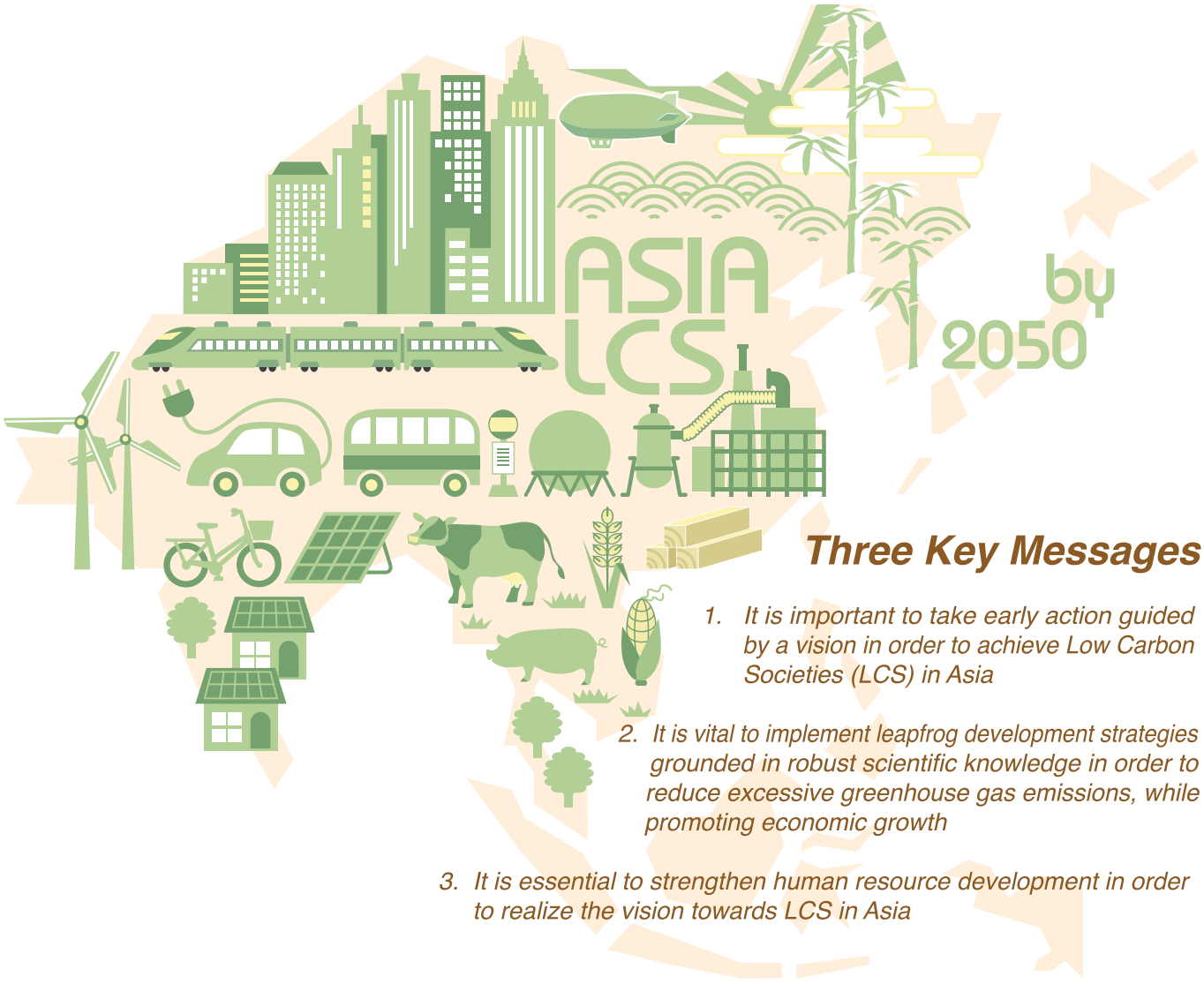
Low Carbon Societies

Asia LCS Research Project



Three Key Messages

1. *It is important to take early action guided by a vision in order to achieve Low Carbon Societies (LCS) in Asia*
2. *It is vital to implement leapfrog development strategies grounded in robust scientific knowledge in order to reduce excessive greenhouse gas emissions, while promoting economic growth*
3. *It is essential to strengthen human resource development in order to realize the vision towards LCS in Asia*

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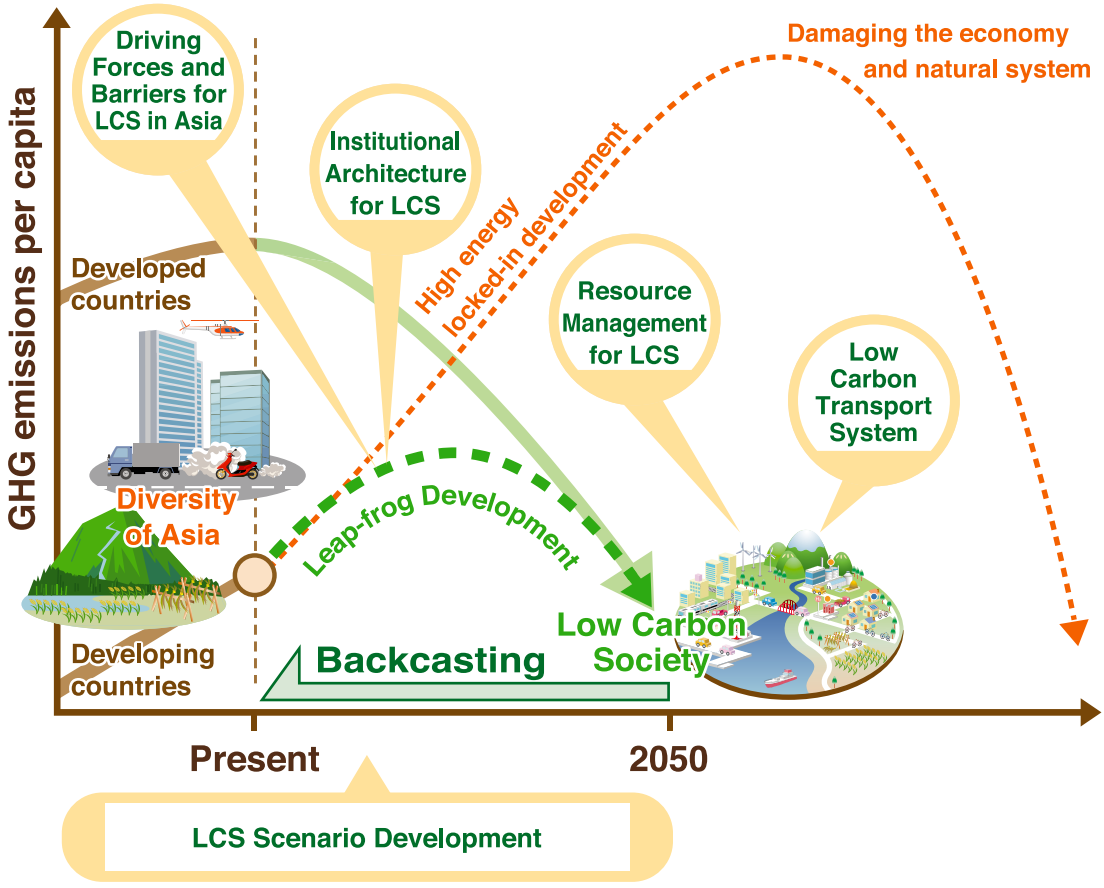
Research Overview

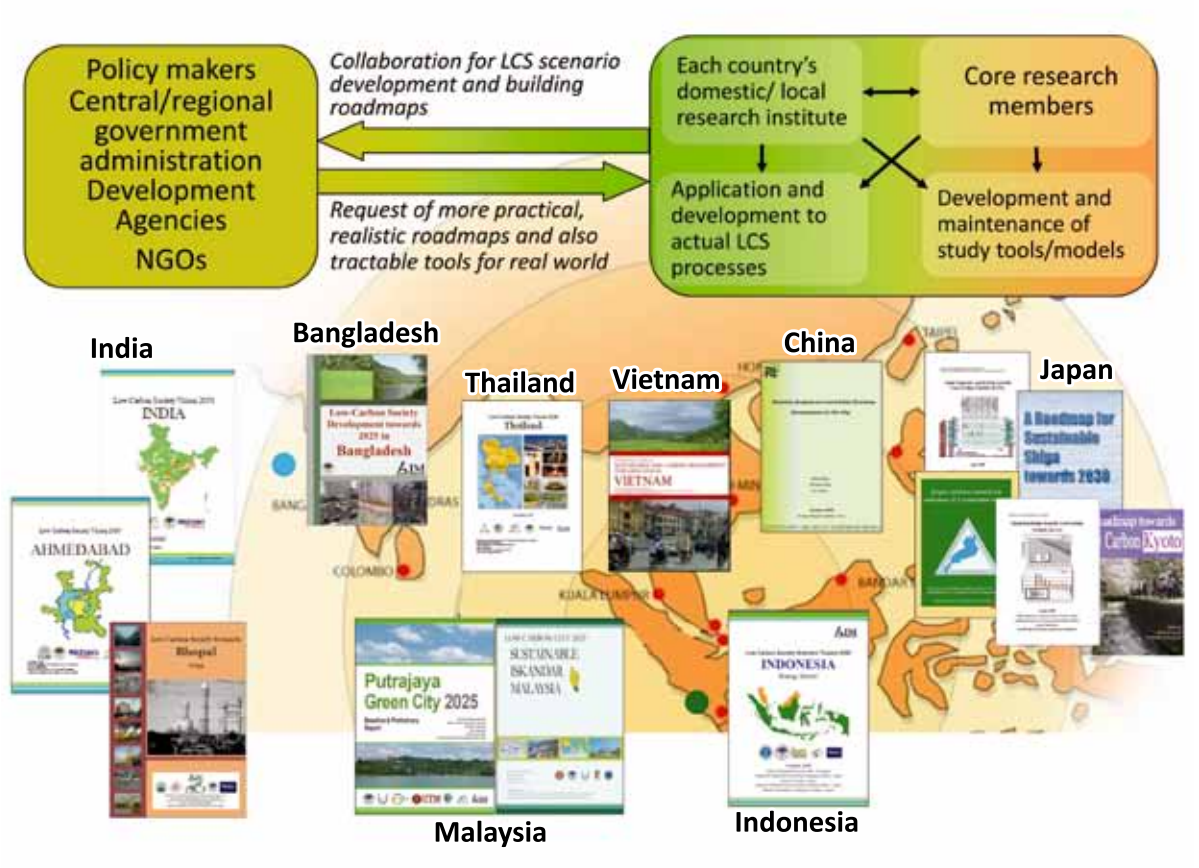
The international community has recognized the need to reduce greenhouse gas (GHG) emissions by 50% by 2050 in order to keep global mean temperature change within 2 degree centigrade compared to preindustrial times. In order to achieve the target, it is imperative to develop the Low Carbon Societies (LCS) in Asia, as Asian countries account for more than half the global population and GHG emissions. It is thus necessary to identify leapfrog development pathways to enable a shift to low carbon emissions and low-resource consumption while simultaneously improves daily life through economic growth.

The primary objective of the Asian LCS Research Project is to establish the vision of LCS in Asia which assists in keeping global mean temperature change within 2 degree centigrade compared to preindustrial times, and to develop comprehensive methodologies to design, calculate and evaluate the mid to long term policy options towards LCS in Asia, which integrated robust scientific knowledge and the multi-faceted needs of each Asian country. The Asia LCS Research Project explores and identifies such development pathways by the means of five research perspectives: (1) integrated research on scenario development towards the realization of LCS in Asia, using global, national, subnational, and city scale models; (2) fundamental analytical research exploring the possibility of leapfrog development strategies in Asia along with the analysis of institutional



driving forces and barriers; (3) research into the medium to long-term international and domestic institutional design options and their formative processes, including funding mechanisms for the development and distribution of low carbon technologies; (4) research to limit GHG emissions from the resource consumption associated with economic growth, which would also avoid resource depletion through the efficient and cyclic utilization of resources; (5) research into concrete measures to establish a low carbon transport system in Asia along with an analysis of the best combination of leapfrog technologies in transport sector to enable the achievement of CO_2 mitigation targets.

Through these research perspectives, the Asia LCS Research project aims to identify feasible and robust pathways over the medium to long-term for the realization of LCS in Asian countries, at both national and sub-national levels. The project also aims to formulate policy roadmaps and disseminate these with a view to positively influence implementation activities to facilitate a shift to Asian societies characterized by low carbon emissions, low-resource consumption, and solid economic growth.



How to deploy our study to real world

*The official name of Asia LCS Research Project is the "Research Project to Establish a Methodology to Evaluate Mid to Long Term Environmental Policy Options toward Asian Low carbon Societies" (S-6 research project). It is supported by Environment Research and Technology Development Fund of the Ministry of the Environment, Japan (MOEJ).

Message from Asia Low Carbon Societies Research Project

The realization of Low Carbon Societies (LCS) in Asia is imperative to reduce greenhouse gas (GHG) emissions in 2050 by 50 percent globally compared with 1990 level. LCS in this research project means the realization of societies which will be able to achieve not only low carbon emission, but also improve energy access, reduce poverty, enhance energy security, and realize economic growth and decoupling of energy consumption with growth. Asian countries are faced with country-specific environmental and developmental concerns, together with increasing global problems including the impact of climate change. These countries have thus urged to find synergistic solutions by sharing the vision to develop a new social foundation that improves economic and institutional structures and daily lives of people. Our Asia LCS Research project recommends the robust pathways to realize this vision, along with concrete countermeasure, using back-casting methodology. Three key proposals emanate from this research project, as summarized below.

1. It is important to take early action guided by mid to long-term vision in order to achieve LCS in Asia.

Halving global GHG emissions by 2050 from the 1990 levels will be achievable, but not be easy. The preliminary simulation results show that the associated carbon price becomes as high as 485$/t-C, if only limited mitigation options based on existing social structure and currently feasible technology measures are introduced. The scenario analysis also indicates huge differences in the GDP loss between regions and between counties of each region. Especially, if Asian countries primarily pursue short-term economic growth and delay their actions for countermeasures to tackle the impact of climate change, high energy intensive societies would be established, and that will make it very difficult for Asian countries to achieve sustainable development pathways. Effective LCS actions in Asian countries vary depending on their particular circumstances – such as economic and social development level; renewable energy sources; land area, and other factors. The countermeasures should thus be well-designed so as to accord with the local conditions in order to prevent uneven distribution of burden among the countries under this LCS scheme.

2. It is vital to implement leapfrog development strategies grounded in robust scientific knowledge in order to reduce excessive greenhouse gas emissions, while promoting economic growth.

Asian countries, particularly newly developed countries have pledged their emission reduction target in line with the Copenhagen Agreement at COP15. Although it is a good beginning, it is vital to plan and implement the effective measures for the construction of LCS so as to achieve the 2 degree target. Such measures include development of low carbon technologies, curbing unnecessary resource consumption through efficient and cyclic utilization of resources, and organization of low carbon transport systems which will be the foundation of development of low carbon cities.

Efficient and cyclical use of resources will be one of the necessity actions to drastically reduce certain GHG emissions, given that GHG emissions in some countries, particularly in China, have dramatically increased because of rapid expansion in manufacturing base associated with the rising demands for steel and cement necessary for infrastructure development such as construction, road network, and railway network. Our research has shown that there is a potential to reduce the GHG emissions by up to 50%, from roughly 1000Mt CO_2 to 500Mt CO_2 in 2050, if longer-life social infrastructure and recycling of demolition wastes are promoted, instead of the existing scenario of short-lifespan infrastructure and limited progress of recycling.

We also emphasize the importance to develop comprehensive low carbon transport policies by

analysing the best integration of three types of low carbon transport strategies – avoiding unnecessary travel demand (AVOID); shifting transport modes to lower-carbon ones (SHIFT); and improving energy efficiency and emission intensity of transport (IMPROVE) in order to limit the CO_2 emissions from transport in the developing cities in Asia. Our analysis, focused on Bangkok as one of the case studies in Mega-cities, shows that a prudent combination of IMPROVE, AVOID and SHIFT interventions can yield desired results. Early implementation is crucial to enjoy the co-benefit from the establishment of comprehensive efficient low carbon transport networks and limiting the GHG emissions due to the inappropriate land use planning.

3. It is essential to strengthen human resource development in order to realize the vision towards LCS in Asia.

While some Asian countries have the opportunities to conduct the projects for the formation of LCS, the number of people who have knowledge to realize the LCS is limited. It is partly because such projects have been conducted by fragmented organizations with different and disparate purposes that limited environmental integrity has been achieved. It is thus necessary to provide capacity development for a wide range of stakeholders to equip them to plan their own mid-to long term comprehensive pathways towards LCS and to develop shared visions and strategies while appropriately understanding and using the LCS scenarios focused on their own country and city.

The researchers who have conducted the Asia LCS project have conducted a variety of training workshops for policy-makers and researchers in Asian countries in order to delineate their own LCS pathways grounded in scientific knowledge. Moreover, the researchers have also developed comprehensive policy roadmaps while consulting and collaborating with various relevant organizations in Asia. This has ensured that the measures derived from our research outcomes complement the need for practically feasible and robust measures.

International community has to develop and implement the effective institutional architectures which will enable a smooth shift to the LCS. Such a process needs to consider international equity in the targets and a fair allocation of emission reduction targets. Asia LCS research project shows that it is necessary to develop decentralized autonomous institutions to promote LC investments and efficiently disseminate LC technologies in order to respond to public needs and achieve carbon reduction. This is because different countries will need different institutional architectures in line with their specific conditions to realize the targets. It is also vital to establish the partnership among multiple stakeholders – the governments, private companies who have access to the LC technologies and know-how, research institutes and NGOs. Such partnerships are necessary to establish effective low carbon governance architecture so as to make use of the strength of each actor and to prevent lock-in transition to high energy intensive social infrastructure. Mainstreaming sector-based development policies and climate policies, besides availability of financing mechanisms, will be essential to enhance acceptance and diffusion of low carbon technologies.

The researchers in this research project have also actively participated in discussion about the institutional architectures required to promote the LC innovation. They have contributed to the relevant policy-making processes involving key international organizations, providing scientific knowledge derived from our research outcomes. Ownership and willingness to realize the LCS vision of each Asian country will be a fundamental pre-requisite to enable a shift to LCS by means of a thorough review of people's lifestyles; transport systems; material flow and international/domestic institutional architectures.

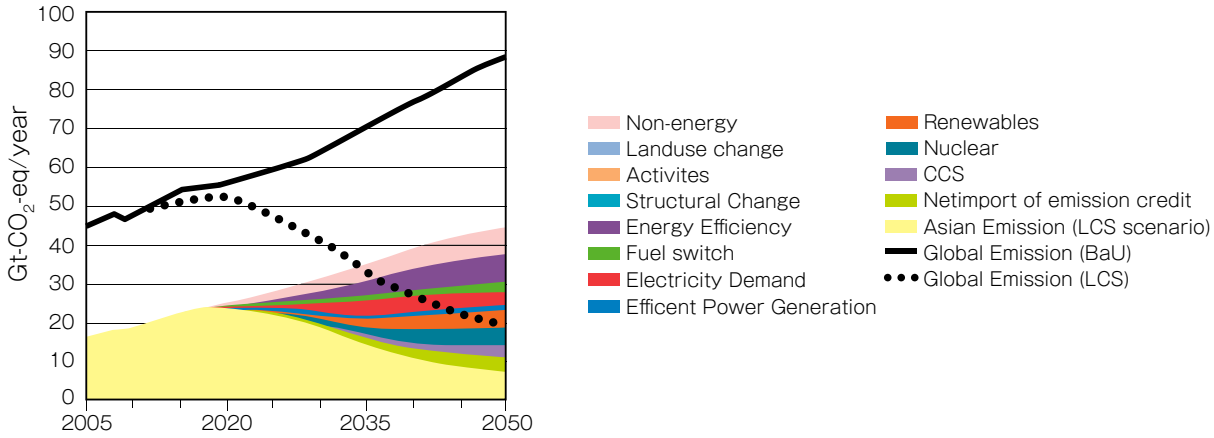
Scenario development towards Low Carbon Society (LCS) in Asia [S-6-1]

1 **Halving global greenhouse gas (GHG) emissions by 2050 from the 1990 levels will be achievable, but is not easy.**

2 **Actions in Asian regions are essential to achieve this GHG reduction target.**

3 **Effective LCS actions in Asian countries vary depending on their particular circumstances –economic level; renewable energy sources; land area, and other factors.**

In the LCS scenario development study, possible LCS scenarios by which global GHG emissions in 2050 are reduced to 50% of the 1990 levels are analyzed using the global model. In addition, mitigation actions for the targeted 15 countries/regions are evaluated in detail using the country specific models.



GHG emissions and mitigation options for Asia to achieve a 50% reduction in global emissions

1 Firstly, the socio-economic factors likely to have significant impacts on future Asian economic developments are identified for the purpose of the global emission reduction study. The analysis concludes that LCS requires greater international cooperation and technological development, and that improvement in education and governance are the key for those changes.

Secondly, possibilities for climate mitigation are evaluated using global models that reflect the above socio-economic scenario. In the analysis, the

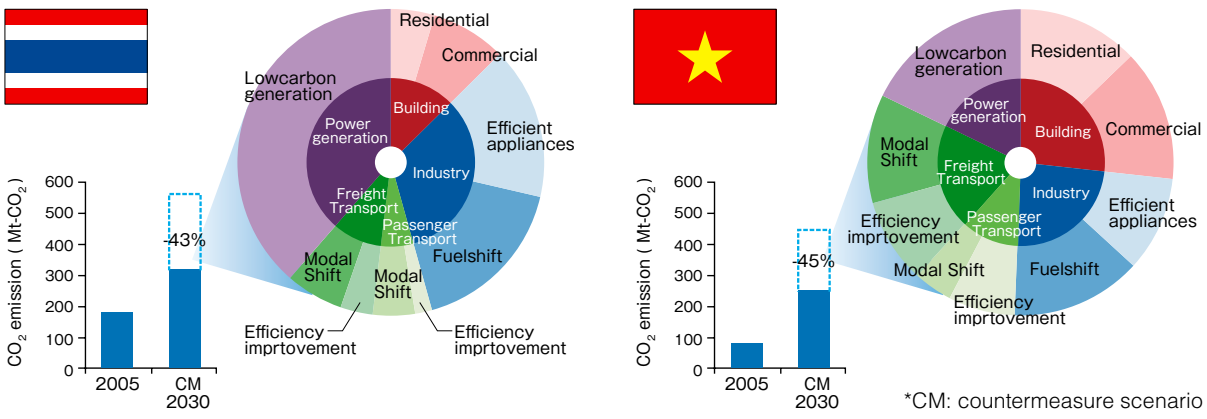
global GHG emissions target for 2050 is set as 50% of those in 1990, and a C&C scheme - in which per-capita emissions allowance for 2050 is identical globally - is applied to allocate the emissions cap for each country as “LCS scenario”.

The preliminary simulation results, which assume that the change of the socio-economic structure will be limited and the technological countermeasures will be dominant, show that the LCS scenario is achievable, but the associated carbon price becomes as high as 485 $/t-C. The global GDP loss in 2050, necessary to achieve the LCS scenario (in comparison with BAU scenario), is estimated to be approximately two percent. This result indicates the limitation of relying primarily on the technology change to achieve LCS. The GDP change in each country/region in 2050 is +6% to -16% compared with the BAU case. These results indicate the likelihood of uneven burden among the countries under this LCS scheme.

2 The annual mean economic growth rate in the targeted Asian countries between 2005 and 2050 is estimated in the range of 3.4-4.4%. This growth rate is higher than the annual global economic growth rate of 2.3-3.2%. With this relatively higher economic growth, the share of GHG emissions in those regions increases, reaching approximately half of global emissions by 2050. As explained above, actions in Asian regions are essential to achieve drastic global GHG reduction targets.

3 Country-specific scenarios are developed for the targeted Asian countries - in parallel with the global-scale analysis. These scenarios take the specific conditions of those countries into consideration, namely: existing GHG emission structures; economic status; as well as political, cultural and social background.

For a comprehensive analysis these studies are implemented in collaboration with local LCS researchers. Since the effective policy package and measures identified in each country study are quite diverse, it is concluded that the countermeasures should be well-designed so as to accord with the local conditions.



Differences in the effects of countermeasures between the Thailand scenario (left) and the Vietnam scenario (right)

Analytical research on potential for low carbon development in Asia [S-6-2]

1 **The mechanism of urbanization on national energy use and CO_2 emissions is complex. Developing countries emit more CO_2 emissions in the process of urbanization, although CO_2 emissions decrease after their economic level reaches about 34,787 USD (per capita GDP). Therefore, sustainable urban development toward leapfrogging to low carbon societies (LCS) is crucial in developing countries.**

2 **Emissions reduction to achieve 2℃ policy scenario requires substantial reduction of greenhouse gas (GHG) in Asian countries. Innovative measures, such as energy-savings, renewable energy development, and technologies such as CCS (Carbon Capture & Storage) and clean coal can greatly contribute to GHG mitigation. Changes in value systems are the basis of sustainable local lifestyle.**

3 **Low carbon development is closely associated with industrial structural change of a country, and contributes to economic development through ensuring energy security and reducing fuel imports.**

Leapfrogging for Low Carbon Growth

Urbanization and leapfrogging	Technology and institution for leapfrogging	Policy mix for leapfrogging
Economic development	Technological Innovation	Reducing fuel import
Urban management	Institutional mechanism	Investment
Development stages	Law, regulation	Long-term policy design
Rural-urban migration	Change in values	Co-benefits
Embodied CO_2 emission	Citizens, NGOs	Renewable energy

1 Urbanization mitigates CO_2 emission only at the economic levels above 34,787 USD per capita GDP.

Asian countries with blooming economies are characterized by rapid urbanization. The effects of urbanization on CO_2 emissions is complex since various factors are mutually intertwined. The research estimated the impacts of urbanization on CO_2 emissions at the national and sectoral levels, and showed that CO_2 emissions have increased during urbanization processes in developing countries, where energy shifts from traditional fuels to modern one have occurred. On the contrary, CO_2 emissions started to decrease when per capita GDP exceeded 34,787USD. Total primary energy consumption has decreased through urbanization in developing countries, but increased in the developed ones. Furthermore, the case studies of Asian megacities indicated that migrants from rural areas to urban centers increased the modern energy consumptions and CO_2 emissions in developing countries. Another research estimated the direct and indirect CO_2 emissions of the cities, and revealed that urbanization induced more indirect CO_2 emissions since economic developments changed the urban structures from industry-oriented to serv-

ice-oriented. Our researches confirmed the importance of sustainable urban development toward leapfrogging to LCS in developing countries.

2 Technological innovations, institutional development and change in values are crucial to achieve 2℃ policy scenario.

To achieve low carbon development in Asian countries, there are five main premises; (1) proliferation of low carbon technologies in the manufacturing sectors, (2) introduction and compliances to the strict laws, regulations and environmental standards, (3) development of institutional mechanisms for effective and efficient monitoring of GHG emissions, (4) ensuring monetary supplies to support those initiatives, and (5) change in the values towards environmental consciousness.

For example, our researches confirmed the large potential of renewable energy installations in Asian regions. Our case studies assessed the low carbon initiatives with solar energy installation. The findings from Bangladesh confirmed that the installation of solar photovoltaic is one of the promising solutions for electrifying rural households, as well as simultaneously achieving improved standards of living and sustainable livelihoods. It revealed that household income alone did not adequately determine the demand for solar photovoltaic, and non-income factors played a significant role in the dissemination. The research also confirmed that reduction in price of the equipments has a possibility to accelerate the demands for solar photovoltaic in rural households.

The findings from China indicated that the government initiatives (e.g. subsidy) with business sector participation played vital roles in disseminating solar water heating systems in the residential sectors. Our research confirmed that cost reduction accompanied with technological innovation is crucial for enhanced deployment of renewable energies, and government initiatives (such as carbon pricing, clean coal technologies, feed-in tariff) play important role in this process.

With regards to the technologies toward leapfrogging, the possibility of nuclear energy and CCS need to be carefully examined accounting for the acceptance of the citizens. Introduction of nuclear energy requires close examination after nuclear power plant accidents in Fukushima, Japan. CCS requires technological breakthrough as well as cost reduction.

Implementing low carbon initiatives require (1) supports from citizens and (2) fully utilizing market mechanisms to ensure efficiency. Voices of citizens and NGOs will be driving forces for disseminating distributed renewable energy systems and enhancing environmental consciousness, which contribute to achieve LCS. Low carbon initiatives need to ensure policy coherence among central and local governments, since there are some examples that highlight lack of consistency of the policy programs among central and local governments in Asian countries becoming a barrier to implementation of environmental programs. Policy evaluation (including cost-effectiveness and cost-benefit analysis) is required to ensure the efficiency and effectiveness of low carbon initiatives.

3 Low carbon development contributes to economic development through ensuring energy security and reducing fuel import.

Currently governments in Asian countries have invested in renewable energy technologies and energy savings, which not only contribute to climate change initiatives but also to establishing energy security and reducing fuel import. Those initiatives are closely linked with regional development, poverty reduction, and preventing air pollutions in developing countries. Introducing renewable energy would be costly in the short run, but would be worth investing in the long run if we account for sharp fuel price increases and job creation in new industries under the condition that the appropriate policy interventions are provided.

Options and processes for establishing medium to long term international and domestic governance architecture towards low carbon Asia [S-6-3]

1. **Establishing low carbon society requires equal allocation of emissions reduction targets. Equal per-capita emission criterion deserves more attention for possible equity consideration.**
2. **The key for effective low carbon governance architecture is the configuration of actors and their networks.**
3. **Increasing synergies across fragmented institutions require institutional mechanisms to secure mainstreaming of low carbon policies by integrating energy and climate policies.**

International Technology Governance for Low Carbon Future?

The research team is working on the allocation of emissions reductions towards low carbon society. What level/degree of reduction is required in order to realize a low carbon society? Who should reduce emissions; and who should bear the cost? The team pays particular attention to conceptual development for allocation of emissions mitigation among countries and other actors, which requires insights from political science and international relations. Current debate is centered

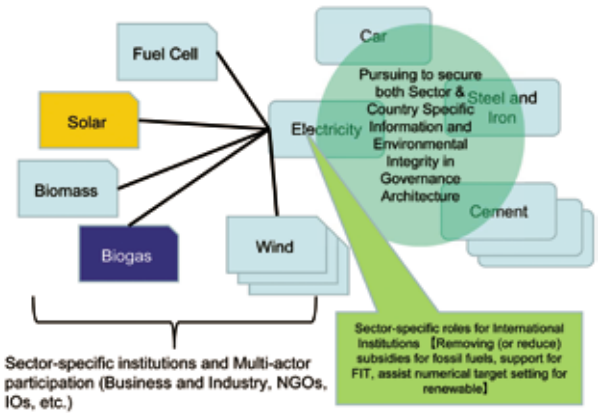
on three criteria, namely: responsibility; ability (or capability); and efficiency. We argue that equal levels of per-capita emissions should eventually be realized. Such a criterion should take into consideration three dimensions of sustainable development – environmental, social and economic. The decision-making process necessary for realization of such a vision needs to be further researched.

2 The establishment of a global institution for cap and trade based on economy-wide emissions reduction target for major emitters is the ideal. However, given the current dynamics of diffused political interests and different expectations of international institutions, as characterized by the failure of COP15, the likelihood of such a situation emerging, at least in the foreseeable future, is low. A concurrent diffusion of low carbon technology and technology transfer is also indispensable if low carbon society is to be established.

Considering a strong characteristic of globalization to be found in multi-stakeholder involvement in various governance activities, the key for governance architecture for low carbon development rests on the configuration of actors in such governance components as agenda-setting, negotiation, implementation, or compliance. Industries and companies which develop and utilize technology are the key actors in this regard, and the challenge involved in this process is to streamline the means by which public goods are secured through the involvement of other crucial actors such as international organizations and NGOs. A technology-specific and country-specific mechanism is necessary, while inclusiveness of multilateralism is also crucial to facilitate wider distribution of low carbon technology. Such an emphasis on multilateralism would build an institution that goes beyond the CDM (Clean Development Mechanism).

3 Country- and technology-specific technology institutions tend to result in fragmented institutions with different and disparate purposes, some of which may even lack environmental integrity. To avoid such conflicts, an overriding mechanism is necessary to secure low carbon aspect of policies. We consider options, including the creation of a *UN High Commission for Environment and Energy,* and the creation of a *UN Sustainable Development Council.*

We propose a transformative change towards international institutions for low carbon society directed by a clear vision addressing both energy and climate, within a framework of sustainable development.



Low Carbon Technology Governance Model

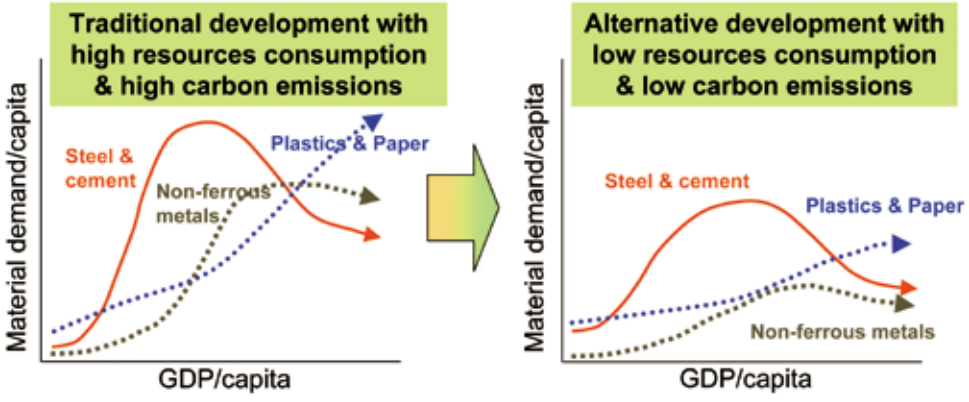
Research to limit GHG emissions from the resource consumption associated with economic growth [S-6-4]

1. **Resource consumption and greenhouse gas (GHG) emissions associated with infrastructure, durable goods, and consumer products will increase due to economic development in Asian countries.**
2. **Efficient and cyclical use of resources can reduce certain GHG emissions. In particular, reduction of resource consumption through efficient use of resources is effective.**
3. **As penetration of mitigation technologies is likely to cause bottlenecks in supply of certain metal resources, systems for efficient and cyclical use of these metals need to be developed.**

This study has been undertaken in order to estimate GHG emissions from Asian countries based on the future resource demand and materials production associated with infrastructure development; more general use of durable goods; and enhanced consumption of consumer products based on increased demands originating from economic development and the popularization of low-carbon technologies. This study examines the potential of these countries to contribute to the construction of a low-carbon society from two points of view: (1) the supply side - as exemplified by efficiency improvements in material production; fuel switch; secondary and renewable materials substitution; and international division of work in material production and recycling, and (2)

$$\text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology}$$

$$\text{GHG emissions} = \text{Population} \times \frac{\text{GDP}}{\text{Population}} \times \left(\frac{\text{Resource consumption}}{\text{GDP}} \times \frac{\text{Energy consumption}}{\text{Resource consumption}} \times \frac{\text{GHG emissions}}{\text{Energy consumption}} \right)$$



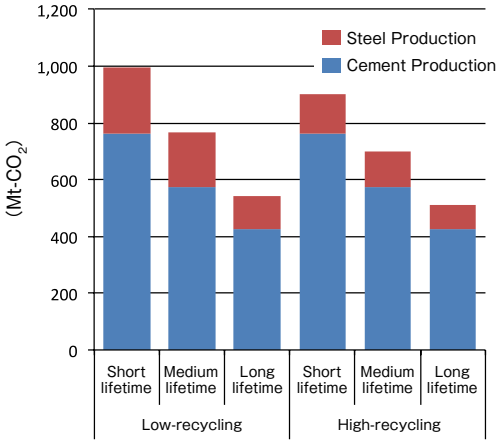
Possibility to take alternative development pathways from the viewpoint of resource consumption

the demand side - as exemplified by reductions in material-intensive infrastructure development; changes in ownership modes of durable goods; and transformations in consumption patterns.

1 In regards to infrastructure, material flow and stock model has been developed for buildings, roads, and railways in China, and the demand level for steel and cement and GHG emissions associated with production of those materials were estimated. The results show that GHG emissions will increase together with the increased demand for steel and cement necessary for future infrastructure development in China. In regards to durable goods and consumer products, the penetration of automobiles in China and the consumption of paper and paperboard in Asian countries have been analyzed. The results show that resource consumption and GHG emissions will increase along with growth in demand for these goods.

2 At the same time, the result indicates the possibility that the lifetime extension of infrastructure and recycling of demolition wastes could reduce CO_2 emissions by up to 50% (see figure). In particular, reduction of resource consumption through lifetime extension is effective. In regards to automobiles, it is found that the penetration of electric vehicles in China does not necessarily contribute to the construction of low-carbon society if there is no improvement in the CO_2 emission co-efficient of electricity sector in China: it is necessary to reduce emission factor of electricity by energy supply side measures. In regards to paper and paperboard, it is shown that transformation into consumption pattern similar to that in countries with less paper and paperboard demand is effective, and reduction of CO_2 emissions of several ten percentages is expected through technological improvements and efficient and cyclical use of resources in the production processes.

3 The possibility of resource limitations in the future because of the expected increase in demand for several metals necessary for new generation vehicles and renewable energy technologies has been analyzed. The analysis of the relationship between accumulated demand for these metal resources in the future and accumulated potential CO_2 reduction due to new technologies shows that the supply of metals associated with electric vehicles (EV) and plug-in hybrid vehicles (PHEV) could become a bottleneck. Therefore technological development and establishment of system for efficient and cyclical use of these metals will be required for effective mitigation of climate change.



CO_2 emissions associated with production of steel and cement necessary for infrastructure development in China in 2050

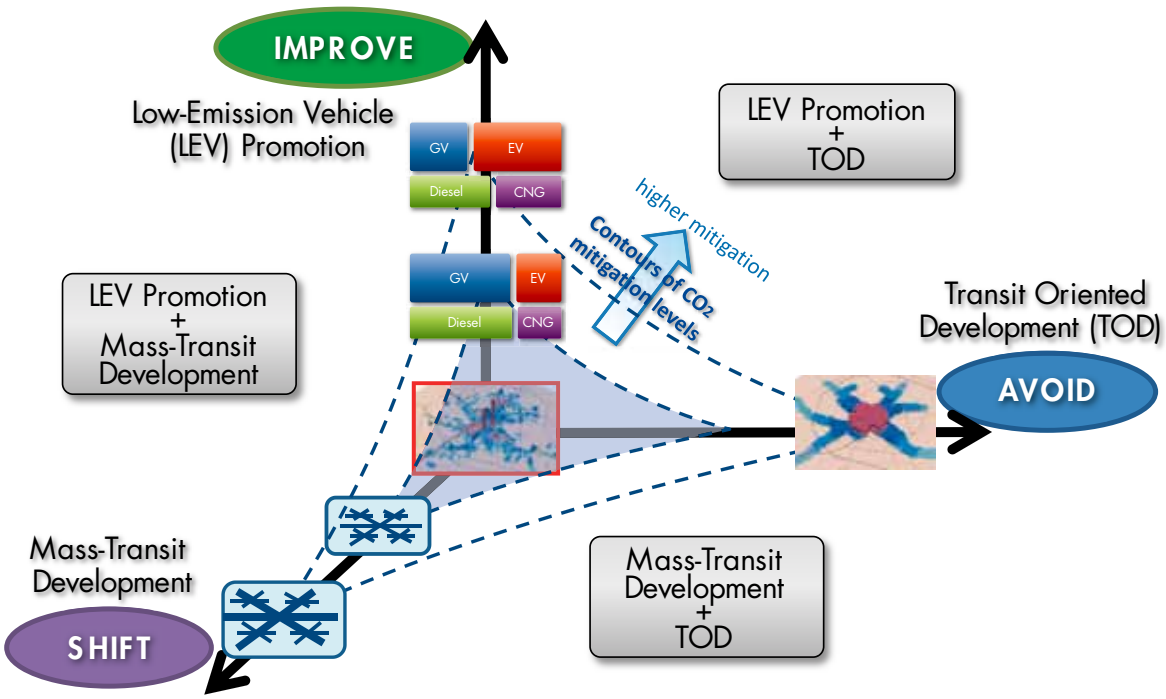
Low Carbon Transport System

Research on measures to establish a low carbon transport system in Asia [S-6-5]

1 **CO_2 emissions from transport will drastically increase due to rapid economic growth in developing countries of Asia.**

2 **Low carbon transport systems for developing cities in Asia can be designed with AVOID, SHIFT and IMPROVE strategies.**

3 **Early implementation of extensive and comprehensive measures is required to realize low carbon transport systems in developing cities in Asia.**



Approach to designing a Low Carbon Transport System

1 · In the transport sector which is responsible for a large proportion of CO_2 emissions, the amount of CO_2 emissions has increased rapidly due to motorisation fuelled by economic growth. Motorisation causes urban sprawl by promoting development in suburbs, where the unplanned expansion of built-up area makes public transport development less efficient and less affordable.

· Due to the excessive level of motorisation, an urban land-use transport system falls into a vicious circle where

motorisation is accelerated by road development and urban sprawl, and becomes the cause of escalating congestion, emissions and even economic bottlenecks. This failure of the system has been experienced by developed countries and is being repeated in developing countries of Asia.

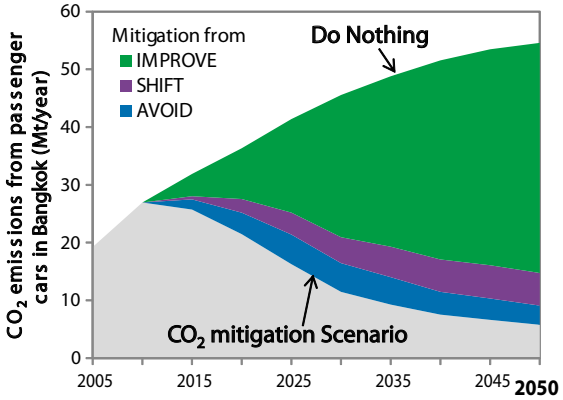
· In our forecast, if road development continues to be prioritised over railway development in Asian developing countries, car ownership would increase 2 to 10 times its current levels in Beijing, Shanghai, Bangkok and Delhi by 2050.

2 · A low carbon transport system can be designed by combining three types of low carbon transport strategies – avoiding unnecessary travel demand (AVOID); shifting transport modes to lower-carbon ones (SHIFT); and improving energy efficiency and emission intensity of in transport (IMPROVE).

· Measures to achieve each strategy are further classified by instrument, including technological, regulatory, informational and economic ones, represented as the CUTE matrix (Comparative study on Urban Transport and the Environment) proposed by the WCTRS (World Conference on Transport Research Society). The ones suitable for Asian developing countries and cities can be identified, such as introducing Transit Oriented Development (TOD) and Bus Rapid Transit (BRT) systems, and promoting Low Emission Vehicles (LEV).

3 · It is important to identify a comprehensive package of measures for the strategies to achieve the challenging target of CO_2 mitigation in transport in developing cities in Asia, using a backcasting approach.

· Our analysis shows that, in order to achieve 70% mitigation from 2005 to 2050 in Bangkok, the city must introduce highly-advance transport technologies to the same extent as in developed cities (IMPROVE); and strong intervention of land-use transport planning to control the expansion of built-up areas to the current levels and develop mass-transit networks to a level four times larger than planned (AVOID and SHIFT). The challenging mitigation target can be more achievable by earlier implementation of these strategies.



Asia Low Carbon Societies Research Project

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