Low Carbon City Development Guidance

[Digest]

Ministry of Land, Infrastructure, Transport and Tourism JAPAN

Part I A Concept of a Low Carbon City

Part II Measures for Low-carbon City Development

Part III Effective analytical methods of Low-carbon city development policies

Part I　A Concept of a Low Carbon City

Chapter 1　What is the Low Carbon City Development Guidance?

Chapter 1 explains the purpose of the Guidance, its contents and the situations where it can be put to use.

(1) Purpose of the Guidance

Purpose of the Guidance

The Guidance aims to support municipal authorities in their efforts to foster low carbon cities, by indicating

1) **Basic concepts of low carbon city development, and**
2) **Methods and required statistical data to assess the effects of policy measures proposed for low carbon city development**

Greenhouse gases (GHGs), principal causes of global warming, are emitted in large quantities in cities where various activities are intensively carried out and where vast volumes of energy are thereby consumed. The Kyoto Protcol Target Achievement Plan calls for urban governance to reduce GHG emissions in the respective cities.

Urban activities are diverse and complex, requiring a wide range of policy instruments to cope effectively with global warming. There is a need to measure and analyze current GHG emissions and absorptions in the urban sector and to estimate the effects of policy instruments on urban GHG emission levels.

To this end, the Guidance has been written to support the initiatives of local authorities, by indicating what they should consider and do when promoting low carbon city development, including above all the basic concepts, the necessary policy measures and the methods of assessing the effects of such measures.

The contents of the Guidance will be regularly updated to keep abreast of changing needs and emerging issues.

(2) Contents of the Guidance

The Guidance consists of three parts: “Part I: Concept of a Low Carbon City” sets out the rationale for creating low carbon cities. “Part II:　Low Carbon City Development Measures” describes the methods for developing a low carbon city in three sectors, namely transportation and urban structure, energy (private homes and private businesses), and greenery. “Part III: Analysis of the Effects of Low Carbon City Development Measures” explains the methodologies for assessing the effects of the measures.

(3) Scope of the Guidance

1) Target Greenhouse Gas

The Guidance deals with carbon dioxide (CO_2), the most significant greenhouse gas in Japan that is closely related to the nature and functions of the urban structure.

2) Types of Measures Covered in the Guidance

The Guidance offers a broad range of measures, describing both physical and non-physical development approaches to the reduction of CO_2 emissions in various aspects of urban life.

3) Mitigation and Adaptation

The Intergovernmental Panel on Climate Change (IPCC) distinguishes two types of measures to counteract global warming. Mitigation aims to slow down the pace of global warming by reducing GHG emissions. Adaptation proposes to alleviate the adverse impacts of global warming (e.g. rising temperature) by adjusting social and economic activities. Mitigation as related to the urban sector includes those measures which would facilitate the emergence of a compact urban structure, the increased use of public transport, the efficient use of energy and the increased capacity of CO_2 sinks by such efforts as urban greening. Adaptation includes the urban preparedness against localized torrential rains and temperature rises and the efficient use of water in response to the depleting water resources, among others. Both mitigation and adaptation measures will be essential to cope with global warming and have to be formulated and implemented in balanced combination.

The focus of the Guidance is on “mitigation” which consists of radical measures to counteract global warming. “Adaptation” measures will be given due consideration in the future revisions of the Guidance.

(4) Expected Utilization of the Guidance

The Guidance defines the basic concepts of low carbon city development and proposes necessary policy measures for its realization and the methods to assess the effects of such measures.

The Guidance is a “technical advice” as stipulated in the provisions of Article 245–4 of the Local Autonomy Law. Accordingly, local authorities are free to decide its application to their urban policy decisions. Usefulness of the Guidance is suggested for the following decision-making opportunities.

- When the master plan of city development is in need of revision, the issues involved in low carbon city development are added to the agenda for review.
- The problem of CO_2 emissions is given due consideration at such occasions as the formulation of a comprehensive urban or area transport strategy and the investments in urban transport infrastructure, urban renewals and urban facilities.
- When a New Action Plan* to Counteract Global Warming is being formulated, the aggregated effects of the Guidance-advised policy measures are consulted and incorporated.

- When low carbon city development is included in the municipal policy agenda, the Guidance-suggested procedures are applied to assess the reduction effects of the proposed measures.

More detailed suggestions of possible utilization will be added in the future revisions of the Guidance.

It is presumed that the Guidance would be helpful primarily to the city planning departments of municipal authorities. In addition, the descriptions in the Guidance are prepared to be usable in an integrated manner by other departments as well, notably those in charge of environmental protection, transport development and management, and other related administrative responsibilities.

The results obtained by the application of the Guidance-suggested procedures can be incorporated into the respective Municipal Action Plans, which are to be prepared according to the Manual for New Action Plans.

The Guidance suggests a number of analytical methods to assess specific measures proposed to counteract global warming. In order to have these methods put to effective use, the Guidance explains what local authorities should do in preparation for such assessment. Namely, the Guidance suggests

- Methodologies to accumulate baseline data (e.g. utilization of the local database compiled for city planning) that are essential to assess the effects of proposals
- Alternative methods, and practicable combinations thereof, in anticipation of possible database inadequacies or limited administrative capacity

Sewerage is one of the administrative responsibilities of the respective municipal governments and the Guideline for Promoting Countermeasures against Global Warming in Sewerage Development has been issued in March 2009. This Guidance suggests a number of measures to reduce GHG emissions which might be relevant for planning sewerage development as well.

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* New Action Plan

New Action Plan is “Municipal action plan to Counteract Global Warming: Measures for local area” based on “Law Concerning the Promotion of the Measures to Cope with Global Warning”. Municipal governments must decide on the Plan. Municipal governments are to cope with the problem of global warming with the Plan. The Ministry of the Environment compiled "The Manual of the Action Plan for Greenhouse Gas Emission Reduction in Local Government Operations" to help the non-designated municipalities develop their own action plans based on the Law Concerning the Promotion of the Measures to Cope with Global Warming.
The results of city development policy based on this Guidance assume to be positively incorporated into The New Action Plan, with the result of the Manual.

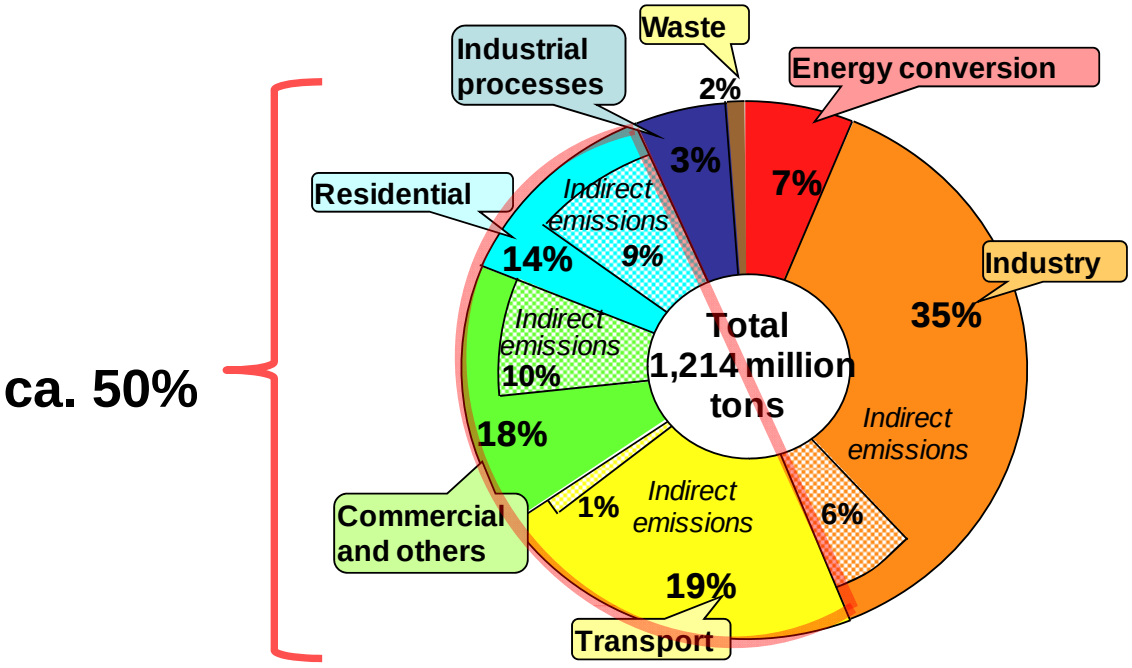
Chapter 2 Backgrounds to the Development of Low Carbon Cities

Chapter 2 explains the relationship between global warming and cities, including how urban activities contribute to global warming and why city-based initiatives for carbon reduction are vital.

(1) Global Warming and Present Urban Activities

① Urban activities account for more than a half of all CO_2 emissions

Global warming is a serious environmental hazard that could threaten the survival of humankind. It is triggered by atmospheric concentrations of greenhouse gases emitted from human activity. Carbon dioxide concentrations are the largest among greenhouse gases and account for most of the emissions. In Japan, about 50% of the total CO_2 emissions are attributed to socio-economic activities across the residential sector, the business sector (e.g. offices and shops) and the transport sector (roads, railways, etc.) in the cities.



Source: Ministry of Environment, Greenhouse gas emissions in FY2010 (preliminary figures)

Fig. Ⅰ－1 Breakdown of CO_2 Emissions in Japan (FY2010)

(2) Urban Activities and Structures in Global Warming

① Urban activities affecting the level of CO_2 emissions

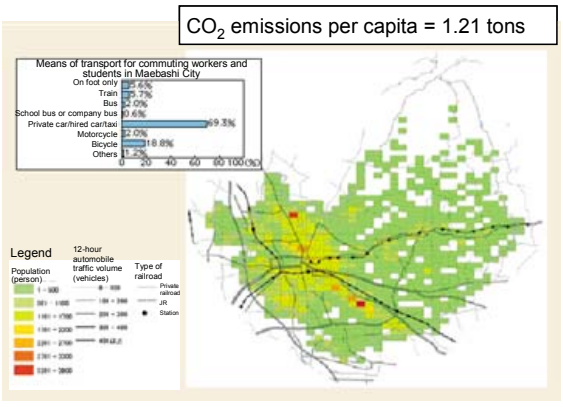
CO_2 emissions have been rising because of the following changes in urban life.

- Transport sector: Progress of motorization and growing dependence on passenger cars in daily life;
- Business sector: Increase of high-rise office buildings and large-size retail shops, increased energy consumption due to around the clock business hours, etc.;
- Residential sector: Increased building floor area apace with the increase of households (mostly of nuclear families and singles), progress of information technologies, larger sizes of home appliances, etc.;
- Accumulation of buildings and structures that are not energy-minded, because convenience, comfort and economy take priority over energy efficiency;
- Heat island phenomena that arise from a negative spiral of buildings and sealed surfaces increasing at the expense of greenery and water bodies, and the resultant changes in the thermal environment, in turn, requiring increased energy consumption for heating or cooling; and
- Reduced CO_2 absorptions by the loss of greenery in cities apace with sprawling urbanization.

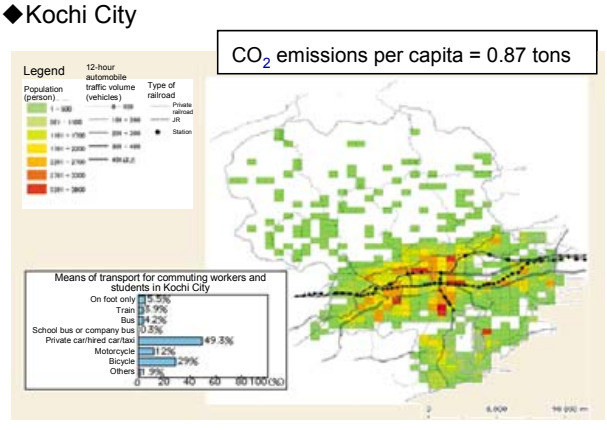
② Urban structures and CO2 emissions

Although the cities of Maebashi and Kochi are almost the same in terms of area and population, Maebashi has a greater expanse of low-density built-up areas and a higher rate of dependence on automobiles. As a result, annual CO_2 emissions per capita in the transport sector are about 40% higher in Maebashi than in Kochi.

◆Maebashi City



◆Kochi City

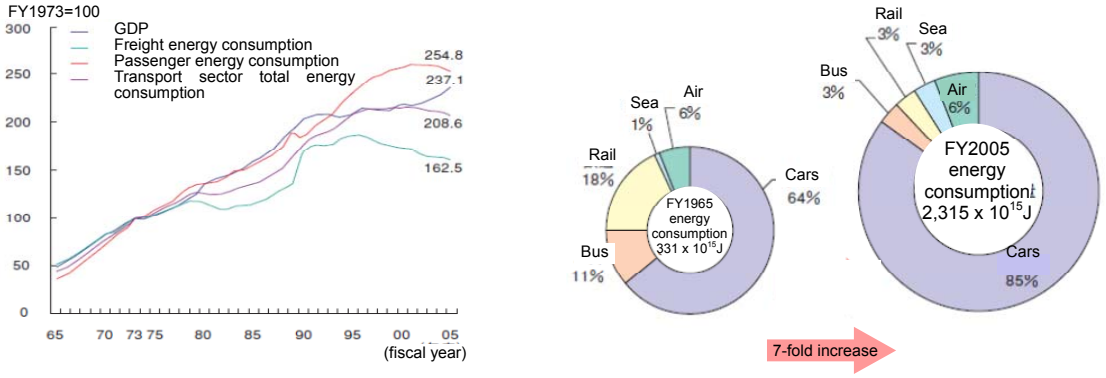


Note) Per capita CO_2 emissions pertains to passenger transport.

Source: Environmental White Paper of FY2006

Fig. Ⅰ－2 Urban CO_2 Emissions Per Capita by Passenger Transport (Maebashi and Kochi)

The extensive sprawls of urban functions precipitate various problems both on the levels of global and local environments. They would lead to the increased use of private cars and longer traveling distances, among others, thereby raising the level of CO_2 emissions and the environmental stress. Another problem of dispersed urban functions is the aggravation of traffic congestion in built-up areas, which would bring added strain to local living environments. The conventional response to rapid population concentration in urban areas has been to provide housing in suburbs and exurbs, without touching city centers which might have included locations of relatively low land use. This outward expansion shaped the present sprawling urban structures that are prone to pose a great stress to the environment, notably by the characteristics of transport demand. The rethink in recent years has begun to shift gear towards the need of shaping more compact cities and thereby reducing their current negative environmental externalities.



Source: Cabinet Office, *National Economy Statistics Yearbook*; and Agency for Natural Resources and Energy, *Comprehensive Energy Statistics.*

Fig. Ⅰ－3 Trends of Energy Consumption in Transport Sector

It is anticipated that cities would face more intense and more extensive heat island phenomena and suffer higher temperature as a result of shrinking urban green space, increasing anthropogenic emissions of heat, growing density of built-up areas and deteriorating water cycle. In addition, tightly insulated buildings equipped with computers releasing heat would require increasingly longer hours of air-conditioning, even to the extent of requiring indoor cooling while the buildings themselves are being heated. All these would add up to a sizable increase of energy consumption in the cities.

As shown briefly above, urbanization and global warming are inescapably interlinked. Accordingly, a radical transformation of the existing urban structure is a requisite part of the solution to the problem of global warming.

Chapter 3 Basic Concepts of Low Carbon City Development

Chapter 3 presents the rationale and the policy stance for low carbon city development.

The restructuring of a present city to a more compact form must go hand in hand with efforts to reduce carbon emissions across the sectors.

This chapter presents the rationale of low carbon cities and the approach to the urban restructuring with concomitant CO_2 reducing measures needed in three sectors of transport, energy and greenery.

3-1 Rationale for Low Carbon City Development

(1) CO_2 Emissions from Urban Activities and Structure

The reduction of CO_2 emissions and the increase of sinks are two basic steps to mitigate global warming. In Japan, CO_2 emissions mostly come from energy use. The energy policy thus focuses on energy-saving across the transport, residential and industrial sectors and harnessing of untapped and renewable "green" energy sources.

Regarding the CO_2 absorption, natural sinks such as greenery in built-up areas and green belts surrounding urban agglomerations must be restored and expanded. Greening of urban space will put the brakes on heat island phenomena in cities.

As mentioned in Chapter 2, urban restructuring to a compact form is likely to have a favorable impact on the level of CO_2 emissions. Along with measures to reshape the spatial distribution of urban functions interspersed with greenery and provided with adequate open space, it would be necessary to cut back on CO_2 emissions from various socio-economic activities.

(2) Conversion to a Compact Urban Structure

A compact urban structure is conceptualized as an integrated network of the central built-up area (CBD) and other major hubs of transportation in the metropolitan area. The central and other hubs in the network are to serve as centers for attracting and agglomerating urban functions. These integrated centers would be efficiently interconnected by public transport with other communities in the metropolitan area and thereby provide a better livability for citizenry and ensure sustainable development of the metropolitan area as a whole.

(3) Concomitant Efforts of CO_2 Reduction for Low Carbon Urban Structure

As mentioned earlier, the conversion to a compact urban structure must be accompanied by various sectoral measures to reduce CO_2 emissions and increase the absorptive capacity of sinks. Based on the above-mentioned model of a compact urban structure, necessary actions in three sectors can be summed up as follows.

Initiatives in Transport and Urban Structure

The transport-related energy consumption would be substantially reduced when metropolitan citizens can reside, work and satisfy their daily needs in narrower areas in the respective integrated centers that are conveniently placed in the

compact urban structure. Their daily travel distances would be shortened and the total transport demand would decrease in the metropolitan area. Reduced travel distances would encourage a shift from the use of passenger cars to cycling or walking. When the traffic demand increases its density in the compact urban structure, the operation of public transport would become profitable enough to improve its service frequency and amenity. This would expedite a shift from automobiles to public transport.

Initiatives in the Energy Sector

The shift to a compact urban structure would prepare conditions to foster and establish an urban energy system of high efficiency and low carbon emission. Therefore, urban restructuring must be carried out in close integration with energy-related measures.

Dense, mixed land use agglomerated in the integrated centers includes high-rise buildings for residential and business purposes, which provide opportunities to economize energy consumption. Concentrations of energy demand in the integrated centers and the leveling out of energy demand across such centers would help introduce a spatially integrated system of efficient energy supply and consumption. By encouraging the location or relocation of urban functions closer to the places of untapped energy sources within the city limits (e.g. factories, waste incineration plants and sewage treatment plants), a new energy system could be introduced with relative ease to harness low carbon energy sources.

Initiatives in the Green Sector

It is just as important to pay attention to green space in urbanized areas. Greenery is one of the key elements to consider in designing an urban structure of low carbon emission. Vegetation not only acts as natural sinks to remove CO_2 but mitigates deteriorating urban microclimates, thereby indirectly helping to reduce CO_2 emissions from air-conditioners and heaters. From the viewpoint of biomass energy, vegetative covers would have an important role to play in the urban structure. The area expansion and quality improvement of greenery and green space in both built-up areas and outlying suburbs would positively contribute to low carbon metropolitan development.

As outlined above, it is important to carry out various sectoral measures in conjunction with urban restructuring towards a compact form. A multitude of activities take place in the complex nexus of a given city. Regardless of urban structural forms, therefore, CO_2 reduction in urbanized areas requires a wide and diverse range of actions, comprising those measures which directly lower carbon emissions (e.g., exploitation of untapped and renewable "green" energy sources) and others which contribute to the reduction by way of pursuing different primary goals (e.g. measures for transport improvement, woodland and farmland conservation, etc.).

It must be noted that urban policy measures are mostly multi-purpose in orientation. Low carbon measures must be considered as a facet of urban policies that address to diverse challenges of how to provide better convenience, disaster preparedness, stimulation for myriad urban activities. For instance, an expansion of building floor area and an increase of traffic volume, among others, are both signs of a growing city. It is up to city administrators to make policy decisions by balancing the needs to support such a process of urbanization with the needs to

reduce CO_2 emissions in a comprehensive manner.

Many cities are now facing the problem of declining or rapidly aging population and the need to rationalize the rising costs of administration. A compact urban structure offers a range of possibilities to deal with these issues. In a compact urban structure designed to fit local topographic and historical conditions, citizens are encouraged to live in one of the demographic agglomerations of certain appropriate size where necessary urban functions and public services are concentrated. They would be offered favorable living environments with provision of open spaces to interact one another. A compact urban structure is the foundation of a low carbon city. In other words, various measures and actions taken to establish a low carbon city are necessarily oriented towards a compact structure, which promises a sizable reduction of administrative costs by enabling efficient city management. The greening efforts would contribute to the betterment of urban landscape and be welcomed by citizenry. It is important to note that the measures proposed for low carbon city development serve the objectives of on-going policy measures that address to the current urban issues and problems.

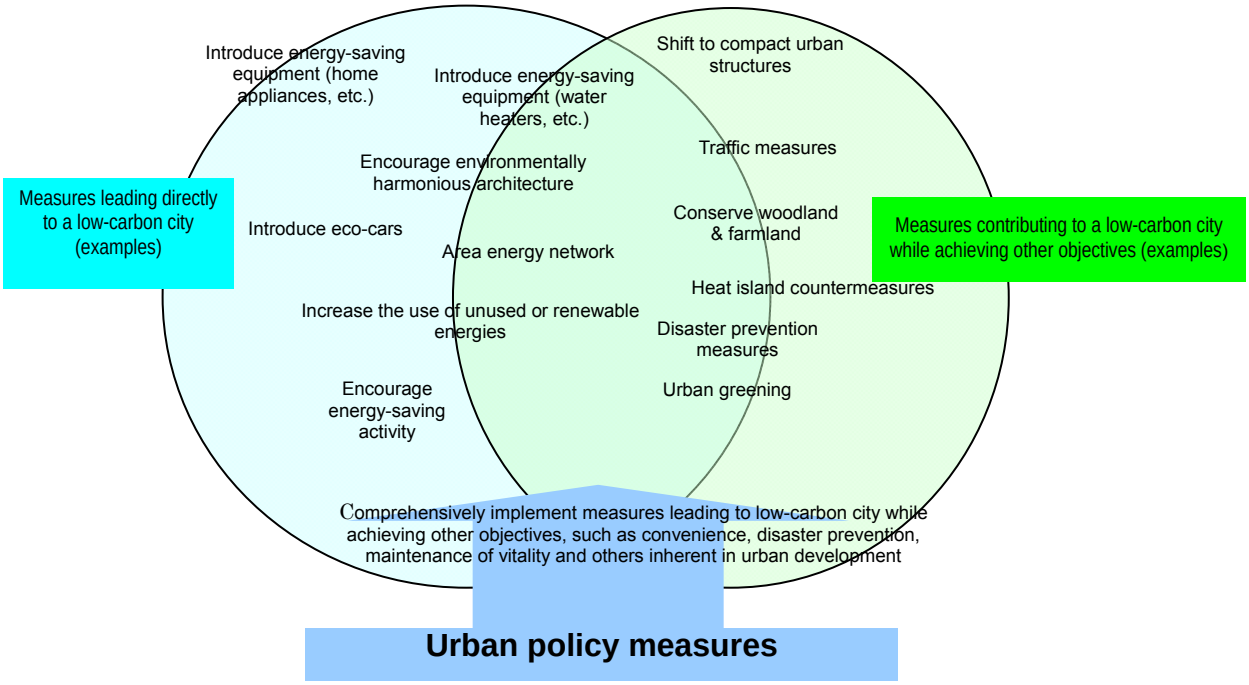


Fig. Ⅰ－4　Overlapping Urban Development Policies and Low Carbon Measures

3-2 Nine Policies for Low Carbon City Development

Based on the foregoing arguments, nine policies are proposed for low carbon city development with appropriate attention to local characteristics. These policies are grouped into three sectoral categories for presentation: namely, (1) compact urban structure and transport development, (2) efficient energy consumption and exploitation of untapped and renewable energy sources, and (3) conservation of green belts and greening of urban built-up areas.

(1) Urban Restructuring and Transport Development: A Shift from the Sprawling Urban Structure to a Compact Form

① Policy 1: Shaping a Compact Urban Structure

- *Locating public facilities and service establishments in integrated centers and attracting residents close by*

A compact city in the future will be founded on the following policy mix.

- A shift to a compact structure is to be planned by taking advantage of the existing intra-city arterial roads, public transport services and characteristics of agglomerated urban functions.
- Integrated centers in a future compact city are to be interconnected by railroads or trunk bus routes of high service standards. The suburbs and exurbs under metropolitan influence would be provided with good access to the integrated centers by public transport as far as judged feasible. The operation of community bus services and the upgrading of road networks might be advisable depending on the level and the pattern of urban agglomeration.
- When considered necessary, land readjustment projects could be implemented in the built-up areas to expedite appropriate concentrations of residences, open space and urban functions. In other locations in the metropolitan area, restrictions would be needed to stem further urbanization. Regarding suburban or outlying agglomerations losing local businesses and inhabitants, it would be necessary to induce a low-density pattern of land use while providing local communities with adequate access to basic services.
- Urban activities with lower levels of GHG emissions and energy consumption would be promoted or attracted so as to reduce environmental burdens of urban livelihood.

The image of a compact city to be shaped by the actions described above will serve the objective of improving the efficiency of urban socio-economic activities and curtailing the environmental externalities of urbanization. Both the public and the private sector must work together to realize such a city.

- *Leveling energy demand by promoting mixed land use*

- The pattern of energy use varies by type of buildings. The demand for energy in residential buildings is high during nighttime, while business establishments consume more energy during daytime. The peaking of their daily demands is radically different.
- In those areas where land use is dense and mixed, daily aggregate energy consumption is evened out by taking advantage of the different demand peaking patterns of residential buildings and business establishments. This

enables to set up an area-wide energy system serving evened energy consumption (cf. Policy 5 on area energy network). It would be important to make use of this possibility for the purpose of lowering CO_2 emissions.

- *Locating or relocating large users of heat close to untapped energy sources*
  - The same unit of energy consumption releases a different quantity of CO_2 depending on the kind of energy source. Large facilities with high heat demand could be located or relocated next to the untapped sources of energy. Namely, heat released by waste incineration plants, biomass energy from water treatment plants (sludge recycling), power generation by temperature difference (at rivers, drainage pipes, etc.) and other untapped sources would be put to effective use with capital investment, justified by the nearby presence of large-scale energy users. This would contribute to the reduction of CO_2 emissions.
- *Forming a metropolitan green network by increasing greenery in the built-up areas and conserving green belts or zones in the outlying areas*
  - In those suburbs where the resident population is declining, it is important to conserve woodlands and farmlands and attain a harmonious balance between local communities and the surrounding natural environment.
  - In integrated centers where various urban functions are being concentrated by the provision of public transport connection and various policy instruments promoting mixed land use, it is important to strengthen the efforts of conserving, restoring and creating greenery in conjunction with the on-going process of urban agglomeration.
  - Expansion and placing of greenery and green spaces must be planned and implemented so as to put their capacities as CO_2 sinks to the fullest possible effect.

② Policy 2: Shaping Traffic Flows

- *Developing road links to allow smoother flows of motorized traffic*
  - The urban road network need be developed chiefly by upgrading bottleneck links including railway crossing points to ensure less congested flows of motorized traffic. The absence of traffic congestion would contribute to the reduction of CO_2 emissions and could significantly ease the environmental burden of urban transportation.
  - Smoother and less obstructed flows result in a higher average speed of motorized traffic, indicating improved fuel efficiency and thus lower CO_2 emissions. The investment in ring roads, arterial routes and grade separation at intersections will be needed along with improvements at railway crossing points. In the end, the introduction of an intelligent transport system (ITS) might be judged feasible.
- *Managing transport demand*
  - In addition to investments in physical infrastructure for motorized traffic, a compact city would need the transport demand management (TDM) that offers other emission-reducing possibilities. It is advisable to adopt policy instruments that promote walking, cycling and public transportation in place

of private automobiles, such as “park and ride” facilities for cars and bicycles provided at railway or trunk bus stations.

- Along with hardware development of transport facilities, it is desirable to employ some strategic software approach to mobility management, aiming ultimately to inculcate irreversible changes in passenger behaviors and preferences regarding mobility.
- To promote walking and cycling, it is important to provide safe and comfortable passages and spaces for pedestrians and cyclists. It will be essential moreover to develop a network connecting such passages and spaces. Combined with application of universal designs and appropriate positioning of bicycle parking facilities, these measures will serve to enliven the city’s CBD that are comfortable for citizens to visit on foot or by bicycle.
- In recent years, some signs of changing attitudes are observable regarding automobile ownership and use. For example, campaigns for no-car days try to persuade car owners to voluntarily refrain from driving one day per certain period, or the car sharing movements have been initiated in some cities to promote joint ownership and use of car pools among commuters. It is important for a future low carbon city to encourage these promotional campaigns and movements.

③ Policy 3: Promoting the use of public transport

- *Developing public transport facilities and improving their services*
  - It is necessary to strengthen public transport to suit the basic character of a given city’s past development, by providing sufficient spaces or rights of way for a chosen public transport means and taking specific actions to raise its level of service. It is advisable to ensure convenience of transfer at major transport nodes such as train stations and bus terminals with barrier-free provision. When deemed necessary, it would be effective to introduce a new transit system like light rail transit (LRT).
  - To support affluent bustles in the city and ensure ease of movement for elderly citizens, alternative modes of travel need be provided to avoid total dependence on passenger cars. Then, every segment of the population can enjoy easy access to the means of smooth and comfortable mobility in the metropolitan area.

(2) Efficient Energy Consumption and New and Renewable Energy Sources: Transforming High Energy Urban Activities

① Policy 4: Replacing built-up areas with energy saving low carbon buildings

- *Raising energy efficiency on occasions for renovating existing buildings*
  - When a built-up area or a block of buildings is in need of renewal as part of restructuring towards a compact city, new buildings would be of more advanced thermal insulation and their appliances and equipment more energy efficient. This replacement with new energy saving stocks of buildings would reduce CO_2 emissions originating from buildings.
  - Restructuring into a compact city leads to a higher density of land use. High-rise condos would consume significantly lower energy per household than detached houses for single households. In this respect, compact agglomerations of dense land use would contribute greatly to energy saving by urban buildings.
- *Inducing location or relocation of eco-minded buildings*
  - The energy demand of urban buildings will be reduced by encouraging eco-buildings equipped with passive types of ventilation and air-conditioning. Passive indoor space cooling or ventilation by letting in fresh air would become more practicable by creating well-arranged wind paths in built-up areas. The promotion of such eco-buildings accompanied by appropriate ecological or green engineering in the neighborhoods will help reduce the level of CO_2 emissions from urban buildings.

② Policy 5: Establishing Area Energy Networks

- *Introducing an area energy network on occasion of land use readjustment*
  - A land use readjustment project over a certain area offers a good opportunity to realize compact urban renewal with a new energy system at a stroke. An area energy network would make it possible to achieve higher aggregate efficiency of energy consumption in the area as a whole, thereby reducing CO_2 emissions as well.
  - Agglomerations of densely-packed mixed land use in the central part of a city could take advantage of different peaking patterns of energy demand between businesses and residential buildings. Such areas would be able to raise energy efficiency by leveling off consumption around the clock, and on occasions of urban renewal, would be suited to the installation of an area-scale system of indoor heating and cooling that promises even higher efficiency of energy use.

③ Policy 6: Utilizing Untapped and Renewable Energy Sources

- *Connecting available untapped energy sources with potential users*
  - Significant progress of low carbon city development could be made by harnessing untapped urban energy sources of low CO_2 emission.
  - Untapped energy stocks are unevenly distributed in urban space: namely, they are found at the sites of factories, waste incineration plants, sewage treatment plants, local rivers and so on. Accordingly, it is important to plan and implement the facilitation of their linkage with potential energy users.

This issue could be approached on three fronts, viz. induced proximate location, engineering technology and selective demand-side incentives. Potential energy users could be encouraged to locate or relocate themselves close to the sites of energy stocks. Research and development would be needed on new engineering systems, for example, to retrieve waste heat easily from the central heat sources of the respective plants mentioned above. It would also be necessary to devise incentives for potential users with bulk demand for heat, such as hospitals, hotels and sports facilities.

- *Utilizing renewable energy sources*
  - Energy sources like sun and wind can be harnessed for low carbon city development.
  - Renewable energy sources are thinly dispersed far and wide. Their harnessing requires special facilities and devises (e.g. solar panels and wind turbines), which must be properly set up after careful examination of locational characteristics including surrounding environments. It is essential to establish a locally manageable system of production and consumption for renewable energies. Regarding biomass energy, for example, it would be necessary to develop a system of collecting and bulking diverse local biomass resources from a wide area for the central power plant. On the demand side, it would be necessary for the private and the public sector interests to collaborate closely to identify the ways and means for supplying power effectively to a wide variety of potential users.
- *Establishing area networks for utilizing untapped and renewable energies on occasions of urban redevelopment*
  - Urban development projects (urban renewals, replacements of public facilities, reconstruction of roadside structures along with road improvements, etc.) provide opportunities to rethink local energy systems. Such occasions could be made pivotal for introducing an area energy network system that utilizes renewable energies as well, thereby advancing decisively towards a low carbon city.

(3) Conserving Green Spaces and Greening Urbanized Areas: Towards Urban Symbiosis with Nature

① Policy 7: Securing Adequate CO_2 Sinks

- *Conserving and creating green space*
  - Because vegetation functions as natural GHG sinks, conservation of green spaces and greening of built-up areas are crucial to advance the development of a low carbon city.
  - Some carbon offsetting mechanism might be set up to strengthen greening efforts in a given city. Namely, local authorities collect "green taxes" or voluntary contributions from urban dwellers and corporate sponsors and use the fund to finance greening or conservation projects that would earn the offsets to balance out the CO_2 emissions in the city.
- *Collaborating with citizens for urban greening*
  - Green space preservation and expansion can be carried out as joint projects of public authorities and citizens and as campaigns organized by the citizens' initiatives. By improving the quality of urban greenery management, it is possible to raise the level of CO_2 absorption.

② Policy 8: Expediting Utilization of Wood-based Biomass

- *Utilizing wood-based biomass obtainable as byproducts from greening and conservation efforts*
  - As urban wood stocks increase by greening projects and improved greenery management, wood-based biomass as byproducts from such efforts could be utilized for power generation and compost production. Increased consumption of renewable biomass energy would contribute to the lowering of carbon emission.
  - The sustainability of biomass energy utilization largely depends on the cost of collecting and bulking wood-based byproducts and wastes. Where built-up areas are located relatively close to outlying woodlands, for example, biomass materials could be collected in wooded peripheries (sites of greenery conservation and management) for power generation and generated power would be transmitted to consumers in integrated centers. It will be crucial in any situation to coordinate effectively between the activities of conservation and greening and energy consumption in built-up centers, with the aim of fostering a locally sustainable system of power supply and consumption.

③ Policy 9: Improving Thermal Environment by Diminishing Heat Island Phenomena

- *Deploying multi-scale measures against heat island phenomena*
  - Alleviation of heat island phenomena can be achieved by reducing, among others, the demand for air-conditioning, which implies a cut-back on carbon emissions. Mitigation measures are especially important in large metropolises suffering rampant heat island phenomena.
  - Mitigation measures have different time and space scales to achieve desired results, depending on the levels of their planning and implementation ranging from districts, cities and wider administrative units. In other words, it will be essential to formulate mitigation measures appropriate to each

characteristic time and space scale, and coordinate, moreover, such multi-scale actions against heat island phenomena.

- On the level of a wider administrative unit, emphasis would be more on “mitigation” which aims to lower urban air and surface temperature, such as measures to diminish waste heat and to expand vegetative covers through greening efforts. On the district level, mitigation need be accompanied by “adaptation” which aims to improve livability under urban high temperature, such as increasing tree shades and improving outdoor wind paths in built-up neighborhoods.

Low-carbon city development concept and policy

Since reforms of the urban structure are closely related to reduction of CO_2 emissions, it is important not only to convert cities to more compact structures, but also to strive for reduced carbon emissions in the sectors of energy and greenery.

Concept of the development of a low-carbon city

- Selection of effective CO_2 reduction measures based on the status and structure of CO_2 emission in a city is necessary.
- Understanding the current level of CO_2 emissions in comparison to other cities is necessary to examine oneself and decide what measures are effective in which areas.
- As for the selection of measures based on self-assessment above, clarified 9 policies for each area of "transport/urban structure", "energy" and "greenery", in line with transformation based on compact urban structure→Volume Ⅱ summarizes measures based on the 9 policies.
- Specific procedure to understand the effect based on the selection and combination of the measures are shown in Volume III.

Shift to a compact urban structure

- Realize compact urban structure that is compact based on mixed-use of facilities for efficient land use and preservation of natural environment ⇒policy 1
- Realize traffic system not excessively dependent on automobile ⇒policy 2, 3

Efforts to develop a low-carbon city when making shift to a compact urban structure

- Shift to an urban structure sets right conditions and provide opportunities to implement measures in energy and green areas .
- Move away from city activities dependent on heavy energy consumption and establish energy supply system that circulates in an area ⇒policy 4,5,6
- Secure green spaces in every corner of a city and around a city ⇒policy 7,8,9

A . Realize compact urban structure and transportation measures (shift from diffused urban structure to compact urban structure)

Policy 1 Realize compact urban structure

- Location of public facility/service facility etc. and houses in a hub
- Leveling of energy demand based on compound (mixed) land use
- Encourage relocation of large scaled heat demand facilities to areas close to unused energy sources
- Build a green network by promoting greening of cities and preserving green areas around cities

Policy 2 Promote measures to address traffic flow

- Road improvement for smooth automobile traffic
- Traffic demand management

Policy 3

Promote the use of public

B. Efficient use of energy and use of unused/renewable energies (Move away from city activities dependent on heavy energy consumption)

Policy 4 Renovation to energy saving buildings that contribute to low-carbon society

- Realize efficient energy use by seizing opportunities of building renewal as part of efforts to realize compact structure .
- Encourage to locate energy saving buildings that matches with the surrounding environment

Policy 5 Area Energy Network

- Introduction of Area Energy Network by seizing opportunities of holistic urban function renewal etc.

Policy 6 Utilization of unused/renewable energy

- Adjustment of stock and demand of unused energy
- Utilization of renewable energy
- Promotion of district-scale introduction of unused/ renewable energy in times of urban development

C. Conservation of green spaces and promotion of urban greening (coexistence with nature)

Policy 7 Securing of carbon sink

- Conserve and create green areas
- Conserve urban greening in collaboration with the citizens, etc.

Policy 8 Promotion of the use of wood-based biomass

- Protect and manage green spaces, use wood biomass in built-up areas

Policy 9 Improvement of thermal env't thru heat island countermeasures

- Link heat island countermeasures in accordance with diversity of scale

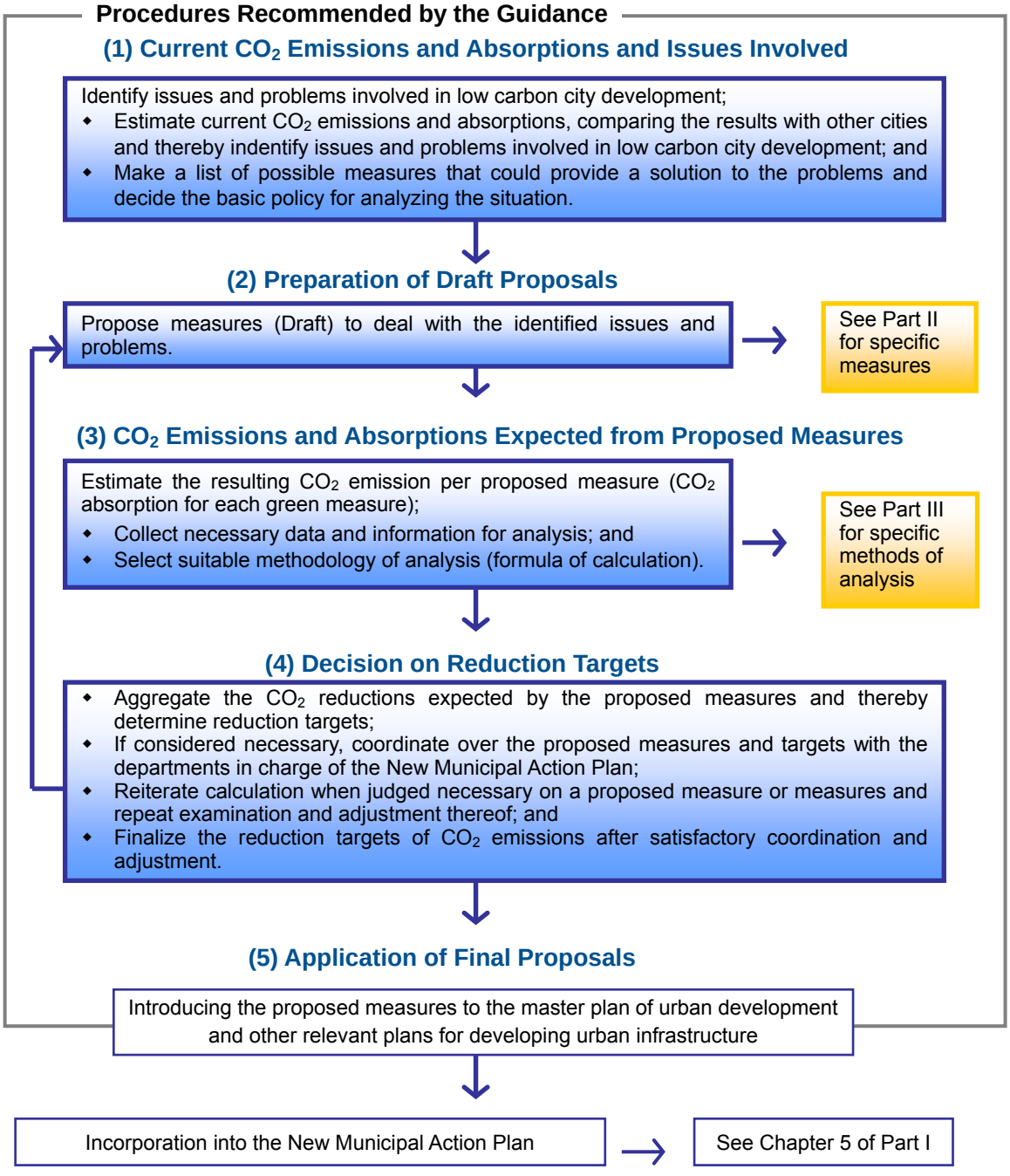
Specify land use | *Concentrate urban functions* | *Secure biodiversity with greenery* | *Make efficient/ environmentally friendly buildings* | *Improve traffic efficiency/ operation frequency*

Realize a low-carbon and compact urban structure

Chapter 4 Suggested Procedures for Low Carbon City Development

Steps for Estimating CO_2 Emissions and Absorptions and Setting Reduction Targets

This chapter shows how to estimate the volume of CO_2 currently emitted and absorbed in a given city and set the targets for CO_2 reduction with time frames. The Guidance recommends the procedures shown in the flow chart below, with more detailed descriptions of specific policies and measures in Part II and calculation methods in Part III.



(1) Current CO_2 Emissions and Absorptions and Issues Involved

It is essential to grasp the current CO_2 emissions and absorptions as close to reality as possible. Without such attempts, it would be difficult to understand the factors contributing to urban warming. Without such understanding, it would be difficult to select an apt blend of measures for reducing carbon emissions from various urban activities and to implement them efficiently.

The Guidance explains in more detail how to approach the task of estimating emissions and absorptions in Part II and suggests specific formulas of calculation in Part III.

In addition to the present Guidance, there are other guidelines describing the methods of estimating current emissions: notably, *the Manual for the action plans of local governments to Counteract Global Warming: Measures for Local Areas*, or in short, *the Manual for New Action Plans*.

Municipal authorities are to choose an appropriate method from the alternatives indicated in such guidelines. They must be aware that the suggested methods vary a great deal, from applying some simple formula to following the complicated procedure of model building. In some cases, it is difficult to collect the data required as parameters by the suggested methods. In other cases, the reduction effects expected from the respective countermeasures cannot be included in the forecast of future emissions made by a given method. Municipal authorities have to keep in mind the following precautionary suggestions when they choose a method of emission estimation.

Precautionary Suggestions (Consistency with Forecast)

The estimation of current CO_2 emissions must be followed by the forecast of future emissions by the same method. In order to include the effects of the proposed measures into the forecast, it is crucial to select a method of calculation with the following points in mind.

- CO_2 emissions are calculated per emission source and then added up instead of being estimated from the macro data and then broken down to component parts in certain proportion.
- Parameters used in the formula of calculation must be of the type that can reflect the variation in policy stance and local conditions.

(2) Preparation of Draft Proposals

The next step is to propose various measures needed to deal with the issues and problems identified from the estimation of current CO_2 emissions and absorptions. Measures need be selected by taking note of the following points.

① *Selecting those measures that are compatible with the city's future vision and goals*

- Proposed measures for low carbon urban development need be consistent with the objectives of city development stated in the master plan and other sector plans. It would be important that the selected measures contribute to the reduction of emissions by influencing the projects designed for urban restructuring and urban facilities development.
- Proposed measures must take careful note of the characteristics of transportation in the metropolitan area, such as distribution of agglomerated and agglomerating centers, available networks of roads and public transport means and, moreover, specific development objectives in force in the spheres of economic stimulation, disaster preparedness, emergency medical services and transport modernization. The selected measures have to include the promotion of increased use of public transport, the improvement of the speed of motorized traffic and other actions that would serve to reduce CO_2 emissions.

② *Selecting those measures that are suited to the characteristics of local climate*

- Areas in cold climate have the higher energy demand for heating than warmer areas. In those areas, it is important to raise the efficiency in energy supply and consumption.

③ *Selecting those measures that are suited to the characteristics of local industries*

- Large-scale industrial complexes along the coast or elsewhere are yet untapped sources of energy. It will be essential to examine the ways and means of harnessing such sizable endowments for urban energy consumers.
- It is difficult to relocate urban-type industries and distribution centers located in urban peripheries into the built-up areas. It would be effective to establish commuting systems of low carbon emission, by promoting car sharing, community bus services operated by private corporations or residential complexes and so forth. It is important to select such measures after examining the effects of their synergy.

The Kyoto Protocol Target Achievement Plan stipulates that each local government must strive to formulate and implement a comprehensive plan of actions for reducing GHG emissions, by carefully taking into account natural and social conditions in its administrative area. Local governments are advised to make right decisions in their selection of measures by heeding the suggestions above.

It might be useful to know the current levels of CO_2 emissions in other cities of similar size and climate and what has been planned and being put into action there. The selection of appropriate measures might benefit from such comparison, but it must be remembered that impacts of the same measure might vary under different urban conditions and structures.

(3) CO_2 Emissions and Absorptions Expected from Proposed Measures

In order to set the targets, the current BAU emissions and the emission reductions realizable by the selected measures are calculated as indicated below.

① *Sources of CO_2 emissions and absorptions to be covered*

❍ Residential sector

- Residential buildings
- Business facilities (office buildings, commercial facilities, hospitals, universities, public facilities, etc.)

❍ Transport sector

- Motorized vehicles (passenger cars, business vehicles, trucks and vans, etc.), railways and ships

❍ Green sector

- All greeneries within the area of city development planning

② *Target Area of the proposed measures*

The target area is the administrative jurisdiction of a local government. (The emission estimates after the implementation of the proposed measures must be made for the respective levels of the entire urban structure, districts, street blocks and specific projects.)

③ *Time frame for planning*

The planning on low carbon city development would be best done in two time frames. The short-term plan would cover the period of 10 years during which the momentum of low carbon city development builds up and tangible opportunities present themselves. The medium-term plan could be synchronized with the master plan of city development, which usually envisions the urban future over the period of 20 years or so.

When the proposed measures and targets are finalized and incorporated into the New Municipal Action Plan, it would be necessary to adjust the target years between the two plans.

④ *Policy frame*

The policy frame (e.g., urban activities envisioned for the future) provides a set of assumptions on which possible measures are to be examined for selection. It is advisable that such a frame maintains consistency with the available city development plan, because such a plan explicitly states the development potentials and goals of a given city.

The future number of population and households can be estimated on the basis of the projections by the National Institute of Population and Social Security Research. The growth of building floor area could be estimated by taking into account the prospects of development potentials in the city.

Various parameters and factors needed for emission calculation, such as transport parameters, energy parameters and intensity coefficients, could be determined by using the results of traffic surveys in the city and by consulting the parameters developed for use by various organizations of related industries (see Part III for details of determining parameters and coefficients).

⑤ *Calculation of CO_2 emissions and absorptions*

The present Guidance suggests the following procedures for calculating CO_2 emissions and absorptions per source.

- CO_2 emissions from the transport sector are calculated by using the results of person trip surveys and road traffic censuses. Parameters used for calculation are traffic volume, trip length per OD route, and emission factors per vehicle type and per speed in the target area.
- Emissions from residential and business buildings are calculated by using, among others, estimated gross floor areas and unit energy loads per purpose of buildings.
- CO_2 fixation and sink in the greenery sector are calculated by using the activity volume obtainable from the number of trees and the area planted to trees and the sink coefficients by tree type. The formula for calculation is explained in Part III.

(4) Target Setting

The targets of emission reduction are obtained by adding up the results of calculation per proposed measure. The targets are assigned along the time frame of the respective plan periods as suggested below. If the initially estimated short- and the medium-term targets are judged out of line, the process of calculation must be reiterated to reach the acceptable finalization.

Short-term Targeting (10 years)

It is possible to foresee the build-up of the momentum and the opportunities for low carbon city development over the short-term plan period. Therefore, it is advisable to take advantage of the foreseen occasions of urban development projects and programs and identify a scenario of incorporating feasible low carbon measures per project or program.

The short-term targets can be obtained by aggregating the emission reduction effects calculated per proposed measure for the entire city area.

Medium-term Targeting (20 years)

As evidenced in the respective master plans of development in various cities, the medium-term plan period of 20 years is suitable for defining what a city aims at through its development efforts. Therefore, it would be important to draw up a coherent medium-term strategy (a basic plan or policy stance) for fitting carbon reducing measures into the overall direction and the basic aim of urban development.

The medium-term targets can be obtained by adding up the reduction effects calculated for the respective sector measures. When it is judged difficult to foresee tangible occasions for calculating emission reductions, it would be possible to extrapolate from the short-term targets. Rough estimates can be obtained as medium-term targets for the entire city, by assuming the same pace of project implementation after the first ten years.

In addition, it is advisable to pay close attention to the long-term targets of emission reduction that are to be announced in the New Municipal Action Plan.

Long-term Targeting (40 years)

As for the long-term plan period, it is necessary to heed the long-term goals of CO_2 reduction announced in the New Municipal Action Plan. The future image of a low carbon city and the conceivable paths to reach there need be presented in unquantified perspective.

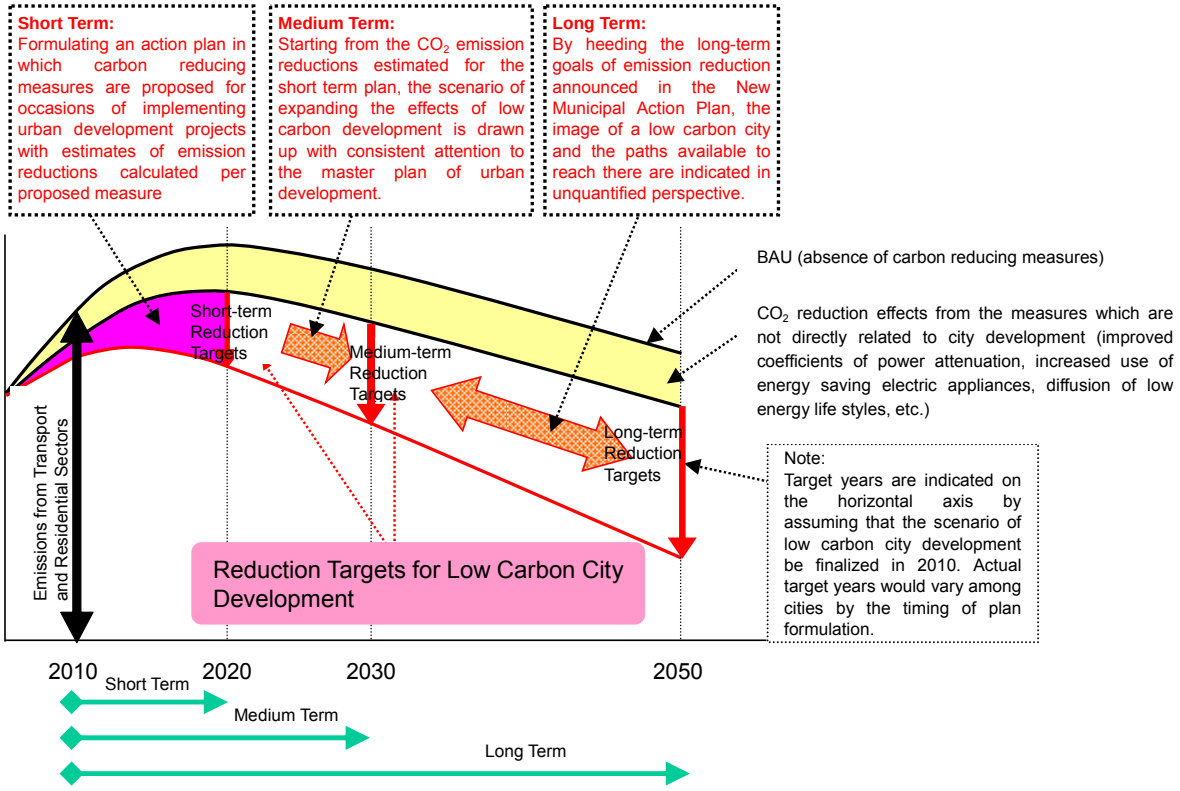


Figure Ⅰ－5　Image of Time Frames for Low Carbon City Development

Chapter 5 Municipal Action Plans to Counteract Global Warming (Measures for Local Areas)

Chapter 5 explains how the reduction targets prepared in accordance with the Guidance are related to those presented in the New Action Plan and how to coordinate activities among the departments of urban development and environmental administration in the municipal government.

(1) Reduction Targets of the Guidance and the New Action Plan

① *Scope of Coverage*

The New Action Plan covers the total emissions from the administrative area of a given municipal government. It encompasses the entire gamut of emission sources: namely, industries (e.g. factories), businesses (e.g. office buildings), households (e.g. residential buildings), transportation, energy conversion (e.g. power plants) and so forth.

The Guidance focuses on those activities that are closely related to city development planning, viz. the residential sector (households and business establishments) and the transport sector.

② *Incorporation of the Guidance-suggested measures into the New Municipal Action Plan*

Those measures proposed in accordance with the Guidance and used to calculate emission reductions would be included in the categories of measures described in the New Municipal Action Plan as "pertaining to the increased convenience to users of public transport and the improvement of local environment through urban greenery conservation, greening promotion and other actions that would contribute to GHG emission reductions."

③ *Incorporation of the Guidance-suggested Reduction Targets into the New Municipal Action Plan*

Effects of the measures for low carbon city development would account for an important part of the reduction targets in the New Municipal Action Plan regarding the residential sector (households and businesses) and the transport sector (passenger traffic).

Accordingly, the emission reductions estimated per proposed measure should be explicitly introduced into the New Municipal Action Plan that proposes the reduction and absorption targets for all sectors in the entire municipal area by following the procedures in the Manual for Formulating Municipal Action Plans.

Coordination is advisable among the municipal departments of urban development on the one hand and environmental protection on the other to adjust the relationship between the area-wide and sector-wide targets of the New Municipal Action Plan and the aggregated emission reductions calculated per proposed measure according to the Guidance-suggested procedures.

(2) Points to Remember at Incorporation into the New Municipal Action Plan

① *Future Vision and Prospects*

The future image of a low carbon city envisioned in the application of the Guidance should be shared by the master plan for urban development. Municipal departments respectively in charge of urban development and environmental protection are advised to coordinate their activities and incorporate the vision of low carbon city development into the New Municipal Action Plan.

② *Plan Period*

The timing of formulation might differ between the New Municipal Action Plan and the low carbon city development plan. The period of time covered by the respective plans would not exactly match. In such a case, the incorporation into the New Municipal Action Plan of those emission reduction measures prepared on the basis of the Guidance would need appropriate adjustments of target years.

③ *Calculation of Emissions*

In the New Municipal Action Plan, two alternative cases of CO_2 emissions are to be calculated: namely, the baseline alternative without low carbon city development (BAU) and the alternative with suitable carbon reducing measures (the basis for target setting). The present Guidance also suggests two alternatives of "with" and "without" cases to estimate CO_2 emissions respectively. Moreover, the Guidance stresses the importance of individual measures proposed for low carbon urban development and advises to calculate emission reductions per proposed measure for subsequent aggregation. The project cycle of urban development usually has a long time span from the planning stage to implementation and operation. It takes that much time for carbon reducing projects to achieve their expected targets. Acknowledging this aspect of reality, it would be advisable to incorporate the proposed measures explicitly into the New Municipal Action Plan, which is to be formulated according to the procedure specified in its Manual.

Note: The National Institute for Environmental Studies et al. calculated in the Scenario 2050 of 70% Reduction in GHG Emission that one fourth of the total expected reduction would originate in those measures proposed for urbanized areas. This points to the crucial importance of low carbon city development as proposed in the Guidance.

Figure I-6 Estimated Contribution of Residential and Transport Sectors to the Scenario 2050 of 70% Reduction in GHG Emission (prepared in 2007)

④ *Incorporating into the Roadmap and Other City-wide Plans*

To properly place the proposed carbon-reducing measures in the roadmap and other city-wide development plans, it would be necessary to keep in mind the points already mentioned concerning the estimates of emissions. Namely, the emissions are calculated per proposed measure and added up. Urban development projects would normally take a long time to complete the necessary stages from planning and implementation and therefore their intended effects would materialize after that much time.

(3) Urban Development Goals and Carbon Reduction Targets

When measures and targets for carbon reduction are being formulated for implementation, it is necessary to keep their consistency with the urban development goals laid down in the comprehensive city development plan and/or the master plan for urban development that are currently in force. The carbon reduction targets must be integrated with the city's goals as regards good housing conditions, livable urban environment, economic development and so on.

When the master plan is judged needing revision or updating, it is advisable to examine and rethink the needs of carbon reduction in the city-wide perspective and formulate a set of policy measures which would serve to reduce carbon emissions along with other multi-sided objectives of urban development.

For example, the future frame that represents an envisioned low carbon city

(quantified in terms of population, building floor area, traffic volume, etc.) need be so constructed as not to contradict the goals announced in the master plan. It is crucial to formulate a set of sustainable carbon reducing measures and determine feasible targets for low carbon city development.

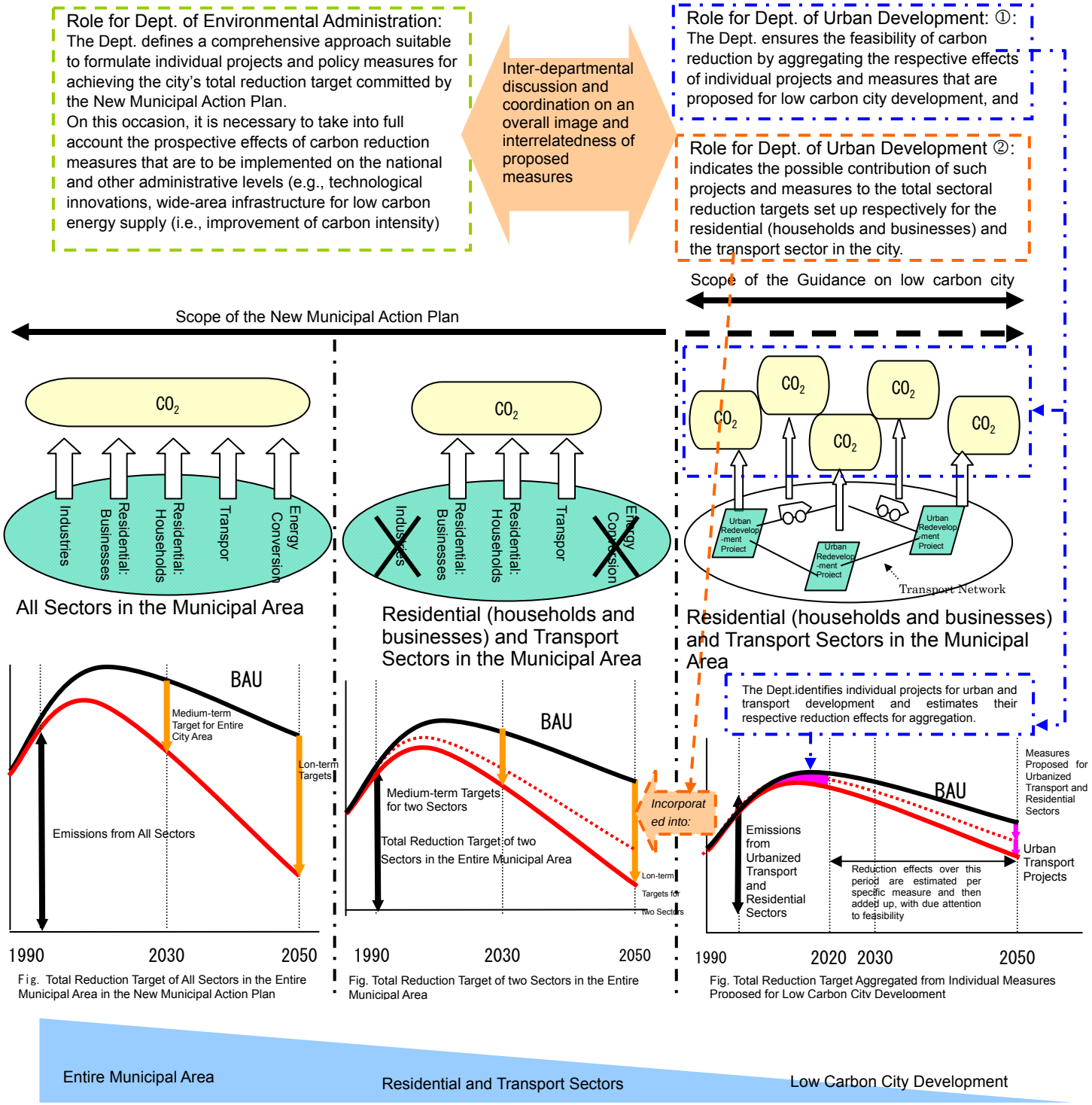


Figure I-7 Coordination between Departments of Urban Development and Environmental Administration

(Reference) Relationship between the New Municipal Action Plan and the Guidance

Contents of the Manual for the New Municipal Action Plan

1. Backgrounds and Significance of the New Municipal Action Plan
   - 1.1 Backgrounds to the New Municipal Action Plan Formulation
   - 1.2 Significance of the New Municipal Action Plan: Area-level Measures

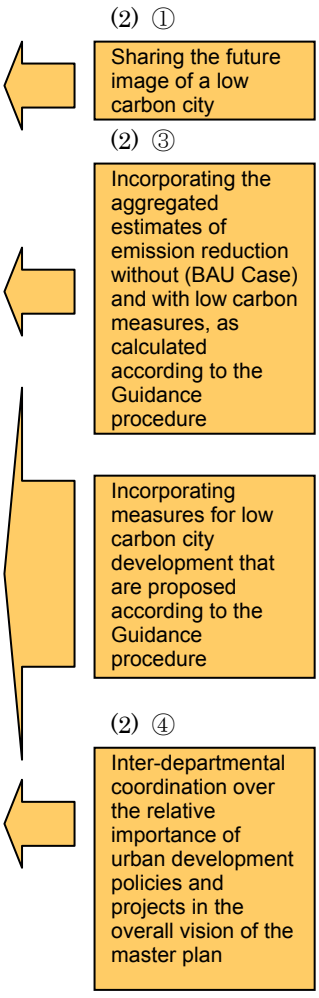
2. Estimation of Current Emissions and Absorptions of Green House Gases
   - 2.1 Importance of Current Emissions and Absorptions for Plan Formulation
   - 2.2 Scope of Estimation and Available Methods of Calculation
   - 2.3 Calculation of Energy-origin CO_2 Emissions
   - 2.4 Calculation of CO_2 Emissions from Other Sources
   - 2.5 Methods of Analysis on Factors Increasing or Decreasing Emissions
   - 2.6 Compilation of Data Needed to Estimate GHG Emissions

3. Forecast of Future GHG Emissions and Absorptions (Target Setting)
   - 3.1 Methods to Determine Reduction Targets for the New Municipal Action Plan: Area-level Measures
   - 3.2 Methods to Forecast the Baseline Emissions without Implementation of GHG Reducing Measures
   - 3.3 Methods to Forecast the Emissions with GHG Reducing Measures

4. Measures Contributing to the Reduction of GHG Emissions
   - 4.1 Measures to Promote the Utilization of Solar Power, Wind Power and Other Non-fossil Energy Sources that Suit Local Conditions
   - 4.2 Measures to Promote GHG Reducing Activities among city residents and businesses
   - 4.3 Measures to Promote Increased Use of public Transport, Conservation and Greening, and Other Efforts to Improve Local Environment by Reducing GHG Emissions a
   - 4.4 Measures to Promote Waste Reductions and Other Efforts for Creating a Recycling Society

5. Summation of Proposed Policies and Measures
   - 5.1 List of Policies and Measures
   - 5.2 Roadmap Drawing
   - 5.3 Procedure for Drawing a Roadmap

6. Cycle of PDCA (Plan-Do-Check-Action)
   - 6.1 Institutional Development on the National and the Municipal Levels of Administration
   - 6.2 Methods of Monitoring and Evaluation (How to Apply the PDCA Cycle)



Chapter 6 Low Carbon City Development through PDCA Cycle

Chapter 6 explains the cycle of PDCA (Plan-Do-Check-Action) for low carbon city development.

Low carbon city development can be efficiently and effectively carried out by following the PDCA cycle. In the first step P (Plan), the Guidance-inspired measures for low carbon city development and their aggregated targets of CO_2 reduction and absorption are incorporated into the frame of the municipal master plan of urban development, the comprehensive strategy for urban or area transport development or some other plan of similar long-term commitment. The second step D (Do) is the implementation of carbon reducing measures along with the projects of urban renewal and development envisaged in the master plan or elsewhere. The third step C (Check) involves monitoring activities to check on the performances of emission reduction and absorption. In the last step A (Action), the monitored results are compared with the initial targets, and when judged necessary, the master plan or the comprehensive strategy would be closely reviewed and revised. The cycle of four steps is to be repeated at suitable intervals.

Specifically regarding the third step C, monitoring activities needed in the transport sector would include surveys of person trips and other passenger behaviors at appropriate intervals. In the energy sector, it would be necessary to monitor the individual and area-wide performances of buildings in energy consumption by keeping pace with the diffusion of new energy management systems in individual buildings, particular localities, or wider areas. The findings of the basic studies conducted for urban planning would provide the baseline data for such monitoring. Changes in quantity and quality of urban greenery, resulting from conservation and planting efforts by the municipal authorities and citizens, could be monitored by inventory surveys organized in collaboration with interested citizens and local communities.

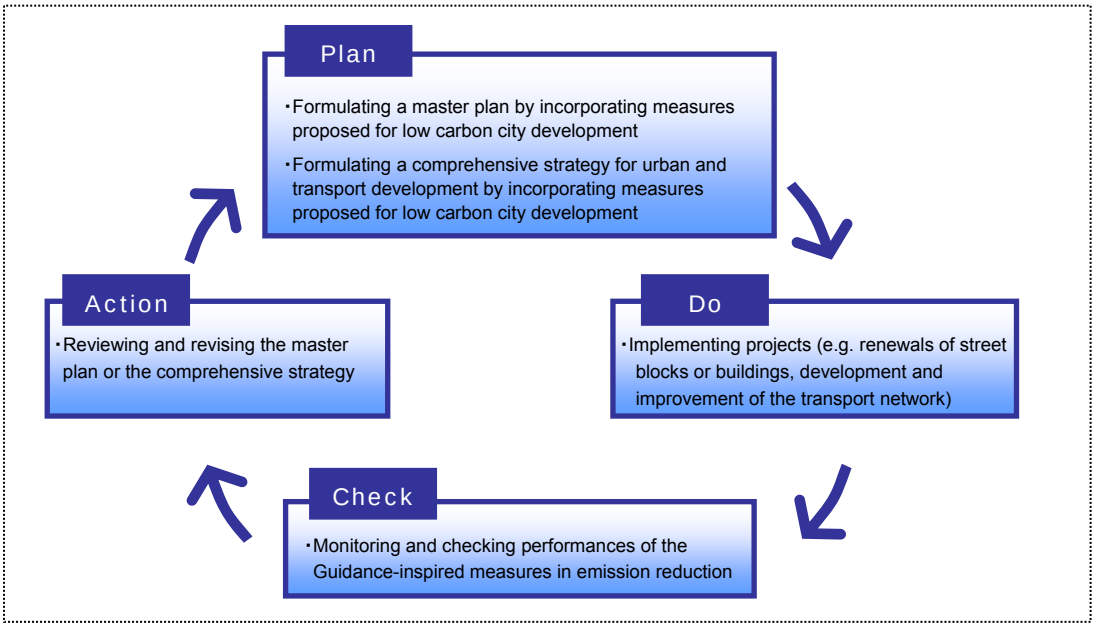


Figure I-8 PDCA Cycle Suggested for Low Carbon City Development

Moreover, such participatory monitoring on urban green environment can be made an integral part of the area management system for local communities. It would be important to realize by this approach a more efficient application of available financial and human resources and thereby stimulate grassroots capacity building.

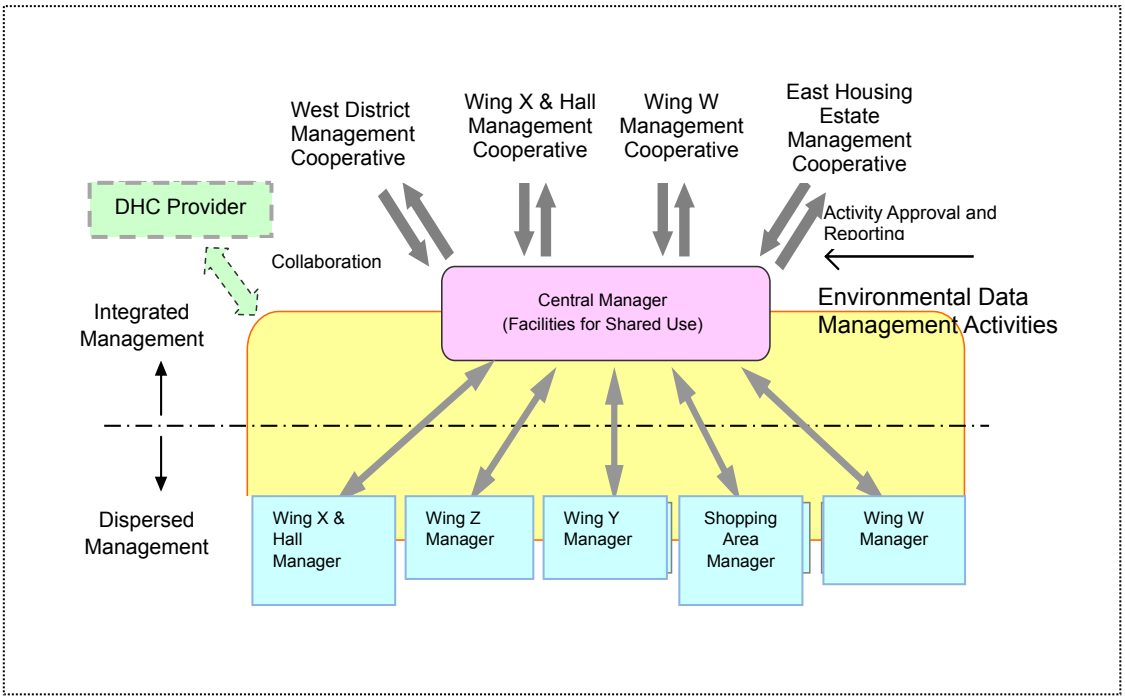


Figure I-9 Image of CO_2 Emission Reductions by the City Block Energy Management System

Part II Measures for Low-carbon City Development

Important Points for the Selection of Measures

Based on the basic concepts for the selection of measures described earlier, the following table shows the important points in considering measures for low-carbon-city development in each of the sectors to be discussed in Part II.

Table II-1
Outline of Measures and Important Points for the Selection of Measures in Each Sector Discussed in Section II

Sector	Category	Outline	Important points for the selection of measures from the viewpoints of urban size and characteristics
Transportation and urban structure sector	・ CO_2 emission diagnosis from the viewpoint of urban characteristics ・ Concept for transportation and urban structures of a low-carbon city based on urban characteristics	Show the concept for measures based on urban characteristics, with reference to the relationship between urban characteristics and CO_2 emission in the transportation sector and lists of land use and transportation measures by urban size.	・ The form of a "compact structure" varies depending on the development level of public transportation. (Large cities carry out many measures related to railroads.) ・ Such measures as promotion of bicycle use, creation of pedestrian space and measures related to vehicle use are carried out in cities of various population scales.
	・ Outline of individual measures	Show individual measures of five menus concerning transportation and urban structures in low-carbon city development.	・ Select measures appropriate for the urban characteristics and the size of the target area (city block to wide area) as well as the above-mentioned important points.
	・ Concept for combination of measures	Show the concept for combination of measures because effective selection of combined measures is necessary, rather than considering individual measures.	・ Consider such factors as synergetic effects (e.g., of a combination of improvement of public transportation and driving restrictions in the city center) and tradeoffs (e.g., between a dense, mixed-use compact urban structure and traffic congestion).
Energy sector	・ Directions of low-carbon city development and ideal urban policies ・ Geographical division for low-carbon city development	Show viewpoints, concrete image and ideal urban polities of 4 directions of low-carbon city development measures in the energy sector. Show target areas and details of each measure.	・ Consider appropriate measures to reduce energy load of buildings according to the characteristics of land use of the target city/district (whether it is a service/commercial district or residential district). ・ Consider measures to improve the efficiency of an area energy network in highly-dense areas. ・ Select untapped energy available in the target city/district and consider highly dense areas where such energy can be utilized. ・ As for renewable energy, consider spaces for its introduction and opportunities for area-wide urban development based on the characteristics and resources of the target city/district.

	・ Examples of opportunities and measures for low-carbon city development	Show energy-related policies and measures for low-carbon city development concerning individual opportunities for area-wide renewal of buildings, development of centers, function renewal of a group of buildings etc.	・ In the energy sector, it is important to carry out such actions as building renewal, area-wide development and redevelopment of urban districts, development of centers, function renewal of surrounding buildings as opportunities for low-carbon city development.
Greenery sector	・ Roles of urban greenery in low-carbon city development ・ Target urban greenery	Summarize roles of urban greenery and shows comprehensive measures for low-carbon effects. Show the methods and effects of target greenery by city scale and structure.	・ Clarify the roles of greenery (e.g., CO_2 fixation and absorption, biomass, and heat island mitigation) according to the scale of the city and the structure of a low-carbon city. Select an appropriate form or methods of utilization of greenery. ・ Plan reservation and placement of greenery, considering the creation of a compact city structure and a good urban environment.
	・ Urban greenery measures in low-carbon city development	Shows concepts and actions (concrete measures, institutions etc.) for each role of greenery (CO_2 fixation and absorption, biomass, and heat island mitigation).	・ Keeping in mind the viewpoint of a compact city structure and roles of greenery in line with the characteristics of the area/district (3-1), make efforts to reserve and maintain greenery and utilize biomass. ・ As for the utilization of greenery for heat island mitigation, it is important to conduct city development in an effective manner with due consideration of space scaling (wide area, city and district) and characteristics of wind flows, land use etc.

Chapter 1 Transportation and urban structure sector

(1) Overall Picture of Measures

As shown in Part I of this Guidance, the major source of CO_2 emission in the transportation sector is automobiles, accounting for about 90% of the total emission in the sector. Therefore, measures to reduce CO_2 emission from automobiles should be in the central part of the low-carbon measures in the transportation and urban structure sector.

Low-carbon measures in the transportation and urban structure sector contribute to "shift away from automobiles", "shortening of travel distance" and "improvement of travelling performance". Many of these measures have been carried out as measures to improve roads and public transportation facilities (tangible measures) and traffic demand management (intangible measures). That means all low-carbon measures in the transportation and urban structure section do not necessarily have to be new, but the important thing is to carry out measures in appropriate combination and measures that have not been sufficiently conducted after identifying what effects past measures will have in the reduction of CO_2 emission.

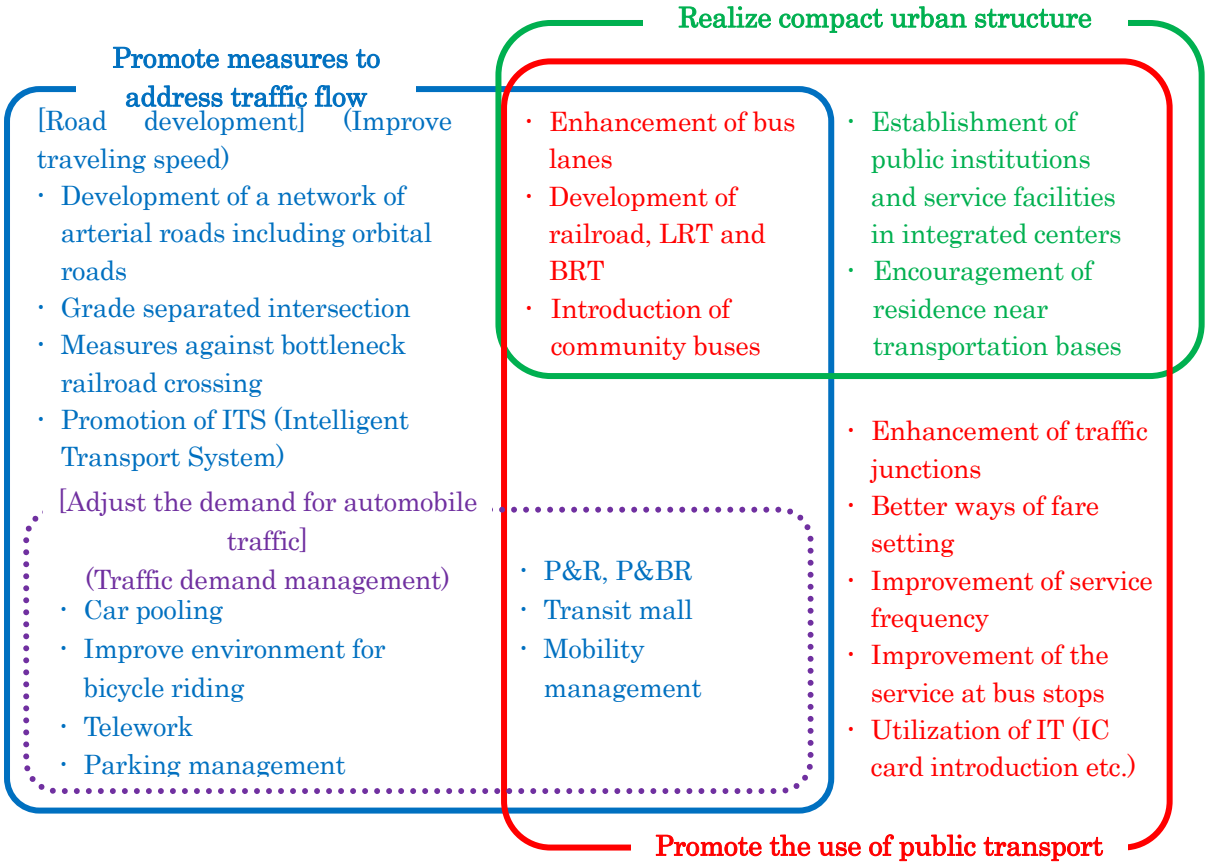


Figure II-1 Structure of Low-carbon Measures in the Transportation and Urban Structure Sector

Policy 1 Realize compact urban structure
← Shorten travel distance and shift away from automobiles

Policy 2 Promote measures to address traffic flow
← Improve traveling performance and shift away from automobiles

Policy 3 Promote the use of public transport
← Shift away from automobiles

(2) Outlie of Individual Measures

Regarding the five menus of low-carbon city development in the transportation and urban structure sector, as discussed in (1), contribution to CO_2 emission reduction of each measure should be identified and individual measures should be appropriately selected and carried out in right combinations according to the scale and characteristics of the city and space scaling (from city blocks to the whole urban areas).

Table II-2 Examples of Low-carbon Measures in Transportation and Urban Structure Sector (Individual Measures)

Policy	Manus of Environmental Measures	Measures (Examples)
Policy 1 Realize compact urban structure	Menu 1 Shift to a compact urban structure	(1) Location of public facility/service facility etc. (2) Encouragement of residence near transportation hubs
Policy 2 Promote measures to address traffic flow	Menu 2 Road development (improve traveling speed	(1) Development of a network of arterial roads including orbital roads (2) Grade separated intersection (3) Measures against bottleneck railroad crossing (4) Promotion of ITS (Intelligent Transport System)
	Menu 3 Adjust the demand for automobile traffic (traffic demand management)	(1) P&R, P&BR (2) Transit mall
		(3) Car sharing (4) Car pooling Improve environment for bicycle riding
		(5) Telework
		(6) Mobility management (7) Parking management (fringe parking, parking supply control, parking fee control)
Policy 3 Promote the use of public transport	Menu 4 Development of public transportation)	(1) Development of railroad, LRT and BRT (2) Introduction of community bus (3) Enhancement of bus lane (4) Enhancement of traffic junction like open space in front of stations
	Menu 5 Promote the use of public transportation)	(1) Figure out a better way of setting fare (2) Improve service frequency (3) Improve the service at bus stops (4) Utilization of IT (IC card introduction etc.)

Chapter 2 Energy sector

(1) Reduction of Energy Load on Buildings

1) Viewpoints of Energy Load Reduction in the City

Air-conditioning equipment, lighting fixtures and OA devices are used in office buildings, and lighting fixtures, water heaters and air-conditioning equipment in residences. It has been pointed out that the electricity consumed for air conditioning and lighting to maintain comfortable indoor environment varies greatly depending on the building structure, relationship with the external environment and how to use the building.

In order to reduce CO_2 emission attributable to energy consumption in the city, it is advisable to give first priority to considering measures to maintain the indoor environment where people can work and lead a life comfortably without consuming too much energy, i.e., measures to reduce energy load of the building.

2) Concrete Image, Effectiveness and Ideal Urban Measures of Energy Load Reduction

■ Introduction of Passive Environmental Technologies

It will be effective to improve buildings with passive environmental technologies to control indoor environment with the architectural use of properties of solar light, solar heat, wind, rain water, land etc. Specifically, we can consider increasing buildings where comfortable room temperature is maintained with enhanced heat insulation, solar shading, cooling with outside air without using air-conditioning equipment, and buildings where the indoor brightness and air cleanness are maintained with the use of daylight and natural ventilation instead of electricity.

Taking such opportunities as redevelopment, building renewal, conversion of building use and renovation of a house, we can consider encouraging the development of a building with passive environmental technologies and energy management to reduce the actual energy load of buildings in the whole area.

■ Promotion of Energy Management at Architectural Level

Promotion of energy management is effective for preventing unnecessary energy load by properly adjusting the operation method of existing facilities. Specifically, Building Energy Management System (BEMS) and Home Energy Management Systems (HEMS), which automatically turn off lights of the rooms that are not in use and control and manage air-conditioning and lighting according to the changes in room temperature and illuminance.

■ Promotion of Energy Management on the Level of Area/District

It is hoped that, with a monitoring/control system and a high-speed communication network, monitoring and operation control of heat source equipment at multiple facilities will be conducted centrally to prevent production of unnecessary energy load in the whole area. Such system is already in practical use as Area Energy Management System (AEMS), in distinction from BEMS and HEMS that are introduced for each building, and can be promoted as an effective low-carbon measure for existing buildings on an area or district level.

(2) Improvement of Efficiency of Energy Utilization in Buildings, Districts and City Blocks

1) Viewpoint of Efficient Utilization of Energy in the City

City centers of a large metropolitan area and areas around terminal stations are heavily developed with tall buildings, commercial and service function, residence function, culture and exchange function etc., and blocks with high land utilization and those with various functions are blended into each other. In such areas it is expected that there will be many buildings with high energy load.

In local cities, where promotion of residence in city centers and revitalization of central urban districts are major challenges, we can consider gathering buildings with various different patterns of energy load in the same area by increasing density of convenient urban districts with well-developed urban infrastructures and improving land use to complex use (mixed use) for residential, commercial, service, administrative, lodging and educational purposes as well as through conversion to a compact city and an urban structure with smaller environmental load.

2) Concrete Image, Effectiveness and Ideal Urban Measures of Efficient Energy Use

■ Economy-of-Scale Advantage of Consolidated Energy Load

(Introduction of highly-efficient equipment and sophistication of operation management)

In urban districts where land is to be highly utilized, as energy load of heating and cooling etc. of concentrated buildings grows larger, the capacity of heat source equipment will also become larger. Consolidation of heat source equipment of such buildings will allow the introduction of highly efficient heat source equipment with economy-of-scale advantage. Proper division of equipment will improve the operational efficiency and the central control of heat source equipment will allow more sophisticated operational management according to the load properties. Thus the efficiency of energy consumption in the whole district can be enhanced.

(Shift of peak energy load to nighttime)

In case an urban district where land is to be highly utilized has many buildings of a single use such as office buildings, the peak of energy load in the area can be prominent. As the capacity of heat source equipment should satisfy the peak load, the operation rate of the equipment becomes low. If the heat source equipment of such buildings is consolidated and the peak hour is shifted to nighttime with the use of heat storage tanks, the efficiency of energy use will be improved and the CO_2 emission from electric sources will be reduced with the use of nighttime electric power.

■ Adjustment of Area-Wide Energy Balance in Buildings for Multiple Uses

(Increase of operation rate of heat source equipment by smoothing the level of energy load)

Urban districts for mixed uses have buildings with different time patterns of energy load, such as commercial and service facilities where energy load is high during the day, and houses and lodging facilities where energy load is high at night. If heat source equipment of such buildings is consolidated after investigation of load patterns and consideration of the scope of area-wide energy utilization, energy load peaks will be smoothed and waste heat from the buildings can be utilized. The total capacity of heat source equipment can be minimized and the annual capacity utilization rate will be improved. Therefore the efficiency of energy utilization will be enhanced.

(Introduction of cogeneration through consolidation of electric power and heat load)

Urban districts for mixed uses have buildings of different energy load characteristics, such as commercial and service facilities with high electricity load caused by OA devices, air-conditioning, lighting etc. and houses and lodging facilities with high thermal load caused by nighttime heating and hot-water supply for cooking and baths. Consolidation of heat source

equipment of such buildings will equalize the electricity and thermal load in a district/block and increase the effect of the introduction of efficient decentralized electric power sources such as gas engine cogeneration and fuel cells.

■ Promotion of Area Energy Network

In urban districts with high land use density and complex use of land, we can consider developing a network for consolidation of energy load and interchange of energy and energy centers with consolidated heat source equipment in line with city development. Introduction of an area-wide heating and cooling system and interchange of heat among buildings are effective measures for the promotion of "Area Energy Network".

Moreover, it is also important to carry out measures to plan and ensure buildings that will create energy load exceeding certain size and density so that the feasibility of the area energy network business will be ensured. Consolidation of small-scale lots at the time of renewal of an urban district can be carried out so that the shape and scale of the buildings will be suitable for the use of an area energy network.

(3) Utilization of Untapped Energy as Energy Source for the City

1) Viewpoints of Utilization of Untapped Energy in the City

■ Untapped Energy

Heat is generated steadily during the incineration of garbage and sewage sledge and also production processes at plants in the city. However, as potential receiving sites (mainly large consumers) are often geographically distant, a large amount of energy (urban waste heat) is just thrown away. Moreover, energy (thermal energy) of river water, sea water, sewage water and treated sewage water, which has smaller changes in temperature than the air throughout the year and therefore can be utilized as a heat source or sink with the use of a heat pump, is also left unused as there are no consumers to receive the energy. Such unused energy is referred to untapped energy and should be effectively utilized as a unique energy source in the area.

■ Viewpoints of Utilization of Untapped Energy

Large cities often have urban districts where plants and public utility services such as a sewage disposal plant are relatively adjacent to other buildings and houses. Even in local cities, sewage pumping stations and rivers are often in an urban district. It is important to design energy recycling based on the links between facilities that produce untapped energy and buildings and houses in the surrounding areas as “energy supply facilities” and “energy consumption facilities”.

2) Concrete Image, Effectiveness and Ideal Urban Measures of Utilization of Untapped Energy

■ Creation of Heat Consumers and Connectivity in line with City Development

(Utilization of unused energy through the concentration of new thermal load)

In case the introduction of residential function is encouraged as a way to consolidate various functions in the city center, a sizeable amount of new thermal load will be created by hot water supply and air-conditioning equipment of newly built urban houses. If such thermal load is consolidated with the introduction of a central system and properly distributed to where it is needed together with hot-water feeding load of existing facilities such as hospitals and welfare institutions, it will contribute to the effective utilization of relatively low-temperature urban waste heat including heat of sewage water and waste heat from incinerators and plants, which have been thrown away as there is no consumer nearby.

(Securing of a waste heat transportation route in line with the development of roads and other public facilities)

As untapped energy is concentrated on specific locations like manufacturing plants, waste disposal facilities and sewage disposal plants, it is important to consider connections (matching) of such facilities to buildings and areas with high energy load. At the time of phased renewal of an urban area or road improvement around facilities that produce untapped energy, if road underground space is planned to be used exclusively for energy supply pipes, urban waste heat can be transported to other buildings and districts with high energy load and thus untapped energy can be effectively utilized.

■ Collaboration with Measures to Improve Urban Heat Environment

(Proper treatment of waste heat from cooling with the use of thermal energy)

In the central urban districts of large cities, the energy load density is high and the improvement of urban environment including heat island phenomena is strongly required. If waste heat from cooling during summer is released into river water, sea water, sewage water or treated sewage water instead of going into the air through a rooftop cooling tower, the thermal environment of the air can be improved.

However, for proper treatment of centralized waste water from cooling, it is desirable to have

sufficient discussion with managers of the facilities where the heat will be released as well as confirming that the sewage canal or river has enough volume of flow and released waste heat will not be locally concentrated.

(4) Utilization of Renewable Energy as Energy Source for the City

1) Viewpoints of Utilization of Renewable Energy in the City

■ Renewable Energy

Renewable energy is a type of energy that naturally exists and can be repeatedly used, such as solar energy, wind power energy, biomass energy and geothermal energy. Renewable energy is considered as zero-carbon energy that does not generate CO_2 when used. (Biomass energy generates CO_2 when used but absorbs CO_2 when generated; therefore CO_2 emission is offset by the absorption at the time of energy generation. CO_2 generation during production and transportation processes should be separately considered.)

In order to use renewable energy that exists in low density and in a wide area for electricity or heat generation, it is important to concentrate and distribute the energy in a proper way with energy conversion equipment such as solar panels and wood pellet factories.

■ Viewpoints of Utilization of Renewable Energy in the City

A certain amount of solar energy and geothermal energy can be utilized in any city regardless of the local characteristics. However, the business seems more feasible in suburban areas and small and medium local cities than in the center of large cities where it is difficult to find a sufficient area for equipment installation.

Although the type of renewable energy that can be used as electricity can be introduced for general purposes regardless of local conditions, the method to introduce the type of renewable energy used as heat varies depending on the local conditions (e.g., whether there is thermal load of a heated pool). The trend of heat utilization in the city and new methods of heat utilization are the key to the promotion of the introduction of renewable energy from the standpoint of heat utilization.

2) Concrete Image, Effectiveness and Ideal Urban Measures of Utilization of Renewable Energy

■ Introduction of Solar Energy based on the Characteristics of the Urban Space

(Effective utilization of rooftop space)

As there are restrictions on the installation of solar panels on individual buildings in the city, installation of solar panels can be considered on a district level.

In dense urban areas in big cities, where it is difficult to find space for the installation of energy conversion equipment (such as solar panels and biomass fuel boilers), one possible measure is to adjust the shape and layout of the buildings in those areas so that rooftop solar panels will receive enough sunlight. Another possible measure is to correct mismatches on a district level by introducing energy conversion equipment in line with urban district development, e.g. case where energy conversion equipment cannot be installed on the building whose owner wants to introduce the equipment or the owner of an eligible building does not want to introduce the equipment.

(Utilization of Unused Plots and Slope Areas)

One possible measure in local cities is to develop a renewable energy plant as a base by installing solar panels or biomass boilers in unused plots or facilities in urban districts. Slope areas adjacent to urban districts can also be a good installation site for solar panels with good sunlight. By using such areas, we can increase the places for energy generation with due consideration for greenery development and landscape formation.

(Promotion of seizing every opportunity for city development)

In local cities that have urban districts with low building density, while the effect of introducing renewable energy such as solar or biomass energy (ratio of urban energy load covered by renewable energy) seems to be relatively large, there are only a small number of redevelopment and building renewal projects that can be good opportunities for renewable energy introduction. Therefore, priority can be put on low-carbon measures in line with characteristics of the local climate and natural environment through such opportunities as improvement of housing stock, renovation of government buildings, hospitals and other public facilities and renovation of existing buildings by residents or NPO.

■ Introduction of Biomass Energy in line with the Characteristics of Local Industries and Communities

(Economy-of-scale advantage of regional resources recycling)

In areas where the major industries are forestry, livestock farming and other types of agriculture, and fisheries, renewable energy introduction can be increased by recycling such wastes as thinned wood, wood waste and animal manure that are produced in large amounts during production processes. By carrying out consolidation of wastes and energy conversion with the economy-of-scale advantage of such local industries in combination with consolidation of energy load through city development, a system for local energy production for local consumption can be established.

(Collaboration with the development of living environment and communities in the area)

Areas with a decreasing birth rate and an aging population have a great need for the development of local facilities to provide detailed support for new life and the improvement of living environment based on local communities. In such areas, a potential low-carbon measure is to provide safe and free-of-charge heating and hot water supply services from local facilities to the surrounding neighborhoods. Development of an area energy network of solar heat or biomass energy can also be considered as a way to introduce renewable energy to the extent that local communities are willing to participate.

Chapter 3 Greenery sector

(1) Roles of Urban Greenery in Low-carbon City Development

As shown in Part I of this guidance, for the development of a low-carbon city, it is important to make efforts to reduce CO_2 emission and increase absorption through the conversion to a compact urban structure. The roles that greenery are expected to play from the viewpoint of low-carbon city development are 1) a role to realize a compact urban structure, 2) a role to reduce CO_2 in the air as a sink, 3) a role to reduce CO_2 emission with the utilization of wood biomass, and 4) a role to mitigate heat island effect through the improvement of ground surface covering.

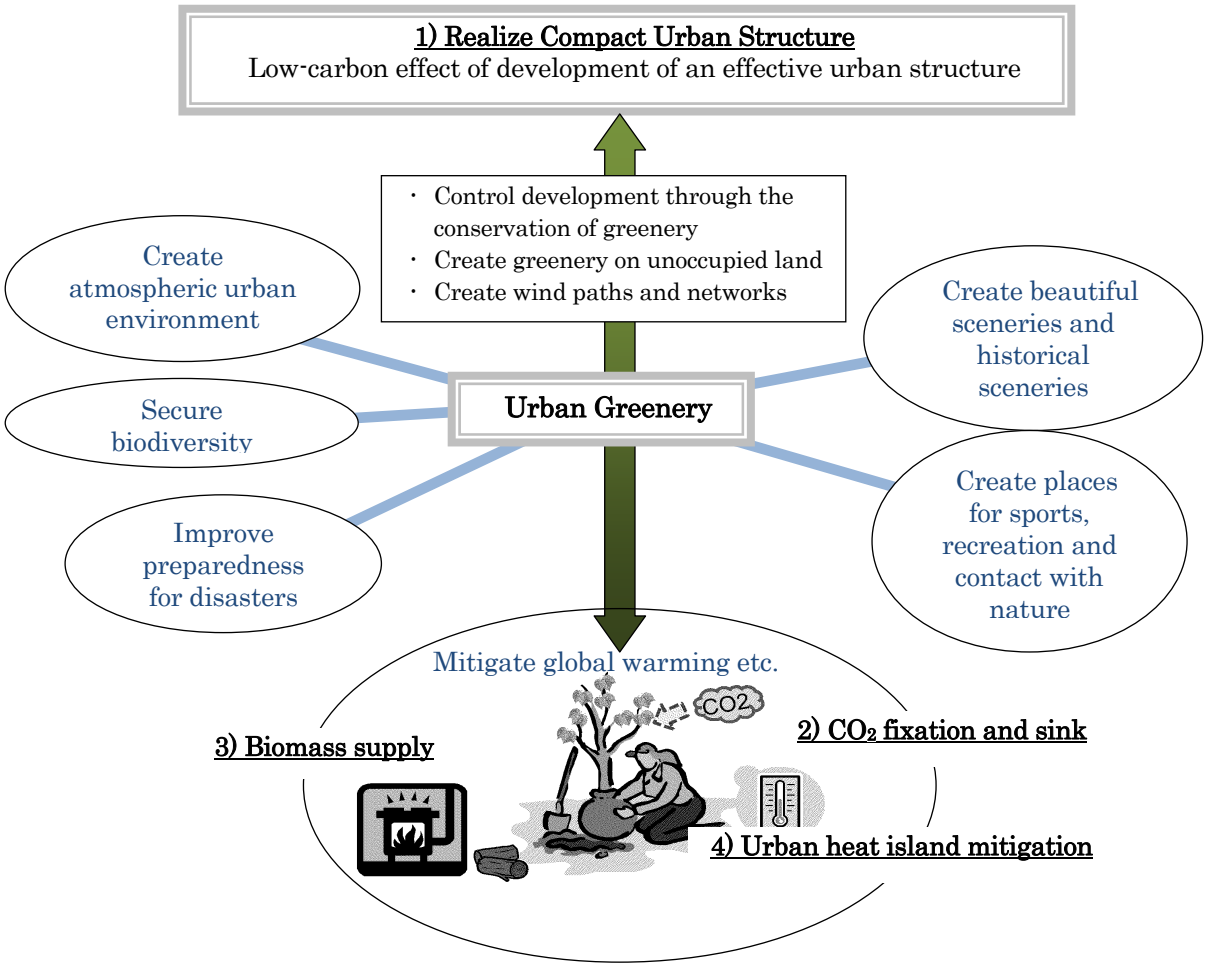


Figure II-2 Roles of Urban Greenery

1) Role to realize a compact urban

As greenery is a key element to define an urban structure, it is important to properly preserve wood land and farm land around urban districts through the implementation of city planning and to protect such land from dispersive development. It is also important to create greenery on unoccupied land that is expected to appear as the population decreases.

In urban districts where integrated centers are to be created, it is important to create sustainable integrated centers with a greenery network through efforts to create greenery in public and private space in various methods including green rooftops and walls as well as efforts to create greenery in urban parks and on ground surfaces.

2) Role to reduce CO_2 in the air as a sink

Considering that trees work as a CO_2 sink through the carbon fixation process of photosynthesis, where CO_2 is absorbed, converted into organic matters and stored in trunks and trees, it is important to promote measures to increase trees through the preservation and creation of urban greenery.

Although the amount of CO_2 fixed and absorbed varies depending on the form of greenery (type of plants, conditions of ground surface covering, maintenance status etc.) as well as on the area, the absorption amount can be estimated by the method used for CO_2 absorption report based on the Kyoto Protocol. (See Part III.)

3) Role to reduce CO_2 emission with the utilization of wood biomass

Biomass materials produced during maintenance of urban greenery, such as pruned branches, fallen trees and pulled weeds, can reduce CO_2 emission if utilized as alternative energy to oil and other types of fossil fuel. It is also important to recycle these materials into compost and chips so that they can be reused as soil conditioner.

Wood biomass produced by urban greenery has an advantage that it is found in cities and city fringes where the energy is consumed, not in forests in the mountains, and therefore the energy and cost for transportation can be relatively smaller.

4) Role to mitigate heat island effect through the improvement of ground surface covering

Compared with artificial ground surface materials like asphalt and concrete, ground surface covering with trees and flowers reduces built-up heat from sunlight etc. and therefore contribute to the mitigation of urban heat island effect. While the heat (sensible heat) built-up on artificial surface materials is released at night and keeps the temperature high, plants consume heat (latent heat) through evapotranspiration and have the effect of lowering the temperature. Thus, it is important to mitigate heat island effect by replacing artificial ground surfaces with greenery. If heat island measures are carried out in combination with efforts to reduce artificial waste heat, there will be indirect effects in CO_2 reduction such as reduction of air-conditioning demand.

In addition to the above-described viewpoints, it is also important to promote greenery measures that will contribute to the preservation of biodiversity and the creation of good living environment as well as low-carbon city development, through such actions as the utilization of plants suitable for the local ecosystem and plants that bring a sense of the season.

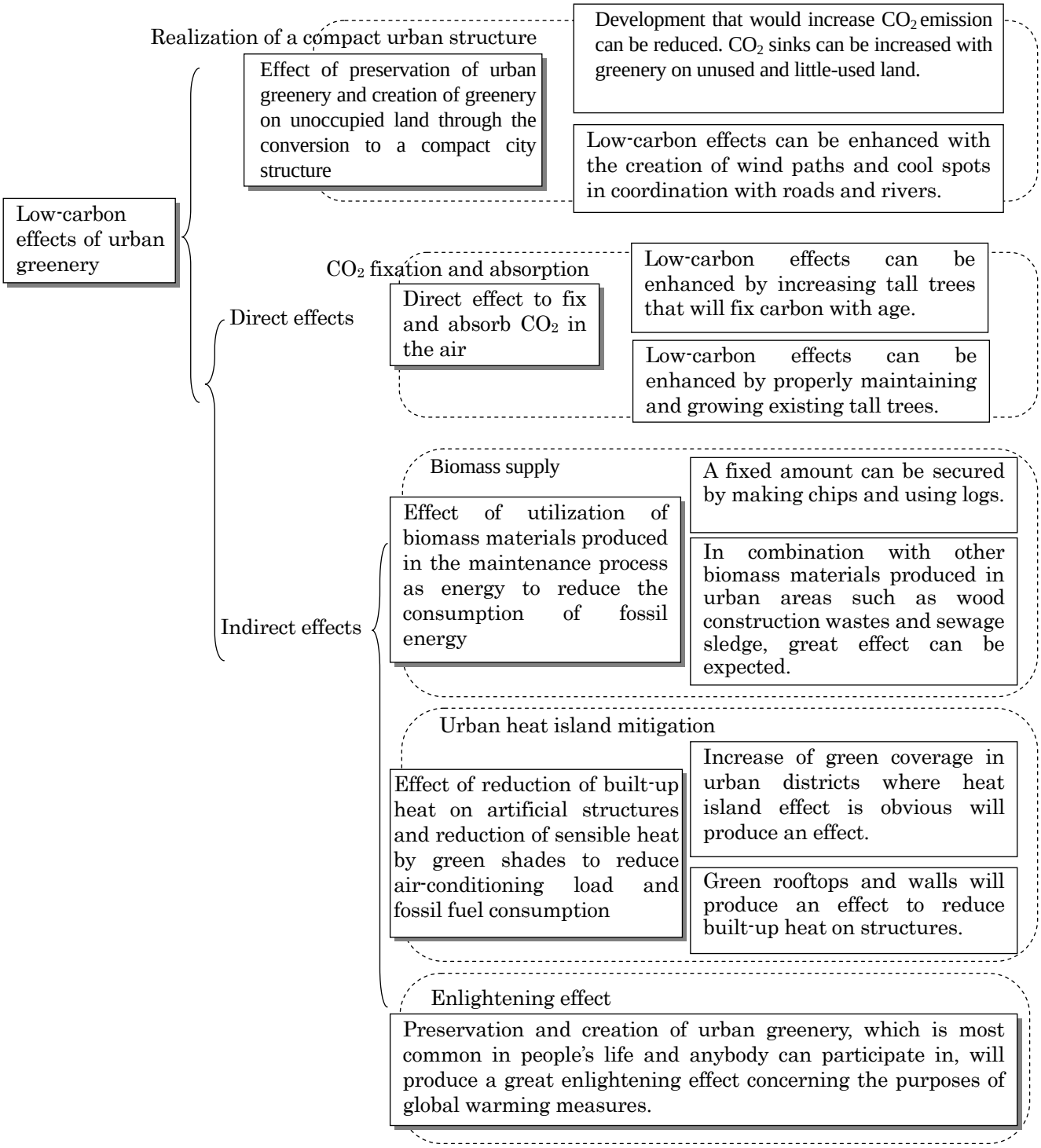


Figure II-3 Low-Carbon Effects of Urban Greenery

(2) Target Urban Greenery

Target greenery is all the greenery in the city planning area.

As CO_2 absorption of the forests regulated by the forest law may be separately calculated by the forest administration department of the local government, attention should be paid to overlaps when calculating CO_2 absorption.

Note) Farmland and forests should be handled according to the Guidelines on City Planning and the Guidelines on Urban Green Space Conservation Law.

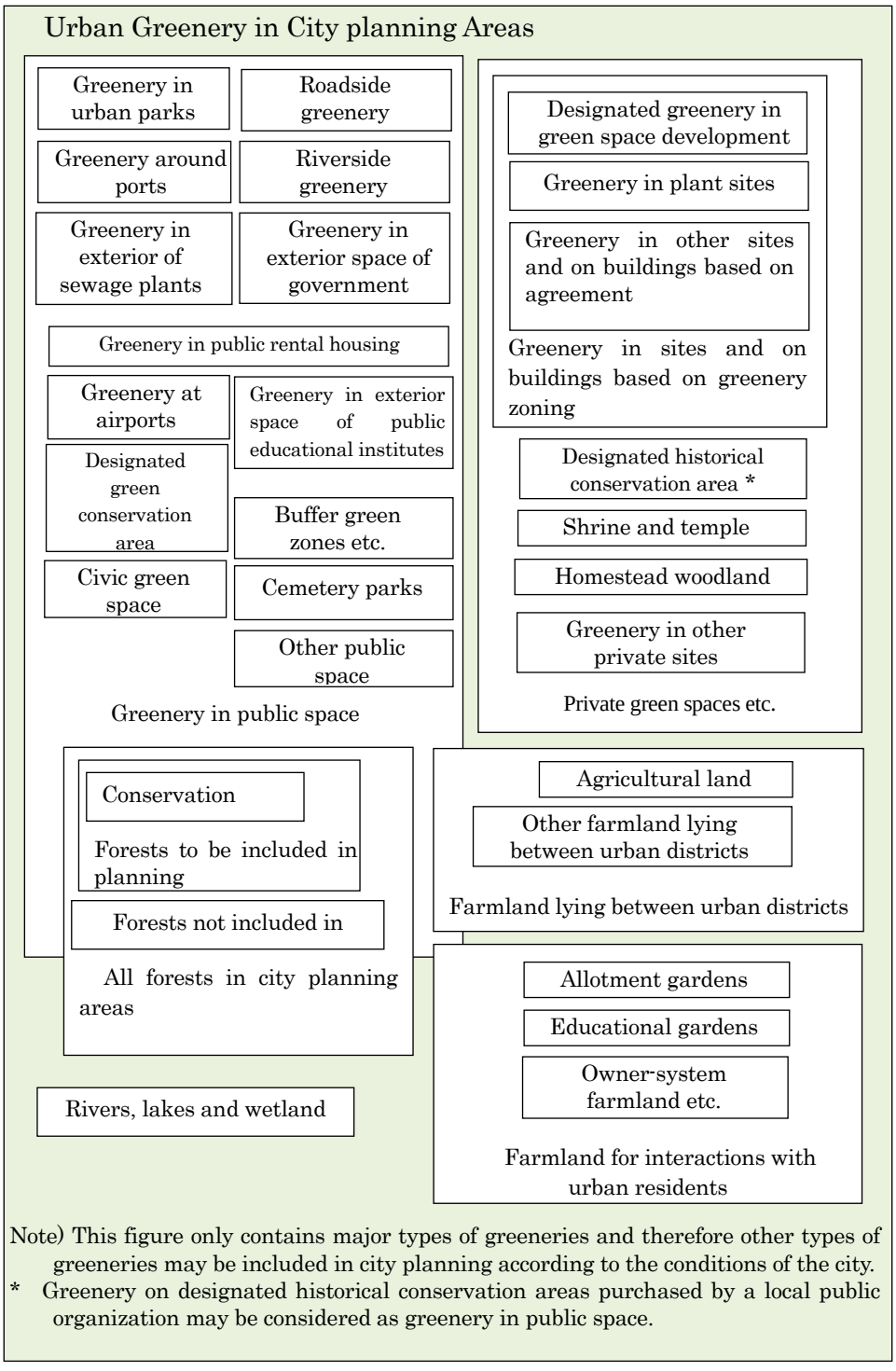
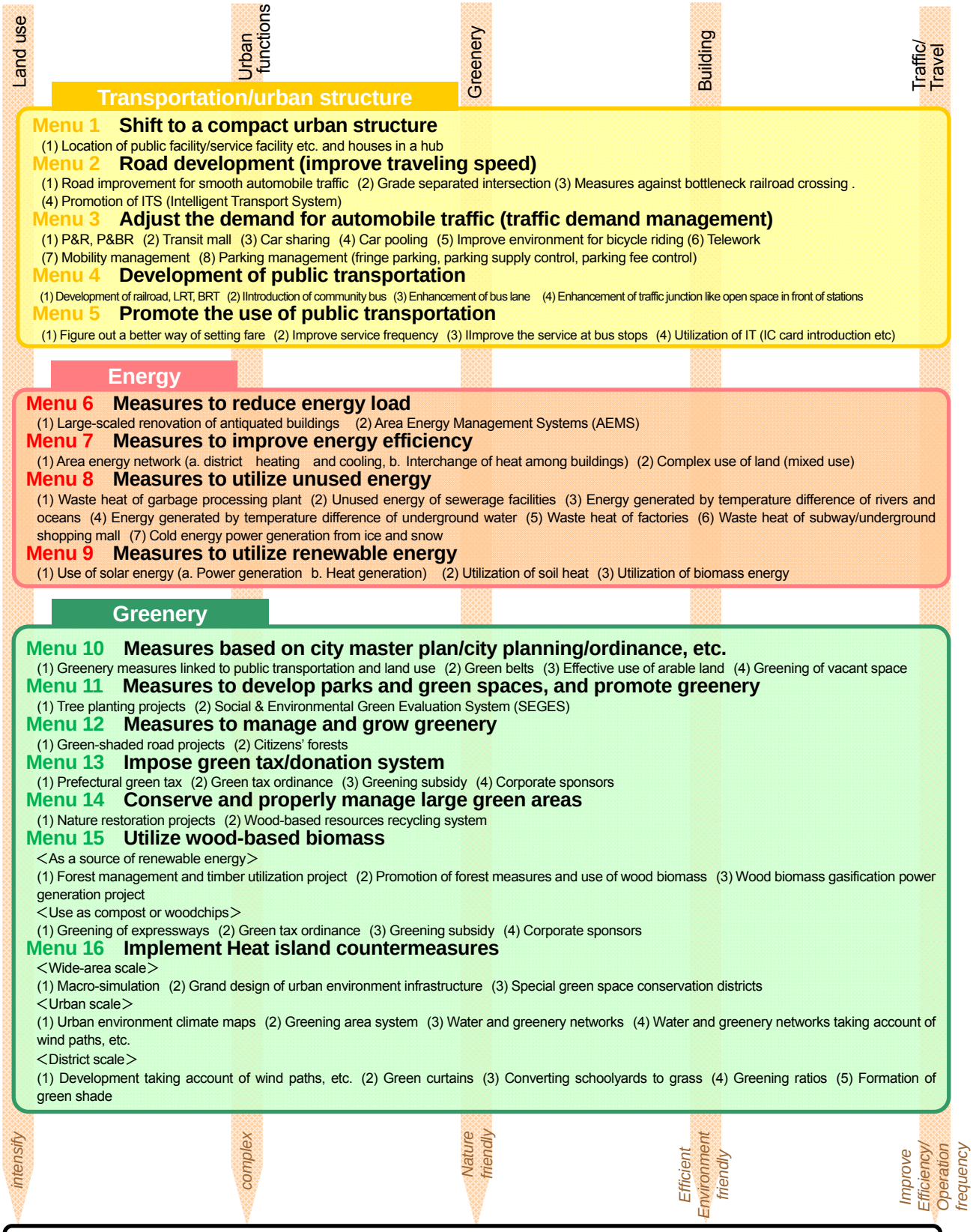


Figure II-4 Target Urban Greener

Policy menu of low-carbon city development

In this section, menus and examples of measures for the transportation and urban structure sector, the energy sector, and the greenery sector are provided.



Part III Effective analytical methods of Low-carbon city development policies

Estimates of CO_2 Reduction and Absorption

Method of calculating CO_2 emissions in the transportation and urban structure sector

Cars are the main sources of CO_2 in the transportation sector, accounting for about 90% of emissions in the sector. Therefore, measures to reduce such CO_2 emissions are key low-carbon measures in the transportation and urban structure sector.

Formula for calculating CO_2 emissions in the transportation sector

CO_2 emissions = traffic volume × travel distance (trip length) × emissions intensity

Selection of methods for impact analysis in the transportation and urban structure sector

3 methods of predicting effects in the sector

Method 1 Calculation based on person-trip survey data
* A 4-stage estimation method is used to calculate the effects of a set of measures in line with a pre-set traffic scenario

Method 2 Calculation based on census OD survey data
* Calculation based on sample calculations of the range of impact of, and reduction obtained through, each measure based on the conditions in each city

Method 3 Calculation of the effect of individual measures
* Evaluation method will be developed with prerequisite conditions, in case there is no applicable analysis method

Method of calculating CO_2 emissions in the energy sector

The building floor area will be used as an activity volume to quantify CO_2 emissions, since low-carbon strategies in the energy sector mainly focus on reducing CO_2 emissions of buildings.

Formula for calculating CO_2 emissions in the energy sector

CO_2 emissions = gross floor area × unit energy load of a building ÷ the overall energy efficiency of heat reservoir × emission factor by type of energy

4 directions in energy

Assuming that building floor area is the same, 4 directions toward low-carbon cities in the energy sector with a view to reducing CO_2 emissions in other elements are set as follows:

1) **Reduce energy load of buildings**
   → Construct buildings requiring low energy to power coolers, heaters, etc., and reduce the unit energy load
2) **Improve efficiency of buildings, districts, and towns**
   → Introduce equipment with high energy efficiency and improve the total energy efficiency of heat resevoir
3) **Utilize unused energy**
   → Replace fossil fuels with unused energy and reduce the coefficient of energy emissions per type of energy
4) **Utilize renewable energy**
   → Replace fossil fuels with renewable energy and reduce the coefficient of energy emissions per type of energy

Method of calculating CO_2 fixation and sink in the greenery sector

Increasing greenery is the only measure to increase CO_2 sink in cities. Meanwhile, the effect of conserving and creating urban greenery can be directly quantified as "CO_2 fixation and sink" effect, since fixation and sink data have already been more or less developed for tall trees.

Formula for calculating CO_2 fixation/sink in the greenery sector

Effect of CO_2 fixation/sink = activity volume 1 × sink coefficient 1＋ … ＋activity volume n × sink coefficient n

Part III

Chapter 1 Basic Concepts for Assessing Emission Reduction Measures in the Transport and Urban Structure Sector

(1) General Procedures of Assessment

The following procedures are suggested to assess reduction effects of those measures proposed for low carbon city development.

Step 1: Finalizing specs of the proposed measures

It is necessary to decide the specifications of the proposed measures for low carbon city development. For instance, a proposal for "public transport development" must be planned by specifying the links it would concern in the transport network, its chosen mode (LRT, BRT, etc.) and so on.

Step 2: Selecting the method of assessment and preparing necessary database

Based on the specs of the respective measures, an appropriate method for assessing their reduction effects is chosen along with the preparation of the database needed for assessment.

Step 3: Calculating CO_2 emissions and reductions thereof per proposed measure according to the chosen method

Step 4: Aggregating and adjusting the outputs of calculation

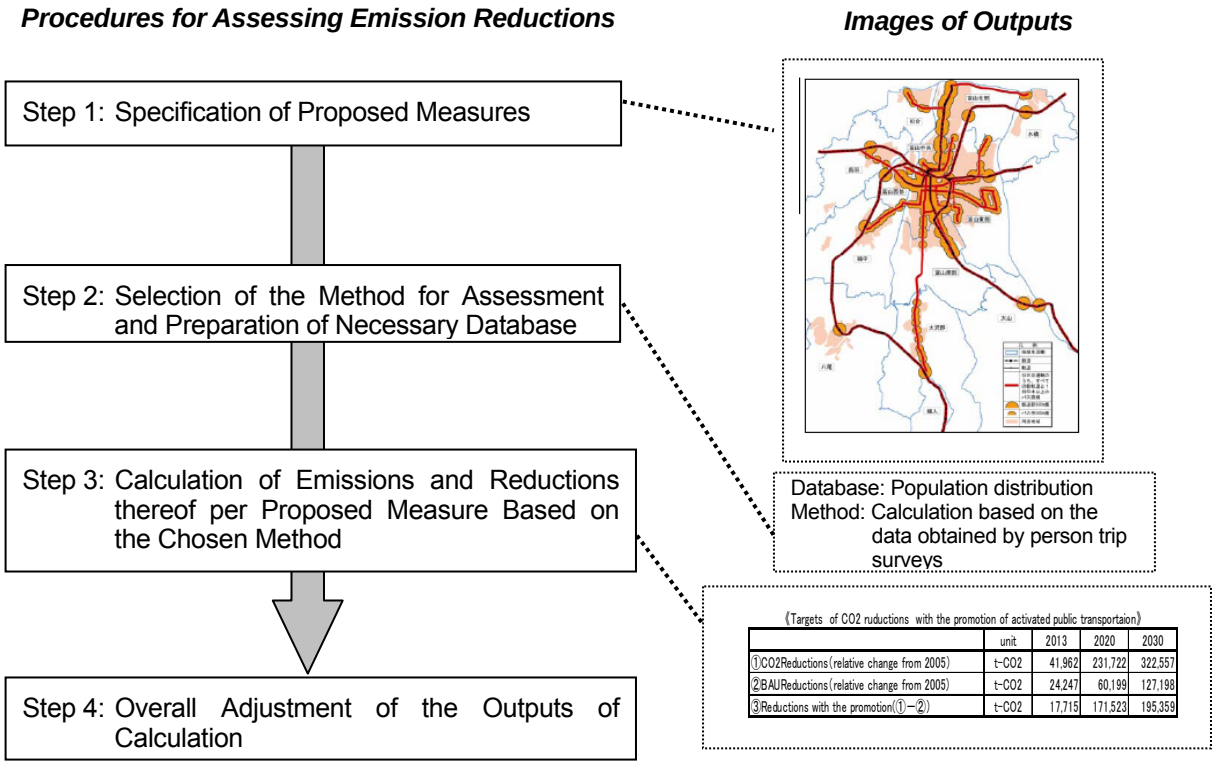


Figure III-1 Outline of the Procedures for Assessing Emission Reductions (An Example for the Transport and Urban Structure Sector)

(2) Identification of Measures to Propose

■ Analysis of the Present Situations

It is advisable to examine various traffic problems in the metropolitan area and thereby pinpoint the basic issues involved in the present urban transport system. For this purpose, it is necessary to analyze the present land use patterns and traffic behaviors, supply-side performances of the existing transport infrastructure and the available public transport services, and on-going changes in the socio-economic context (e.g. demographic trends, economic activities, life styles, etc.) of a given city. Furthermore, after calculating CO_2 emissions of the baseline year, it is desirable to analyze how the present form of urban structure and the present provision of transport infrastructure are related to the level of emissions. This would help clarify the issues involved in launching various measures to reduce CO_2 emissions of the city.

■ Decision on the Future Frame of Social and Urban Structures

On the basis of population forecasts and the expected social changes (e.g. declining birthrate, increase of gainfully employed women and the elderly, etc.), it is possible to determine the future demographic frame, viz. population, labor force and employment by gender and age cohort. From the problems and issues identified by the analysis of the present situations, it is possible to envision future possibilities of urban structure, land use pattern and population distribution. It is desirable to prepare two or more alternatives of the envisioned future.

■ Formulation of Alternative Scenarios of Future Transportation towards a Low Carbon City

Based on the identified issues and problems and the future frames, it is necessary to examine possible measures that could contribute to low carbon city development; namely, construction and improvement of physical transport infrastructure (e.g. roads, railways and spatial provision for bus lanes) and transport policies that improve software aspects of urban traffic management. It is desirable that two or more alternative scenarios be prepared with significantly different combinations of hardware and software measures. More specifically, at least three alternative cases are advisable; i.e. a scenario consisting of all identified measures, another scenario stressing a feasible combination of measures and another scenario which does not implement any carbon reducing measure.

Chapter 2 Basic Concepts for Assessing Emission Reduction Measures in the Energy Sector

(1) General Procedures of Assessment

The volume of CO_2 emissions provides the basis for planning low carbon city development and can be calculated by the basic formula shown below.

CO_2 emissions = Activity Volume x Unit Energy Value x Carbon Intensity

The following procedures are suggested to assess reduction effects of those energy-sector measures proposed for low carbon city development.

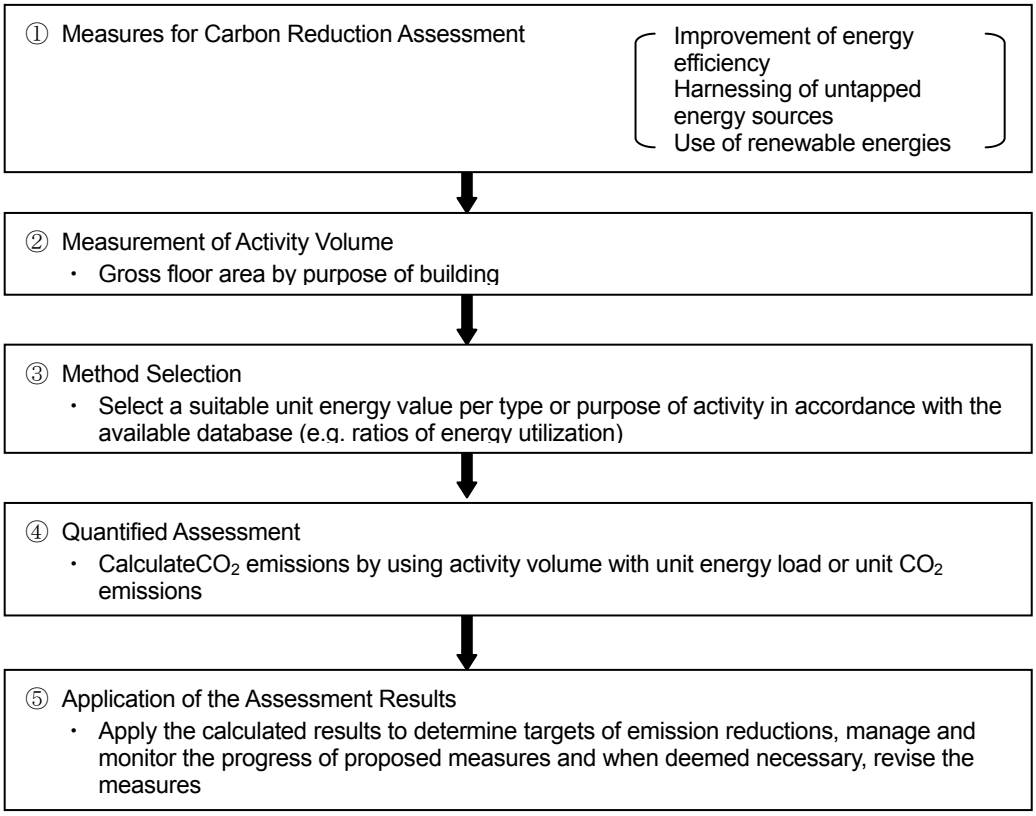


Figure III-2 Procedures for Assessment in the Energy Sector

① Measures for Carbon Reduction Assessment

Appropriate measures are selected for carbon reduction assessment; i.e. improvement of energy efficiency in individual buildings, street blocks or districts, harnessing of untapped energy sources, utilization of renewable energies, etc.

② Measurement of Activity Volume

The activity volume is quantifiable as energy consumption of buildings. Because the energy load of a building is generally correlated with the size of its floor area, gross floor area must be measured per purpose of individual targeted buildings and then aggregated. The aggregation can be extended to cover a street block or a district.

③ Method Selection

The selection of an appropriate method depends on the availability of statistical data on energy consumption by targeted buildings or street blocks. The flow chart shown below indicates the procedure of selecting a method to estimate CO_2 emissions. Where the data on electricity and gas consumption are available, CO_2 emissions are calculated by using the unit energy load of a building per purpose of the building. Where such data are not available, the unit CO_2 emissions per unit of floor area per purpose of a building are used for calculation.

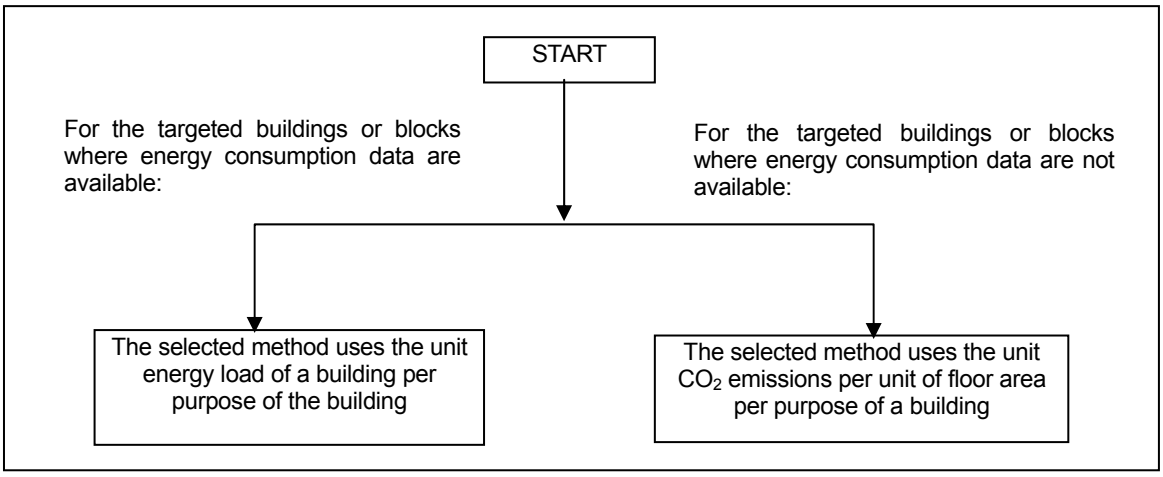


Figure III-3 Procedure for Method Selection

④ Quantified Assessment

The energy load of a building can be calculated by using the unit value of energy load or of CO_2 emissions as shown below.

CO_2 Emissions = Activity Volume x Unit Value x Carbon Intensity

Gross Building Floor Area x (Unit Energy Load of a Building ÷ Overall Energy Efficiency of Heat Reservoir) x Emission Factor

(Unit CO_2 Emissions of a Building per purpose of the building

⑤ Application of the Calculated Results

The results of calculation are applied to estimate the present volume of CO_2 emissions in the baseline year and the future volume thereof in the target year when the trend should continue without any implementation of carbon reducing measures (BAU scenario). Then, the impacts on CO_2 emissions regarding the targeted years are estimated per measure proposed for low carbon city development. The carbon reduction effect per individual building as a result of building regulations and the wider-area effects of urban development projects are separately estimated and then aggregated for the entire city. The results of calculation would be used to determine the carbon reduction targets for the city and to review and revise the components of the respective proposed measures.

Chapter 3 Basic Concepts for Assessing Emission Reduction Measures in the Green Sector

As mentioned in Part II, urban greening is the only measure to increase CO_2 sinks in a city. Moreover, the carbon reduction effects of greenery conservation and expansion efforts are quantifiable because the data of CO_2 fixation and sink by tall trees are available.

The "CO_2 fixation and sink" effect can be calculated, as shown below, by using "activity volume" and "sink coefficient" per type of greenery.

CO_2 Fixation/Sink Effects = Activity Volume 1 x Sink Coefficient 1 + ... Activity Vol. n x Sink Coefficient n

It is important to make the expected impacts of greening efforts "visible" by calculating CO_2 fixation and sink effects with the data on various greening activities and the available sink coefficients.

The "visible presentation" of carbon absorbing effects of urban greenery would make it possible to measure the annual progress of greening efforts, determine the emission reduction targets, and engage in appropriate monitoring and management of urban greeneries.

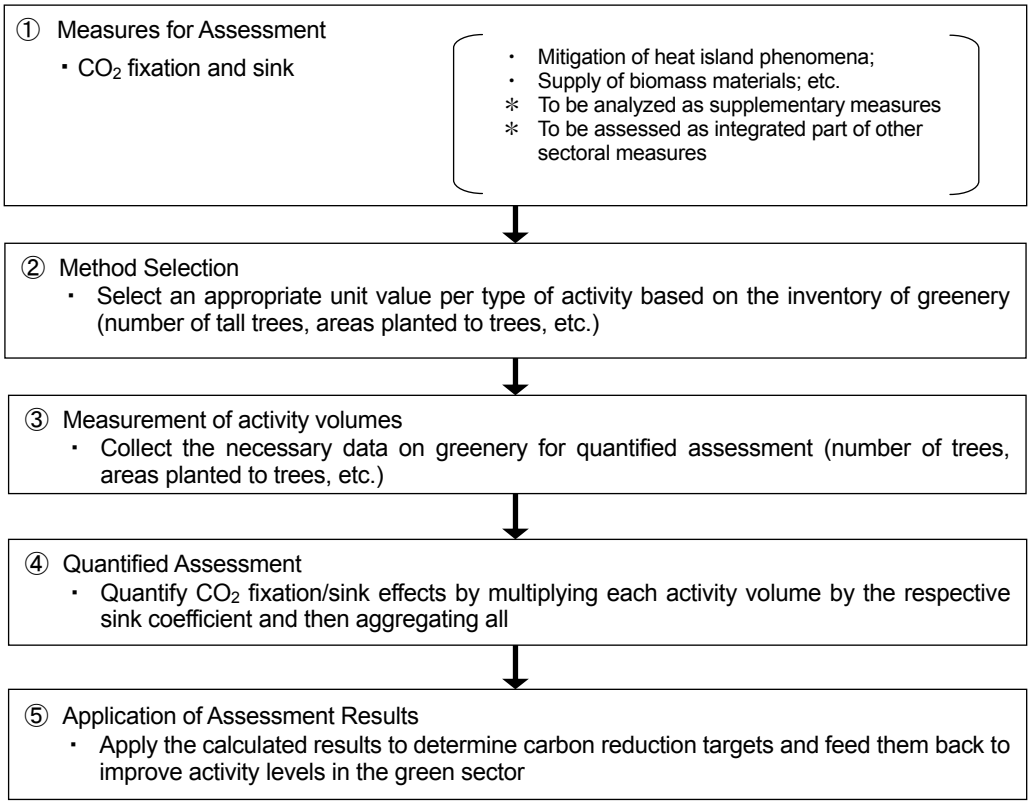


Figure III-4 Procedures for Assessing Greening Activities

Examples of Calculations Based on Simulation

The following is a result of a simulation based on the Guidance, assuming that ambitious measures are implemented in the Sendai metropolitan area.

Set preconditions concerning urban development measures

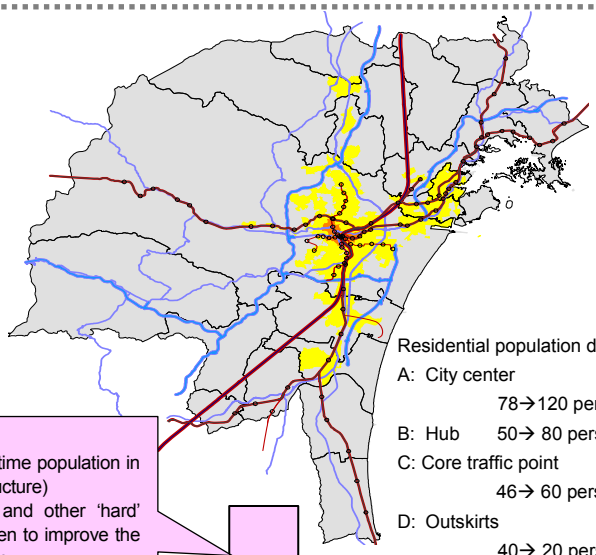
(with 30 or more indicators which can be set in even greater detail)

- Residential population distribution and density (intensity level)
- Status of transportation infrastructure and implementation of 'intangible' measures
- Redevelopment of buildings, etc.
- Renewal of buildings etc.

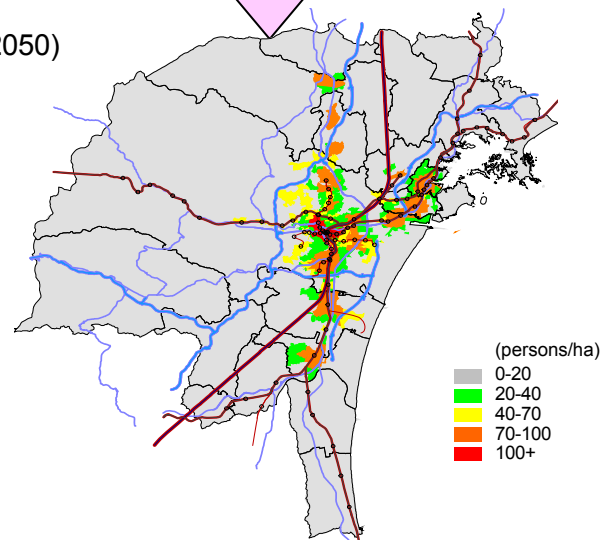
Simulation by systematically organizing various elements

Preconditions for simulation
- Aggregation of residential and daytime population in centers (compactness of urban structure)
- Development of roads, railways and other 'hard' amenities, and 'soft' measures taken to improve the convenience of public transportation

Now



Future (2050)



* Various combinations of measures can be compared by changing the preconditions

Calculate change in CO_2 emissions of the whole city in response to a combination of measures

CO_2 emissions from traffic in a compact city by 2050 would be:
Reduced by 24.0% compared to the current level **(820,000t CO_2 /year)**

Effect of conversion to a compact urban structure (concentration of population in centers) in terms of increased efficiency of movement, etc. : 12.0% reduction
Effect of traffic measures : 4.9% reduction
Effect of population reduction : 7.1% reduction

< Obtaining method >

The Low Carbon City Development Guidance can be obtained on the following and the Ministry of Land, Infrastructure, Transport and Tourism homepages.

http://www.mlit.go.jp/toshi/city_plan/teitanso.html

< Inquiry >

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< Issue >

February, 2012 .