The Concept of the Low-Carbon Town in the APEC Region

Final Report

October, 2011

The APEC Low Carbon Model Town Task Force

APEC Energy Working Group

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Part I

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This report was compiled based on a preparatory study by the Task Force (TF) Japan, the team of Japanese low carbon town experts, under the guidance of Project Overseer of APEC Low Carbon Model Town (LCMT) Project, International Affairs Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI), Japan.

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Executive Summary

The “Concept of the APEC Low Carbon Town (LCT)” aims to provide a basic idea of what is a low-carbon town and an effective approach on how to develop it. The LCT Concept aims to promote the development of low-carbon towns in the APEC region by providing a basic principle that can assist the central and local government officials of the member economies in planning effective low-carbon policies and in formulating an appropriate combination of low-carbon measures while taking socio-economic conditions and city specific characteristics.

The APEC Low Carbon Town(LCT) means towns, cities and villages which seek to become low carbon with a quantitative CO_2 emissions reduction target and a concrete low carbon developing plan irrespective of its size, characteristics and type of development (greenfieild or brownfield development).

The overall planning to develop the LCT proceeds on a step by step basis. The first stage of the planning is to create a basic low carbon town development plan, which builds upon the existing town development plan and goals and backgrounds of the central and local government’s low carbon plan

The following stage is the formation of a low carbon town development strategy, two essential features of which are to 1) set quantitative low carbon reduction targets with a time frame to achieve them, and 2) select the most appropriate set of low carbon measures in a comprehensive manner. In this planning process, it is vital to completely grasp the characteristics of the town under consideration, because the characteristics of town makes a difference in selecting the most appropriate set of low carbon measures.

There are several different characteristics of towns including climate conditions, geography, industrial structure, town structure or intensity of land use and town infrastructure. Unlike the first two characteristics, industrial structure, town structure and town infrastructure are variable. Therefore, the government officials responsible for low carbon town development, especially in the developing economies where rapid growth of town is being observed, should look at the future picture of the town, or even think about guiding these changes from a view point of reducing CO_2 emissions in the town.

The LCMT project offers a very good opportunity for the central as well as local government officials in the APEC economies to refine and enhance their current low carbon town development plans based on the “Concept of the APEC Low Carbon Town”.

Introduction

At the 9th APEC Energy Ministers Meeting (EMM9), which was held in Fukui, Japan on 19 June 2010, focusing on the theme “Low Carbon Paths to Energy Security”, the Ministers observed that “Introduction of low-carbon technologies in city planning to boost energy efficiency and reduce fossil energy use is vital to manage rapidly growing energy consumption in urban areas of APEC”. Responding to this observation, they called for the APEC Energy Working Group (EWG) to implement an APEC Low-Carbon Model Town (LCMT) Project “to encourage creation of low-carbon communities in urban development plans, and share best practices for making such communities a reality”.

The APEC LCMT project consists of three activities, namely, i) development of the “Concept of the Low-Carbon Town ”, ii) feasibility studies（hereafter “F/S”）and iii) policy reviews of planned town and city development projects. The LCMT Project will be a multi-year project. The first phase of the LCMT Project will develop an initial version of the “Concept of the Low Carbon Town” and provide F/S and policy review for the Yujiapu CBD (Central Business District) Development Project in Tianjin, China.

To develop the “Concept of the Low-Carbon Town ”, Study Group A was formed, in which experts from interested APEC member economies participate as a task-shared activity. Over the next several years, the “Concept of the Low-Carbon Town” will be further refined into a useful guidebook for planners who wish to implement low-carbon urban design, building on the case studies of other Low Carbon Towns in the APEC as well as incorporating the practical methodologies for urban planning and design. In the similar way, Study Group B was formed to conduct policy review.

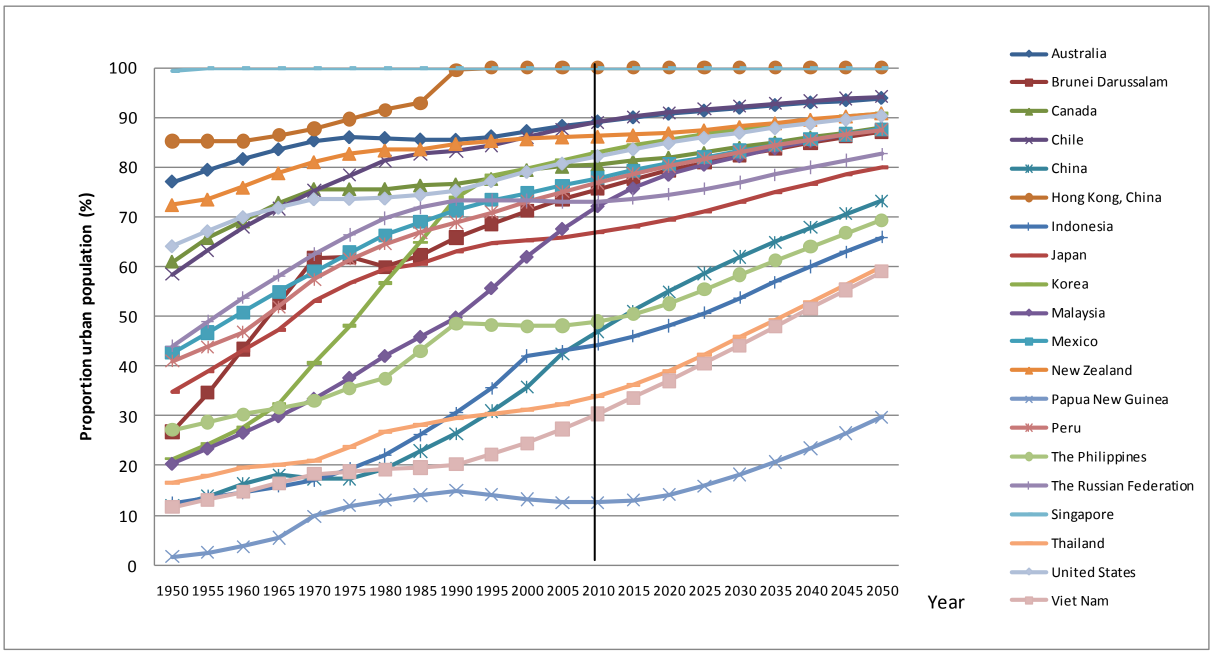
As the key advisory body for the APEC LCMT project, LCMT Task Force (TF) was established in response to the Energy Minister’s instructions in their Fukui Declaration. LCMT TF is responsible for supporting development of the “Concept of the Low Carbon Town”. The Asia-Pacific Energy Research Centre (APERC) coordinates the overall work of APEC LCMT project including the work of the Study Group A and B under the direction of the Agency for Natural Resources and Energy, METI Japan (Project Overseer).

Chapter 1 Background

1.1 Urbanization and the impact in the APEC region

The APEC region has increasingly been urbanized in recent years. In 2010, the average urbanization rate in all APEC economies was 68.5%. Urbanization is likely to increase in the future. In 2050, the average urbanization rate is predicted to be around at 80.9%. Especially in Asia, the increase in urbanization has been remarkable and has a strong possibility of increasing as represented by economies such as China, Indonesia, the Philippines, Thailand and Viet Nam, etc. (Figure 1).

Figure 1 APEC Economies Urbanization Outlook

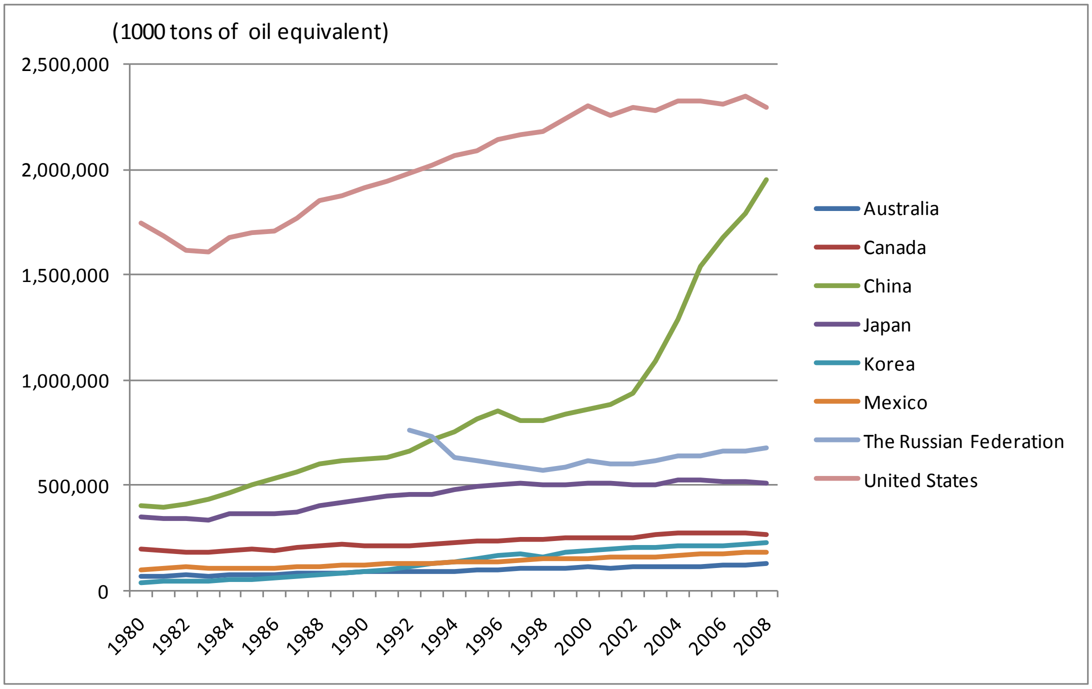


Source: World Urbanization Prospects 2009 (United Nations Development Program)

Energy consumption has also increased in responses to urbanization advances. The amount of primary energy consumption in the APEC region has increased at an annual average rate of 3.5% since 1990. In 2008, the consumption stood at approximately 6.8 billion toe (tons of oil equivalent), an 84.2% increase compared to year 1990 and a 26.2% increase compared to year 2000.

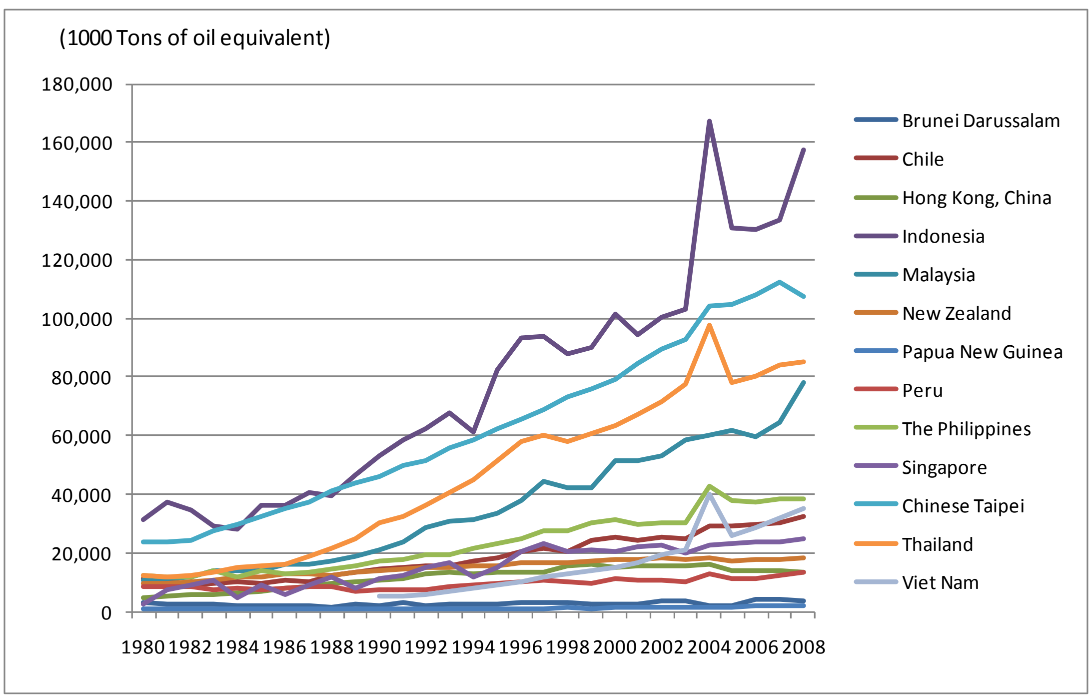
The increase in the energy consumption is remarkable especially in China where the consumption has more than doubled during the period from 2000 to 2008. China accounted for 76.9% of the total increase in energy consumption in the APEC region during the period (Figure 2). Energy consumption has also significantly increased in Indonesia, Chinese Taipei, Thailand and Malaysia (Figure 3). Energy consumption is expected to increase significantly as emerging economies especially in Asia achieve high economic growth

Figure 2 Historical Trend of Primary Energy Supply for APEC Economies-1



Source: APEC Energy Statistics, 2000, 2004 and 2008

Figure 3 Historical Trend of Primary Energy Supply for APEC Economies-2



Source: APEC Energy Statistics, 2000, 2004 and 2008

The urbanization has led to the increase in energy consumption in the APEC region. Naturally, much of the energy is consumed in the urban areas. Reducing green house gas emissions in the area is important challenge for the APEC economies. Therefore, making the concept of low carbon model towns to help the implementation of low carbon town in the APEC region is significant in this respect.

1.2 Low carbon target for each APEC member economy

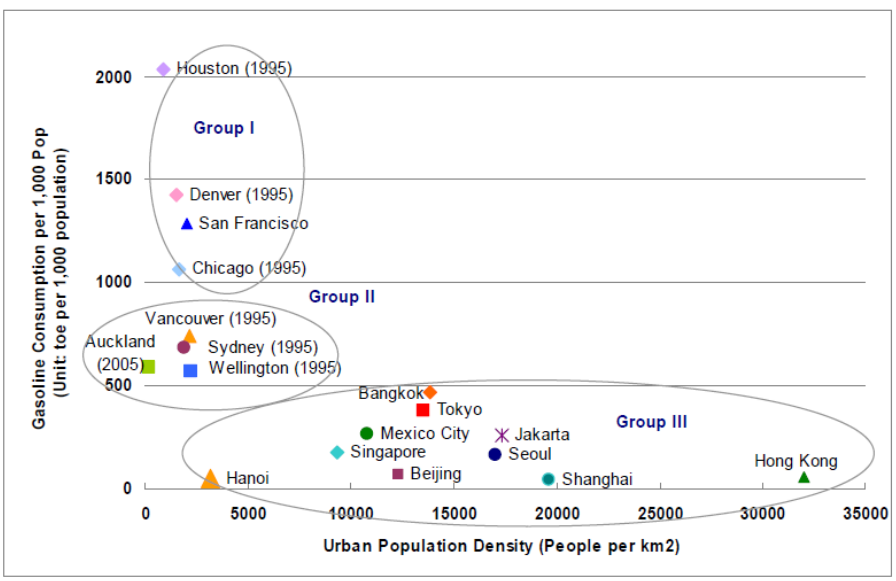
As discussed, the energy consumption in the APEC region, especially in Asia, has been increasing, resulting in increased greenhouse gas emissions. This has prompted APEC member economies to work on carbon reductions by developing their own low carbon targets (Appendix 1).

1.3 Trend of CO_2 emissions in cities

The increase in energy consumption and greenhouse gas emissions tends to be conspicuous in urban areas. Therefore, understanding the level of greenhouse gas emissions and absorptions in each city is important to define low carbon targets and enact methods to achieve set targets.

CO_2 emissions resulting from urbanization show that per capita gasoline consumption in cities in developing economies is currently lower than that in North American cities (Figure 4). However increasing dependency on private transport with improving per capita income is expected to increase per capita CO_2 emissions in the future.

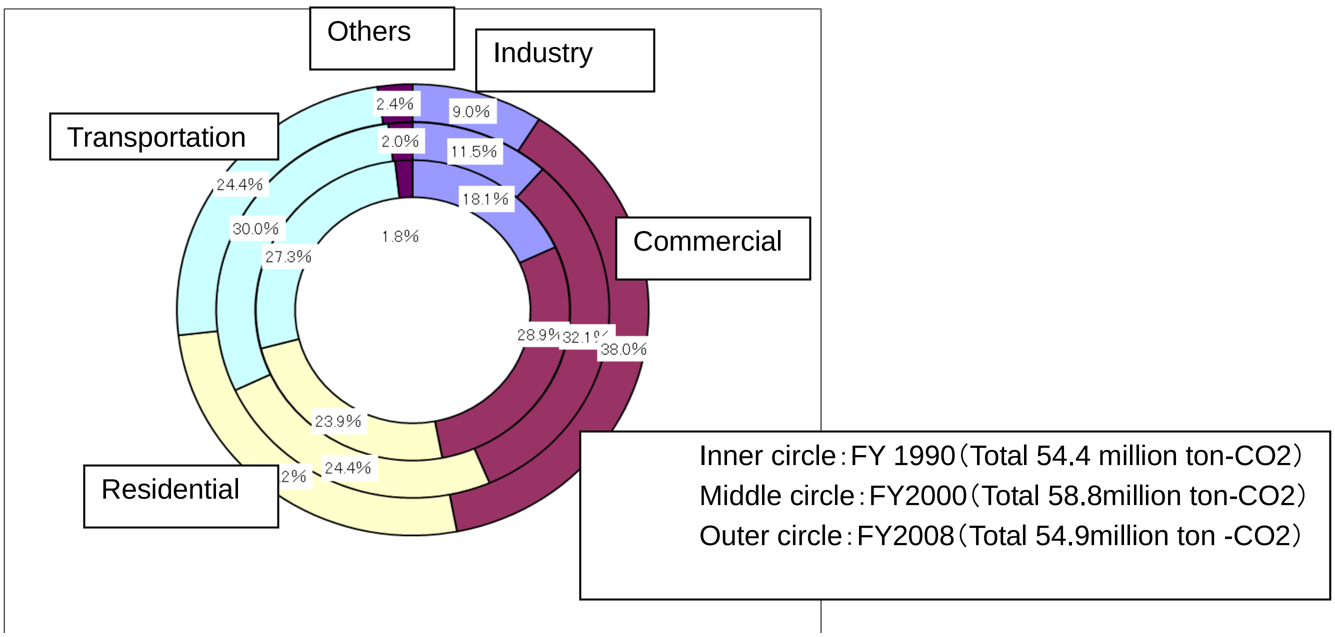
Figure 4 Urban Population Density and Gasoline Consumption per 1,000 Person



Source: Urban Transport Energy Use in The APEC Region

Changes in life styles resulting from economic growth will also change the energy demand and hence the percentages of CO_2 emission sources in cities. To put it differently, as the urbanization process changes the living habits, CO_2 emissions in residential, commercial and transportation sectors increase. For example in Tokyo, the percentage of CO2 emissions in industrial sector decreased from 18.1% to 9.0% during the period from 1990 to 2007. On the other hand, the percentage of CO2 emissions in residential and commercial sector increased from 23.9% to 26.3%, from 28.9% to 38.1% respectively during the same period (Figure 5).

Figure 5 CO2 Emissions in Tokyo



Chapter 3 describes the basic approach to develop Low-Carbon Town. When planning a low carbon town, it is important to study fully the current status and future changes in energy demand in cities as a low carbon town development spans long periods of time.

Urbanization could also lead to overpopulation, deteriorated sanitary conditions, traffic congestion, air and water pollution and decreased Quality of Life (QOL) for people. Efforts for reducing CO_2 emissions in cities where various life activities take place intensively and a large volume of energy is consumed could also help resolve such urban problems in cities. Working on and achieving low carbon towns is expected to create new values to them.

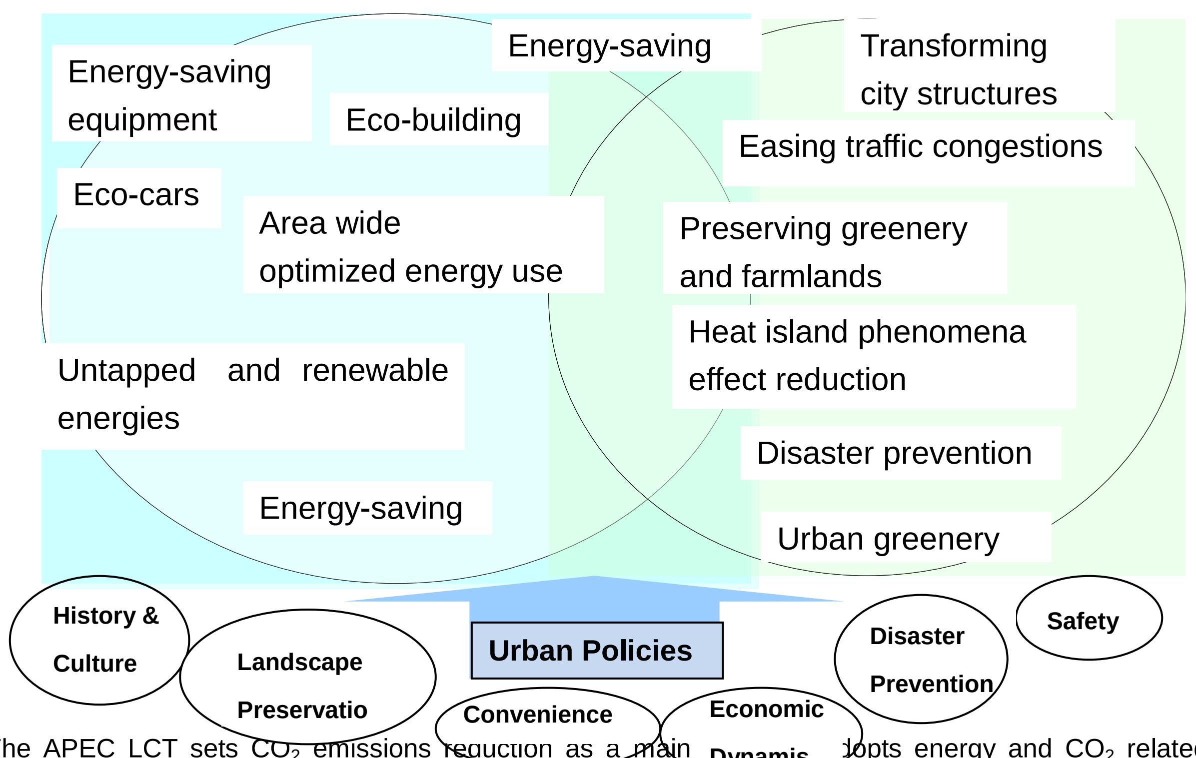
Chapter 2 The APEC Low Carbon Town (LCT) and Its Concept

2.1 What is the Concept of the APEC LCT?

The “Concept of the APEC LCT” aims to provide a basic idea of what is the APEC Low-Carbon Town and an effective approach on how to develop the APEC Low Carbon Town, considering the characteristics of the intended town. The target audience of this Concept is the central as well as local government officials responsible for low-carbon town policies and its development plans. The basic approach for low carbon town development, and characterization of towns and low carbon measures will be explained in detail in Chapter 3 and 4 respectively.

As is shown in Figure 6, there are many different types of measures to mitigate CO2 emissions. They are divided into different types of measures, namely, 1) energy related measures which directly result in CO2 emissions reductions such as introduction of energy efficient equipments/facilities, use of renewable energy, etc. (shown in the left-hand circle of the figure) and 2) other environment related measures which indirectly facilitate CO2 emissions reductions such as public transport, recycling, afforestation, etc. (shown in the right-hand circle of the figure). The “Concept of the APEC LCT” will be helpful for them to identify the appropriate set of low carbon measures for a town considered.

Figure 6 Measures for Low Carbon Measures



The APEC LCT sets CO_2 emissions reduction as a main [illegible] adopts energy and CO_2 related indicators. Other indicators like reduction of car traffic, reduction of waste, reuse of water, etc. are used as supplemental indicators of CO_2 emissions reduction. As these measures are interrelated, it is important to select the most appropriate set of measures when designing low carbon towns.

There are several sustainable urban development projects on going in the APEC region. Some have a broader objective of achieving a sustainable development through setting multiple goals, such as green society, recycle based society and mitigating heat island phenomenon. In these projects, there are several different indicators to measure the progress towards the targets.

For example, the Asian Green City Index, which is a research project conducted by the Economist Intelligence Unit, measures and assesses the environmental performance of 22 major Asian cities. It adopts 29 indicators which cover 8 different categories, namely, energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality and environmental governance.

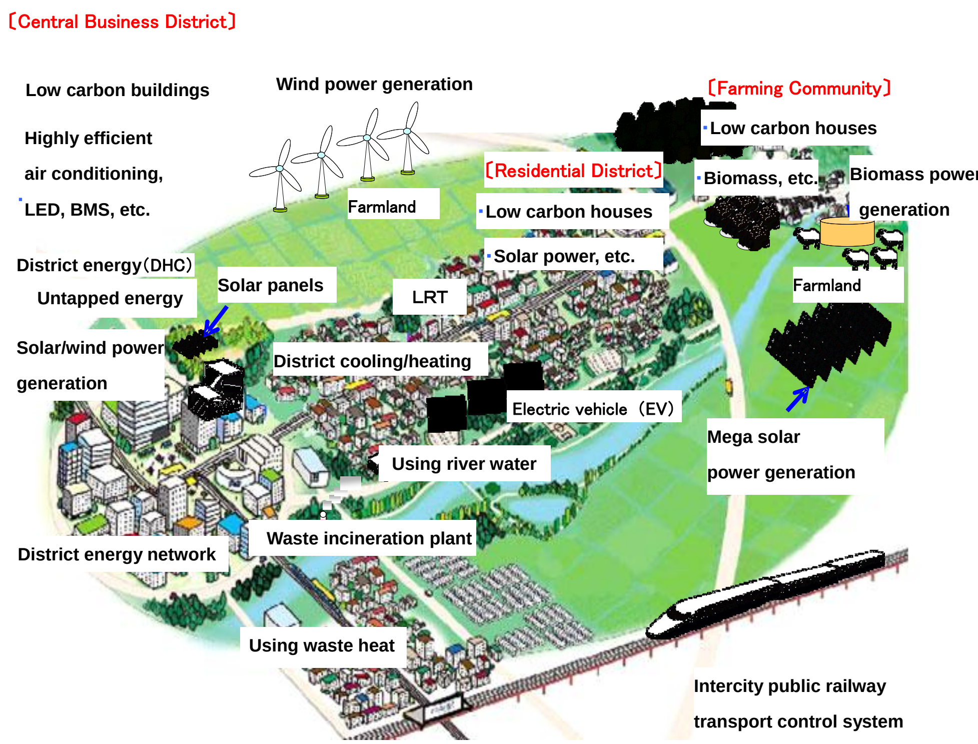
2.2 What is the APEC LCT?

The APEC "Low-Carbon Town (LCT)" refers to towns in the APEC region that have a clear target of CO_2 emissions reduction and comprehensive measures to achieve it for sustainable development.
In this report, a town is defined as part of a city, while a city stands for any size of cities ranging from a small city to a big city and a greater city area. As per this report, a district is considered part of a town. A town also means a village as a village is deemed as a smaller agricultural/fishing/resort town/area.
There are two types of low carbon town development, namely, greenfield development and brownfield development. In the case of greenfield development, it will make sense to make a low carbon development plan covering a whole city. In the case of brownfield development, it is not practical to make a whole existing city low carbon at one time. Instead, a low carbon development will normally proceed on a step by step basis, for example, from one district to another, or from one part of city to another.
To summarize, the APEC LCT means towns, cities and villages which seek to become low carbon with a quantitative CO_2 emissions reduction target and a concrete low carbon developing plan irrespective of its size, characteristics and type of development.

Figure 7 shows the image of the APEC LCT where the most suitable low carbon measures are applied to different districts of the "Town" in a comprehensive manner considering cost effectiveness, availability of resources and characteristics of each district.

Towns in the APEC region have varying degrees of population, population density, economic capability, climatic conditions, and level of basic infrastructure provision. There is also different land usage patterns observed in the towns, for example, one town may be comprised of mainly business and commercial districts, while another town may be comprised of a primarily industrial manufacturing district, and another mainly comprised of residential districts, while another may be an agricultural town, etc.
An applicable combination of low-carbon measures and available non-fossil energy resources will be different according to the characteristics of the town for a low carbon development.

Figure 7 Image of a Low Carbon Town



2.3 The Criteria for the APEC Low Carbon Model Town Project

The low carbon town development project which will apply for the feasibility study of the APEC Low Carbon Town Project is selected by EWG as a model for planning or implementing the APEC LCT. The criteria for selecting the low carbon town development project are as follows.

- The low carbon development project is coordinated or supervised by a relevant government authority of the APEC member economy. It is ideal if the LCT is under cooperation with other member economies.
- Responsible entity for the low carbon town development project is identified, and the project is already on-going or has been committed to being implemented.
- The low carbon development project implementation plan has been developed. The plan should include major items, such as land use plan, transportation plan, energy plan, environment plan and area management plan.
- Organization and people responsible for the F/S have been identified, and committed to provide necessary information for the purpose of F/S. Member economy may need to prepare for necessary funding and human resources for internal use.

Any low carbon development projects are candidates for future APEC LCMT Project, and will not be excluded from the selection for the reason of its size, scale and characteristics.

The F/S, which is conducted under the LCMT Project, provides the local government officials, municipal officials and the developer with a clear assessment on the most appropriate low-carbon measures in a comprehensive manner. It will also provide the opportunity to test the viability of the low carbon development strategies they have taken. The F/S will proceed according to the process specified in the strategy to develop a low carbon town discussed in Chapter 3. An ordinary feasibility study is conducted to determine if and how a project can succeed with an emphasis on identifying potential problems before the actual project is initiated. In this sense, the F/S provided by APEC LCMT project is different from an ordinary feasibility study.

The Yujiapu CBD (Central Business District) project in Tianjin, China was selected as the first case of the F/S, as jointly proposed by Japan and China at the EMM9. It is located on the east coast of northern China and is about 40 km east of Tianjin City Center. Yujiapu is the largest CBD development plan in BINHAI new area, in Tianjin city where a variety of large development projects have been in progress. The district consists of 120 blocks and is expected to be a business center for finance and insurance in China. Land use of CBD is mainly office and commercial, but hotels and residential facilities will also be located in the district.

The project is already being undertaken by a local development company with the strong support from the Tianjin local government. It is planned that the site area is approximately 3,650,000 m^2, day time population is approximately 500,000, and a completion target year is 2020. The F/S is conducted by the urban design consultant selected by the APEC Central Secretariat.

Similar aspirations for large-scale urban developments are also on the rise in other APEC economies, especially in Asia. At the same time, there are different types of low carbon town projects on going or under planning, which vary in size and design approach according to their individual circumstances. An appropriate set of low carbon measures to be applied will be different depending on the size of the area and the characteristics of the town. However, the strategy to develop a low carbon town is basically the same irrespective of the magnitude and characteristics of the low carbon development. Therefore, it will be valuable to undergo a feasibility study of the planned low carbon development project in various APEC member economies, where the overall planning process and strategy will be reviewed. It will also be valuable to have an assessment of policy issues by Study Group B. Policy issues include:

- What kinds of regulatory schemes are appropriate for land use, energy use, water quality, air quality, etc.?
- How should government be best organized for the town/city/region to promote low-carbon development?
- What kinds of economic incentives can be used?
- What kind of infrastructure investment is most suited?

Chapter 3 Basic Approach to Develop the Low-Carbon Town

There are cities and areas within the emerging economies in the APEC region that have quickly developed in recent years and have not gone through the systematic planning and assessment of low-carbon town development. Given these situations, the necessity of developing a low-carbon concept that defines an effective approach on how to develop the low carbon town in the APEC region is increasingly important.

3.1 Overall Planning to develop the Low Carbon Town

The procedure of overall planning to develop the low carbon town is shown in figure 8. First of all, when planning a low-carbon town development, a full and complete understanding of goals and backgrounds of the central and local government's low carbon plan is indispensable so as to confirm that the low carbon town development plan is consistent with the economy level plan. For this reason, coordination and cooperation with relevant offices in all tiers of government should be pursued as necessary.

The first stage of the overall planning of the low carbon town is to develop a low carbon town development plan. The plan is closely associated with the distribution of town functions, land utilization, and control of building density, etc., especially in the case of urban development. Therefore, a low carbon town development plan should be developed by taking advantage of the ordinary town development plan already in place.

The first step is to make the target area clear including a clear definition of the town area, highlighting the perimeter and boundary of the town, and whether it is a greater city area, a whole city, a district within a town, or a block within a district. The next step is to completely grasp the characteristics of the area for the development. These are important steps because ideal combinations of low carbon measures for creating a synergistic effect will vary depending on the size of the area and its characteristics.

Examples of effective measures for the low carbon development plan for a big city may include, strengthening of traffic axes via a public transportation system such as LRT (Light Rail Transit), BRT (Bus Rapid Transit), etc. and guiding land utilization to areas near such traffic axes, coordinated creation of a green network along the traffic axes, and provision of incentives to utilize lands near unused heat source. On the other hand, if it is a low-carbon development plan at the level of a district within a town or a block of a district, spatial utilization of energy tailored to its main activity centers, leveling of energy load through mixed use of various energy sources, side-by-side development of energy and transportation facilities with parks and other spatial development, and transport and energy management using AEMS (Area Energy Management System) might be effective.
The last step of this planning stage is to develop a low carbon development basic plan. In that regard, it is essential to take a holistic approach, giving full consideration to other aspects of towns rather than just CO2 emissions reductions, such as economic dynamism, convenience and disaster prevention, etc. in order to develop an attractive as well as economically sustainable low carbon town. Developing a low carbon town relates closely the way the life will be in the future of the town. Therefore, it is also important to take a transparent decision making process including relevant stakeholders in order to develop a

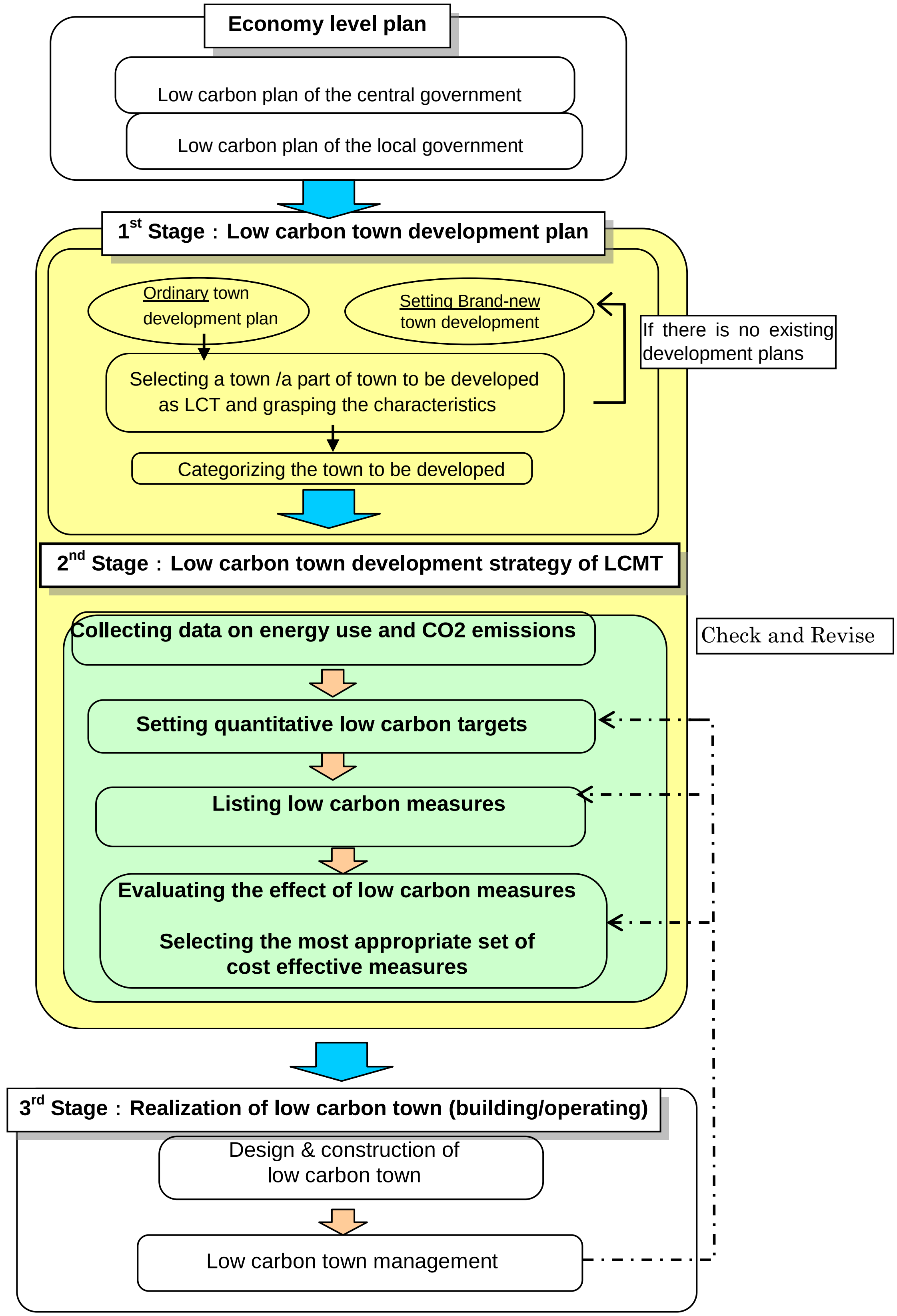
viable plan which gains full support from the people.

There are many stakeholders involved when planning a low carbon town. Therefore, it is not easy to get them properly involved in the transparent decision making process. At a later stage of the LCMT project, policy issues will be assessed, such as what kinds of regulatory schemes are appropriate for land use, energy use, water quality, air quality, etc. At that time, the issue of a transparent decision making process will be explored.

The second stage of planning the low carbon town is to develop its strategy. Key steps of developing a low carbon town development strategy are to collect necessary energy and CO_2 emissions related data, set quantitative low carbon targets, and select the most appropriate set of cost effective low carbon measures. This will be discussed in the following section in detail.

The last stage is to actually design, construct and operate a Low Carbon Town based on the Low Carbon Town development strategy. It is not covered in this “Concept of the Low Carbon Town”. However, it will be discussed when the “Concept of the Low Carbon Town“is to be further refined, and a practical guide may be prepared at a later stage of LCMT project depending on the results of the discussion..

Figure 8 Procedure of overall planning to develop the low carbon town



3.2 Strategy to Develop the Low Carbon Town

It is essential to set quantitative low carbon reduction targets with a time frame to achieve them, and select the most appropriate set of low carbon measures in a comprehensive manner. These make up the core of the strategy to develop a low carbon town. The process to follow under this strategy, which starts with collecting energy related data and ends with selecting measures, is shown in figure 9 in detail.

1) Collecting data on energy use and CO_2 emissions

Baseline energy balance and energy efficiency data for all sectors as well as predicted future energy consumption. It is important that these data be collected from reliable and consistent sources.

2) Setting quantitative low carbon targets

The quantitative low carbon targets are set for the town as a whole, considering the upper level low carbon target, i.e., economy level, provincial level, etc., and characteristics of the intended town. It is recommendable to set both an overall and setoral low carbon targets, for example, building sector, transportation sector, residential sector as a holistic approach is effective to reduce CO_2 emissions across a town.

The way which is explained here on how low carbon targets are set is a so called “Top-Down Approach”. The targets set this way are not backed up by the result of CO_2 reduction calculations which would come out through applying a certain set of low carbon measures. So, ideally, the target should be backed up by the ideas on how much CO_2 reduction could be possible through studying the actual examples where the same low carbon measures were applied to other towns with similar characteristics.

To evaluate the effect of low carbon measures, proper indicators should be selected. These indicators will also be used to measure the progress toward the targets in the implementation stage. There are several different indicators to measure CO_2 reduction. The following indicators could be used to assess low-carbon objectives directly.

- Reduction in CO_2 emissions: t-CO_2 / year, t-CO_2 / year- floor space
- Reduction in CO_2 emissions per GDP
- Reduction in CO_2 emissions per person
- CO_2 emissions reduction rate (%)
- Reduction in primary or secondary energy consumption: GJ / year

There are other indicators, which could be used complementarily so as to enable a multi-dimensional assessment of low carbon targets.

- Reduction in the amount of traffic
- Public transportation conversion rate
- Reduction in wastes produced
- Water recycling rate

3) Listing low carbon measures

There are limits to the measures that can be selected to pursue a low-carbon town solely from the energy supply side. However, by combining low-carbon measures from the energy demand side along with the supply side, greater results can be achieved. A comprehensive low-carbon approach that aims to balance both the demand and supply side energy consumption is crucial.

For this purpose, the most possible low carbon measures that can be adopted for developing a low carbon town should be screened based on the town categorization, which will be mentioned in Chapter 4. Then, a listing of these measures will be carried out on the energy supply side and demand side, with more detailed classification on both sides, for example, building, transportation, etc. on the demand side. An example of the classification of low carbon measures is shown in the table of the appendix 2.

4) Evaluating the effects of low carbon measures screened through the previous step

Based on the energy and CO_2 related data, the effect of low carbon measures in terms of CO_2 emissions reduction is to be made for each measure using an appropriate method. A variety of simulation models and tools are developed for conducting comprehensive and detailed simulations of energy-saving measures. These include energy efficiency improvements for different building types (such as office, commercial and residential buildings), area energy systems such as DHC (District Heating and Cooling) Systems, and technologies for the utilization of untapped energy supplies.

The effect will be summed up to generate total CO_2 emissions reduction as well as sub-total of CO_2 emissions by the classification of low carbon measures. The costs of implementing these measures are also estimated. The method how the effect of low carbon measures should be evaluated will be explained in Part II of “The Concept of the Low Carbon Town in the APEC”.

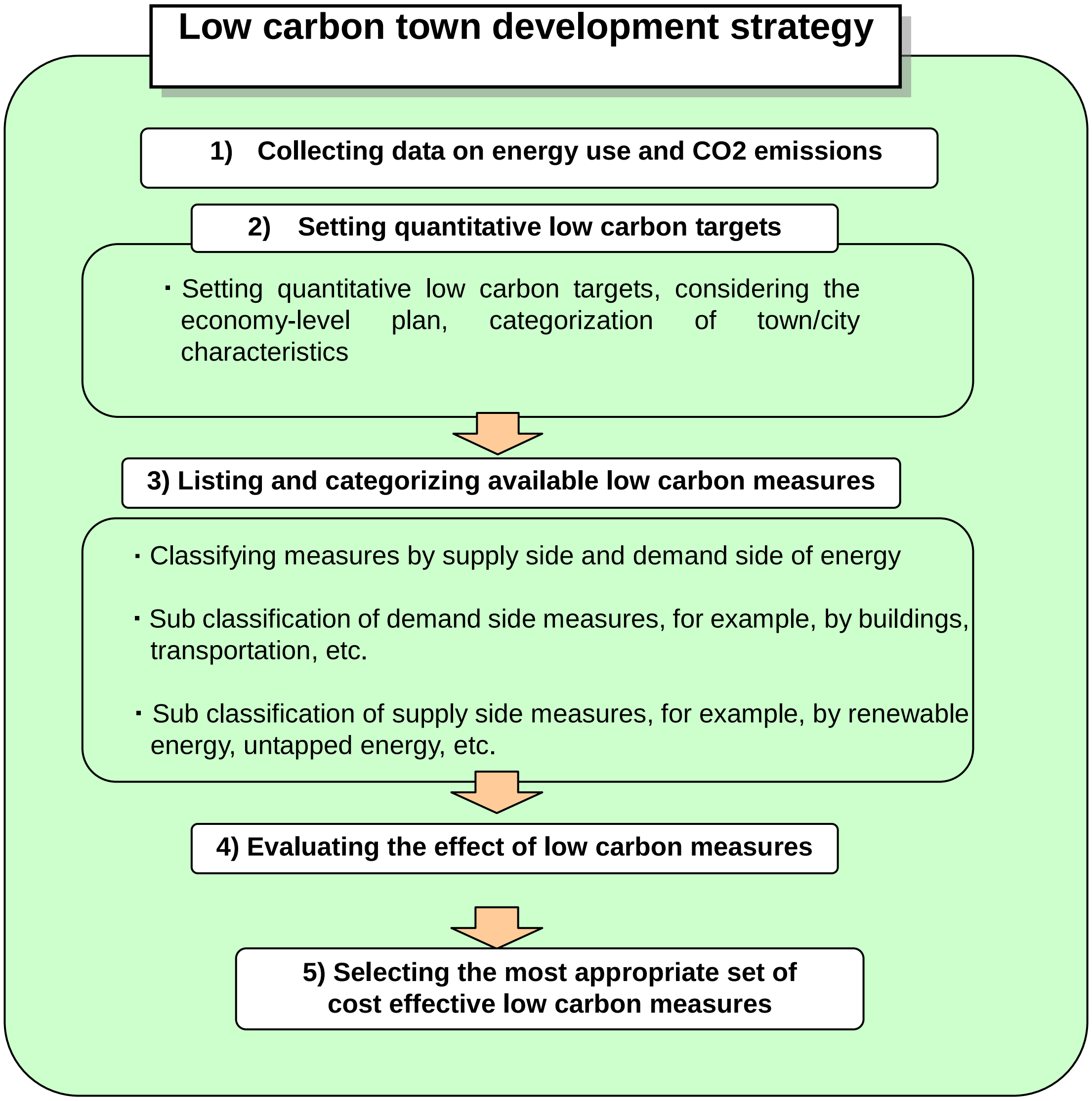
5) Selecting the most appropriate set of cost effective low carbon measures

The most appropriate set of cost effective low carbon measures to achieve the set targets is to be selected by considering the cost required for implementing these measures versus the benefits that will be acquired. In some cases, the selection will be made in reference to the basic low carbon development plan, which covers wide ranging features of the town at present as well as the future vision of the town. From this perspective, it may become necessary to prepare multiple options.

The step from 3) to 5) is the process to check the validity of the set targets. The work needs wide ranging professional expertise of urban design, and therefore, they will normally be commissioned to urban design consultants.

APEC LCMT Project is designed to provide responsible government officials with the opportunity to assess and refine the low carbon development plan through conducting F/S.

Figure 9 Low Carbon Town Development Strategy



Chapter 4 Characterization of Towns and Low Carbon Measures

Low carbon measures are classified according to whether they are on the supply side or demand side of energy. Cogeneration system, DHC (District Heating/Cooling) system, using untapped energy such as waste heat from waste incineration plants and use of renewable energy like biomass power generation, etc. are classified as supply side measures. Meanwhile, TOD (Transit Oriented Development), energy efficient buildings, public transportation system and energy management system, etc. are classified as demand side measures.

It is worthwhile to mention that depending on the characteristics of town, it makes a difference as to whether these measures can be easily adopted or not, and/or whether they exert far-reaching effects or not. So, it is a useful approach to characterize the type of towns when selecting the most appropriate set of low-carbon measures.

There are several different characteristics of towns; including 1) climate conditions like solar irradiation, temperature, wind conditions, 2) geography like flat landscape or hilly land, 3) industrial structure, for example, the way different kind of industries are located across the town, 4) town structure or intensity of land use, namely, whether town is developed intensively in 3D space or it is developed loosely in 2D space and 5) town infrastructure, whether it is sufficiently developed or not.

It is worthwhile to note that town structure as well as its industry structure will change along with its growth. Therefore, the government officials responsible for low carbon town development, especially in the developing economies where rapid growth of town is being observed, should look at the future picture of the town, or even think about guiding these changes from a view point of reducing CO2 emissions in the town.

There are several different types of categorization reflecting the different socio economic conditions of towns. Table 1 shows the categorization which is based on land related characteristics, such as size of the town, population density, and land utilization.

Table 1 Characterization of Town

Type of Town			Characteristics of Town			Infrastructure Development	Laws and Regulations
Symbol	Type		Size	Population Density	Land Usage		
I	Urban	CBD	100ha-	High	Mixed	Sufficient	Sufficient
II		Commercial Oriented Town	-100ha	Middle to High	Mixed	Insufficient	Insufficient
III		Residential Oriented Town		Middle	Mainly Housing		Limited
IV	Village	Village Island		Low	Farming Fishing Resort		

City infrastructure, which is categorized into water/environment infrastructure, energy infrastructure, communications infrastructure and mobility infrastructure, supports the wide variety of activities in the city. Therefore, the level of its provision makes a big difference in evaluating whether a particular low carbon measure is applicable or not, especially in the case of introducing an advanced low carbon technology like a smart grid. So, it is an important factor to be considered in selecting the appropriate measures.

Laws and regulations are also an important factor to develop a low carbon town. Take reuse of raw garbage in Japan. Japan has technologies to utilize raw garbage into energy. However, present national legislations regulate collecting raw garbage beyond the border of the local government, resulting in the delay of practical applications of these technologies.

The list of low carbon measures along with their applicability based on the town categorization is shown in the Appendix 2.

In the APEC region, there are several towns where a low carbon development project is ongoing or being planned. These projects vary in size and design approach according to their individual circumstances. The following table 2 shows some examples of low carbon town development projects based on the available information, and classified according to the type of town described as above. More examples will be added as there are more planned low-carbon towns in the APEC region.

Table 2　Low Carbon Town in the APEC

Type of Town	Low Carbon Town Project	Economy	Population
I　Urban Type1	Yujiapu CBD, Tianjin	China	500,000
	Sino-Singapore Tianjin Eco City	China	350,000
	Quezon City Green CBD	Philippine	
II　Urban Type2	Putrajaya　Green City	Malaysia	68、000 (300,000 planned)
	Chiang Mai	Thailand	160,000
	Da Nang (Pilot City of WB Eco2 Cities Project)	Viet Nam	1 million *
	Cebu City (Pilot City of WB Eco2 Cities Project)	Philippine	820,000*
	Surabaya (Pilot City of WB Eco2 Cities Project)	Indonesia	2.8 million*
	Yokahama Smart City Project	Japan	3.7 million*
III　Residence Type	Plunggol Eco Town	Singapore	
IV　Village Type	Muang Klang Low Carbon City	Thailand	17,000
	Jeju Island Smart Green City	Korea	6,000 households
	Low Carbon Island (Penghu Island and Others)	Chinese Taipei	88,000

* Total population

Chapter 5 Summary

The LCT Concept aims to promote the development of low-carbon towns in the APEC region by providing a basic principle that can assist the central and local government officials of the member economies in planning effective low-carbon policies and in formulating an appropriate combination of low-carbon measures while taking socio-economic conditions and city specific characteristics.

Setting quantitative low carbon targets is an essential element when planning a low carbon town development, as is the case with APEC PREE project. In the developed APEC economies, most of the local governments and municipalities have already started undertaking a task of developing low carbon towns. However, the level of their efforts in planning with targets is still at an early stage. Take Japan for example, more than half of municipalities are judged to be at 1^{st} or 2^{nd} level under the 4 levels classification of their efforts, namely, 1) making a start, 2) stepping forward, 3) moving for the top, and 4) taking a lead over others.

In the emerging economies in the APEC, there are a number of cities which have quickly developed in recent years. Therefore, it is no wonder that such cities do not always have the systematic methodology for planning and evaluating low-carbon town development. For example, in Japan, it is just 2010 when a report on “How to design low carbon cities” was published, which includes a concept for low-carbon town development and calculation methods of CO_2 mitigation. Given such circumstance, to develop the APEC “Concept of the Low Carbon Town” would be considered as a forehanded attempt.

Another important element described in “the Concept” is selecting a set of appropriate measures considering town characteristics. It is because that those town characteristics are critical for selecting appropriate measures. At the same time, it is to be noted that town characteristics such as city structure is variable so that it would be possible to guide transformation of town into economically as well environmentally sustainable one through carefully planning low carbon town on a long term perspective.

Appendix 1

Low Carbon Target for APEC economies

Economy	Emission reduction in 2010	Base year
Australia	-5% up to -15% or -25% Australia will reduce its greenhouse gas emissions by 25% on 2000 levels by 2020 if the world agrees to an ambitious global deal capable of stabilising levels of greenhouse gases in the atmosphere at 450 ppm CO_2-eq or lower. Australia will unconditionally reduce our emissions by 5% below 2000 levels by 2020, and by up to 15% by 2020 if there is a global agreement which falls short of securing atmospheric stabilisation at 450 ppm CO_2-eq and under which major developing economies commit to substantially restrain emissions and advanced economies take on commitments comparable to Australia's.	2000
Brunei Darussalam	Pledges to contribute to the 25% regional improvement in energy intensity by 2030 compared to 2005 levels, as agreed by APEC Leaders in the 2007 Sydney Declaration	2005
Canada	17%, to be aligned with the final economy-wide emissions target of the United States in enacted legislation	2005
Chile	Take nationally appropriate mitigation actions to achieve a 20% deviation below the “Business-as-Usual” (BAU) emissions growth trajectory by 2020, as projected from year 2007. To accomplish this objective Chile will need a relevant level of international support.	2007
China	Endeavor to lower its carbon dioxide emissions per unit of GDP by 40-45% by 2020 compared to the 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020 and increase forest coverage by 40 million hectares and forest stock volume by 1.3 billion cubic meters by 2020 from the 2005 levels.	2005
Hong Kong, China	Pledges to reduce energy intensity of GDP by 25% by 2030 relative to 2005 levels, and to reduce electricity consumption in government buildings by 5% by 2013-14 relative to 2009-10 levels.	2005
Indonesia	-26% The reduction will be achieved, inter alia, through the following action: (1)Sustainable peat land management, (2)Reduction in rate of deforestation and land degradation, (3)Development of carbon sequestration projects in forestry and agriculture, (4)Promotion of energy efficiency, (5)Development of alternative and renewable energy sources, (6)Reduction in solid and liquid waste, (7)shifting to low-emission transportation mode	
Japan	25% reduction, which is premised on the establishment of a fair and effective international framework in which all major economies participate and on	1990

	agreement by those economies on ambitious targets.	
Korea	To reduce national greenhouse gas emissions by 30% from the business-as-usual emissions by 2020.	
Malaysia	Pledges to reduce carbon dioxide emissions per unit of GDP in 2020 by up to 40% relative to 2005 levels contingent on the provision of international finance. Now in the process of instituting a renewable energy law and one of the mechanisms of the law are feed-in tariffs to promote the use of renewable energy. Malaysia also plans to include nuclear energy in the electricity generation fuel mix after 2020.	2005
Mexico	Reduce its GHG emissions up to 30% with respect to the business as usual scenario by 2020, provided the provision of adequate financial and technological support from developed countries as part of a global agreement	
New Zealand	New Zealand is prepared to take on a responsibility target for greenhouse gas emissions reductions of between 10 per cent and 20 per cent below 1990 levels by 2020, if there is a comprehensive global agreement. This means: • the global agreement sets the world on a pathway to limit temperature rise to not more than 2° C; • developed countries make comparable efforts to those of New Zealand; • advanced and major emitting developing countries take action fully commensurate with their respective capabilities; • there is an effective set of rules for land use, land-use change and forestry (LULUCF); and • there is full recourse to a broad and efficient international carbon market.	1990
Papua New Guinea	Pledges to reduce greenhouse gas emissions by at least 50% by 2030 (75% is technically possible subject to enabling finance) while becoming carbon neutral before 2050, contingent on international support.	
Peru	-By 2021, net deforestation of primary or natural forest to be reduced at 0% -At the end of 2020, total energy demand will represent, at least, 33% of share from renewable energies(non-conventional energies, hydro and biofuels -Design and implementation of measures to reduce emissions by inappropriate management of solid wastes	
The Philippines	Sets the goal of improving energy utilisation through the National Energy Efficiency and Conservation Program (NEECP) launched in August 2004. This program will save a cumulative 9.08 million barrels of fuel oil equivalent during the period 2007-2014 compared with business-as-usual. Sector energy efficiency goals are to reduce final energy demand by 10% (under the 2009-2030 Philippine Energy Plan) in each sector: industry, residential, commercial, transport, and agriculture.	
The Russian Federation	15-25 % the range of the GHG emission reductions will depend on the following conditions: - Appropriate accounting of the potential of Russia's forestry in frame of contribution in meeting the obligations of the anthropogenic emissions reduction;	1990

	- Undertaking by all major emitters the legally binding obligations to reduce anthropogenic GHG emissions.	
Singapore	Mitigation measures leading to a reduction of greenhouse gas emissions by 16%(footnote 1) below Business-as-Usual (BAU) levels in 2020, contingent on a legally binding global agreement in which all countries implement their commitments in good faith(footnote 2). (Footnote 1) Although a legally binding agreement has yet to be achieved, Singapore will nonetheless begin to implement the mitigation and energy efficiency measures announced under the Sustainable Singapore Blue print in April 2009. These measures are an integral part of the measures to achieve a 16% reduction below BAU referred to in (1). When a legally binding global agreement on climate change is reached, Singapore will implement additional measures to achieve the full 16% reduction below BAU in 2020. (Footnote 2) The clarifications set out in Singapore's Letter dated 28 January 2010 apply to paragraph (1).	
Chinese Taipei	Pledges to reduce economy-wide CO_2 emissions to the 2008 level during the period 2016-2020, and then further reduce emissions to the 2000 level by 2025 (uncontingent). The main measures to achieve this goal are to develop carbon-free renewable energy, to increase the utilisation of low carbon natural gas, and to promote energy conservation schemes in various sectors. Chinese Taipei has overall energy efficiency goals to reduce energy intensity by 20% by 2015 and by 50% by 2025 compared with 2005. All sectors have specific energy efficiency goals, such as: reducing the CO_2 intensity of industry by 30% by 2025, raising new car energy efficiency standards 25% by 2015, improving the energy efficiency of appliances and devices by 10% to 70% by 2011, and a 7% reduction of government energy use by 2015. All of the sectoral energy efficiency improvement goals are compared to 2008 levels.	
Thailand	Pledges to reduce energy intensity by 8% by 2015 and 25% by 2030 compared with 2005. To reduce greenhouse gas emissions, Thailand will also increase the use of renewable energy and nuclear power.	2005
United States	In the range of 17%, in conformity with anticipated U.S. energy and climate legislation, recognizing that the final target will be reported to the Secretariat in light of enacted legislation. [1]The pathway set forth in pending legislation would entail a 30% reduction in 2025 and a 42% reduction in 2030, in line with the goal to reduce emissions 83% by 2050.	2005
Viet Nam	Pledges to reduce total energy consumption by 3% to 5% by 2010 and by 5% to 8% by 2015 compared with 2006. The government has also approved the following targets for renewable energy and the development of nuclear power plants: a) achieve a 3% share of renewable energy in total commercial primary energy by 2010, 5% by 2025 and 11% by 2050 b) introduce the first nuclear power plant in 2020 and then quickly increase the	2006

	contribution of nuclear energy to the energy structure.	

（Source）UN FCCC (http://unfccc.int/meeting/cop/_15/copenhagen_accord/items/5264.php) and (http://unfccc.int/meeting/cop/_15/copenhagen_accord/items/5265.php),

”Pathways to Energy Sustainability: Measuring APEC Progress in Promoting Economic Growth, Energy Security, and Environmental Protection”, pp.86-91, APERC, 2010(Brunei Darussalam, Hong Kong, China, Malaysia, the Philippines, Chinese Taipei, Thailand and Viet Nam).

Appendix 2

Low Carbon Measures and their Applicability

Supply / demand	Major Classification	Minor Classification	Low Carbon Measure	I	II	III	IV
Supply side	Generating / distributing power	Infrastructures for generating/ storing power					
			Distributed power facility	M	M	L	L
			Cogeneration system	H	H	L	L
			Large-scale power storage, etc.	M	M	L	L
	District energy (heat supply)	District heating /cooling			H	M	L
	Untapped energy	Using sea/river/sewage water			H	M	L
		Using waste heat from as waste incineration plants			H	M	M
		Using waste heat from sewage treatment plants			H	M	L
		Using waste heat from factories		M	M	M	X
	Renewable energy	Solar power generation (mega solar power generation)		M	M	M	M
		Using solar heat (large-scale solar heat)		M	M	M	M
		Biomass power generation (bio gas power generation, etc.)			L	L	M
		Wind power generation			L	L	H
		Geo-thermal power generation			L	L	M
		Hydroelectric power generation (small- and middle-scale)			L	L	M
Demand side	Composition of urban space	TOD development					
		Environment space development	Green way NW	H	H	H	M
			Underground space NW	M	L	X	X
	Buildings	Reducing loads		H	H	H	H
		Highly efficient facility systems		H	H	H	H
		Equipment installed at facilities	Fuel cells, etc.	H	H	M	M

Column header notes: "Classification of Measures" spans Supply / demand, Major Classification and Minor Classification; "Applicability as per Type of Town Note 1)" spans I, II, III, IV.

	Management	Energy management systems	BEMS (HEMS, FEMS)	H	H	H	H
			ZEB	M	M	H	H
			AEMS	H	H	H	H
	Environment-related infrastructures	Urban climate	Micro climate, heat island	H	M	M	X
		Wastes	Collecting wastes, recycling resources	H	H	H	H
			Using energy (bio gas), using sewage sludge	M	M	L	H
		Water supply / sewage	Re-using treated waste water Using rainwater	H	H	M	L
		Reducing pollutions	Treating exhausts, contaminated soils (Treating waste water is included in the sewage.)	H	H	H	H
	Transportation system	Public transportation systems	Public transportation NW	M	M	M	X
			Intra-district transportation system (busses, LRT, etc.)	H	H	H	L
		Short-distance transportation systems	Intra-city community bicycle	H	H	H	L
			Short-distance transportation system	H	H	H	L
		Vehicles	EV	M	M	M	M
			EV bus	M	M	M	M
		EV-related hardware	Fast charger, small battery	M	M	M	M
		Natural gas-driven vehicles, etc.		M	M	M	M
Both supply and demand sides	Smart grid system (mainly for electric power system)	Power control systems	Power monitoring control system	H	H	M	L
			Power stabilization system	H	H	M	L
			Other systems				
		Network	Network infrastructures	H	H	M	L
			Network-related technology, communication modules, measuring systems, etc.	H	H	M	L
	Smart energy system (energy integration)		Smart energy system	H	H	M	L

Note 1:

H: Potentially highly effective
M: Potentially effective
L: Potentially less effective or difficult to apply
X: Not effective at all or unlikely to apply

BEMS: Building Energy Management System
HEMS: Home Energy Management System
FEMS: Factory Energy Management System
ZEB: Zero Energy Building
AEMS: Area Energy Management System
TOD: Transit Oriented Development

The Concept of the Low-Carbon Town in the APEC Region

(Part II)

Final Report

October, 2011

The APEC Low Carbon Model Town Task Force

APEC Energy Working Group

The Concept of the Low Carbon Town in the APEC Region

Part II

CONTENTS

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Introduction

The first part of “The Concept of the Low Carbon Town (LCT) in the APEC Region” set out the basics of what low carbon towns are, as well as an effective way they can be developed, taking into account the characteristics of individual towns. This second part of the document outlines the overall planning process for low carbon towns, including how to set quantitative low carbon targets. It details a range of measures and /or technologies that can be employed to reduce carbon emissions on both the energy demand and supply side、 effective selection processes to choose the best of these for individual situations, and methodologies to evaluate their actual effect.

“The Concept of the Low Carbon Town (LCT) in the APEC Region - Part II” is intended to be a guidebook for central and local government officials responsible for low carbon town policies, as well as municipality officials and city planners who are directly responsible for low carbon town development.

The planning of a low carbon town requires considerable public input. And if the project is to keep going, it is essential to gain buy-in from champions among all groups of people involved and affected (the stakeholders). These issues will be explored at the later stage, - this initial “Concept”, focuses on the practical methodologies for low carbon town development planning and design.

The “Concept of the Low Carbon Town (LCT) in the APEC Region” stresses the importance of setting quantitative low carbon reduction targets with a time frame for achievement. Most of the towns in the developing economies in the APEC region, however, do not have such targets at present. In the meantime, they have been actively dealing with air and water pollution, waste management, and recycling of used water with numerical targets. It may not be an easy task for cities and towns to set quantitative low carbon reduction targets.

However, the efforts in this direction would help resolve many of the urban problems they already face. Moreover, working on and achieving low carbon development will make a town and city more attractive and livable. Note that the targets are designed town specific and are not broad- based ones that would apply across all APEC economies.

Chapter 1 Basic Approach to Developing a Low Carbon Town

1.1 Overall planning for development of a low carbon town

The overall planning process for the development of a low carbon town is shown in Figure 1.

The essential preparatory step is to gain a full and complete understanding of the goals and background of your economy's central and local government low carbon plans, to ensure the low carbon town development plan is consistent with economy level planning.

The first stage of the actual planning process is to develop a low carbon town development plan. This needs to build on the existing urban development planning if available, especially in regard to integration of town functions, land utilization, and control of building density,

A low carbon town development plan will focus on setting targets for reducing CO_2 emissions. It should also emphasize that land utilization, urban transport, energy, green space etc. should be considered in a comprehensive manner. When addressing the integration of town functions, it may be useful to outline the basic principles of area energy network (including District Heating and Cooling) and energy management, while the discussion of the control of building density may need to define appropriate town scale and population density in line with the ideal of a compact town.

Town development planning traditionally centers on the transportation and energy departments of local governments and municipality offices, with supporting roles played by other departments such as science, technology and telecommunications. A difference in the low carbon development process is that environmental departments also need to be central to the planning process.

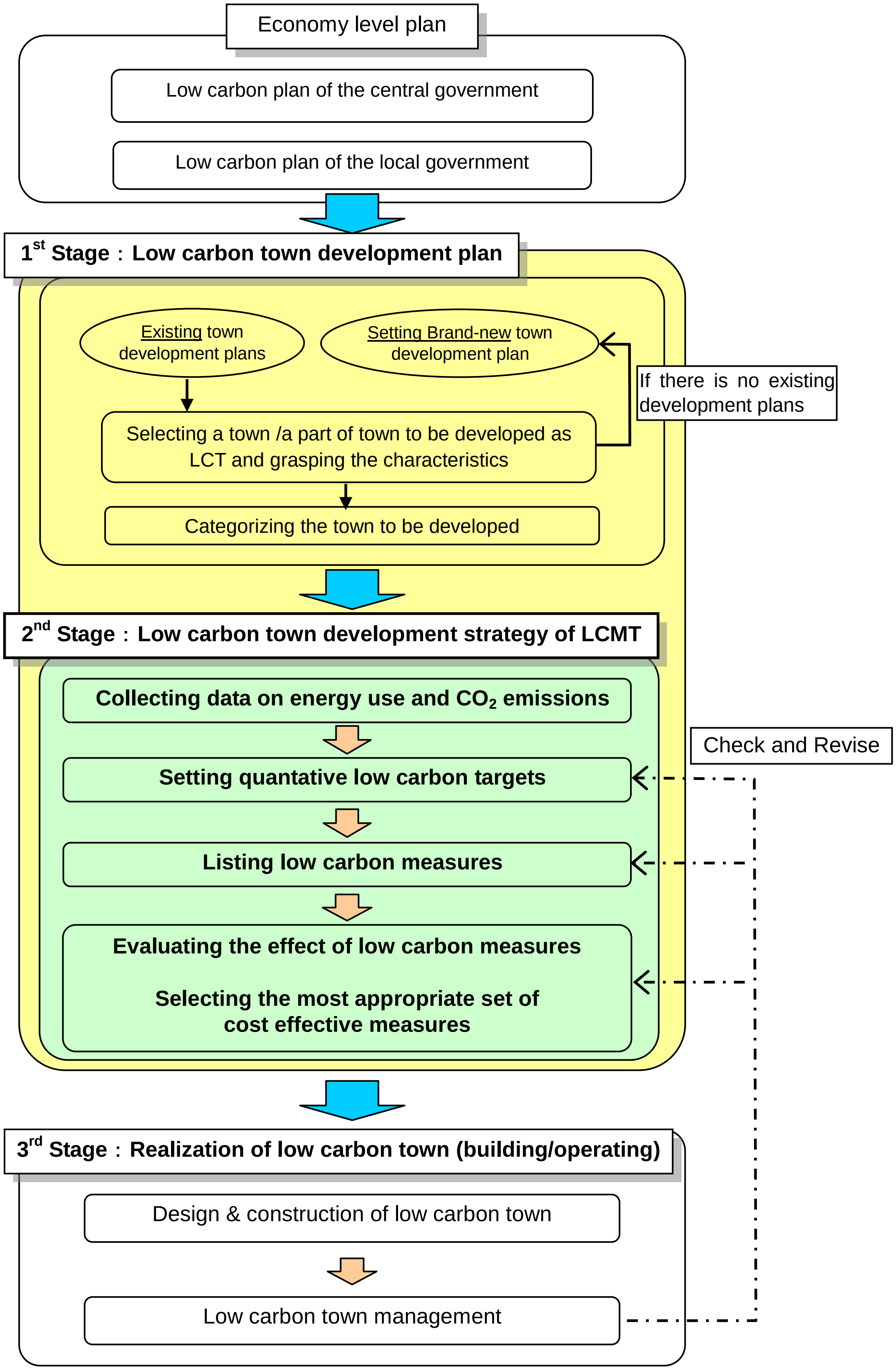
The scope of the plan needs to be set, including a clear definition of the town area, highlighting its perimeter, and whether it is a greater city area, a whole city, a district within a town, or a block within a district. The next step is to identify the characteristics of the designated area. This is essential, as ideal combinations of low carbon measures for creating a synergistic effect will vary depending on the size of the area and its characteristics.

The last step of this initial stage is to prepare a low carbon development plan. This requires a comprehensive planning approach, giving full consideration to other aspects of towns besides CO2 emissions reduction, such as economic dynamism, convenience, and disaster prevention, to develop an attractive as well as economically sustainable low carbon town. Low carbon town development relates closely to the way the life will be in the town's future. Therefore, it is also important to take a transparent decision making process including relevant stakeholders in order to develop a viable plan which gains full support from the people.

The second stage of planning the low carbon town is to develop the development strategy. Key steps include collecting the necessary data about energy and CO_2 emissions, setting quantitative low carbon targets, and selecting the most appropriate set of cost effective low carbon measures.

The last stage is to actually design, construct and operate a low carbon town based on the low carbon town development strategy. It is not covered in this “concept” document.

Figure 1 Procedure of overall planning to develop the low carbon town



1.2 Setting quantitative low carbon targets

The recommended course is to set low carbon targets for the town as a whole, taking account possible carbon reductions in each sector such as building, transportation, etc.

The validity of these targets can be checked using the "Plan Do Check Action" (PDCA) process:

> Set the targets for the town as a whole → select the set of low carbon measures to apply to the individual sectors → conduct trial calculations of the effects on CO_2 reduction → determine whether the target can be achieved based on the trial calculations →examine the alternative set of measures if the reduction target is not met.

There are various indicators that can be used to measure CO2 reduction. Indicator selection is key to accurate evaluation of the effect of low carbon measures. These indicators will also be used to measure progress toward the targets in the implementation stage.

The following indicators could be used to assess low-carbon objectives directly.

- Reduction in CO_2 emissions: t-CO_2 / year, t-CO_2 / year- floor space
- Reduction in CO_2 emissions per GDP
- Reduction in CO_2 emissions per person
- CO_2 emissions reduction rate (%)
- Reduction in primary or secondary energy consumption: GJ / year

There are other indicators, which could be used complementarily so as to enable a multi-dimensional assessment of low carbon targets.

- Reduction in the amount of traffic
- Public transportation conversion rate
- Reduction in wastes produced
- Water recycling rate

<INDICATOR OF SUSTAINABLE TRANSPORTATIN PLANNING>

Developing and implementing efficient transportation policies and programs will require more rigorous collection, analysis, and dissemination of both quantitative and qualitative transport data. The following resources deal with the selection of indicators of sustainable transportation planning.

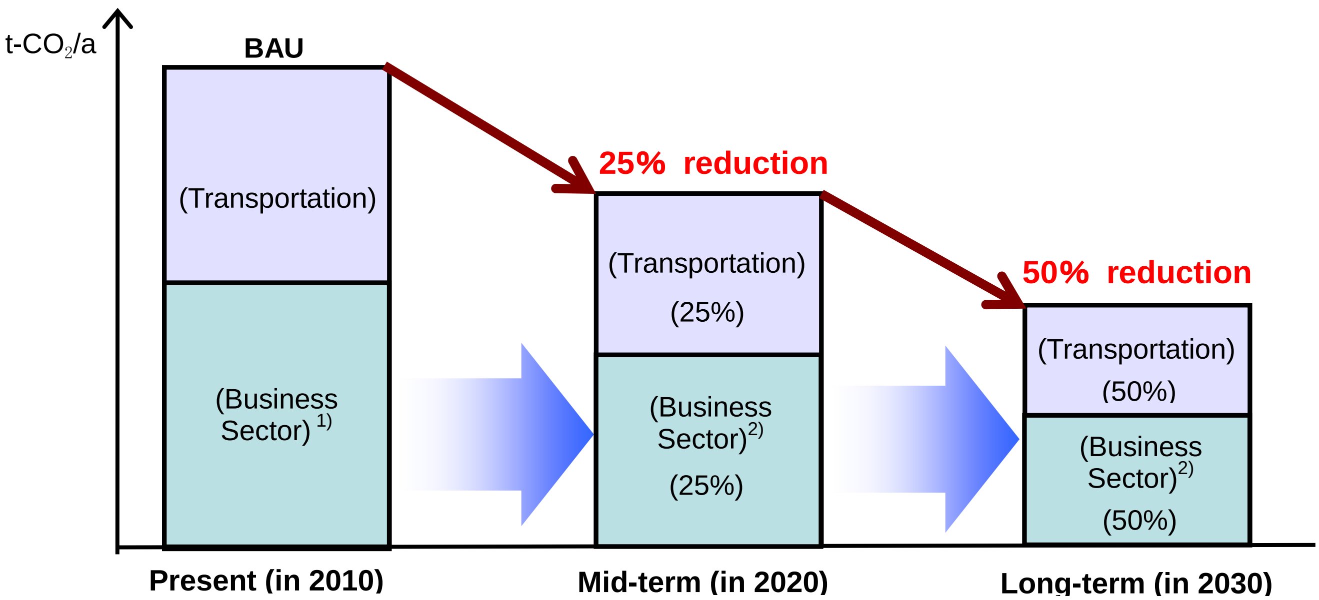
Resources for Developing a Data Collection Methodology

"Developing Indicators for Comprehensive and Sustainable Transport Planning" outlines how to identify, organize and collect indicators. (http://www.vtpi.org/sus_tran_ind.pdf))

"New Zealand Transport Monitoring Indicator Framework" is a tool for monitoring and evaluating transport policies and programs. It contains a large set of transport indicators that the Ministry of Transport updates on an on-going basis. (http://www.transport.govt.nz/ourwork/tmif/)

The baseline for calculating the reduction amount is based on the CO_2 emission amount in the target region in the base year. The base year itself is selected in reference to the policies of the economy and town concerned. In the case of unused land where no development is being pursued at present or where a large-scale urban development is planned, it is desirable to set the CO_2 reduction amount of BAU (Business as Usual) under the assumption that the development will be carried out without employing any low carbon measures.

Figure 2 Example of CO_2 reduction target



1) Standard type buildings without low carbonized

2) Business sector includes the reduction effects in terms of buildings, district energy, unused /renewable energy etc.

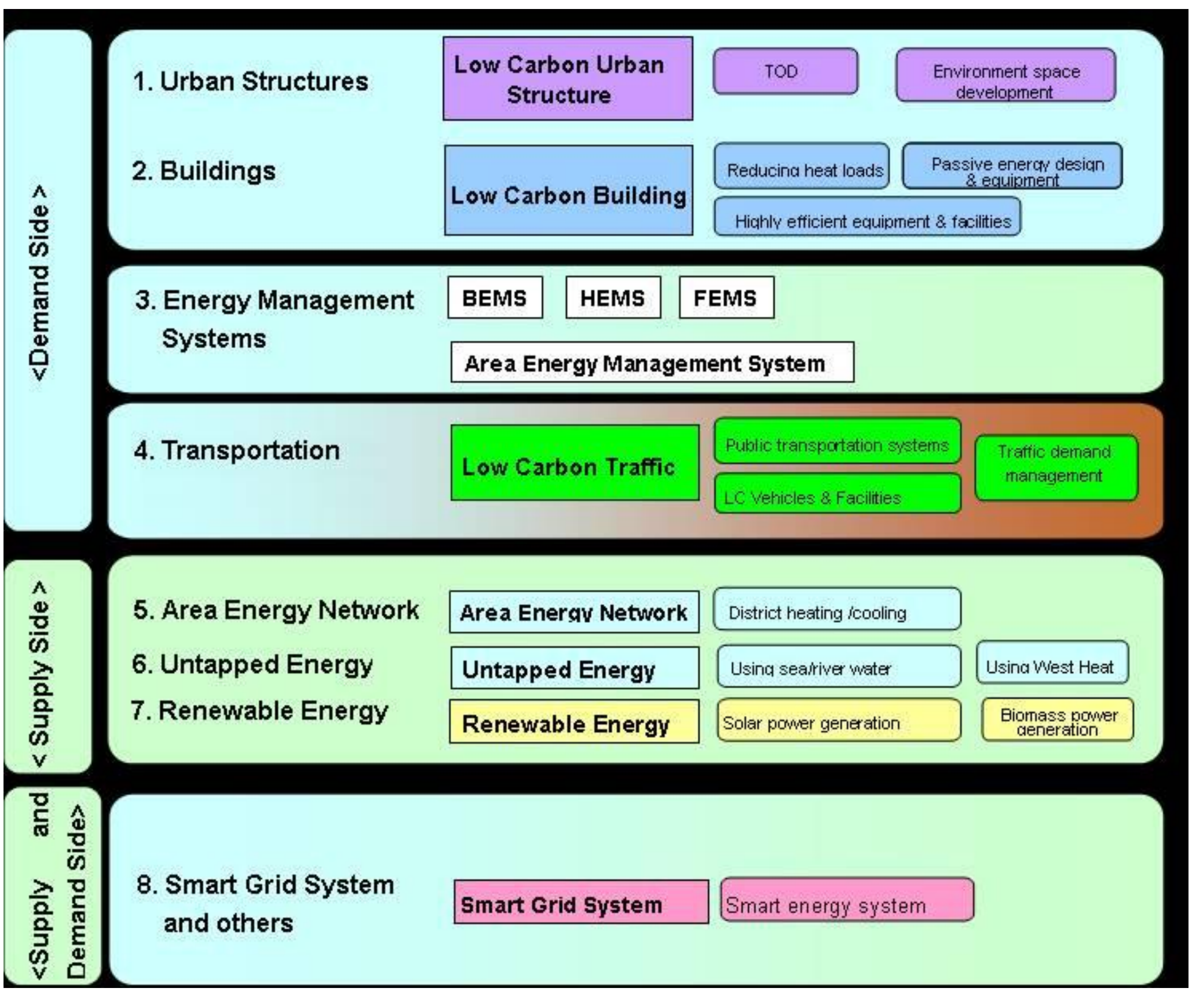
Chapter 2 Measures to Use in the Development of a Low Carbon Town

As in the figure 3, low carbon measures can be categorized under these headings:

1. Urban Structures
2. Buildings
3. Energy Management Systems
4. Transportation
5. Area Energy Network
6. Untapped Energy
7. Renewable Energy
8. Smart Grid System and others

Measure types 1 – 4 are on the energy demand side, and measures type 5 – 7 are on the energy supply side, while measure 8 type straddles both energy demand and supply. An overview of these measures and basic ideas on how to introduce them are provided in the following section.

Figure 3 Overview of low carbon measures



2.1 Measures on the energy demand side

2.1.1 Low carbon urban structures (TOD Type Land Use)

Transit Oriented Development (TOD) is to create a town concentrated around public transportation systems, which do not depend on automobiles. TOD has the following specific development means.

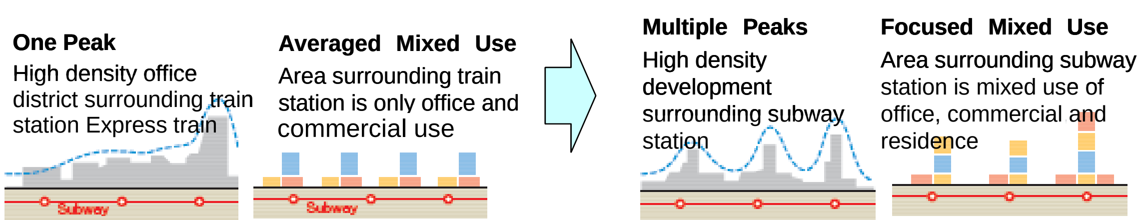
- Build a less CO_2 emitting town area by improving the land use around the stations of the public transportation systems, as well as through systematic development of commercial, public, and residential areas.
- Build a town area whose transit is based on walking, bicycle, bus, etc. without depending on automobiles through concentrating a broad range of urban functions around the main transportation nodal points.

< TRANSIT MALL >

Many towns in APEC developed economies have established a commercial space called a Transit Mall. It limits the car ride, and allows pedestrians and mass transit systems including buses and tramcars. Transit Mall is expected to vitalize the central built-up areas, improve road transportation environment and public transportation services.

When residential and office buildings are planned in the same area, energy demand equalization and/or energy sharing systems would be required to absorb the different peak energy demands.

Figure 4 Image of high density development surrounding train stations



<TOD Examples>

Creating a plan – New Zealand Transport Strategy:
http://www.transport.govt.nz/ourwork/Contents- New Zealand Transport Strategy/
Transport oriented development in Subiaco Australia:
http://www.sra.wa.gov.au/Subi-Centro/Precincts/Subiaco-Square
Bicycle Network in Chinese Taipei: http://bikeway.cpami.gov.tw/bikeway */ (in Chinese)*

2.1.2 Low carbon building

In office and commercial buildings, a lot of electricity and heat energy are used for air conditioning, lighting, office automation (OA) equipments, and for hot water supply. The same applies to residential buildings, although on a different scale. When evaluating the low carbon building measures, it is advisable to follow the following three steps as it will lead to more efficient and cost effective CO_2 reduction.

1st Step: Reduce heat load into the building through rooftop greenery and improvement of the heat insulation of the windows, etc.
2nd Step: Deploy passive energy design such as natural lighting and natural ventilation.
3rd Step: Improve energy efficiency in air conditioning, lighting equipment, etc.

There are plenty of reduction measures within each step. It is necessary to examine the most appropriate combination of measures considering the use, targeted CO_2 reduction amount, construction cost etc. of the intended buildings.

i) Reduction of heat load in the building

Evidence shows that heat energy demand for cooling/heating and electricity use for lighting depends greatly on the structure of the building, its outer environment and the use of the building.

In order to reduce CO_2 emissions associated with the building, the first step is to consider measures that will create a comfortable work and living environment in the building without using too much energy, in other words, the measures which will reduce the energy load of the building.

ii) Adoption of passive energy design

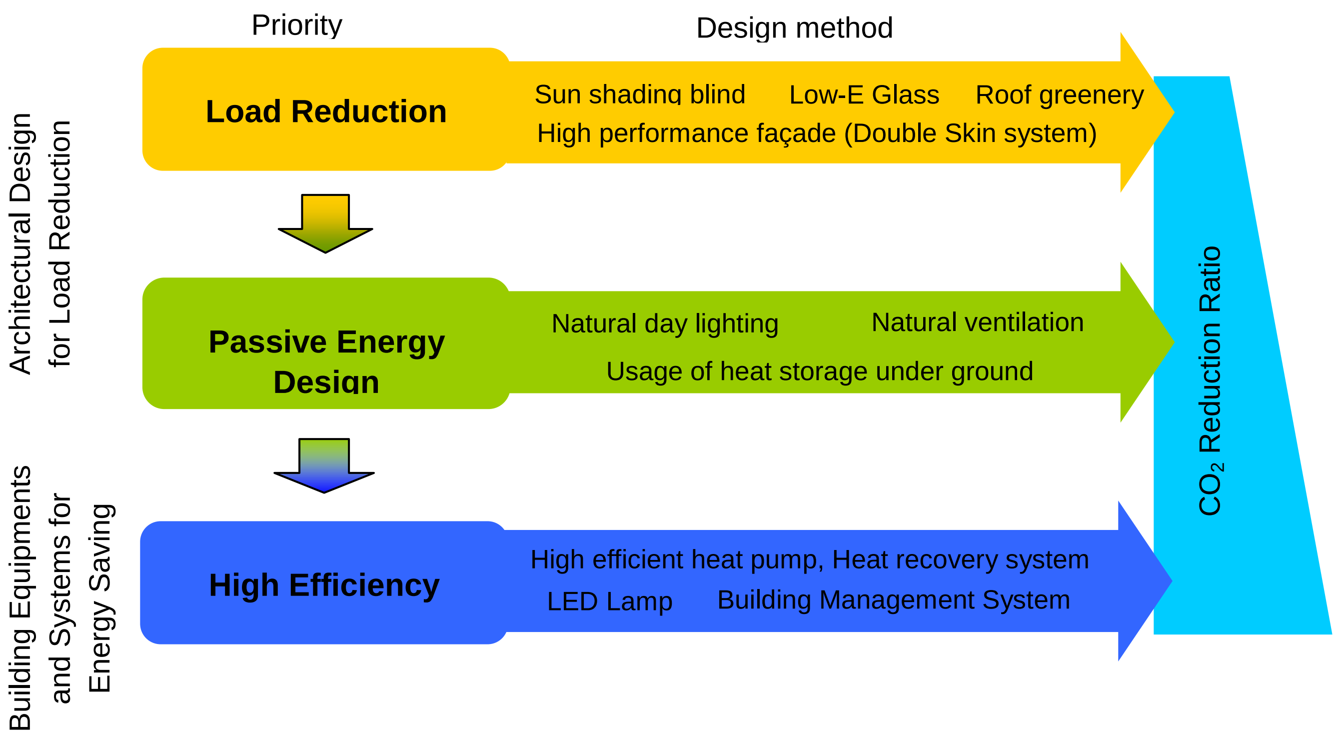
It can be effective to adopt passive forms of environment-friendly technology, which makes use of sunlight, solar heat, wind, rainwater and geological conditions to adjust the indoor environment. For example, it may suit to construct buildings that maintain comfortable room temperature by adopting sun shading blinds and cooling with outside air, and ensures the brightness and clean air by utilizing daylight and natural ventilation respectively.

iii) Improvement of equipment efficiency

Energy use in the building can be reduced by adopting high efficiency equipment for functions such as air conditioning, lighting, office automation, hot water supply.

Schematic design flow of low carbon building is shown in Figure 5.

Figure 5 Schematic design flow of low carbon building



2.1.3 Energy management systems

i) Building-level energy management systems

Building-level energy management systems prevent unnecessary energy use by automatically adjusting the operation of equipment in a building. For example, this kind of system turns off lights in unused rooms and controls the air-conditioners and lighting in response to variations in room temperature and light intensity. Depending on the type of the targeted buildings, there are different forms of building-level energy management systems; building energy management systems (BEMS), home energy management systems (HEMS) and factory energy management systems (FEMS). Their introduction can result in significant reduction of energy use.

ii) Regional or district-level energy management system

Energy management systems at regional or district level similarly prevent unnecessary energy use in the central heat supply plants. These systems use surveillance and control systems and high-speed communication networks to monitor and control the plant operation. This energy management system is called AEMS (Area Energy Management System). AEMS may be regarded as an area-wide energy use based on IT technology, and this system has already been put to practical use.

2.1.4 Low carbon transport

i) Low carbon measures in the transportation sector

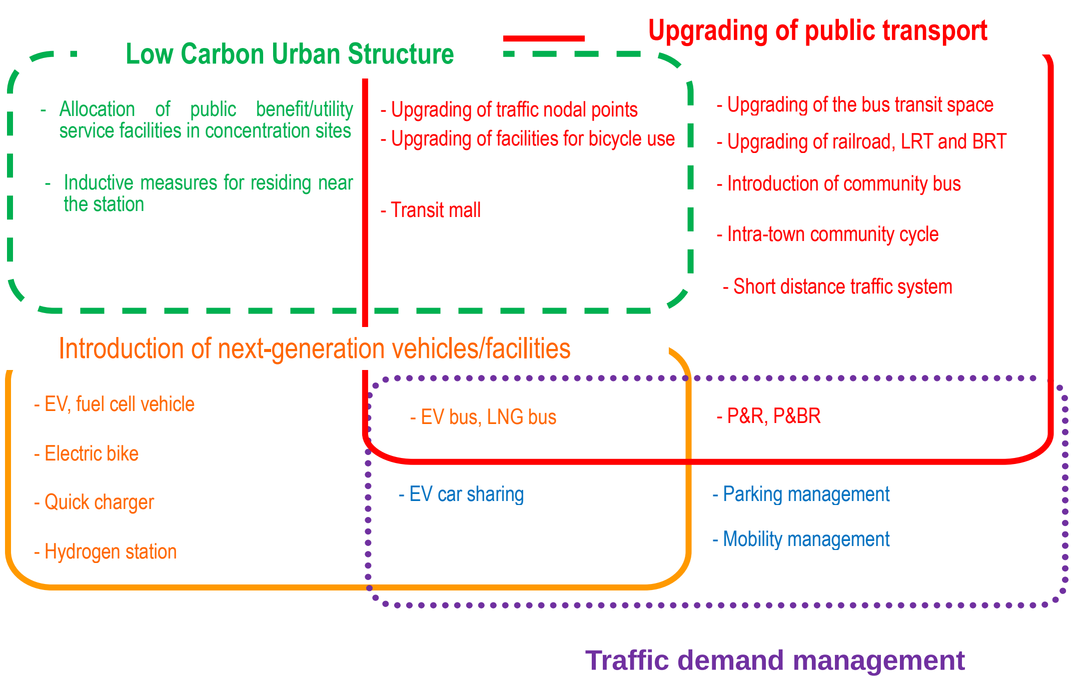
Most of the CO_2 emissions from the transportation sector come from motor vehicles. CO_2 emissions from vehicles are represented as the product of traffic volume, distance traveled (trip distance) and emission intensity of automobiles. It follows that the low-carbon measures for the transportation sector will be based on measures to reduce values of these three factors by:

a Reducing traffic volume through promoting the shift to walking or bicycling and using mass transit systems such as trains, which have less per capita CO_2 emissions than automobiles
b Reducing the distance that needs to be traveled, for example, through promoting a compact city which shortens the commuting distance
c Reducing intensity of CO_2 emissions per unit distance traveled through improving the road conditions to reduce time spent in traffic, and introducing more fuel efficient vehicles

Figure 6 shows how these low carbon transport measures can be integrated in low carbon urban structures.

The effects of measures to reduce CO_2 emission may not be obtained as anticipated if the measures are implemented individually. It is recommended that measures are implemented in ways where the greatest synergetic benefits can occur. The most important is to combine promotion of public transit systems with traffic demand management for motor vehicle. In addition, it is recommended practice to review how well the existing public transit facilities fit the requirement of the particular town.

Figure 6 Combination of low carbon traffic measures



ii) Upgrading of public transit systems

Public transit systems can reduce CO_2 emissions by reducing the volume of traffic of private vehicles, such as automobiles and motorbikes. They can also reduce traffic jams and travel time.

There are many types of public transportation system including standard bus, bus rapid transit (BRT), light rail transit (LRT) and subway or metro systems. It is crucial to select the most appropriate system to match the town size and traffic demand. As shown in Figure 7, the capacity of a bus system is about 6,000 passengers per hour per direction, while that of an LRT system is 6,000-12,000 passengers, and a metro system is efficient for loads of above 25,000 passengers per hour per direction. Figure 8 illustrates the variation in capital cost between the different forms of public transportation.

Increased use of public transit systems can be promoted by improving the convenience of connections between different modes of transit, such as at train stations. Features to consider include barrier- free design, comfortable spaces for pedestrians and bicycle parking areas.

Figure 7 Transportation capacity by traffic mode

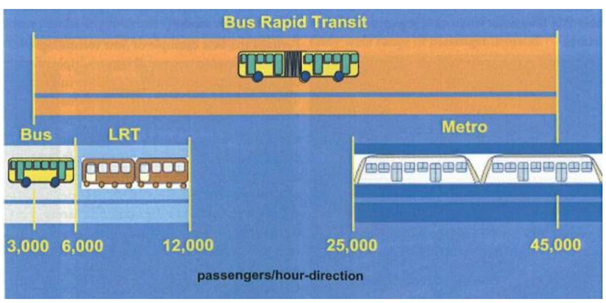
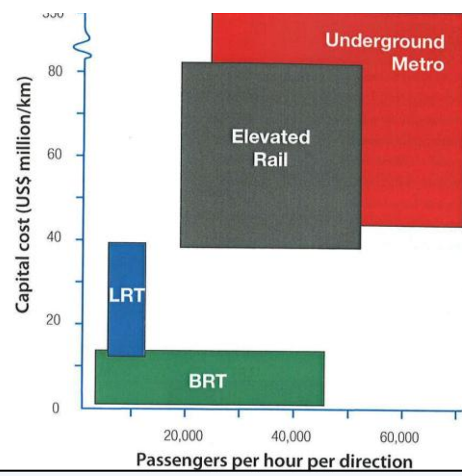


Figure 8 Transportation capacity and capital cost



<Spotlight: Bus Rapid Transit Systems>

Many BRT systems use specially designed buses—called "trunk" or "bi-articulated" buses—that are long and divided into two or three compartments. Such buses can carry up to 140 passengers and travel in exclusive bus lanes, often with signal priorities at traffic lights. Since BRT uses or builds on existing road infrastructure, it is less expensive than light rail. In some cases where demand for mass transit is expected to grow but is not yet sufficient to justify the cost of light rail, BRT is an effective way to build ridership and shift driving commuters to the use mass transit, potentially paving the way for future light rail projects.

Successfully changing commuter behavior to maximize ridership on new BRT systems depends to a large extent on system planning. Criteria for successful BRT systems include:

- *Orientation (route alignment) to population centers and business/office centers*
- *Accessibility to housing and offices along the route*
- *Speed and efficiency of service (how fast to board, how fast to ride)*
- *Frequency of service at different times of day*

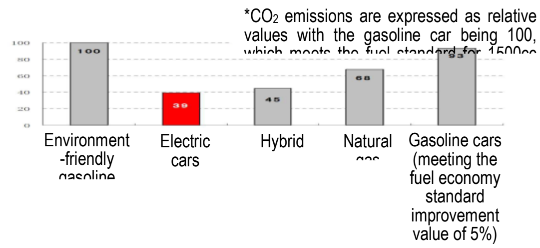
iii) Introduction of next-generation vehicles and facilities

One option for reducing CO_2 emissions in the transport sector is to shift the current gasoline –driven cars and motorbikes to low-carbon emitting vehicles - such as the hybrid cars, electric cars, electric motorbikes and the fuel cell cars that are currently being developed and promoted.

CO_2 emissions from an electric car are about 40% of that from a gasoline car. Fuel cell cars emit extremely small amount of CO_2. Figure 9 shows comparative levels of emissions from different vehicle types.

Motorbikes are now widely used in Southeast Asian economies - the motorbike share of total road traffic in Vietnam is almost 90%. While it is expected the number of automobiles will increase significantly along with economic growth in APEC economies, it is also anticipated that motorbikes will make up a high proportion of future vehicle use, and the development of electric motorbikes is considered imminent.

Figure 9 Comparison of CO_2 emissions by type of vehicle



iv) Traffic demand management

Traffic demand management is a valuable element of low carbon transport measures. This management includes parking management, mobility management, "park & ride (P&R) systems. "Park & ride" systems provide facilities for people to drive in a private car from home to the nearest train station or bus stop, park there and transfer to the public transit systems to get to the center of the town. The systems which allow people to make connections from private cars to buses is especially called "park and bus ride (P&BR)".

The greatest benefit in reducing CO2 emission comes from supporting permanent change in commuter habits with other tangible measures.

> ***<APEC Workshop on Policies that Promote Energy Efficiency in Transport (WPPEET)>***
> *The workshop, which was held in Singapore on 24-25 March, 2009 provided a lively forum on a range of topics that covered fuel economy standards, operational efficiency programs, freight efficiency, mass transit, reducing road congestion, land use and urban planning, and the integration of transportation and energy policy.*
> *http://www.apec-esis.org/www/egeec/webnews.php?DomainID=17&NewsID=178*

2.2 Measures on the energy supply side

This section provides an overview of measures to reduce CO2 emission on the energy supply side of low carbon town development.

2.2.1 Area Energy Network

An area energy network is a system that efficiently supplies cold/hot water to consumers from a central plant at the district or regional levels. The heat energy demand may be for cooling, heating or hot water supply, and is supplied via heat energy supply conduits, on a large scale.
These networks are possible in built-up urban areas around central transport nodes such as train stations where there is dense, mixed use of land, combining business, commercial, hotels, residential and cultural functions. These areas would usually contain a number of high-rise buildings, and variety of energy load patterns there would include some buildings with high energy loads.

It is possible to reduce CO2 emission in a town through this kind of area-wide energy utilization by purposefully constructing an "energy center" that integrates heat demands of different buildings based on a network that allows for the cross supply of energy.
Area energy network can be divided into three categories, depending on their scale.

a District heating and cooling systems (DHC), covering a wide area – see Figure 10
b Point heating and cooling systems, targeting multiple buildings in a single site – see Figure 11
c Cross-supply of heat among multiple buildings

Figure 10 District heating/cooling systems (DHC)

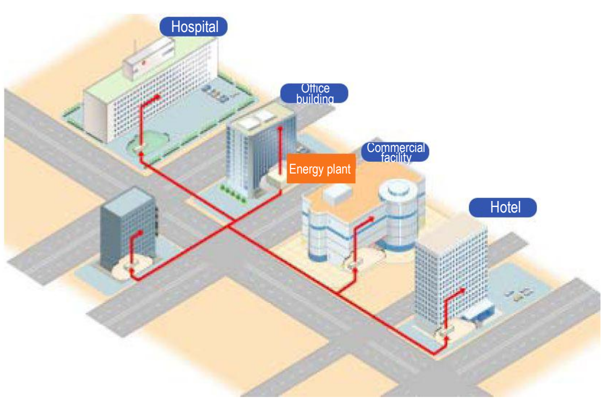
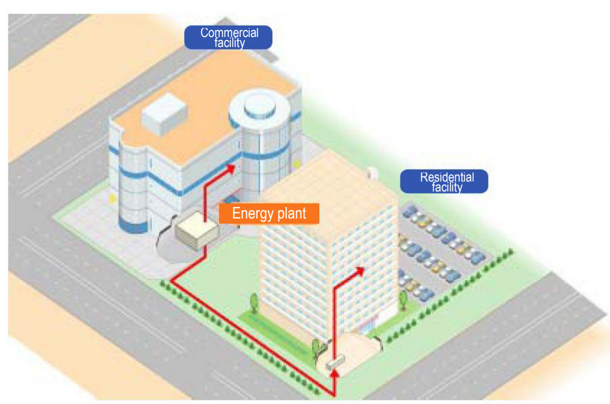


Figure 11 Point heating/cooling systems



2.2.2 Use of untapped energy

i) Untapped energy sources

In many towns and cities, waste heat is constantly produced in plants that incinerate garbage and/or sewage sludge . However, these high volumes of urban waste heat are generally discarded, as there is little coordination with nearby energy demand. There are also other potential energy sources around urban centers, such as river water, seawater, sewage water and sewage treated water. These can be used as a heat source or a heat sink using a heat pump technology, with the advantage that they vary less in temperature through the year than the ambient temperature.

These untapped energy sources could be developed at a regional level as part of low carbon town development.

Heat pump technology efficiently transfer the heat energy contained in air or water in a source outside a building into cooling or heating required to keep interior temperature levels comfortable; the energy demand for electricity or gas to run the heat pump is comparatively very low owing to the recent development of heat pump technology.

ii) Utilizing untapped energy in towns

In large cities and towns, garbage/sewage sludge incineration plants are often located near residential area, as are sewage pumping stations. These energy sources could be converted to energy supply for nearby buildings and houses, which would facilitate the cyclic use of energy at a regional level.

iii) Managing urban development to promote untapped energy use

An essential element of the effective use of untapped energy is to take all opportunities to link potential consumers with the energy source. Greenfield developments could intentionally site these waste treatment plants near urban areas with high energy load. In existing urban areas, road maintenance and other infrastructure improvements provide opportunity to establish the heat energy supply conduits.

vi) Linking with improvements to urban thermal environment

In the central built-up areas of large cities, the “heat island” phenomenon is of serious concern, because of the volume of heat released into the atmosphere from rooftop cooling towers. In this case, water bodies such as river can be effective absorbers of waste heat. This requires consultation with the administrators of the water body to make sure that it has sufficient flow to avoid the localized accumulation of heat in the waterway.

2.2.3 Use of renewable energy

i) Renewable energy sources

The energy that exists in nature and that can be used repeatedly is called renewable energy. It includes solar energy (PV, and solar heat usage), wind energy, biomass energy, underground heat energy. Renewable energy is widely available but is also widely dispersed. To make such low-density energy effective for power and/or heat generation requires concentration and distribution through energy conversion facilities, such as, wood pellet manufacturing plants.

ii) Using renewable energy in towns

While solar energy and underground heat energy can be utilized regardless of the regional characteristics, there will be a higher potential for utilization in suburban areas or middle/small-sized local towns rather than in the central areas of large towns. While renewable energy that is used as electricity will be developed widely, the deployment of renewable energy as heat depends on the regional conditions about the heat requirement. In this sense, it is essential to foresee the future status of heat use and to formulate a strategy for use of heat in the future.

< Renewable Energy for Urban Application in the APEC Region>

The above report, which was commissioned by APEC EWG/EGNRET and published in January 2010, assessed best practices in renewable energy technologies, systems and resources in urban areas of APEC member economies. It includes examples in the residential, commercial, industrial and utility sectors. It is worthwhile to read as it will provide insights about the approach to utilize renewable energy in the urban area.
http://www.egnret.ewg.apec.org/reports/210_ewg_urban_application.pdf

iii) Managing urban development to promote renewable energy use

The benefits of renewable energy such as solar and biomass are considered to be relatively high in the local towns where the building density in the built-up areas is relatively low. However, in these towns, there tend to be less opportunity such as district redevelopment and replacement of buildings, which could trigger the introduction of such renewable energy. Therefore, it will be necessary to capture the opportunities of refurbishment of government office buildings and hospitals etc. It will be also important to cooperate closely with town developers who have a plan of large scale development.

iv) Linking biomass sources to urban development

Low carbon urban development in areas where there is agriculture, forestry, and livestock farming has the advantage of biomass energy. To use this effectively will require consolidation of the widely dispersed waste materials, and establishment of a framework for the production of energy locally and use of energy locally.

2.3 Measures that straddle energy demand and supply

2.3.1 Smart grid systems

The smart grid system is a new concept of electricity transmission/distribution network that controls and optimizes the flow of electricity from both the demand and supply sides. These systems require the installation of a “smart meter” on the demand side.

Conventional electricity transmission is designed for peak demand, which results in electricity wastage. In addition, outdated and aging transmission/distribution lines are vulnerable to overload and natural disasters, and can be difficult to restore service on after an outage. Smart grid systems have been proposed as the next-generation transmission/distribution system that can maximize efficiency, while also facilitating the introduction of electricity from renewable sources.

As well as offering these low carbon benefits, it is noted that smart grid rely on advanced communication systems, which could be vulnerable to tampering or computer virus infection , and so need to be carefully safeguarded.

Smart grid systems differ by economy as electricity market structure as well as stability of power transmission/distribution network are different from one economy to another. Smart grid systems have these potential benefits:

1. Reduction of electricity consumption can be expected at demand side through measuring and visualizing the electricity consumption with the smart meter. It is also possible to shift peak demand by restraining the consumption at the time of peak electricity generation.
2. Stability of electricity supply and prevention of blackouts will be improved by the safety-control equipments installed on the electricity transmission/distribution network. This reduces the social disturbances caused by blackouts, providing economic benefits for the whole society.
3. Electricity generated from solar and wind energy can be highly variable in volume, depending on the season or time of the day. If renewable power is connected to the power transmission/distribution network, it may turn out to be a voltage variation for the network. The smart grid systems avoid such a problem by matching the supply from the utilities with the demand of the consumers.
4. Under the smart grid systems, it is expected that surplus electricity generated by renewable energy can be controlled by temporarily storing and discharging the electricity using batteries connected to the grid. In future, it may be possible to adjust the demand-supply balance in the whole electricity network, making efficient use of the batteries mounted on “plug-in” type electric cars and hybrid vehicles stationed at households.

Overall, smart grid systems seek to reduce the wasteful electricity consumption on the consumer side and to promote the introduction of renewable energy on the supply side. In many towns and cities in the APEC member economies, smart grid system demonstration projects are under way, supporting innovation not only in the energy area but also in the wider urban infrastructure, including buildings, traffic system design and management. The goals of these projects address the different socio-economic conditions of their respective economies and regions.

<APEC Smart Grid Initiative>

The APEC Smart Grid Initiative (ASGI), established in 2010 by APEC's Energy Working Group (EWG), evaluates the potential use of smart grids and grid management technologies, energy efficiency, renewable energy technologies, and intelligent controls to link customers to the grid and enhance the use of renewable energy and energy efficient buildings, appliances and equipment. The goal of the Initiative is to crate best practices in operation (through workshops and actual testing) as well as interoperability standards to create highly efficient systems that are easily replicable.

http://www.egnret.ewg.apec.org/meetings/egnret36/E3-APEC%20Smart%20Grid%20Initiativ

2.3.2 Smart energy system

Future energy systems will be "smart" at all levels. On the supply side, it is expected that urban energy systems will combine large-scale integrated power generation from sources such as thermal, hydroelectric and nuclear, and a large number of small-scale renewable-energy power generation in individual households. On the demand side, there will be energy management systems in place at all levels: in homes, commercial and civic buildings and at area level.

Smart Energy System seeks to optimize the total energy use by coordinating all the energy management systems for a single district. It is also possible to optimize the total energy supply and consumption by combining not only electrical systems but also heat supply systems which use cogeneration and thermal storage equipments.

Another type of smart energy system in development aims to connect energy systems with water circulation systems by using water as a heat storage media and adjusting the operation of water treatment facilities to absorb variation in energy load.

Smart energy systems are likely to be central to future low carbon urban development, even if not immediately applicable to all current projects.

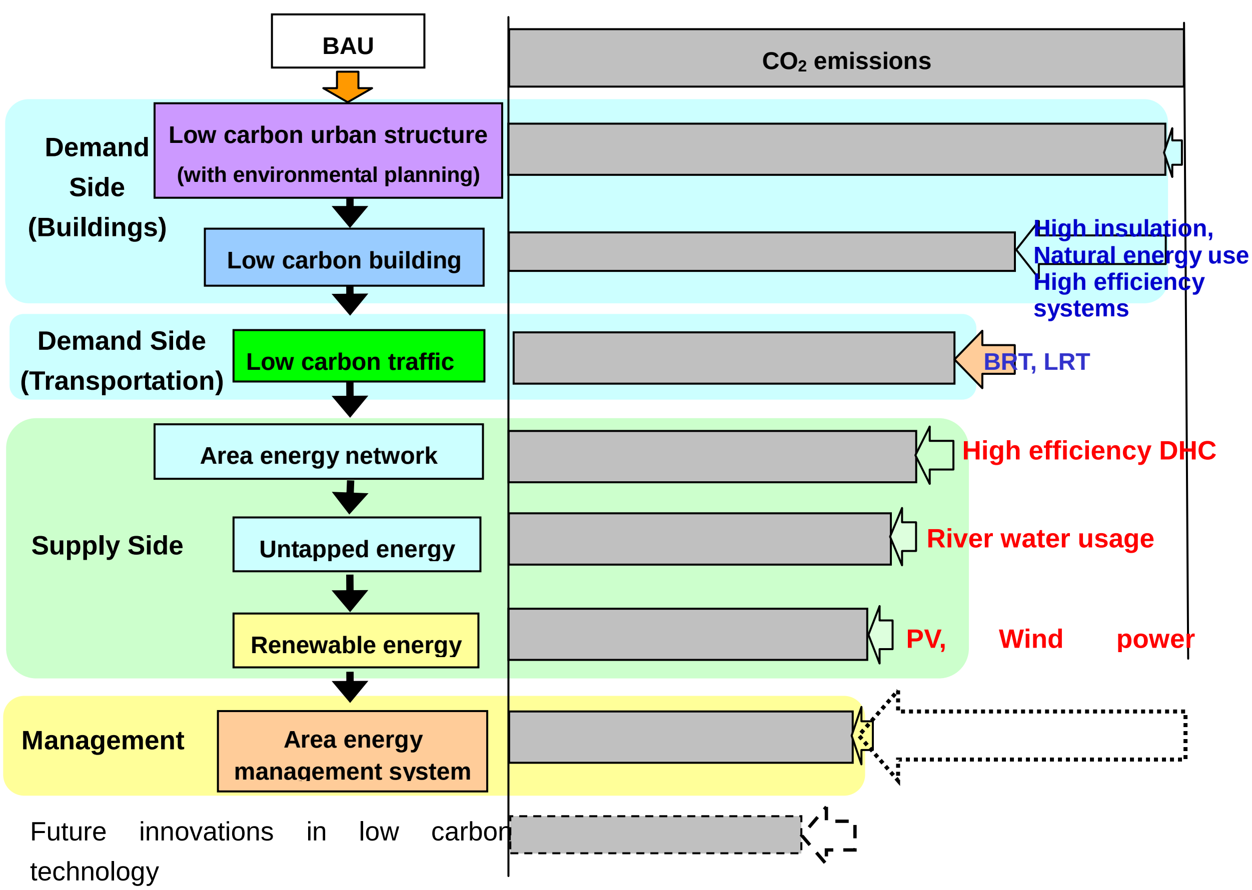
Chapter 3 Evaluating the effect of low carbon measures

3.1 Purpose of evaluating the CO_2 reducing effects

Estimates of the reduction in CO2 emissions from various measures, and combinations of measures will make it possible to quantify the effectiveness of a planned approach to low carbon town development. This also makes it possible to compare the predicted reductions with the designated CO2 reduction target for the town, which provides a check on the practicality of the target itself.

A hierarchy approach is recommended for the review approach. This uses the emissions level in a business-as-usual (BAU) scenario as the basis, and assesses the increase in emission reduction in a hierarchical fashion as shown in Figure 12.

Figure 12 Hierarchy approach for assessing effectiveness of low carbon measures



3.2 Basic methodology to evaluate CO_2 reducing effects

Basic methodologies for evaluating the CO_2 reducing effects of the different measures are shown below.

3.2.1 Demand Side

i) Low carbon urban structures (TOD type land use)

Transit Oriented Development (TOD) has two key CO2 reducing effects:

- Reduced energy use in buildings through their concentration in high density zones
- Reduced motor traffic

The two methods used to evaluate the effects of TOD type land use are set out separately below.

ii) Low carbon buildings

General procedure for evaluation

CO_2 emission from the building sector can be calculated by multiplying "total floor area of buildings by use", "CO_2 emission intensity of buildings by use " and "(1- Overall CO_2 reduction rate)", as shown in the formula below.

CO_2 Emission= (Total floor area of buildings by use) × (CO_2 emission intensity of buildings by use) x (1- Overall CO_2 reduction rate)

Data

a) Total floor area of buildings

The "floor area of buildings by use" figure is estimated based on the development plan of the area in question.

b) CO_2 emission intensity of buildings by use

Method 1: If statistical data on the energy consumption of the buildings by use is available for the area in the development plan, a figure for CO_2 emission intensity data can be obtained by conversion of such data.

Method 2: If that data is not available, but data for other cities of a similar nature is accessible, this can be used to estimate a figure for the CO_2 emission intensity.

Method 3: If that data is not available from the development zone or similar cities, an alternative can be to gather data via a survey of energy consumption of buildings in the town in question. The survey will have the greatest value if it documents seasonal differences in energy consumption and type of fuel use.

Estimation of the CO_2 emission reduction effect of each measure

The overall CO_2 emission reduction rate can be calculated by following these steps:

1. Evaluate separately the CO2 emission reduction effect at energy consumption points in the building, such as heat source equipments, heat transfer, lighting, electric apparatus, hot water supply system.

2. Estimate the aggregated value by prorating these figures.

Heat source equipments are those that generate cold or hot energy, such as turbo or absorption type refrigerators and heat pump chillers, as shown in the schematic diagram of the district cooling/heating system in Appendix 2. The efficiency of this technology, especially of heat pumps, has been improving year after year. Replacing outmoded equipment with high efficiency models is an effective way of reducing CO_2 emissions.

Heat transfer equipments include cold/hot water pumps and air conditioning fans. Effective energy savings can be achieved through adjusting the number of these equipments in operation, and by using an inverter system to control their use according to actual demand.

In terms of lighting, energy savings can be achieved by adopting high-efficiency fluorescent lamps (Hf-type lamps), LED, organic EL lighting, illumination control using light sensors and motion sensors.

Reducing of the amount of electricity used for lighting and office appliances will result in the reduced internal heat, which also contribute to a reduction in electricity consumption for cooling purposes.

The reduction in CO_2 emission from the adoption of area energy network, such as district cooling/heating (DHC) can be estimated in a similar way.

iii) Low carbon transportation

General procedure for evaluation

In principle, CO_2 emissions in the transportation sector can be calculated as the product of “traffic volume” multiplied by “distance traveled” multiplied by “emission intensity”. These figures need to be obtained in order to calculate the reduction effect of low carbon transportation measures. The process for automobile traffic is set out below. (this concept guide does not cover other transportation forms in detail)

CO_2 emission = Traffic volume × Distance traveled × Emission intensity

a) Traffic volume

If an automobile traffic census has been conducted in the targeted district, this should be used to determine traffic volume. An automobile traffic census counts the number of vehicles passing a particular point of each district, by type of vehicles, by time of the day and by direction. This is then used to calculate traffic volume of each target district covered by the census, per day and per year.

Person-trip surveys can also be used to calculate traffic volume. A person-trip survey investigates “when”, “what type of people” moved, “from where”, “to where”, “by what means of transportation”, and “for what purpose” in a given district in one day. The survey, which studies the actual travel behavior of the people living in the cities, is a valuable source of information for urban traffic planning.

A “trip” is a unit for the movement of a person from one point to another for some purpose; the total of the number of trips that started from a certain district (traffic generation) and the number of trips that ended in the district (traffic concentration) is called the “generation concentration volume” of the district.

While the modes of transportation covered by these surveys include railroads, buses, automobiles, two-wheeled vehicles (bicycles, motorized bicycles), walking, it is possible to estimate the automobile traffic volume in a given district by calculating the generation concentration volume by the percentage use of automobiles. Person-trip survey data will provide automobile traffic volumes by type of vehicles and by routes.

b) Distance traveled

If an origin/destination survey (OD survey) has already been conducted in the targeted district, this should be used to determine the travel distance of automobiles. An OD survey investigates the movement of the cars in one day, regarding information such as the point of departure and destination, purpose of the trip and time of travel. This is carried out by selecting a certain number of car owners from a car registry, who are then surveyed by questionnaire. The OD survey data will provide figures for distance traveled by type of vehicle.

If a person-trip survey was used to calculate traffic volume, the distance traveled should be calculated as the distance of each route.

c) Emission intensity

If statistical data on the fuel consumption and distance traveled by type of vehicle is available, the CO_2 emission intensity should be determined from these data. The CO_2 emission intensity of automobiles varies according to type of vehicles and the traffic speed.

Calculation of the CO_2 emission reduction effect of each measure

a) Effects attributable to the upgrading of the public transit network

> In principle, the effects can be estimated by assuming the reduction of traffic volume and distance traveled, that will be achieved through upgrading of the public transit network.

b) Effects attributable to the introduction of low-carbon vehicles

> In principle, the effects can be estimated by assuming the number of low carbon vehicles that will replace conventional vehicles and their emission intensity.

c) Effects attributable to the introduction of other measures (such as traffic demand management)

> In principle, the effects can be estimated by assuming the change in traffic volume, distance traveled and emission intensity accordingly.

3.2.2 Supply Side

a) Effects attributable to the introduction of area energy networks

> The effects can be estimated by assuming the increase in efficiency at the central plants that supply heat energy used for cooling, heating, hot-water supply and other purposes in the

b) Effects attributable to the introduction of untapped energy/renewable energy

> Heat: The CO_2 emission reduction effect can be calculated by assuming the amount of fuel necessary to generate the same amount of heat produced by untapped energy/renewable energy
>
> Electricity: The CO_2 emission reduction effect can be calculated by reducing the electricity supply from the commercial grid, which is equivalent to the electricity generated by

3.2.3 Demand and Supply Side

The CO2 reduction effects can be estimated separately for different types of benefits, such as energy efficiency increase in building sector, or increase of renewable energy power generation.

Chapter 4 Summary

Low carbon town development requires clearly specified carbon reduction targets, and the careful selection of measures to achieve those targets, chosen as the best match to the town's individual situation.

"The Concept of the Low Carbon Town in the APEC Region – Part II" sets out the range of measures available. These are organized by category, and overall by whether they affect energy demand or energy supply. The Concept also sets out key points for effective implementation of these measures, and methods of quantifying their effects on carbon use.

Transit oriented development (TOD) is one of the key elements of low carbon town design. TOD land use planning combines intensive land use and public transit systems with other non-car transport forms, to reduce energy use and traffic volumes. Control of land use and enforcement of relevant policies are the crucial factors in successful implementation of TOD.

On the individual building level, there are opportunities in design and construction, and in retrofitting, to improve energy efficiency to reduce CO2 emission. The potential measures include use of thermal insulation on windows and roofs, passive energy design, and high efficiency technology for air-conditioning and lighting. The integration of that technology with consolidated energy management systems is essential for effective reduction in carbon use. Models of innovative low carbon buildings are available in many APEC member economies.

Some of the most pressing issues facing large cities in the APEC region are air pollution and traffic congestion. Measures to reduce traffic volumes and emission levels offer significant benefits in energy use and also in urban traffic management. As well as TOD land use planning, other key options in this area are upgrading public transportation, traffic demand management and introduction of next generation low emission vehicles. The most effective set of measures for any given low carbon town development is the combination that has the greatest overall synergic effect.

As well as improving overall management of energy use and supply to increase efficiency, new low carbon town developments can also incorporate untapped energy sources, such as heat from garbage incineration plants. When such heat energy is supplied to large-scale co-generation plants, significant improvements in energy efficiency are possible at regional level. River water and sewage treatment water can also improve energy efficiency if used as a heat source or heat sink via high efficiency heat pump technology.

Data is key to effective choice, implementation and monitoring of low carbon measures. However, good quality transport data is in short supply in most Asian developing economies. Statistics that would be of real assistance include figures for traffic volume, the distance vehicles are driven in a year, and fuel consumption by vehicle type. At the state or metropolitan level, occasional travel surveys and traffic counts are made, but there is little reliable data on fuel consumption and almost no data on vehicle use.

For the development of low carbon towns in APEC economies, transport data collection will need to improve markedly.

Appendix 1

Low Carbon Measures Along and their Applicability

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town [Note 1)]			
Supply / demand	Major Classification	Minor Classification		I	II	III	IV
Supply side	Generating / distributing power	Infrastructures for generating/ storing power	Distributed power facility	M	M	L	L
			Cogeneration system	H	H	L	L
			Large-scale power storage, etc.	M	M	L	L
	District energy (heat supply)	District heating / cooling			H	M	L
	Untapped energy	Using sea/river/sewage water			H	M	L
		Using waste heat from as waste incineration plants			H	M	M
		Using waste heat from sewage treatment plants			H	M	L
		Using waste heat from factories		M	M	M	X
	Renewable energy	Solar power generation (mega solar power generation)		M	M	M	M
		Using solar heat (large-scale solar heat)		M	M	M	M
		Biomass power generation (bio gas power generation, etc.)			L	L	M
		Wind power generation			L	L	H
		Geo-thermal power generation			L	L	M
		Hydroelectric power generation (small- and middle-scale)			L	L	M
Demand side	Composition of urban space	TOD development					
		Environment space development	Green way NW	H	H	H	M
			Underground space NW	M	L	X	X
	Buildings	Reducing loads		H	H	H	H
		Highly efficient facility systems		H	H	H	H
		Equipment installed at facilities	Fuel cells, etc.	H	H	M	M
	Management	Energy management systems	BEMS (HEMS, FEMS)	H	H	H	H
			ZEB	M	M	H	H
			AEMS	H	H	H	H
	Environment-related infrastructures	Urban climate	Micro climate, heat island	H	M	M	X
		Wastes	Collecting wastes, recycling resources	H	H	H	H
			Using energy (bio gas), using sewage sludge	M	M	L	H

Demand side		Water supply / sewage	Re-using treated waste water Using rainwater	H	H	M	L
		Reducing pollutions	Treating exhausts, contaminated soils (Treating waste water is included in the sewage.)	H	H	H	H
	Transportation system	Public transportation systems	Public transportation NW	M	M	M	X
			Intra-district transportation system (busses, LRT, etc.)	H	H	H	L
		Short-distance transportation systems	Intra-city community bicycle	H	H	H	L
			Short-distance transportation system	H	H	H	L
		Vehicles	EV	M	M	M	M
			EV bus	M	M	M	M
			Natural gas-driven vehicles, etc.	M	M	M	M
		EV-related hardware	Fast charger, small battery	M	M	M	M
Both supply and demand sides	Smart grid system (mainly for electric power system)	Power control systems	Power monitoring control system	H	H	M	L
			Power stabilization system	H	H	M	L
			Other systems				
		Network	Network infrastructures	H	H	M	L
			Network-related technology, communication modules, measuring systems, etc.	H	H	M	L
	Smart energy system (energy integration)		Smart energy system	H	H	M	L

Note 1:

H: Potentially highly effective
M: Potentially effective
L: Potentially less effective or difficult to apply
X: Not effective at all or unlikely to apply

HEMS: Home Energy Management System
FEMS: Factory Energy Management System
ZEB: Zero Energy Building
AEMS: Area Energy Management System
TOD: Transit Oriented Development

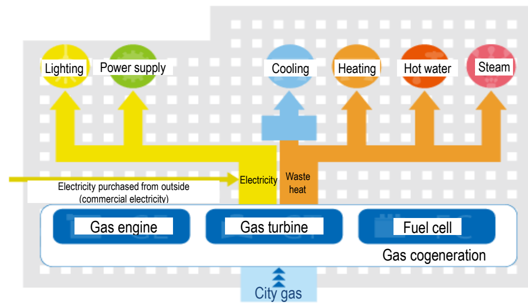
Appendix 2

Low Carbon Measures Along With Case Examples

(1) Cogeneration System

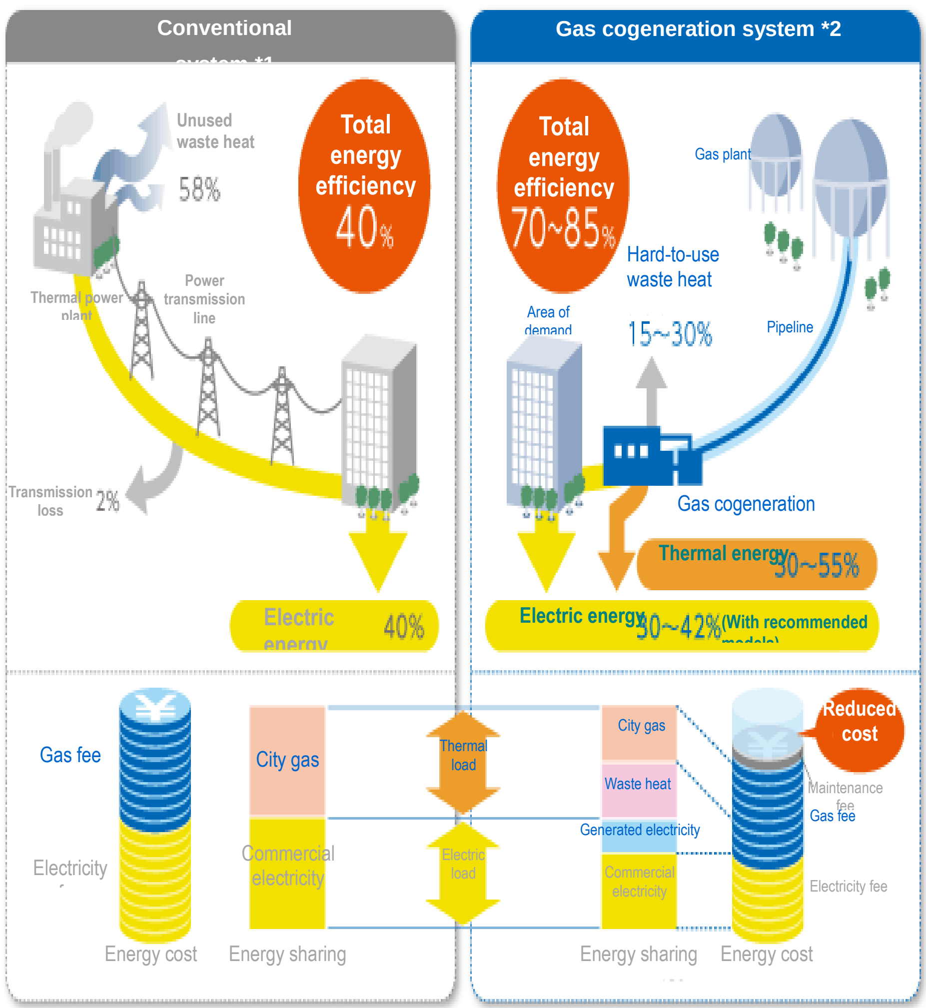
<table>
<tr><th colspan="3">Classification of Measures</th><th rowspan="2">Low Carbon Measure</th><th colspan="4">Applicability as per Type of Town</th></tr>
<tr><th>Supply/ Demand</th><th>Major Classi-fication</th><th>Minor Classi-fication</th><th>I</th><th>II</th><th>III</th><th>IV</th></tr>
<tr><td>Supply side</td><td>Generating/ distributing power</td><td>Infrastructures for generating/ storing Power</td><td>Cogene-ration System</td><td>H</td><td>H</td><td>L</td><td>L</td></tr>
<tr><th colspan="8">Overview of Measures and Applicability</th></tr>
<tr><td colspan="8">• Cogeneration is a system that generates electricity where needed using city gas for fuel, and at the same time makes efficient use of generated heat for cooling, heating, hot-water supply, steam etc.
• Cogeneration has a wide range of application for a variety of areas and systems that use heat, including those for households/businesses, large cities, middle cities and farming villages etc., as well as district cooling/heating (district-scale use) and smart energy systems etc.
• As for its application in farming villages, there are cases where this system is used as a tri-generation using electricity, heat and CO2 for greenhouse cultivation.
•</td></tr>
<tr><th colspan="8">Expected CO2 Reducing Effect</th></tr>
<tr><td colspan="8">• Compared with conventional systems (thermal power + boilers), it can reduce CO2 emissions by about 30-40%.</td></tr>
<tr><th colspan="8">Examples of Application</th></tr>
<tr><td colspan="8">• Around 5 million kW in total has been introduced in Japan (in stock).</td></tr>
<tr><th colspan="8">Schematic Diagram of the System etc.</th></tr>
</table>

- A schematic diagram of the system



The generated electricity is combined with that purchased from outside and is supplied into the building.

- The energy/cost-saving performance of gas cogeneration



*1 LHV standard. The thermal efficiency and total loss of thermal power plants were calculated on the basis of the operation performance of nine (9) power utilities and wholesale power utilities in 2003FY (The Working Group on Energy-Saving Standards, September 2005)

*2 The efficiency of gas cogeneration system is an example based on LHV standard.

(2) Using sea/river water

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Untapped energy		Using sea/ river water		H	M	L

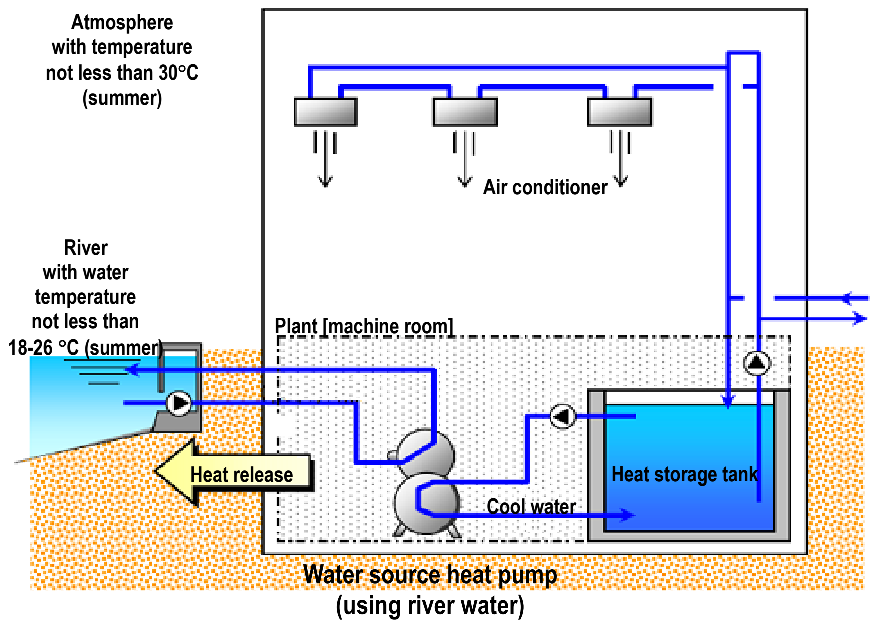
Overview of Measures and Applicability

- As sea/river water temperature is stable and is lower in summer and higher in winter than the atmospheric temperature, it will contribute to improving energy efficiency both as a coolant of heat pumps used in heat source equipment for cooling and as a heat source water of heat pumps for heating/hot-water supply.
- As the use of seawater requires countermeasures for salt damage to equipment and for marine organisms, and the use of river water requires drought management measures etc., it is a common practice to combine the use of sea/river water with large-scale facilities such as district heat supply systems.

Expected CO2 Reducing Effect

- It is expected that CO2 will be reduced through improving energy efficiency in cooling/heating and hot-water supply in the relevant communities.

Examples of Application

Schematic Diagram of the System etc.	
	 Source : "An Investigative Report on District-Scale Energy Use", March 2005

(3) District heating and cooling (DHC)

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	District energy (heat supply)		District heating and cooling (DHC)		H	M	L

Overview of Measures and Applicability

- It connects multi-purpose buildings in certain regions via regional conduits, and supplies cooling/heating media from regional energy supply plants in an efficient manner.
- By means of this system, not only energy-saving but also energy security and urban aesthetic can be promoted, which include labor-saving, efficient use of building spaces, pollution-abatement, heat-island countermeasures, prevention of urban disasters etc.

Expected CO2 Reducing Effect

- Compared with individual (heat source) systems, primary energy consumption can be reduced by 10%-14%*. Further reduction of energy consumption (by not less than 20%) can be realized by utilizing unused energy, contributing to a significant reduction of CO2.

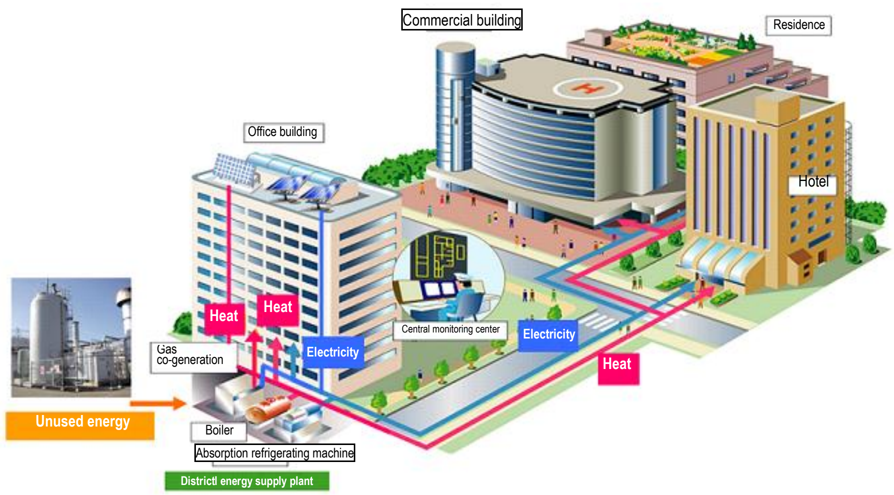
* "District-Scale Utilization of Unused Energy - the Current Status of Heat Supply and the Direction towards the Next Generation", Ministry of Economy, Trade and Industry (March 2008)

Examples of Application

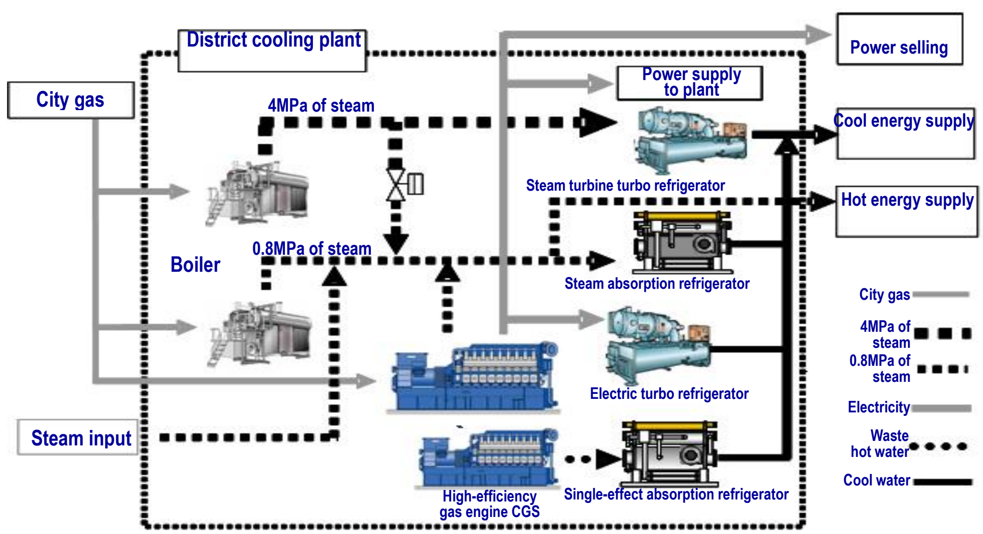
Shinjuku Sub-center, Marunouchi District, Osaka Senri New Town Chuo District etc.

Schematic Diagram of the System etc.

- Schematic Diagram of the System



- An Example of a Regional Cooling/Heating Plant



(4) Sunlight shading and thermal insulation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Demand side	Building	Reducing load (Thermal)	Sunlight shading and thermal insulation				

Overview of Measures and Applicability

- Sunlight shading is very effective in reducing thermal load put into a building from outside. As the solar elevation changes according to its bearing, the type of suitable eaves or blinds also varies. In planning sunlight shading, it is necessary to take the building exterior into account so that the sunlight would be effectively shaded.
- Shutting off sunlight on the outer side of a building is more effective. External blinds installed on the outer side of a building would help reduce the thermal load in the rooms. They also play the role of adjusting natural lighting when the blinds are designed to change their angles automatically according to the solar elevation.
- Planting vegetation around a building cuts direct sunlight off the concrete surface and takes effect on controlling the rise in the air temperature around the building because of evapo-transpiration effect.

Expected CO2 Reducing Effect

- Power consumption cut is expected due to the reduction of air conditioning load thanks to the lowered temperature inside the building and natural lighting. As a result, it takes effect on the reduction of CO2 emission.

Examples of Application

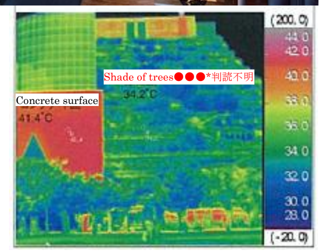
Itoman city Municipal Office, Institute for Global Environmental Strategies (IGES) Main office Building, Across Fukuoka (Commercial-Office-Cultural Complex)

Schematic Diagram of the System etc.

●Itoman city Municipal Office

●Institute for Global Environmental Strategies (IGES)

●Acr



(5) Façade engineering

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Demand side	Buildings	Reducing load (Thermal)	Façade engineering				

Overview of Measures and Applicability

- The façade engineering refers to the technology of reducing thermal load from outside by applying high heat characteristics to the window and outer wall which constitute a façade.
- The important component is high performance glass, such as the duplex glass containing air space between two pieces of glass and low-e glass with specific coating for blocking the radiation heat from traveling through. These types of glass also enhance indoor environmental performance around the windows.
- One possible approach is the "Air flow windows". They improve the thermal insulation properties and sunlight shading around a bow window by creating a kind of air curtain by ventilating inside the double-layered glass equipped with a built-in blind. Ordinarily, room air is sucked from beneath the glass window and the air inside the double-layered glass is led to under the ceiling with a ventilation fan mounted under the ceiling.

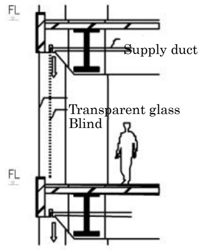
Expected CO2 Reducing Effect

- Diagrams below show the simulation examples of PMV when using ordinary glass only and using low-e glass plus eaves, the peak load of the perimeter, and annual thermal load. The result shows that the employment of eaves plus low-e glass cuts the peak load by 43%, indicating that approximately 16% of thermal load will be slashed annually.

Examples of Application

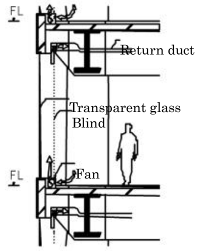
Iidabashi First Building, etc.

Schematic Diagram of the System etc.



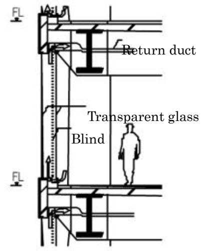
The load around the window is handled by the air conditioner. In winter, some devices such as a panel heater is required because cold draft is generated.

Iidabashi First Bldg.



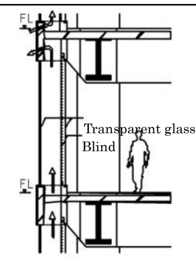
By creating an air curtain barrier between the glass and the blind by a fan, the thermal load generated around the window is collected in order to cut in-room load.

PCP Marunouchi



The thermal load around the window is contained inside the Air Flow, and then collected by the air taken from the slits of sashes in the room in order to cut in-room load.

JR East Japan Head Office



In summer, open air is taken in from the slits on the outer wall to naturally ventilate thermal load accumulated inside the double skin. In winter, open air is shielded off to collect heat.

Chiba Prefecture Autonomous Hall

(6) Natural ventilation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi- fication	Minor Classi- fication		I	II	III	IV
Demand side	**Buildings**	**Reducing Load (Thermal)**	**Natural ventilation**				

Overview of Measures and Applicability

- The mid-term air-conditioning energy can be reduced by planning to take natural wind into rooms, for instance by installing apertures or opening-closing windows effectively or natural ventilation voids inside the building.
- The void enables natural air flow even when it is calm. (The natural ventilation by the difference in temperatures between tops and bottoms.) Moreover, natural ventilation can be effectively obtained no matter which direction the wind blows. (The wind shielding board prompts natural ventilation as negative pressure zone is created when the wind flows through the upper part). Example: Meiji University Liberty Tower (Top figure)
- Natural ventilation using the staircases can also produce the same effect as installing natural ventilation voids and wind shielding boards. (When air is calm, ventilation is enabled naturally by the difference in temperatures between upper and lower part of the staircases. When a wind shielding board is mounted on the top, a negative pressure zone is created as the wind passes through the upper part, thereby allowing natural ventilation free of the wind direction. (Bottom figure)

Expected CO2 Reducing Effect

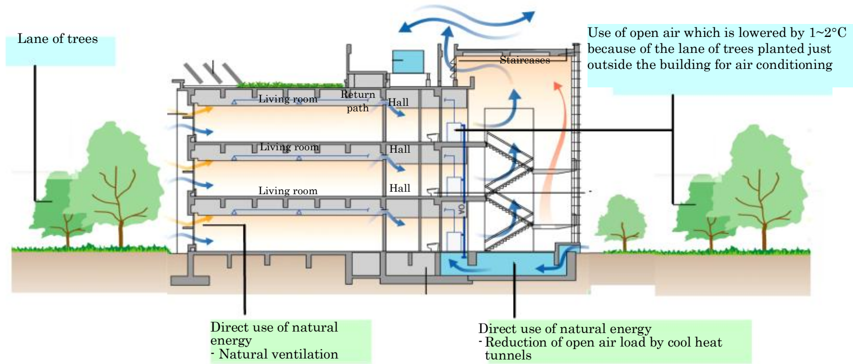
- Reduction of CO2 as a result of reduced air conditioning load

Examples of Application

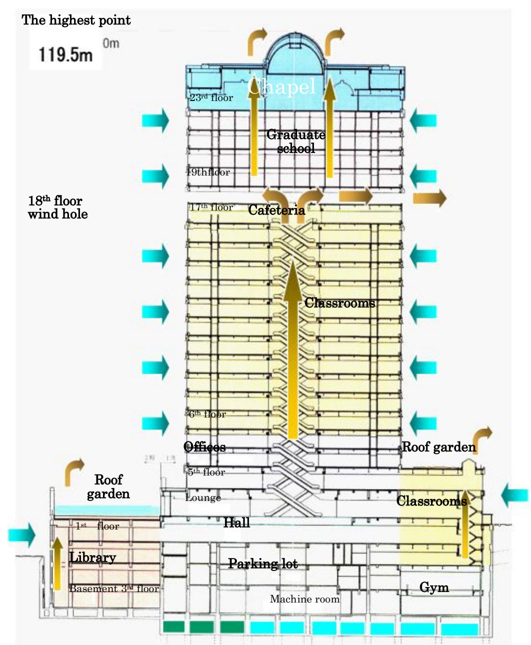
Meiji University Liberty Tower

Schematic Diagram of the System etc

● Natural ventilation using the staircases



● Meiji University Liberty Tower



(7) Daylight use plus lighting system

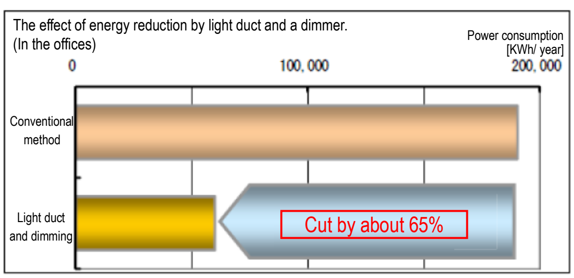
Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	**Building**	**Reducing load**	**Daylight use plus lighting system**				

Overview of Measures and Applicability

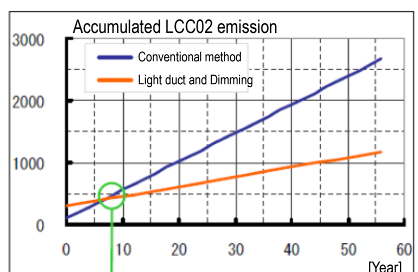
- The light from the window is limited in its reach, or no lighting is available if there is no window in the room. However, natural light can be reached to the darker areas in the building by using a light duct. The illustrations given below show the system of a light duct using aluminum mirror with 95% reflectivity of visible light for its inside in order to get the light transported from the light collection part to the light-releasing part.

Expected CO2 Reducing Effect

- The system of using light ducts shown below is effective in cutting the annual electricity consumption by approximately 65% over the conventional systems. It is noted that the Life Cycle (LC) CO2 can be recovered in 7 to 8 years.



Amount of annual electricity consumption for illumination



7~8 years

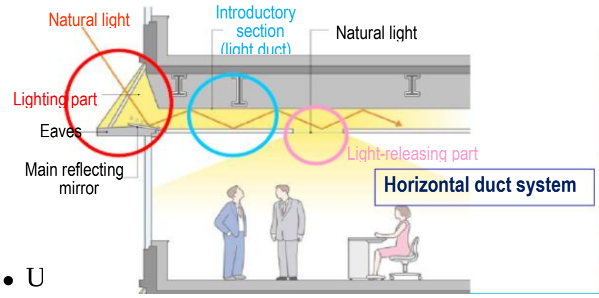
Accumulated amount of CO2 emission

Examples of Application

Japan Aerospace Exploration Agency (JAXA), Tsukuba Space Center (TSC), Toyota Motor Corporation Office Main Building

Schematic Diagram of the System etc.

- Example of using light duct in offices (JAXA, TSC)



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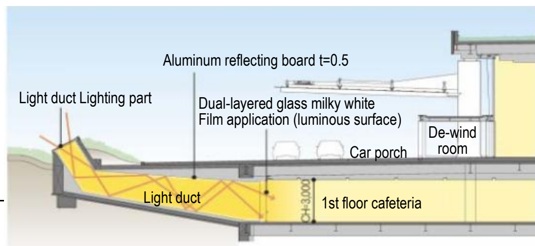
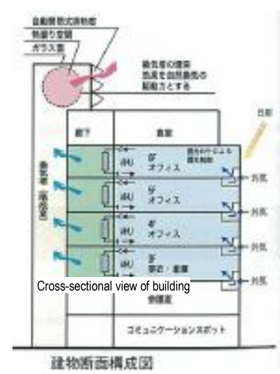


(8) Hybrid of natural ventilation plus air conditioning

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	**Building**	**Reducing load (Thermal)**	**Hybrid of natural ventilation plus air conditioning**				

Overview of Measures and Applicability

- As an air conditioning facility system incorporated into a building, it is a hybrid air conditioning system which combines three types of air conditioning systems, air current feeding by the ceiling fan, floor blow-out air conditioning as well as the natural ventilation.
- A ceiling fan generates gentle air current by stirring a large amount of wind with less electricity. It can realize a comfortable space at 28°C even in summer.



Expected CO2 Reducing Effect

- Air conditioning load can be reduced by making natural ventilation as the principal approach. Further CO2 reduction can be expected by employing a human sensor or an automatic light dimmer for making the best of daytime light along with natural ventilation.

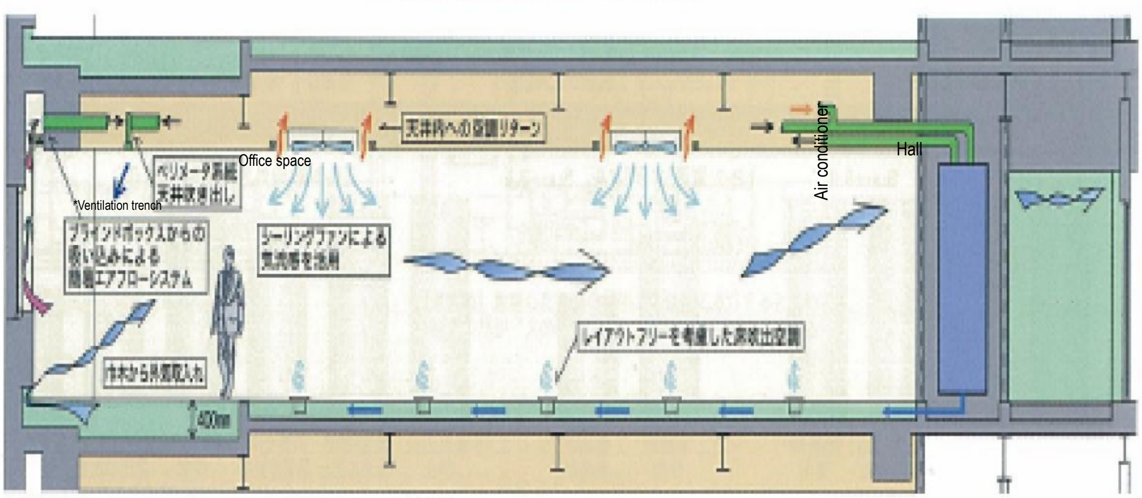
Examples of Application

Sakai Gas Building

Schematic Diagram of the System etc.

- Sakai Glass Building

- Hybrid AC ventilation system using natural ventilation and ceiling fans



Source) CASBEE Studies on Actual Examples, JSBC, 2005

(9) High-efficient heat source plus heat storage

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	**Building**	**High-efficient Facility systems**	**High-efficient heat source plus heat storage**				

Overview of Measures and Applicability

- In an intensive and high density district development on a large scale, a system of generating cold/hot water and steam at the central plant in the district and supplying them to individual buildings can better contribute to the realization of a low-carbon society by making the best of scale merit.
- The central plant in the district is divided into three categories.

1) Electricity system: a system of generating cold and hot water by using turbo chillers, heat pump chiller, etc.

2) Gas system: a system of generating cold water and steam by gas-absorption chillers or steam absorption chillers using the co-generated (CHP) steam exhaust heat.

3) Electricity/gas combination system: a system of generating cold water, steam (hot water) by combining 1) electric heat source and 2) gas heat source.

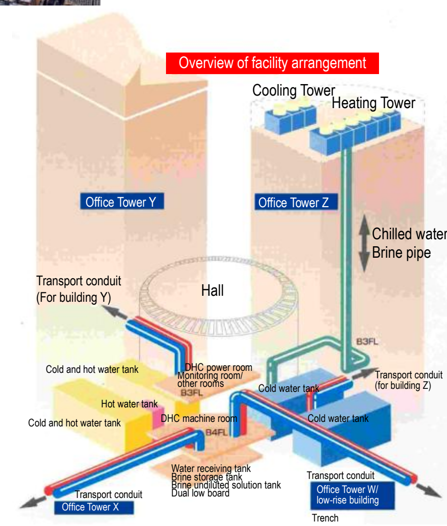
- There are systems which combine one of the above-mentioned systems with unused energies such as river water, sewage heat, exhaust heat from waste incineration plants, and so on.

Expected CO2 Reducing Effect

- The use of highly efficient district air conditioning and heating allows the reduction of air conditioning load, which is expected to reduce CO2 emission significantly.
- Furthermore, the reduction of CO2 emission in per unit can be expected by storing heat energy in thermal storage tanks with the use of night time electricity.

Examples of Application

Harumi Island, Triton Square

Schematic Diagram of the System etc.	
	• Harumi Island area   

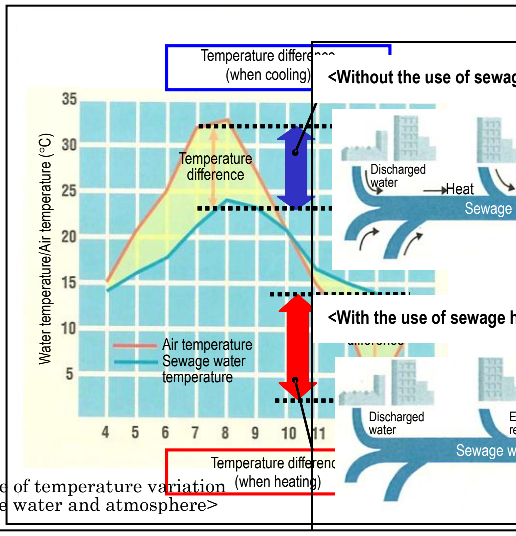
(10) Waste heat from sewage treatment plant

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Untapped energy		Using Waste heat from sewage treatment plant		H	M	L

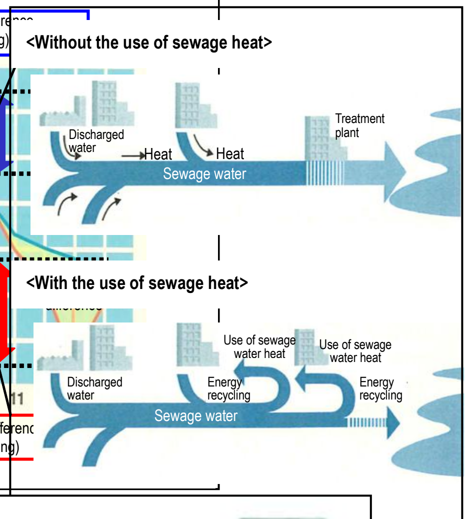
Overview of Measures and Applicability
• As sewage water temperature is lower in summer and higher in winter than the atmospheric temperature, it will contribute to improving energy efficiency both as a coolant of heat pumps used in heat source equipment for cooling and as a heat source water of heat pumps for heating/hot-water supply. • Using sewage water heat means the reuse of city waste heat, and it may be regarded as a recycling-oriented city energy system. • It is necessary to pay attention to the balance between the heat supply source and the heat load from cooling/heating as well as hot-water supply, considering such regional conditions as the amount of sewage water, daily/seasonal variations in temperature and interfusion of snow-melt water. In addition, as heat demand also varies in terms of time period and season, this variation should be reduced by installing heat storage tanks. • Moreover, it requires corrosion-resistant treatment of the related equipment based on the water quality, as well as strainers for removing foreign matters contained in the sewage water.
Expected CO2 Reducing Effect
• It is expected that CO2 will be reduced by means of improving energy efficiency in cooling/heating and hot-water supply in the relevant communities.

Examples of Application

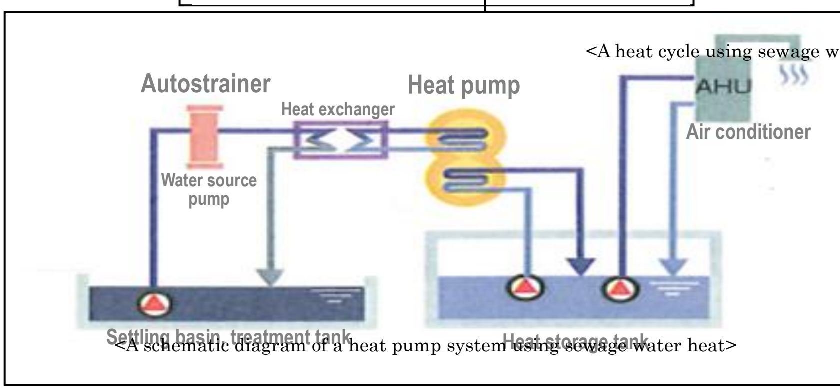
Schematic Diagram of the System etc.



<An image of temperature variation in sewage water and atmosphere>



<A heat cycle using sewage water heat>



<A schematic diagram of a heat pump system using sewage water heat>

(11) Hydroelectric power generation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Renewable energy		Hydroelectric power generation (Small and middle scale)		L	L	M

Overview of Measures and Applicability

- In principle, introduction of renewable energy power generation systems will lead to the reduction of carbon dioxide emissions etc. However, because of the fact that the cost and efficiency are dependent on such factors as the climate condition and administrative support measures in the relevant regions, and the generated amount of electricity is highly variable, it is a common practice to combine hydroelectric power with large-scale power generation and energy storage systems.
- Small and middle scale hydroelectric power generation generally makes use of water without storing it. Depending on the method of water use and the structure for gaining a head of water, several forms exist.
- Small and middle scale hydro power generation carries a heavy burden of electrical equipment costs. It takes a greater share of the total construction cost in comparison to large scale hydro power generation.
- In addition to the systems utilizing the nearby rivers, the cases can be assumed where hydroelectric power generation systems are installed as a form of agricultural drainage facility in farming villages.

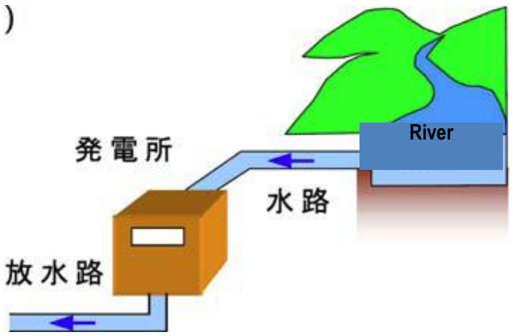
Expected CO2 Reducing Effect

- It is expected that CO2 will be reduced by means of increasing electricity generation from renewable source.

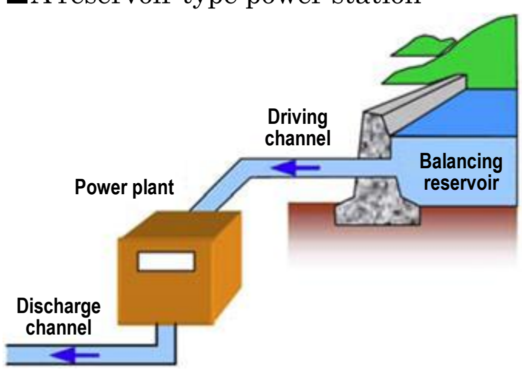
Examples of Application
Schematic Diagram of the System etc.

■A run-of-river type power station

)



■A reservoir type power station



ergy Technologies)

(12) Waste heat from incineration plants

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Untapped energy		Using Waste heat from incineration plants		H	M	M

Overview of Measures and Applicability

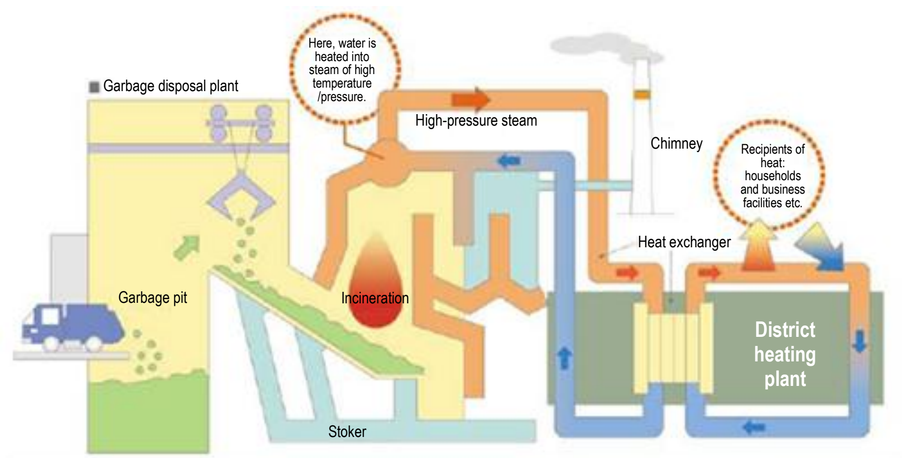
- The exhaust gas from refuse incineration at garbage disposal facilities has a high temperature and it can be utilized for power generation and as an infrastructure for heat supply.
- As garbage disposal facilities are often built away from residential areas, it is necessary to develop a sitting plan which facilitates heat use, on the basis of garbage disposal facilities as an infrastructure for energy supply.

Expected CO2 Reducing Effect

- It is expected that CO2 will be reduced by means of improving energy efficiency in each region through power generation from unused energy and utilization of surplus waste heat.

Examples of Application

Schematic Diagram of the System etc.



(13) Solar power generation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Renewable energy		Solar power generation	M	M	M	M

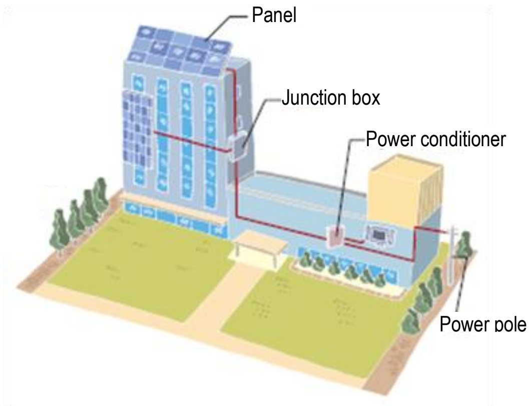
Overview of Measures and Applicability
• In principle, the cost and efficiency of renewable energy power generation depend on such factors as the climate condition and administrative support measures in the relevant regions. Since the generated amount of electricity is highly variable, it is a common practice to combine the renewable power generation systems with conventional power generation and energy storage systems. • Solar photovoltaic power generation is a collective term for technologies using semiconductors to convert light energy into electricity. Semiconductors (solar cells) can be classified into the types using multi-crystalline silicon, thin film silicon, chemical compound/organic etc. Solar power generation ranges from large-scale power generation systems to middle- and small-sized power generation systems for industry and household use. • Compared with other renewable energy power generation systems, this system has an advantage in terms of the ease of installation and maintenance, and no conditions for installation. On the other hand, it has the highest introduction cost per unit of electricity generated. • A certain amount of energy output can be expected where solar insolation is obtained, and this system has a wider applicability than solar heat power generation or wind power generation systems.

Expected CO2 Reducing Effect
• It is expected that CO2 will be reduced by means of improving energy efficiency in electricity/heat generation in the relevant communities.

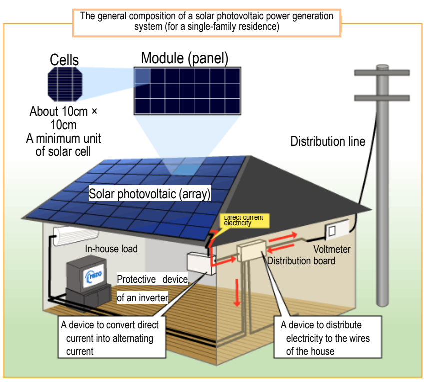
Examples of Application

Schematic Diagram of the System etc.

■A middle-sized power generation system



■A small-sized power generation system



(14) Solar heat

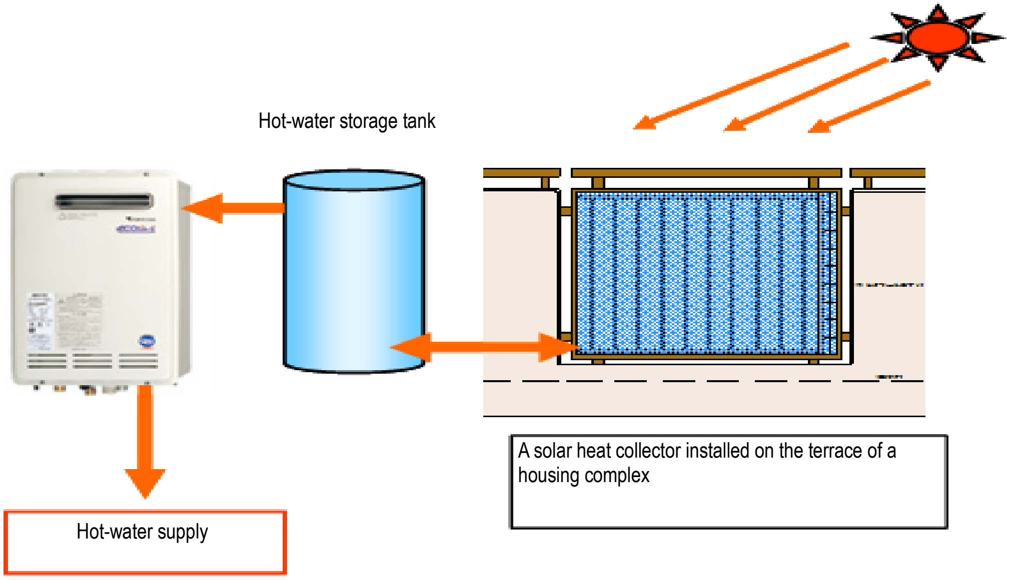
Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Renewable energy		Using Solar heat	M	M	M	M

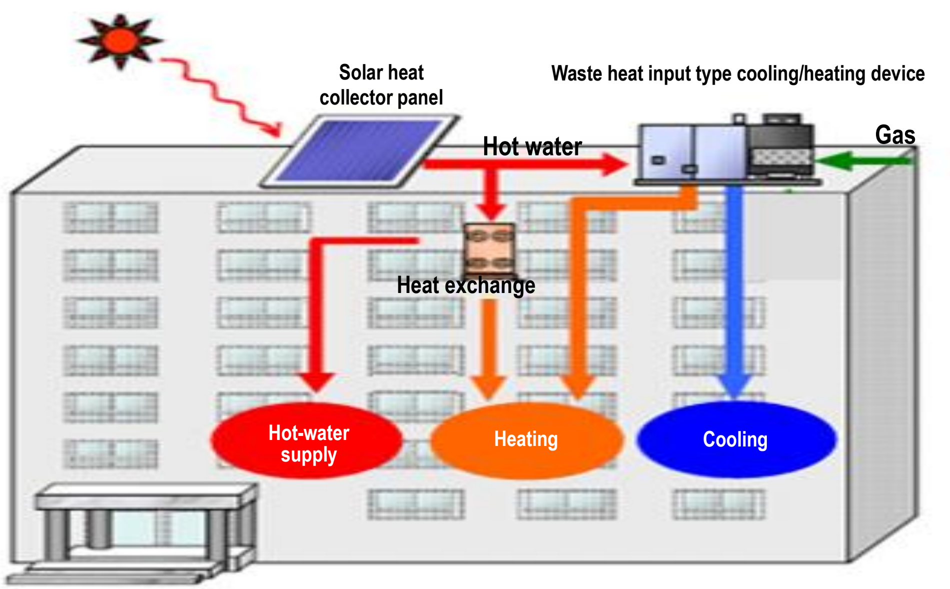
Overview of Measures and Applicability
• Utilizing the natural energy of solar heat for hot-water supply and cooling/ heating makes it possible to promote energy saving and CO_2 reduction in buildings. • Solar heat can be utilized for household and commercial use.

Expected CO2 Reducing Effect
• Yearly gas consumption and CO_2 emissions can be reduced by about 30% by using solar heat. (Based on an average household of three family members in a housing complex; a trial calculation for a solar heat system with a heat collection area of 3m^2, installed facing south.)

Examples of Application
A housing complex in Kawasaki, An office building in Kumagaya, Japan

Schematic Diagram of the System etc.
A combination of solar heat and gas hot-water heater systems (for household use)

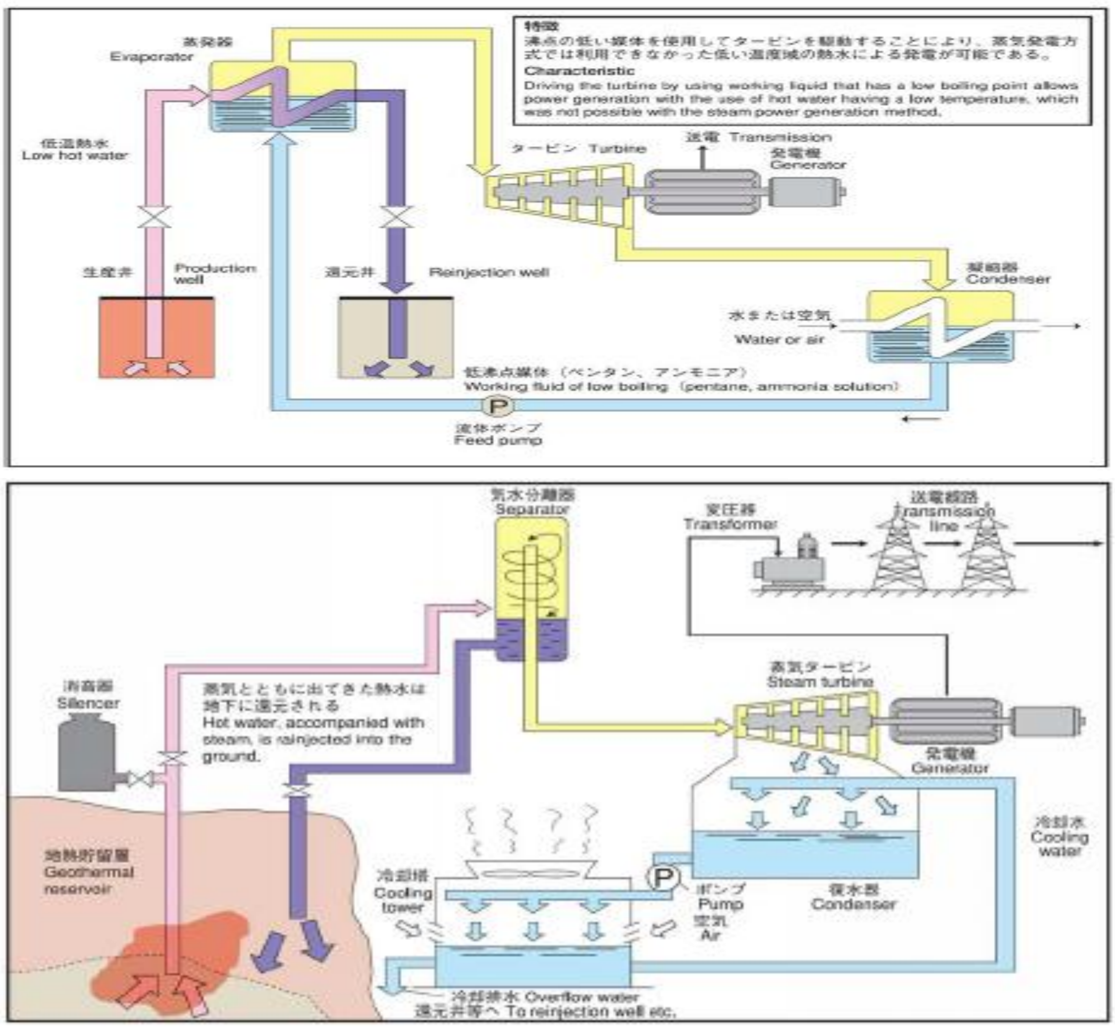




(15) Geo-thermal power generation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	**Renewable energy**		**Geo-thermal power generation**		**L**	**L**	**M**

Overview of Measures and Applicability
・Geo-thermal power generation is a collective term for power generation using geo-thermal energy. There are two different systems to convert thermal energy into electrical energy via steam turbines; a flash and binary system. ・Compared with other renewable energy generation systems, this system has an advantage in terms of energy stability, but it is necessary to take account of environmental risks (air pollution caused by releases of hydrogen sulfide etc.). ・The regions where this system can be applied are limited to those which can meet the criteria, namely, a specified amount of geo-thermal energy resource existing under the ground which can be developed at a reasonable cost.
Expected CO2 Reducing Effect
・It is expected that CO2 will be reduced by means of using clean energy for electricity/heat generation in the relevant communities.
Examples of Application

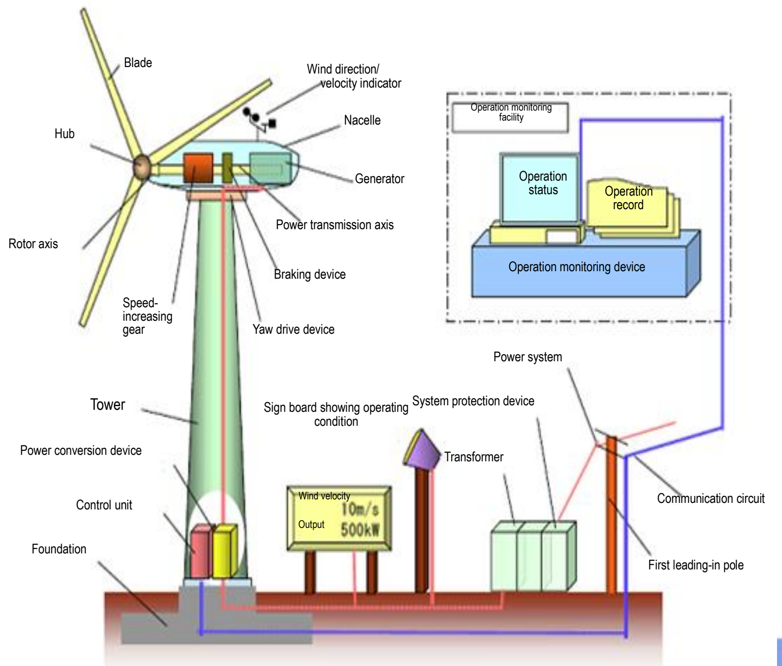
Schematic Diagram of the System etc.
■A geo-thermal power generation system (A binary system (upper) vs. a flush system (lower) – "White Paper on Renewable Energy", NEDO) 

(16) Wind power generation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	Renewable energy		Wind power generation		L	L	M

Overview of Measures and Applicability
• Wind power generation is a collective term for technologies used to generate electricity by means of capturing wind energy with rotor blades and transferring the rotational energy to generators. This power generating system has various types depending on the structure of blades and size, but it can be roughly classified into large-scale wind power generation linked to the grid and middle- or small-scale wind power generation intended to be used within each region. • Compared with other renewable energy generation systems, this system has an advantage in terms of low introduction cost per unit of electricity generated. On the other hand, it has a disadvantage of low energy efficiency in case of limited geographical conditions (dependent on wind conditions) or small-scale power generation. • As wind energy increases in proportion to the wind velocity, it is highly probable that this system can be applied in regions with favorable wind conditions.

Expected CO2 Reducing Effect
• It is expected that CO2 will be reduced by means of using clean energy in electricity generation in the relevant communities.

Examples of Application	
Schematic Diagram of the System etc.	
	■A wind power generation system (NEDO - "White Paper on Renewable Energy") 

(17) Biomass Power Generation

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication			I	II	III	IV
Supply Side	Renewable Energy		Biomass Power Generation		L	L	M

Overview of Measures and Applicability

- Biomass power generation is a collective term for power generation technologies using biomass (animal/plant resources and organic wastes from these resources) for direct incineration, heat decomposition, fermentation etc. The form of biomass can be roughly classified into unused resources (forest resources, agricultural residues etc.), waste resources (building materials, paper manufacturing materials, livestock manure, food residues etc.) and production resources (pasture grass, water plant, vegetable oil etc.).
- Suitable locations vary with the type of resources because biomass needs stable supply.

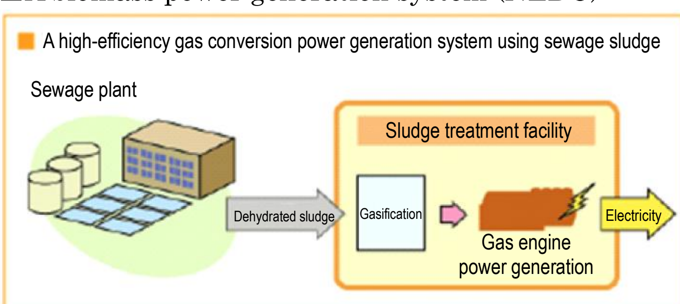
Expected CO2 Reducing Effect

- CO2 will be reduced through renewable power generation.

Examples of Application

Schematic Diagram of the System etc.

■A biomass power generation system (NEDO)



(18) Fuel cell

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	**Buildings**	**Equipment installed At facilities**	**Fuel cell**	**H**	**H**	**M**	**M**

Overview of Measures and Applicability

- Electricity is generated by hydrogen taken out of natural gas, methanol, etc. and oxygen from air, while the heat concurrently generated is collected as steam or hot water. This is a highly efficient power generation because electricity is generated directly from hydrogen using an electrochemical reaction.
- Fuel cell can be used for various uses and systems with different scales.
- It also contributes to the reduction of peak time power consumption and the improvement of energy security.

Expected CO2 Reducing Effect

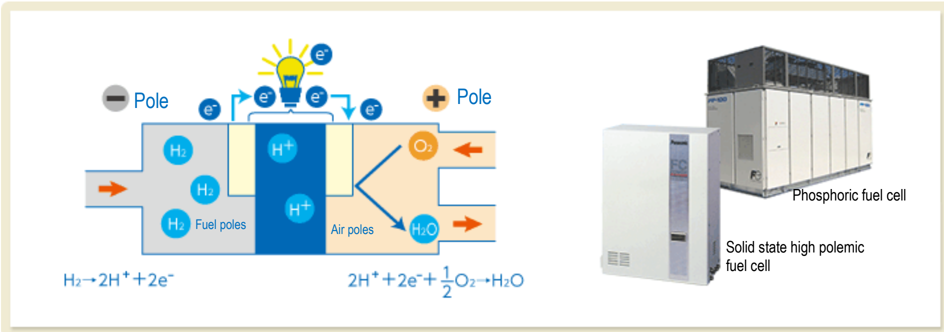
- Because power is generated as hydrogen and oxygen react to each other, water is the only substance that is formed. Although carbon dioxide (CO2) is generated while hydrogen is being produced, its generated amount is less while using the identical volume of electricity and heat, thanks to the high overall efficiency.
- For an ordinary household of four people living in a house, CO2 can be reduced by approximately 40% per year compared to the conventional system (thermal power generation +boiler).

Examples of Application

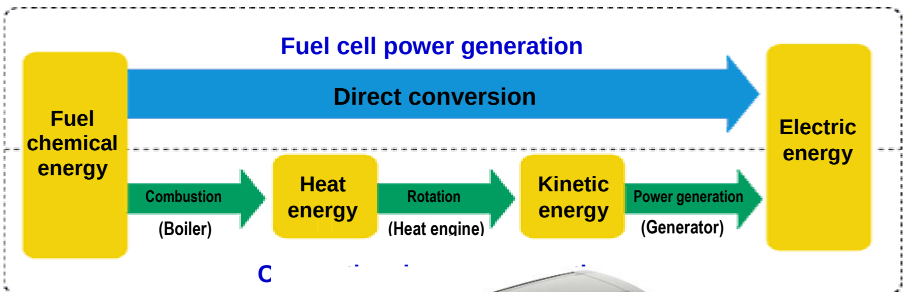
- For buildings, automobiles, personal computers, etc.

Schematic Diagram of the System etc.

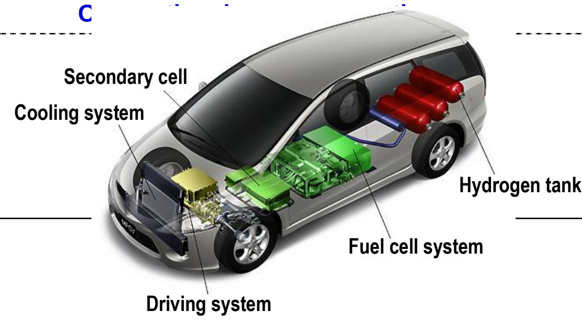
●Fuel cell system



●Power generation with fuel cell



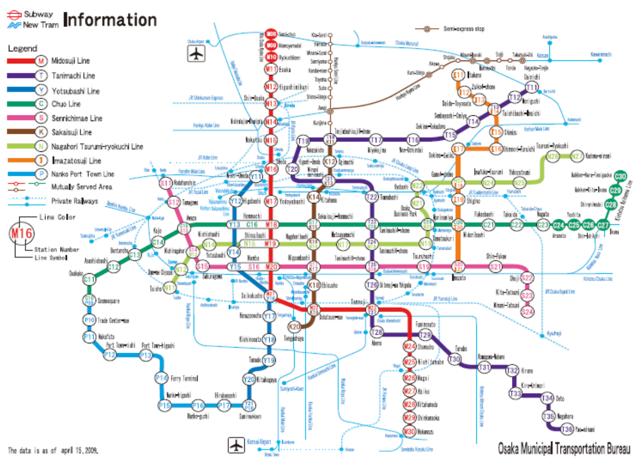
●Fuel cell cars



(19) Transportation (Establishment of public transportation network)

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Demand	**Transportation system**	**Public transportation systems**	**Well developed Public Transportation Network**	**M**	**M**	**M**	**X**
Overview of Measures and Applicability							
• There are a variety of public transportation systems in cities. Typical transportation systems are subways, LRT, BRT, route buses, etc. • By establishing a public transportation network which combines optimal public transportation systems based on the city size and the demand for transportation, low carbon urban life and sustainable cities must be realized through the use of public transportation with less CO2 emission.							
Expected CO2 Reducing Effect							
• As people use public transportation systems which emit less CO2 than automobiles do, its development contributes to curbing the amount of CO2 emission in cities.							
Examples of Application							
• There are a number of examples of well developed public transportation network in cities in the APEC region.							

Schematic Diagram of the System etc.



Subway network of Osaka City, Japan

(BRT) (UMRT)

(BUS) (LRT)

(20) Local Transportation System (Bus, LRT, etc.)

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi- fication	Minor Classi- fication		I	II	III	IV
Demand	**Transportation system**	**Public Transportation System (Bus, LRT)**	**Intra-district Transportation system**	**H**	**H**	**H**	**L**

Overview of Measures and Applicability

- The LRT, BRT, and buses are the public transportation systems that offer services in a part of city area such as CBD (Central Business District). The establishment of those systems would serve to improve convenience for the people who travel in the area.
- Although the carrying capacity is smaller than that of mass transportation systems such as subways, they can be established with less cost and the distance between stops can be set shorter as well, compared to subways.

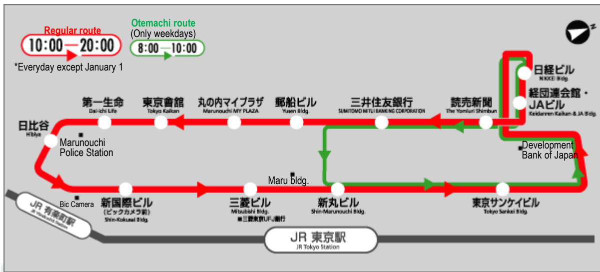
Expected CO2 Reducing Effect

- As traveling by local public transportation becomes more convenient, people begin to use public transportation systems which emit less CO2 compared to cars. Therefore these measures are effective in curbing the amount of CO2 emission from inside cities.

Examples of Application

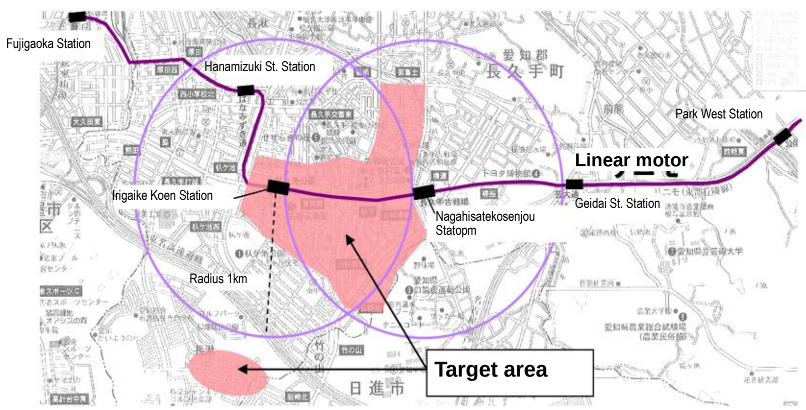
- There are a number of examples in cities in the APEC region.

Schematic Diagram of the System etc.



(http://www.hinomaru.co.jp/metrolink/marunouchi/index.html)

FigBus Service Route & Vhechles in Tokyo CBD (Marunouchi)



http://www.linimo.jp/sonota/index.html#02

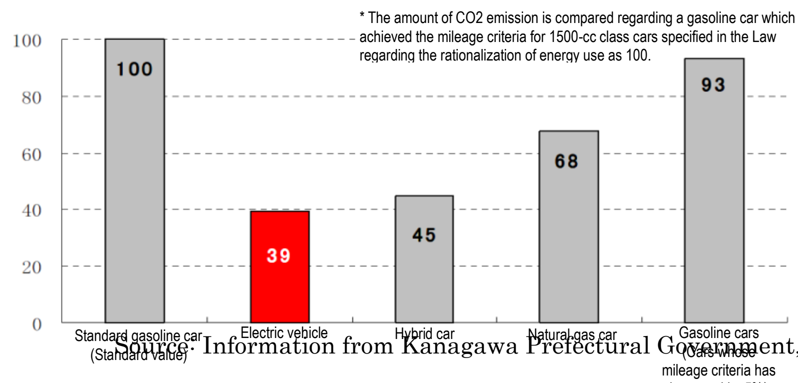
Fig　Light Rail System(Linimo) in Nagoya,Japan

(21) Electric Vehicle

<table>
<tr><th colspan="3">Classification of Measures</th><th rowspan="2">Low Carbon Measure</th><th colspan="4">Applicability as per Type of Town</th></tr>
<tr><th>Supply/ Demand</th><th>Major Classi-fication</th><th>Minor Classi-fication</th><th>I</th><th>II</th><th>III</th><th>IV</th></tr>
<tr><td>Demand Side</td><td>Transportation system</td><td>Vehicles</td><td>Electric Vehicle (EV)</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
<tr><th colspan="8">Overview of Measures and Applicability</th></tr>
<tr><td colspan="8">• The wide use of electric vehicles will be promoted through improving the environment for the usage such as installing fast-chargers, and public relations activity for the EVs environmental performance over conventional cars, etc.</td></tr>
<tr><th colspan="8">Expected CO2 Reducing Effect</th></tr>
<tr><td colspan="8">• EVs don't run on fossil fuel such as gasoline unlike existing automobiles, and therefore, they serve to reduce the amount of CO_2 emission from traffic.</td></tr>
<tr><th colspan="8">Examples of Application</th></tr>
<tr><td colspan="8">• Introduction of EVs has already started in some economies in the APEC, even though it is in a small scale and for the experimental purposes. Recently, commercial production of EV has started for the use of general public.</td></tr>
</table>

Schematic Diagram of the System etc.

Electric Vel



Source: Information from Kanagawa Prefectural Government, Japan

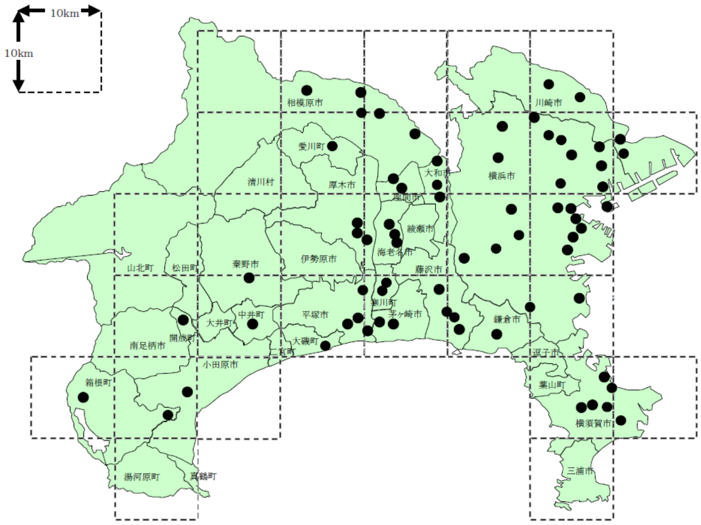
Comparison of CO_2 emission between gasoline cars and EVs
(Comparison of 1500cc-class vehicles)

(22) Fast charger, Small-size storage battery

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Demand	Transportation system	EV-related hardware	Fast charger, Small-size storage battery	M	M	M	M

Overview of Measures and Applicability
• Fast chargers for electric vehicles will be installed taking their usage scenes and driving ranges into account. • The introduction of fast chargers will be promoted by grasping business opportunities such as city redevelopment projects, etc.
Expected CO2 Reducing Effect
• Compared to gasoline cars, the driving range of EVs is limited (approximately 160km with one full-charge), which exerts a significant influence on the sales of EVs. As fast chargers spread and small-size storage batteries are improved, the diffusion of EV will be boosted, which will, in turn, contribute to the reduction of CO2 emission from traffic.
Examples of Application
• Installation has already started at parking lots, gasoline stations, and shopping malls, etc.

Schematic Diagram of the System, etc.



overnment

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(23) Community Cycle Sharing

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Demand side	**Transportation system**	**Public transportation systems**	**Community Cycle Sharing**	**H**	**H**	**H**	**L**

Overview of Measures and Applicability

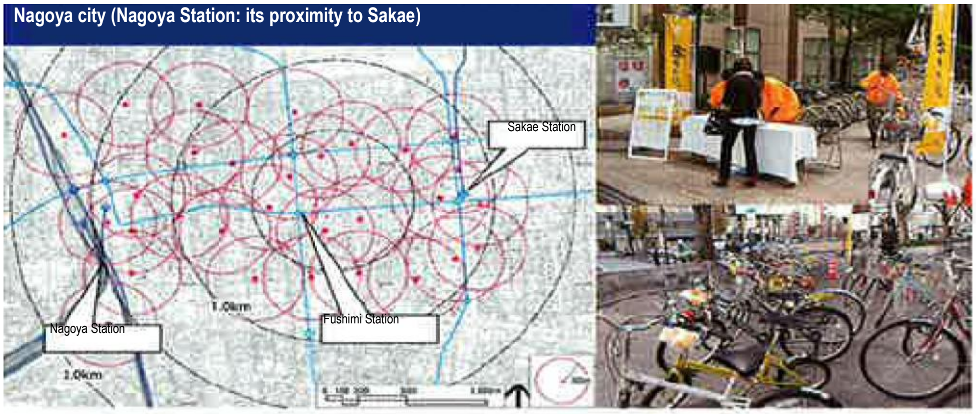
- The community cycle or bike-sharing (hereinafter, the CCS) refers to a system of sharing bicycles where users can pick-drop a bicycle at their convenience. This system aims at improving the use of bicycles as an alternative to cars, and addressing the problems of illegal parking or abandoned bicycles.
- By installing CCS ports mainly around railroad stations and public facilities, this system is expected to take effects in making up for the unavailability of public transportation infrastructure and improving accessibility.

Expected CO2 Reducing Effect

With respect to the NUBIJA (the CCS of Changwon city, South Korea), about 45% of users in their 30s and older have reportedly switched from cars to bicycles for commuting, after one year of the CCS introduction (source: NUBIJA HP). The appropriately introduced CCS will prompt people to switch from automobiles to bicycles, and it is expected to take effect in reducing CO2 emission in the transportation sector.

Examples of Application

The CCS ports will be installed at railroad stations, public facilities, parks, commercial facilities, office buildings, apartment complexes, and so on. Users can pick-drop a bicycle freely. Registration required. IC cards will be introduced for payment.

Schematic Diagram of the System etc.
 (Source: [illegible] Report, City and Transportation, Japan Transportation Planning Association、2011)

(24) Garbage

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Supply side	**Renewable energy**		**Biogas injection into City gas combustion**				

Overview of Measures and Applicability

- Excessive biogas generated from sewage sludge or food waste, etc. is put to an effective onsite use as the fuel for power generation or automobiles. If generated biogas or electricity still remains after onsite use, it would be possible to supply energy (biogas, co-generation power) to outside.
- Not only these measures contribute to energy conservation and CO2 reduction, but also they help make the best use of and recycle the local biogas resources, such as sewage sludge or kitchen garbage, for a long-term in a stable manner. .

Expected CO2 Reducing Effect

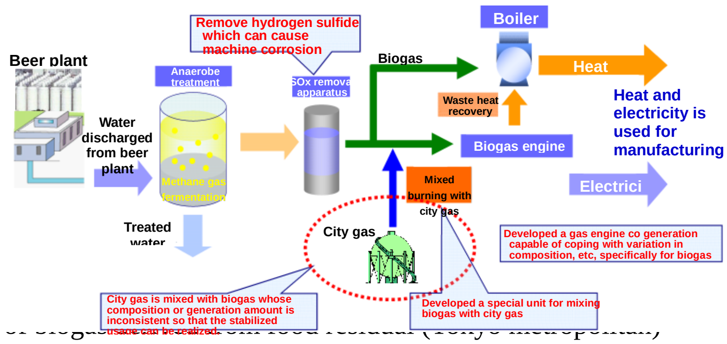
- CO2 can be drastically reduced by using carbon-neutral biogas.
- (Example) Injection of biogas into city gas conduits: Approx. 1,830 tons/year
- (outlined in below: case example of Tokyo metropolitan)

Examples of Application (In Japan)

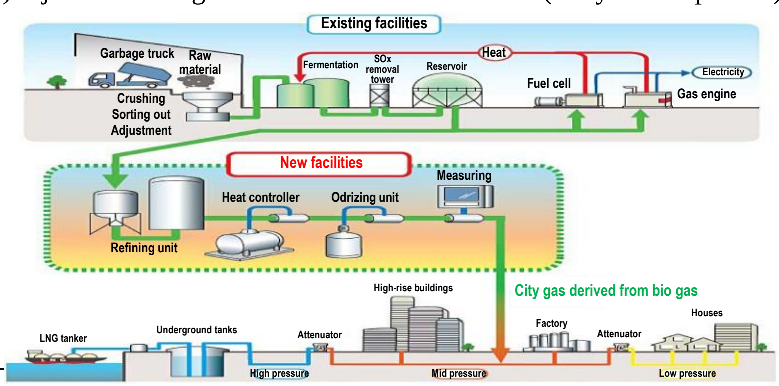
- Biogas generation… Tokyo metropolitan, Yokohama city, etc. (About 30 sewage treatment facilities, etc.)
- Biogas automobiles… Kobe city, Ueda city
- Injection of biogas into city gas conduits … Kobe city, Tokyo metropolitan

Schematic Diagram of the System etc.

(1) Example of onsite biogas use (Beer plant)



(2) Injection



(25)Smart Grid

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classification	Minor Classification		I	II	III	IV
Supply/ Demand	**Electric Power System**	**Smart Grid**	**Smart Grid**	**H**	**H**	**H**	**H**

Overview of Measures and Applicability

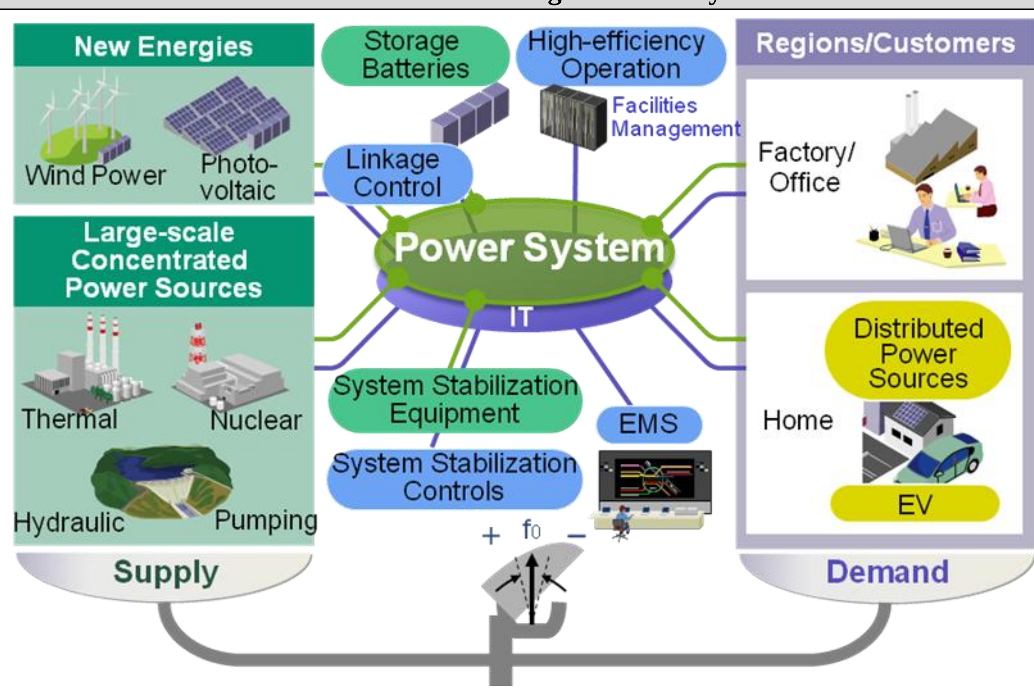
- The supply side of electricity comprises large-scale power station and renewable energy sources such as wind and solar, which are unstable in nature. The demand side is equiped with solar cells and electric vehicle which act as distributed power sources, and the consumers are linked to the electricity supply system with the options on the selection of energy consumption structures.
- The electricity system is equiped with power stabilization facilities, which balance the demand and supply on the realtime basis to maitain the high quality of electricity supply.

Expected CO2 Reducing Effect

- Expansion of the use of the renewable energy sources and distributed power supply through the system stabilization control
- Reduction of the overall emission of CO2 from electric power generation

Examples of Application (In Japan)

Schematic Diagram of the System etc.



(26)

Classification of Measures			Low Carbon Measure	Applicability as per Type of Town			
Supply/ Demand	Major Classi-fication	Minor Classi-fication		I	II	III	IV
Demand	**Energy Management System**	**Community Energy Management System (CEMS)**	**Community Energy Management System (CEMS)**	**H**	**H**	**H**	**H**

Overview of Measures and Applicability

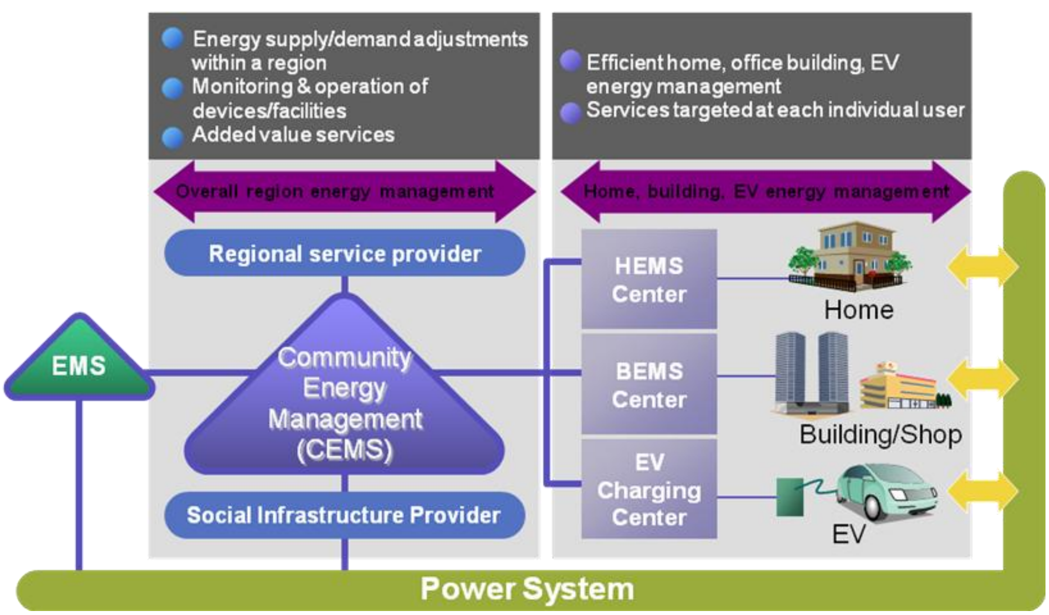
- Community energy management system (CEMS) collects information from the demand-side energy management systems such as home energy management systems and building energy management systems, in a neighborhood, and optimizes the use of energy in the neighborhood.
- CEMS also provide the supply side of electricity with such information as the configuration and state of devices and facilities in the neighborhood.

Expected CO2 Reducing Effect

- Reduction of CO_2 emission in a neighborhood
- Reduction of CO_2 emission from the concentrated power supply through the total optimization of energy consumption in a neighborhood

Examples of Application (In Japan)

Schematic Diagram of the System etc.



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