Chapter 1
GHG Reduction Potential in Asia

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Abstract 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 double the 2005 levels if efforts are not made toward achieving low-carbon societies (LCSs). The reduction of emissions in Asia is imperative for the transition by 2050 to an LCS worldwide that has halved GHG emissions. 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 another and being aware of the roles they need to play. In addition, careful attentions should be placed on the diversity of the Asian countries when it comes to the implementation of countermeasures. 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.

In order to analyze the feasibility, in this study two future scenarios, namely, advanced society scenario and conventional society scenario, are developed. In addition, "Ten Actions toward Low Carbon Asia," a guideline to plan and implement the strategies for an LCS in Asia, was developed. The ten actions are the following:

Action 1: Hierarchically connected compact cities
Action 2: Mainstreaming rail and water in interregional transport
Action 3: Smart ways to use materials that realize the full potential of resources
Action 4: Energy-saving spaces utilizing sunlight and wind
Action 5: Local production and local consumption of biomass
Action 6: Low-carbon energy system using local resources
Action 7: Low-emission agricultural technologies

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Action 8: Sustainable forestry management
Action 9: Technology and finance to facilitate achievement of LCS
Action 10: Transparent and fair governance that supports low-carbon Asia

The contributions of the ten actions have been quantified by a global computable general equilibrium model. The model outputs showed that GHG emissions in Asia can be reduced by 20 gigatons of CO_2 equivalent ($GtCO_2$), i.e., 68 % of the emissions in the reference scenario, in 2050, if all the actions are applied appropriately.

In practice, on the other hand, it should be bear in mind that we need the smart strategies to meet the LCS pathways in each country depending on each development stages. For that purpose, knowledge sharing becomes important. 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.

Keywords Asia • Greenhouse gas • Low-carbon society • Transportation sector • Building sector • Industry sector • Renewable energy • Scenario • Global computable general equilibrium model

Key Messages to Policy Makers

- GHG emissions in Asia must be reduced drastically to meet the 2 °C target, which represents that the global mean temperature should be below 2 °C compared with preindustrial level.
- This paper presents common ten actions to achieve the low-carbon society in Asian countries although their situations are quite different.
- By applying the ten actions, Asia can reduce 68 % of GHG emissions in 2050 compared with the reference scenario.
- In practice, knowledge sharing among the countries is essential to achieve leapfrog development.

1.1 Introduction

Greenhouse gas (GHG) emissions from Asia have increased continuously and accounted for approximately 38 % of global emissions in 2005 (Fig. 1.1). Considering the rapid economic growth expected in the coming decades, emissions from Asia in 2050 are projected to double the 2005 levels if efforts are not made toward achieving low-carbon societies (LCSs). The Fifth Assessment Report of IPCC Working Group III (IPCC 2014) mentioned that, in order to achieve the 2 °C target, which is to limit the increase in global mean surface temperature to less than 2° C, the GHG emissions in 2050 and 2100 will have to be reduced by 41–72 % and 78–118 %, respectively,

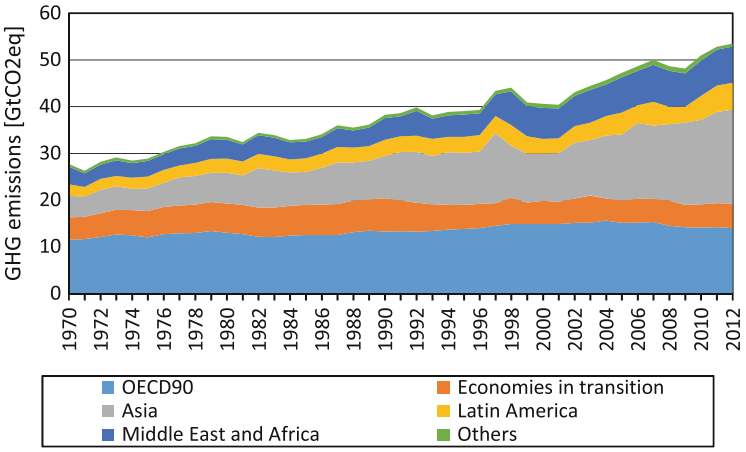

Fig. 1.1 Total GHG emissions by region between 1970 and 2012 (Notes: Data source is EDGAR v4.2 FT2012 (EDGAR 2014). Others include international aviation and shipping)

compared with the 2010 level. This means that the reduction of GHG 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 another and being aware of the roles they need to play.

In addition, careful attentions should be placed on the diversity of the Asian countries when it comes to the implementation of countermeasures. 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 (Fig. 1.2). 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.

There are many future scenarios, and future society will be diverse and uncertain. Based on the previous studies, we summarize the future scenarios of this study into two types: one is advanced society scenario and another is conventional society scenario (Kawase and Matsuoka 2013). Advanced society scenario will accept the new social system, institution, technologies, etc., positively and proactively. On the

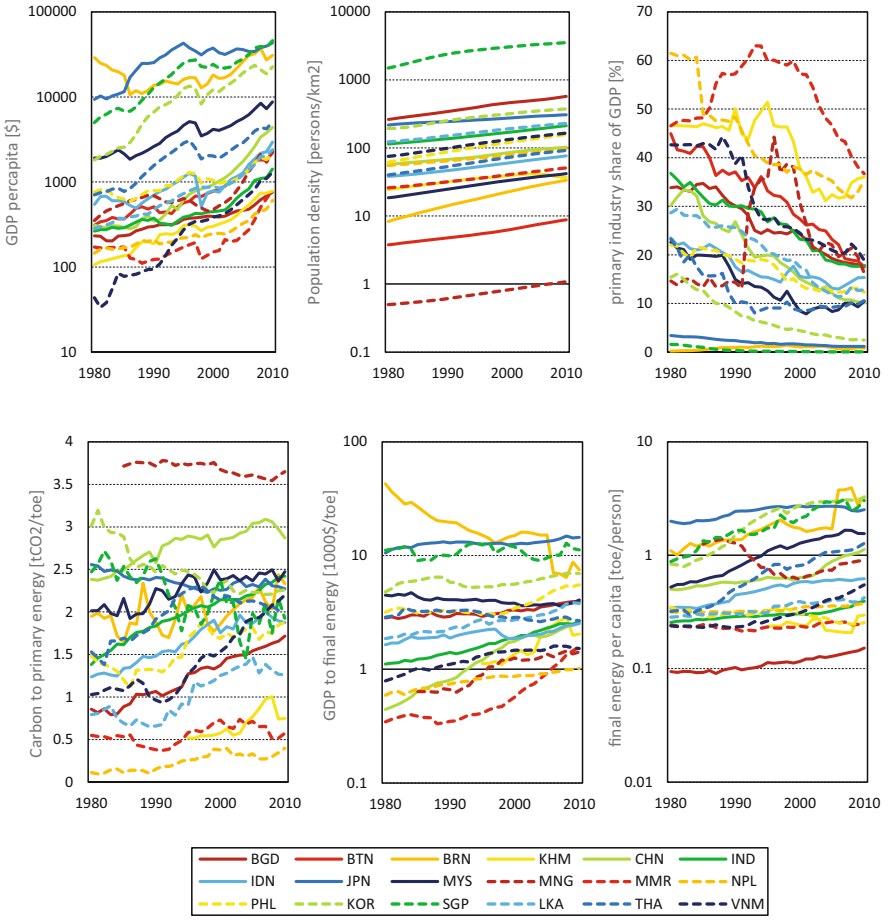

Fig. 1.2 Diversity and trends of Asian countries (Data source: UN Statistics Division 2015; IEA 2014a, b, c)

other hand, conventional society scenario will be discreet about the new social system, institution, technologies, etc., and worry about their transition cost. Table 1.1 shows the features of these two types of socioeconomic situations in Asia in 2050 for the quantitative analysis. The quantification in the following sections is based on Advanced Society Scenario.

1.2 Ten Actions to Achieve the Low-Carbon Society in Asia

In order to realize an LCS that satisfies the multifaceted needs and values of each Asian country, it is vital to gain the cooperation of a wide range of stakeholders, including policy makers, international aid agencies, private companies, local

Table 1.1 Assumptions of society in 2050

	Advanced society scenario (ADV)	Conventional society scenario (CNV)
Summary	Accepts the new social system, institution, technologies, etc., positively and proactively	Discreet about the new social system, institution, technologies, etc., and worries about their transition cost
Economy	Annual growth rate from 2005 to 2050, 3.27 %/year (global) and 4.16 %/year (Asia)	Annual growth rate from 2005 to 2050, 2.24 %/year (global) and 2.98 %/year (Asia)
Population	Total population in 2050, 9.3 billion persons in the world and 4.6 billion persons in Asia	
Education	Education system will be improved positively	Education system will be improved normally
	Education period, from 4–12 years in 2005 to 11–14 years in 2050	Education period, from 4–12 years in 2005 to 8–13 years in 2050
How to use time	Time for working and improving career will be longer	Time for staying with family or friends will be longer
Labor	Full employment in 2075	Fixed unemployment rate to 2009 level
Government	Efficiency will be improved immediately	Efficiency will be improved gradually
International cooperation	Reduction of trade barriers and FDI risks	Gradual improvement in collaborative relationships among Asian countries
Innovation	High	Medium
Transportation	Increase of demand due to high economic growth	Gradual increase of demand
Land use	More speedy and more efficient land use change	Moderate and careful land use change

communities, and NGOs, and share their long-term visions and strategies for an LCS. "Ten Actions toward Low Carbon Asia" as shown in Fig. 1.3 provides a guideline to plan and implement the strategies for an LCS in Asia (Low-Carbon Asia Research Project 2012, 2013). It takes into account the interrelationships between individual policies and the sequence in which they should be implemented. It also discusses the necessary actions to be taken by governments, private sectors, citizens, and international cooperation agencies on a priority basis.

In the following sections, each action is explained.

1.2.1 Hierarchically Connected Compact Cities

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

Fig. 1.3 Ten actions toward low carbon Asia

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 interregional 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 interregional 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 interregional 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.

1.2.2 Mainstreaming Rail and Water in Interregional Transport

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, has 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.

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 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.

1.2.3 Smart Ways to Use Materials That Realize the Full Potential of Resources

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 by-products and wastes repeatedly. Weight reduction of products, substitution of raw materials that emit excessive carbon with alternative materials, and longer life span 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 life span 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.

1.2.4 Energy-Saving Spaces Utilizing Sunlight and Wind

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, in 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 cooling and heating services 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 in 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 services, it is imperative to design the buildings which can manage sunlight 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 make use of sunlight 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 low interest rate loan in order to rapidly diffuse affordable high energy efficiency cooling and 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 toward 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.

1.2.5 Local Production and Local Consumption of Biomass

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 a 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 fuel subsidies is one policy which can immediately enhance competitiveness of biomass energy. In addition to supply-side policies, there are policies and measures that encourage citizens to follow sustainable land use and forest 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 are 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, is key to promote demand-side pull from the energy market. In these contexts, the industry can play a central role in research and development, and the government's policies and programs could support the widespread adoption of such advanced biomass resources and technologies.

1.2.6 Low-Carbon Energy System Using Local Resources

Toward the realization of an LCS in Asia, the low carbonization in energy demand and supply has a vital role. Energy-saving activities and the application of *renewables* such as *solar photovoltaic (PV)* and *wind power* are keys to a reduction of GHGs. The use of renewable energies will also improve energy access, eliminate energy poverty, and establish 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 coordination 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 the 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 an important role to support the infrastructure supply.

The industrial sector in Asia experiences 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 responds 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 interchanges. 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.

1.2.7 Low-Emission Agricultural Technologies

The *agriculture sector* contributed 14.3 % of global anthropogenic GHG emissions in 2004, according to the Fourth Assessment Report of the 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.

CH_4 and N_2O are the main GHGs emitted by the agriculture sector. While energy-induced emissions, primarily CO_2, were a strong focus of attention in the 1990s, emissions other than CO_2 and emissions from nonenergy sectors, particularly CH_4 and N_2O, have begun to attract more attention since then have shown that the nonenergy 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.

1.2.8 Sustainable Forestry Management

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 GHG emissions and enhancing the function of forests as a carbon sink.

Planting of trees on land that was not previously forestland 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 is required.

1.2.9 Technology and Finance for a Low-Carbon Society

To achieve 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 and 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 life cycle. 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 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 was established in 2010 under the Copenhagen Accord of 2009, and it was stipulated that developed countries were to supply 100 billion US dollars 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.

1.2.10 Transparent and Fair Governance That Supports Low-Carbon Asia

For Asian countries to become LCSs and enjoy the related benefits, all actors – governments, industry, citizens, and international society – need to share a common vision and strategy for an 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 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 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.

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.

1.3 GHG Reduction by Introducing "Ten Actions"

The contributions of the ten actions have been quantified by a global computable general equilibrium model. The model used here divides the world into 17 regions as shown in Table 1.2 and contains the categories of governments, households, and producers. The 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. About the more detailed model structure, please see Fujimori et al. (2012, 2013). Figures 1.4, 1.5, and 1.6 show the trajectories up to 2050 in population, GDP, and primary energy supply by region in the reference scenario, respectively. First, the GHG emissions in the reference case of the advanced society scenario in Table 1.1 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.

Table 1.2 Regional classification in this analysis

Japan (JPN)	EU25	Brazil
China (CHN)	Rest of Europe	Rest of Latin America
India (IND)	CIS	Middle East
South East Asia + Rest of East Asia (XSE)	Turkey	North Africa
Rest of Asia (XSA)	Canada	Rest of Africa
Oceania	USA	

Note: The five gray cells are regarded as Asia

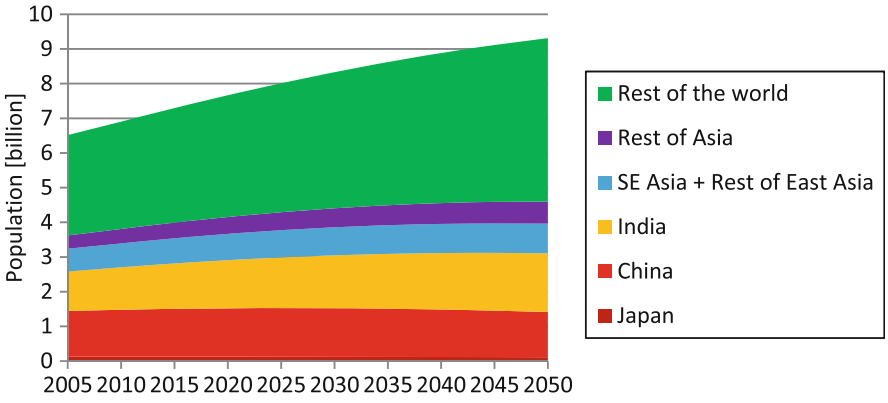

Fig. 1.4 Regional population trends by 2050 in reference scenario (unit, million)

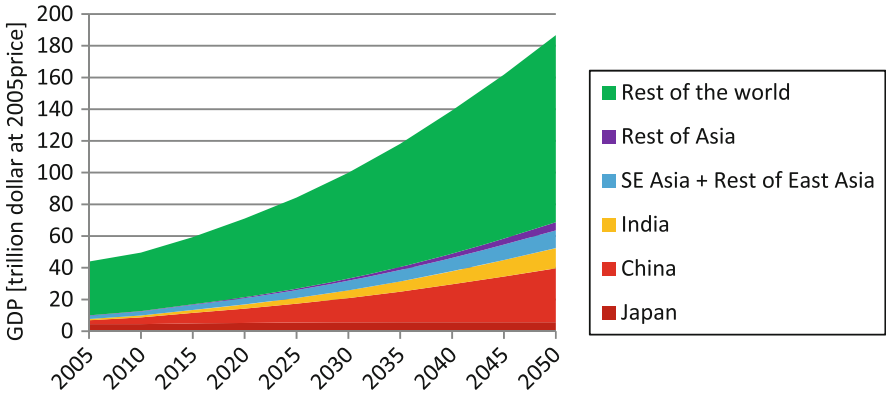

Fig. 1.5 GDP trends by 2050 in reference scenario (unit, trillion $ at 2005 price)

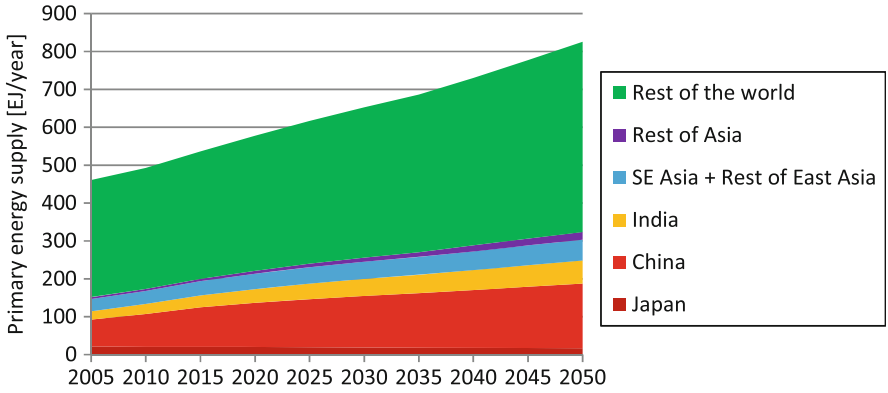

Fig. 1.6 Primary energy supply by 2050 in reference scenario (unit, EJ/year)

Figure 1.7 shows the future GHG emissions in Asia and the world in reference scenario and LCS scenario. As for the Asia, the quantities of GHG emission reduction by actions are also represented.

1.3.1 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 ($GtCO_2$), 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. Figures 1.8 and 1.9 show the primary energy supply by energy type and electricity generation by technology in Asia, respectively. From these figures, the energy saving becomes important through 2050. Moreover, introduction of

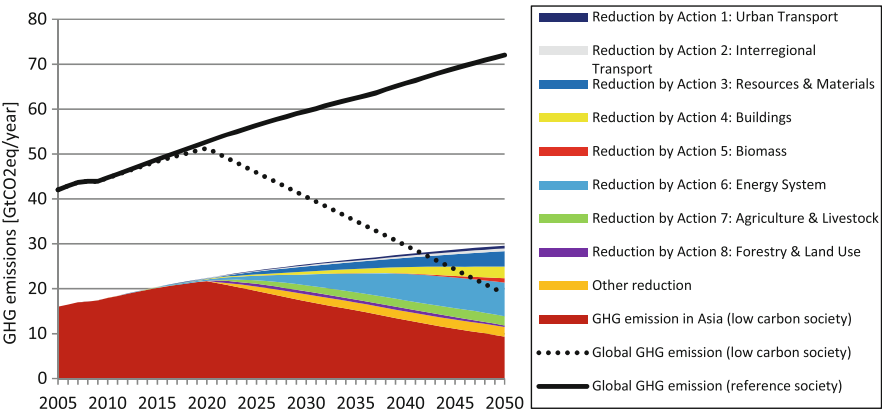

Fig. 1.7 GHG emissions in low-carbon Asia

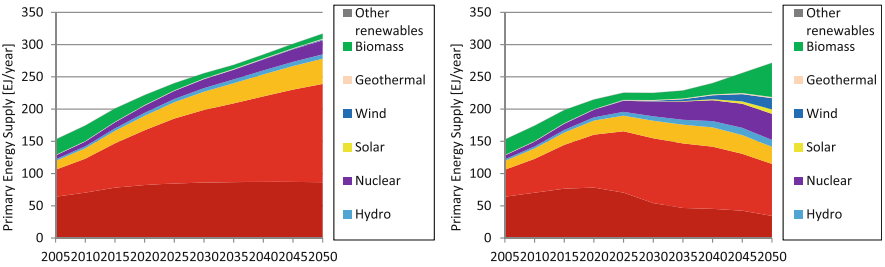

Fig. 1.8 Primary energy supply in Asia by energy type: reference scenario (*left*) and LCS scenario (*right*)

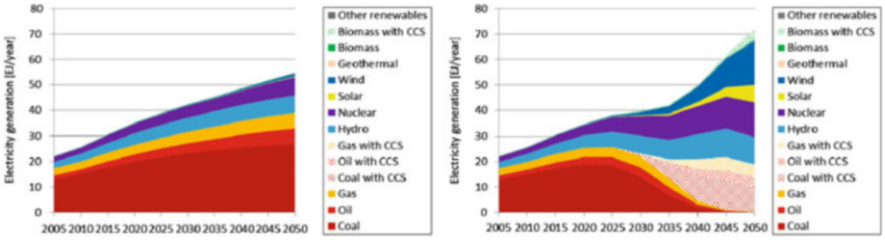

Fig. 1.9 Electricity generation in Asia by technology: reference scenario (*left*) and LCS scenario (*right*)

non-carbon energies, which include renewable energies and fossil fuels with carbon capture and storage (CCS) technology, becomes important after 2030. The share of fossil fuels in LCS scenario becomes smaller than that in reference scenario, and in the fossil fuel thermal power sectors install the CCS technology.

Actions 1 and 2, which focus on transportation, account for a combined share of 6.1 % of the total reduction in Asia. 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 the largest in XSA&XOC (South Asia excluding India and small island states in Oceania) and the second largest in India.

1.4 Conclusion

As is discussed in the previous section, GHG emissions in Asia must be reduced drastically to meet the 2 °C target. In order to analyze the feasibility of such deep reduction, two scenarios are developed and analyzed in detail, namely, reference scenario and LCS scenario, and ten actions to meet the low-carbon Asia are identified. The analysis shows that it is possible to reduce the GHG emissions drastically in Asia by appropriately applying such actions. The reduction can reach 68 % from reference case. In other words, leapfrog development can be achievable in Asia.

In practice, on the other hand, it should be bear in mind that we need the smart strategies to meet the LCS pathways in each country depending on each development stage. For that purpose, knowledge sharing becomes important. 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.

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