Extended Summary

1. OUTLINE OF THE PROJECT

Twenty-first century Japan is facing difficulties that must all be addressed at the same time: the two great issues of a super-aged society and a low-carbon society. For our country to achieve the goal of "by 2020, reducing levels of greenhouse gases by 25% compared to 1990" (former Prime Minister *Hatoyama*, 2009), which was laid out before the international community, the introduction of CO_2 reduction technology must be markedly accelerated. Subsequently, Japan's energy situation changed greatly with the effects of the Fukushima nuclear power plant accident caused by the Great East Japan Earthquake in March 2011. It is no longer as possible to greatly rely on nuclear power generation for energy supply as it was in the past. It emerged that it is even more necessary to accelerate the introduction of CO_2 reduction technology than it was before in order to make up for this deficit.

Meanwhile, Japan has become the world's most aged society; and if the super-aged society works in the direction of causing the economy and society to stagnate and contract, this could become a brake on realizing a low-carbon society. If it can become the case that the growing class of elderly are able to play an important role in actively participating in and contributing to society and, in addition, support CO_2 reduction, it could clear the path to realizing a "bright" low-carbon society that holds the possibility of sustainable growth.

In the present project, first, a future bright low-carbon city vision was constructed, the social system reform that is required to realize that vision was clarified, and the necessary technologies were researched and developed.

Integrated demonstration experiments was conducted in the Kashiwa-no-ha Campus Town (Kashiwa City in Chiba Prefecture) regarding the implementation of these measures, the bright low-carbon city was modeled from the results, and the outcome data was packaged, and it is expected that the data will be disseminated and deployed nationwide and around the world.

The mission of the project was to aim to realize a bright low-carbon society, and the specific goals are to:

- Carry out technology development for super-energy-saving heat pumps that utilize solar energy; develop super-compact electric vehicles; and develop senior plant doctor training programs that can be implemented in society; and unveil the social systems issues and propose reforms at the time the new technologies are implemented in society.

- Propose city planning and agricultural and landscape architecture planning that will allow for simultaneously overcoming the aging society and realizing a low-carbon society through demonstration experiments aimed at enhancing elderly residences and planning agricultural area utilization and green zone management activities to be conducted by the elderly.

- Package the program results and promote the program's spread and deployment around the nation and the world.

Implementation structure of this project is composed of a technology development and social reform promotion team with the University of Tokyo as the core organization and with the participation of Chiba Prefecture, Kashiwa City, and Mitsubishi Research Institute. The following six groups carried out the research and development: (1) energy, (2) mobility, (3) plant medical science, (4) city planning, (5) agricultural and landscape architecture planning, and (6) information systems.

The project, the "Urban Reformation Program for Realization of a Bright Low-Carbon Society," started as a part of the FY 2010 Strategic Coordination Fund Promoting Science and Technology's "Social System Reformation Program for the Creation of a New Society Matching Climate Change." The planned implementation period was five years, from FY 2010 to FY 2015. From FY 2011, the framework changed to the Strategic Funds for the Promotion of Science and Technology, and it continued to be implemented as a part of that program. From FY 2013, the framework changed to Funds for Leading Creative Science and Technology Development, and it was implemented as a part of the Comprehensive Promotion of Social System Reform and Research and Development "Social System Reformation Program for the Creation of a New Society Matching Climate Change." In FY2014, supplementary budget was compiled for this project, and was carried over to FY2015.

2. VISION OF A "BRIGHT" LOW-CARBON CITY

Kashiwa City's situation and challenges

Kashiwa, a city with a growing population, is located less than 30 km from central Tokyo. In addition to community deterioration, the city faces challenges such as the deepening problem of global warming, the rapid aging of the 5 population, and worsening economic conditions. Such challenges are expected to be faced by many other cities as well. This project will provide suggestions regarding the management of these challenges in efforts to expand the achievements of this project to other cities.

Vision of a "bright" low-carbon city

Without solutions to resolve the aforementioned issues, the aging of society and increase in vacant lots and homes will degrade the habitable environment. The reduction in municipal traffic and increase in shop closures will degrade various areas' attractiveness as places to live. There is a concern that these trends may result in a reduced quality of life among citizens, a decrease in employment and production, and an increase in municipal budget deficits. Short- and medium-term measures will be undertaken: among others, solar heat and biomass technologies will be adopted, communities will be created, more effective transportation networks will be facilitated through the usage of information and communication technology, the supply and demand for energy usage will be visualized and adjusted, and the social participation of the elderly will be encouraged through the utilization of vacant lots. In the long term, a city that is simultaneously "bright" and low-carbon will be targeted through the creation of core centers. Consolidating community functions in each area will ensure daily life functions, promote the creation of community, enhance social participation and outdoor activities among the elderly, reduce traffic, and encourage people to switch to transport alternatives with low CO_2 emissions, such as walking.

What does "Bright" mean?	What does "Low-Carbon" Society mean?
Ensuring a high quality of life and active lifestyle for the elderly and other residents	Reducing CO_2 emissions through a bright society lifestyles, mobility, industry, and absorption
・ Ensuring safe and secure lifestyles ・ Realizing comfortable and convenient lifestyles ・ Involving with society	・ Preventing personal CO_2 emissions ・ Preventing industrial CO_2 emissions ・ Preventing transportation CO_2 emissions ・ Protecting and creating greening

Realized image of a "bright" low-carbon city

The image of a Kashiwa as a "bright" low-carbon city will be realized in the establishment of core centers around railway stations and comfortable, habitable environments in suburban housing complexes with ample infrastructure. Specific descriptions of this plan are as follows. The urban cores will concentrate commercial functions around the core railway stations, suburbs will be areas that concentrate housing and daily functions, and rural areas will stretch around the suburbs.

Urban core areas	Suburbs	Rural areas
Creation of the "Kashiwa model" and the dissemination of information ・ An advanced, world-class, low-carbon lifestyle ・ Environmental city planning for the future with public involvement ・ A highly convenient life for the young generation	**Multi-generational communities to satisfy the needs of both families with small children and the elderly** ・ Broadly available housing, part-time farming, and community businesses ・ A high quality of life for all generations through work and community development activities ・ Multi-generational childcare support for working couples ・ A community where families with small children and the elderly are not isolated	**Recreational spaces and fields for activities** ・ Sustainable suburban agriculture as the sixth industry ・ Management of *satoyama* by citizens ・ Promotion of the tourism industry and fields for recreational activities ・ Unexpected spaces familiar to citizens
Network linking the above areas: A low-carbon public transportation network, participation in rural activities by urban and suburban citizens, a distribution system for second-hand housing that facilitates choice in habitation environments, an organizational system for sharing information at core centers in each area and conducting community management, the dissemination of information and management of the community by using ICT		

Expected effects of realizing a "bright" low-carbon city

Realizing Kashiwa as a “bright” low-carbon city is expected to exert economic and CO_2 reduction effects, which were estimated. The economic effects will derive from maintaining and enhancing residents’ health and the increase in consumption expenditures resulting from the increase in the number of elderly people enjoying agricultural activities. The CO_2 reduction effects will derive from the adoption of air conditioning driven by solar thermal energy and ultra-compact electric vehicles, greening activities by citizens, and resource recovery from a mixture of thinned timber and waste materials. Estimation was based on population estimates and a prediction regarding the dissemination of activities, which was obtained from an existing questionnaire regarding respondents’ inclinations to participate in agricultural activities.
The effects of implementing this plan in cities around the three major metropolises in Japan, which are as concerned about rapid aging as Kashiwa, were assumed identical to the effects demonstrated in Kashiwa. Potential effects were roughly estimated as follows, and the expansion of activities in the future will induce further effects.

Areas	Actions for the aging society (as of 2050)	Actions for CO_2 reduction (as of 2050)
Kashiwa	Consumption expenditures: Annual increase of 2.08 billion yen Health , care and park maintenances expenditures: Annual decrease of 430 million yen	CO_2 reduction effect: about 25 kt-CO_2
Nationwide development 113 cities around three metropolises	Consumption expenditures: Annual increase of 119.7 billion yen Health , care and park maintenances expenditures: Annual decrease of 24.5 billion yen	CO_2 reduction effect: about 2,253 kt-CO_2

3. ENERGY GROUP

As part of the urban transformation program for the realization of a bright low-carbon society, the present study focused on the development of a high-concentration photovoltaic and thermal (HCPVT) system that simultaneously generates electricity and heat. The feasibility of such a cogeneration system applied in the Tokyo area is analysed by comparing with other photovoltaic and solar thermal systems. By concentrating the sunlight to a multijunction solar cell while using an effective cooling unit to control the temperature of the solar cell below 100 °C, the HCPVT system can harvest the same amount of electricity with additional thermal energy to provide a heating effect or drive an absorption chiller to provide a cooling effect. Compared to other systems that can only generate electricity or thermal energy, an HCPVT system has the highest annual economic yield and is the only system with a payback period that is less than 10 years. An HCPVT system is a promising technology for the realization of a low-carbon society.

Another important task of this program is to develop a super-high-efficiency heat-pump system using the recovered solar thermal energy for heating, cooling, and dehumidification, which operates year-round. Specifically, the intention was to implement a comprehensive study that included conceptual design; fundamental theoretical and experimental studies; system design; and practical applications of a solar-energy-driven absorption chiller, a desiccant air conditioner, and an ejector–vapor compression hybrid air conditioner. The purpose of this study was to design a system to provide an environment with a comfortable temperature and humidity for the health maintenance of elderly people, the reduction of carbon emissions by introducing renewable energy, and the promotion of the participation of elderly people in society.

As for the solar absorption chiller, a double-effect absorption chiller assisted by solar thermal energy is proposed, and its system performance is analysed through cycle simulation. It is found that the latent-heat input reverse-flow cycle has better performance than the other configurations for the utilization of solar thermal energy. In addition, a direct comparison of the measured input heat and coefficient of performance (COP) of the actual solar absorption chiller with the predicted results shows good agreement. The overall system COP of the solar absorption chiller ranges between 2 and 2.2. Finally, a solar COP is defined, which represents the amount of solar energy converted into the cooling capacity. It is found that the solar COP is 0.8 for the proposed solar absorption chiller. This result is important in the design of a clean thermal certificate system.

In addition, a desiccant air-conditioning system using both the solar thermal energy and condensation heat of a heat pump is proposed, and the selection of a desiccant material and the system performance are experimentally studied. Two different materials, mesoporous silica and a polymeric sorbent, are experimentally tested, and the proposed mathematical model of the desiccant wheel exhibits very good agreement with the experimental data. The performance of proposed solar desiccant cycle using these two materials is predicted on the basis of the real meteorological data for Miami, Salt Lake, and Tokyo city. The simulation results show that the solar desiccant system using EXLAN in the

Tokyo area could reduce the energy consumption by 20% compared to the conventional cooling dehumidification system.

An ejector–vapor compression hybrid heat pump using solar thermal energy is proposed to provide both heating and cooling throughout the entire year, even when solar radiation is not available. The ejector performance is experimentally studied, and the energy-savings potential is calculated from a cycle simulation. It is found that the proposed hybrid cycle has higher performance compared to the conventional heat-pump cycle, and the energy savings is theoretically 28%.

The CO_2 reduction in Kashiwa city in 2020 is estimated to be 1,900 t-CO_2/year and 1,500 t-CO_2/year in the business building sector and household sector, respectively.

4. MOBILITY GROUP

The lack of a simple way for the elderly to travel becomes a major concern in the super-aging society of Japan. To address this issue, the Mobility Group focused on developing micro electric vehicles (MEVs) which are convenient for the elderly to use. This chapter describes a wireless charging system that can become a cornerstone in implementing MEVs, a car-sharing system, the utility of the MEV prototypes, and the results of a survey of MEV users.

We have developed a wireless charging system using a new wireless power transfer technology. Its purpose is to eliminate the troublesome task of charging EVs for the elderly and to help provide them a comfortable lifestyle with the use of electric vehicles for low carbon personal mobility.

The MEV with the wireless charging system will eliminate the difficulty of charging it, which is the leading cause of the unpopularity of EVs. It is demonstrated that a frequency of approximately 85 kHz, which will become the standard for wireless charging, produced good results. This technology can become the best way to provide a comfortable life for the elderly because electric vehicles do not need to be manually charged.

There are two types of MEV users: the owners, because MEVs can be easily purchased.
It is concluded that car-sharing is more suitable and efficient by using MEVs because the MEV is not expected to be used frequently for individual user. However the car-sharing operation is complicated especially for the aged person who do not have smart phones, and it relies on the popularity of the smartphone. This is not a technical defect, so it is possible that the car-sharing system developed here can become a suitable system for a specific grouped members.

The greatest advantage of the MEVs is that it is easy to park, while the greatest disadvantage is that it feels dangerous to drive on a major road together with fast-moving traffic. Moreover, the demand for two-seater MEVs is growing.

The MEVs can improve the daily lives of the elderly and can simplify transportation for them. The MEVs can also mobilize the local community and be operated in farms and woodlands, both of which will soon be affected by Japan’s super-aging. Additionally, the MEVs will be suitable to be driven for leisure by retired workers because the MEVs are easier to be used for the purposes discussed compared to regular-sized cars. Moreover, CO_2 emission can be reduced by the activation of the light service of the farms and woods in the suburban areas near the central cities.

The Mobility Group has carried out studies on wireless charging systems, car-sharing systems, developing several prototypes and testing them, and making enquiries through the probe person survey for MEVs. As a result, MEVs will become an excellent means for personal short-range transportation in the local community once the problems related to wind and rain, low output, insufficient range, collision safety, and retail price can be solved.

It would be easier for car-sharing users to use the wireless charging system for charging the MEVs. A large amount of CO_2 emission can be reduced if MEVs are used for short-range transportation instead of ordinary internal combustion cars. The MEVs can also change the city structure, reduce the transportation volume, and facilitate the aged agricultural and forestry workers become more active.

In conclusion, the MEV is an excellent means to activate and sustain the super-aging society of Japan.

5. CLINICAL PLANT SCIENCEGROUP

Over one-third of potential global food output is lost due to plant disease. Additionally, the waste of facilitators of food production, such as fertilizer and pesticides, are connected to CO_2 emissions. In Japan, public institutions such as agricultural experiment stations have been tackling the challenges caused by plant disease. However, amateur gardeners and agribusiness firms are less likely to receive support from these institutions, since their main target is farmers. Therefore, we need to introduce a new system for plant disease prevention that supports these individuals and companies. To build such a system, the University of Tokyo has integrated various academic fields related to plant disease to form a new discipline, Clinical Plant Science, in order to apply the results of this integration to clinical practice. Accompanying the creation of this discipline was the establishment of the Laboratory of Clinical Plant Science and Plant Clinic, and the publication of the textbook *Clinical Plant Science*, Volume One. The university also launched the Expert System, a service that provides detailed information on the features and methods of addressing a few thousand plant diseases.

To strengthen the system for preventing plant diseases nationwide, it is essential to establish a community-based system for plant protection. To this end, it is important to develop human resources who are familiar with the actual cultivation conditions in each area and are able to connect with experts and agricultural organizations. However, such human resources have not been cultivated in Japan. Thus, in our research, we provided a variety of educational programs for local citizens, most of whom are elderly, to help them learn more about clinical plant science and play an important role in underpinning local plant protection activities as “Community Plant Doctor” (CPD). These approaches will contribute to various positive outcomes, such as decreased carbonization, agricultural vitalization, maintenance of green spaces, invigoration of local communities, and promotion of general good health and motivation.

In order to better understand the need for Clinical Plant Science, a questionnaire survey was conducted in Kashiwa city. The survey was conducted to about 140,000 homes (which corresponds to about 90% of all households in Kashiwa city), and received approximately 7,000 answers. Based on the results of the survey, the Program for Training Community Plant Doctors was conducted. More than 1,000 Kashiwa citizens participated in the briefing session and training program, which consisted of lectures on basic knowledge of plant disease and training in diagnosis skill. After the program, a CPD certification test was conducted; as a result, about 700 CPDs (with an average age of 62 years) were certified. CPD residences are scattered across the entirety of Kashiwa city, indicating that, as a human resource, elderly people can easily cover the entire city. Furthermore, teams consisting of 10–15 CPDs were organized to promote their activities. We divided the city into seven sections and set up several teams in each (about 60 teams in total). CPDs studied plant disease diagnosis through the cultivation of various crops and the maintenance of the Perennial Garden. In addition, the effect of carbon reduction was examined through the cultivation of *ashitaba* and wild rice. Further, a Community Plant Clinic, in which citizens can ask CPDs for advice about plant disease, was temporarily opened with the support of professional plant doctors.

To assist and accelerate these efforts, it is necessary to establish several support systems and a self-operating system by CPDs. To that end, the Japan Association of Clinical Plant Science has implemented several education programs, such as certification tests and skill improvement courses. Furthermore, the Committee of Plant Protection Engineers was established to strengthen cooperation between nationally qualified professional engineers (PEs) in plant protection, as well as to develop them. The PEs have served as instructors in training programs. In addition, the International Conference of Clinical Plant Science was established to exchange information about plant disease protection in each country. Several universities and institutes (mainly in East Asia) participate in the conference. A private web page for CPDs, which includes various helpful resources such as a plant disease database, was also established to facilitate their study.

Furthermore, since it is essential to establish a foundation in the local area for their self-sustaining organization, “Society of Community Plant Doctors in Kashiwa” was established in 2014. Through the society, CPDs have carried out autonomously various activities for plant disease protection in many parts of the city. Additionally, they have conducted several activities, such as an opening of “community plant clinic” in in the community events of Kashiwa city, to inform the public about the importance of clinical plant science and the activity of plant disease protection.

In this study, we developed the education system and the certification system about Clinical Plant Science and Plant Doctors system for general public. As a result, more than seven hundreds citizens were certified as “Community Plant Doctor”. Furthermore, we also developed several support systems such as the Committee of Plant Protection Engineers and the International Conference of Clinical Plant Science to accelerate the social implementation of Clinical Plant Science. Therefore, there is a possibility that the results of our study can be applied to other cities, including foreign countries. If a large number of plant doctors are developed and plant clinics as bases for the activities of plant doctors are set up around the country, a wide variety of positive effects such as agricultural vitalization, decreased CO_2

emissions, maintenance of green spaces, invigoration of local communities, promotion of general good health and motivation are expected to be realized on a worldwide scale.

6. URBAN PLANNING GROUP

Today, various elemental technologies have been developed that can contribute to creating a "low-carbon society." To facilitate the smooth creation of a low-carbon society, it is necessary for people to imagine the "bright" lifestyles created by the technologies. However, the shape of such a "bright" low-carbon society and the roadmap for this society have not been identified. Thus, this research group aims to develop social, political, and planning technologies that can contribute to the institution of a "bright" low-carbon society. In particular, this research group develops a) urban planning methodology at the macro scale, such as distribution of urban facilities and controlling land use, and b) urban management methodology at the micro scale, such as community-based management programs for vacant lots and vacant houses.

The objectives of this research group are as follows:

1. To identify the geographical distribution of the elderly and to show how it differs from a desirable distribution, paying a special attention to the elderly's daily trips within a city
2. To examine urban residents' subjective or psychological evaluations of the quality of residential environments and attitudes toward land-use mix and various planning regulations
3. To identify the salient features of the *Kashiniwa* Program operated by Kashiwa City in Chiba Prefecture while examining the sequence of steps involved in the creation of the *Jiyu-hiroba* as a specific example of a community garden created under this system
4. To clarify the problems of residential suburbs and to investigate the means for a resident-led *machizukuri* (community building), which will provide an enriched, comfortable lifestyle
5. To suggest the procedure for the application of this methodology to urban areas other than Kashiwa City.

The results of these objectives are as follows:

1. Statistical data and the results of the questionnaire surveys conducted in Tokyo's 23 wards and in Kashiwa City in Chiba Prefecture were analysed. We found that the actual distribution was far from coinciding with a desirable one. Moreover, there is a possibility of two type policies: "hard" policies, which would refer to spatial relocation or new construction of facilities, and "soft" policies, those that do not require a change in the location of facilities.
2. People's perceptions of residential environment quality and attitudes toward mixed land use were analysed based on a questionnaire survey administered to residents in Tokyo and Kashiwa City. The results suggested that it is important to take residents' perceptual and attitudinal attributes, as well as physical-environmental characteristics, into consideration for effective residential planning. Moreover, it may be possible to apply performance-based regulation methods to urban residential planning so that land-use mix can be developed to an "optimal" degree, taking the residents' psychological evaluation into account.
3. The salient features of the *Kashiniwa* Program, operated by Kashiwa City in Chiba Prefecture, and the sequence of steps involved in the creation of the *Jiyu-hiroba* under this system were identified. From the results of the survey, the potential for an organizational framework for achieving appropriate management of vacant lots in suburban residential areas was discussed.
4. A questionnaire survey and social experiments with the *Kasseika* (Revitalization) Committee—a committee concerning a *machizukuri* (community building) at the Kashiwa Village neighborhood council—were conducted. As social experiments, two kinds of community centers were established: 1) a community-building center using a vacant shop in the *shotengai* (shopping street), and 2) small hubs to supply lifestyle services, like deliveries and sales, through mobile shopping units linked to shopping in the large community center and to provide a space for interaction through the implementation of events and workshops at a scale comfortable for neighborhood participation.

In an aging society, we need to change urban structures to support the quality of life for the elderly, as they will gradually become transportation-poor. To do so, personal transportation modes that consume a lot of energy cannot serve as major elements in the solution owing to the necessity of the low-carbon society. Thus, accessibility to facilities is particularly important, and relocating facilities that will have a strong effect in terms of upgrading satisfaction levels is significant. Facilities in this context should include delivery hubs in neighborhoods that are fitted to the demand level in the area.

To enhance compact cities, a variety of land uses should be promoted. In a traditional exclusive zoning system, mixed land use is barely permissible, so these are not strongly recommended targets. However, our research suggests that right mixed use is possible, and we have clarified the conditions for performance regulation. For example, in an area where residents with traditional and altruistic mind excels, mixture with bus stops, hospitals, shopping streets, parks is

permissible. Moreover, in an (commercial) area where residents value daily convenience, mixture with railway stations, shopping street, shopping center, convenience stores is permissible. Furthermore, in an area where residents value educational environments, mixture with facilities for kids and nurseries is permissible, and in an area where elderly people excel, mixture with elderly care facilities is permissible. There findings will contribute to appropriate guidelines for establishing regulations by performance standard.

For concrete management system prototypes, several social experiments are devised for maximum use of vacant sites and facilities. *Kashiniwa* (rental garden) systems and *choi-nou* (community-based petit agriculture) are prototypes of such coproduction between citizens and local governments. Moreover, experiments in running community cafes reveal that the scheme can be implementable, provided the initial costs are covered. Key factors for establishing community cores are found to be (1) understanding the areal needs, (2) establishing management bodies, (3) investigation of service contents, (4) coalition with other organizations, (5) reserving a place to operate, (6) raising initial funds, (7) appropriate financial plan, and (8) appropriate management organization.

To achieve a good life in this low-growth age, mutual assistance among citizens should be maximally promoted, and social regulation should be revised toward this end. The following aspects may be pointed out for future revision of social systems so that the results in this project may be expanded:

1. New land-use types to allow for bases of mobile facilities should be established.
2. Performance regulation schemes should be introduced to enhance elastic land-use management that fits local needs.
3. To establish mutual community cores in neighborhoods, a subsidy system should be established, taking into account the decrease in administrative costs owing to the establishment of such cores.
4. To ease the use of private space, a system by local governments or other organizations should be established between the owners of the spaces and the users so that owners can provide their properties without anxiety and users can find it easy to use the spaces.

We expect that these findings will be useful to establish and promote supporting systems for residents including elderly people.

7. AGRICULTURE/LANDSCAPE PLANNING GROUP

The goal of the agriculture/landscape planning group is to develop and implement social technologies that will enable city residents, particularly senior citizens, to "vibrantly" participate in the management of green spaces while a low-carbon city is achieved. If we are to create compact cities in a low-growth environment, the only option is to concentrate investments in the city center, which leaves little to no resources for managing green spaces in peripheral areas of the city. If, however, we achieve the objectives of this group, it will be possible to maintain healthy environments in all areas of the city by actively engaging senior citizens in social activities. Furthermore, it will be possible to enhance biodiversity through appropriate management measures, and to secure local energy resources by utilizing the biomass generated through management activities.

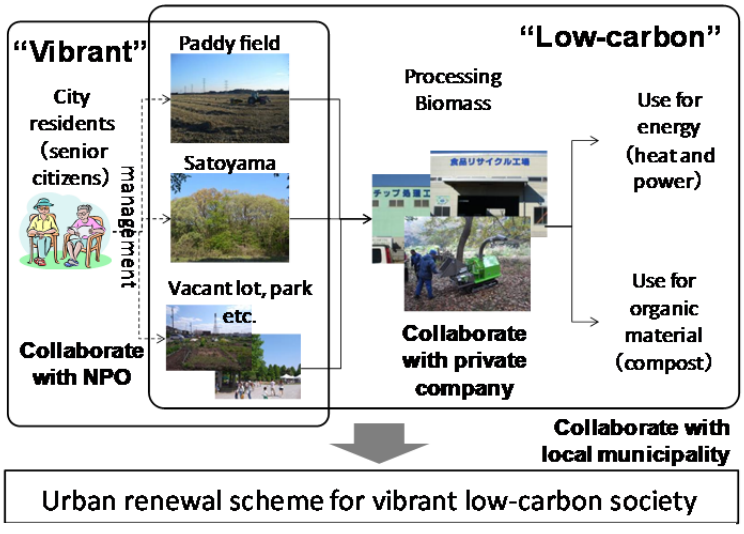

Figure: Research overview

An overview of this research is presented in the figure above, which collaborates with a non-profit organization (NPO) engaged in the management of the remaining satoyama, woodland historically maintained to obtain firewood or other organic materials (the Chiba Satoyama Trust), a commercial farm business (Kashiwa Mirai Farm), and a local residents' group (the Kashiwa City Shinwakashibacho-kai). Through this collaborative effort, this group has conducted empirical research on the management of green spaces in satoyama, paddy fields, and vacant lots. In paddy fields, we conducted an intermittent irrigation experiment designed to extend dry conditions longer than under conventional cultivation. We also measured the inhibitory moisture content during the production of methane, a major greenhouse gas (GHG). In addition, we identified changes in biota associated with periodic thinning and cutting of undergrowth in satoyama, and

also estimated the magnitude of carbon accumulation by satoyama and the related reduction in carbon dioxide emissions resulting from biomass use. In vacant lots, we are exploring the potential for developing "casual agriculture" (*choi-nou*), with a low threshold for participation, while also working with the local town council to operate a farm. With respect to each of these research objectives, we have examined case studies and consulted with government agencies (the Kashiwa City Department of Urban Parks and Green Spaces, City Planning Division) regarding the challenges to and conditions necessary for implementing these activities in the broader society as part of public policy. Based on this analysis, our ultimate goal was to propose a scheme for urban renewal that achieves a vibrant, low-carbon society from the standpoint of agriculture/landscape planning.

In this chapter, we present a summary of the group's research accomplishments as follows.

1. **Agro-activities in shrinking cities:** we introduced a new theory of urban compaction based on the key concept of "agricultural greens" as the group's end goal for urban renewal.
2. **Low-GHG paddy field water management:** we quantified the reduction of greenhouse gases (methane) through intermittent paddy field irrigation, and examined the potential for paddy field management by local residents.
3. **Conservation of biota in satoyama:** we investigated the response of plants and Japanese rhinoceros beetles to various woodland management techniques and, based on the insights gained, proposed management actions that will contribute to the preservation of biodiversity.
4. **Carbon accumulation and biomass usage in satoyama:** we evaluated undeveloped woodlands as both a carbon sink and a source of biomass. In addition to quantifying the contribution of undeveloped woodlands to carbon reduction, we explored the potential problems associated with expanding biomass utilization, as well as the countermeasures required to resolve these problems.
5. **Summary of the project outcomes:** we summarized the outcomes of the project in the last section.

To explore the possibility of developing "agriculture" in nearby vacant lots, an investigation is being carried out in collaboration with city planning groups. The results are described in Chapter 6.

8. INFORMATION SYSTEM GROUP

Our mission is to develop a series of information systems that provide other research groups with information that is useful in developing an aging society with low-carbon emission, and to evaluate the efficacy of such systems. Therefore, we built and maintained the relevant web services and databases in order to support various experiments by other groups. We also analyzed the enormous amounts of multi-dimensional data obtained from these experiments, with the aim of gaining useful knowledge for the design of a futuristic urban system. Our main activities are as follows:

1. Research about application of sensing various data in daily life and industrial field

In order to develop the methodology to improve the usability of various sensing data which is accumulated in daily life and industrial filed, following experiments were conducted by use of electric power consumption data;

a. Experiment to evaluate electric power savings by information feedback to consumers in a building regarding their indoor electricity consumption.
b. Development of the system to visualize multidimensional and chronological power consumption data which is consumed by various users and equipment effectively
c. Development of the process simulation system by use of power consumption data in manufacturing factories
d. Development of the information system to encourage the activities of "community plant doctors" with the human resource development program which is managed by the Clinical Plant Science Group, and evaluation of the system with gathered activity data

2. Research and study for systematization of various knowledge about sustainability of cities

We conducted a survey of case studies for domestic and foreign cases, where universities play an important role of collaborator between various stakeholders, such as urban government administrations, private companies, and non-governmental organizations, to integrate knowledge. We reviewed effective strategies, governmental policies and institutional designs, and designed a social business model geared towards the future sustainability of cities.

2. Development of a digital archive system of case studies extracted from social experiments carried out by other research groups

In this project, six research groups conducted a wide variety of social experiments. We developed a digital archive system of social experiments cases that serves as a tool to obtain an overall image and to expand the project achievements to other areas. The digital archive structuralized cases obtained from interviewing the persons in charge of each social experiment. Analysis and retrieval of the social experiment cases are available in the web.