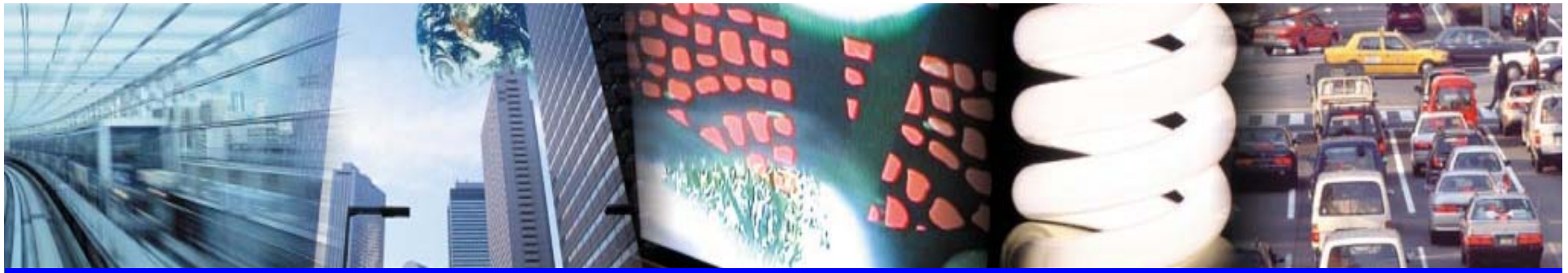


The Concept of the Low Carbon Town in the APEC (2nd Part)

Low Carbon Model Town Workshop

Kaohsiung, Chinese Taipei 18 October 2011

Michinaga Kohno

APEC LCMT Taskforce

Taskforce Japan for Study Group (A)

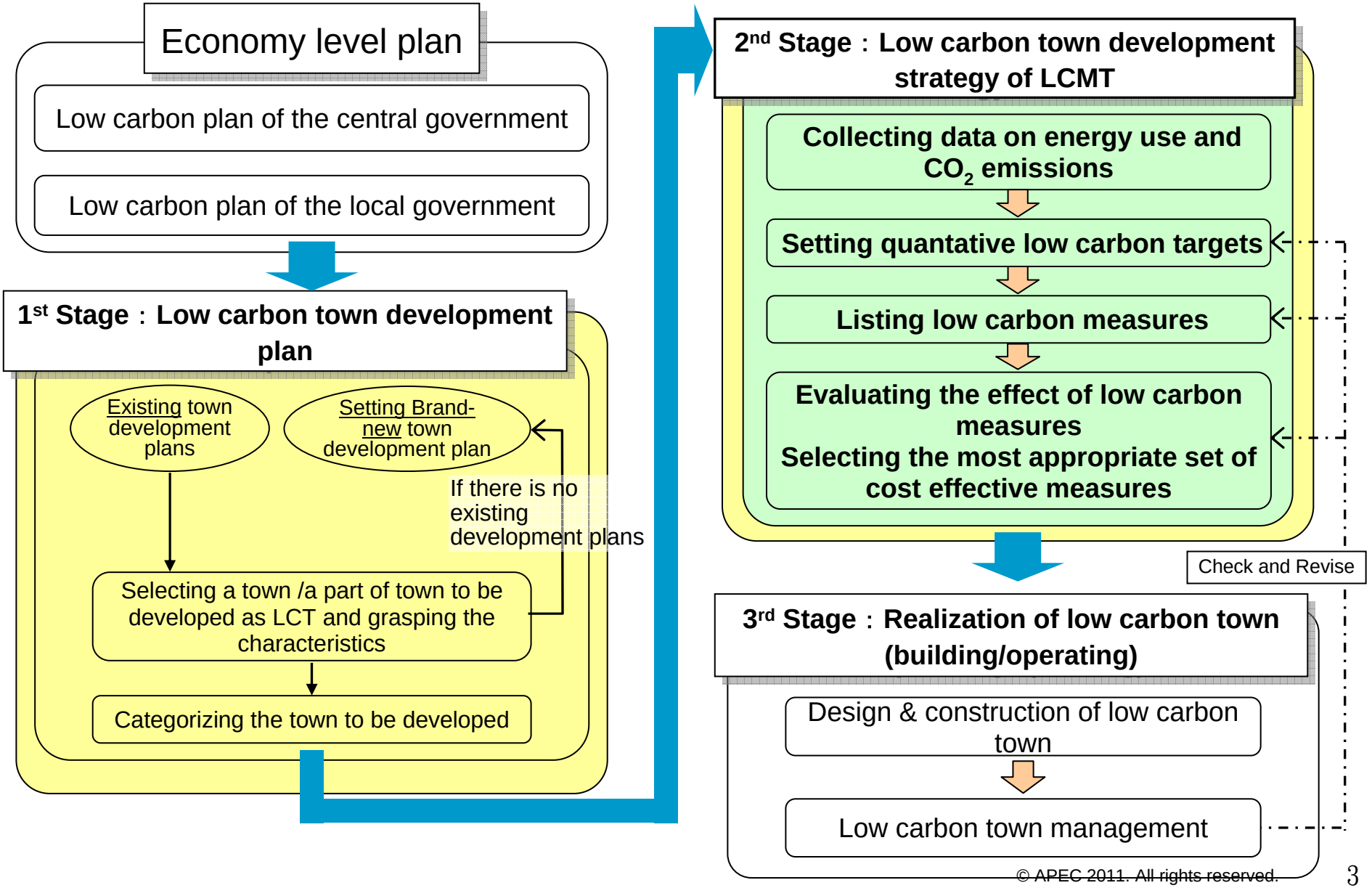
[Hitachi, Ltd.]

Asia-Pacific Economic Cooperation

0 Contents of the guideline

1 Basic Approach to Developing LCT

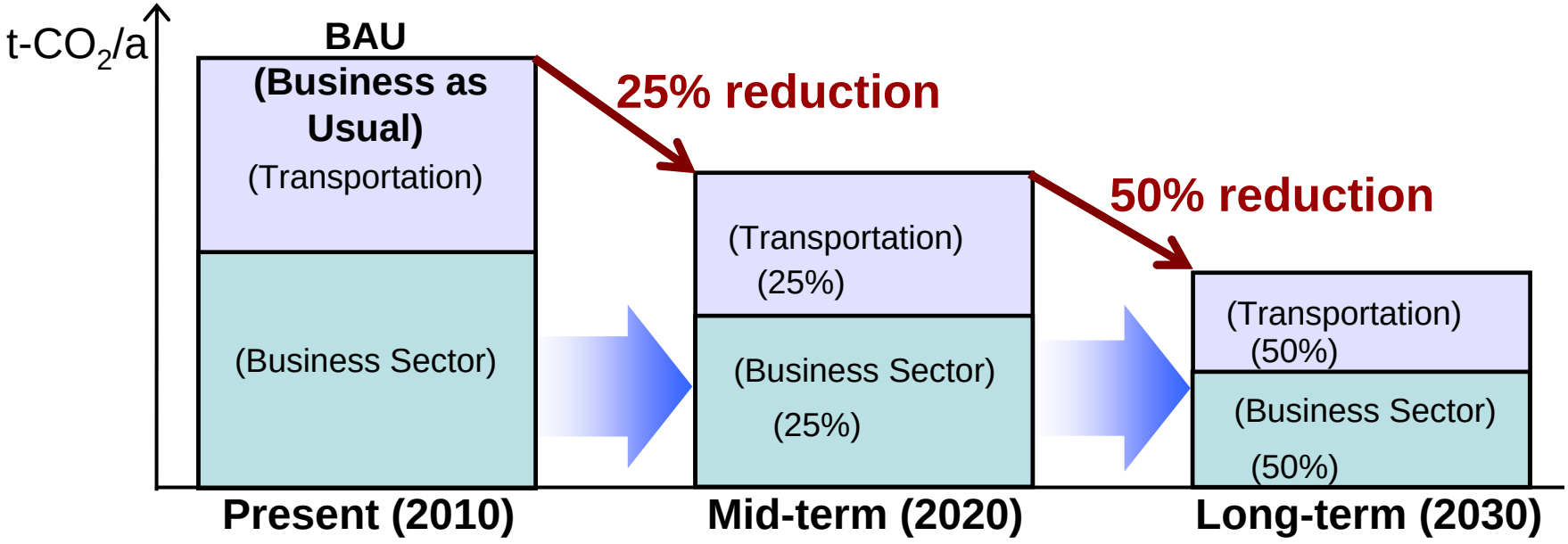
1.1 Overall planning for development of a LCT



1.2 Setting quantitative low carbon targets

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



2.0 Setting quantitative low carbon targets

Low carbon measures can be categorized under the following headings.

1. Urban structure
2. Buildings
3. Energy management systems
4. Transportation
5. Area energy network
6. Untapped energy
7. Renewable energy
8. Smart grid system and others

2.0 Setting quantitative low carbon targets

Demand Side

(Urban Structure & Building)

- Low Carbon Urban Structure
- TOD
- Environment space development
- Reducing heat loads
- Passive energy design & equipment
- Low Carbon Building
- Highly efficient equipment & facilities

Energy Management

- BEMS
- HEMS
- FEMS
- Area Energy Management System

Demand Side (Transportation)

- Low carbon Traffic
- Public transportation systems
- LC Vehicles & Facilities
- Traffic demand management

Supply Side

- Area Energy Network
- District heating /cooling
- Using waste heat
- Untapped Energy
- Using sea/river water
- Biomass power generation
- Renewable Energy
- Solar power generation

Demand & Supply Side

- Smart grid system
- Smart energy system

Urban structure | Buildings | Energy management systems | Transportation

Area energy network | Untapped energy | Renewable energy | Smart grid system and others

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 Energy management systems.

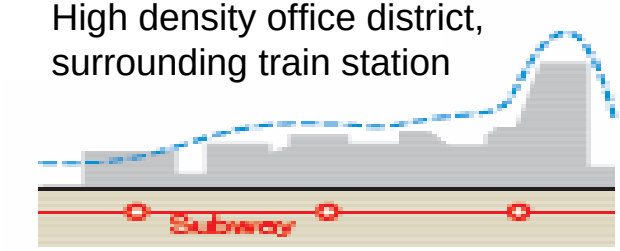
1. Build a less CO_2 emitting town area by improving the land use around the stations of the public transportation systems, as well as through systematic development of commercial, public, and residential areas.
2. Build a town area whose transit is based on walking, bicycle, bus, etc. without depending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

2.1 Measures on the energy demand side

2-1-1 Low carbon urban structures (TOD type land use)

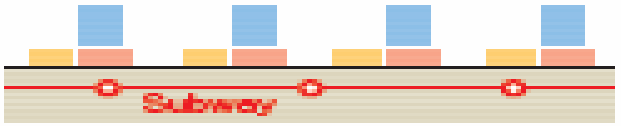
One Peak

High density office district, surrounding train station



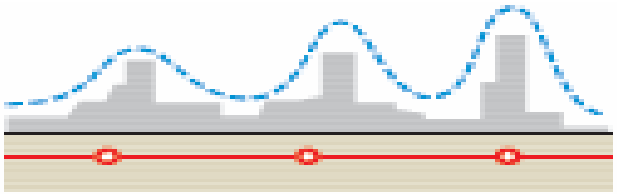
Averaged mixed use

Area surrounding train station is only for office and commercial use.



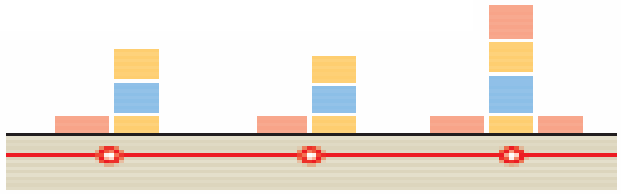
Multiple peaks

High density development, surrounding subway stations



Focused mixed use

Areas surrounding subway are for mixed use of offices, commercial and residential.



2-1-2 Low carbon building (1)

- Three steps to evaluate the effects of low carbon building measures:

1. 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.

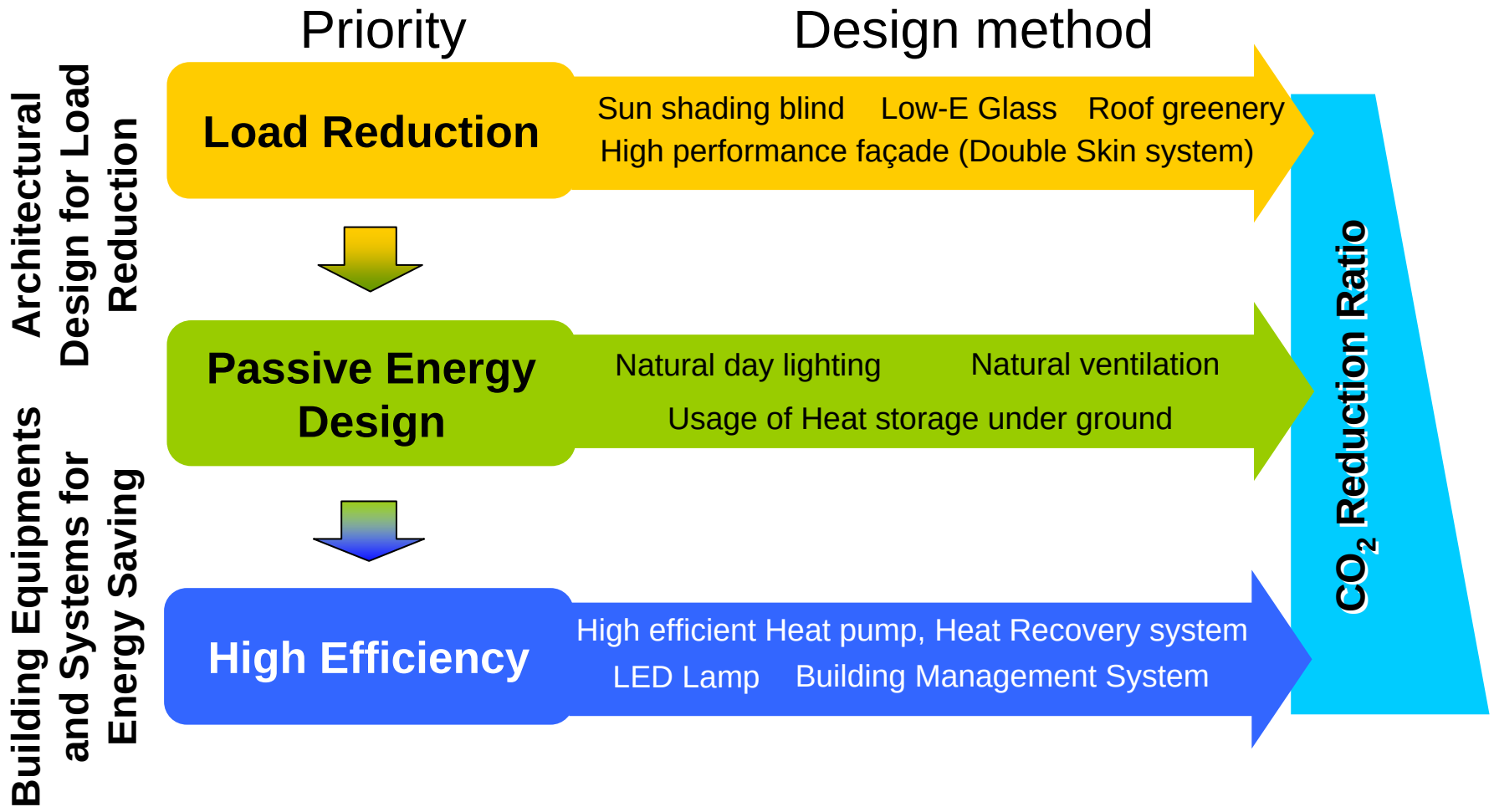
2. Passive energy design

   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.

3. Improvement of equipment efficiency

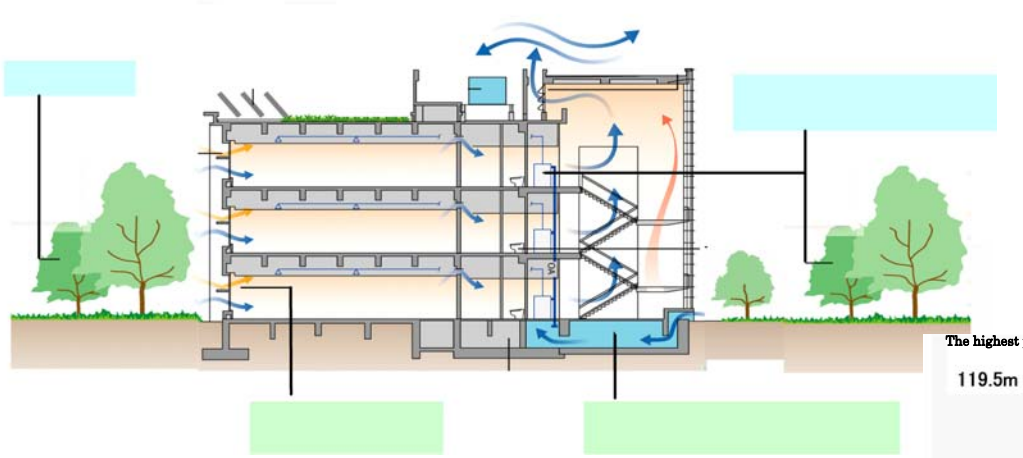
   Energy use in the building can be reduced by adopting high efficiency equipment for functions such as air conditioning, lighting, office automation, hot water supply.

2-1-2 Low carbon building (2)



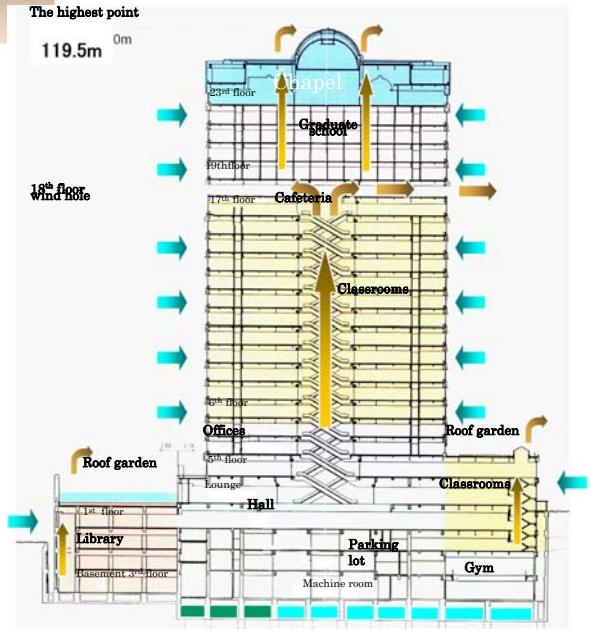
2-1-2 Low carbon building (3)

Natural ventilation



Overview

- ✓ 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.



Expected CO_2 Reducing Effect

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

2-1-3 Energy management systems

1. Building-level energy management systems

Building-level energy management systems prevent unnecessary energy use by automatically adjusting the operation of equipment in a building.

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).

2. Regional of district-level energy management systems

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.

2-1-4 Low carbon transport (1)

1. Low carbon measures in the transportation sector

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

2. Upgrading of public transit systems

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.

2-1-4 Low carbon transport (2)

3. Introduction of next-generation vehicles and facilities

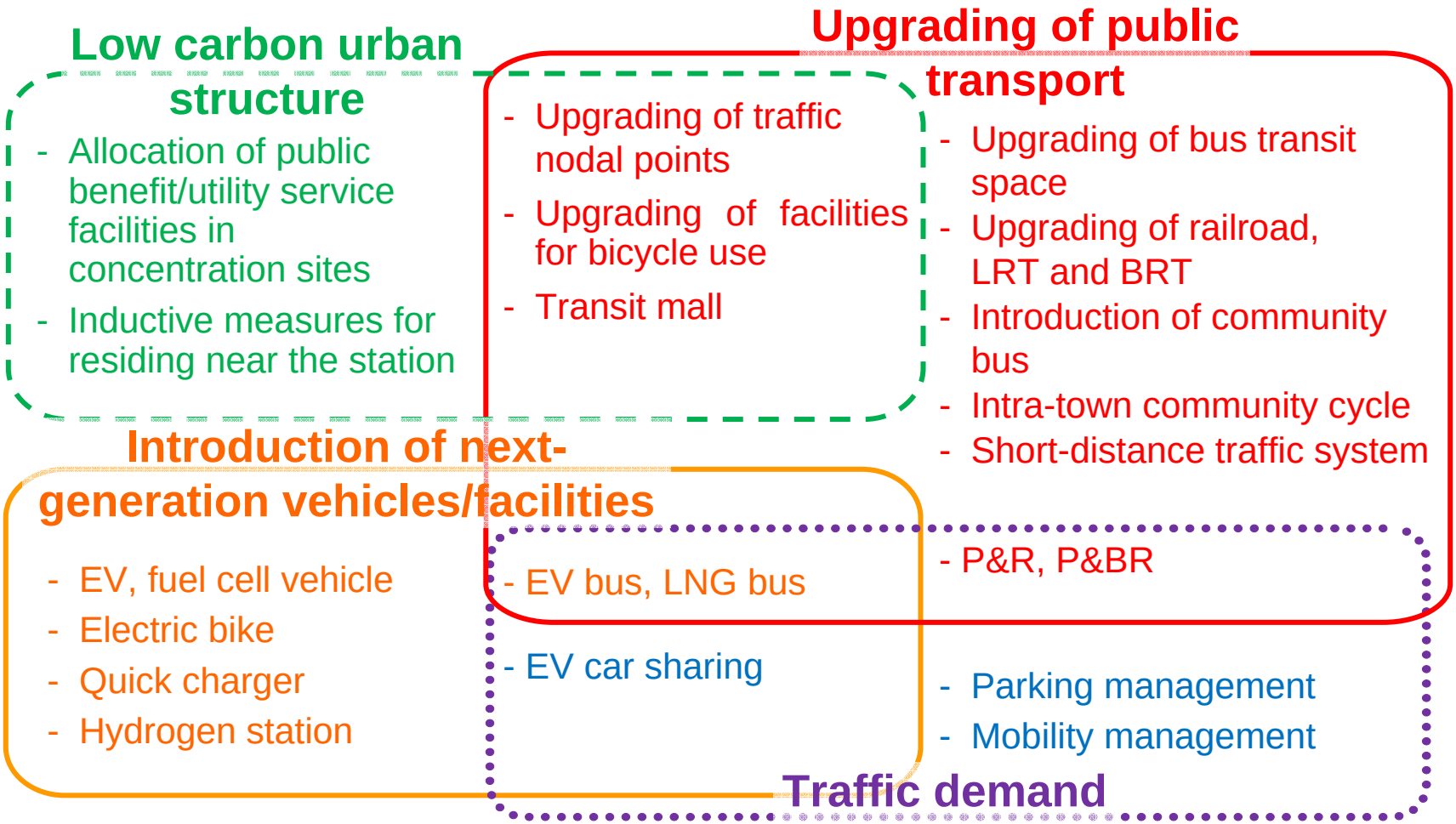
One option for reducing CO_2 emissions in the transport sector is to shift the current gasoline –driven cars and motorbikes to low-carbon emitting vehicles - such as the hybrid cars, electric cars, electric motorbikes and the fuel cell cars that are currently being developed and promoted. CO_2 emissions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

4. 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.

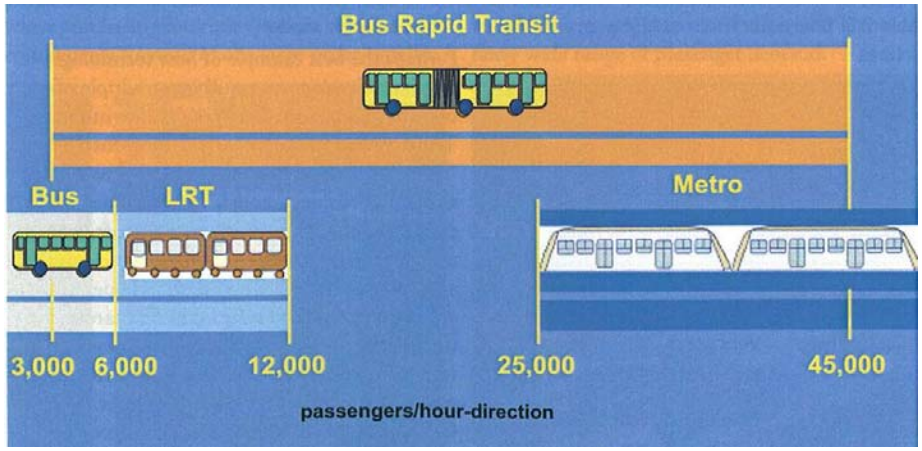
2-1-4 Low carbon transport (3)

1. Low carbon measures in the transportation sector

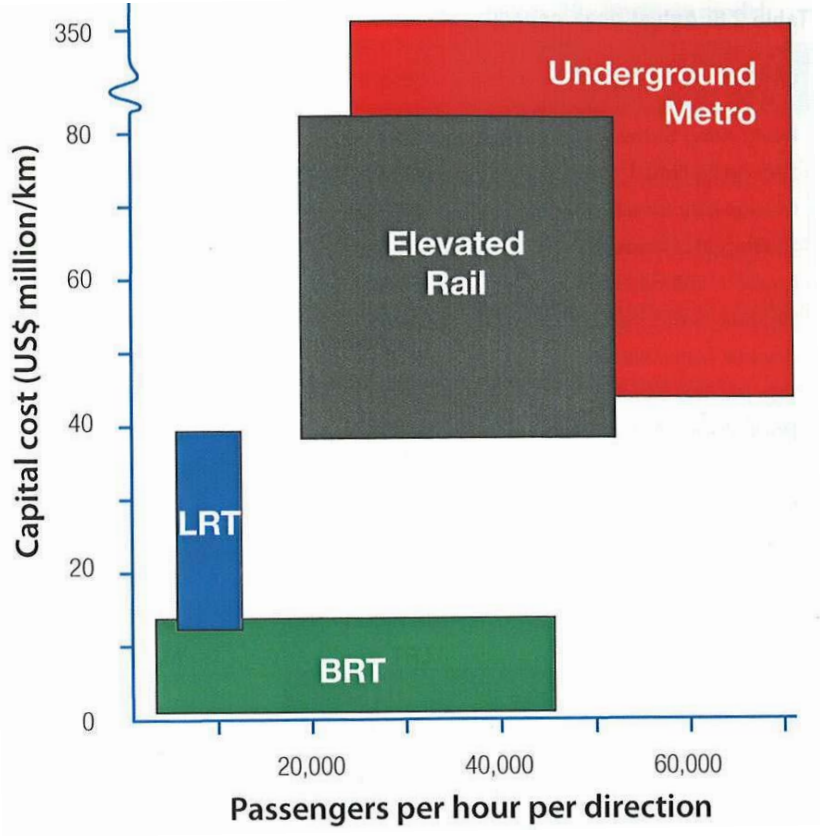


2-1-4 Low carbon transport (4)

2. Upgrading of public transit systems



Transportation capacity by traffic mode



Transportation capacity and capital cost

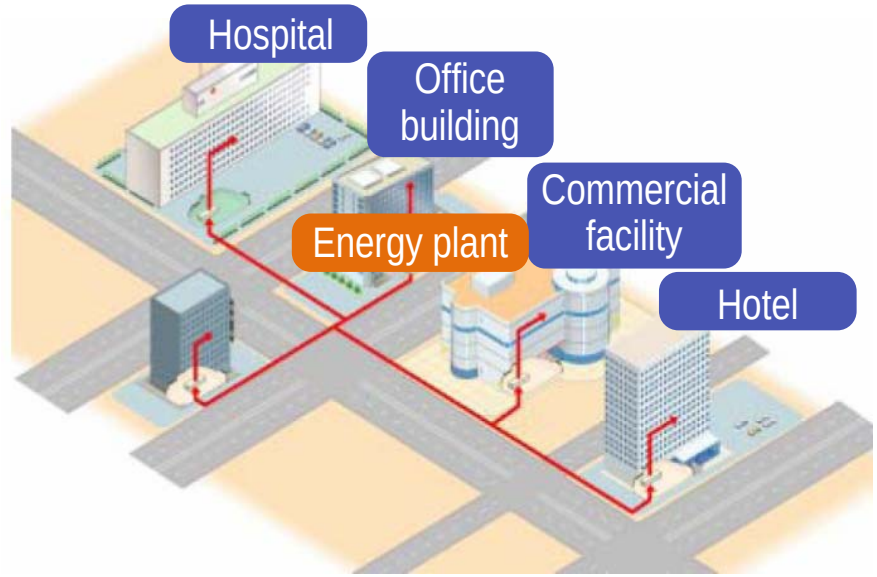
2.2 Measures on the energy supply side

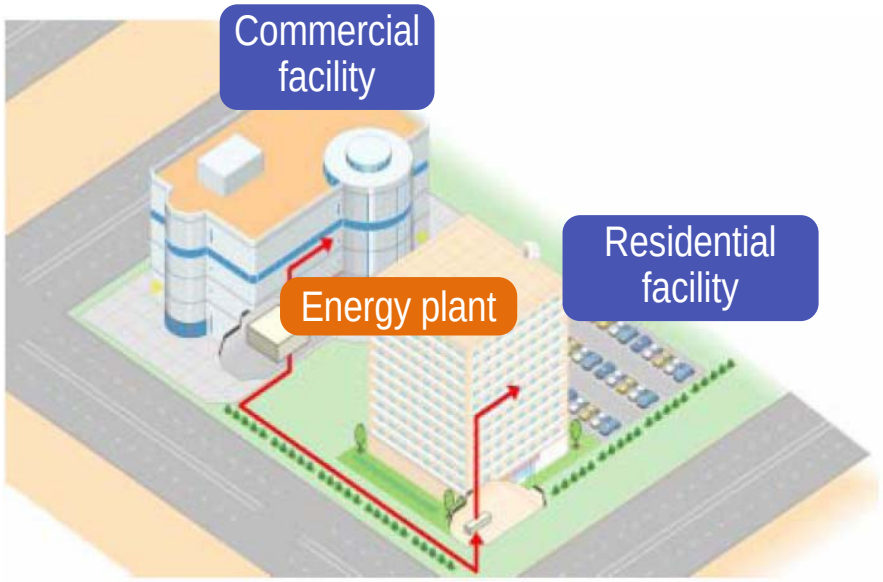
2-2-1 Area energy network (1)

- 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.
- Area energy network can be divided into three categories, depending on their scale.

1. District heating and cooling systems (DHC), covering a wide area.
2. Point heating and cooling systems, targeting multiple buildings in a single site.
3. Cross-supply of heat among multiple buildings

2-2-1 Area energy network (2)

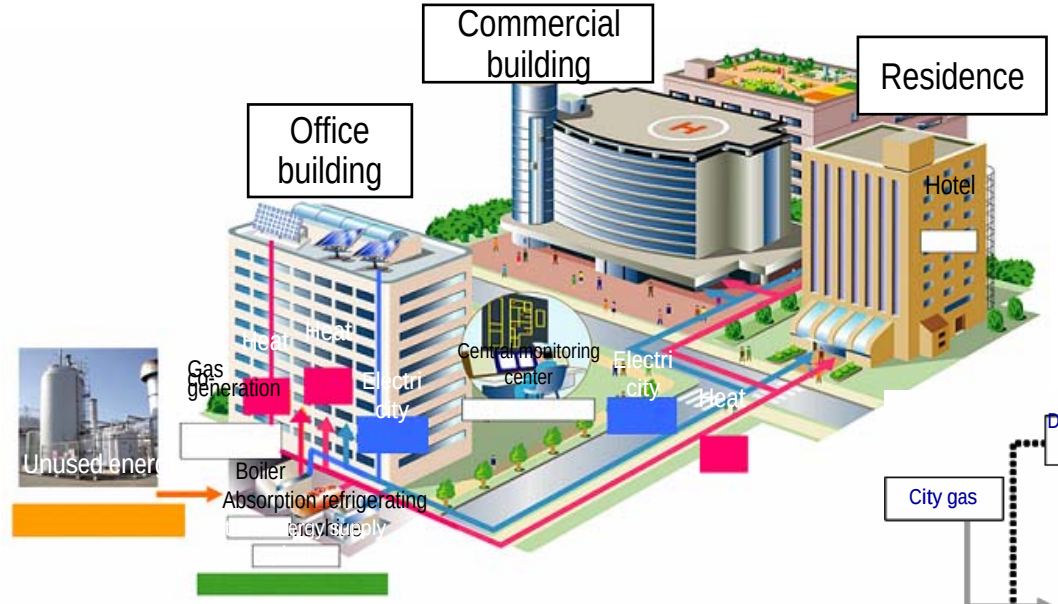




2.2 Measures on the energy supply side

2-2-1 Area energy network (3)

District heating and cooling (DHC)

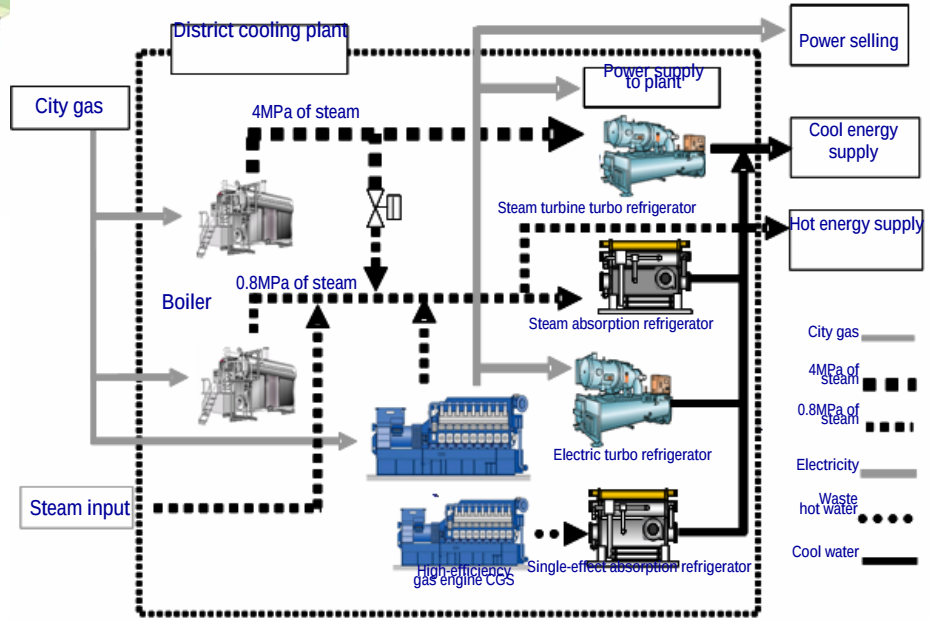


Overview

- ✓ 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 CO_2 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 CO_2.

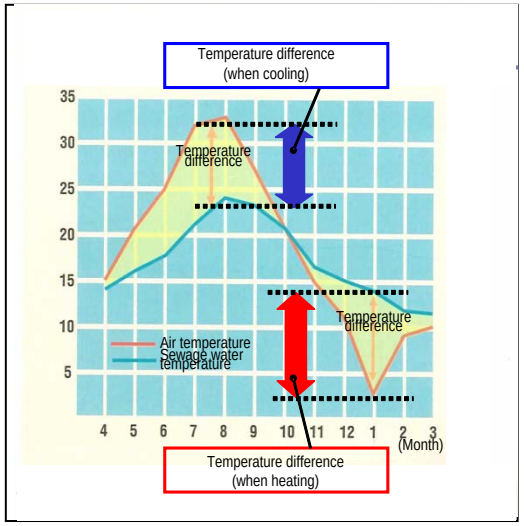


2-2-2 Use of untapped energy (1)

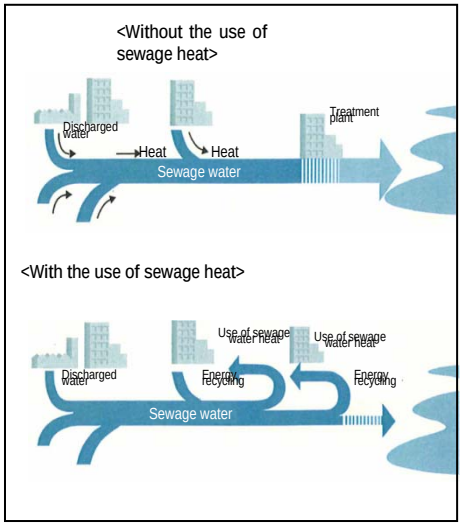
- Untapped energy sources
  - Waste heat from garbage or sewage sludge incineration
  - River water, seawater, sewage water and sewage treated water as heat sink or heat source
  - Heat pump technology efficiently transfer the heat energy contained in air or water in a source outside a building into cooling or heating
- Utilizing untapped energy in towns
- Managing urban development to promote untapped energy use
- Linking with improvements to urban thermal environment

2-2-2 Use of untapped energy (2)

Waste heat from sewage treatment plant



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



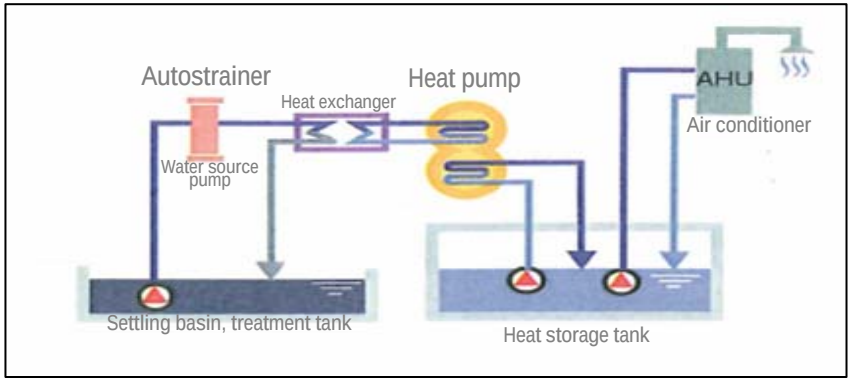
<A heat cycle using sewage water heat>

Overview

- ✓ 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

Expected CO_2 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.



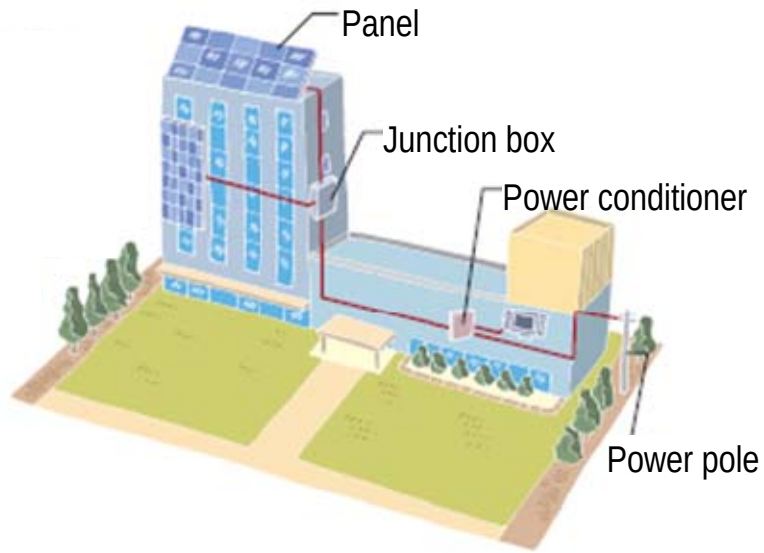
<A schematic diagram of a heat pump system using sewage water heat>

2-2-3 Use of renewable energy (1)

- Renewable energy sources
  - Solar energy (PV, and solar heat usage), wind energy, biomass energy, underground heat energy
  - River water, seawater, sewage water and sewage treated water as heat sink or heat source
  - Heat pump technology efficiently transfer the heat energy contained in air or water in a source outside a building into cooling or heating
- Using renewable energy in towns
- Managing urban development to promote renewable energy use
- Linking biomass sources to urban development

2-2-3 Use of renewable energy (2)

Solar power generation

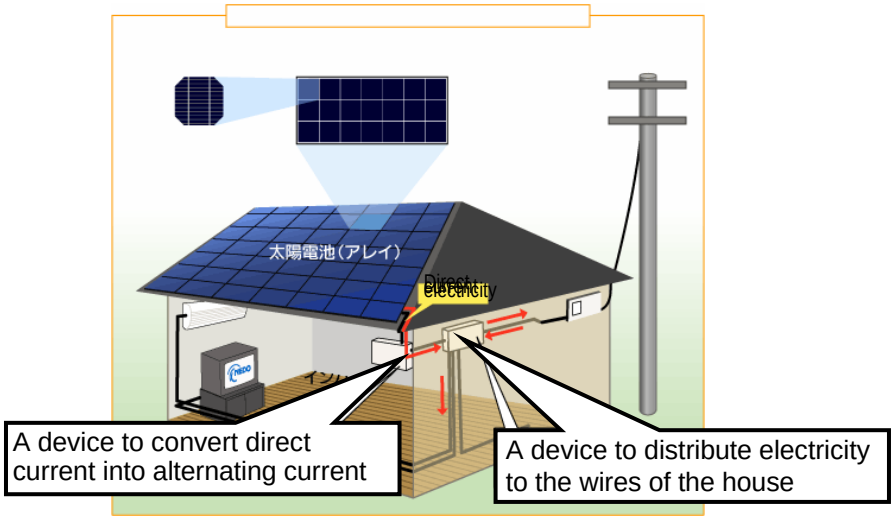


Overview

- ✓ 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.

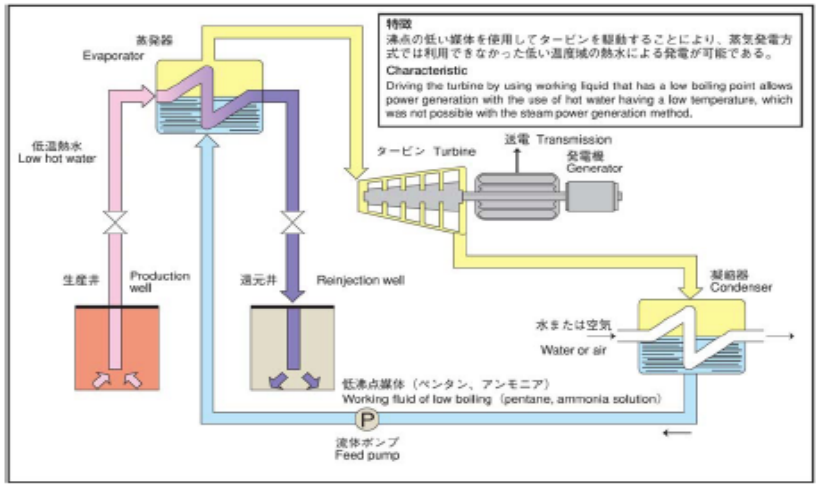
Expected CO_2 Reducing Effect

- ✓ It is expected that CO2 will be reduced by means of improving energy efficiency in electricity/heat generation in the relevant communities.



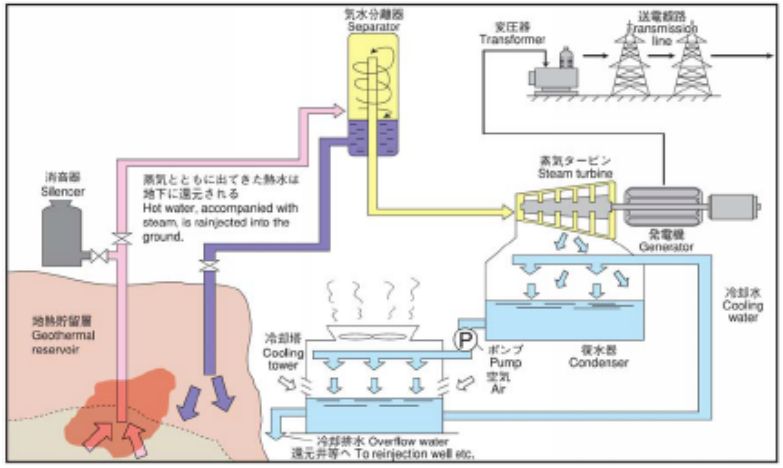
2-2-3 Use of renewable energy (2)

Geo-thermal power generation



Overview

- ✓ 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.).



Expected CO_2 Reducing Effect

- ✓ It is expected that CO2 will be reduced by means of using clean energy for electricity/heat generation in the relevant communities.

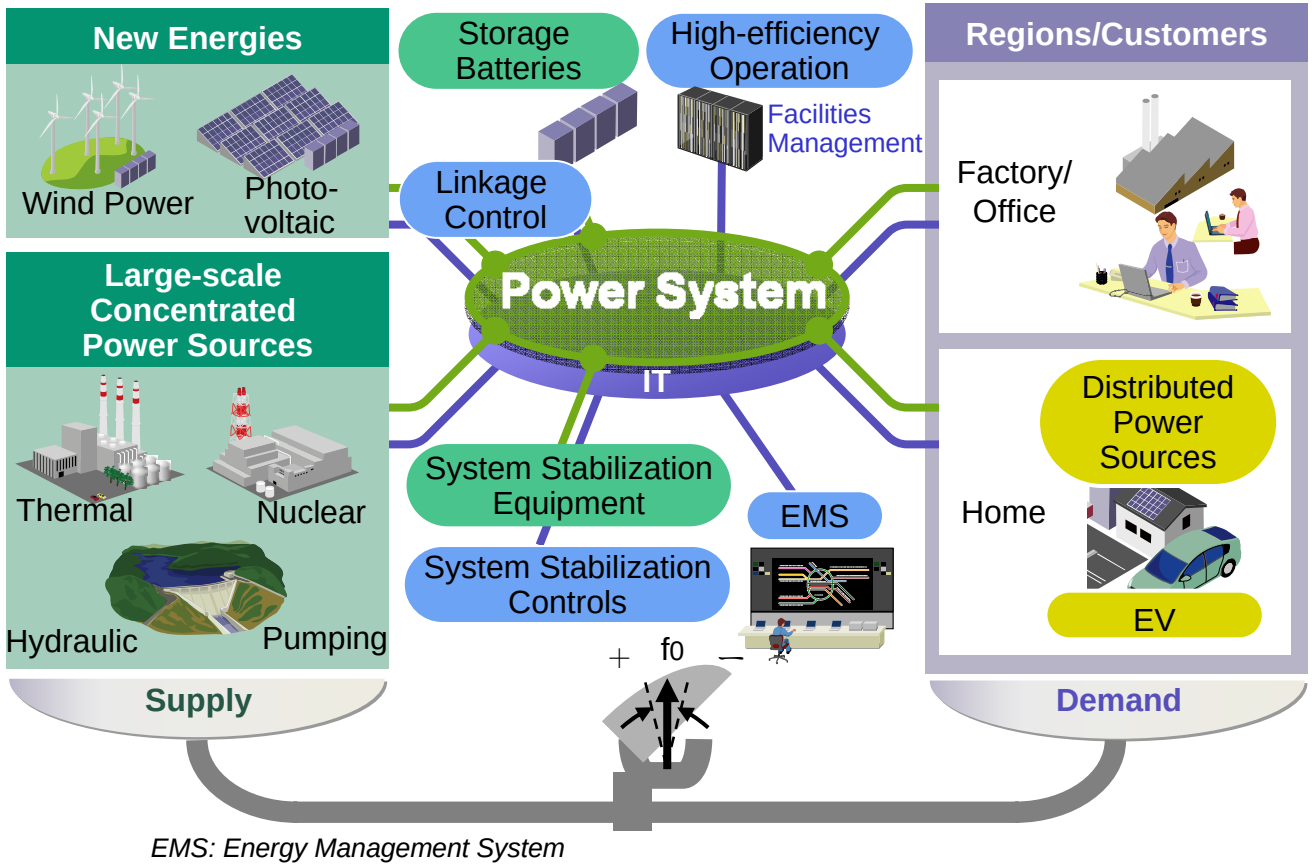
2-3-1 Smart grid systems (1)

- 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.

2-3-1 Smart grid systems (2)

- Smart grid systems have the following potential benefits:
  1. Reduction of electricity consumption can be expected at demand side through measuring and visualizing the electricity consumption with the smart meter.
  2. Stability of electricity supply and prevention of blackouts will be improved by the safety-control equipments installed on the electricity transmission/distribution network.
  3. The smart grid systems avoid such problems as voltage variation caused by the season or time of the day by matching the supply from the utilities with the demand of the consumers.
  4. Surplus electricity generated by renewable energy can be controlled by temporarily storing and discharging the electricity using batteries connected to the grid.

2-3-1 Smart grid systems (3)



EMS: Energy Management System

Overview

- ✓ Smart grid stabilizes the variation in voltage and frequency caused by the introduction of renewable energy sources such as solar power and wind, which fluctuate by the weather conditions.
- ✓ Smart grid also stabilizes the electricity system from the reversed current from PVs installed at the consumers' end of the feeder network.
- ✓ Smart grid balances demand and supply of electricity.

Expected CO_2 Reducing Effect

- ✓ It is expected that CO_2 will be reduced by avoiding unnecessary generation of electricity by conventional power plants as a result of the use of renewable energy sources and demand response.

2-3-2 Smart energy systems (1)

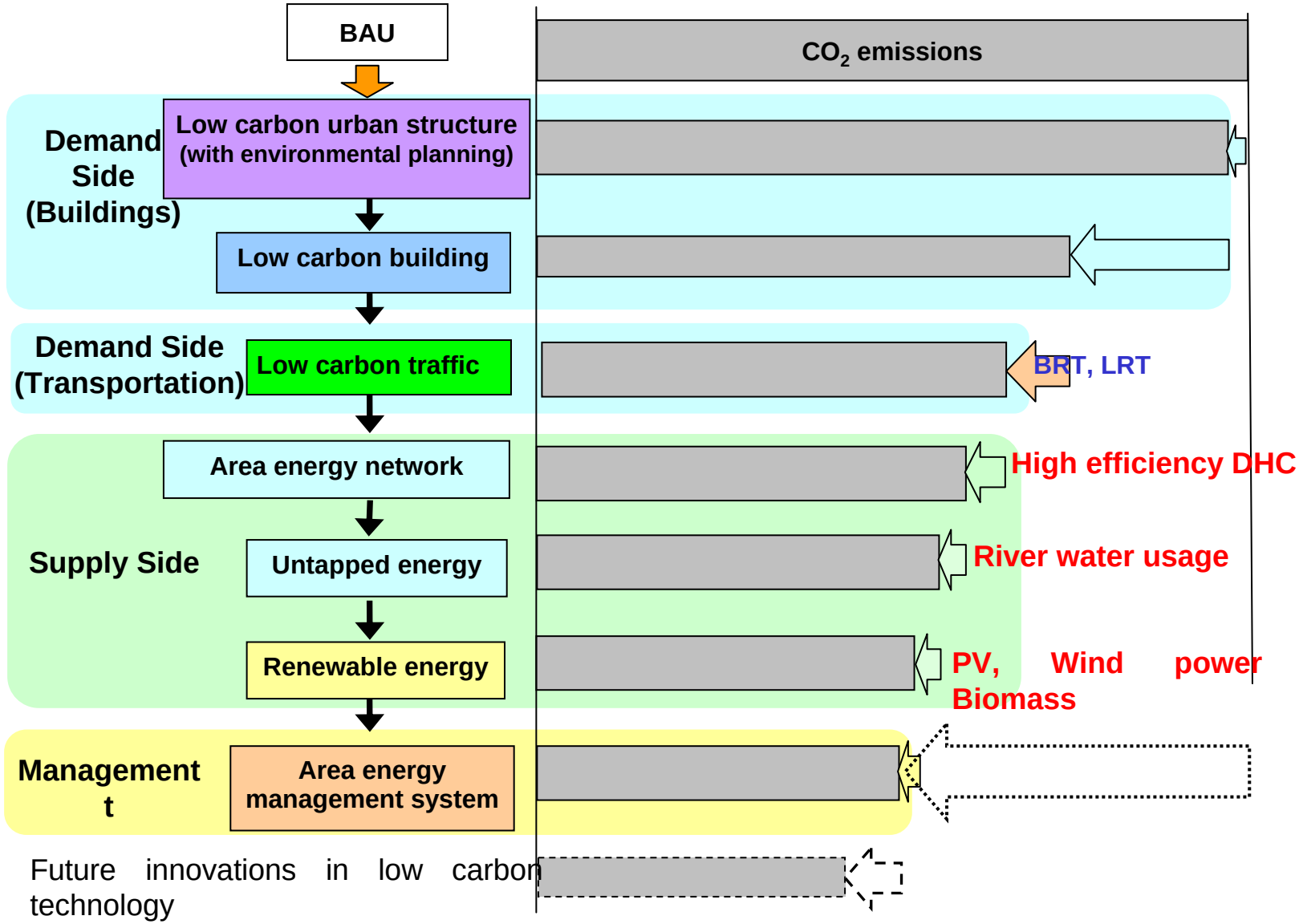
- Future energy systems will be “smart” at all levels. On the supply side, it is expected that urban energy systems will combine large-scale integrated power generation from sources such as thermal, hydroelectric and nuclear, and a large number of small-scale renewable-energy power generation in individual 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 equipment.

3.1 Purpose of evaluating the CO_2 reducing effects

- Estimates of the reduction in CO_2 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.
- 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 the next slide.

3 Evaluating the effect of low carbon measures

3.1 Purpose of evaluating the CO_2 reducing effects



3-2-1 Demand Side

- Low carbon urban structures (TOD type land use)
  - Reduced energy use in buildings through their concentration in high density zones
  - Reduced motor traffic
- Low carbon buildings

[CO_2 emission] = [Total floor area of buildings by use] ×
[CO_2 emission intensity of building by use] ×
(1 – [overall CO_2 reduction rate])

- Low carbon transportation

[CO_2 emission] = [Traffic volume] × Distance traveled] ×
[Emission intensity]

3-2-2 Supply Side

- 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.
- 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 Sides

- The CO_2 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.


APEC
Asia-Pacific
Economic Cooperation