Asia-Pacific
Economic Cooperation

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

Acknowledgement

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.

We would like to thank members of TF Japan; Dr. Shinji Yamamura, Dr. Ken Kodama, Mr. Tadashi Takimoto, Mr. Michinaga Kohno, Mr.Yasue Furuta and Mr. Junichi Ogasawara.

We would also thank members of Study Group A for LCMT, who provided invaluable comments to the draft report as well as participating in the site visits for the Concept development which were conducted in the cities where low carbon town development is being planned; Mr. Meng Xu (China), Ir. Eko Budi Santoso (Indonesia), Ms. Punitha Silivarajoo (Malaysia), Ms. Lilian Fernandez (Philippine), Ms. Hershey T. dela Cruz (Philippine), Ms. Caroline Quitaleg (Philippine), Dr. Twarath Sutabutr (Thailand), Dr. Sorawit Nunt-Jaruwong (Thailand), Mr. Do Thanh Vinh (Viet Nam) and Dr. Yie-Zu Robert HU (Chinese Taipei)

Special thanks go to members of LCMT Task Force for their thoughtful advice, especially Dr. Ken Church (Canada), who provided invaluable input to the draft report.

This report benefited from the insight described in the report titled “Low Carbon City Development Guidance” prepared by Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan.

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 ways 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.

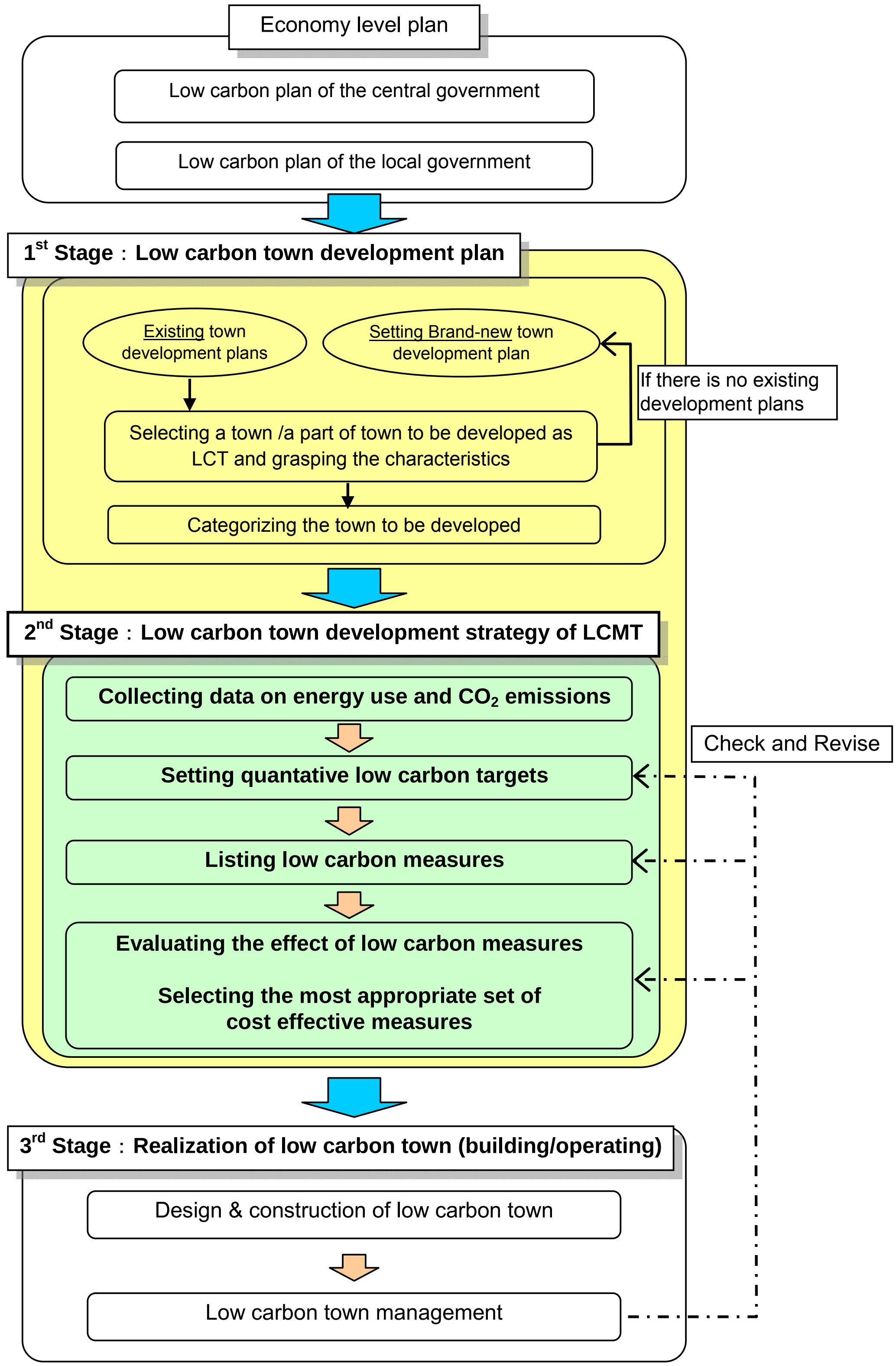


Figure 1 Procedure of overall planning to develop the low carbon town

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>

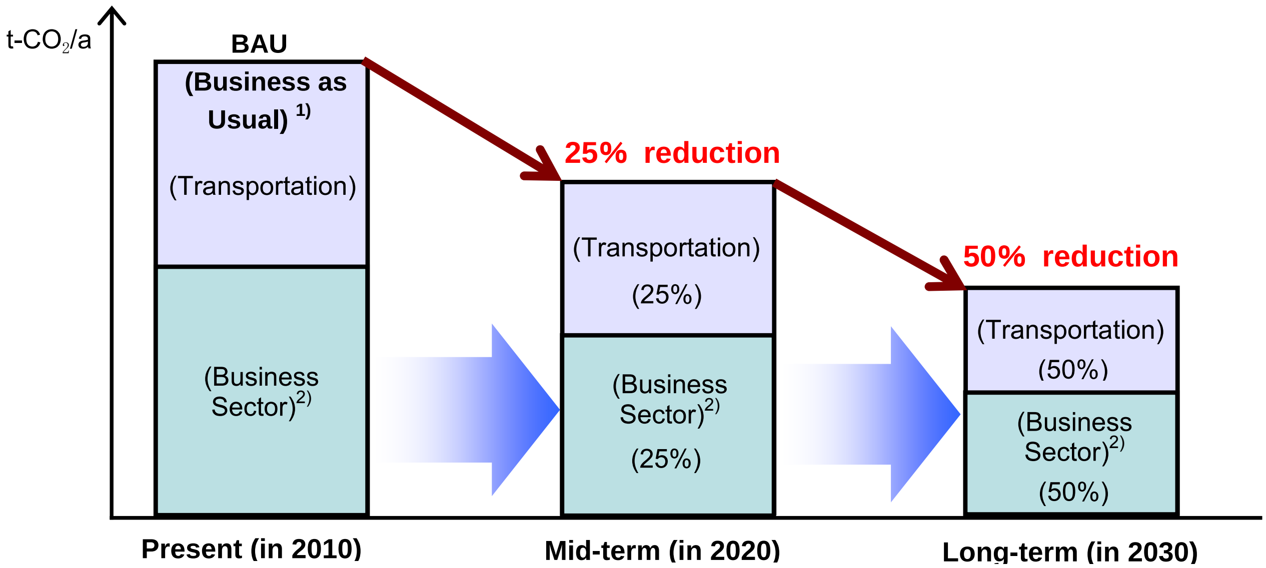
Developing and implementing efficient transportation policies and programs will require more rigorous collection, analysis, and dissemination of both quantitative and qualitative transport data. The following resources deal with the selection of indicators of sustainable transportation planning.

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 under the assumption that the development will be carried out without employing any low carbon measures.



1) Standard type buildings without low carbonized
2) Business sector includes the reduction effects in terms of buildings, district energy, unused /renewable energy etc.

Figure 2 Example of CO_2 reduction target

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.

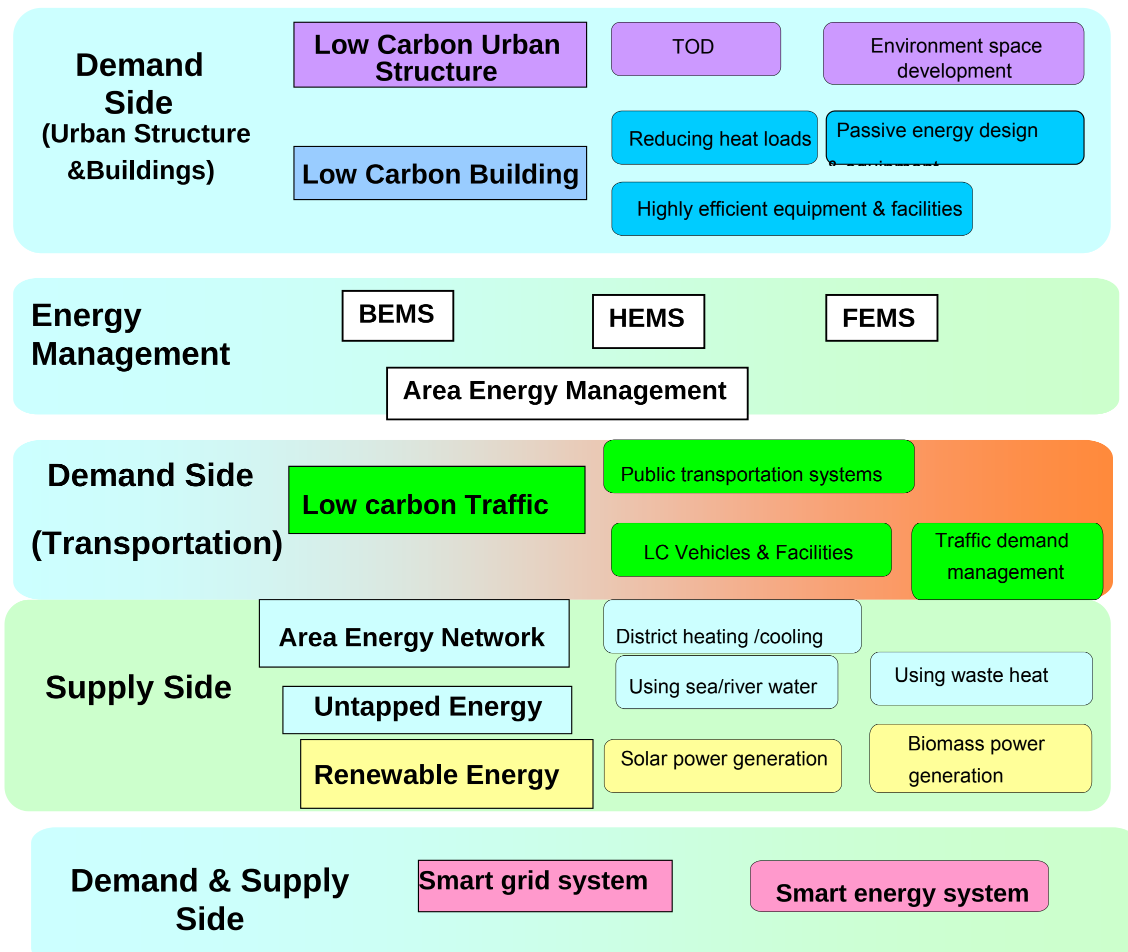


Figure 3 Overview of low carbon measures

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..

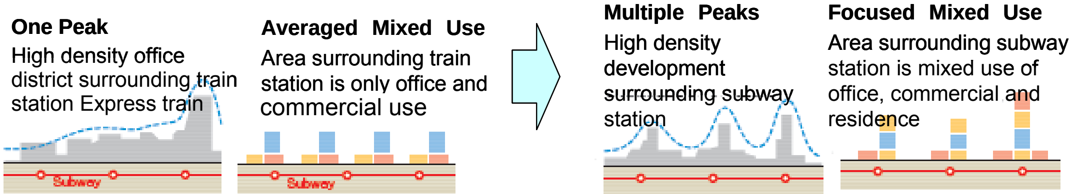


Figure 4 Image of high density development surrounding train stations

TOD Examples

Creating a plan - New Zealand Transport Strategy: http://www.transport.govt.nz/ourwork/Contents-NewZealandTransportStrategy/

Transit 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, namely, evaluating the measures which will reduce the energy load of the building.

ii) 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.

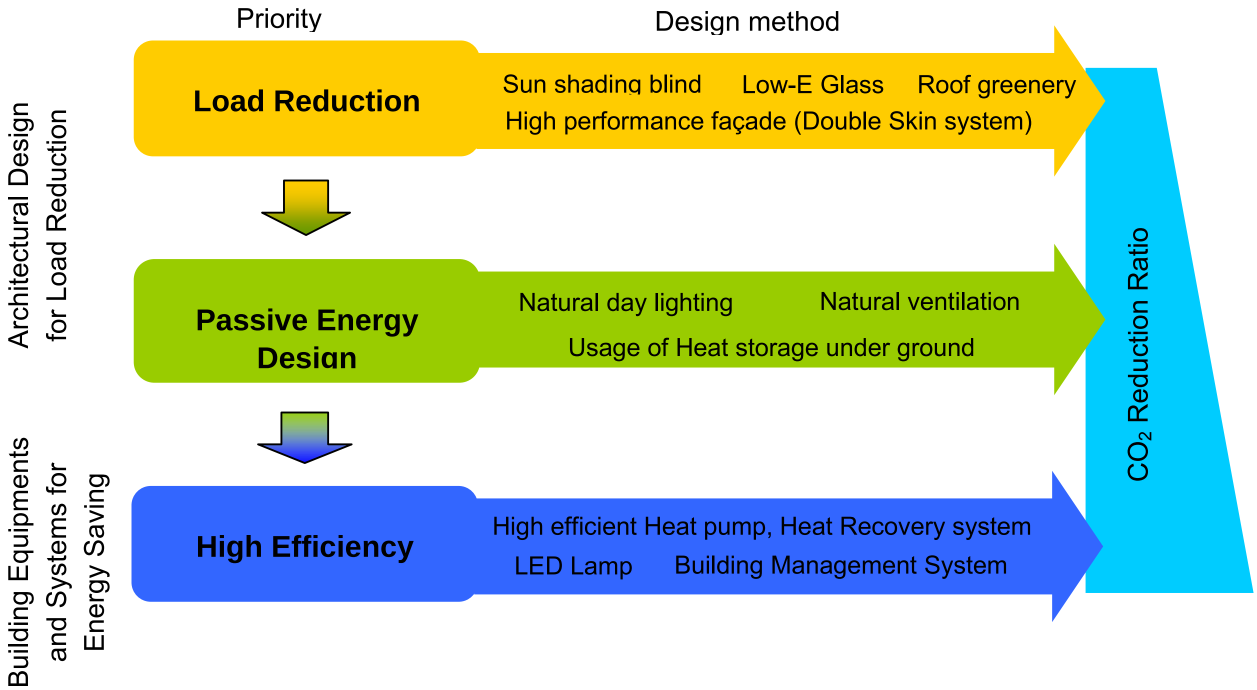


Figure 5 Schematic design flow of low carbon building

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 insignificant 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 developing more fuel efficient engines

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.

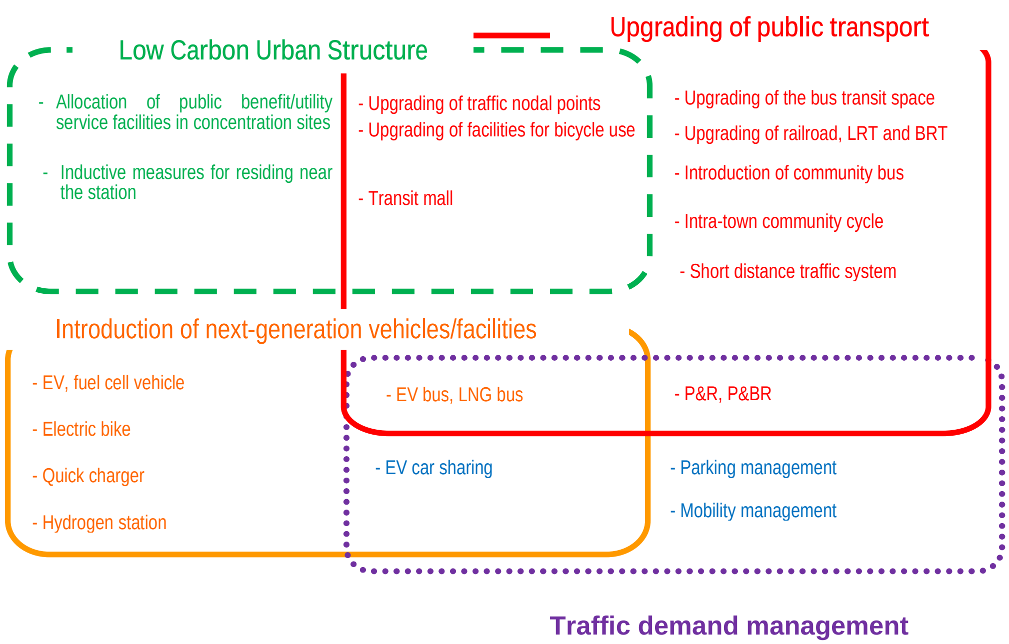


Figure 6 Combination of low carbon traffic measures

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.

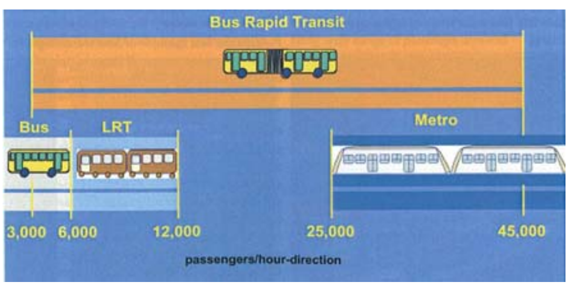


Figure 7 Transportation capacity by traffic mode

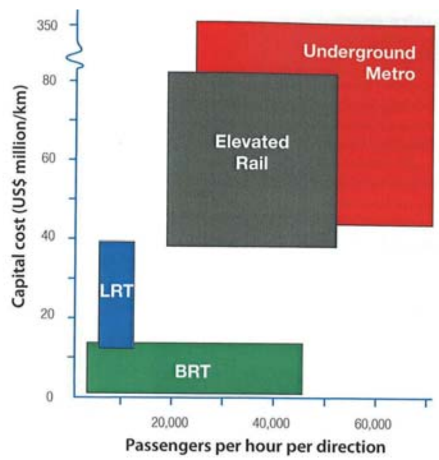


Figure 8 Transportation capacity and capital cost

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
- Efficient operation (e.g., through utilization of information technology--see box below)

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.

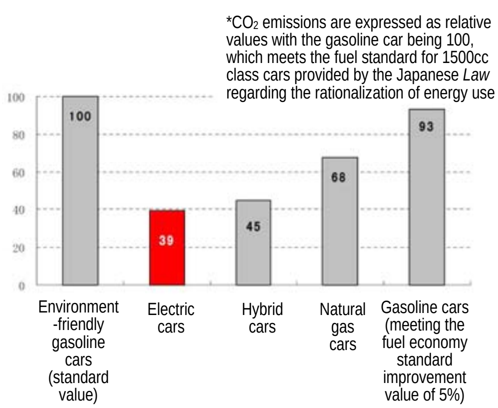


Figure 9 Comparison of CO_2 emissions by type of vehicle

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

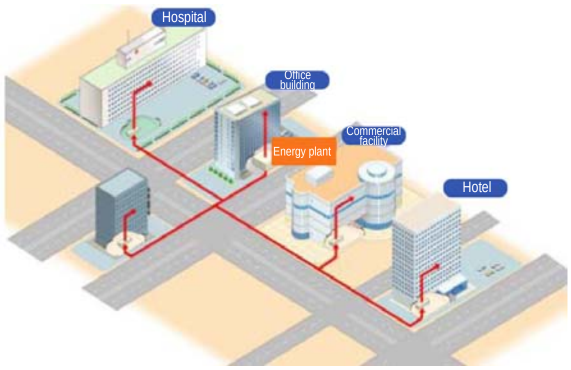
This section provides an overview of measures to reduce CO2 emission on the energy supply side of low carbon town development.

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



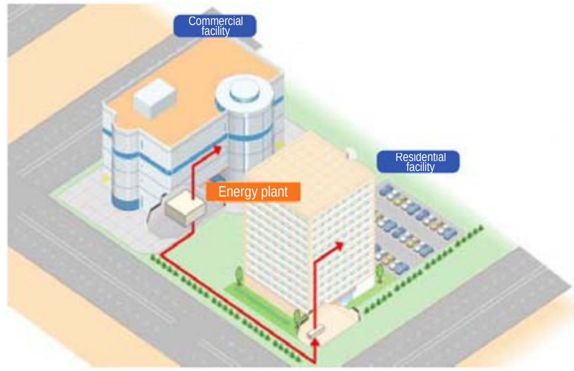


Figure 10 District heating/cooling systems (DHC)   Figure 11 Point heating/cooling systems

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.

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 create 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.

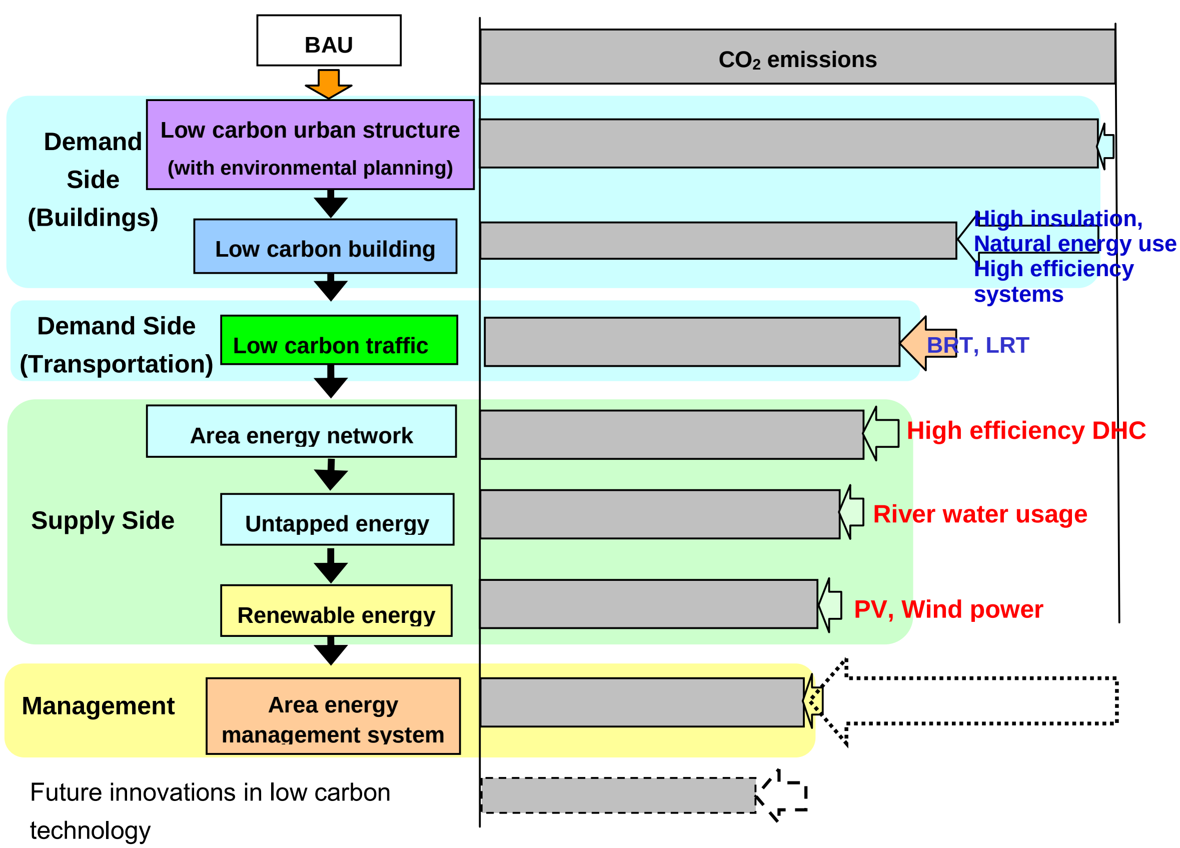


Figure 12 Hierarchy approach for assessing effectiveness of low carbon measures

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.

$$CO_2 \text{ Emission} = \boxed{\text{Total floor area of buildings by use}} \times \boxed{CO_2 \text{ emission intensity of buildings by use}} \times \boxed{(1 - \text{Overall } CO_2 \text{ reduction rate})}$$

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)

$$CO_2 \text{ emission} = \text{Traffic volume} \times \text{Distance traveled} \times \text{Emission intensity}$$

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 district.

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 solar photovoltaic etc.

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.

The key to effective choice of measures and implementation and monitoring is data. 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 With Their Applicability

Appendix 1: Low Carbon Measures Along With 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 and cooling			H	M	L
	Untapped energy	Using sea/river water			H	M	L
		Using waste heat such as waste incineration plants			H	M	M
		Using waste heat such as sewage treatment plants			H	M	L
		Using waste heat from factories		M	M	M	X
	Renewable energy	Solar power generation		M	M	M	M
		Using 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	Greenery network	H	H	H	M
			Underground spaces connecting each other	M	L	X	X
	Buildings	Reducing heat load		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,	H	H	H	H

			recycling resources				
			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	Quick 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