S-3 Low-Carbon Society Scenario toward 2050: Scenario Development and its Implication for Policy Measures

3. Effects of introducing countermeasures for carbon dioxide emission reduction in urban area（Abstract of the Final Report）

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1. Introduction

Carbon dioxide emissions in transportation, office and commercial and household sector have been increased significantly. Evaluation of potential reduction of carbon dioxide should be done with taking into consideration of urban activity and structure. Simple summation of reduction potential of each technology will overestimate the actual reduction in urban area, because its implementation is limited and there are interactive effects among technologies.

2. Research Objective

The research objectives are to develop the method of evaluation of potential carbon dioxide emission reduction in urban area, and to apply the developed method to cities with various sizes and in various climate conditions in Japan in 2020 and 2050. The unique method of this research is to evaluate the effect of implementing integrated technological options into actual cities for carbon dioxide emission reduction. Prediction of cities in the future target years is also included.

3. Research results

1) Scheme of the modeling

Carbon dioxide emission is compared between the case with and without countermeasures in various cities in 2020 and 2050. Scheme of evaluation of carbon dioxide is shown in Figure 1. Based on building geographical information system (GIS) data, energy consumption of electricity generation in building sector, photovoltaic sector, district heating sector, transportation sector were modeled. Electricity generation model can convert energy saving or generation effect into carbon dioxide emission reduction on hourly basis. Development of method was the main target in this year. Among various cities, Utsunomiya was chosen as the main target city.

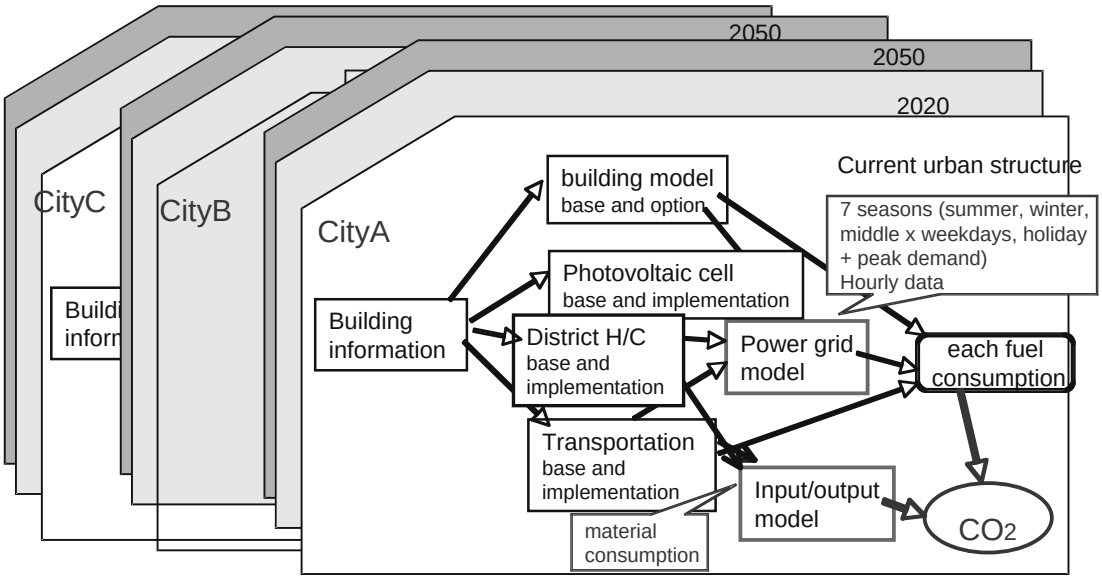

Figure 1. Flow diagram of evaluation of carbon dioxide emission in urban area.

2) Urban scenario and integrated evaluation

Five cities, namely, Sapporo, Utsunomiya, Tokyo, Hiroshima and Naha were chosen as standard cities. These cities vary in their size and climate conditions. Potential countermeasures in urban area were summarized as Table 1.

Table 1. Future trend of each emission sector and target innovative technology and policy.

Sector	Future trend and target innovative technology or policies	Remarks
Urban area	・More difference in population and development depending on city size ・Localized material flow ・Global information flow	・Implemented technology significantly differs depending on city size
Office and commercial	・More hospital and less school ・Innovation in insulation, air-conditioning, lighting, hot water supply	・Floor area for each purpose will significantly change due to less population and social change.
Transportation and automobile	・decrease of commutation trip and increase of leisure trip ・Implementation of innovative fuel automobile ・Change in public preference of car ・Decrease of trip due to SOHO ・Home and office relocation ・Innovation of carbon neutral fuel	・Shift in trip purpose
Energy supply	・Home-scale cogeneration ・Fuel cell in grid electricity ・Increase in photovoltaic cell ・Implementation of innovative fuel cell and photovoltaic cell	・Uncertainty in new technology development and implementation

3) Innovation in energy supply to urban area

Future trend of fuel source for electricity generation was simulated up to 2035 with dividing Japan into nine regions assuming that implementation of carbon capture

technology. The simulation is to show the optimal fuel source balance for every one hour in seven seasons, namely weekdays and weekend in summer, winter and spring/autumn, and the peak days. The results show that 70% reduction of carbon dioxide emission against 1990 level is possible even without demand side management and no significant increase in nuclear power plant.

4) Energy saving in building sector.
The effect of implementation of energy saving countermeasures in building in Utsunomiya City was evaluated up to 2020. Carbon dioxide would increase by 35% against 1990 in business as usual case. On the other hand 3% reduction is possible by increase in insulation performance, implementation of electric heating, cooling, and hot water supply system, innovative electric appliance, and life style change.

5) Photovoltaic cell development
Life cycle assessment of innovative photovoltaic cell was conducted. Three different cell performances were assumed based on the trend of technology innovation. Carbon dioxide emission intensity was about 1/10 of grid electricity. Electricity cost will be low enough to compete with grid electricity. The simple calculation considering the roof area in residential sector shows that potential electricity supply by photovoltaic cell in Utsunomiya City is five times of the demand.

6) Urban mobility
Both passenger traffic and freight traffic were analyzed to see the potential reduction of carbon dioxide by decreasing the demand. Preliminary analysis in Utsunomiya City shows that about 40% of carbon dioxide could be reduced by relocation of house and office so that the average distance becomes short. Freight traffic has longer trip and is loaded higher than Tokyo.

7) Urban heat recovery for energy saving
Utilization of sewage heat into heating and cooling was simulated by developing a model of district heating/cooling system using geographical information system on building use and sewer pipe network. The area showing the maximum reduction of carbon dioxide was chosen by comparing hundreds of cases. When hear recovery in introduced into 5 places along one sewer trunk in part of Tokyo, the maximum reduction of carbon dioxide was 9,900 t-CO2.

8) Induced carbon dioxide emission by urban activity
Input/output analysis was conducted for Sapporo City to know the intensity of induced carbon dioxide emission. Electricity supply, transportation and household sector are the major emitter of carbon dioxide. This suggests that countermeasure in these sectors, such as fuel change in electricity, long-life building and energy saving in service sector

are effective in Sapporo City.

9) Relationship among stakeholder for technology implementation
Stakeholders such as national government, local government, company and citizens are competing in implementation of countermeasures for carbon dioxide emission reduction. To simulate the strategy and know the final results a model was developed. This model gives the most reasonable implementation after compromising the benefit and loss among the stakeholders.

10) development of integrated tool for knowledge sharing
Web-based collaboration platform to support the transformation of knowledge from different experts in the group to an explicit, easily sharable form was developed. The site is divided into a publicly accessible set of web pages for dissemination of information about the project to the general public and a login site that allows members to access personal databases that they can modify in order to describe their knowledge related to the project and comment on knowledge representations provided by other members. This platform is currently used among the research group, but it could be open to the outside.

4. Research strategy
The research strategy toward the final goal was discussed intensively. Five cities, namely Utsunomiya, Sapporo, Tokyo, Hiroshima and Naha were chosen based on city size and climate condition. Scenario of social condition of these varieties of cities in 2050 will be set up and the effect of countermeasure will be evaluated. The overall emission and effect of countermeasures in Japan will be analyzed based on the research results of these five cities. Utsunomiya was chosen as a target city in FY2004. The analysis of other city as well as predicting future urban activity should be done.