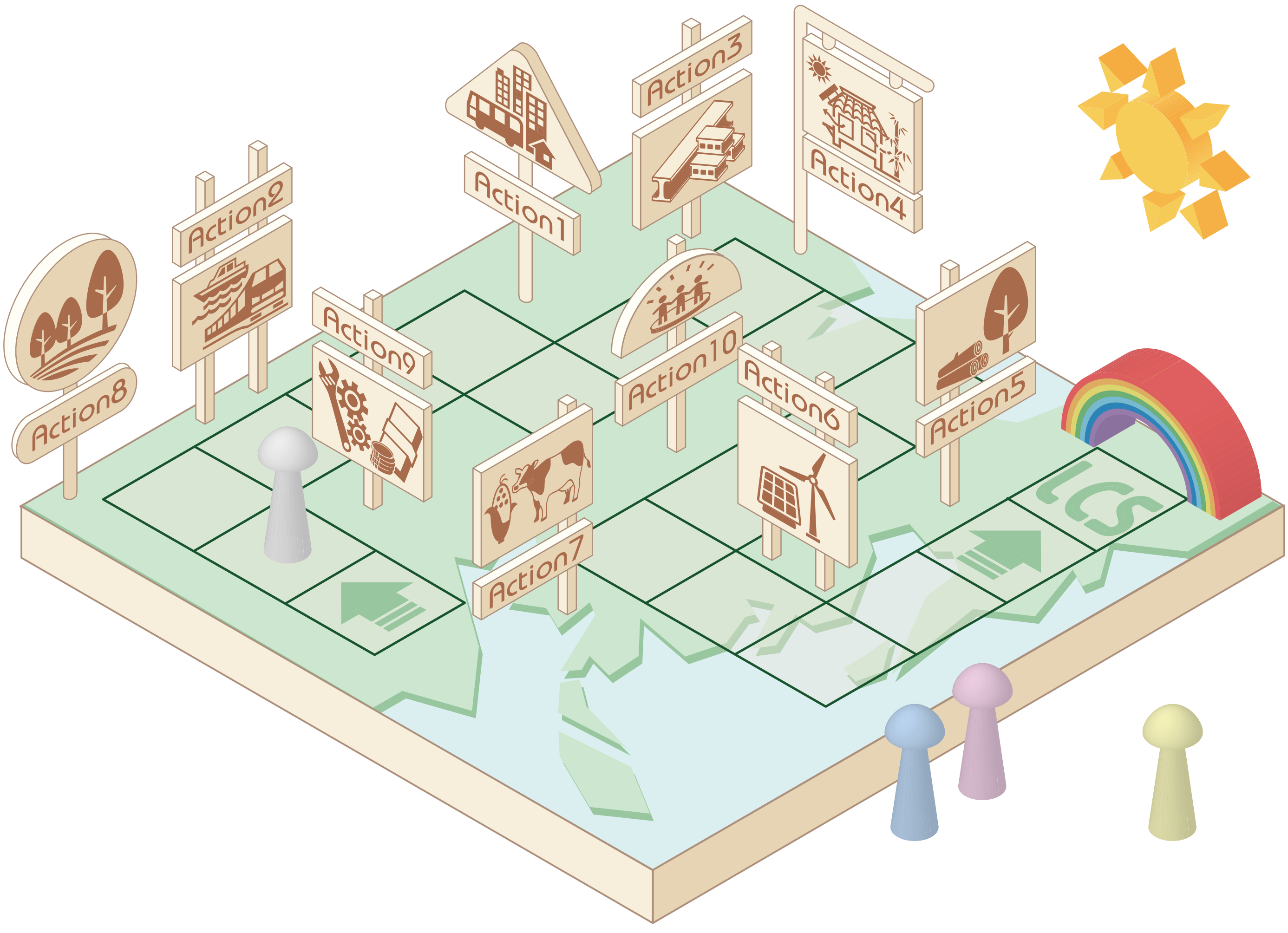
Realizing Low Carbon Asia

- Contribution of Ten Actions -



Low-Carbon Asia Research Project
http://2050.nies.go.jp

Ten Actions Leading to Low Carbon Asia in 2050

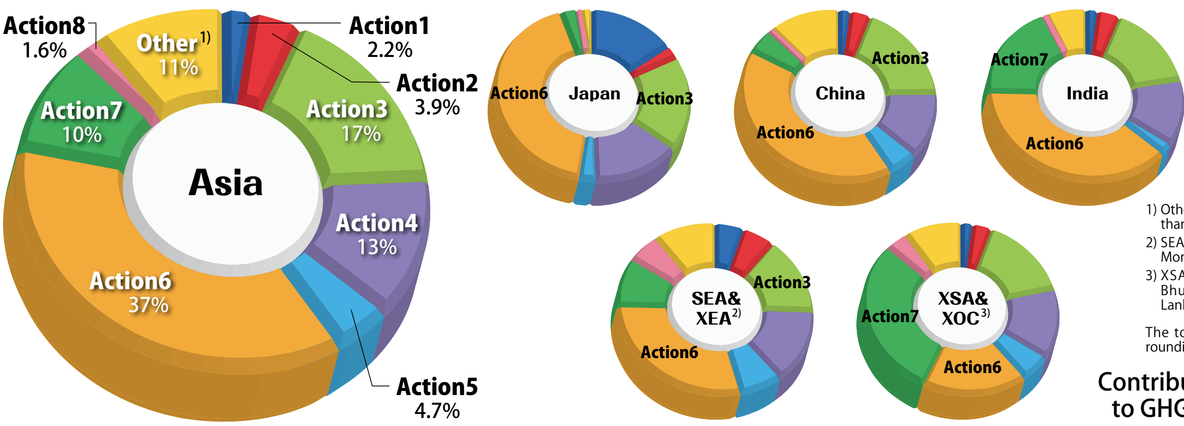
Introduction

Greenhouse gas (GHG) emissions from Asia accounted for approximately 38% of global emissions in 2005. Considering the rapid economic growth expected in the coming decades, emissions from Asia in 2050 are projected to be double the 2005 levels if efforts are not made toward achieving Low Carbon Societies (LCSs) (Fig. 1). The reduction of emissions in Asia is imperative for the transition by 2050 to an LCS worldwide that has halved GHG emissions. As the energy consumption is expected to grow continuously with economic development, the reduction of CO_2 emissions from fossil fuel burning is an important goal. In addition, as the GHG emissions other than CO_2 emissions from fossil fuel burning account for approximately 40% of the Asian GHG emissions, it is equally important to reduce them by actions like stopping deforestation, increasing CO_2 absorption from forestry, and decreasing such emissions from farmland and livestock. Furthermore, taking measures toward the realization of an LCS may also lead to the resolution of other key developmental challenges such as improving energy access, reducing local pollution, and eradicating poverty.

The LCS transition by Asian countries will not be an easy task. In order to accomplish this transition, it is vital that stakeholders including central and local governments, private-sector enterprises, NGOs and NPOs, citizens, and the global community tackle it with a focused and common vision of the society they wish to achieve, while cooperating with one other and being aware of the roles they need to play.

Depending on the country or region in Asia, the level of development, amount and type of resources, climate conditions, culture, and other factors differ, and the actions that are effective may vary accordingly. However, guidelines showing the common requirements for realizing an LCS in Asia are extremely useful when each country considers measures and strategies that are highly feasible and effective.

"Realizing Low Carbon Asia - Contribution of Ten Actions -" reveals the common directions toward achieving an LCS. Actions 1 to 6 show the directions of actions for mitigating CO_2 emissions from the use and production of energy and materials. Action 7 is targeted at the reduction of methane (CH_4) and nitrous oxide (N_2O) emissions mainly from agriculture. Action 8 deals with land use-related emissions and the absorption of CO_2. Actions 9 and 10 do not directly contribute to the reduc-



1) Other: CH_4 and N_2O emissions from other than agriculture and livestock
2) SEA&XEA: Southeast Asia, Korea (DPR), Mongolia, Republic of Korea, and Taiwan
3) XSA&XOC: Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka, and Small Island States in Oceania

The total is not always 100% because of rounding error.

Contribution of Ten Actions to GHG Reduction in Asia

The Low-Carbon Asia Research Project* is supported by the Environment Research and Technology Development Fund (S-6) of the Ministry of the Environment, Japan.
*A research project to establish a methodology to evaluate mid- to long-term environmental policy options toward Asian low-carbon societies

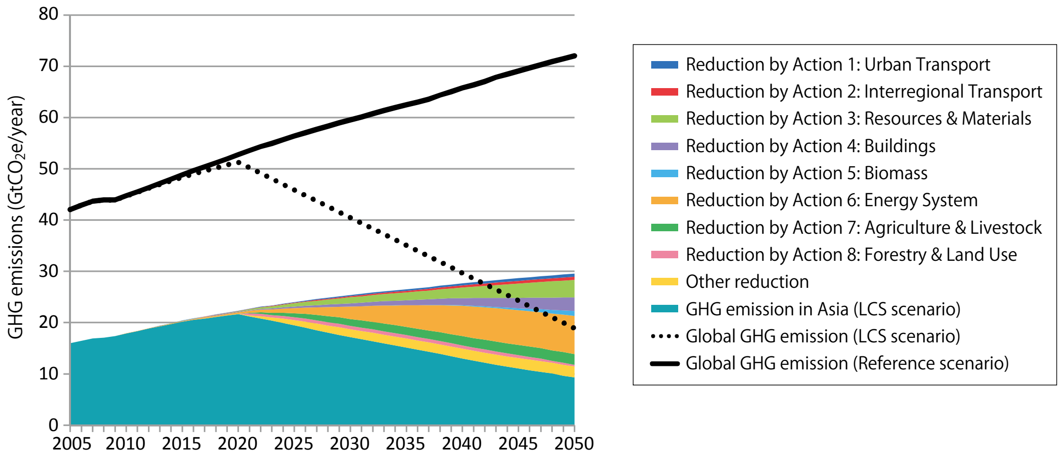


Fig. 1 Global and Asian Emissions in the LCS scenario and the Reference scenario

tion of GHG emissions but are concerned with governance, funding initiatives, and technology transfers that are essential for effective planning and implementation of the policies and measures presented in Actions 1 to 8. The table below shows the Ten Actions and the three approaches for each Action.

Feasibility of Reducing GHG Emissions by 68%

If all the Actions are applied appropriately, GHG emissions in Asia can be reduced by 20 gigatons of CO_2 equivalent ($GtCO_2e$), i.e. 68% of the emissions in the Reference scenario, in 2050. These include all the ten actions covered in this report, and some other actions for CH_4 and N_2O emission reduction in non-agriculture sectors.

Actions 1 and 2, which focus on transportation, account for a combined share of 6.1% of the total reduction. The share of Action 3, which aims to lower carbon emissions in the usage of materials, is 17%, while the share of Action 4, which encourages energy saving in buildings, is 13%. The share of Action 5, which utilizes biomass energy, is 4.7% and the share of Action 6, which is related to other energy supply systems, is 37%. The shares of Actions 7 and 8, dealing with agriculture and forestry, are respectively 10% and 1.6%. The remaining 11% of the reduction is accounted for by measures that are not listed in this report.

The results of the Actions will vary according to each country and region. For example, Actions 3, 4, and 6 will be effective for most countries and regions, whereas the contribution of Action 7 will be largest in XSA&XOC (South Asia excluding India and Small Islands States in Oceania) and second-largest in India.

Quantification of Actions

The contributions of the Ten Actions have been quantified by a global computable general equilibrium (CGE) model. The model used here divides the world into 17 regions, and contains the categories of governments, households, and producers. Production is classified into 32 goods. The model deals with power generation technologies in detail. This report depicts the Advanced Society scenario developed by the Low-Carbon Asia Research Project*.

First, the GHG emissions in the reference case are estimated. Then the LCS scenarios with the Ten Actions are quantified, targeting a halving of global GHG emissions by 2050. Subsequently, the emission reductions and the contribution of each Action in 2050 are estimated.

It should be noted that the Actions presented in this report are not the only pathway to achieve an LCS. The important point is to use this report to encourage discussions among stakeholders and to develop specific actions for each country or region in Asia.

*Fujimori et al. (2013) Global low carbon society scenario analysis based on two representative socioeconomic scenarios, *Global Environmental Research*, Vol. 17, No.1

Action 1 Hierarchically Connected Compact Cities: Urban Transport
- Compact cities with well-connected hierarchical urban centers
- A seamless and hierarchical transport system
- Low carbon vehicles with efficient road-traffic systems

Action 2 Mainstreaming Rail and Water in Interregional Transport
- Formation of industrial corridors using a low carbon transport system
- Establishment of an intermodal transport system incorporating rail and water
- Reduction of CO_2 emissions from vehicles and aircraft

Action 3 Smart Ways to Use Materials that Realize the Full Potential of Resources
- Production that dramatically reduces the use of resources
- Use of products in ways that extend their lifespan
- Development of systems for the reuse of resources

Action 4 Energy-Saving Spaces Utilizing Sunlight and Wind: Buildings
- Improvement of the energy-efficiency performance of buildings
- Application of high-efficiency equipment to buildings including heating/cooling equipment
- Visualization of energy-saving efforts

Action 5 Local Production and Local Consumption of Biomass
- Sustainable co-production of biomass energy and food
- Low carbon energy systems using local biomass resources in rural areas
- Improvement of living environments with intensive biomass utilization

Action 6 Low Carbon Energy System Using Local Resources
- Promotion of sustainable local energy systems with renewables
- Creation of smart energy supply and demand systems
- Enhanced energy security by integrating low carbon energy sources and fossil fuels effectively into an energy system

Action 7 Low Emission Agricultural Technologies
- Water management in rice paddies
- Highly efficient fertilizer application and residue management
- Recovery and use of methane gas from livestock manure

Action 8 Sustainable Forestry Management
- Forest protection and effective plantation
- Sustainable peatland management
- Monitoring and management of forest fires

Action 9 Technology and Finance for a Low Carbon Society
- Promote private-sector R&D for LCS
- Establish adequate funding to support R&D and technology diffusion
- Foster environmentally conscious consumers who choose low carbon products

Action 10 Transparent and Fair Governance that Supports Low Carbon Asia
- Create an efficient administrative management framework
- Establish fair and transparent business practices
- Improve literacy with respect to environmental policies and technologies

Ten Actions toward Low Carbon Asia

(Note: Three illustrative approaches are mentioned for each Action; However, the list and priority of approaches will be specific to a country or region)

Action 1 Hierarchically Connected Compact Cities

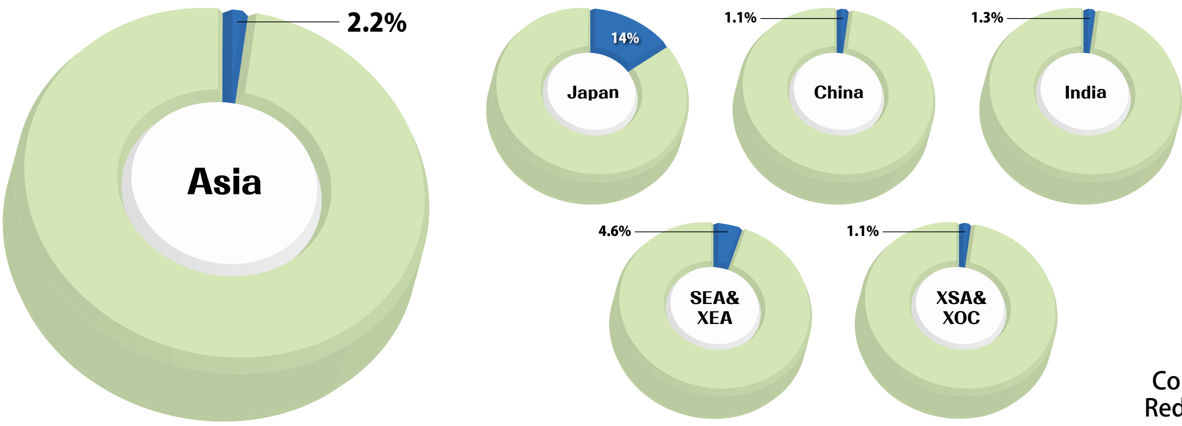
Overview

Economic growth has led to rapid motorization and urban sprawl in major cities in Asia, giving rise to various problems such as traffic congestion and air pollution. Nevertheless, most developing countries lack low carbon, sustainable city planning. Many developing countries have prioritized road development in response to growing transport demand, resulting in a vicious circle in which even greater car use is induced. Since around 2000, major cities in Asia have begun to undertake urban railway development, but so far its level is not at all adequate. Developing countries are also far behind developed countries in terms of vehicle technologies, as advanced technologies are not currently affordable.

Strategies for low carbon urban transport are to AVOID unnecessary transport demand, to SHIFT transport modes to lower carbon types, and to IMPROVE energy efficiency in transport. These can be realized with compact cities having well-connected hierarchical urban centers (AVOID strategy), a seamless and hierarchical transport system (SHIFT strategy), and low carbon vehicles with efficient road-traffic systems (IMPROVE strategy). Moreover, it is important to integrate urban transport systems with inter-regional transport systems in ways that reduce traffic congestion.

Taking into account the CO_2 emission target of a city in a developing country, the national government is responsible for determining the appropriate types of urban structure and urban transport network consistent with the vision of inter-regional transport development. To support such development, international financing for green development needs to be greatly strengthened. Newly introduced international financial assistance should actively include low carbon transport development. On the other hand, industries are responsible for developing electrification technologies for smaller vehicles to reduce congestion and CO_2 emissions. Citizens should thus be encouraged to explore a higher quality of life by using public transport and smaller vehicles, not following the conventional path of mobility growth to larger cars.

On the development pathway through 2050, according to urban agglomeration in cities along inter-regional rail corridors for passenger and freight transport, low carbon urban transport systems can be developed. These transport systems will provide reliable services to support globalized economic activities by improving the efficiency of urban freight movement and increasing the speed of urban public transport. On the other hand, as resource constraints become more serious and Asian developing countries begin to become aged societies from 2030, systems adaptable to diverse transport requirements can be developed as urban infrastructure stock.



Contribution to GHG Reduction by Action 1

Changes in Asia Due to Action 1

With the ongoing economic development of Asia, further increases in both transport demand and CO_2 emissions from transport are expected. The following three strategies are effective to move toward low carbon transport and urban systems: encouraging a shift from the use of car through the preparation of trunk public transport systems and a transition to compact city structures (SHIFT strategy), achieving low carbonization of intra-city transport by avoiding unnecessary transport demand (AVOID strategy), and improving energy efficiency of each transport means (IMPROVE strategy).

By implementing these strategies, trunk public transport networks, such as metro railways and bus rapid transit systems, will be realized by 2050 in correspondence with the urban population density, achieving a widespread use of public transport systems. As a result of quantitative analysis of these strategies, the efficiency of passenger transport by car will be improved, and the demand for car passenger transport by households will be reduced by 20% in 2050 compared with 2005. Additionally, with regards to the demand for car passenger transport originating from industrial and commercial activities, the demand per unit of production will decrease by approximately 20% in 2050 compared with 2005. The efficiency of freight transport systems will be improved, resulting in a decrease in the freight traffic demand per unit of production by 10% in 2050 compared with 2005.

Moreover, a hierarchical traffic system will be established where traffic terminals in form of bus and paratransit will cooperate with trunk traffic, due to the diffusion of short-distance, small-size personal mobility systems required by increasingly ageing society. As a result, a portion of passenger transport by car will shift to public transport systems in 2050; approximately 20% will shift to bus and another 20% to rail.

To support these traffic systems, metropolitan functions will be distributed among city center and circumferential sites, resulting in a highly dense and multipolar hierarchical form of land use. Promotion of such multipolar hierarchical urban development will also be effective for the reduction of passenger transport by car. With regards to the demand for car passenger transport originating from industrial and commercial activities, the demand per unit of production will decrease by approximately 20% in 2050 compared with 2005.

Due to the progress of vehicle technology development, energy efficiency of car, truck, and bus is estimated to improve by 0.5% annually until 2050 in the Low Carbon Society (LCS) scenario, compared with the Reference scenario.

Appropriate land use and population distribution will be achieved so that excessive intra-city traffic demand will be avoided in 2050. In the meanwhile, a portion of transport by private car will shift to public transport systems, while the overall transport demand will be restrained. Specifically, the passenger transport in Asia in the LCS scenario in 2050 will decrease by 23% compared with that in the Reference scenario, caused by a decline in passenger transport by private car (Fig. 1-1).

In the Reference scenario, the energy demand in the transport sector in overall Asia in 2050 will double that in 2005, and the demand of fossil-fuel for combustion as the major energy source will increase by 1.9 times. However, in the LCS scenario, the demand of energy and the demand of fossil-fuel will respectively decrease by 56% and 64% compared with the Reference.

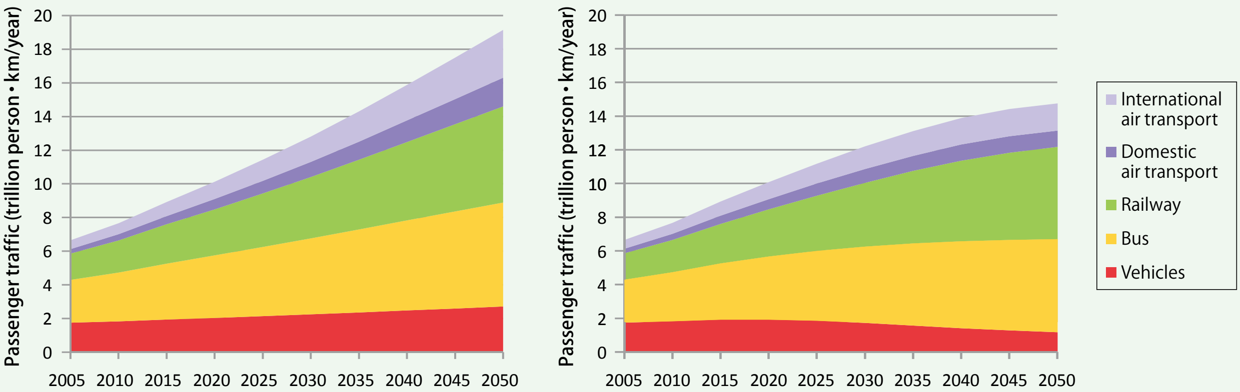


Fig. 1-1 Passenger traffic: Reference scenario (left) and LCS scenario (right)

Contribution to GHG Reduction

By implementing Action 1, CO_2 emissions from the intra-city transport in Asia in the LCS scenario will decrease by 81% compared with the Reference scenario. The regional share is shown in Fig. 1-2.

As some of the GHG reductions in urban cities are counted in other sectors, the contribution of the urban transport in Asia will not exceed 2.2%. The individual contribution in China, India and XSA&XOC (South Asia excluding India and Small Island States in Oceania), will be lower than that in Asian average. However, the contribution of Action 1 in Japan will be higher, at 14%. The reason is that in Japan the reduction achieved by constraining transport demand, shifting to public transport, and promoting more efficient transport methods is expected to be more significant, because the emissions from private cars in Japan is larger.

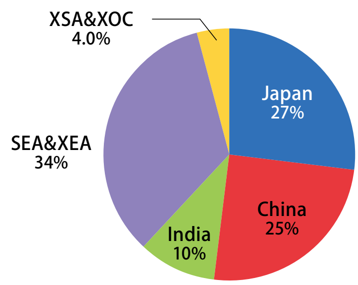


Fig. 1-2 Regional shares of GHG reduction in Asia by Action 1 in LCS scenario (2050)

Components of the Action

Action 1 consists of three approaches: (1) compact cities with well-connected hierarchical urban centers, (2) a seamless and hierarchical transport system, and (3) low carbon vehicles with efficient road-traffic systems.

1.1 Compact cities with well-connected hierarchical urban centers (AVOID)

- 1.1.1 Development of employment cores in urban transit corridors
  - 1.1.1.1 Integrated land-use transport planning
  - 1.1.1.2 Transit-oriented development with value capture
  - 1.1.1.3 Residential tax discount for non-car owners
- 1.1.2 Exclusion of private cars from inner city areas
  - 1.1.2.1 Car usage control
  - 1.1.2.2 Road space reallocation for slow modes
  - 1.1.2.3 Provision of communal facilities

1.1.1 Development of employment cores in urban transit corridors: Although increases in trip generation under economic growth conditions are difficult to avoid, it is important to develop a land-use transport system to reduce travel distances. Freight-rail corridor development has more potential for industrial agglomeration around suburban freight stations than conventional road-oriented freight systems. Transit-oriented development (TOD) to integrate industrial and residential development around stations of urban public transport can form more self-contained urban cores, bringing workplaces closer to the home. For the implementation of TOD to develop suburban industrial cores, transport planning needs to be integrated with urban and regional planning, which are likely to be separated in many developing cities. Moreover, it is effective to apply value capture schemes to exploit the benefit of land value increases from transport development, which is more significant at the earlier stage of development with low land values. TOD promoted with a value capture scheme is effective not only in central business districts (CBDs), but also in urban fringes and suburbs, particularly in sprawling cities. The effect of TOD on reducing car use can be further secured with a residential tax discount for non-car owners.

1.1.2 Exclusion of private cars from inner city areas: A more drastic approach to reducing car use is to exclude private cars from inner city areas. Extensive rail infrastructure development is not necessarily feasible under the constraints of financial budgets and resources. The necessary level of development can be lowered by excluding car traffic from the inner city area to improving the mobility of public transport. This provides the opportunity to reallocate road space from cars to slower modes, such as bicycles and walk. In addition, easy accessibility for aged and low-income people to meet their health and education requirements needs to be secured by providing communal facilities in their local areas.

1.2 A seamless and hierarchical transport system (SHIFT)

- 1.2.1 Early development of urban public transport networks
  - 1.2.1.1 Mass rapid transit development
  - 1.2.1.2 MRT network development between urban cores
- 1.2.2 Improvement of feeder transport systems
  - 1.2.2.1 Separation of trunk and feeder transit services
  - 1.2.2.2 Provision of circular feeder transit services
  - 1.2.2.3 Promotion of shared personal mobility
- 1.2.3 Integrated management of public transport systems
  - 1.2.3.1 ICT-based public transport management
  - 1.2.3.2 Reform of paratransit management

1.2.1 Early development of urban public transport networks: Urban transport planning is required to shift increasing demand for car use to low carbon public transport options. As interregional rail development generates new travel demand in cities, such as for commuting, business, and leisure, it is important to instill the habit of public transport use through the early development of urban public transport networks. An urban public transport network to connect urban cores and interregional stations can enhance public transport accessibility. Although developing countries are likely to develop smaller-capacity transit systems due to budget constraints, transport infrastructure adaptable to mass transit systems, such as urban railways and bus rapid transit (BRT), needs to be developed from the beginning to meet growing transport demand in the future. Moreover, the mass-transit networks should not only be radial for commuting to the CBD, but also orbital to handle increasing multi-purpose travel in an aged society.

1.2.2 Improvement of feeder transport systems: As feeder transport is important to promote mass-transit use, it needs to be improved, taking advantage of existing paratransit services. Excessive provision of paratransit may cause traffic congestion, particularly in city centers, and their feeder routes should therefore be separated from the trunk routes. Moreover, it is effective to provide more circular feeder transit services in order to encourage low-income and aged people to have the habit of public transport use. Small-size and easily driven personal mobility vehicles for short-distance travel also have the potential to secure the mobility of aged people. Schemes for shared personal mobility will make transport systems more seamless.

1.2.3 Integrated management of public transport systems: An efficient public transport system needs an integrated management system for various mass-transit and feeder transport modes. The efficiencies of transport management can be improved with an integrated fare system and dynamic service operation, taking advantage of information and communication technology (ICT). Moreover, the management system for individually operated paratransit services needs to be reformed to survive as community-based feeder transport services under economic growth conditions.

1.3 Low carbon vehicles with efficient road-traffic systems (IMPROVE)

- 1.3.1 Vehicle technology development
  - 1.3.1.1 Promotion of small-size EVs
  - 1.3.1.2 Development of medium- and large-size LEVs
- 1.3.2 Promotion of alternative fuels
  - 1.3.2.1 Promotion of biofuels
  - 1.3.2.2 Development of smart-grid systems
- 1.3.3 Development of integrated freight transport systems
  - 1.3.3.1 Development of suburban freight cores
  - 1.3.3.2 Connection of urban road systems to freight cores

1.3.1 Vehicle technology development: As mass-transit development is less efficient and less low-carbon in local cities, it is necessary to improve the energy efficiency of road transport by improving vehicle technologies. The development of technologies for electric vehicles (EVs) is more advanced for small-size vehicles, including motorcycles, paratransit vehicles, and delivery cars. Although it may take more time to develop low emission vehicles (LEVs) in the case of larger-size vehicles, more technology development is expected by 2050, supported by developing countries.

1.3.2 Promotion of alternative fuels: The development and promotion of alternative green fuels is another effective option. In Asian developing cities, there is potential for the production of biofuels for local use. Moreover, the promotion of EVs requires more infrastructure development for charging stations. The development of smart-grid systems can improve the efficiency of power provision on a neighborhood or city-wide scale, utilizing renewable power generation facilities.

1.3.3 Development of integrated freight transport systems: Transport energy efficiency can be enhanced not only by technology development but also by efficient traffic management. In particular, it is important to improve the efficiency of urban freight transport, which is centered on road transport. An efficient urban freight transport system plays the role of integrating inter-regional freight rail systems and urban road transport as feeder systems. Such an integrated system requires the development of freight cores with distribution terminals around interregional freight-rail stations in suburbs. These freight cores work better with urban expressways for radial delivery transport to inner city areas and for orbital feeder freight transport to inter-regional hubs.

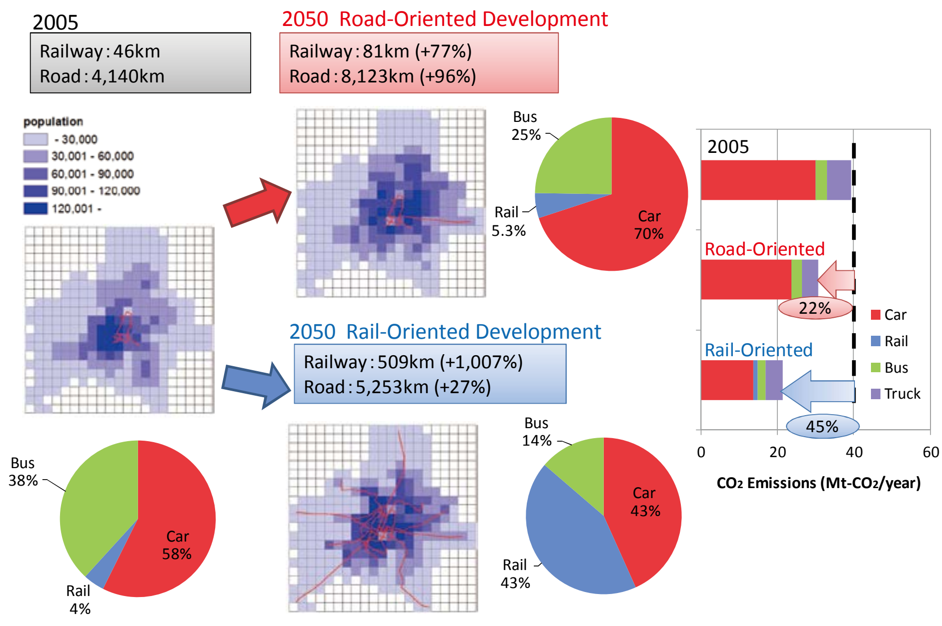
Low carbon urban transport development by policy shift to rail-oriented development in Bangkok

In Thailand, transport development has been centered on road transport, as in many other Asian developing countries, but the development policy has completely shifted following the urban rail development that has taken place since the 2000s. The master plan for Bangkok in the 1960s gave priority to wide-lane road development, and promoted car-oriented urban development. However, as urban rail development was increasingly demanded due to serious traffic congestion in the 1990s, 80 km of urban rail systems were realized through the development of the Skytrain in 1999, Blue Line in 2004, and Airport Link in 2010. These achievements have made the local population aware of the importance of urban railways, which has led to a proposal to invest 80% of the national budget for transport in rail network based on high-speed rail development, inter-city rail improvement, and urban rail development.

A study was conducted to examine the potential effectiveness of future transport development in Bangkok in 2050, comparing the conventional transport development policy with a new transport development policy. By estimating the future investment budget for transport based on GDP forecasts up to 2050, two transport development scenarios were tested by differentiating the investment balance into road and rail transport; i.e., a road-oriented development scenario in which the transport budget was invested only in roads after 2010, and a rail-oriented development scenario in which investment was made in 500 km of urban rail development planned by the Office of Transport and Traffic Policy and Planning (OTP), Thailand. It was found that while the road-oriented development scenario accelerates motorization and urban sprawl, the rail-oriented development scenario promotes development along urban rail lines and encourages rail use. These results show that rail-oriented development would reduce CO_2 emissions by 45% and the average road travel time by 30%, by shifting road transport demand to rail transport. The rail-oriented scenario is more effective than road-oriented development, even considering the development of automotive technologies for better fuel efficiency and EVs. (Kazuki Nakamura)

Reference

Kazuki Nakamura, Yoshitsugu Hayashi, Hirokazu Kato (2013) "Low-carbon Land-use Transport Systems to Improve Liveability for Asian Developing Cities." Selected Proceedings of the 13th World Conference on Transport Research.



Comparison of CO_2 emissions between the scenarios of road-oriented development and rail-oriented development in 2050

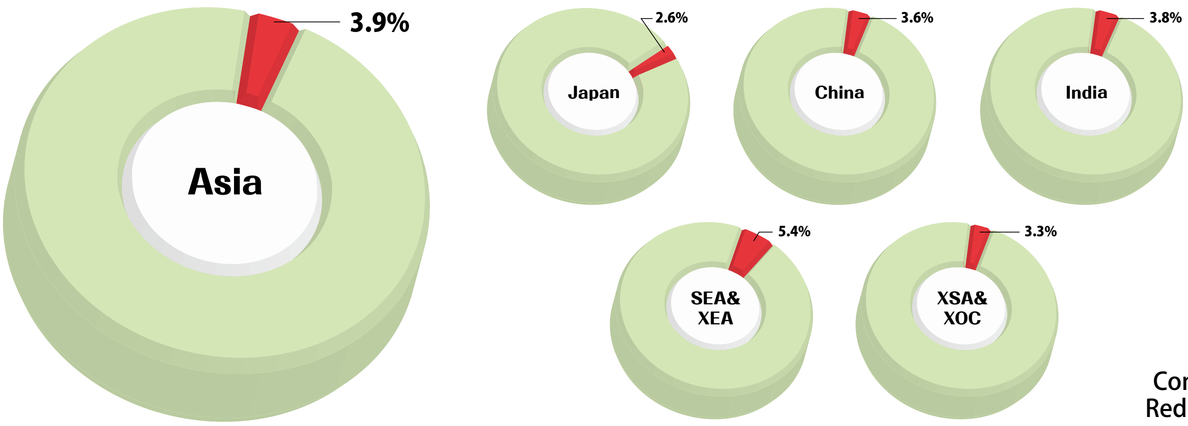
Mainstreaming Rail and Water in Interregional Transport

Overview

Demand for international passenger and freight transport has been growing in Asian developing countries compared with other regions in the world. Although international freight transport throughout Asia has low carbon emissions because it is dominated by marine transport, truck transport has been increasing for short- and medium-distance inland movement. Demand for international passenger transport in Asia, and the accompanying CO_2 emissions, have also been increasing in line with the development of the global economy and decreases in airfares due to the expansion of routes served by low cost carriers (LCCs).

Similar to the case of urban transport in Action 1, the AVOID strategy for reducing unnecessary transport demand, the SHIFT strategy for shifting to low CO_2-emitting transport modes, and the IMPROVE strategy for improving transport energy efficiency will be effective for establishing low carbon interregional transport systems in Asia. Regarding the AVOID strategy, we propose rail-oriented development of industries (industry ROD) on an interregional scale, in which high-speed freight railways form industrial corridors. For the SHIFT strategy, shifting away from road transport to intermodal transport based on the development of railways and waterways is necessary. In the case of the IMPROVE strategy, CO_2 emissions from vehicles, aircraft, and marine vessels can be reduced by electrification, alternative fuels, and lightweight body design. Within the continental region encompassing the area from China to the Greater Mekong Subregion (GMS), shifting from air to high-speed rail for passenger transport and from road to rail and waterways for freight transport will be highly effective. Additional reductions in CO_2 emissions can be achieved by industrial agglomeration along the high-speed freight railway corridors, which will be effective over medium and long distances in reducing the per-unit time and cost.

Through the implementation of these strategies, cities in coastal areas will become connected by low carbon transport modes centered not only on maritime shipping but also on high-speed rail. A low carbon transport system that combines high-speed rail, local rail, and technologically advanced large trailers, can be introduced within the GMS region and the inland areas of China to connect with coastal areas, creating an intermodal transport system. Furthermore, by implementing an environmental impact tax, both the cost and environmental impact will be considered while siting industrial facilities and building supply chains. This will promote the formation of industry clusters along a low carbon, interregional transport system that is centered on the mainstreaming of rail and water.



Contribution to GHG Reduction by Action 2

Changes in Asia Due to Action 2

AVOID strategy, SHIFT strategy, and IMPROVE strategy are effective for inter-regional transport, in the similar way as for intracity transport. Substantial increase in international passenger transport and freight transport in Asia is expected, and therefore a development model where rail transport and water transport play a key role is indispensible for AVOID strategy. Within the continent ranging from China to the Mekong basin, SHIFT strategy should be implemented in distinct ways in passenger transport and freight transport sectors. Specifically, in the case of passenger transport, a shift from air to high-speed rail will be effective. On the other hand, in the case of freight transport, a shift from truck transport to rail transport or river transport will be more effective. In addition, IMPROVE strategy is necessary to develop efficient technologies of large trailer, aircraft, and vessel, and to innovate fuel technologies.

Stakeholders will consider both costs and environmental burdens when making decisions on location of industries and construction of logistics systems, because of taxation policies on environmental burdens. As a consequence, inter-regional transport systems focusing on rail and water transport will spread widely. As a result of quantitative analysis of such ‘space development based on low carbon transport system’, air and water transport per unit of production in the industrial sector and the civilian sector will decrease by 20% in 2050 compared with 2005.

In the coastal areas of Japan, China, and Southeast Asia, inter-regional development that takes advantage of maritime transport will proceed, and cities will be connected by low carbon transport systems utilizing rail and large trailers with advance technology. Furthermore, industrial agglomeration that adapts to rail and water transport mentioned above will pervade in inland areas, and low carbon transport systems that connect inland areas and coastal areas will appear, establishing an intermodal transport system for both passenger and freight movements. As a result of quantitative analysis of such ‘intermodal transport system for passenger and freight focusing on rail and water transport’, rail and water transport per unit of production in the industrial sector and the civilian sector in 2050 will decrease by 20% compared with that in 2005.

Due to ‘low carbonization of vehicle and aircraft’, energy efficiency of truck and aircraft is estimated to improve by 0.5% annually until 2050, compared to the Reference scenario. In addition, promotion of use of biofuels is anticipated in the Low Carbon Society (LCS) scenario.

Similar to Action 1 the energy efficiency of all transport means for inter-regional transport will be improved. In the meanwhile, low carbon transport system for passenger and freight focusing on rail and water transport will be established, and the traffic demand will decline. The freight transport in Asia overall in the LCS scenario in 2050 will decrease by 35% compared with that in the Reference scenario, by various measures including those mentioned above. The ratio of transport by truck in the LCS scenario will be lower than that in the Reference scenario, while the ratio of transport by rail will be higher. The international freight transport by marine and air will decrease by 29%, and the domestic freight transport will also decrease, in spite of a lower rate (Fig. 2-1).

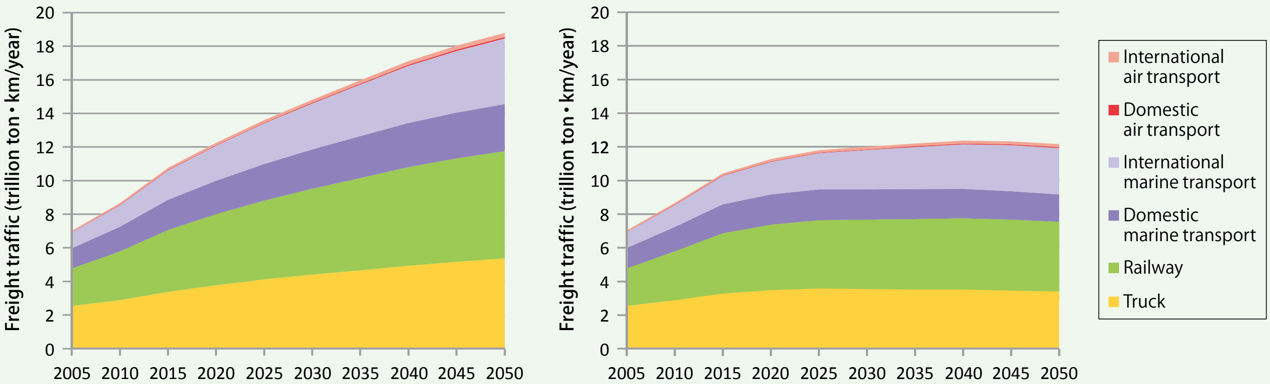


Fig. 2-1 Freight traffic: Reference scenario (left) and LCS scenario (right)

Contribution to GHG Reduction

CO_2 emissions from inter-regional transport in Asia in the Reference scenario in 2050 will be 1.41 $GtCO_2$. These can be reduced by 56%, to 0.62 $GtCO_2$ (Fig. 2-2), by implementing all the measures in Action 2. This reduction contributes to 3.9% of the overall reduction in Asia.

Breaking down the 0.78 $GtCO_2$ of reduction from inter-regional transport into countries, the ratios of (i) Japan, (ii) China, (iii) India, (iv) SEA&XEA, and (v) XSA&XOC (South Asia excluding India and Small Island States in Oceania) will be (i) 2.9%, (ii) 49%, (iii) 18%, (iv) 23%, and (v) 7.2%, respectively.

In each country or region, reduction from inter-regional transport contributes to the overall reduction at a similar level of 3-5%, where the top contributor is SEA&XEA at 5.4%. It is expected that the traffic demand in Southeast Asia region will keep rising, and greater CO_2 reduction can be achieved by pervasion of rail and water transport.

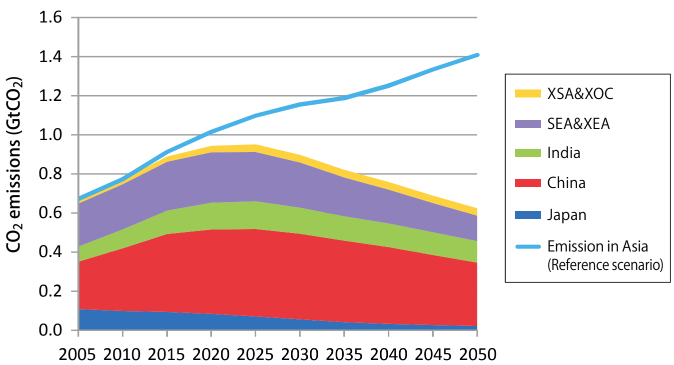


Fig. 2-2 CO_2 emissions from inter-regional transport

Components of the Action

Action 2 consists of three approaches: (1) formation of industrial corridors using a low carbon transport system, (2) establishment of an intermodal transport system incorporating rail and water, and (3) reduction of CO_2 emissions from vehicles and aircraft.

2.1 Formation of industrial corridors using a low carbon transport system (AVOID)

- 2.1.1 Creation of arterial corridors for high-speed freight rail
  - 2.1.1.1 Restructuring of high-speed rail development plans to include freight shipment
  - 2.1.1.2 Development of new high-speed rail lines in conjunction with industrial decentralization
  - 2.1.1.3 Development of high-speed rail lines in conjunction with the establishment of hub ports
- 2.1.2 Clustering of industries around the arterial and terminal connection hubs of high-speed freight rail
  - 2.1.2.1 Streamlining of the conventional railway network
  - 2.1.2.2 Development of dry ports
  - 2.1.2.3 Restructuring of supply chains by clustering industries around high-speed rail stations
- 2.1.3 Creation of institutions and systems to suppress transport demand
  - 2.1.3.1 Introduction of a carbon tax
  - 2.1.3.2 Introduction of carbon footprint practices
  - 2.1.3.3 Installation of videoconferencing systems

2.1.1 Creation of arterial corridors for high-speed freight rail: In order to handle the increased demand for international passenger and freight transport within the continental region in Asia, it is important to establish high-speed rail networks within China and the GMS, and between them. There are several visions for a high-speed passenger rail system such as a rail system running north to south from Kunming (the gateway to southern China) to Singapore, via Bangkok. In addition, there is a plan to construct a conventional passenger railway that connects Bangkok to Yangon in Myanmar. Furthermore, Kyaukpyu Port (located on Myanmar's west coast) is likely to become a gateway that will allow large-scale container vessels to make port calls. By positioning Kyaukpyu Port as a new hub, the opportunity of high-speed freight rail development can also be found in the plan to construct a passenger railway from Kyaukpyu Port to Yangon and Kunming.

2.1.2 Clustering of industries around the arterial and terminal connection hubs of high-speed freight rail: In order to make use of high-speed rail for freight transport, it is essential to establish a comprehensive freight transport network. First, it is necessary to establish a conventional freight rail network for the shipment of heavy loads, extending the existing railway. Then, it would be effective to develop dry ports in highly accessible locations where the high-speed freight rail, conventional freight rail, and highways cross. By connecting these rail and road networks to urban transport system, distribution efficiency and traffic congestion within the city can be improved. In addition, by fostering industry clusters in the vicinity of dry ports, transport distances in the supply chain can be shortened.

2.1.3 Creation of institutions and systems to suppress transport demand: To realize low carbon manufacturing through restructuring of the supply chain, awareness must change not only among manufacturers and suppliers but also consumers in preferences for products manufactured and consumed locally. An effective means of accomplishing this is to introduce a carbon tax. Expanding the mandate to estimate the carbon footprint of products and to organize the information will also be of critical importance. To further reduce CO_2 emissions, long-distance business travel for meetings can be reduced by fully using information and communication technology (ICT) such as videoconferencing.

2.2 Establishment of an intermodal transport system incorporating rail and water (SHIFT)

- 2.2.1 Development of base ports to support international maritime transport
  - 2.2.1.1 Expansion of facilities to allow port calls by large container vessels
  - 2.2.1.2 Development of transit yards connected to rail networks
  - 2.2.1.3 Development of integrated coastal industrial parks
- 2.2.2 Creation of infrastructures for inland high-speed rail
  - 2.2.2.1 Development of a freight rail network based on high-speed rail
  - 2.2.2.2 Training in freight rail operation skills
- 2.2.3 Establishment of institutions to promote the use of low carbon transport modes
  - 2.2.3.1 Abolition of fuel subsidies
  - 2.2.3.2 Introduction of a fuel tax/carbon tax

2.2.1 Development of base ports to support international maritime transport: The use of maritime transport should continue to be promoted for freight shipments outside of the continent. It is therefore necessary to establish base ports in geopolitically important locations, such as Kyaukpyu Port in Myanmar. Specifically, deep-water berths that allow large container vessels to make port calls and intermodal transit yards linked to the freight railroad should be constructed, and the efficiency of distribution should be improved by constructing integrated coastal industrial parks.

2.2.2 Creation of infrastructures for inland high-speed rail: Within the continental region, the use of both passenger and freight rail as low carbon transport modes should be promoted by developing the high-speed rail systems described in 2.1.1. For freight shipments in particular, rail usage can be further advanced by linking high-speed rail to conventional rail and highway networks, and by promoting industry clusters and supply chain restructuring. In addition, skill education and training for efficient operation of freight rail systems that ensures punctuality and reliability is also necessary.

2.2.3 Establishment of institutions to promote the use of low carbon transport modes: In order to promote the use of low carbon transport modes such as rail and waterways, the establishment of institutions that encourage such shifts in usage will be effective as well as building infrastructures. The introduction of a new international taxation system through the cooperation of individual countries, abolishing the current domestic fuel subsidy system, is also desirable.

2.3 Reduction of CO_2 emissions from vehicles and aircraft (IMPROVE)

- 2.3.1 Technological improvements to transport modes
  - 2.3.1.1 Reduction of the weight of aircraft
  - 2.3.1.2 Switch to hybrid diesel freight vehicles
  - 2.3.1.3 Development and introduction of electric maritime vessels

2.3.1 Technological improvements to transport modes: CO_2 emissions can be reduced by making technological improvements to the various types of transport modes. Examples include reducing the weight and improving the engine performance of aircraft, switching to hybrid diesel freight vehicles, and developing technologies to power maritime vessels by electricity. Similarly, reductions in CO_2 emissions can be expected in freight distribution at terminals by upgrading automated guided vehicles (AGVs) through technological innovations and encouraging electrification, automation, and streamlining.

2.3.2 Development of biofuels and promotion of their use: In the case of transport modes that use fossil fuels, switching to biofuel will be effective. According to technological developments for the use of biofuels, it is expected that fuels can provide performance identical to existing fossil fuels.

2.3.3 Optimization of the speed of maritime vessels: For freight shipments, operation of vessels at the optimized speed to enhance environmental efficiency can be promoted by conducting analyses to evaluate the optimal speed and environmental efficiency of various types of vessels. This awareness of efficient methods can be spread by conducting training in the operation of optimized ships.

Potential improvement of supply chains in the GMS for economic efficiency and CO_2 mitigation

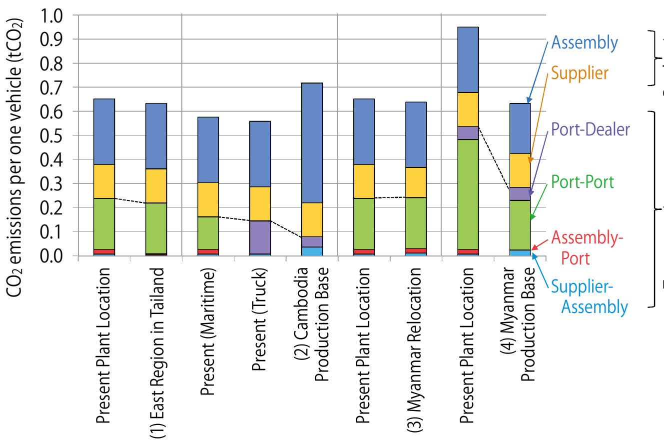
Freight shipment is expected to rapidly grow from the continuous expansion of manufacturing plants in the GMS where wages are relatively low. We analyzed the future changes in CO_2 emissions based on the differences in the conditions of the supply chains according to the locations involved in the manufacturing stage. The suppliers in the automobile manufacturing industry, which involves a large number of suppliers, are dispersed throughout Asia, resulting in approximately 1.4 times CO_2 emissions compared with automobile manufacturing within Japan. We built scenarios for future locations of supply chain bases, considering future growth in automobile demand, the cost of labor, and capital investment in the GMS countries. The results showed that if the base is placed in Myanmar to target the Indian market, CO_2 emissions from transport can be significantly reduced. Thanks to the low emission factor for power generation for manufacturing in Myanmar, the overall reduction in this scenario is approximately 34%.

In addition, we analyzed the share of freight that must be transported by rail to reduce CO_2 emissions to the target level in the GMS. Using two rail lines – Bangkok-Hanoi and Bangkok-Yangon – as case studies, we built two development scenarios; the first improves the existing transport modes, while the second constructs new freight rail systems. Based on targets for reducing CO_2 emissions, costs, and time, the optimal mode share of freight transport was calculated. The results showed that the economic advantage of maritime transport is low in long distances, and the shares of truck and rail are thus high for the Bangkok-Yangon line. The high share of rail use is necessary for both lines when aiming to concurrently reduce both time and CO_2 emissions.

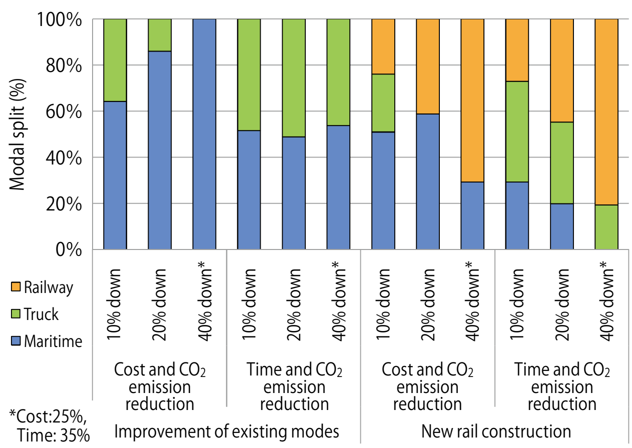
(Shinya Hanaoka)

References

Kumiko Nakamichi, Shinya Hanaoka, and Yuki Kawahara (2013) CO_2 emissions estimation considering the location of an automobile company in the global supply chain, *Proceedings of Infrastructure Planning*, Vol. 47, CD-ROM (in Japanese).
Shinya Hanaoka, Tomoaki Kato, and Kumiko Nakamichi (2013) Eco-efficient modal split of interregional freight transport in Greater Mekong Subregion, *Proceedings of Infrastructure Planning*, Vol. 48, CD-ROM (in Japanese).



CO_2 emissions under supply chain location scenarios



Optimal modal split in freight transport (Bangkok-Yangon route)

Action 3
Smart Ways to Use Materials that Realize the Full Potential of Resources

Overview

Because of the increasing utilization of various raw materials such as steel and cement for the construction of social infrastructure, the penetration of durable goods, and the rising consumption of consumables in Asian nations, it is predicted that GHG emissions associated with these materials (from mining of natural resources and processing to final materials) will increase. The ratio of GHG emissions related to the production of such raw materials to gross GHG emissions is not negligible. The possibility also exists that resources used for mitigation technologies such as solar power, wind power, fuel cells, batteries and the like might become insufficient as these technologies come to be extensively used.

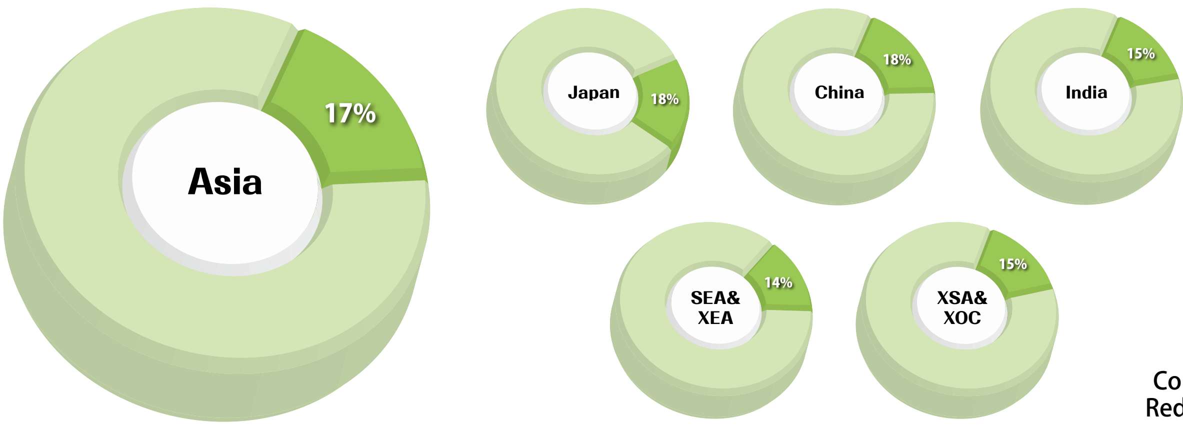
The efficient utilization of these resources is therefore indispensable to achieve a meaningful reduction in GHG emissions. To attain this, it is necessary to employ innovative manufacturing that uses minimal resources, to use manufactured products as long as possible, and to reuse byproducts and wastes repeatedly. Weight reduction of products, substitution of raw materials that emit excessive carbon with alternative materials, and longer lifespan of products should be promoted. Discarded products should be recycled using cleaner energy and better reused.

For governments, it is crucially important to design low carbon cities and national land based on a medium- to long-term perspective to realize long-life infrastructure. Recycling and reuse systems should be established for various goods to enhance their reuse and recycling institutionally. Studies of efficient utilization of resources should also be supported.

In industries, weight reduction, substitution of raw materials, and longer lifespan of products should be promoted to provide the same goods and services with less resource consumption and lower environmental emissions. Simultaneously, technologies related to the recycling and reuse of products and wastes should be developed and adopted.

Citizens are expected to play an important role in reducing GHG emissions related to resource use. In particular, lifestyles that are simple from a material viewpoint but create richness should be realized and practiced. For example, people could change their residence depending on each stage of life and use long-life products that allow recycling and reuse.

In addition to the above activities, international cooperation in the development and diffusion of technologies for efficient utilization of resources will reduce GHG emissions related to resource use in Asia. Furthermore, if environmental labeling systems for internationally traded products become accepted and upgraded, it will become possible for consumers to recognize and support the efforts made by producers.



Contribution to GHG Reduction by Action 3

Changes in Asia Due to Action 3

The efficient use of and drastic reduction of demand for resources are indispensable for meaningful reduction of GHG emissions. The impacts of resource use reduction on GHG emissions are particularly noticeable in the industrial sector, which produces and consumes large volumes of resources. To realize a dramatic reduction of demand for resources, it is crucially important to ensure that infrastructure design in cities and national land is based on a long-term perspective. Furthermore, it is essential to reduce product weight, prolong product life, and promote material substitution so that the same level of utility can be provided with less resource consumption and a lower environmental burden. In addition, used products should be further reused and recycled with clean energy.

Implementation of the measures in Action 3 will encourage the use of highly functional materials as well as smarter product design. This will reduce resource consumption and the environmental burden while providing same level of utility. As a result, it is estimated that the total demand for materials (iron, nonferrous metals, cement, etc.) to maintain the same level of production in the industrial sector will decrease at an annual rate of 1% from 2005 to 2050.

Throughout Asia, product life will be prolonged by the widespread use of maintenance technologies and systems. In addition, resource recycling will expand in line with the penetration of clean energy and the reuse market will become active. These developments will reduce the demand for machinery products in the industrial sector. It is estimated that the demand for machinery products to achieve the same level of economic production will also decrease at an annual rate of 2% from 2005 to 2050. Moreover, the ratio of the percentage change in demand of durable consumer goods such as electronics in the residential sector to the percentage change in income is expected to down 25% in the Low Carbon Society (LCS) scenario compared to the Reference scenario in 2050.

The drastic reduction of material inputs and decline in purchases of durable consumer goods such as machinery will engender a transformation from a goods-centric to a service-oriented society. As a result, energy consumption in the industrial sector will undergo a significant change. In the Reference scenario, consumption of all energy sources in the industrial sector will increase with the exception of coal. Gas consumption will see a particularly significant surge. In contrast, in the LCS scenario, the reduction of coal consumption will further accelerate and oil and gas consumption will enter a declining trend after 2035. In the LCS scenario, despite significant increases in electricity and biomass consumption, the total energy consumption in the industrial sector in 2050 will be 9% lower compared with the Reference scenario (Fig. 3-1).

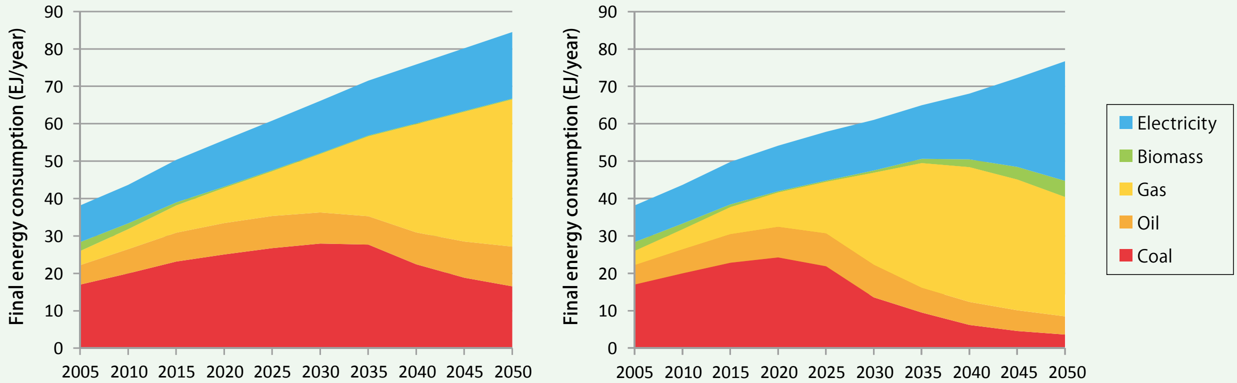


Fig. 3-1 Final energy consumption in the industrial sector: Reference scenario (left) and LCS scenario (right)

Contribution to GHG Reduction

The implementation of Action 3 will contribute to 17% of the overall reduction of GHG emissions in the Asia region. This is due to the higher energy consumption and larger GHG emissions in the industrial sector compared with the residential and commercial sectors (Fig. 3-2).

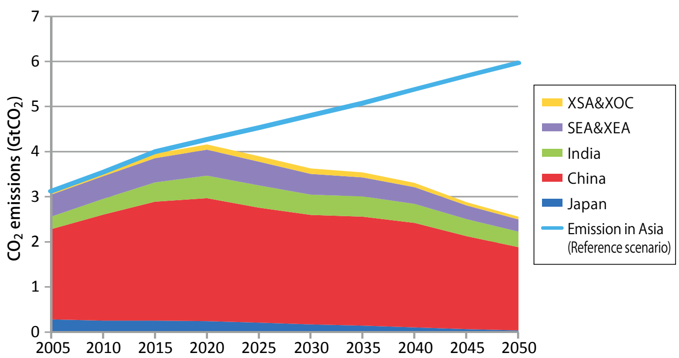


Fig. 3-2 CO_2 emissions from the industrial sector

The contributions are higher in both Japan and China, where a reduction of about 18% of GHG emissions could be achieved by the measures in Action 3. Especially in China, although the use of materials such as iron and cement will be increased because of the accelerated development of infrastructure in the Reference scenario, material consumptions will decline after 2020 in a LCS by implementing Action 3.

The contributions in both India and XSA&XOC (South Asia excluding India and Small Island States in Oceania) are 15%. On the other hand, the contribution in SEA&XEA are lower, at approximately 14%.

Components of the Action

Action 3 consists of three approaches: (1) production that dramatically reduces the use of resources, (2) use of products in ways that extend their lifespan, and (3) development of systems for the reuse of resources.

3.1 Production that dramatically reduces the use of resources

- 3.1.1 Development and active employment of technologies for weight reduction and raw material substitution
  - 3.1.1.1 Support for research and development of technologies
  - 3.1.1.2 Support for diffusion of technologies
- 3.1.2 Creation of materially simple lifestyles while still enjoying richness
  - 3.1.2.1 Utilization of new indices including level of happiness
  - 3.1.2.2 Diffusion of product evaluation systems

3.1.1 Development and active employment of technologies for weight reduction and raw material substitution: Drastic reduction in resource use is a key to reducing GHG emissions substantially at the point of raw material production. To do so, the amounts of raw materials that are used should be reduced while the present roles of materials in the products are maintained (weight reduction). Alternatively, substitute raw materials that serve the same functions should be used (raw material substitution). However, weight reduction technology and raw material substitution technology require further research and development in the future, and support for the development of these technologies is therefore needed. Support for the diffusion of technologies should also be promoted through tax reductions, subsidies, and involvement of international institutions.

3.1.2 Creation of materially simple lifestyles while still enjoying richness: Affluent lifestyles that rely on the consumption of abundant materials should be shifted to materially simple lifestyles while still providing richness. To attain this transformation, an atmosphere in which people accept such lifestyles willingly should be created by quantitatively demonstrating the fact that the level of happiness is unchanged even with materially simple lifestyles, through the utilization of new indices including the level of happiness. Consumers should also gain an understanding of efforts by producers to realize the manufacturing of products with less use of resources and a smaller carbon footprint, and should select such products to boost these activities by producers. Systems to evaluate resource consumption and environmental loads related to products should be constructed and the results should be disseminated to consumers.

3.2 Use of products in ways that extend their lifespan

- 3.2.1 Development and active employment of product life-extension technologies and maintenance systems
  - 3.2.1.1 Support for research and development of technologies
  - 3.2.1.2 Support for diffusion of technologies
- 3.2.2 Development of cities and national land from a long-term perspective
  - 3.2.2.1 Design of cities and national land from a long-term perspective
  - 3.2.2.2 Support for construction of long-lasting infrastructure and maintenance of existing infrastructure
  - 3.2.2.3 Establishment of institutions for evaluation of the effectiveness of public projects and their operation
- 3.2.3 Construction of long-lasting housing and replacement of housing
  - 3.2.3.1 Support for construction of long-lasting housing
  - 3.2.3.2 Diffusion of housing evaluation systems
- 3.2.4 Selection of less resource consuming, long-lasting, recyclable, and reusable products
  - 3.2.4.1 (3.1.2.2) Diffusion of product evaluation systems
  - 3.2.4.2 Creation of incentive systems such as green points

3.2.1 Development and active employment of product life-extension technologies and maintenance systems: After resources are transformed into infrastructure or products, using them for as long as possible is an effective strategy to reduce the input of new resources.

To attain this goal, technologies to extend the lifespan of infrastructure and products for as long as possible and to provide appropriate maintenance during their use should be established and diffused widely throughout society. Additional research and development of such technological systems will necessarily be undertaken with the joint support of governments and industries. Diffusion of these technological systems should also be supported through tax reductions and subsidies.

3.2.2 Development of cities and national land from a long-term perspective: Infrastructure is normally constructed using large amounts of carbon-intensive raw materials (see Topic). If urban areas and national land are designed only from a short-term perspective, it may result in the society concerned being locked into high resource consumption and high carbon emissions. Hence, even at the design stage of cities and national land, resource savings and low carbon concepts should be incorporated on the premise of a minimum level of infrastructure investment and a longer lifespan. In addition, existing infrastructure should be maintained in good order so that resources that have already been consumed can be used for a long time. If public projects related to infrastructure are evaluated from the viewpoints of resource and carbon efficiency as well as financial efficiency, the knowledge obtained will be valuable for investigations into which public projects should be launched by the government. The establishment of third-party institutions to evaluate the effectiveness of public projects is also expected to be effective.

3.2.3 Construction of long-lasting housing and replacement of housing: The reduction of resource consumption for the construction of housing is important because resource consumption and carbon emissions associated with housing are substantial. The lifespan of housing should therefore be lengthened. In this case, flexible responses to the ever-changing life stages and lifestyles of residents play an important role. The construction of housing should allow for alteration of the room layout and facilities while the principal structures are used for a long time. Diffusion of such long-lifespan housing should be promoted. An alternative way of approaching the long-term use of housing is for residents to move to another house that better meets the desired size and room layout over time depending on their life stage and lifestyle. To promote this, a system for the correct evaluation of housing should be established. Under such a system, incentives for maintaining housing values at a high level will be generated and high-quality housing will be able to be used for a long time.

3.2.4 Selection of less resource consuming, long-lasting, recyclable, and reusable products: For goods used in daily life, it is important to select products that consume less resources and that are long-lasting, recyclable, and reusable. Several measures should be pursued to support consumers' choices, such as the appropriate disclosure of product information to consumers through product evaluation systems that can be used as a reference at the time of selection, and incentive systems including green point accumulation when the consumer selects green products.

3.3 Development of systems for the reuse of resources

3.3.1 Development and active employment of recycling and reuse technologies
- 3.3.1.1 Support for research and development of technologies
- 3.2.1.2 Support for diffusion of technologies

3.3.2 Establishment of recycling and reuse systems for various goods
- 3.3.2.1 Establishment of various recycling laws
- 3.3.2.2 Establishment of institutions related to reuse

3.3.3 (3.2.4) Selection of less resource consuming, long-lasting, recyclable, and reusable products

3.3.1 Development and active employment of recycling and reuse technologies: The amounts of new resources (primary resources) consumed can be reduced, thereby reducing carbon emissions in many cases, if resources already stocked in society in various forms are recycled or reused. Although recycling and reuse technologies have already been established for diverse byproducts and wastes, it is necessary that the range of target byproducts and wastes be expanded, high-level recycling and reuse be introduced, and the efficiency of existing technologies be improved further. Consequently, additional support for research and development of technologies is necessary, and support for the diffusion of technologies that have already been developed is also indispensable. International institutions and national governments should jointly promote such activities.

3.3.2 Establishment of recycling and reuse systems for various goods: For the expanded recycling or reuse of byproducts and wastes, the establishment of a new legal system and/or expansion of the scope of existing systems is necessary. It is noteworthy that the establishment of such an institution also enhances technological development.

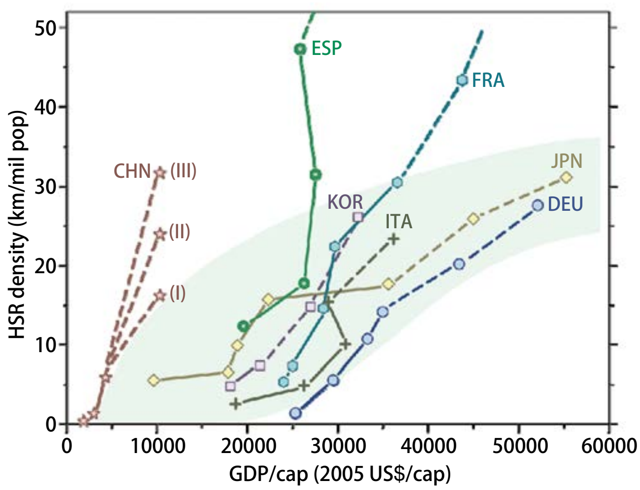
3.3.3 (3.2.4) Selection of less resource consuming, long-lasting, recyclable, and reusable products: From the demand side, as described above, selection of products that consume smaller volumes of resources, that are long-lasting, and that are amenable to recycling and reuse should be promoted.

Material flow analysis of high-speed rail in China

Construction of a nationwide high-speed rail (HSR) network has emerged as one of the largest and most ambitious infrastructure projects in China. As of December 2012, some 8,800 km of double-track HSR lines were in service in the country, accounting for 40% of the total length of HSR in the world. Moreover, there are 35 lines under construction and proposals for the building of some additional 30 lines. The figure shows GDP per capita and HSR density in several countries. Material flow analysis was conducted for three scenarios of expansion of HSR in China up to 2030.

Nearly 70% of the HSR tracks in China are laid on bridges or inside tunnels, which are structures that contain large amounts of raw materials. The entire network will cumulatively require 83–137 Mt of steel and 560–920 Mt of cement up to 2030, depending on the scenario. Although this will not have a significant direct effect on China's demand for material resources, the large-scale use of steel- and cement-intensive structures may abate the environmental benefits of HSR in comparison with automobiles and aircraft over a long life cycle. In Europe and the U.S., where the ratio of bridges and tunnels on HSR routes is usually less than 30%, it may take up to 20 years for the GHG emissions resulting from infrastructure construction and material production to be counterbalanced by the emissions avoided through the shift in traffic from high-emitting modes to rail. This environmental payback is found to be highly sensitive to traffic ridership changes and the electricity mix. If coal-fired generation remains predominant in China's electricity supply, some 20 to 30 years would be needed to reclaim the environmental profit of HSR.

(Tao Wang)



GDP per capita vs. HSR density in China (CHN), Japan (JPN), South Korea (KOR), France (FRA), Germany (DEU), Italy (ITA), and Spain (ESP)

The solid line represents historical trends, and the dashed line shows future plans or scenarios.

Action 4

Energy-Saving Spaces Utilizing Sunlight and Wind

Overview

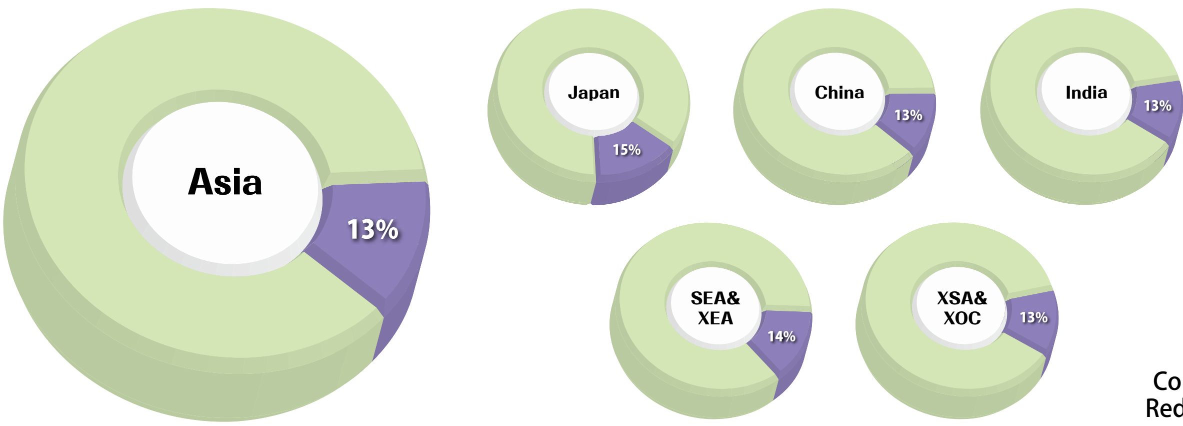
As a number of Asian countries are located in tropical and subtropical regions, the demand of cooling service in the building sector has been rapidly increasing in line with their economic development and the pursue of comfort. In addition, the countries with template and subarctic zone, the demand of heating has also rapidly increasing in addition to the demand of cooling. Therefore, it is important to conduct the measures to respond to the cooling and heating service in order to make low carbon in the building sector. In parallel, it is also necessary to address the measures to reduce the energy consumption from the appliances the building sector as the number of appliances has been also rapidly diffused year by year in line with Asian countries' economic growth and the expansion of the economic activities.

In order to reduce the demand of cooling and heating service, it is imperative to design the buildings which can manage sun light and humidity by making the ventilation. In line with the characteristics of each region's climate, it is also necessary to make device for insulation and making use of sun light in order to provide sufficient cooling and heating services as well as enhance energy efficiency. Moreover, the development of energy efficiency building performance standard which suits to each climate zone will also contribute to the creation of high energy efficiency space.

In parallel, it is also necessary to provide financial support, such as subsidy and row-interest rate loan in order to rapidly diffuse affordable high energy efficiency cooling heating and other appliances by activating the competition to penetrate the market about the high energy efficiency appliance. The diffusion of high efficiency appliance will assist reducing the energy demand and energy consumption in the building sector.

It is also imperative to provide social benefit in addition to the financial ones in order to promote the low carbonization in the building sector. Objective evaluation about the low carbon activities by each business office and household, recognition of their best practices, and prize-giving to their great contribution will encourage the proactive activities towards the low carbonization.

It is essential to develop the mechanism to evaluate objectively about the effort by each stakeholder. Visualization of each stakeholder's effort by the third party's evaluation and prize-giving will be very important measures to reward their effort and encourage their continuous and proactive effort.



Contribution to GHG Reduction by Action 4

Changes in Asia Due to Action 4

With the economic growth taking place in Asia, energy demand in the building sector is projected to increase further. However, significant reductions in energy consumption and CO_2 emissions can be envisaged by implementing the approaches in this Action aimed at realizing a Low Carbon Society (LCS); namely, improvement of the energy-efficiency performance of buildings, application of high-efficiency equipment to buildings including heating/cooling equipment, and visualization of energy-saving efforts.

In a LCS, there will be widespread use of construction technologies and designs reflecting the regional climate, such as passive systems incorporating sunlight and natural wind. Moreover, energy consumption will be reduced while maintaining comfort and convenience in houses and buildings thanks to the improvement of technologies in such fields as insulation, solar shading, and natural ventilation.

In 2050, the energy efficiency of consumer electrical appliances and commercial equipment including air conditioners will have dramatically improved from the current levels. Appropriate utilization of equipment based on its characteristics will realize effective use of energy while maintaining sufficient comfort and convenience. Furthermore, energy-efficiency efforts in the building sector will be visualized and promoted by international standards as well as regional environmental performance standards.

Based on these assumptions of the LCS scenario, cooling and heating demand in the residential sector is estimated to drop by 1% per annum by 2050, while the energy efficiency of household appliances and commercial equipment is projected to improve by 0.5% per annum compared with the Reference scenario.

In a LCS, reductions in property taxes and loan interest rates in accordance with certified environmental performance (e.g., energy consumption, CO_2 emissions) will be widely applied to incentivize the construction and purchase of houses with higher environmental performance. Owners of existing houses will be able to utilize consultancy services at reasonable prices for consultations including renovation proposals to improve environmental performance. In addition, improvement of the environmental performance of houses will be incentivized through such measures as discounts in renovation fees and reductions in loan interest rates. A LCS will have a well-developed system where high environmental performance of houses is highly evaluated. This will induce people to prefer such houses even if they are not particularly concerned about the environment.

Designers and architects capable of combining building designs reflecting the regional climate and state-of-the-art equipment will be nurtured in each region and their know-how will be handed down to the next generation. Furthermore, long-life buildings such as houses with a 200-year lifespan will be widely used, restraining wasteful use of resources and energy. As a result, in the LCS scenario, final energy consumption in the building sector will reach a peak in around 2030, while it will increase by 132% between 2005 and 2050 in the Reference scenario. Oil consumption will significantly grow in the Reference scenario, but will peak after 2030 in the LCS. Instead, the share of electricity will become much higher (Fig. 4-1).

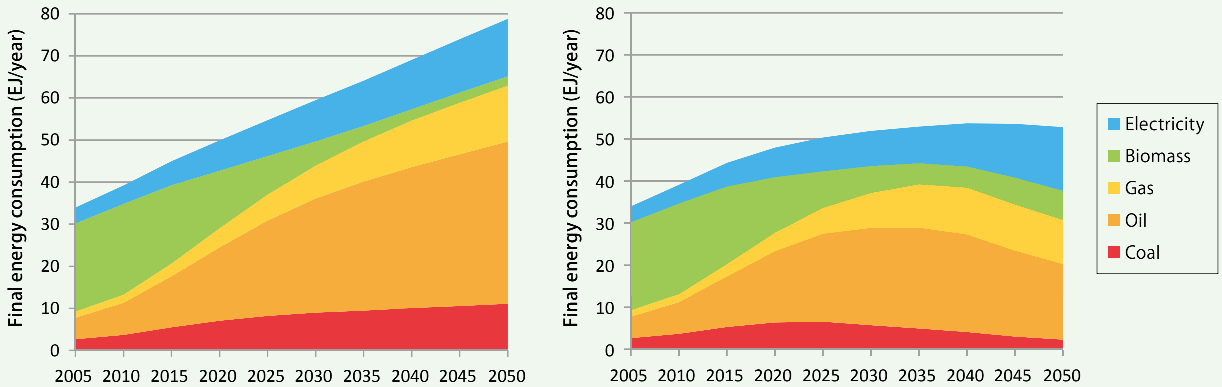


Fig. 4-1 Final energy consumption in the building sector: Reference scenario (left) and LCS scenario (right)

Contribution to GHG Reduction

In the Reference scenario, total CO_2 emissions from the building sector in Asia in 2050 are estimated to be approximately 5.4 $GtCO_2e$, the third-largest amount following the emissions of the energy and industrial sectors. This is five times the 2005 level. In the LCS scenario, however, CO_2 emissions in the building in Asia could be cut by approximately 2.8 $GtCO_2e$ through implementation of the measures in Action 4. This reduction represents 51% of the Reference emissions, and results in an increase to only 2.8 times the 2005 level.

The contribution of the building sector to the overall reduction of GHG emissions in Asia in 2050 will be 13%. The figures for Japan and SEA&XEA, at 15% and 14%, respectively, are higher than the Asian average, while those for other Asian regions are 13%. This is due to the fact that the share of GHG emissions reduction in the agricultural sector is lower in Japan and the share of GHG emissions reductions in the industrial and energy sectors is lower in Southeast Asia compared with the Asian average.

Although Japan's CO_2 emissions in the building sector in 2005 account for approximately 22% of the figure for Asia overall, its share will significantly drop to 5.1% in 2050, while the share of China increases from 43% in 2005 to 45% in 2050.

Components of the Action

Action 4 consists of three approaches: (1) improvement of the energy-efficiency performance of buildings, (2) application of high-efficiency equipment to buildings including heating/cooling equipment, and (3) visualization of energy-saving efforts.

4.1 Improvement of the energy-efficiency performance of buildings

- 4.1.1 Mandatory energy-efficiency standards for new and renovated buildings
  - 4.1.1.1 Development of regional building energy-efficiency standards and gradual strengthening of them toward a mandatory standard
  - 4.1.1.2 Implementation of demonstration projects for energy-efficient buildings matching each country's conditions
- 4.1.2 Creation of comfortable environments through maximum use of renewable energy
  - 4.1.2.1 Development of passive building designs using natural ventilation and lighting associated with each country
  - 4.1.2.2 Promotion of renewable-energy equipment for residential buildings
- 4.1.3 Development of a financial support scheme for improvement of building energy performance
  - 4.1.3.1 Support for insulation of new and renovated buildings
  - 4.1.3.2 Development of incentives for high-energy-performance buildings
  - 4.1.3.3 Implementation of energy-performance improvement programs through financial support from international organizations

4.1.1 Mandatory energy-efficiency standards for new and renovated buildings: Energy demand for heating and cooling is dramatically increasing in Asia. In many large buildings, the walls are not well insulated and the air-conditioning load is considerable. In order to curb energy demand for buildings, it is essential to consider energy efficiency as well as comfort from the design and construction phases by setting standards for energy consumption, heat load, and airtightness. One option is to build an energy-efficient building that meets the criteria of each country's standards so that people can actually experience the benefits and comfort of such a building.

4.1.2 Creation of comfortable environments through maximum use of renewable energy: To reduce cooling and heating demand, the use of natural ventilation and sunlight is effective in addition to insulation. The application of renewable energy to buildings from a photovoltaic or wind turbine generation system is also an effective option for reducing fossil fuel consumption although this does not reduce the cooling or heating demand directly. For this option, a strengthened R&D program and the application of energy storage system are important.

4.1.3 Development of a financial support scheme for improvement of building energy performance: Buildings with high energy performance are generally costly, especially during the design and construction phases. Financial support such as subsidies or tax reductions can therefore serve as a great incentive for owners. In Asia, both subsidies and reductions in property taxes will be important measures for the promotion of energy-efficient buildings and renewable-energy systems. The development of financial support schemes by international organizations will also be important.

4.2 Application of high-efficiency equipment to buildings including heating/cooling equipment

- 4.2.1 Promotion of energy-efficiency improvement of equipment
  - 4.2.1.1 Development of equipment energy performance standards
  - 4.2.1.2 Implementation of a "top runner" program
  - 4.2.1.3 Development of energy-efficient technologies and promotion of technology transfers
- 4.2.2 Development and deployment of comprehensive evaluation systems for energy-efficient equipment
  - 4.2.2.1 Development and deployment of building energy management systems through IT solutions and sensors
  - 4.2.2.2 Development of a support scheme for planning of energy-efficient equipment
- 4.2.3 Provision of financial support for energy-efficient equipment
  - 4.2.3.1 Development of a support scheme in line with energy performance standards
  - 4.2.3.2 Implementation of an energy-efficient equipment promotion program through financial support from international organizations

4.2.1 Promotion of energy-efficiency improvement of equipment: Improvement of the energy efficiency of equipment reduces its energy consumption while maintaining the same energy service level, thus contributing significantly to GHG reductions. In order to successfully achieve this, relevant information must be provided to the consumer in an appropriate manner. By setting energy performance standards and obliging suppliers to follow these standards, energy-efficient equipment can be further promoted. The standards should be reviewed regularly and updated according to technical developments. The "top-runner" scheme implemented in Japan is an effective approach to improve the energy efficiency of equipment.

4.2.2 Development and deployment of comprehensive evaluation systems for energy-efficient equipment: To efficiently implement low carbon measures in a building, attention should be focused not only on each item of equipment but also on the overall system. One example of a method for achieving this is a building energy management system (BEMS), which realizes central control of equipment such as air conditioners used by the various tenants of a building through information technology (IT) solutions.

4.2.3 Provision of financial support for energy-efficient equipment: Financial support should be provided based on objective energy performance evaluations. It is desirable to develop a policy package combining evaluation indices and financial support schemes, such as energy performance labeling and tax incentives. Programs for the promotion of energy-efficient equipment with financial support from international organizations are also important.

4.3 Visualization of energy-saving efforts

- 4.3.1 Development and management of evaluation systems for energy-saving actions
  - 4.3.1.1 Mandatory building energy auditing scheme
  - 4.3.1.2 Development of a common energy-saving standard for Asian countries
- 4.3.2 Development of incentive schemes in line with energy-saving efforts
  - 4.3.2.1 Development and management of an awards program based on disclosed information and an evaluation system

4.3.1 Development and management of evaluation systems for energy-saving actions: By visualizing energy consumption and the cost to the consumer, wasteful energy consumption can be. The acquisition of appropriate data that reflect the actual efforts being made is essential for such visualization. To accomplish this task, an energy auditing system should be developed and adopted and the accuracy of the published data should be reconfirmed. Energy-efficiency codes have been developed and operated differently in individual countries up to now. Henceforth, it may become easier to evaluate technologies by expanding the scope of these standards to a common standard for Asia.

4.3.2 Development of incentive schemes in line with energy-saving efforts: If energy-saving efforts can be visualized in Asia, the efforts of industries or citizens can be compared. These efforts can then be further accelerated by providing grants or tax incentive schemes associated with the efforts. A system that allows users to browse a list of energy-efficient technologies should also be developed and managed in order to improve access to relevant information

4.3.3 Education on energy-saving actions and promotion of knowledge sharing: It is consequently essential to develop information distribution measures that help people to continuously learn about these matters and improve their actions accordingly. An example of such measures is an experts dispatching program, in which experts analyze the current actions of citizens or private companies and provide advice for improvements from their perspective.

Rural electrification and solar energy in Bangladesh

Bangladesh has a low electrification rate, with 82% of urban residents and only 33% of the rural population having access to electricity, resulting in 87.8 million citizens lacking electricity supplies (IEA, 2012). To upgrade electrification, the government needs to improve infrastructure facilities such as power plants, substations, and transmission lines. However, the high initial costs and low cost-effectiveness of expanding the national grid to rural areas, particularly to isolated and sparsely populated areas, is an impediment to the supply of electricity to off-grid populations.

The promotion of decentralized electrification based on solar photovoltaic (PV) systems is acknowledged to be one of the best alternative methods of facilitating electrification, due to the relatively low initial costs for acquiring systems and the fact that large infrastructure investments for delivering electricity are not required. Usually, a household-level solar electrification kit called a Solar Home System (SHS), consisting of a solar panel (10–130 W), a battery for storing electricity, electric lighting, and accessories, is sold or leased to households. As the generation capacity is limited by the availability of sunshine, electricity generated by the SHS is normally used for low-power electrical devices such as electric lamps and television sets (black and white).


Household use of a fan powered by a solar system in rural Bangladesh (September 2010)

Based on a household survey conducted in rural Bangladesh (Komatsu et al., 2011a), we have identified multiple benefits obtained from the adoption of SHS; namely, that households with SHS have reduced kerosene consumption and dependence on rechargeable batteries, and enjoy the benefits of using electric lights, watching TV, and recharging mobile phones at home. Households with electric lighting also benefit from an extension of study time for children, and of working time until late at night. Households requested for using electric fans to keep off summer heat (see photos), then the demands will show a sharp increase if sufficient power supply permits them to use fans. To quantitatively determine factors that affect user satisfaction with SHS (Komatsu et al., in press), we found that user satisfaction improved in households that achieved a decrease in the frequency of battery repairs, lower dependence on kerosene, and extension of children's study time. Moreover, the results of a study to quantitatively determine factors affecting the decision to purchase SHS (Komatsu et al., 2011b) indicated that household income, ownership of rechargeable batteries, kerosene consumption, and the number of mobile phones were the key determinants of the adoption of SHS.

Kaneko et al. (2012) evaluated institutional mechanisms of the rural electrification, political interference associated with electrification and anti-corruption mechanisms, and the roles of rural electrification cooperatives which contributed to expand the areas of electrification. Accounting for the fact that the costs of PV cells are still high, they propose innovative technological cooperation initiatives in which new but appropriate technologies from developed countries would be invested and commercialized in developing countries such as Bangladesh to substantially reduce the costs and expand the coverage of SHS. (Satoru Komatsu)

References

IEA, *World Energy Outlook* 2012.
Komatsu et al. (2011a) *Energy Policy*, Vol. 39(7), pp. 4022-4031.
Komatsu et al., *Energy* (in press).
Komatsu et al. (2011b) *Energy for Sustainable Development*, Vol. 15(3), pp. 284-292.
Kaneko et al. (2012) *Climate Change Mitigation and International Development Cooperation*, Fujikura and Toyota (eds.), Routledge, Chapter 10, pp. 202-226.

Action 5 Local Production and Local Consumption of Biomass

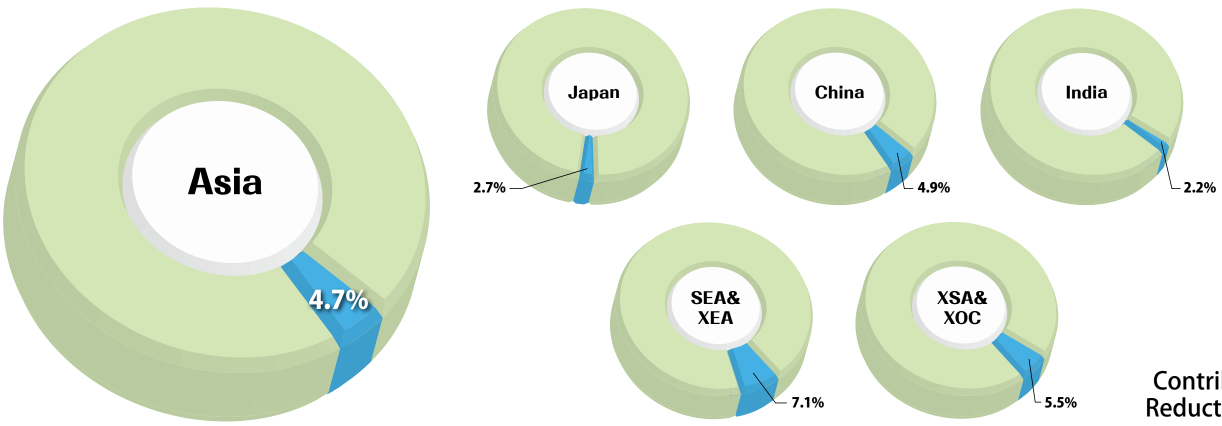
Overview

Biomass energy can be used directly by end-users or as an energy resource in production activities like power stations or other centralized energy supply facilities. It plays vital role in low carbon development in rural and urban areas of Asia. Firewood and charcoal are primary energy resources used by households for cooking and hot-water supply in many Asian countries. Their use causes serious health problems. Hence, improving living environments is an important associated issue for biomass use while achieving low carbon development.

Using biomass energy as a major energy source in low carbon Asia is ordained on establishing sustainable biomass production and utilization systems that avoid conflict with food production and forest conservation, and promoting the consumption of these biomass resources locally. The installation of such energy-supply systems using woody biomass, waste, and animal biomass in rural agricultural communities having plentiful biomass resources will enhance the supply of low carbon energy, besides improving the standard of living.

For promoting the utilization of biomass in Asia, governments need to implement land use regulations and other policies that prevent conflict among 'food, forest and fuel'. Phasing out of fossil fuels subsidies is one policy which can immediately enhance competitiveness of biomass energy. In addition to supply-side policies, the policies and measure that encourage citizens to follow sustainable land use and forests management practices that enhance biomass production and food production; minimize harvesting of forest biomass; and prompt agro-industry, to make innovations of commercial biomass resources that do not compete with food production.

Since biomass production and use is dispersed, the global scale research and development of biomass energy resources and conversion technologies, and the transfer of technology and the best practices is very vital to develop the supply-push ahead of the development of the global biomass market. In addition, the preferential support to biomass energy through carbon finance instruments, including the carbon credits, are key to promote demand-side pull from the energy market. In these contexts, the industry can play central role in research and development and government's policies and programs could support the widespread adoption of such advanced biomass resources and technologies.



Contribution to GHG Reduction by Action 5

Changes in Asia Due to Action 5

In order to establish a Low Carbon Society (LCS) based on the efficient use of biomass, it is necessary to work toward realizing not only the diffusion of technologies but also the design of a comprehensive system covering the production, collection, and consumption of biomass. Such a new system will require a cost-effective technology transition, starting with improvements in current mature technologies such as cook-stoves and followed by deployment of advanced biomass technologies such as biomass boilers, gasifiers, anaerobic digesters.

Through the implementation of Action 5, energy systems using locally available biomass resources will be introduced in rural areas, while the use of biofuels for transport will grow in urban areas. As a result, the share of biomass energy in the primary energy supply in Asia by 2050 in the LCS scenario will reach 19%, equivalent to 6.8 times that in the Reference scenario. This amount is 2.2 times the level in 2005 (24 EJ). It is worth noting the significant growth of biomass energy after 2030 in the LCS scenario. In contrast, the consumption of fossil fuels will decline considerably after 2025 (Fig. 5-1). The area of land used for biomass production in Asia will be 6.4 Mha (Mha = 10^6 ha) in the Reference scenario, on the other hand, in the LCS scenario, the area will grow 51 Mha. Even in the LCS scenario, such area corresponds only 2.4% of total Asia (2,122 Mha) (Fig. 5-2). The model includes competition of land use between biomass production and food production, however, modeling analysis has been made on the assumption that biomass energy production will not affect food supply.

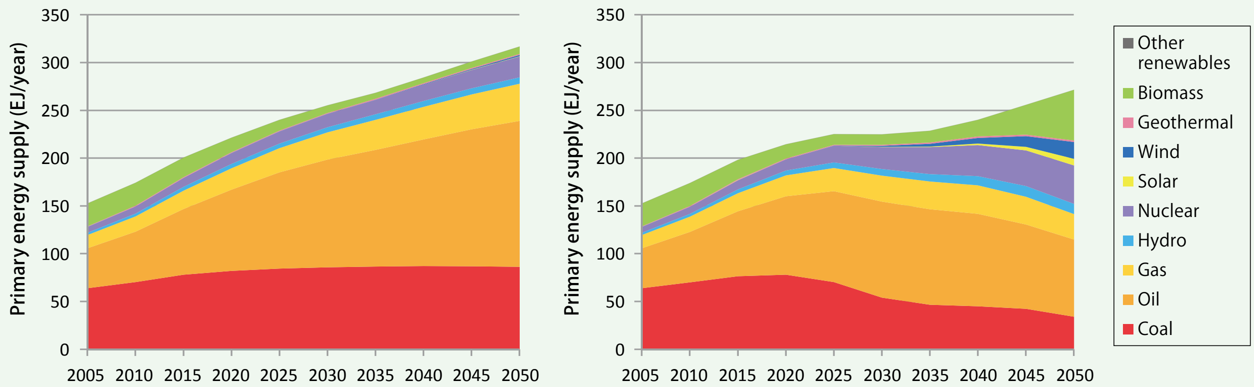


Fig. 5-1 Primary energy supply: Reference scenario (left) and LCS scenario (right)

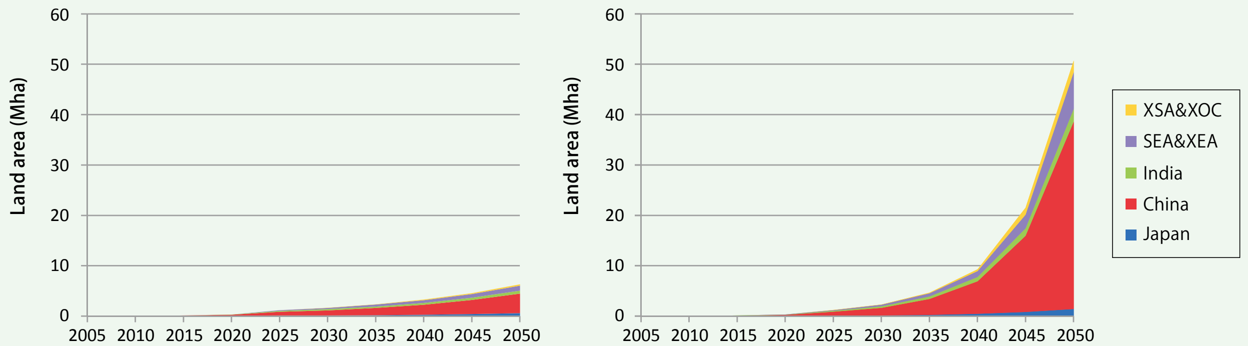


Fig. 5-2 Land area for biomass production: Reference scenario (left) and LCS scenario (right)

Contribution to GHG Reduction

The GHG reduction by Action 5 in Asia will be 0.96 $GtCO_2$. The GHG emissions reductions consists of 2.5% of Japan, 55% of China, 8.1% of India, 25% of SEA&XEA, and 9.8% of XSA&XOC (South Asia excluding India and Small Island States in Oceania) (Fig. 5-3). In particular, reduction in China is most dominant and will be 0.52 $GtCO_2$ by 2050 (Fig. 5-3).

The contribution of Action 5 to GHG reduction in Asia will be 4.7%. The corresponding contribution in India is the lowest, at 2.2%, and that in Japan is also small, at 2.7%. In India, about 60% of land area has been cultivated and unused area except for forest is not available so much. In the future, due to the increase of population and income, food demand will increase twice from current level. Biomass energy demand expects increase as well, but India will face difficulties to keep land area for biomass production.

In contrast, this action accounts for 7.1% of GHG reduction in SEA&XEA, 5.5% in XSA&XOC, and 4.9% in China.

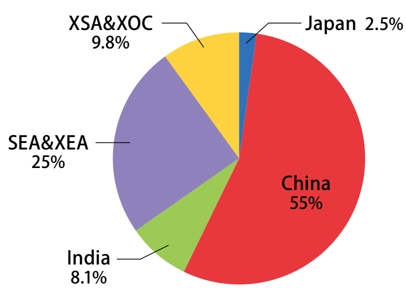


Fig. 5-3 Regional shares of GHG reduction in Asia by Action 5 in LCS scenario (2050)

Components of the Action

Action 5 consists of three approaches: (1) sustainable co-production of biomass energy and food, (2) low carbon energy systems using local biomass resources in rural areas, and (3) improvement of living environments with intensive biomass utilization.

5.1 Sustainable co-production of biomass energy and food

5.1.1 Improved biomass production technologies
- 5.1.1.1 Development of production technologies for unused biomass resources
- 5.1.1.2 Development of sustainable business models for biomass use and promotion of agriculture and forestry

5.1.2 Land use for sustainable biomass production
- 5.1.2.1 Establishment of land use regulations to resolve competition between food production and biomass production
- 5.1.2.2 Understanding of sustainable forest management, farmland management, and biomass production

5.1.3 Development and implementation of biomass CCS technologies
- 5.1.3.1 Development of biomass CCS technologies
- 5.1.3.2 Implementation of biomass CCS technologies

Biomass is a renewable energy, but if it is used excessively in a short time, the amount consumed will exceed the amount renewed, resulting in a negative impact on the environment. Although some biomass resources such as energy crops may compete with food production in terms of land use, ensuring the supply of food takes priority over energy. It is therefore necessary to establish systems that can produce and utilize biomass resources without competing with food production.

5.1.1 Improved biomass production technologies: To establish a sustainable biomass production system balanced with food production and forest conservation, it is necessary to improve efficiency of biomass production technologies, as well as to achieve sustainable biomass production by adjusting land use. Technologies need to be developed and disseminated for the effective utilization of both already exploited and currently unused biomass resources. Moreover, since excessive reliance on biomass may lead to shortages of biomass resources to meet future demand, business models should be formulated and implemented based on sustainable biomass use at an early stage.

5.1.2 Land use for sustainable biomass production: The easiest means is to adjust land use and establish regulations so that competition between food production and biomass production does not arise. It is also necessary to obtain the understanding of the public regarding these regulations, so as to foster understanding of restrictions on biomass production and the importance of compliance for the sustainable management of forests and farmland.

5.1.3 Development and implementation of biomass CCS technologies: Since biomass is a carbon-neutral resource, the CO_2 emitted by its use is not counted as an emission. If a carbon capture and storage (CCS) system is applied with biomass, it can contribute to the reduction of atmospheric CO_2 emissions. Biomass CCS technology is currently at the research and development stage and further technological development is required. However, pursuing this and encouraging its widespread adoption is expected to play an important role in establishing low carbon energy systems using biomass resources in Asia.

5.2 Low carbon energy systems using local biomass resources in rural areas

5.2.1 Design and implementation of energy systems using biomass
- 5.2.1.1 Research and development of independent energy-supply systems using biomass
- 5.2.1.2 Establishment of funds to support widespread adoption by communities, and to research and development
- 5.2.1.3 Visualization of the state of electric power generation
- 5.2.1.4 Knowledge sharing through an international platform
- 5.2.1.5 Phasing out of subsidies for fossil fuels

5.2.2 Visualization of the benefits of independent energy-supply systems
- 5.2.2.1 Implementation of a system for evaluating environmental conservation through local production of biomass for local consumption
- 5.2.2.2 Provision of community information services as a secondary effect of advanced biomass use
- 5.2.2.3 Promotion of small-scale biomass use and improved quality of life in agricultural communities

In order to introduce and popularize independent energy supply systems using local biomass resources in rural areas, it is necessary to design and implement systems for biomass energy, as well as visualizing the advantages of implementing such systems so that people in rural areas understand their benefits beyond reduced carbon emissions.

5.2.1 Design and implementation of energy systems using biomass: Before implementing energy systems using biomass, it is necessary to conduct research and development of applicable technologies for a range of biomass resources, and to identify the optimal combination for a stable, low carbon energy supply. In the implementation phase, investment by governments and international organizations is important, but to achieve widespread adoption of the systems in Asia, it is desirable for agricultural communities to procure funds themselves. In the operating phase, incentives for energy conservation and energy utilization can be provided as appropriate. It is also important to remove subsidies for fossil fuel and electricity to improve the competitiveness of biomass resources.

5.2.2 Visualization of the benefits of independent energy-supply systems: In the popularization phase, it is important to visualize the benefits of the systems in addition to their lower emissions and to disseminate this information to the public. To achieve this, it is vital to first evaluate how the implementation of biomass energy systems will contribute to local environmental conservation and economic development. Providing such information to the public will foster understanding of the various benefits beyond lower emissions, and of the need to bear the costs of introducing, maintaining, and replacing the system.

5.3 Improvement of living environments with intensive biomass utilization

5.3.1 Widespread adoption of high-efficiency furnaces in homes
- 5.3.1.1 Change of lifestyles toward use of enegy efficient furnaces
- 5.3.1.2 Promotion of proactive local approaches toward positive deployment of improved furnaces

5.3.2 Widespread adoption of new biomass technologies
- 5.3.2.1 Transfer of new biomass technologies

5.3.2.2 Taxation and institutional support for the transfer and adoption of advanced biomass technologies
5.3.2.3 Implementation of advanced biomass application technologies in each community

5.3.1 Widespread adoption of enegry efficient furnaces in homes: Changing cooking stoves to gas or electric cooking systems is the most effective approach to solve health issues and improve household living standards in rural areas. However, as the costs of such systems and the required infrastructure are high compared with income levels in rural areas, the widespread adoption of energy efficient furnaces in homes is more feasible. Energy efficient furnaces can now be acquired cheaply, but the barrier to their use is the change required in the entrenched traditional lifestyle of collecting biomass directly for cooking, etc. Efforts to diffuse energy efficient furnaces and change lifestyles, including through subsidies, tax breaks, and so on by governments and international organizations, will lead to improved living standards and economic activation in rural areas.

5.3.2. Widespread adoption of new biomass technologies: The widespread adoption of new technologies is an effective means of improving living environments as well as reducing the carbon intensity of energy systems. New biomass technologies are presently used in a few countries and regions. It is therefore necessary to promote technology transfers and establish tax breaks and institutional support for the adoption of these technologies. Even if advanced biomass energy technologies are too expensive to be introduced in each home, they can be implemented at the community level as joint-use systems, thereby reducing costs and accelerating adoption.

Renewable energy strategy in China

The 12th five-year plan adopted by the Chinese government in 2011 increased non-fossil energy for primary energy consumption from the 2010 rate of 8.6% to 11.4% by 2015. Table summarizes the amounts of renewable energy in the sequential individual non-fossil energy targets.

Renewable energy strategy targets in China's 12th 5-year plan

Renewables	2010	2015		
	Actual	Target	Annual quantity	10^4tce*/yr
Ⅰ Electricity Generation	253.3 GW	394 GW	1,203 TWh	39,000
1. Hydropower (excl. pumped hydro)	216 GW	260 GW	910 TWh	29,580
2. On-grid wind power	31 GW	100 GW	190 TWh	6,480
3. Solar photovoltaic	0.86 GW	21 GW	25 TWh	810
4. Biomass generation	5.5 GW	13 GW	78 TWh	2,430
Agricultural and forestry biomass generation		8 GW	48 TWh	1,500
Biogas generation		2 GW	12 TWh	370
Generation from municipal waste		3 GW	18 TWh	560
Ⅱ Gas supply			22 km^3	1,750
1. Homes supplied with biogas	40 mil. houses	50 mil. houses	21.5 km^3	1,700
2. Industrial organic wastewater biogas facilities		1,000 facilities	0.5 km^3	50
Ⅲ Heating and Cooling				6,050
1. Solar heating	168 km^2	400 km^2		4,550
2. Solar cookers		2 mil. units		
3. Geothermal				1,500
Space heating and cooling		5,800 km^2		
Hot water		1.20 mil. houses		
Ⅳ Fuel				1,000
1. Biomass solid fuel	3,000 kt	10,000 kt		500
2. Biomass ethanol	1,800 kt	4,000 kt		350
3. Biomass diesel	500 kt	1,000 kt		150
Total				47,800

*tce: tons of coal equivalent

Compared with the results for 2010 (the final results achieved in the 11th 5-year plan period), the solar power generation target of 21 GW in 2015 is the most ambitious, almost 25 times that of 2010 (annual percentage rate: 89.5%). Next is wind power generation with a target of 100 GW, 3.3 times that of 2010 (annual percentage rate: 26.4%), followed by 13 GW for biomass representing 2.4 times that of 2010 (annual percentage rate: 19.1%).

China's solar power generation capacity was only 0.86 GW until 2010, of which 0.63 GW was achieved through the government's Golden Sun Pilot Project, a subsidy program that started in 2009. Those authorized under the project received a 50 to 70% subsidy from the government for capital investment and an agreement to purchase surplus power for 15 years. By 2012, the total capacity installed through this system increased to 6.87 GW. With the commencement of the fixed tariff system in 2010 (1 to 1.15 yuan/kWh, for 15 years), new applications will be terminated after 2013.

A fixed tariff system was established for wind power and biomass power, in 2009 and 2010 respectively, with a tariff of 0.51 to 0.61 yuan/kWh and 0.75 yuan/kWh for agricultural and forestry biomass generation.

The reasons why the Chinese government is focusing on renewable energy go beyond responding to climate change, ensuring energy security, and fostering environmental technologies and related industries. One is to expand access to energy. Currently there are at least four million people living without electricity. The Chinese government is spending large sums on subsidies for solar and biomass power generation facilities as part of its social security and welfare policies.

Another reason is to protect its industry through the expansion of domestic demand, and to disperse trade risk in overseas exports. In addition to stagnant exports of solar panels, trade friction with the U.S. and EU, which intensified from 2010, brought about an unprecedented crisis for China's solar businesses. The significant increase in the target for solar power generation can be seen as a reaction to earlier tardiness in stimulating domestic demand. However, besides dealing with a supply surplus, it also has considerable benefits in dispersing trade risk and improving energy access.

As of the end of 2012, the total capacity of hydroelectric power generation had expanded to 249 GW, that of wind power generation to 6.5 GW, and the installed area of solar water heating to 258 million m^2. This means that renewable energy overall accounted for 9% of primary energy production, which corresponds to 28% of all electric power plant capacity.

However, there are many problems with the implementation of renewable energy in China. First, the power grid cannot keep up with the increase in new facilities, and transmission companies deliberately avoid involvement with it. Some 17% of the total renewable energy generating capacity has no access to transmission lines. The fixed tariff is also too low in some regions, and the application procedures can be confusing, with a certain tariff added to fossil fuel prices, set differently in each region. (Zhen Jin and Jusen Asuka)

Low Carbon Energy System Using Local Resources

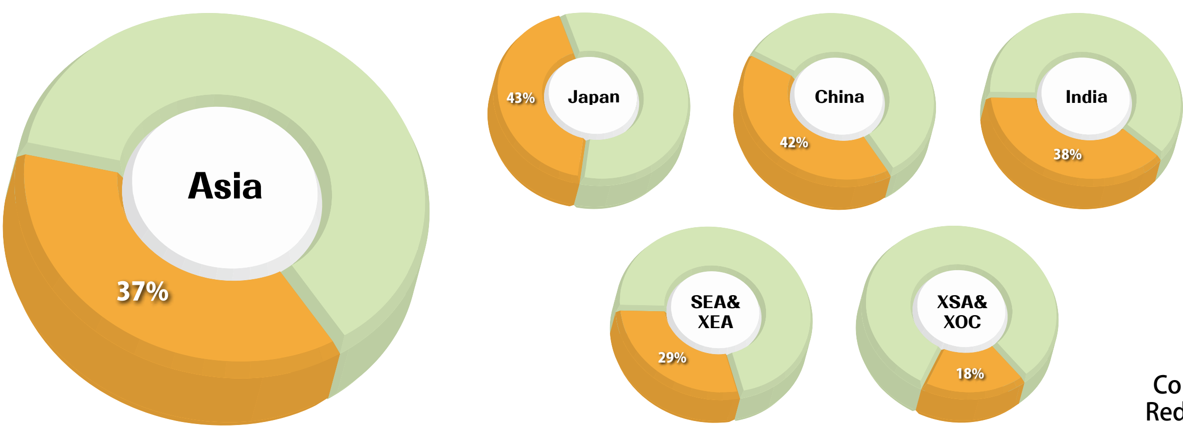
Overview

Toward the realization of a Low Carbon Society (LCS) in Asia, the low carbonizing in energy demand as well as supply have vital role. Energy-saving activities and the application of renewables such as solar photovoltaic (PV) and wind power are keys to a reduction of greenhouse gases (GHGs). The use of renewable energies will also improve energy access, eliminate energy poverty, and establishment of sustainable local energy systems.

In a low carbon Asia, it will also be essential to make fossil-fuel-based energy-supply systems more efficient and to facilitate co-ordination between fossil fuels and renewable energy, thereby improving energy security. Similarly, creation of a "smart" energy system that integrates the energy-demand side will be vital. To establish these systems, governments have to develop a medium to long-term energy policy that provides a clear direction domestically and globally on the key goals and related targets to be achieved. Achieving these goals and targets would, in the short to medium term, need institutional interventions and policy incentives that enable introduction of renewables and energy efficient appliances and facilities. In the long run, i.e. beyond 2030, the market pull in the wake of declining costs would deploy these technologies even without government incentives. In some countries, where the electricity access is limited by the short-supply of infrastructure, the governments would have important role to support the infrastructure supply.

The industrial sector in Asia is experience strong competition from outside the region as well as within the region. The technological innovations such as for improving grid control systems that can integrate and use diverse sources of electric power, as well as smart grids and demand responses, are important areas to enhance competitiveness of industries. Innovative industries have new market opportunities to innovate, develop and supply solutions which can support the consumers showing preference for low carbon or green energy sources such as solar PV systems or preferences for energy efficient appliances or insulation technologies, The supply-side solution are responding by integrating renewable energy and energy efficient technologies to match the consumer preferences.

International cooperation will also be essential. The establishment of an Asia grid network among Asian countries should be pursued using international financing mechanisms and uniform standards should also be promoted in individual countries, creating an infrastructure for cross-border electric power inter-changes. It will also be important to share best practices from the efforts in each country to encourage the use of renewable energies, and to establish local weather information-gathering systems and share knowledge about the ways to use such systems.



Contribution to GHG Reduction by Action 6

Changes in Asia Due to Action 6

Electrification of the energy system is one of the main measures that will lead Asia toward becoming an LCS. Thus, decarbonization of the electricity supply system will make a large contribution. The implementation of Action 6 will realize almost complete electrification in all Asian regions. Low carbon electricity supply in urban areas will be supported by an electricity grid supplying electricity from fossil-fuel-based plants with high energy efficiency and centralized renewable-energy plants of large scale such as mega solar facilities and wind farms. In rural areas, systems linking power supply and demand by means of microgrids will be introduced, tapping local renewable resources to the optimal extent. In addition, electricity grids in each country will be interconnected to each other, creating a grid across the Asian region that will strengthen the stability of power supplies.

The level of penetration of renewable energy in low carbon Asia is expected to grow significantly. This will not only bring about reductions in GHG emissions but will also speed up the learning effect, which will, in turn, reduce the costs of introducing new power plants. Through the implementation of Action 6, it is estimated that the initial investment costs for solar PV and wind power systems in 2050 compared with 2005 will decrease from 2400 US$/kW to 1200 US$/kW and from 1750 US$/kW to 1500 US$/kW, respectively.

Action 6 will lead to a significant change in electricity supply compared with the Reference society. The changes in electricity generation in Asia by technology is shown in Fig. 6-1 and those by country and region is shown in Fig. 6-2. In the Reference scenario, coal-fired power plants relying on cheap fuel have a large share. In the LCS scenario, on the other hand, although fossil-fuel-based power plants will continue to be introduced up to 2050, almost all of them will be coupled with carbon capture and storage (CCS) technology. The share of electricity generation from thermal power plants coupled with CCS, including biomass power plants, will grow to 32%. Moreover, the share of wind power in 2050 will increase from 2% in the Reference society to 24% in the LCS. For solar PV, the share will increase to 10%. As a result, the combined share of renewables including hydropower and biomass power will account for more than half of the total amount of electricity generated. Overall, the image of a society implementing Action 6 will be one in which renewable energy, centered on solar and wind power, is positioned as the main pillar of energy supply.

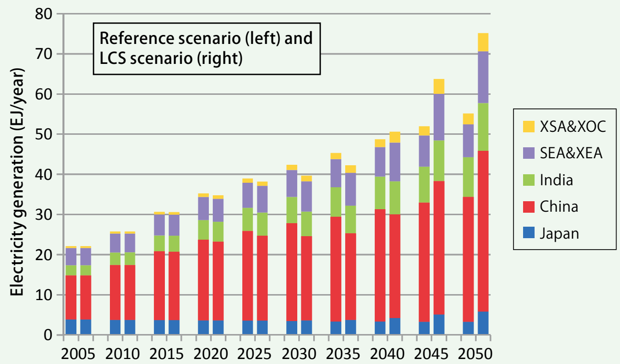


Fig. 6-2 Electricity generation in Asia by country and region

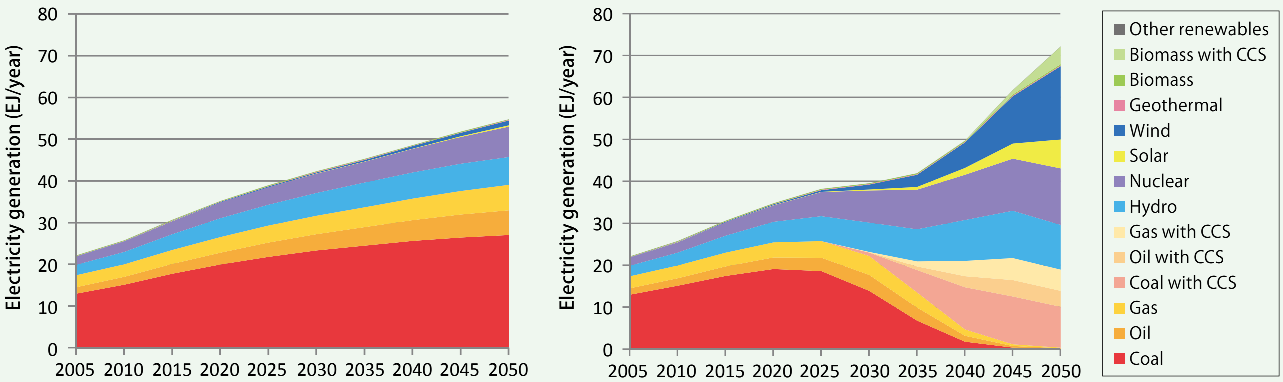


Fig. 6-1 Electricity generation in Asia by technology: Reference scenario (left) and LCS scenario (right)

Contribution to GHG Reduction

GHG reduction by Action 6 in whole Asia is 7.5 $GtCO_2$. By region and countries, share of Japan is 5.1%, China is 59%, India is 18%, SEA&XEA is 13%, and XSA&XOC (South Asia excluding India and Small Island States in Oceania) is 4.1% (Fig. 6-3).

The contribution of Action 6 in the entire Asian region is 37%, and this action is one of key for GHG reduction in Asia. The relevance of this action by country is at a similar level, for example, more than 40% of the emissions reductions in Japan and China will come from Action 6. In India, it is equivalent to 38% of the emissions reduction. In India, photovioltaic and wind power have share of 0.2% and 1.2% in electricity generation in the Reference scenario, in contrast, in the LCS scenario, share of PV and wind will grow up to 11% and 19%, respectively. Decarbonization of the power sector is therefore a key to the realization of an LCS in Asia. In addition, because installation of renewables accelerates after 2035, contribution of Action 6 to GHG reduction will be progressed after 2035.

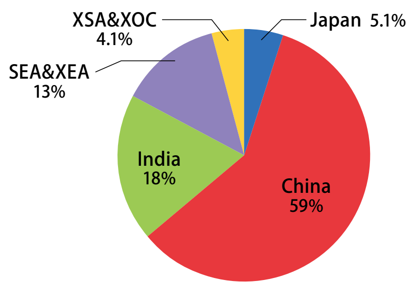


Fig. 6-3 Regional shares of GHG reduction in Asia by Action 6 in LCS scenario (2050)

Components of the Action

Action 6 consists of three approaches: (1) promotion of sustainable local energy systems with renewables, (2) creation of smart energy supply and demand systems, and (3) enhanced energy security by integrating low carbon energy sources and fossil fuels effectively into an energy system.

6.1 Promotion of sustainable local energy systems with renewables

- 6.1.1 Use of solar and wind power energy
  - 6.1.1.1 Introduction of solar and wind power energy systems
  - 6.1.1.2 Introduction of energy storage systems
  - 6.1.1.3 Introduction of a system that enable coordinated operation of solar and wind power plants in multiple locations
- 6.1.2 Use of hydrogen energy
  - 6.1.2.1 Research and development of hydrogen use technologies
  - 6.1.2.2 Expansion of hydrogen production and use
- 6.1.3 Incentives for introducing renewable energy
  - 6.1.3.1 Establishment of an incentive system for the introduction of renewable energy
  - 6.1.3.2 Incentives for use of renewable energy
  - 6.1.3.3 Establishment of energy markets for renewable energy

6.1.1 Use of solar and wind power energy: Solar and wind power are promising sources of renewable energy in the Asian region. Renewable energies are intermittent energy resources whose output fluctuates according to natural conditions. Energy output can be equalized and balanced with energy demand not only by introducing energy storage systems, but also by coordinating the operation of renewable energy systems in multiple locations. Such technologies will maximize the use of power generated from renewable, beginning with regions that have an adequate transmission infrastructure.

6.1.2 Use of hydrogen energy: If power generation systems are introduced in which the output from renewable energy is converted into hydrogen energy and then stored, and power is then generated using fuel cells and the like in accordance with demand, it will become possible not onlyto equalize imbalances in supply and demand, but also to use the stored hydrogen for energy demand other than power generation, such as in fuel cell vehicles. This will require the development of technologies that use hydrogen to supply energy.

6.1.3 Incentives for introducing renewable energy: Compared with conventional systems, the cost of renewable is still high. Incentives to support introduction should therefore be provided, including subsidies and low-interest loans. Incentives to encourage use should also be provided, including discounts of electric charges in accordance with the quantity of power generated, and reductions in the property taxes. In addition, exchanges for electric power transactions should be established to facilitate profits from the sale of generated power.

6.2 Creation of smart energy supply and demand systems

- 6.2.1 Introduction of smart energy systems
  - 6.2.1.1 Research and development of smart energy systems
  - 6.2.1.2 Introduction of power storage equipment to equalize imbalances in energy supply and demand
- 6.2.2 Introduction of demand response systems
  - 6.2.2.1 Fostering of understanding regarding the need to cut peak power and cooperation through incentives
  - 6.2.2.2 Establishment of incentives to encourage cooperation in equalizing the output of intermittent resources
- 6.2.3 Introduction of power management systems
  - 6.2.3.1 Introduction of monitoring systems to achieve transparency in grid status
  - 6.2.3.2 Research and development for ensuring physical and information security through self-diagnostics
- 6.2.4 Introduction of incentives for managing demand
  - 6.2.4.1 Incentives for power quality control and introduction of highly efficient equipment in the industrial sector
  - 6.2.4.2 Incentives for demand response
  - 6.2.4.3 Establishment of electrical utility rate systems that distinguish between peak and off-peak use

6.2.1 Introduction of smart energy systems: To expand the renewable and other low carbon energy sources, it will be essential to establish systems that make it possible to vary demand flexibly to match the supply. Such systems are known as smart energy systems. Some of the component technologies such as smart meters have already entered the market, but further research and development is required in order to realize key smart energy system technologies. Energy storage systems will also be key technical components.

6.2.2 Introduction of demand response systems: Systems that can vary energy demand flexibly to match the energy supply are known as demand response systems. Methods include demand shifts and peak cuts Such "peak cut" measures in particular reduce energy demand through suppress activities in the demand sector. It will therefore be crucial to promote the cooperation of consumers by fostering understanding Moreover, it will also be essential to insall storage systems in the energy supply side, and to make it easy for consumers to predict the energy-supply capacity.

6.2.3 Introduction of power management systems: To ensure the smooth operation of smart energy systems, information on the energy system must be constantly shared, but such system must be developed and put into use In addition, information must be closely coordinated with the status of industrial activities, people's lifestyles, and so on. To this end, there is a need to ensure adequate security to prevent unauthorized third-party access. Moreover, as these systems will operate 24 hours a day, 365 days a year, self-diagnostic systems that constantly monitor the system will need to ensure immediate detection and restoration in the event of a security breach.

6.2.4 Introduction of incentives for managing demand: Incentives for the installation of demand response will attract the participation of many consumers. Such incentives could include incentives for consumers who cooperate in cutting peak demand or shifting demand to non-peak times, as well as for consumers who introduce energy efficient equipment. In addition, peak and off-peak pricing of electricity could also provide an incentive to reduce peak demand.

6.3 Enhanced energy security by integrating low carbon energy sources and fossil fuels effectively into an energy system

- 6.3.1 Enhancement of the efficiency of power-supply equipment
  - 6.3.1.1 Establishment of subsidies and tax breaks for increasing power plant efficiency
- 6.3.2 Use of carbon capture and storage (CCS) equipment

- 6.3.2.1 Research and development of CCS technologies
- 6.3.2.2 Survey of storage locations
- 6.3.2.3 Introduction of CCS-equipped thermal power plants
- 6.3.3 Promotion of international cooperation
- 6.3.3.1 Study of the concept of an Asia-wide system network
- 6.3.3.2 Construction of an Asia-wide system network and study of financial measures

6.3.1 Enhancement of the efficiency of power-supply equipment: For existing energy systems, it will be important to develop technologies to increase the efficiency of power-supply equipment in order to reduce GHG emissions to the greatest extent possible. To ease the cost burden of developing and introducing highly efficient power-supply equipment, incentives through subsides, etc. will be effective.

6.3.2 Use of carbon capture and storage (CCS) equipment: CCS is a technology for capturing generated GHGs (particularly CO_2) so that they are not emitted into the atmosphere, and then injecting, isolating, and storing them underground or in some other location. This technology makes it possible to reduce GHGs into the atmosphere even for existing energy systems. Further technical development as well as studies to determine locations where the isolated GHGs are required.

6.3.3 Promotion of international cooperation: There is considerable variation among countries in Asia in terms of possible locations for renewable and fossil fuel reserves. Constructing a system network that spans the entire Asian region will make it possible to introduce renewables on a large scale in places with good conditions for generating energy, and to export the surplus power to other countries and regions. Such a network would also make it possible to construct energy efficient gas-fired plants in regions with abundant gas, and to send the power to regions that are dependent on coal-fired thermal power. These efforts, which will require support from international financing mechanisms, will promote the shift to a low carbon energy supply throughout Asia.

Functions of decarbonization in Asia

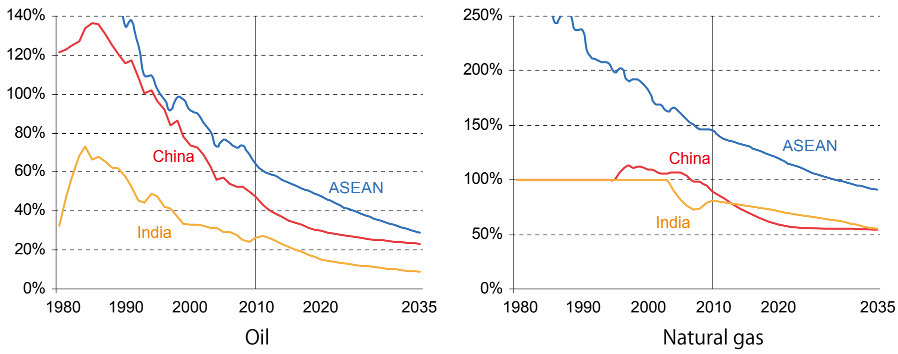
Decarbonization of the energy supply is important not only for reducing GHG emissions but also for ensuring energy security. In this regard, the fact that the problem of stable energy supplies exists behind Asian governments' proactive low carbon policies is worthy of attention.

In the past, Asia – including major oil producers Indonesia, China, and Brunei – had a relatively high oil self-sufficiency rate. Oil demand has increased rapidly, however, while oil output has failed to expand substantially. China became a net oil importer in the first half of the 1990s, as did Indonesia in the early 2000s. During the decade from 2000 to 2010, the oil self-sufficiency rate fell rapidly from 72% to 47% in China, from 33% to 26% in India, and from 124% to 72% in Indonesia. The net oil exporters in Asia are now limited to Brunei and Malaysia. Even Malaysia saw its oil self-sufficiency rate fall steadily from 169% in 2000 to 132% in 2010 due to increased domestic demand.

China had achieved natural gas self-sufficiency before expanding net imports from 2005. In the five years to 2010, its natural gas self-sufficiency rate dropped to 87%. India began to import natural gas in 2003, and saw its self-sufficiency rate fall to 80% in 2010. The Association of Southeast Asian Nations (ASEAN) countries have had rich domestic natural gas resources and have continued exports to Japan and South Korea. In 2011, Malaysia, Indonesia, and Brunei accounted for nearly 40% of Japan's liquefied natural gas imports. However, even ASEAN's natural gas self-sufficiency rate has decreased steadily, from 238% in 1990 to 145% in 2010.

Even taking the progress of shale gas development in China into account, gas demand is expected to increase more rapidly than production. If the past trend continues, oil and gas self-sufficiency rates will decline rapidly, as shown in figure. As Asia is in transition from an energy exporter to the world's largest importer, each country is making all possible efforts to hold down fossil fuel consumption.

In the scenarios presented in the figure, cumulative fossil fuel imports through 2035 will total 13 trillion US$ in China, 5 trillion US$ in India, and 4.2 trillion US$ in the ASEAN countries. Annual fossil fuel imports will be equivalent to 3 to 5% of the annual gross domestic product of these countries, indicating that this trend will greatly affect their economies. Unlike growth in investment in low carbon energy and energy-saving technologies, an increase in fossil fuel imports represents a pure national wealth outflow and depends heavily on the external factor of primary energy price fluctuations, making national energy security vulnerable. In this sense, a low carbon energy system is viewed as indispensable for the sustainable growth of Asian economies. (Yuji Matsuo)



Asian oil and natural gas self-sufficiency rates

Reference

Y. Matsuo, A. Yanagisawa, and Y. Yamashita (2013), A global energy outlook to 2035 with strategic considerations for Asia and Middle East energy supply and demand interdependencies, *Energy Strategy Rev.*, 2, pp.79-91.

Action 7
Low Emission Agricultural Technologies

Overview

The agriculture sector contributed 14.3% of global anthropogenic greenhouse gas (GHG) emissions in 2004, according to the Fourth Assessment Report of the IPCC (IPCC, 2007). To achieve the target of cutting global GHG emissions in half by 2050, mitigation options in the agriculture sector in Asia are expected to play an important role. Some mitigation measures contribute not only to GHG reductions but also to improvements in environmental conditions such as water quality and hygiene. In addition, as the cost of agricultural mitigation options is relatively low, they are attracting increasing public attention.

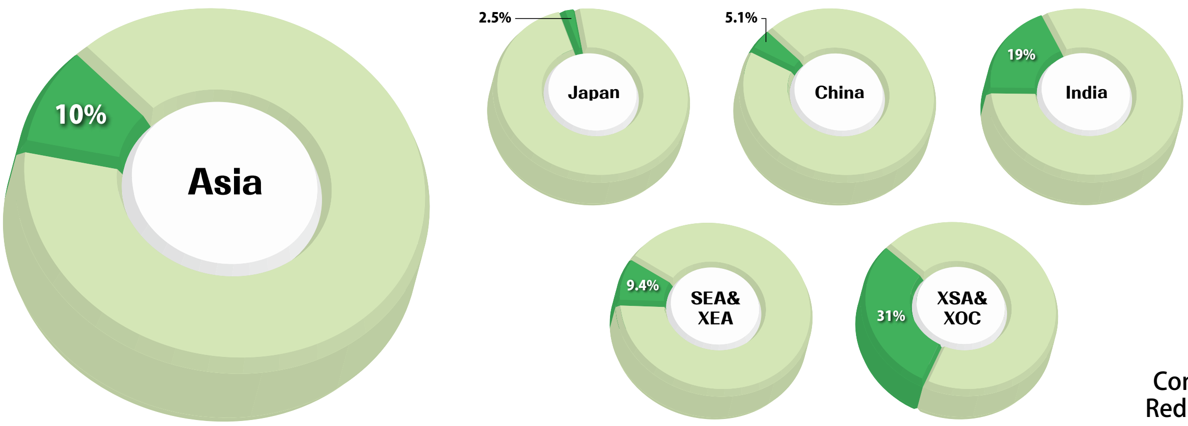
To implement these measures, governments need to expand social infrastructure such as irrigation for water management in rice fields and to implement manure management plants for diffusion of low emission agricultural technologies. They should also promote the dissemination of information on highly efficient fertilizer application. In particular, a gradual shift to the management of fertilization at the proper times and quantities is required in areas with excessive reliance on fertilizers.

The agriculture sector should implement low carbon water management such as midseason drainage by paddy farmers, collection of manure, and management of fertilizer and crop residues. Additionally, the methane gas emitted from manure should be actively utilized as an energy source. New technologies need to be positively adopted with the aim of achieving compatibility between productivity improvement and reduction of emissions.

If citizens select locally cultivated or raised products, local agriculture will be activated. Moreover, the selection of agricultural products produced by low carbon farming methods will enhance their market value.

International activities are also important to promote the international joint development of low emission agricultural technologies aimed at improving feed, livestock productivity, paddy field management, and so on. Additionally, international certification for low carbon agricultural products should be introduced and its dissemination promoted.

Methane (CH_4) and nitrogen oxides (N_2O) are the main GHGs emitted by the agriculture sector. While energy-induced emissions, primarily carbon dioxide (CO_2) were a strong focus of attention in the 1990s, emissions other than CO_2 and emissions from non-energy sectors, particularly CH_4 and nitrous oxide (N_2O), have begun to attract more attention since then. Weyant et al. (2006) have shown that the non-energy sectors and non-CO_2 gases can potentially play an important role in future climate change mitigation, although there is greater uncertainty in estimating CO_2 emissions from land use and CH_4 and N_2O emissions than in estimating CO_2 emissions from fossil fuels.



Contribution to GHG Reduction by Action 7

Changes in Asia Due to Action 7

In 2050, the agriculture sector will be characterized by the widespread diffusion of water management in paddy fields, particularly midseason drainage, as well as techniques such as the plowing-in of rice straw, and CH_4 emissions will have decreased. Excessive fertilizer use on farmland will be avoided, and N_2O emissions will be reduced by the adoption of appropriate fertilization, such as split fertilizer application and the deployment of slow-release fertilizers. Livestock manure will be collected and processed, and the CH_4 collected will either be used directly as an energy source, or for household power generation. Livestock feed will be improved, leading to a reduction of CH_4 emissions from rumination and contributing to increased livestock productivity.

The model used to reproduce the future vision described above includes a marginal abatement cost curve for CH_4 emissions from paddy fields, livestock, and manure management, and N_2O emissions from fertilization and crop residues. A marginal abatement cost curve is a means of showing the relationship between the cost of additional emissions reduction and the reduction effect with that cost, and utilizes a function calculated by a bottom-up model. Specifically, the reduction rate is set at (i) 14% in the case that the additional reduction cost is 20 \$/tCO_2, (ii) 12% in the case of 50 \$/tCO_2, and (iii) 11% in the case of 100 \$/tCO_2, where technologies are developed incorporating the additional reduction cost compared with technologies in the Reference scenario. Here, the additional reduction cost illustrates the incentives or disincentives for emission reduction, such as subsidies or emission taxes, and the marginal abatement cost curve shows that the reduction effect increases as the reduction cost rises.

By setting a carbon price, countermeasures with a low additional reduction cost will begin to be deployed, followed by more expensive countermeasures in the order of cost. The reduction effect hits a ceiling around 2030, and no great effect is seen thereafter, for the reason that most of the reduction effect is demonstrated at an early stage due to the cheap reduction costs of the agriculture sector. Indonesia's introduction of concrete countermeasures, together with the related reduction costs and reduction effects, is described as an example in the Topic at the end of this article.

Toward the realization of a Low Carbon Society (LCS) in Asia, the research and development of countermeasure technologies, construction of social infrastructure, provision of sufficient financial support, and dissemination of information, which will contribute to technology transfers adapted to the particular situation of each country or region, are necessary. These efforts will overcome the constraints on the diffusion of countermeasure technologies in the agriculture sector arising from differences in the environment, local situation, and economic conditions of each country or region. Furthermore, the establishment of a system that involves the government, municipalities, farming households, consumers, and all other stakeholders is also necessary at the local level, to promote the dissemination of information and education of farmers.

Contribution to GHG Reduction

In the Reference scenario, GHG emissions from the agriculture sector in Asia in 2050 will reach 4.4 GtCO_2e, which is 1.7 times the level in 2005. In the LCS scenario, on the other hand, since a carbon price is charged on GHG emissions, emission reductions will be achieved after 2020, with the level of emissions in 2050 reduced to 2.3 GtCO_2e, 91% of the level in 2005 (Fig. 7-1). This represents a 48% decrease in emissions compared with the Reference scenario, and is equivalent to approximately 40% of the amount of reduction in the agriculture sector worldwide. The reduction ratios of Japan, China, India, SEA&XEA, and XSA&XOC (South Asia excluding India and Small Islands States in Oceania) will be 1.0%, 26%, 33%, 15%, and 25%, respectively, indicating that India will have the largest amount of reduction in Asia (Fig. 7-2).

The contribution of the agriculture sector to the overall reduction of GHG emissions in Asia will be 10%. Looking at the contributions of countermeasures by country or region in Asia, Action 7 will contribute 19% of the total reduction in India, making it the action with the third-highest contribution in that country. In XSA&XOC, the contribution of Action 7 will be 31%, the highest contribution of all actions.

In XSA&XOC, GDP in 2050 will increase by 21 times or more from 2005 in both the Reference and LCS scenarios, the highest rate of increase in Asia. In the LCS scenario, the ratio of this area's GDP to that of Asia overall will increase from 2.4% in 2005 to 7.5% in 2050. In the Reference scenario, GHG emissions from the agriculture sector will increase by 4.3 times from 2005 to 2050, reaching 1.2 GtCO_2e, due to growth in demand for agricultural and livestock products. This level of emissions will account for 27% of the total emissions from the agriculture sector in Asia. In contrast, the emissions from this sector in the LCS scenario will be 0.65 GtCO_2e, a decrease of 44% compared with the Reference scenario. This amount will still be 2.4 times that in 2005, however, and will account for 29% of the total emissions from this sector in Asia in 2050, representing a slight increase.

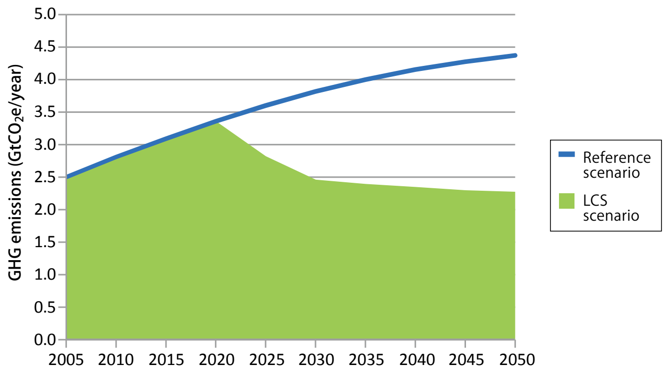


Fig. 7-1 GHG emissions in Asia in the agriculture sector in Reference and LCS scenarios

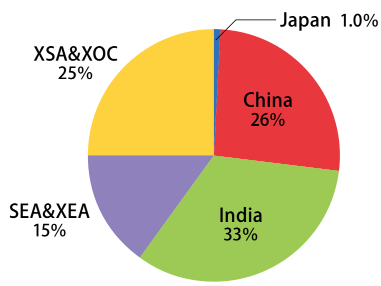


Fig. 7-2 Regional shares of GHG reduction in Asia by Action 7 in LCS scenario (2050)

Components of the Action

Action 7 consists of three approaches: (1) water management in rice paddies, (2) highly efficient fertilizer application and residue management, and (3) recovery and use of methane gas from livestock manure.

7.1 Water management in rice paddies

7.1.1 Construction of infrastructure
- 7.1.1.1 Implementation of irrigation
- 7.1.1.2 Installation of reservoirs

7.1.2 Development of water management technologies
- 7.1.2.1 Improvement of water usage efficiency
- 7.1.2.2 Diffusion of alternating flooding and drainage

Fields that are continuously flooded during the entire cultivation period produce more CH_4 emissions than fields that are not flooded the whole time. Such "midseason drainage" involves the removal of surface water from the field during the cultivation period. This is a longstanding custom to prevent root decay and increase crop yield in Japan. Moreover, alternating flooding and drainage is also applied to manage crop growth and avoid lodging. Recently, this practice has also come to be considered as a means of reducing CH_4 emissions. Compatibility of productivity improvement and control of emissions can be expected from this technique.

7.1.1 Construction of infrastructure: To implement midseason drainage and alternating flooding and drainage, the appropriate infrastructure is necessary. In addition, high water storage capacity is needed to hold sufficient water for rice paddies in rainfed areas. For these reasons, irrigation facilities and reservoirs should be installed as required.

7.1.2 Development of water management technologies: At the same time, transfers of knowledge and techniques to improve the efficiency of water resource usage are necessary. Such knowledge and techniques can be expected to contribute not only to emissions mitigation but also to stable water supplies for food production. By implementing the above measures, starting with areas where irrigation is already installed, midseason drainage and alternating flooding and drainage will become possible.

7.2 Highly efficient fertilizer application and residue management

7.2.1 Development and diffusion of fertilizer management techniques
- 7.2.1.1 Improvement of fertilizer use and efficiency
- 7.2.1.2 Use of organic fertilizers

7.2.2 Improvement of tillage and residue usage
- 7.2.2.1 Estimation of crop residues
- 7.2.2.2 Crop residue management
- 7.2.2.3 Implementation of no or low tillage

In the soil, N_2O is generated from the biological reaction of microbes with nitrogen fertilizer applied to croplands. Avoiding excessive use of nitrogen fertilizer and increasing the efficiency of nitrogen use will contribute to the reduction of N_2O emissions from croplands.

7.2.1 Development and diffusion of fertilizer management techniques: The efficiency of fertilizer application can be improved by the use of spreader machinery. By this means,

fertilizer runoff can be avoided and N_2O emissions reduced by appropriately allocating fertilizer for efficient consumption by crops. To stop fertilizer runoff, the shape of the area for fertilizer spreading can be improved. "Split fertilization" (the application of small amounts of fertilizer several times) is also considered a good practice for efficient utilization of fertilizer to meet the nitrogen demand of crops. New types of fertilizer such as slow-release fertilizers facilitate efficient fertilization and are effective in reducing N_2O emissions. Knowledge of these techniques needs to be diffused so that they can be widely put into practice.

7.2.2 Improvement of tillage and residue usage: The tillage of cropland can cause soil disturbance and reduce the carbon stock in the soil. Carbon is contained in crop residues and is emitted into the atmosphere through burning and decomposition. The methods of tillage and residue management used are therefore important for the reduction of GHG emissions. First, farmers should estimate the amount of crop residues and decide how they will be managed. As one way of managing crop residues to reduce emissions, farmers can lay down rice straw two months before the growing period, rather than only immediately beforehand, which will help to prevent organic matter from being broken down in the soil and reduce CH_4 emissions from rice paddies. As another method, farmers can lay down composted rice straw, not fresh straw, immediately after harvest to reduce methane emissions. Stopping the practice of burning residues will also contribute to reductions in emissions. With regard to tillage, no tillage or only a low degree of tillage are known to avoid soil disturbance and the reduction of carbon stock in soil.

7.3 Recovery and use of methane gas from livestock manure

7.3.1 Installation of manure management systems
- 7.3.1.1 Introduction of manure management systems
- 7.3.1.2 Direct use of biogas from livestock manure

7.3.2 Establishment of regulations and provision of financial support for manure management
- 7.3.2.1 Introduction of regulations on manure management
- 7.3.2.2 Provision of financial support

7.3.1 Installation of manure management systems: Untreated manure releases CH_4 emissions into the atmosphere due to anaerobic decomposition. Therefore, the use of CH_4 derived from manure as energy realizes compatibility between GHG emissions reduction and energy supply. In Asian countries, there are examples of simple, low-cost, and small-scale unheat-

ed digesters and tubular digesters in a hole dug in the ground being used to recover CH_4 from manure management, with the CH_4 mainly being consumed as fuel for cooking and lighting or for generation of electricity. Toward wide implementation and diffusion, the first step is the installation of manure management plants. There are various types of manure plants. In an anaerobic decomposition plant, manure is decomposed by bacteria and biogas is generated and used at the farm or home for cooking and lighting. Since large plants are still expensive, farmers can start by installing a farm-scale plant or a simple and low-cost plant. It is reported that unheated type decomposition plants with the same mechanism have already been installed in some Asian countries including China and India.

7.3.2 Establishment of regulations and provision of financial support for manure management: At the same time, the introduction of regulations on manure management and financial support for the installation of manure management systems are expected to promote implementation of these infrastructures.

Agricultural emissions mitigation strategy in Indonesia

The agriculture, forestry, and other land use (AFOLU) sectors are one of the largest sources of anthropogenic GHG emissions in the countries and regions of Asia because their domestic economies greatly rely on these sectors. In Indonesia, for example, more than 60% of the total GHG emissions come from agriculture, land use, and peat fires (Ministry of Environment, Indonesia, 2010). Mitigation measures in these sectors are therefore expected to play an important role in reducing Asia's GHG emissions in the future. For this purpose, quantitative evaluation of future mitigation potentials and specification of high-priority sources and measures may help Asian countries to make decisions and promote appropriate mitigation policies and strategies in the AFOLU sectors.

We have developed a bottom-up type model, named the AFOLU model, to estimate GHG emissions and mitigation potentials in the AFOLU sectors at the country/regional level, based on detailed information on mitigation measures. This model illustrates countermeasures (technologies) that can be selected by an agricultural producer or land owner for climate mitigation based on economic rationality. Agricultural production and area of land use change in a baseline case where emission reduction is not strongly addressed are given exogenously as future scenarios. To reflect the specific situation in Indonesia, we developed the scenarios based on Indonesian national statistics, governmental plans, and so on. The results for the agriculture sector are described below.

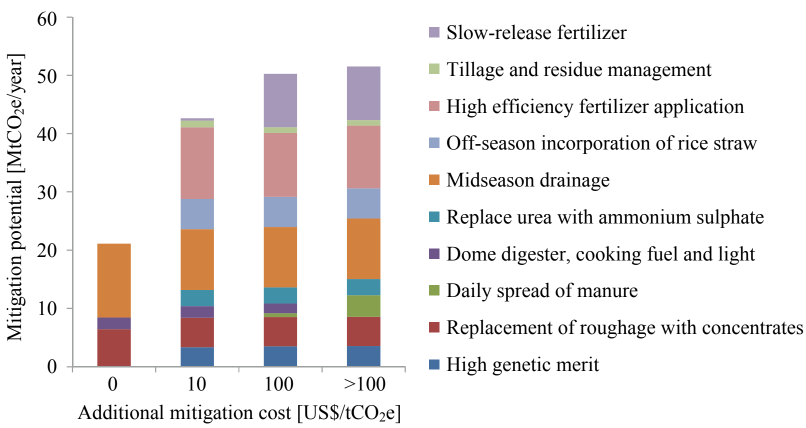
The net emissions in 2005 are estimated to have been 885 $MtCO_2e$/year (agricultural emissions 77 $MtCO_2e$/year and net emissions from the land use sector 810 $MtCO_2e$/year). In 2030, total emissions from agriculture and land use are expected to increase to 1510 $MtCO_2e$/year in the baseline case, comprising agricultural emissions of 150 $MtCO_2e$/year and net emissions from the land use sector of 1360 $MtCO_2e$/year. As regards the increase in the agriculture sector, emissions from livestock management and managed soils are expected to increase drastically, while in the land use sector, 48% of the emissions from land use change will derive from peat drainage.

In 2030, an additional mitigation cost of 10 US$/$tCO_2e$ generates a mitigation potential of 43 $MtCO_2e$/year, representing 55% of the agricultural emissions in 2005. Of this amount, high-efficiency fertilizer application on managed soils and midseason drainage in rice cultivation will contribute 23 $MtCO_2e$/year. A mitigation potential of 21 $MtCO_2e$/year could be generated with no additional mitigation cost by no-regret countermeasures. In contrast, the maximum mitigation potential at a mitigation cost of more than 100 US$/$tCO_2e$, called the technical potential, is estimated as 52 $MtCO_2e$/year in 2030, representing 67% of the agricultural emissions in 2005 and 35% of the agricultural baseline emissions in 2030.

(Tomoko Hasegawa)

Reference

T. Hasegawa and Y. Matsuoka (2013) Climate change mitigation strategies in agriculture and land use in Indonesia, *Mitig. Adapt. Strateg. Glob. Change*. DOI: http://dx.doi.org/10.1007/s11027-013-9498-3.



Mitigation potentials under different additional mitigation costs in agriculture sector

Action 8
Sustainable Forestry Management

Overview

Deforestation reduces forest carbon stocks, creates soil disturbances, and increases CO_2 emissions. It causes degradation of remaining forestland and lower wood productivity, and inflicts severe damage on biomass growth. It is therefore important to reduce the impact of logging and improve the maintenance of forested areas so as to halt forest degradation, thereby reducing greenhouse gas (GHG) emissions and enhancing the function of forests as a carbon sink.

Planting of trees on land that was not previously forest land is called afforestation, while planting of trees on land where a forest existed is referred to as reforestation. The Kyoto Protocol treats both afforestation and reforestation as methods of reducing emissions under the Clean Development Mechanism. Carbon is absorbed by trees through photosynthesis and stocked in forests and soils.

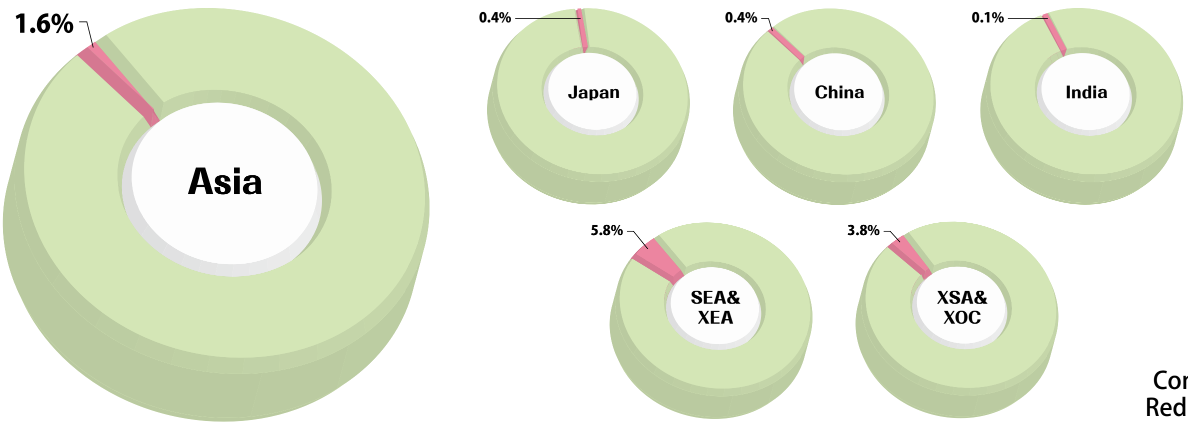
In Indonesia, peat fire and peat decomposition are major emission sources in the land use sector. Both fire management and peatland management are necessary to mitigate these emissions, in conjunction with the suppression of illegal logging, protection of ecosystems, and reduction of poverty.

To manage fires and peatland, the government is expected to play an important role by implementing land use zoning for forest protection, stopping illegal logging and unplanned land clearance, supporting the economic independence of local people by enhancing their level of education, and introducing licenses for tree planting and land clearance to encourage sustainable land use by landowners.

The private sector is expected to conduct logging and planting operations sustainably on properly licensed land, appropriately manage fires lit for land clearance, acquire forestry management skills for appropriate logging and forestation, autonomously maintain land after logging for forest regeneration, and abstain from illegal logging and consumption of illegally logged timber.

Citizens should be encouraged to understand the importance and multiple functions of forest ecosystems and to manage forests at the local level. They can contribute to reduced emissions by selecting products made of certificated wood as much as possible, and actively participating in programs implemented by the government, NPOs, international society, etc.

In the area of international cooperation, it is important to establish international systems to certificate sustainable management of biofuel and wood production, and to regulate the importation of products that do not meet the criteria. Additionally, promotion of international cooperation for forestation and capacity development in timber-producing areas are required.



Contribution to GHG Reduction by Action 8

Changes in Asia Due to Action 8

In the Low Carbon Society (LCS) scenario, not only will sustainable forest management and land use be achieved, but GHG emissions from land use will also be substantially reduced. Specifically, national and local governments will resection forest land, and forests will be managed by appropriate organizations. Frameworks will be introduced to stimulate incentives for participation by local residents and the private sector, citizens will participate in forest management or afforestation programs, and illegal logging will be restrained. Technologies for afforestation will be widely diffused in the private sector, and a large number of companies will enter the afforestation business. Timber will be produced only within permitted areas and producers will place a high priority on enhancing sustainable land use, while disorderly cultivation will be reduced. In brief terms, a social infrastructure for sustainable forest protection and production will be established.

Similarly to Action 7, it is assumed that the inclusion of a marginal abatement cost curve in the models applied will lead to more significant emission reductions as the marginal abatement cost increases.

As the marginal abatement cost will increase from 2020 onward, policies for sustainable forest management and land use will be introduced, and larger reductions in GHG emissions will be achieved. Land use will not change drastically, but after 2015, farming areas will be increasingly shifted to biofuel production, expanding to 51 Mha in 2050. This trend will be particularly dominant in China, and in the LCS scenario, the area of farmland used for biofuel production will increase by 8 times than that of the Reference scenario (Fig. 8-1, 8-2).

The total area of forests in Asia was 530 Mha in 2005, but in the Reference scenario, this is expected to shrink to 515 Mha in 2050. In the LCS scenario, on the other hand, deforestation will be restrained after 2020 and the area of forest will be 522 Mha in 2050. In SEA&XEA, where deforestation makes a substantial contribution to GHG emissions, the area of forest was 226 Mha in 2005. This is expected to become 218 Mha in the Reference scenario and 222 Mha in the LCS scenario. The restraining of deforestation will make a major contribution to emissions reduction. It is therefore considered that the protection of forests and regulation of illegal and unplanned logging by the implementation of land use policies will be effective in reducing GHG emissions. On the other hand, in countries that do not have abundant areas of forests but have a greatly increasing population and demand for food such as China and India, it will be more difficult to regulate forest cultivation and farmland expansion.

To achieve the LCS scenario, there are several challenges to overcome. Management units should be established in protected forest areas, and land devoted to forests and other land uses should be managed strictly yet flexibly. In addition, although the process will be time-consuming, it is necessary to implement and disseminate policies such as forest management and afforestation projects aimed at supporting local residents whose livelihoods depend on illegal logging, by providing them with alternative work or other assistance, and to disseminate technologies for the resettlement of itinerant farmers. Moreover, a scheme for licensing the cultivation of land should be applied to companies dealing with palm oil and timber.

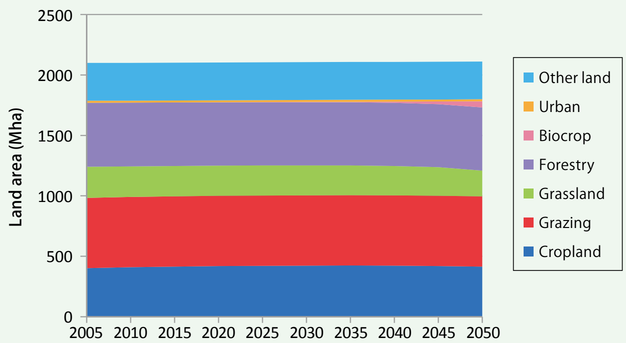


Fig. 8-1 Land use changes in Asia in LCS scenario

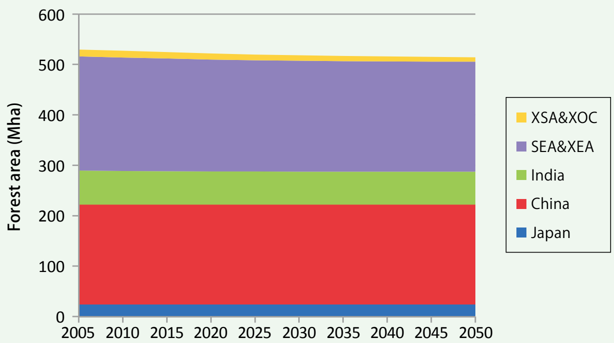


Fig. 8-2 Changes in forest area in LCS scenario in Asia

Contribution to GHG Reduction

In the Reference scenario, GHG emissions from the forest and land use sectors in Asia will reach 0.68 $GtCO_2e$ in 2050, equivalent to 64% of the amount in 2005. In the LCS scenario, on the other hand, this figure will decrease to 34% of that in 2005, due to the implementation of further emission reduction countermeasures.

Emission reduction in the forest and land use sectors in Asia will be 0.31 $GtCO_2e$ in 2050 due to Action 8. The reduction ratios of Japan, China, India, SEA&XEA, and XSA&XOC (South Asia excluding India and Small Island States in Oceania) will be 1.2%, 15%, 0.9%, 62%, and 20% respectively, indicating that the amount of reduction in SEA&XEA will be the largest.

The reduction from implementing Action 8 will contribute 1.6% of the overall reduction from all of the Action in Asias. By country/region in Asia, the contribution of Action 8 in SEA&XEA will account for a relatively high share of 5.8%, followed by 3.8% in XSA&XOC.

In SEA&XEA, GHG emissions from the forest and land use sectors in the Reference scenario will decrease to 0.55 $GtCO_2e$ in 2050, a 40% reduction from the amount in 2005 (0.92 $GtCO_2e$). This is because some mitigation actions are assumed to be implemented in the forest and land use sectors even in the Reference scenario. Further reduction will be achieved in the LCS scenario where GHG emissions from these sectors will be only 0.35 $GtCO_2e$, 39% of the level in 2005.

Components of the Action

Action 8 consists of three approaches: (1) forest protection and effective plantation, (2) sustainable peatland management, and (3) monitoring and management of forest fires.

8.1 Forest protection and effective plantation

- 8.1.1 Reduction of unplanned deforestation
  - 8.1.1.1 Reduction of shifting cultivation
  - 8.1.1.2 Resettlement of forest squatters
  - 8.1.1.3 Improvement of institutional systems
  - 8.1.1.4 Involvement of communities in forest management
- 8.1.2 Reduction of planned deforestation
  - 8.1.2.1 Regulations on land use permits
  - 8.1.2.2 Exchanges of forest functions and swapping
- 8.1.3 Reduction of forest degradation in production forests
  - 8.1.3.1 Improvement of institutional and financial systems
  - 8.1.3.2 Introduction of mandatory forest certification systems
  - 8.1.3.3 Encouragement of the adoption of reduced-impact logging
  - 8.1.3.4 Expansion of community involvement as forest concessionaires
- 8.1.4 Enlargement of forest carbon stock
  - 8.1.4.1 Enhancement of natural regeneration
  - 8.1.4.2 Establishment of private forests
  - 8.1.4.3 Reforestation of critical, degraded, or unproductive forest areas
  - 8.1.4.4 Establishment of timber plantations in degraded forest or critical lands

8.1.1 Reduction of unplanned deforestation: The following four measures can contribute to the reduction of unplanned deforestation. The first is reduction of shifting cultivation. Shifting cultivation is a cycle in which cultivation of crops is carried out in a way that causes soil degradation and decreasing crop productivity, so the farmers create new areas for cultivation by clearing forested land. The dissemination of skills and technologies to allow farmers to continue cultivation on the same land will promote the resettlement of forest squatters and reduction of unplanned deforestation. The second measure is the provision of financial support and basic education to people whose lives depend on illegal logging. Illegal logging can be reduced by tree planting and forest management activities aimed at generating employment and financial support for these people. The third measure is the establishment of forest management units (FMUs). This involves the classification of forests into several units, and establishing an FMU for each unit. The FMUs enforce strict regulations on unplanned deforestation and illegal logging and protect the overall forest from unplanned deforestation. The final measure is involvement of the community in forest management. Local governments should establish community forests and forest boundaries with community participation, and improve forest extension services in high-risk areas. Such community participation will serve as an incentive to promote forest management among the local people and encourage them to gain knowledge and management skills.

8.1.2 Reduction of planned deforestation: Reduction of planned deforestation will contribute to sustainable forest management through regulations on and strict management of land use permits and certifications for deforestation. Certifications of deforestation for land that is permitted to be deforested but on which deforestation has not yet taken place will be withdrawn and the certificated areas will be switched from peatland forest to non-peatland forest for emission mitigation. In addition, clarification of licenses for the protection or conservation of forests and flexible changes in status (e.g., a forest in a non-protected area is redesignated as a forest in a protected area) will contribute to the reduction of planned deforestation. Land swaps, involving the exchange of licenses for land development, will also play an important role.

8.1.3 Reduction of forest degradation in production forests: GHG emissions can also be reduced by preventing the degradation of production forests. The establishment of FMUs as mentioned above, and community involvement in forest management as concessionaires, will also be effective in reducing degradation in production forests. In addition, governments should introduce mandatory forest certification systems and reduce soil disturbance caused by wood harvesting. Heavy logging can damage forest growth, causing forest degradation and lowering timber productivity. Improvement of logging practices and forest management will therefore contribute to the reduction of forest degradation and CO_2 emissions and expansion of the carbon sink function of forests.

8.1.4 Enlargement of forest carbon stock: Enlargement of the carbon stock on remaining forestland is also important. The enhancement of natural regeneration and reforestation of critical, degraded, or unproductive forest areas will increase the carbon stock of forests. The private sector can also contribute to increases in carbon stock through the establishment of private forests. The dissemination of planting techniques and measures for easy access to forestland will need to be implemented for this purpose. Social and financial support will also promote the entry of private participants.

8.2 Sustainable peatland management

- 8.2.1 Improvement of peatland management practices
  - 8.2.1.1 Enforcement of strict compliance with regulations for cultivation of peatland
  - 8.2.1.2 Zero burning policy for land clearance
  - 8.2.1.3 Improvement of water management
  - 8.2.1.4 Best practices in soil management
- 8.2.2 Peatland rehabilitation
  - 8.2.2.1 Prevention of uncontrolled fires
  - 8.2.2.2 Hydrological rehabilitation
  - 8.2.2.3 Reforestation

Peat is a layer of organic matter formed through decomposition over several decades in tropical areas. Peatland contains a large amount of carbon with a high water content. It may be forested, or drained and used as cropland. After water drainage, CO_2 is emitted for some time. Recently, the exploitation of peatland driven by increased palm oil demand has become a serious issue. Fires lit to clear the land also sometimes cause forest fires.

8.2.1 Improvement of peatland management practices: The improvement of peatland management practices is important to reduce peatland exploitation and prevent forest fires. Governments should enforce strict compliance with regulations on the cultivation of peatland, allowing cultivation only on land with a peat depth of less than 3 m and prohibiting it on land with a greater peat depth. These management practices can be flexible according to the demand for land for crops and plantations. In addition, toward the goal of zero burning, the lighting of fires for the clearing of peatland must be strictly controlled, as well as the management of water resources on peatland. For these purposes, governments should introduce systems for the provision of financial or non-financial incentives. Improvement of soil quality can also contribute to reduced degradation of peatland soils and consequently reduced GHG emissions. Soil conditions can be improved by the application of compost and soil-improving agents.

8.2.2 Peatland rehabilitation: Peatland rehabilitation is achieved by preventing uncontrolled fires on peatland and improving water quality. Effective measures for the improvement of water quality include blocking off water channels and establishing regulations on water quality. Reforestation of degraded peatland also contributes to its rehabilitation.

8.3 Monitoring and management of forest fires

8.3.1 Prevention of fires for land clearance
- 8.3.1.1 Incentive mechanism for zero burning practice
- 8.3.1.2 Rental of tractors and machinery

8.3.2 Prevention of uncontrolled fires
- 8.3.2.1 Development of an early warning system for fires
- 8.3.2.2 Establishment of a fire-extinguishing system and deployment of rangers

8.3.1 Prevention of fires for land clearance: Since forest fires are a major source of GHG emissions, fire management is important. The practice of burning for land clearance can cause uncontrolled fires, so it is necessary to prevent the lighting of such fires. To achieve this, the introduction of an incentive mechanism for zero burning practice and rental of tractors and machinery can be effective measures.

8.3.2 Prevention of uncontrolled fires: At the same time, uncontrolled fires themselves also need to be prevented. The development of an early warning system for fires and establishment of a fire-extinguishing system, as well as the deployment of rangers, are important measures for this purpose. Members of local communities should also be encouraged to participate in firefighting at the local level.

Forestry and land use management and its impact on renewable energy potential

Toward the realization of the Asian LCSs, it is important to utilize renewables such as solar photovoltaic (PV) and wind. On the other hand, some types of renewables including solar PV, wind, and biomass from energy crops require a certain area for the production and use of energy, and the availability of land in Asia therefore affects the energy supply from such renewable sources. This project assessed the renewable energy potentials based on global land use information such as forests, savanna, grasslands, croplands, urban areas, and so on.

Table summarizes the results of estimations of technological potentials in three scenarios: a Default scenario, an All Cropland scenario, and an All Forest Scenario. The Default scenario shows the results based on our original assumptions, the All Cropland scenario assumes that solar PV and/or wind turbine systems will be installed on all croplands, and the All Forest scenario assumes that all forest areas will be changed to solar farms and/or wind farms.

In the Default scenario, solar PV and wind power in the whole of Asia could generate 8,672 TWh and 33,744 TWh of electricity, respectively, per year. Compared with Asia's primary energy consumption in 2050 in the Reference scenario, projected to be 99,620 TWh/yr, solar PV could contribute 9% of the primary energy supply and wind power 34%. If solar PV and/or wind systems are installed on croplands or in forests, the amount of electricity generated could be increased. The potential of wind power increases to almost double that in the Default scenario in both the All Cropland and All Forest scenarios. On the other hand, the potential of solar PV in the All Cropland scenario increases to 110 times the level in the Default scenario, while that in the All Forest scenario increases to 187 times the Default level.

Based on this analysis, it can be seen that the availability of croplands and/or forests will significantly affect the potential of solar PV, and that it might be possible to supply most of Asia's primary energy consumption by renewable energies, especially solar PV. However, the installation of renewable energy systems in forest areas will accelerate deforestation and lead to reduced carbon stock in forests, resulting in CO_2 exhaustion due to the disturbance of soils. The installation of renewable energy systems on croplands may also have a negative impact in a low carbon Asia, such as acute shortages of food. For the achievement of sustainable land use, it is essential to take the measures shown in Action 8. In addition, a balance between maintaining sustainable land use and enhancing the production of low carbon energy can be attained by adopting well-designed strategies for renewables such as installation on abandoned or unused croplands and/or only in forest areas with a higher level of solar radiation. Such strategies will also contribute to achievement of the targets of forest protection, improvement of food security, and low carbonization in Asia.

(Shuichi Ashina)

Summary of potentials for solar PV and wind power in Asia by country/region (unit: TWh/yr)

Scenario	Solar PV			Wind Power		
	Default	All Croplands	All Forests	Default	All Croplands	All Forests
Asia	8,672	959,119	1,622,672	33,744	56,166	68,478
By country/region						
Japan	50	1,958	20,357	185	432	2,829
China	4,266	323,357	453,471	18,777	30,632	33,185
India	1,051	310,047	185,540	2,471	5,468	5,159
Southeast Asia[*1]	1,587	180,964	856,686	6,766	10,405	18,398
Other[*2]	1,717	142,793	106,616	5,545	9,228	8,908

[*1] Southeast Asia and East Asia excluding Japan and China
[*2] South Asia excluding India and Oceania

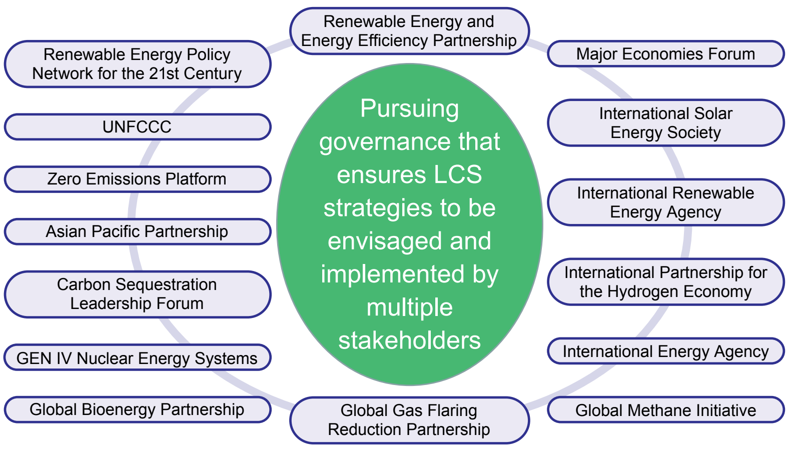
Action 9
Technology and Finance for a Low Carbon Society

Overview

To achieve Low Carbon Societies (LCSs) in Asia as rapidly as possible, existing low carbon technologies must be deployed and commercialized, and innovative new technologies must be developed. For these things to happen, national governments need to establish an environment for the industrial sector to invest with confidence in innovative research. They also need to create frameworks in Asia at the regional level in which each country's private sector can develop efficient technologies that will play a key role in the development of low carbon products, and deliver these products to the general public. At the present time, however, many institutional, economic, financial, and technological barriers exist that are preventing technology transfer and technology diffusion. Many studies in Asia have found that these barriers differ significantly by country and technology. In China, India, and Thailand, for example, technologies such as wind power and bioenergy electricity production that are ready for diffusion and technology transfer for commercial use may encounter such barriers as high patent acquisition costs, or a lack of local expertise with regard to imported technologies and lack of know-how and skills for their operation and maintenance. For technologies such as LED lighting or photovoltaics that are ready for diffusion and technology transfer for business or consumer use, the barriers may be the small size of the market, or an exceedingly small amount of investment from overseas. Because these barriers differ depending on the stage of technological development, level of diffusion, or stage of technology transfer, governments need to consider what funding, technology policies, and support programs might be required, depending on the stage of the technology lifecycle. They also need to implement this in collaboration with the private sector and the relevant international bodies.

The pool of private-sector funding available holds the key to the early transfer and spread of low carbon technologies. In the past, under the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, the Global Environment Facility (GEF) acted as an interim funding institution, providing funding to developing countries. After three funds were set up (the Special Climate Change Fund, the Least Developed Countries Fund, and the Adaptation Fund), however, many issues arose including a shortage of funds and the need to determine priorities for the limited funds available. To overcome this situation, the Green Climate Fund (GCF) was established in 2010 under the Copenhagen Accord of 2009, and it was stipulated that developed countries were to supply 100 billion U.S. dollars per year every year until 2020. However, this amount represents a huge jump in public funding, and the search is still on to find ways to secure the funds. Exacerbating this situation is the disappointing progress of multilateral negotiations under the UNFCCC. Because urgency is required in the Asian region – as it is undergoing rapid economic development – it is necessary to consider ways to procure funds especially in this region, without waiting for further progress in multilateral negotiations.

Past levels of aid from developed to developing countries cannot meet the level of funding required for the spread of technologies and products. In addition to the funding provided by developed countries under the UNFCCC and official development assistance, there is a need to find ways to mobilize diverse sources of public and private funding in the Asian region.



Changes in Asia Due to Action 9

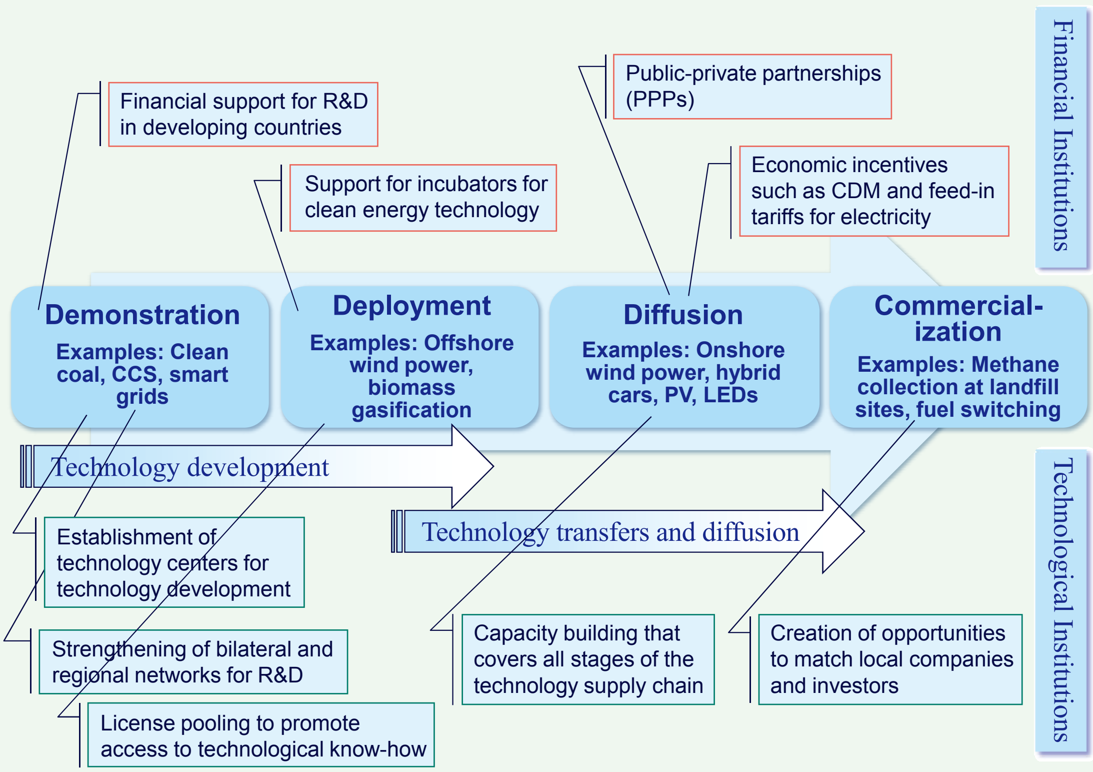
At the UNFCCC COP18/CMP8 climate meeting in 2012, the Climate Technology Centre and Network (CTCN) was established under the joint management of the United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO), and UNFCCC. By having government institutions promote collaboration among government-affiliated financial institutions and private-sector corporations that own technologies, it is hoped that a framework can be created in which many companies will actively share information and data through the CTCN network.

There are three points to note as Asia moves toward being a LCS. First, technological development and diffusion advances in diverse ways in Asia, depending on the country and region. For example, China and India are making inroads into wind power generation. On the other hand, photovoltaics and LED lighting for business and personal use are more common in Japan, whereas deployment in countries like China and India will take more time. Biomass and biomass power generation technology projects are expected to spread in Southeast Asian countries, where they are already making progress, despite some repeated setbacks. The time needed for development and diffusion in parts of Asia where technologies are still at the development stage – clean coal, carbon capture and storage, solar thermal, and smart grid technologies, for example – can probably be reduced by the creation of regional networks, with the areas where the technology is most advanced playing a leadership role.

Second, by strengthening the network within the region, the model of technology transfers might shift from the traditional one-way flow from developed to developing countries, to a model in which technology transfers also take place between developing countries. The transfer of low carbon technologies between developing countries has already been occurring, to some extent, but the rate is expected to accelerate in the future.

Third, the demand for low carbon technologies and products is expected to increase in Asia, which is currently experiencing economic growth. Considering the potential future increase in consumer demand for energy-efficient products, which until now were only targeted at consumers in some developed countries, including Japan, and the potential introduction of economic incentives, these products could spread to areas that were not previously targeted.

In the future, economic development is likely to continue unabated in many countries in Asia, so citizens will be living more affluent lifestyles. As countries achieve these levels, they will likely have reduced needs for official assistance from developed countries, and are likely to find their populaces having a higher level of environmental awareness. The rising environmental awareness is an opportunity for governments of Asian countries to provide incentives that will induce corporations to make environmentally friendly investments. Also, countries could abolish subsidies for fossil fuels and introduce carbon taxes, and those tax revenues could be invested in new technological development. Polices such as these could result in a gradual increase in energy prices, and a shift in public preferences toward low carbon products and lifestyles.



Examples of technological and financial institutions for each stage in the technology life cycle (barriers to technology deployment vary significantly by technology, country, and region)

Components of the Action

Action 9 consists of three approaches: (1) promote private-sector R&D for LCS, (2) establish adequate funding to support R&D and technology diffusion, and (3) foster environmentally conscious consumers who choose low carbon products.

9.1 Promote private-sector R&D for LCS

9.1.1 Strengthen the sharing of knowledge and technology
9.1.2 Strengthen institutional arrangements to promote technology diffusion
9.1.3 Implement economic incentives

The task of creating conditions needed for the R&D and diffusion of low carbon technologies spans many sectors, so it is essential to consider the appropriate distribution of public and private funds, including international environmental funds and sector-based funds, depending on the purpose. For the diffusion of technologies that are at the development stage (e.g., carbon storage and clean coal), however, the implementation of economic incentives alone is not enough; it is also important to establish and/or strengthen technology networks.

The important things for creating a LCS suitable for Asian countries are the promotion of new technological developments to overcome institutional, economic/financial, and technical barriers, and the establishment of integrated policies and institutions to promote existing technologies.

9.1.1 Strengthen the sharing of knowledge and technology: The first measure under this sub-action involves the sharing of knowledge and technologies. Particularly at the technology development stage, it is important to strengthen R&D networks between research institutes, and to build technology-demonstration partnerships. Technical cooperation in Asia is important for the development and diffusion of low carbon technologies, particularly for the efficient use of international resources. For example, in order to create systems for the reuse of resources, it is essential to deploy low carbon technologies in other Asian countries and other regions of the world, through the collaboration of international organizations and governments, etc., by supporting the establishment of building codes suited to certain climate zones and energy efficiency standards for business equipment.

9.1.2 Strengthen institutional arrangements to promote technology diffusion: The second measure involves the strengthening of institutional arrangements to promote technology diffusion. It is important to strengthen technical capabilities and capacity-building to train specialists, to strengthen knowledge of intellectual property rights (including patent systems), and to implement industry-by-industry technical cooperation programs. For example, if the aim is sustainable forest-use and land-use management, in order to prevent illegal logging and achieve sustainable forest resource management it will be important to promote international cooperation activities that involve human resources capacity building.

9.1.3 Implement economic incentives: The third measure under this sub-action involves the implementation of economic incentives to stimulate private-sector investment. Examples include carbon credit systems, electricity-purchasing programs, subsidies, taxes, etc. It is not enough merely to implement incentives. Rather, it is also necessary to introduce measures to facilitate the flow of private-sector funds, such as matching overseas investors with in-country project proponents, and formulating policies to mitigate investment risk. These actions will be effective when it comes to technical transfers for biomass resources. For example, to internationally support R&D for biomass energy sources and usage technologies, to boost transfers to other regions under technical transfer programs based on successful cases, and to introduce and apply advanced biomass-utilization technologies and methods, the following actions are expected to significantly advance the deployment of renewable energy: institutional cooperation to attract foreign investment and boost technology deployment, the promotion of technology transfers, and tax system/institutional support to establish technologies in recipient countries.

9.2 Establish adequate funding to support R&D and technology diffusion

9.2.1 Make official development assistance "greener"
9.2.2 Use public funds to attract private-sector investment
9.2.3 Create an Asian regional funding mechanism to support sectors lacking private-sector incentives

9.2.1 Make official development assistance "greener": Numerous renewable energy and energy-efficiency projects have been implemented in Asian developing countries, funded by official development assistance (ODA) and international institutions, to make basic infrastructure improvements and boost economic development in order to reduce poverty. Included among them, however, have been numerous projects for the construction of energy plants that promote the use of fossil fuels.

To establish low carbon transportation systems and low carbon energy systems in Asia, it will be essential to make ODA for infrastructure development in developing countries greener than it is today. For example, to realize low carbon transportation, infrastructure investments in low carbon transportation systems need to be based on future visions that have been formulated at the early stages of economic growth. When doing so, consideration should be given to the use of ODA funds with a priority on infrastructure improvements for low carbon transportation systems that emphasize rail and water transportation in coastal areas and inland.

Also, to create renewable energy systems, infrastructure improvements to facilitate the international purchase and sale of electricity are essential. One example would be the unification of standards. At the same time, in view of the large number of agricultural communities in the Asian region, it is also necessary to promote the establishment of independent village-level energy supply systems that can make use of local energy resources.

To establish these systems, it is helpful to adopt systems that can evaluate assistance not only in terms of the economic efficiency of funds, but also from the perspective of resource and carbon efficiency.

9.2.2 Use public funds to attract private-sector investment: Equally important is the use of public funds to encourage greater investment from the private sector. Estimates of funds supplied to date for climate change mitigation have found that the amounts of private-sector funds are tens to hundreds of times greater than the amounts of public-sector funds. These findings have reminded us of the importance of private-sector funds in the total picture of financial flows.

Once established, LCSs will enjoy lower costs to sustain themselves than societies that have not switched to low carbon patterns, because the amounts of energy and resources used will be dramatically less. Therefore, judged from a long-term viewpoint and with an economic perspective, investment in a LCS would be the rational choice. Generally speaking, however, high initial investment costs are a major obstacle preventing private-sector companies in Asian countries from developing low carbon technologies and using those that have already been commercialized. The speed with which private-sector companies can take action (e.g., to boost energy efficiency, carry out R&D to expand the use of renewable energy, manufacture energy-efficient products, and sell them) holds the key to success in achieving a country's greenhouse gas emission reduction targets. Governments could therefore help private-sector companies overcome their financial and economic barriers by offering financial support so that the country's industrial centers can invest safely in innovative R&D; for example, programs to assist private-sector R&D, support to cover initial investment costs, and measures to support the commercialization of newly-developed technologies.

9.2.3 Create an Asian regional funding mechanism to support sectors lacking private-sector incentives: Because it is relatively easy to attract private investment for large-scale infrastructure improvements and the development and manufacturing of new products, the situation is quite positive for private-sector investment; thus, bilateral financial assistance for that purpose is relatively easy to obtain. At the same time, it is difficult to attract private investment and bilateral assistance for climate change mitigation projects such as forest protection and tree-planting in non-industrialized least developed countries, because activities in these areas are less profitable. This is where multilateral or regional-level funding mechanisms are needed, to provide financial support in areas where it is difficult to attract private investment. It is necessary to make use of regional institutions such as the Asian Development Bank in cases where it is difficult to attract funding based on market principles.

9.3 Foster environmentally conscious consumers who choose low carbon products

9.3.1 Change consumer awareness by promoting environmental education

9.3.1 Change consumer awareness by promoting environmental education: It is important that citizens are able to choose locally produced agricultural products and products that are certified as sustainably produced. Also, when it comes to biomass resources, the promotion of "local production for local consumption" has important implications for the deployment of low emission agricultural technologies in Asia, and sustainable forest and land-use management. Citizens can also choose low carbon energy sources through their actions such as by installing photovoltaic equipment during new house construction, and purchasing green electricity.

Establishing effective programs to promote low carbon technologies

Since the failure of negotiations at COP15 in Copenhagen, resulting in setbacks in creating institutional arrangements for legally binding GHG emission reduction targets, there has been a need for international mechanisms to promote R&D and technical transfers of low carbon technologies as tools to facilitate GHG emission reductions on a broad regional scale. While a number of international frameworks focusing on low carbon technologies outside the UNFCCC have been emerging, the Climate Technology and Centre Network (CTCN) was established in 2012 under the auspices of the UNFCCC. Its top objective is to effectively promote the deployment of low carbon technologies, through partnerships between governments, multilateral banks, and private-sector companies that own the technologies. That is the purported objective, although the details of the institutional design are not yet clear to observers.

Project S-6 has been studying the governance of low carbon technologies. The research findings have implications for the design of CTCN.

First, it is important to recognize that while the term "low carbon technology" is in common use, large differences exist between individual technologies and there are many technology sub-categories. Thus, it is important to incorporate flexibility into at least three aspects of the network's institutional design: (1) technologies covered, (2) stage of the technology lifecycle, (3) and target countries. For example, different programs would be needed to promote technology transfers for solar cells, versus wind power or biogas. Differences in programs would also arise between India and Indonesia. Indeed, there are differences by country and by region of each country, affecting which type of renewable energy is in greatest demand.

Second, for technologies for which a network already exists, it is important to consider utilizing that network. A number of regional or international networks have already been established in some industrial sectors. While positioning itself above such networks and focusing on low carbon technologies, the CTCN should build itself into a network for problem solving.

Third, it is important that the CTCN involve the appropriate stakeholders. To maintain resilient governance of the network, it will be very important to always bring important stakeholders into the problem-solving framework and work together to find problem-solving strategies. In this respect, involvement should not only be for national governments and industry; the role of international organizations and nongovernmental organizations in monitoring and capacity building should not be overlooked.

As indicated by its very name, it will be important for the CTCN to create an institutional design that benefits most from its strengths as a network. (Norichika Kanie)

Action 10

Transparent and Fair Governance that Supports Low Carbon Asia

Overview

For Asian countries to become Low Carbon Societies (LCSs) and enjoy the related benefits, all actors – governments, industry, citizens, and international society – need to share a common vision and strategy for a LCS. It is essential to plan, implement, and evaluate the options, with coordination of each of the respective roles.

In the past, in order to achieve the greenhouse gas (GHG) emission reduction targets allocated under the Kyoto Protocol, a variety of related policy frameworks were established, and there was much discussion about the roles of national governments in implementation. To truly create LCSs, however, we cannot avoid the need for reallocation of resources and burdens in the domestic context. However, political interests can become a major factor in some cases, and it becomes difficult for national governments to plan and implement effective policies. Furthermore, due to rapid economic development, GHG emissions from developing countries – which are not under legally binding obligations to reduce emissions – are rising significantly. It will not be possible to limit the global temperature increase to 2°C if discussions and efforts continue at the current pace for achieving emission reduction targets that were adopted based on the concept of equity when the United Nations Framework Convention on Climate Change (UNFCCC) entered into effect.

The answer to the question of what is a fair reduction varies significantly depending on a country's perspective of what is "fair." Thus, for "low carbon governance" that will achieve large, long-term reductions in GHG emissions in order to achieve the 2°C target, national commitments are important, but it is also important that other nongovernmental stakeholders make voluntary commitments, depending on their ability to do so. Also, it will be important to create institutional designs that will allow mainstreaming of low carbon policy, in an integrated way, of the frameworks that have so far been built on a sector-by-sector basis. And, based on them, it will be important to create efficient administrative management frameworks.

Photo by Izumi Kubota (NIES)

Notably, many Asian countries have formulated action plans to become LCSs, but in many cases the plans are not being implemented, or even if they are being implemented, the effects are limited. In some cases, government fraud or corruption due to inadequate legislation or governance results in a failure to effectively utilize physical, economic, and human resources. Also, due to inadequacies in governments' management philosophy or concepts, it is not uncommon to see redundancy of policies and measures by different government ministries and agencies, or inadequate sharing of information.

In this context, as a national-level initiative to establish LCSs in Asia, it is necessary to build the foundations of transparent and accountable government and to institute corruption-prevention measures in the public sector, including central and local (municipal) governments. Meanwhile, the international community is expected to provide support to accelerate those efforts at the national level. For example, the World Bank and other institutions have developed frameworks for country-specific evaluations of public-sector policies and institutions, and attempts are being made to reflect these efforts in their international assistance. Thus, strengthening the role of the international community in encouraging improvements in public-sector management in Asian countries could be a major step forward to implement policies and measures proposed under Actions 1 through 9 of this document.

Also, as described below, Asian countries are characterized by the diversity of their political systems, and they need to plan and implement policies not only for sustainable development but also other development objectives, such as reducing health problems and poverty. In many cases the differences between countries are mainly in scale, but they have much in common. Thus, there is a need for intergovernmental policy coordination in the planning and implementation of policies that have some compatibility between development objectives and GHG emission reductions.

Regarding the public-private sector relationship, in the past there has been excessive protection of government-related and/or certain private companies. However, it is important to establish healthy public-private partnerships by establishing objective standardization and certifications.

Changes in Asia Due to Action 10

Development in Asian countries to date has been supported by a variety of political systems of the countries in the region. The diversity of political systems could be described as a unique feature of Asia, not seen in Europe and other regions. Looking at how politics is conducted in each country, one notices other Asian features. Even though there may be differences in political systems, all have followed a path of development led by the state or by a bureaucracy. Typical examples include the successful economic development of Singapore's disciplined regime, Japan's postwar economic development, and China's current rapid development. These Asian features form the basis for future low carbon growth, but on the other hand, in the shift toward LCSs on a global scale, state-led and bureaucracy-led policy processes are likely to change.

Enhancement of international institutions would spread the norm that achieving a LCS is a necessary precondition in Asia for future development. Low carbon policy coordination based on such a norm can be expected to promote consistency of policies and measures in the region, going beyond differences in national political systems. One country's successes in policies and measures (e.g., successes in which results are obtained at no additional cost) will amplify the merits of policy coordination, while demonstrating that the policies and measures are feasible and demonstrating their effectiveness. Also, stronger public-private partnerships (PPPs) and associated standardization and certifications will likely become a driving force for progress toward realizing LCSs, by gradually increasing the influence and presence of non-state stakeholders or by strengthening cross-border networks of stakeholders. In these ways, a norm that supports LCSs will permeate through the activities of people in Asia, and this will lead to stakeholder collaboration across national boundaries.

Components of the Action

Action 10 consists of three approaches: (1) create an efficient administrative management framework, (2) establish fair and transparent business practices, and (3) improve literacy with respect to environmental policies and technologies.

10.1 Create an efficient administrative management framework

10.1.1 Strengthen international institutional linkages
10.1.2 Strengthen multilevel governance
10.1.3 Strengthen policy transfers and policy coordination

Due to the complex nature of the issue of climate change, its policies reside not only with the UNFCCC but also with fora outside of the United Nations system, including many international institutions at the bilateral, regional, and multilateral levels. Thus, for the resolution of climate change issues, we need to draw more implications from "fragmented governance," where the focus is not only placed on policy decisions agreed under the UNFCCC, but also on the functions of various international institutions.

The G8 summits and the Major Economies Forum (MEM) are examples of international fora that focus mainly on economic issues, but at the same time, they address climate change as a high-priority issue. Initiatives in the Asia-Pacific region include the Asian Pacific Partnership (APP), the Major Economies Process on Energy Security and Climate Change (MEP), the East Asia Climate Partnership (EACP), and the Low Carbon Growth Partnership (LCGP) advocated by Japan at COP 17.

To make low carbon Asia a reality, it will be important to expand and spread norms to promote climate change policies into various policy areas, through fragmented international climate institutions. To achieve this, it will be necessary to create and strengthen efficient administrative management frameworks as suggested below.

10.1.1 Strengthen international institutional linkages: One important function of the UNFCCC is to create common understanding worldwide, or, stated differently, to create and spread shared norms by presenting a vision for the creation of a LCS. Fragmented governance, mentioned earlier, can be disruptive. To prevent this, it is necessary to "mainstream"; that is, to integrate environmental policies and energy polices together, and

Photo by Izumi Kubota (NIES)

infuse low carbon policies into many diverse policy areas. Then, the common norms should ideally be shared through various institutions and fora, not conflicting with each other but spread and integrated in a synergistic and cooperative manner. To move toward this type of governance, the key is to have the appropriate actor constellations. If the number of actors increases, the existing norms become more diverse and potentially could lead to conflictive fragmentation. Thus, it is important to encourage collaboration among actors and institutions to create synergistic and cooperative fragmentation.

10.1.2 Strengthen multilevel governance: To strengthen the international system, it is necessary to strengthen governance at different levels: local, regional, national, and global.

Discussions are currently under way related to the Nationally Appropriate Mitigation Actions (NAMAs) under the UNFCCC. Many of the NAMAs proposed by developing countries include measures related to low carbon transportation as a result of modal shifts, so NAMAs could be one of the key drivers to achieve low carbon transportation systems. At the same time, the concept of Locally Appropriate Mitigation Actions (LAMAs) has also been emerging. These are actions not at the national, but at the local level. Measures at the local level are important when it comes to local production of biomass resources for local consumption and the use of low emission agricultural technologies, so it will be important in the future to encourage voluntary emission reduction efforts by developing countries through their use of combinations of NAMAs and LAMAs.

10.1.3 Strengthen policy transfers and policy coordination: To achieve LCSs in Asia, it is necessary to make institutional changes such as revisions to tax systems and land-use plans. For this to occur, there is a need for countries to enhance policy coordination and policy transfers. For example, by sharing knowledge about the creation of smart energy systems, national governments can develop medium-term and long-term policies that incorporate the aims of a LCS, and are able to demonstrate domestically and abroad that they are working toward a LCS.

A review of a tax system involves planning and implementing domestic fuel taxes and carbon taxes, and abolishing existing fuel subsidies. For example, by applying a carbon tax in the transportation sector, it is possible to reduce the advantages of car use, and encourage a modal shift. Also, through support in the form of tax relief or subsidies for the deployment of technology, it is possible to encourage the construction of energy-efficient buildings, or the adoption of energy-efficient equipment. Furthermore, by gradually phasing out developed countries' existing fossil fuel subsidies, it is possible to boost the competitiveness of biomass energy, while other subsidies and tax incentives could encourage greater use of biomass.

A review of land use plans can be an effective approach to extract the greatest value from the use of low carbon transportation systems and resources, further promote bioenergy, and manage sustainable forest resources. For example, it is possible to create a low carbon transportation system by planning cities so as to avoid new and unnecessary transportation demand. Also, by planning urban and national land infrastructure so as to have a long service life and be less material-intensive, it is possible to maximize the value of resources. Furthermore, there have been many cases where biomass production threatened food production, but to address this problem, proper land-use regulation could prevent excessive planting of energy crops. When aiming for sustainable forest management, there is a need to establish adequate land-use plans and manage the land use appropriately. Through this process, it is possible to protect forests, suppress illegal logging, and stop uncontrolled expansion of farmland.

10.2 Establish fair and transparent business practices

10.2.1 Promote public-private partnerships in cooperation with industry
10.2.2 Develop standardization and certification systems

Since companies are typically the actors that own low carbon technologies, their involvement is essential in the creation of effective management frameworks. To this end, there is a need for corporate activities to be conducted based on fair market principles, by encouraging public-private partnerships in cooperation with industry and by creating standardization and certification systems.

10.2.1 Promote public-private partnerships in cooperation with industry: The Asia Pacific Partnership mentioned above is one example of public-private partnership in Asia. With seven countries participating in the APP – Australia, Canada, China, India, Japan, South Korea, and the United States – a task force has been created, consisting of governmental and private-sector members, with the aim of developing, deploying, and transferring low carbon technologies for buildings, electrical equipment, renewable energy, and so forth. This kind of partnership between government and industry is very important for securing funding for technology research and development, and for programs to support deployment of the technologies.

10.2.2 Develop standardization and certification systems: When it comes to the deployment and transfer of low carbon technologies, it is beneficial to share information about best practices related to technology standardization and codes, as well as labeling schemes. As regards product environmental labeling systems, product rating systems can be developed through cooperative international research on the efficient use of resources in technology development. Since emerging economies may not have a well-established law enforcement system, and may be dealing with many administrative issues, being able to effectively make use of existing label certification systems could be valuable for them. Examples include support for the establishment of building codes suited to certain climate zones and energy-efficiency standards for business equipment.

It is also possible to obtain objective, expert evaluations of low carbon technologies, by creating product evaluation systems through industry-government collaboration and operating independent evaluation systems. Such an independent evaluation system can contribute to smart ways to use materials that realize the full potential of resources.

It is also important to link these certification systems with the institutional frameworks of existing certification systems. One example from the forest sector is the Forest Stewardship Council (FSC), which is operated by companies and environmental nongovernmental organizations and realizes non-state market-driven governance. The FSC is a framework for certifying sustainable forest management that allows consumers to choose wood produced without major environmental impacts, even if the wood was produced overseas. As in this example, certification systems are needed in Asia that will not compete with existing certification systems.

10.3 Improve literacy with respect to environmental policies and technologies

10.3.1 Raise citizens' environmental awareness
10.3.2 Raise governments' environmental awareness through policy reviews

Equally important for strengthening the framework of administrative management and promoting business activities based on fair market principles is the promotion of environmental education, to achieve a transformation in citizen lifestyles toward low carbon living. Policy reviews are also essential for raising the environmental awareness of developing-country governments and motivating them to bolster their voluntary GHG emission reduction activities.

10.3.1 Raise citizens' environmental awareness: Stronger environmental education can be expected to transform awareness, possibly leading to the proactive choice of public transportation means such as rail and water transportation. The same can be applied to smart ways to use materials that realize the full potential of resources. By showing the superiority of lifestyles with low material consumption and raising consumer awareness of environmental consideration and energy efficiency, citizens will become imbued with higher awareness and motivation to engage in sustainable consumption patterns, such as purchasing low carbon products and recyclable/reusable products.

10.3.2 Raise governments' environmental awareness through policy reviews: The measures described above are mainly voluntary and up to the discretion of developing countries. In this context, in the future it will also be important to aim for higher environmental awareness in developing countries through policy reviews. Currently, NAMAs are developed in a Measurable, Reportable, and Verifiable (MRV) manner, in order to encourage GHG emission reduction efforts by developing countries. Since the Copenhagen Accord, the MRV concepts are becoming more concrete for national and biennial reports, as well as in the form of International Assessment and Reviews (IAS) and International Consultations and Analysis (ICA). This accumulation of knowledge related to policy reviews is seen as a very important type of initiative to encourage developing countries' voluntary emission control activities.

Carbon trading systems in Asia: Current status and prospects

Acknowledging that global warming and climate change caused by human activities are an urgent issue for humanity, the international community has put considerable effort into the research, development, and dissemination of technological approaches, socioeconomic policies, and institutional approaches such as the Kyoto Protocol, to limit or reduce emissions of the greenhouse gases (particularly carbon dioxide) that are a source of the problem. Meanwhile, due to rapid economic development in countries such as China, India, and the nations of Southeast Asia (ASEAN), Asia has become a growth center in the world, and its CO_2 emissions have also risen. China is now the world's top emitter, India is fourth, and Asia now has more emissions than any other region in the world.

Today, Asian national governments are working actively toward the creation of low carbon systems. Among these efforts, Asian countries are paying much attention to the use of CO_2 emission trading systems as a CO_2 emission reduction strategy that makes use of market forces. Japan has established the Japan Voluntary Emissions Trading Scheme (JVETS) and is encouraging companies to participate voluntarily. In fiscal 2010, the Tokyo Metropolitan Government launched a carbon emission trading system (Tokyo ETS). In fiscal 2011, Saitama Prefecture also introduced a carbon emission trading system, and a joint emission trading system is being considered now by Tokyo, three prefectures, and eight municipalities in the Tokyo metro region. The Japanese government is also considering launching a national carbon emission trading system. While Korea does not have mandatory emission reductions under the Kyoto Protocol, it has established its own national emission reduction targets and has also discussed creating a carbon emission trading system. A related legislative bill was adopted in 2012, and the system launch is expected in 2015.

With the exception of Japan and Korea, however, no concrete plans exist among other countries in Asia regarding any carbon emission trading system. China and Kazakhstan intend to inaugurate a trial carbon trading market in 2013, but it is not known when regular operations might begin. Also, most Asian countries are depending on the Kyoto Protocol's Clean Development Mechanism (CDM) approach to reduce emissions by "baseline and credit," rather than the "cap and trade" approach. Because of this situation, the current emphasis is on CDM project support for Asian countries, and capacity-building for Asian countries toward their future participation in carbon markets, through initiatives such as Japan's bilateral credit program (Joint Crediting Mechanism, JCM), the Asian Development Bank's Carbon Market Program (CMP), and the Low Emissions Asia Development Program (LEAD) of the U.S. Agency for International Development (USAID).

The amount of research into the design of carbon emission trading systems in Asia is very low compared with research related to the European Emission Trading System (EU-ETS). The main emphasis of such research is on the benefits of an integrated Asian regional carbon emission trading system, as well as linkages with carbon emission markets and so forth. Considering the fact that carbon trading markets are not yet well established in Asian countries today, further studies on institutional designs to build an Asian regional carbon emission trading system are needed.

(Shunji Matsuoka)

Low-Carbon Asia Research Project

Project Leader	Mikiko Kainuma (National Institute for Environmental Studies (NIES))	
Advisory Board	Ryokichi Hirono (Professor Emeritus, Seikei Univ.)	Masahiro Kawai (Dean and CEO, Asian Development Bank Institute)
	Li Zhidong (Professor, Nagaoka Univ. of Tech.)	Shuzo Nishioka (Senior Research Advisor, Institute for Global Environmental Strategies (IGES))
Program Officer	Yasuhiro Sasano (Association of International Research Initiatives for Environmental Studies)	

S-6-1 LCS Scenario Development

Team Leader	Toshihiko Masui (NIES)	
	Junichi Fujino (NIES) (Project Manager)	Tatsuya Hanaoka (NIES)
	Kiyoshi Takahashi (NIES)	Yasuaki Hijioka (NIES)
	Yuko Kanamori (NIES)	Shuichi Ashina (NIES)
	Shinichiro Fujimori (NIES)	Yumiko Asayama (NIES)
	Diego Silva Herrán (NIES)	Miho Kamei (NIES)
	Tomoko Hasegawa (NIES)	Dai Hancheng (NIES)
	Park Chan (NIES)	Tomoki Ehara (E-KONZAL)
	Hu Xiulian (Energy Research Institute, China)	Jiang Kejun (Energy Research Institute, China)
	P. R. Shukla (Indian Institute of Management, Ahmedabad, India)	Manmohan Kapshe (School of Planning and Architecture, Bhopal, India)
	Aashish Deshpande (National Institute for Technical Teachers' Training and Research, Bhopal, India)	Rahul Pandey (Integrated General Systems Analysis Laboratories, India)
	Rizaldi Boer (Bogor Agricultural University, Indonesia)	Retno Gumilang Dewi (Institut Teknologi Bandung, Indonesia)
	Lee Dong Kun (Seoul National University, Korea)	Ho Chin Siong (Universiti Teknologi Malaysia, Malaysia)
	Ram M. Shrestha (Asian Institute of Technology, Thailand)	Bundit Limmeechokchai (Sirindhorn International Institute of Technology, Thammasat University, Thailand)
	Sirintornthep Towprayoon (The Joint Graduate School of Energy and Environment, Thailand)	Nguyen Van Tai (Institute of Strategy and Policy on Natural Resources and Environment, Vietnam)
	Yuzuru Matsuoka (Kyoto Univ.)	Gakuji Kurata (Kyoto Univ.)
	Reina Kawase (Kyoto Univ.)	Kei Gomi (Kyoto Univ.)
	Janice J. Simson (Kyoto Univ.)	Go Hibino (Mizuho Information & Research Institute, Inc. (MHIR))
	Kazuya Fujiwara (MHIR)	Yuko Motoki (MHIR)
	Kazuyo Oyamada (MHIR)	Kokichi Ito (The Institute of Energy Economics, Japan (IEEJ))
	Yukari Yamashita (IEEJ)	Shen Zhongyuan (IEEJ)
	Yuji Matsuo (IEEJ)	Yu Nagatomi (IEEJ)
	Akira Yanagisawa (IEEJ)	Yoshiaki Shibata (IEEJ)
	Ryoichi Komiyama (The Univ. of Tokyo)	Jusen Asuka (IGES)
	Kentaro Tamura (IGES)	Yu Yuqing (IGES)
	Nanda Kumar Janardhanan (IGES)	Takeshi Kuramochi (IGES)
	Zhen Jin (IGES)	Shinji Kaneko (Hiroshima Univ.)
	Masaru Ichihashi (Hiroshima Univ.)	Daisaku Goto (Hiroshima Univ.)
	Akimasa Fujiwara (Hiroshima Univ.)	Junyi Zhang (Hiroshima Univ.)
	Satoru Komatsu (Hiroshima Univ.)	Phetkeo Poumanyvong (Hiroshima Univ.)
	Jin Chen (Beijing Normal University, China)	Makoto Chikaraishi (The Univ. of Tokyo, Carnegie Mellon Univ.)

S-6-3 Institutional Architecture for LCS

Team Leader	Norichika Kanie (Tokyo Institute of Technology (Tokyo Tech.), United Nations University - Institute of Advanced Studies (UNU-IAS))	
	Masahiko Iguchi (Tokyo Tech.)	Yasuko Kameyama (NIES)
	Izumi Kubota (NIES)	Kanako Morita (Keio Univ.)
	Masachika Suzuki (Kansai Univ.)	Shunji Matsuoka (Waseda Univ.)
	Chaewoon Oh (Waseda Univ.)	Kazuhiko Takemoto (UNU-IAS)
	Aki Suwa (UNU-IAS)	Sohail Ahmad (UNU-IAS)
	Manu Mathai (UNU-IAS)	Joni Jupesta (UNU-IAS)
	Ping Jiang (Fudan Univ., China)	

S-6-4 Resources Management for LCS

Team Leader	Yuichi Moriguchi (The Univ. of Tokyo)	
	Shinsuke Murakami (The Univ. of Tokyo)	Seiji Hashimoto (Ritsumeikan Univ.)
	Tao Wang (Ritsumeikan Univ.)	Shigekazu Matsui (MHIR)
	Minoru Yoshikawa (MHIR)	Shigesada Takagi (MHIR)
	Arisa Murata (MHIR)	Keisuke Nansai (NIES)
	Kenichi Nakajima (NIES)	Hiroki Tanikawa (Nagoya Univ.)
	Feng Shi (Nagoya Univ.)	Xin Tian (Nagoya Univ.)
	Chihiro Kayo (Tokyo Univ. of Agriculture and Technology)	

S-6-5 Low Carbon Transport System

Team Leader	Yoshitsugu Hayashi (Nagoya Univ.)	
	Hirokazu Kato (Nagoya Univ.)	Kazuki Nakamura (Nagoya Univ.)
	Kei Ito (Nagoya Univ.)	Aoto Mimuro (Nagoya Univ.)
	Atsushi Fukuda (Nihon Univ.)	Hideyuki Ito (Nihon Univ.)
	Tetsuhiro Ishizaka (Nihon Univ.)	Tuenjai Fukuda (Nihon Univ.)
	Matthew Barth (Univ. of California, Riverside, U.S.A.)	Sittha Jaensirisak (Ubon Ratchathani Univ., Thailand)
	Varameth Vichiensan (Kasetsart Univ., Thailand)	Thaned Satiennam (Khon Kaen Univ., Thailand)
	Paramet Luathep (Prince of Songkla Univ., Thailand)	Nuwong Chollacoop (National Metal and Materials Technology Center, Thailand)
	Viet Hung Khuat (Univ. of Transport and Communications, Vietnam)	Nguyen Van Truong (Univ. of Transport and Communications, Vietnam)
	Allexis Fillone (De La Salle Univ., Philippines)	Shinya Hanaoka (Tokyo Tech.)
	Kumiko Nakamichi (Tokyo Tech.)	Fumihiko Nakamura (Yokohama National Univ.)
	Toshiyuki Okamura (Toyo Univ.)	Takaaki Okuda (Nanzan Univ.)

As of September 1, 2013

Scenario Task Force

S-6-1 Tomoki Ehara, Shuichi Ashina, Kazuyo Oyamada	S-6-3 Yasuko Kameyama, Aki Suwa, Masahiko Iguchi
S-6-4 Seiji Hashimoto, Shigekazu Matsui	S-6-5 Hirokazu Kato, Kazuki Nakamura

Contact: Low-Carbon Asia Research Project
National Institute for Environmental Studies
16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan
E-mail: lcs_project@nies.go.jp

December 2013

Secretariat: Chie Shiraishi (NIES)
Cover designed by Information and Public Relations Group,
Center for Global Environmental Research, NIES

Printed on recycled paper.