 2050 and discussing the potential of nuclear energy utilization and the others.

FRAMEWORK

The RES:

This study demonstrates "main study" explained in ALEP using MARKAL model. By considering the basic concept of Japanese MARKAL, we have newly set the regional model suitable for a local scale. MARKAL is a technology rich model, so it would rather be sure that how to gather enough information and how to reflect in detail the structure of local energy system are significant challenges in regional MARKAL model. Fig.1. shows final energy consumption in Tokyo in the year 2000.

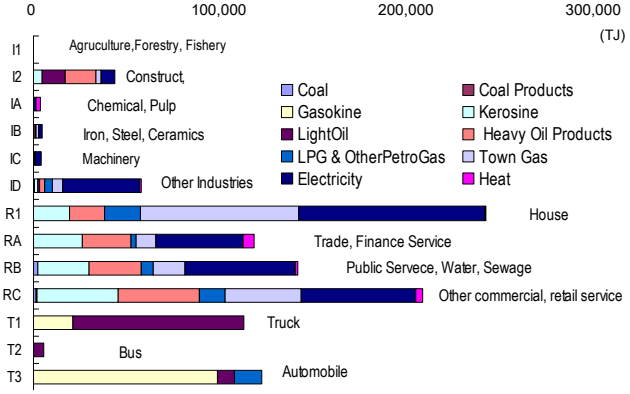

Fig.1 Final energy consumption in Tokyo 2000

Fig.2 shows a framework of the regional MARKAL model of Tokyo, Hachinohe, and Kuzumaki. Fundamental concept of this model is to find suitable combination of fossil fuels, heat, electricity, and renewables to meet the demand in 13 sectors (6 Industries, 4 Residentials, and 3 Transports) from the year 2000 to 2030 (seven 5-year periods). This model defines 2 types of energy: one is "dependant energy" of fossil fuel/products and electricity from the national grid, and "domestic energy" of solar heat, biomass fuels, and renewable energy electricity from distributed generations such as photovoltaic and wind power generations. On the other hand, each model reflects its differences in the geographic features, and the energy system boundaries, and the energy cost. After inputting values to each parameter and doing optimization, the model finds the least cost path to operate the system.

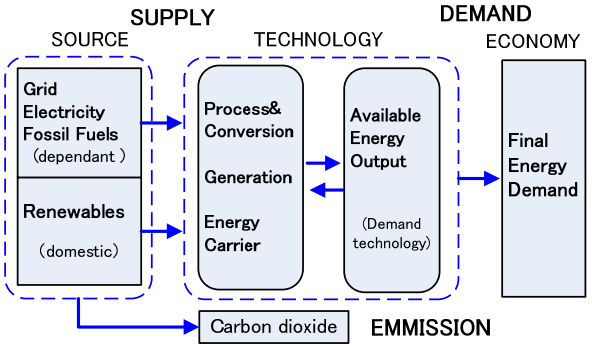

Fig.2 Energy Flows in regional MARKAL

The CO2 reduction scenario:

The MARKAL enables users to make alternative scenarios by changing the boundary conditions. In this model, we define the CO2 reduction scenario taking into account the renewable energy target in each government. The subsidy and other incentives to the installation were assumed to be use. The result is that the conventional energy system based on the grid electricity and fossil fuels is not only emitting much more CO2 compared with renewable energy, but also offering the energy with high marginal cost . Introduction of various renewable energies makes the energy output stabilizing and the cost averaging.

CONCLUSION

It will be indicates from this study that the local energy planning in regional level is variable in accelerating their motivation to CO2 reduction, however, the implementation of renewable energy without incentives is difficult in the present. Thus, sustainability of local energy system might and should be realized by cooperation between the national government and the local government.

REFERENCES

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