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

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Key Words Urban area, modeling, building, photovoltaic cell, electricity

I. Overview

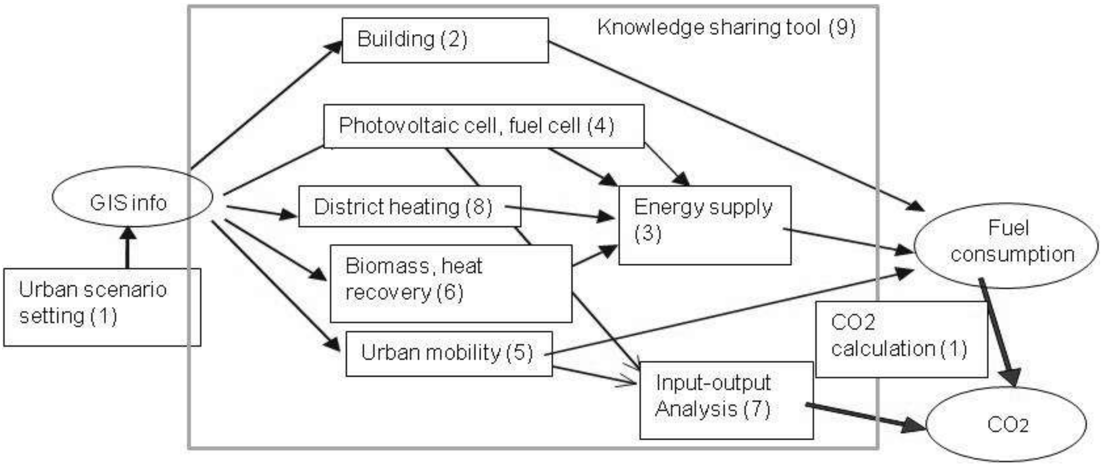


Figure 1. Collaborative research work

As shown in Figure 1, this research was conducted with collaboration of various researchers. Urban scenario setting (theme 1) provides information to calculate CO_2 emission from building (theme 2) as well as from transportation (theme 5) whereas photovoltaic cell (theme 4) as distributed energy source, district heating/cooling (theme 8), biomass and waste heat utilization (theme 6) were also analyzed. Effects of these energy supply and consumption on energy supply sector (theme 3), input-output analysis (theme 7) were studied. These are integrated to estimation of CO_2 emission (theme 1). The collaboration among these themes is strengthened by knowledge sharing tool (theme 9).

II. Scientific outcome

1) Urban scenario and integrated evaluation

This research enabled quantitative analysis about the effect of urban condition on the CO_2

emission reduction by implementing various countermeasures to urban area. The research provided basic information and methods of utilizing various types of geographical information systems. Advantage of compact city was shown in this research. These findings are novel in the research on urban activity in the context of CO_2 emission.

2) Innovation in energy supply to urban area

The output of PV in the Kanto region was estimated from the meteorological observation data for one year by the time series every ten minutes. The simulation result of the optimal power generation mix model indicated that the expected load following capability of fuel fired power plants has a possibility to eliminate the necessity of large-scale power storage plants, and to lessen the economical cost to introduce PV extensively in the power system.

3) Energy saving in building sector

We developed a prediction model for CO_2 emissions related to operation, construction, renovation and dismantlement of all kinds of buildings (houses, offices, commercial buildings, medical facilities, educational facilities, accommodations, others) in Japan up to 2050. It is now possible to provide information to policy makers for achieving the national target of CO_2 emissions up to 2050 in building sector.

4) Introduction of photovoltaic systems into cities

Power generation of photovoltaic cell was accurately evaluated for each prefecture which has varieties of solar radiation and temperature. Power generation cost, cost pay-back time and energy pay-back time were evaluated for each prefecture. Effectiveness of battery system was demonstrated to minimize life cycle cost.

5) Urban mobility

A simulation model of area-based road pricing system was developed and applied to Okinawa city. Economic aspect as well as transportation control was examined in the road pricing system. The developed model was more sophisticated than the conventional ones.

6) Biomass and heat recovery in urban areas

The realistic projection was done for potential of biomass and waste heat use through developing the simulation models. For example, the material flow model of wooden resources, incorporating building, paper production and energy sectors, was developed for integrated assessment of policy scenarios in these sectors. The combined sewage heat transfer and district heating and cooling systems model was developed for sophisticated estimation of the potential of sewage heat utilization.

7) CO_2 emission change in interregional physical distribution

A novel method of the input-output analysis for physical distribution is proposed in this study. Using "Physical Distribution Census" published by National Land and Transportation Ministry in Japan, we developed the method to calculate the physical distribution induced by a unit of final demand and the physical distribution derived by a unit of production. Induced and/or derived CO_2 emissions are directly calculated from induced and/or derived physical distribution.

8) Contribution of CGS, DHC and HP to the potential CO_2 emission reduction in the urban area

The models were developed to estimate the contribution of distributed power system. Although our study could have dealt with the limited number of regions, we have proposed a new method and assessed the contributions of CGS and HP to reduce carbon emissions from the view of macro level considering the micro level properties on both the demand pattern and the energy equipments in the consistent manner.

9) Development of integration tools for sharing knowledge between various actors

We have constructed a "web-based collaboration platform" for using the Internet to support more effective sharing of the knowledge of experts. Based on that platform, we used the DOME (Distributed Object-based Modeling Environment) model integration software to develop a method for integrating and evaluating individual computational models created for each of the different technologies and policies. Specifically, we carried out the integration of a “power planning and dispatch” model developed in Matlab with models developed in MS Excel for reducing energy in the construction and operation of commercial and residential buildings. Although each of the individual models had been developed independently by different researchers in the urban countermeasures subgroup without any special consideration of integration, by using DOME we were able to build an integrated model that was capable of evaluating interactive and time-dependent effects that could not be obtained through the separate models. Finally, in order to enable the integration of an even wider range of related knowledge, we used a method for creating computer-interpretable semantic statements together with several advanced information technologies to develop a web-based platform for sharing, discovery and integration of expert knowledge related to the achievement of a Low-Carbon Society.

III. Contribution to policy of global environmental issues for decision makers

1) Urban scenario and integrated evaluation

The developed methods in this research can be used as powerful tools in the development of CO_2 emission reduction strategic plan of the nation or the city. Estimation of the effect of compact city on CO_2 emission reduction is meaningful to the local government. Though the results are not yet used in local governments, there are significant potential of their use in various cities.

2) Innovation in energy supply to urban area

The interaction between urban energy suppliers and consumers is a very essential issue in the actual implementation of countermeasures. The results of this research suggest the necessity of integrated simulation including both sides.

3) Energy saving in building sector

Findings from this research contribute to setting a national target of CO_2 emissions up to 2050 in building sector and try to feed the result back to the estimation of IPCC.

4) Introduction of photovoltaic systems into cities

Implementation of photovoltaic is one of the most important issues in Japan. Although cost evaluation is very crucial in this technology, there exist several influencing factors. This study showed the cost in various prefectures which have different solar radiation, temperature and other conditions.

5) Urban mobility

Road pricing has been discussed in various cities but not yet introduced. This research provided a simulation tool to predict the effect of such pricing system. Optimal job-housing relocation proposed by this research is an important in long-term planning of low carbon city.

6) Biomass and unused energy use in urban areas

Findings and models developed will contribute not only to national policy, but also to local governments to discuss their action plan. The quantitative results of this study give basic information of various types of biomass and waste heat.

7) CO_2 emission change in interregional physical distribution

We calculated the derived physical distribution and CO_2 emissions when 1000 kg of farm and marine product is demanded in Hokkaido and Tokyo. Modal shift to rail and marine transportation is simulated and the CO_2 emission reduction potential is also evaluated.

8) Contribution of CGS, DHC and HP to the potential CO_2 emission reduction in the urban area

Distributed power system is one of the most promising energy supply systems in urban area. This study provided several important results which should be taken into account in implementation of such system.

9) Development of integration tools for sharing knowledge between various actors

This web-based collaboration platform and ontology provide an effective knowledge resource for evaluating, predicting, and planning the multi-dimensional aspects of mid to long term policy options aimed at achieving a Low Carbon Society. Based on the research results, we believe that it is possible to construct a collaboration platform for supporting the sharing and integration of knowledge of experts both inside and outside the project that can be used as an effective planning tool for global warming countermeasures.

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 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) Urban scenario and integrated evaluation

By using the best available database of urban building survey, telephone book and the city map, the analysis developed a methodological framework of how the spatial distribution of the energy use and accompanied CO_2 emission could be estimated. A mixed floor use of each building and demand of electricity and gas were estimated by the database. In addition, the regional differences were taken into consideration by calculating an adoption ratio of installed air conditioning unit in buildings and the composition of technologies for power generation at each locality (e.g. nuclear, hydro, coal, natural gas etc.). Approximately 8.57 Mt- CO_2/year, 1.43 Mt-CO_2/year, 2.53 Mt- CO_2/year were emitted from Sapporo, Utsunomiya and Naha City, respectively. The methodological framework developed could be a base for setting a future scenario of cities and thus important in terms of assessing various CO_2 reduction technology options in cities. Figure 2 shows the spatial distribution of CO_2 emission in these three cities.

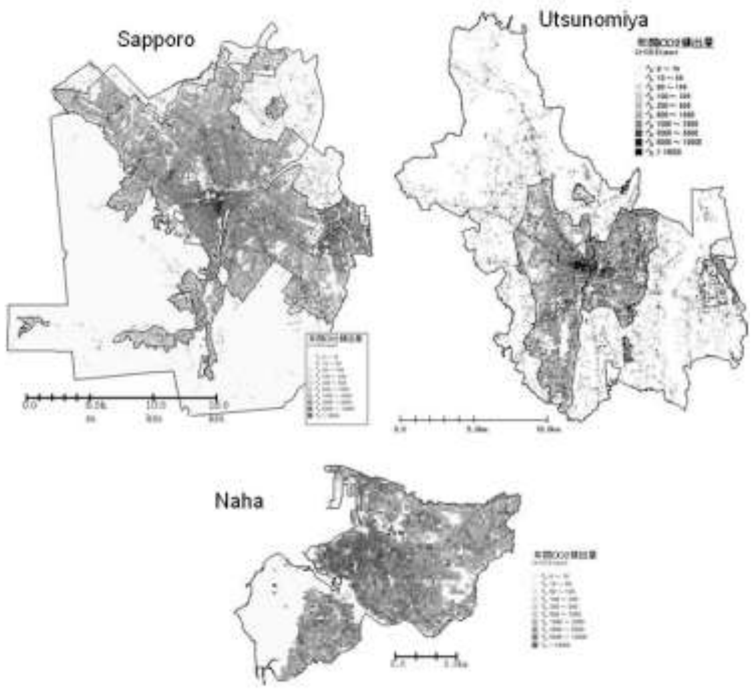


Figure 2. Spatial distribution of CO_2 emission in three Japanese cities.

An influence of 'urban form' to an installation of climate change mitigation technologies and their impacts were analyzed. Three urban forms were considered, namely 'centralized and concentrated distribution form', 'de-centralized and scattered distribution form' and 'mixed centralized and de-centralized form'. Considering the given social scenario in 2050 and those suggested urban forms, a photovoltaic cell technology and a local heat distribution technology, e.g. a district heating system, were analyzed, and their installation rate and CO_2 reduction potential were calculated in each case. The results showed that the centralized and concentrated distribution scenario enjoyed the benefit of both technologies, and in total of 24% of CO_2 emission from buildings' energy demand could be avoided. Whereas in the de-centralized and scattered distribution scenario, no area was found to be suitable for an installation of the local heat distribution technology and the total CO_2 reduction potential remained about 20%. The reduction potential of mixed centralized and de-centralized scenario was the lowest. This indicated clearly that a strategic urban planning for the future would be necessary to maximize the climate change mitigation impact for cities. Further study should improve the following two points, namely the analysis in terms of a threshold of installation for those technologies and other technologies largely depending on the urban form, e.g. waste collection & incineration, drinking and wastewater treatment & distribution, local public transportation etc.

2) Innovation in energy supply to urban area

The influence of the extensive introduction of the residential co-generation systems (CGS) and heat pump (HP) for water heaters were evaluated through the use of 4,700 of household energy system models and an optimal national power generation model for Japan. The optimal operations of CGS and HP for each household, which has severely fluctuating power and heat load curves, are modeled through stochastic dynamic programming. Furthermore, the effects of the extensive introduction of Plug-in Hybrid Electric Vehicles are also investigated with the assumption that each electric vehicle has 6kWh battery that enables cruising range of around 30km at one electric charge. The optimal power generation model involves CO_2 capture and storage technology as one of the abatement measures of CO_2 emissions.

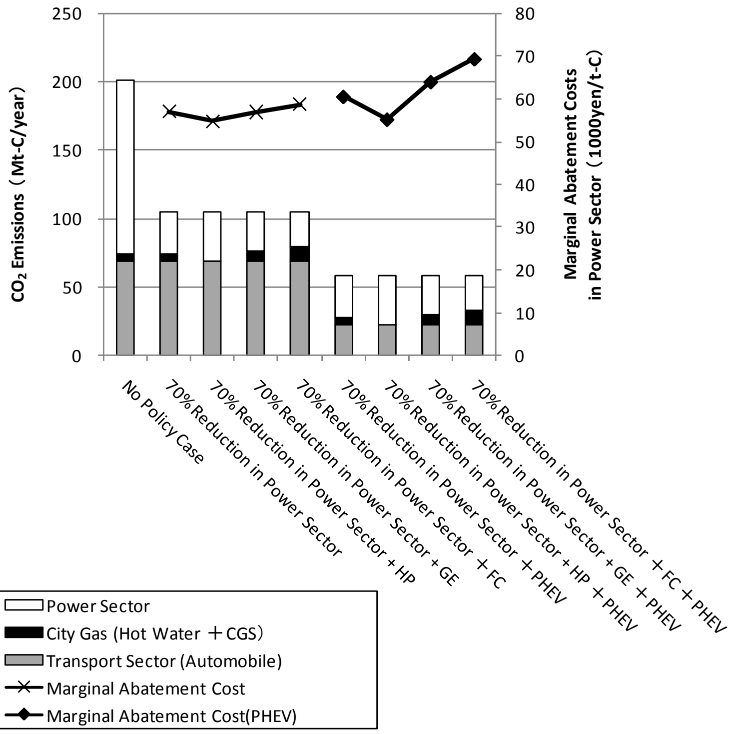


Figure 3 CO2 emissions and marginal abatement costs in 2050 by case
(GE: Gas Engine CGS, FC: Fuel Cell CGS)

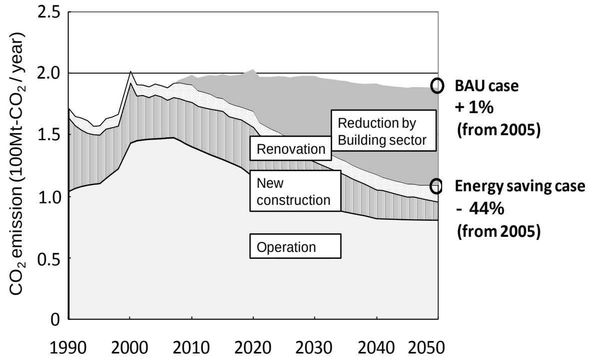
The results show that 70% reduction of CO_2 emissions from the power generation sector against 1990 level is possible with the significant utilization of CO_2 capture and storage. The CO_2

emissions and marginal abatement costs in 2050 by case are summarized in Fig. 3. The technological options of extensive introduction of CGS and/or HP in household sector, however, may not cause a big difference in the marginal abatement costs of CO_2, which are around 60,000yen/t-C. This is because the absolute amounts of energy consumption and CO_2 emissions of household sector are limited. The effect of extensive use of PHEV on the CO_2 reduction is expected to be relatively large. If CO_2 emission coefficient of grid electricity can be reduced significantly with CCS and so on, the increase in the marginal abatement cost of CO_2 in electric power sector may be suppressed, even if PHEV uses are widely spread.

The output of 40GW PV in the Kanto region was estimated from the meteorological observation data for one year by the time series every ten minutes. The simulation result of the optimal power generation mix model of linear programming type indicated that the expected load following capability of fuel fired power plants has a possibility to eliminate the necessity of large scale power storage plant deployment, and to lessen the economical cost to introduce PV extensively in the power system. The result also indicated that the expected excessive output powers of PV, which are to happen in good weather weekend in intermediate seasons, should be simply discarded to minimize the annual total system cost.

3) Energy saving in building sector

The aim of this research is to develop a model which estimates energy consumption and CO_2 emissions related to construction, operation and renovation of building sector(houses, offices, commercial buildings, medical facilities, educational facilities, accommodations, others) in Japan up to 2050. It is also targeted to provide scenarios to achieve the national target for Japan. We estimated 3 scenarios regarding energy consumptions and CO_2 emissions. The first scenario, scenario A expects the urban concentration type society: an active, quick-changing, and technology oriented society. The second, scenario B expects the local decentralized society: a calmer, slower, and nature oriented society. The third, scenario M expects the middle scenario A and B. Each scenario assumes two cases, including the measure of electric sector or not. (The case which CO_2 intensity of electric power supply does not change after 2005, and the case which CO_2 intensity of electric power supply values is based on the “Energy technology vision 2100”. The result of estimation on CO_2 emissions from buildings is shown as Fig.4 and 5. CO_2 emissions in 2050 will increase 1% in the BAU case and decrease 44% in energy saving case. Moreover, the scenario including measure of electric sector will decrease CO2 to 55% in the BAU case and 79% in energy saving case. CO_2 emissions from houses related to new construction, renovation and dismantlement are shown as Fig.6. CO_2 emissions in 2050 will decrease 52% in scenario A and 54% in scenario B. CO_2 emissions from houses related to operation are shown as Fig 7. CO_2 emission in 2050 will increase 5% in the BAU case and decrease 65% in energy saving case.



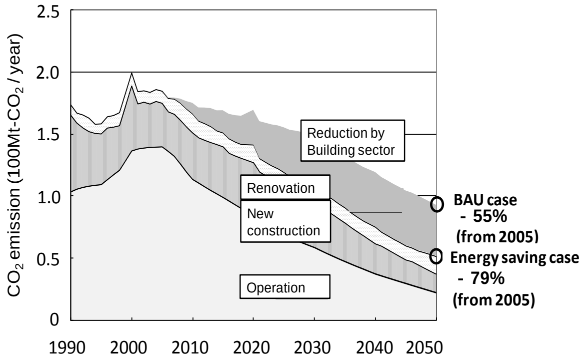
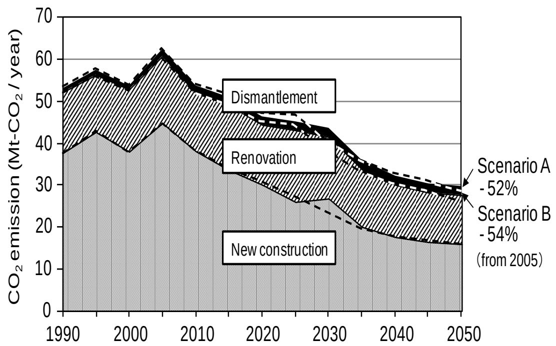


Figure 4 CO_2 emission from buildings (Scenario M, no measure of electric sector)

Figure 5 CO_2 emission from buildings (Scenario M, include measure of electric sector)



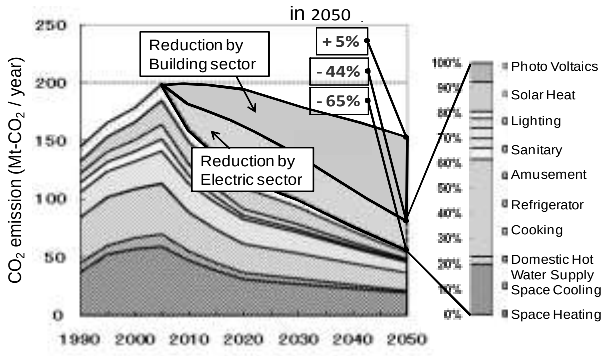


Figure 6 CO_2 emission from housing related to new construction, renovation and dismantlement (BAU case)

Figure 7 CO_2 emission from housing related to operation (scenario M)

4) Introduction of photovoltaic systems into cities

Electricity supply by introducing roof-top photovoltaic (PV) systems in Japan was predicted based on the forecasted future floor areas of residences and NEDO's roadmap of PV systems. The results indicated that the introduced PV systems could supply about 40 % of the total electricity generated in Japan in 2050 and about 60 % of the total roof area of the residences in Japan was covered by the PV modules. The ratio of electricity supply by the introduced photovoltaic systems to the electricity consumption significantly varied among prefectures. Kagoshima prefecture has the highest value, 82 % while Osaka prefecture has the lowest value, 33 % (Fig 8).

In order to enable such large-scale introduction of PV systems, problems associated with grid connection must be overcome. Therefore, two types of PV system with a battery, that is, i) a PV system with a battery isolated from the grid and ii) a grid-connected PV system without a reverse power flow, were proposed and evaluated. The results showed that the former system was not feasible from an economical standpoint even if the battery price was reduced to a tenth of the present value. On the other hand, the electricity cost of the latter system could be comparable with the present price of the grid electricity if the battery price were reduced to the same extent, and it would be an effective way to enable introduction of PV systems in large quantity.

CO_2 reduction cost is an important index for evaluation of economical feasibility and priority as a countermeasure against global warming. In this study, CO_2 reduction cost of a 3.5 kW roof-top grid-connected photovoltaic (PV) system was estimated for different prefectures in Japan by taking into consideration meteorological conditions of prefectures and generation cost and CO_2 emission per unit of electricity by electric companies.

The CO_2 reduction cost at the present status of technological level and production scale was estimated at 95,000 yen/t- CO_2 as an average. It considerably varied among prefectures ranging from 40,000 yen/t- CO_2 at Okinawa to 130,000 yen/t- CO_2 at Nara. When it was assumed that the PV system was substituted for an oil-fired plant and a coal-fired plant, the average CO_2 reduction cost was estimated at 43,000 yen/t- CO_2 and 37,000 yen/t- CO_2, respectively. The results also indicated that a difference in the CO_2 reduction cost among prefectures became larger if the status of the technology was improved and production scale increased, resulting in decrease in cost of PV systems. In order to enhance introduction of PV systems in an more economical way, it would be better that the introduction of the PV systems is started from regions where the CO_2 reduction cost is lower and is extended to other regions where the CO_2 reduction cost is relatively higher after the cost of a PV system is reduced due to development of technology and growth of the production scale.

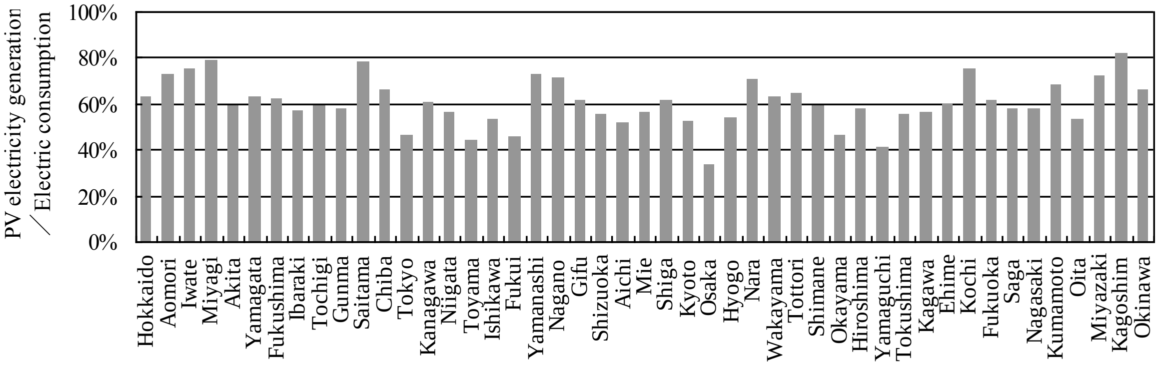


Figure 8 Ratio of PV electricity generation in 2050 to electricity consumption in 2004

5) Urban mobility

Both passenger traffic and freight traffic were analyzed to see the potential reduction of carbon dioxide by decreasing the demand. A job-housing location model considering modal split and congestion in network was developed in last academic year. The model applied to three different regions and high potentials of carbon dioxide reduction were shown. A trip-chain-based network model was developed and applied to evaluate area-based congestion pricing. Also, a new estimation method of freight traffic OD was developed and applied to the evaluation of road pricing measures in the Tokyo region.

We analyzed the effect of area-based road pricing and optimal job-housing relocation policy on reducing carbon dioxide emission derived from car, using network equilibrium models. we estimated the amount of short and single-occupant car trips, which can be replaced with walking and bicycle trips relatively easily, and CO_2 emission from those trips, based on the data of car-owner interview survey of Road Traffic Census. It showed that 5 percent of CO_2 emission from automobiles all over Japan could be reduced if all such trips were shifted to green modes. Also we estimated the potential of CO_2 reduction when each of the two future scenarios developed for whole this project come along with job-housing relocation or reduction of short car trips.

6) Biomass and heat recovery in urban areas

Potential of biogas production from urban wet biomass

Potential of biogas production from urban wet biomass, such as food waste and sewage sludge, was estimated in Japan, under future demographical and social scenarios until 2050. The amount of food waste from households, businesses and sewage sludge were projected based on the population in future scenarios, then the potential of these kinds of biomass was calculated based on the assumption of waste separation and competition with other use. Electricity and heat production was finally calculated by methane generation rate and efficiency of power generation.

Estimated potential of annual electricity production is 3,700 GWh in 2050. If it replaces the current grid electricity and heat generation by gas, 1.8 Mt CO_2 emissions can be avoided in a year.

Potential of wooden resources to use for energy production

A material flow model of wooden resources, incorporating forest management, housing and pulp and paper production sectors, was developed in Japan, then the life cycle CO_2 emissions by policy scenarios, including bio-ethanol production by cultivating rapid-growing trees, were estimated by 2050. Demographic changes were considered in future projection.

Figure 9 shows the potential of CO_2 emission reduction in 2050 by each policy scenario. "Bio-ethanol production" using cultivated trees and construction wooden wastes could reduce 26 million tons of CO_2 emissions, and has the largerst potential among five scenarios analyzed. Increasing "detached houses" and "recycled paper" ratio have caused the increase of CO_2 emissions. If both "bio-ethanol production" and "long-life wooden houses" scenarios are introduced, total CO_2 emissions reduction would be around 44 million tons and the synergetic effects to reduce CO_2 emissions could be expected. These 44 million tons corresponds to 4% of total Japanese CO_2 emission in 1990.

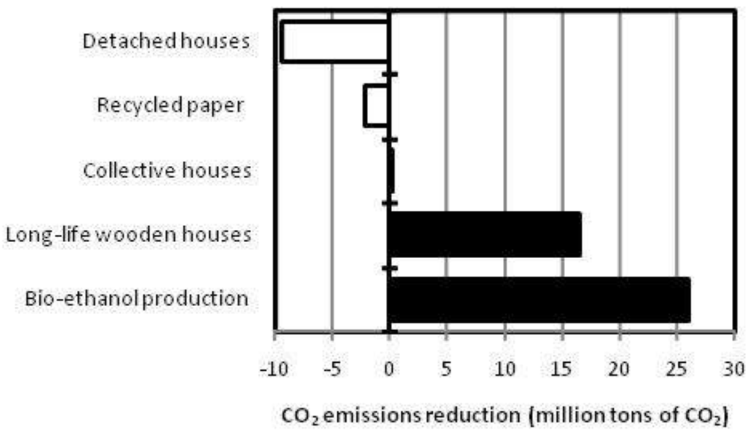


Figure 9. CO2 emission reduction by woodern resource management

Potential of waste heat from garbage incineration plants to district heating and cooling

Potential of CO_2 emissions reduction was estimated in the city scale (Yokohama) and nationwide. The amount of heat supply was calculated using statistical information, and the amount of heat demand around incineration plants was estimated by building and demographic information. CO_2 emissions for construction of pipe network were also assessed. In the shortest case for pipe network, it is expected that 2.8 million tons of CO_2 be reduced in Japan.

Potential of sewage heat to district heating and cooling

The plant operation model of district heating and cooling using sewage heat and sewage flow models were developed. Potential of CO_2 emissions reduction was calculated using these models by using current building information and sewage network in the Tokyo ward area.

In the Shibaura sewage collection area where we have the highest heat demand, 50 thousand tons of CO_2 could be reduced from the conventional district heating and cooling by gas. Then, the cost of CO_2 emissions reduction was estimated as 9.5 thousand yen per ton of CO_2.

7) CO_2 emission change in interregional physical distribution

A method of the input-output analysis for physical distribution is proposed in this study. Using "Physical Distribution Census" published by National Land and Transportation Ministry, we developed the method to calculate the physical distribution induced by a unit of final demand and the physical distribution derived by a unit of production. We applied this method to the evaluation of CO_2 emissions in 2050. Using the population scenario in 2050, we calculated the CO_2 emission change from the physical distribution in 2000. Then, we evaluated CO_2 reduction potential of modal shift to ship or train from automobile (Table 1). If the rate of modal shift is assumed as 40%, CO_2 emission reduction from 2000 reaches approximately 30% and 26% in the population scenario A and B, respectively. This result is promising for the contribution of the environment policy making because the CO_2 reduction potential in the automobile sector is explicitly evaluated.

Table 1 Calculated CO_2 emission, transportation cost and transportation time for each objective function when operating valuable is amount of interregional physical distribution (left) and use rate of each transportation (right)

Condition valuable / Objective Function	CO_2 emissions	Transport cost	Transport time
CO_2 emissions	57.5%	47.9%	92.9%
Transport cost	60.6%	44.1%	92.5%
Transport time	74.9%	54.6%	67.0%

Condition valuable / Objective Function	CO_2 emissions	Transport cost	Transport time
CO_2 emissions	53.8%	69.4%	122.7%
Transport cost	55.7%	65.4%	139.2%
Transport time	520.9%	206.0%	62.8%

We utilized the database of "Physical Distribution Census" published by National Land and Transportation Ministry and developed the method to calculate the physical distribution induced by a unit of final demand and the physical distribution derived by a unit of production. We proposed induced and derived physical distribution. Induced and/or derived CO_2 emissions are directly calculated from induced and/or derived physical distribution. The consistency between the estimated and actual physical distributions is verified for the method of the input-output analysis for physical distribution proposed in FY2006. It is very significant to verify the consistency between the actual data and the estimation so that we can maintain the reliability of this study. The model was revised in detail for the purpose.

After verifying the model, we calculated the derived physical distribution by a unit of final distribution in each region. Larger CO_2 emissions are derived from the regions whose consumption structure induces the transport from the other regions than the regions of local production and local consumption. Okinawa, for example, has large CO_2 emissions due to its location and Tokyo also emits large CO_2 due to its dependence to the other regions for the production of agricultural products consumed in the region.

We applied the model for optimization of CO_2 emissions, transport cost, or transport time. Potential CO_2 emission reduction is calculated as 43 million ton if the structure of our society becomes local production for local consumption and as 47 million ton if there is a progress on modal shift to railway or marine.

8) Contribution of CGS, DHC and HP to the potential CO_2 emission reduction in the urban area

We started the development of the model frame and evaluation procedure in 2004. We applied the regional model integrating GIS and the properties of energy equipments to Utsunomiya city considering the building constitution in 2005. In 2006 we evaluated the potential CO_2 reduction by applying the method developed by us to Sapporo and Okinawa in addition to those in Utsunomiya which locate in the north, the south and the central part of Japan. The results showed us that a linear relationship between the ratios of commercial building floor area to total building floor area holds across the sub regions of Sapporo, Okinawa and Utsunomiya in spite of the large difference of climate conditions as shown in Figure 10.

Extrapolating the relationship on the geographical distribution of residential building area of Utsunomiya, we evaluated the potential CO_2 reduction of the new energy equipments for 950 Japan cities where 18.6% CO_2 emission reduction potential in total is indicated.

In 2007, we applied the above method to the two future population projection cases, i.e. scenario A and B. The results suggest that the potential CO_2 reduction rate in 2050 comes to 42% and 38.6% in scenario A and B respectively according to the population decline in Japan. We also evaluate the new solar heat utilization technologies focusing on the efficient air-conditioning. Expanding our model to include the desiccant systems, we evaluate the potential contribution of the solar heat system in house and commercial building. The results show the optimum allocation of PV and desiccant system can improve the energy efficiency and CO_2 reduction more than the case of PV only.

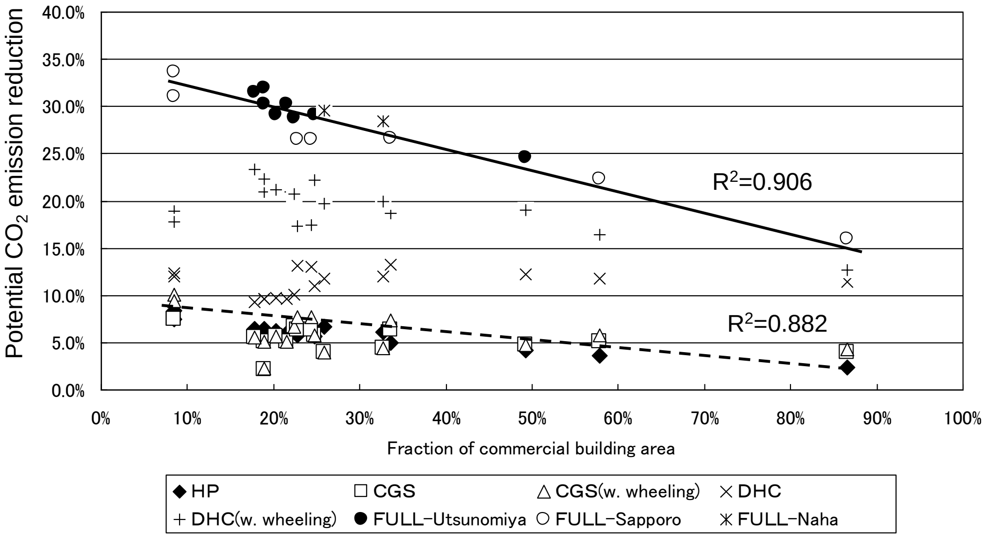


Figure 10 Relationship between the ratio of commercial building floor area to total building floor area and potential CO_2 reduction (Sapporo+Naha+Utsunomiya)

In 2008, we developed a model to assess the interactions between the utility and the diffusion of distributed energy systems including HP and PV to the consumer buildings. We focus on the area of Tokyo Electric Company dividing them into 38 regions. Reflecting the possible difference on the relative importance on the CO_2 emission and the cost minimization of utility and consumers, we employ the two stage optimization model; in the first stage, we evaluate the optimal implementation and operation of CGS and HP by region to generate the demand for utility. Then in the second stage, the optimal power generation planning is generated by minimizing the weighted sum of the total cost and the CO_2 emission. The results show that the potential CO_2 emission reduction in Kanto area is around 26% comparing with the cost minimization case without CGS and HP.

We have constructed a model to evaluate a distributed energy supply network system in an urban district and have evaluated the use of such a system in a real urban district in Utsunomiya. This model enables us to deduce an energy-saving plan, which involves the energy exchange between residential and commercial buildings within the district. We evaluated the CO_2 reduction potential as well as the energy saving rates for the following three cases. Case 1 involves the installation of a cogeneration system (CGS) in each building, case 2 involves the installation of a CGS in each building, where the buildings are connected within an energy exchange network, and case 3 involves the installation of a CGS in an energy exchange network such that purchase of electricity in the district is minimum. We observed that the energy consumption in case 2 was approximately 2% less than that of case 1.

9) Development of integration tools for sharing knowledge between various actors

We have been designing and constructing a Web-based collaboration and knowledge sharing platform to support the achievement of the project goals. In 2004 we constructed a basic web portal with an innovative "CO_2 technology table" for knowledge sharing between researchers. In 2005, we implemented interfaces for manipulating the computational models constructed by researchers both inside and outside the group through the Web-based platform. We also constructed an environment enabling access of computational models through the Web-based platform using DOME (the Distributed Object-based Modeling Environment) that integrated models for evaluating energy saving countermeasures in residential and commercial buildings and the effect on reducing electric power demand, as shown in Figure 11. In 2006, we used the integrated system model to calculate the CO_2 emissions for each of the nine major power companies in Japan. We were able to show the feasibility of calculating the total CO_2 emissions for Japan. In 2007 we adapted the EKOSS (Expert Knowledge Ontology-based Semantic Search) system developed in other research for application to the Web-based platform in order to realize more effective sharing of models and expert knowledge over the Internet. In particular, we created an ontology as a knowledge representation language capable of expressing the multifaceted nature of mid-term policy options for realizing a Low-Carbon Society. In 2008 we further developed the ontology, and we used the EKOSS system to create semantic statements of selected scenarios from the "Japan Scenarios and Actions towards Low-Carbon Societies" related to urban countermeasures as well as the expert knowledge of members of the urban countermeasures subgroup related to individual technologies that could contribute to achievement of a Low-Carbon Society. Finally, we examined methods for integrating knowledge at a semantic level based on those semantic statements.

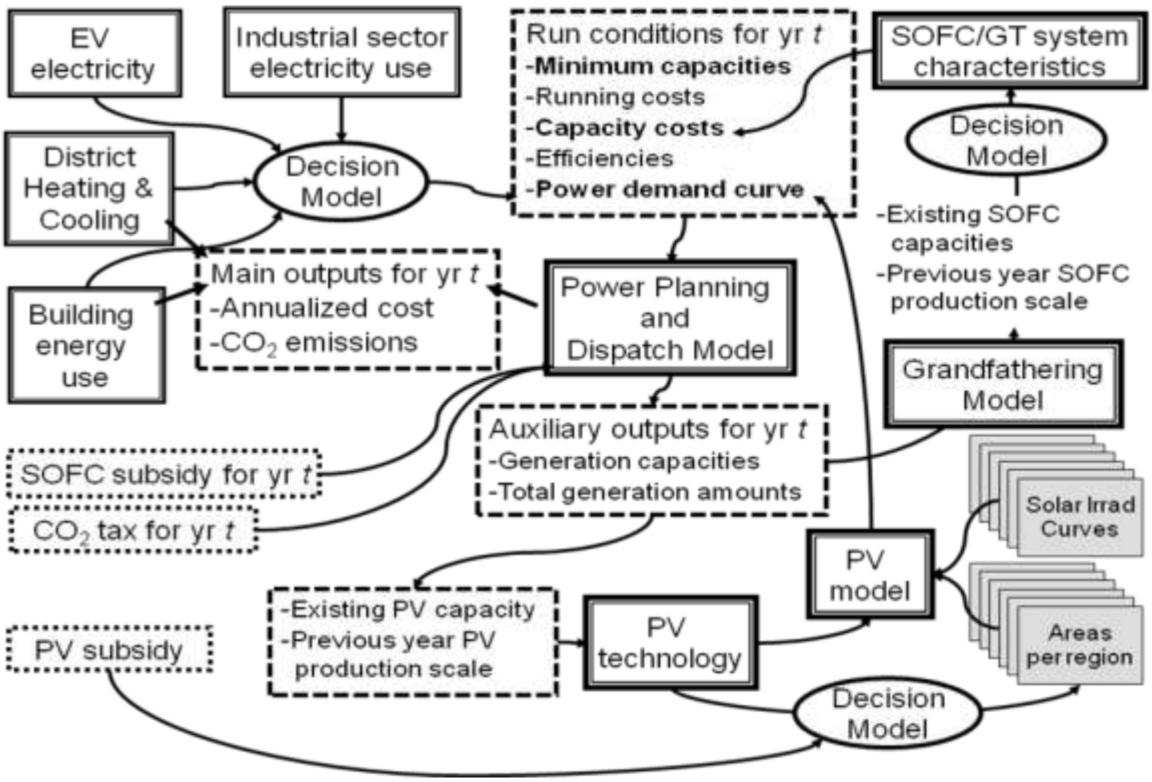


Figure 11: System of computational models integrated using the DOME model to explore positive and negative feedback loops concerning multiple technology and policy options for reducing CO_2

emissions from electric power generation in urban regions.

Major Publications (English papers only)

1) T. Maruyama and N. Harata: “Difference between area-based and cordon-based congestion pricing: Investigation by trip-chain-based network equilibrium model with non-additive path costs”, Transportation Research Record, 2006.
2) Shunsuke Mori , Junichi Ito , Takeshi Ishida and Shinichiro Morimoto: “A GIS-based Model for the Assessment of Energy and Environmental Contributions of Distributed Energy Systems”, Managing Environmental Knowledge (Klaus Tochtermann and Arno Scharl (eds.)), Proc. of the 20-th International Conference on Informatics for Environmental Protection, 107-114, Shaker Verlag, Aachen, 2006
3) Shunsuke Mori , Shogen Koike1 and Takeshi Ishida: “An Analysis of Regional Energy Demand and an Assessment of Potential CO_2 Emission Reduction in Japan using GIS”, Environmental Informatics and Systems Research, Vol.1, 459-463, Shaker Verlag, Aachen, Sep. 2007
4) Yoshikuni YOSHIDA and Ryuji MATSUHASHI: “Analyzing the Environmental Effect of Greening the Automobile Tax System in Consideration of Consumers' Preferences”, Journal of Environmental Information Science Vol.36, No.5, 81-86, 2008
5) Takeshi Ishida and Shunsuke Mori: “Integrated Assessment Model for Urban Energy Network System”, Environmental Informatics and Industrial Ecolohy - 22th International Conference on Informatics for Environmental Protection, 132-141, 2008, ISBN 978-3-8322-7313-2, Shaker Verlag, Germany