ESCAP Energy Resources Development Series

Low Carbon Development Path for Asia and the Pacific: Challenges and Opportunities to the Energy Sector

ST/ESCAP/2589

December 2010

United Nations publication

Printed in Thailand
ST/ESCAP/2589

DISCLAIMERS

This publication presents the Low Carbon Development Path for Asia and the Pacific: Challenges and Opportunities to the Energy Sector While the information contained in this publication is believed to be correct, the information may be incomplete. The United Nations makes no warranty, expressed or implied, or assumes any legal responsibility for the accuracy or completeness of information contained in this publication. The views and opinions expressed herein are those of the authors and do not necessarily reflect the views of the United Nations Secretariat.

The opinions, figures and estimates set forth in this publication are the responsibility of the authors, and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of firm names and commercial products does not imply the endorsement of the United Nations.

This publication has been issued without formal editing.

Table of Contents

CHAPTER 1.
Challenges in applying low carbon development in developing countries

There is an emerging global consensus among decision makers, community practitioners, scientists and academics that addressing climate change is one of the most paramount challenges of the 21st century.

Over many millennia, the world's atmospheric concentration of carbon dioxide (CO_2) emissions has never risen above 300 ppm, while in 2007, it surpassed 382 ppm (Flavin 2008). Many experts agree that the concentration of CO_2 must stabilize in and around 450 ppm at the very highest, and all greenhouse gases (GHG) should stabilize at around 500-550 ppm (e.g. Flavin 2008; Stern 2006).

Important areas requiring energy are the power generation sector and transportation. Globally car ownership is growing, and Asia is the fastest growing region for private vehicle ownership.

At the same time, as the world reels from the affects of a global recession, a continued focus on economic development remains a critical priority for countries, regions and communities. However, rather than viewing the economic downturn as an excuse to disregard climate change and other environmental priorities, many global leaders see the recession as an opportunity to create jobs through undertaking efforts to mitigate and adapt to climate change. A number of leaders recognize the need for a" green stimulus" package, aimed at addressing both the economic recession and climate change through the growth of green jobs, technologies and societies towards innovative, ecological, and sustainable alternatives (Kuroda 2009; Bowen et al. 2009).

Within this context, a number of forecasts indicate that energy demand in the Asia-Pacific region will continue to grow. For instance, Christophe Bongars, of SustainAsia estimates that the Asia-Pacific region will surpass the rest of the world in terms of global energy demand (accounting for more than half) by 2030 (Bongars 2006). The region – like much of the rest of the world – is heavily dependent on fossil fuels to meet their energy needs.

The challenge of addressing climate change has become particularly acute in this region due to rapid urbanization, where the construction and use of buildings often involves energy-intensive processes (i.e. steel, cement) and because a number of economies are heavily based on manufacturing and industry activities. Industrialization and export-oriented technologies have been the two key contributors to energy consumption in the region (Thavasi and Ramakrishna 2009).

1.1 Challenges of applying low carbon concept for developing countries in Asia and the Pacific Region

The Asia Pacific region must overcome many challenges to secure the growing energy requirements needed to maintain the strong development trend while at the same time pursue a low carbon development path. This section explains the four types of challenges seen as being applicable to emerging economies in the region, namely, development challenges, technology challenges, policy challenges and financing challenges.

1.1.1 Development challenges for developing countries in the Asia-Pacific region and their implication to the energy sector

With around 3.3 per cent of the world's proven oil reserves[1], the Asia-Pacific region relies heavily on imports, and this trend will get even stronger in the future. It also faces a looming natural gas supply shortage in the decades ahead, despite a rapidly growing reliance on coal-fired power generation. The region must make some structural adjustments needed to leapfrog or accelerate development by directly attaining rapid economic growth with low greenhouse gas (GHG) emissions and skipping a growth path heavily reliant on pollutants. Only a varied and increasingly low-carbon energy mix can meet the challenges of energy security, climate change and affordability. But to achieve this structure adjustment supporting policies, advanced technologies and investment are required.

1.1.2 Economic challenges and their implication to the energy sector

A major challenge for the region has been to ensure economic growth that spurs development. The region's impressive economic growth has boosted demand for energy and consequently, put strains on the environment. Attaining this goal required a major increase in the energy supply.

Fig. 1-1 shows the GDP growth rate of Asia and the Pacific in four periods. Basically, the GDP growth rates of the whole region rose significantly from 1990 to 2007.

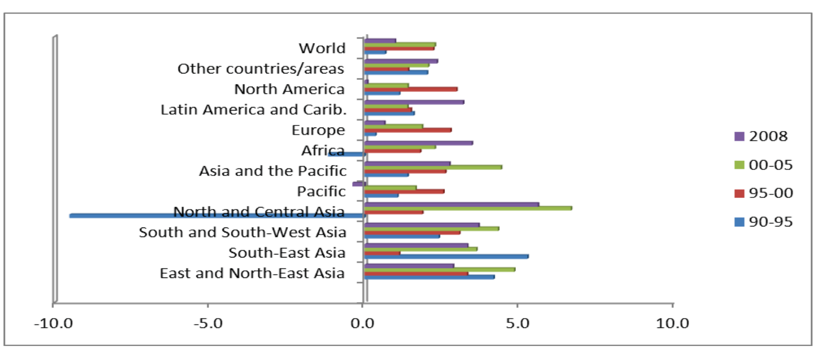


Figure 1-1. Average annual GDP growth rate per capita (1990 US dollars)[2]

In line with the rapid economic growth, energy consumption in this region has increased significantly. Since 1980, the world's consumption of primary energy has doubled and much of the increase has come from Asia and the Pacific. From 2000 to 2007, global consumption expanded about 1.1 per cent, while the rate in Asia and the Pacific increased

2.6 per cent.[3] The contrast was the greatest for natural gas consumption where globally, the increase was 6 per cent, while in Asia and the Pacific it was 13 per cent — more than 2 times greater.[4]

This growth is likely to continue. As of 2007, annual per capita energy consumption in the economic and social commission for the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) region stood at only 862 kilograms of oil equivalent (kgoe), lower that the world average of 1,214.

The energy sector in most parts of the region is struggling hard to meet the rapid growth in demand. Primary energy demand in Asia and the Pacific is projected to grow 2.4 per cent year, a faster rate than the world average.[5] Although parts of this region have relatively abundant sources of renewable energy, a significant share of it is untapped due to various physical and economic factors.

Due to rapid economic growth, massive investments in infrastructure, booming construction industry, rising populations and a decline in the use of non-commercial energy such as biomass, the trend of energy demand in the future is mainly dependent on the development mode and its structural adjustment.

- **Challenges of structural adjustment**

Asia-Pacific countries must undergo structural adjustment to make the key policy changes needed to switch their development mode and promote economic development. Many countries in the region are already developing structural adjustment and others plan to. Economic, social, industrial and energy are among the aspects of structural adjustment. The formation of economic structure will determine the economic development level and energy consumption, which in turn, will affect the environment.

The economic development structure among Economic and Social Commission for Asia and the Pacific (ESCAP) is diverse. Circumstances affecting sustainable development vary depending on national conditions. Consequently, concerns on climate issues differ widely, as well.[6] Most member countries have followed the industrial development model of developed countries, which is the root cause of climate change. This traditional industrial development model results in an unsustainable energy consumption pattern. The mode worsens dependence on fossil fuel as an economy develops. The following figure captures the nexus of an unsustainable energy consumption pattern, economy and environment, especially for developing countries.

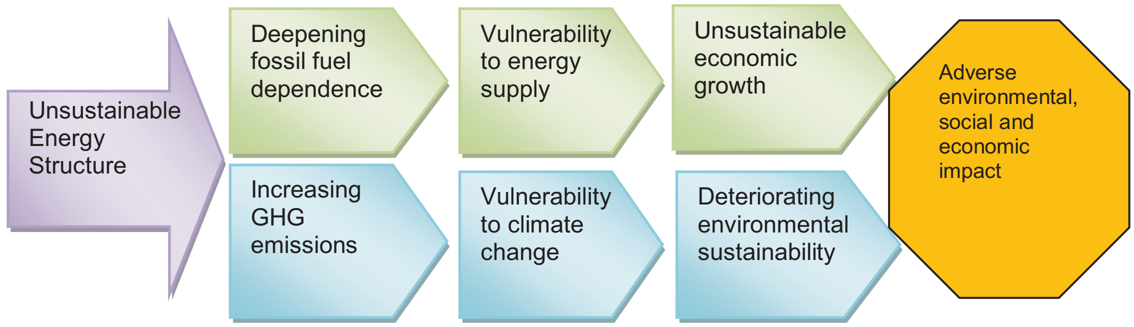
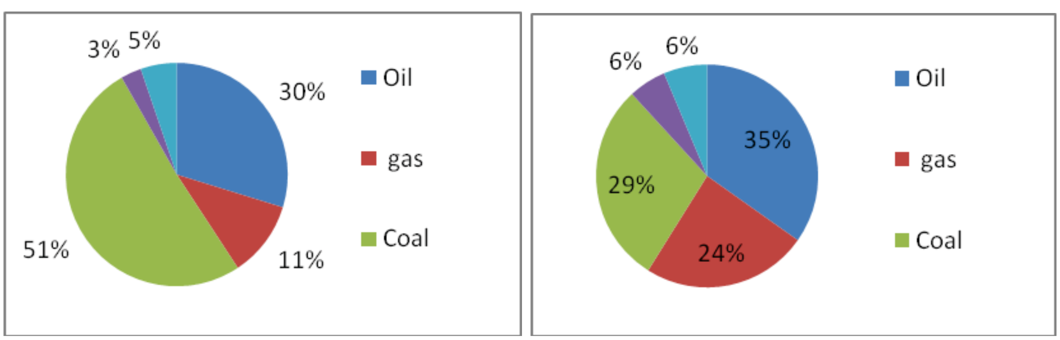


Figure 1-2. Unsustainable energy-economy –environment nexus of fossil fuels[7]

The Asia-Pacific countries, in general, need to consider their energy resource limitations, current development stage and industrial structure while in developing countries, eliminating poverty and improving people's standard of living are still their top two priorities.

Nevertheless, only a varied and increasing low-carbon energy mix can meet the three challenges of energy security, climate change and affordability. To achieve this structure adjustment, supporting policies and advanced technologies are essential.

A larger portion of renewable energy needs to be consumed if the region is to make a dent in reducing GHG emission from energy consumption. Coal is the largest energy source in Asia-Pacific, comprising 51 per cent of the total. This compares with a rate of 29 per cent for the world in 2008 (Fig. 1-3). Meanwhile, nuclear energy and hydro-electricity together account for less than 10 per cent of the total in the region.



Left is Total Asia Pacific, and right is Total World

Figure 1-3. Consumption rate by fuel in 2008[8]

In general, to move toward a low carbon development path, a more complex and diverse energy mix is necessary along with the utilization of a higher proportion of renewable resources, the application of more efficient technologies and improved governance of the energy sector.

- **Challenges of technology innovation and transfer**

Technological innovation is required to make the use of fossil fuel resources more efficient and develop alternative energy sources. Without it, the transition to a low carbon development path would not possible. Major technological advances are needed for conditions such as making renewable electricity generation cost competitive or finding a more technical solution for energy efficiency promotion. But in a system-wide transformation, continual smaller technological advances are also required, ranging from better ways to store electric power to coping with wind power.

The biggest hurdle in developing new technology is securing funding. It is also hindered by lack of qualified scientists and technicians.

The key factor of technological innovation for business is marketization and industrialization.[9] In many countries of the Asia-Pacific region, technology-oriented enterprises often achieve technological leadership. However, these companies often focus more on product outcome instead of market development. As a result, they cannot keep pace with the market and it is difficult to achieve commercialization.

For example, in China, the implementation rate of patented technology is only 10 per cent, the rate of scientific and technological achievements becoming commercial and achieving economies of scale is only 10-15 percent, far lower than that of developed countries, which is 60 -80 per cent. Entities involved in research and development (R&D) need to work closely with firms in the commercial sector.

Technology transfer of low carbon technologies from developed countries to developing countries is a top priority. Despite the rapid growth in Asia and the Pacific, many countries in the region cannot afford advanced technology and technology transfers have been limited due to conditionalities and high prices.

Another factor to consider is large-scale industrialization and urbanization in the region. This has led to higher energy consumption and spurred the need to improve infrastructure through massive construction projects. Under this circumstance, time becomes a factor. If low carbon technology is not applied in time, there will be the technological “lock-in” effect and the current higher GHG emissions will last for several decades in developing countries. In other words, the low carbon development strategy in developing countries is encountering a technical bottleneck. International cooperation and facilitating the process of United Nations (UN) climate change negotiations is therefore urgently needed.

- **Challenges of international trade and investment**

The region as a whole is rich in energy resources, both fossil and non-fossil. Asia and the Pacific has more than 50 per cent of the world’s proven natural gas and coal reserves, 25 per cent of oil reserves, and close to 60 per cent of uranium reserves. But these are not evenly distributed.[10] Many countries in the region are increasingly dependant on imported energy resources.[11] Over the past 15 years import dependency has varied across subregions. Countries of ESCAP, in general, have increased their imports. Small island developing states, in particular, are highly dependent on imported fuel, making them vulnerable to energy market fluctuations. Many countries are very dependent on fossil fuels.

By global standards, this region’s energy trade is underdeveloped. In 2005, the ESCAP region accounted for only 12 per cent of the annual electricity trade worldwide, about two thirds of which was in North and Central Asia. Imports and exports currently represent about 30 per cent of the region's total primary energy supply and production. The region is a net importer of energy but a net exporter of solid and gaseous fuels and primary electricity.[12] The differences in energy resources endowment has created an opportunity to promote further energy trade, which, in turn, contributes to improving energy security in the region. However, economic, social and political challenges need to be addressed to further promote energy trade.

Of note, China and India are increasingly involved in the world integration and have become highly dependent on international trade. Both countries are at the lower stream of the industrial chain with regards to international trade, and are exporting huge amounts of energy and GHG emissions indirectly through the production of exported goods. From the consumption side, they transfer CO2 emissions in all consumer goods from importer to exporter.[13]

In international trade, the net export of embodied energy increases the energy and environmental burden on developing countries in Asia and the Pacific. Developed countries have adopted carbon emissions trading and carbon tax policies. These programmes present an enormous challenge for developing countries' exports. But at the same time, also offer an opportunity for developing countries to change their export and industrial structure and advance to the high end of the value chain.[14]

1.1.3 Social challenges and their implication to the energy sector

While energy is recognized as a critical input to development, traditional development paradigm has focused on energy sector development to support economic growth. Under the traditional development paradigm, economic growth is meant to elevate people out of poverty. However, the adoption of the Millennium Development Goals (MDGs) has shown that economic growth alone will not reduce poverty. More explicit policy measures addressing poverty alleviation are required and the energy sector is not an exception to this.

Across the region, some 1.7 billion people still rely heavily on traditional biomass for cooking and heating, and almost one billion people lack electricity.[15] Without responding directly to the need to improve access to energy services, many of these social issues including employment, poverty and gender will remain challenges.

- **Challenge of unemployment**

The relationship between the environment and employment is evolving from an initial focus on pollution control and waste management towards activities that transform the economy and avoid environmental damage.

Influenced by the economic crisis, the unemployment rate has already started to climb in some countries across the region. It can be seen from fig. 1.4 that the unemployment rate in 2007 is nearly the same with that in 1991, and the unemployment rate in some regions such as South-East Asia has risen yearly.

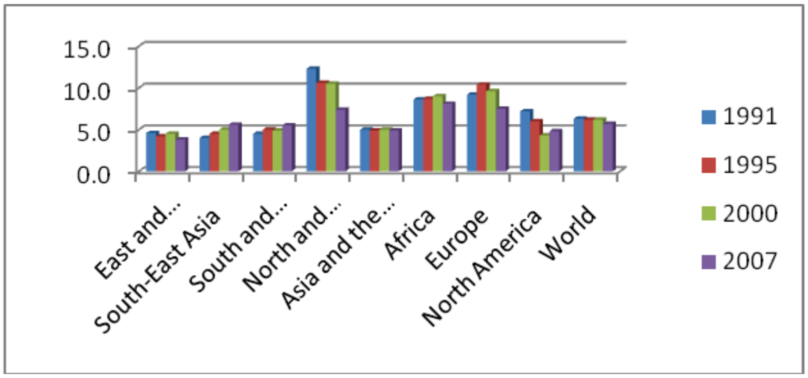


Figure 1-4. Unemployment Rate (In per cent) [16]

The number one priority in developing is to reduce poverty, improve the standard of living and provide decent work. Some evidence show that green jobs (in renewable energy, buildings and construction, transportation, basic industry, agriculture and forestry) would increase under a low carbon development But, on the other hand, some workers in "dirty" fossil-fuel based industries that need to be phased out could lose their jobs., Thus, the challenge is to increase the new green jobs faster than the loss of employment in the sunset industries and carefully manage a just transition.[17]

Job loss (and job shifts) would occur in energy extraction and refining, the power sector, and in energy-intensive industries like steel, aluminium, paper, and cement. The auto industry and industries-related to aviation would be affected as well. Nonetheless, the losses would not only adversely affect individuals but be felt by their families and communities. This would particularly be the case in areas where there are high concentrations of vulnerable industries and a lack of economic diversification.

The success of Germany and Japan in transforming themselves into leaders in renewable technologies in less than a decade is testament to the fact that proper policies play a more fundamental role than an ample resource base: long-term commitments, consistent policies, the use of gradually declining subsidies, and an emphasis on government R&D and market penetration.[18]

Generally, jobs gained are likely to far outweigh jobs lost in a shift to a low carbon economy. Environmentally benign alternatives tend to offer more jobs per unit of investment or unit of industrial capacity. A review of about a dozen studies in the United States and Europe concluded that renewable energy projects generate a multiple of the number of jobs generated in fossil fuel projects per megawatt of capacity.

- **Challenge of poverty alleviation**

Approximately two thirds of the world's poor live in the Asia- Pacific region. As shown in the fig 1-5, progress has been made in poverty alleviation; however, fluctuations in grain and oil prices, climate change and the global economic crisis have put in region in a more vulnerable position in recent years, especially in South and South-West Asia, where in 2005, the per cent of people living below the poverty line was still much higher than the world level in 2005.

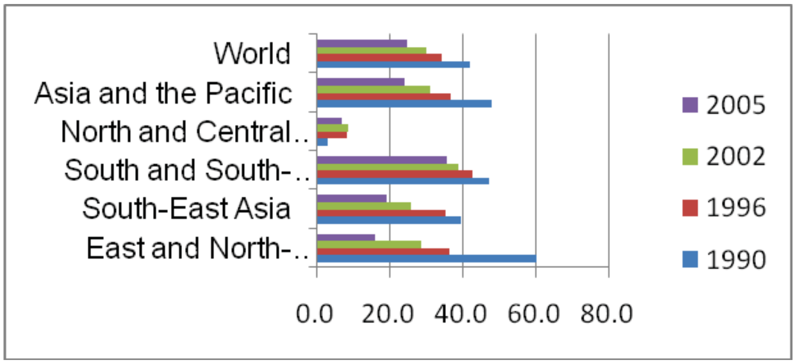


Figure 1-5. Percentage of population living below $1.25 (2005 PPP) a day[19]

In addition, studies show that millions of impoverished people across the Asia-Pacific region are affected by soaring oil prices. The situation is particularly difficult for the 641 million people in the Asia-Pacific region living on less than US$1 per day who spend a higher proportion of their income on energy.[20]

Easy access to energy would enable poor people to carry out more productive activities and essential services, providing them with the opportunity to increase their income. One priority is to integrate energy issues within rural development while another is to ensure that access for the poor plays a central part in a national energy strategy and economic planning. Meanwhile, energy efficiency technologies should be applied in the shift from the traditional development path to low carbon development path.

While energy services alone are not sufficient to eradicate poverty, they are essential in creating the conditions for economic growth and improving social equality. When addressing the need to widen access to energy services, issues at stake not only include providing access to rural communities but also improving the quality of energy used by the poor. Inefficient use of biomass and poor quality cooking stoves foster health issues as well as the degradation of socio-economic and environmental conditions of communities. Considering the low energy consumption patterns of the rural communities, the issue for rural communities with respect to a low carbon development path is not to make the already low emissions even lower but to devise a mechanism to create the space for development for rural communities.

- **Challenge of population growth**

According to the Statistical Yearbook for Asia for Asia and the Pacific 2008, the population growth rate in the region dropped to 1.1 per cent in 2007 from more 1.5 percent in the period from 1990-1995. Despite slowing population growth, Asia still accounts for 60 per cent of the global population and has some of the most densely populated places in the world. Figure 1.6 shows that the population growth rate in Asia and the Pacific, especially the rate of South and South- West Asia, is still much higher than the world average.

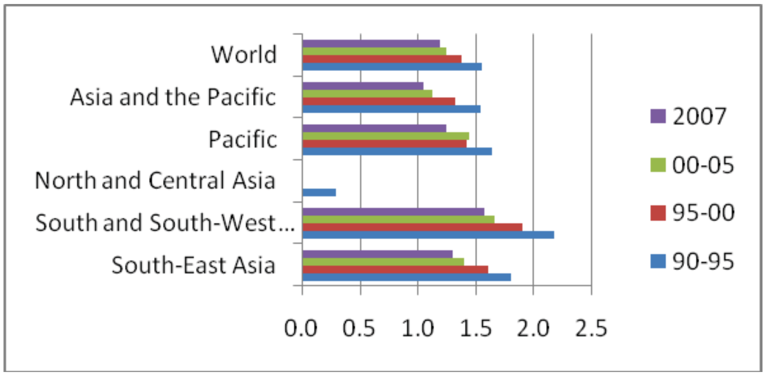


Figure 1-6. Population growth rate in the Asia-Pacific region [21]

This population census and corresponding growth trends will influence the in energy consumption levels at the aggregate level, as well as the direction of the fuel mix. Modern societies have become highly dependent on energy—in businesses, industries and residences. Energy consumption increases hand in hand with population growth, particularly in urban areas. This places considerable pressure on infrastructure, housing, facilities, social services and utilities, and, as a result, many urban centres are experiencing shortages of electricity, natural gas, gasoline, kerosene and biomass. Almost half the world's population still depends on inefficient and highly polluting solid fuels for their everyday household energy needs, in particular coal and biomass—wood, animal dung, and crop wastes.

Across the region, however, the energy consumption per capita varies considerably. Countries such as Australia or New Zealand consume almost 100 times more electricity per capita than Bangladesh, Cambodia or Myanmar. [22] With economic development in developing countries, the energy consumption per capita will rise with the large population base.

Under the current scenario of stable population growth, a key question remains as to whether the benefits of economic growth and development are keeping up with the slowing but still increasing number of people in the region. The process of moving to a low carbon economy must take this factor into consideration and focus on the distribution of benefits to its population.

- **Challenge of gap between urban and rural area**

The level of urbanization in Asia and the Pacific differ considerably from country to country. However, access to energy services is an issue in both urban and rural areas for developing countries.

Many people lack access to energy services, especially in rural areas for lighting, cooking, heating, mechanical power, transport and communication. While no explicit barriers exist, factors such as limited sources of capital, regulatory uncertainties and inadequate technical capacity present hurdles for new rural service providers from entering the market. Although the problems of access are now much bigger in rural than in urban areas, expected rapid urban population growth in the next decades could lead to growing gaps in access to electricity in cities. In urban areas where service providers exist but poor neighbourhoods often have no service,, lack of solid regulations, including appropriate pricing rules restrict greater access.[23]

One problem is that policies to promote rural and community development and poverty often do not include issues related to energy. In 2008, the number of people in Southeast Asia without access to electricity was 160 million — or 28 per cent of the region's population, with the bulk of them living in rural areas. Rural and urban electrification rates in the region are currently around 55 per cent and 91 per cent, respectively.

Electrification levels vary widely throughout the region. In Myanmar the overall electrification level is only 13 per cent, whereas in Singapore, the rate is 100 per cent. Indonesia, Myanmar and Philippines have the greatest number of people who are living without electricity; the numbers are respectively 81 million, 43 million and 13 million, which together account for 85 per cent of the total population living without electricity in the Association of Southeast Asian Nations (ASEAN) region.[24]

Since 2005, the number of people with access to electricity in Southeast Asia has increased by 27 million. Nonetheless, in the absence of concerted efforts, 9 per cent of the ASEAN population, 63 million people, is projected still to lack electricity in 2030, despite more widespread prosperity and advanced technology. Urgent steps must be taken to reduce the disparity between urban and rural areas. They include vigorously promoting energy efficiency in urban areas as well as in the industry/commercial/sectors and transferring the financial benefits for rural development.

- **<u>Gender issues</u>**

Estimates show that one billion people have no access to electricity, resulting in serious health and social conditions, particularly for women and children. In many developing countries, women and children spend a disproportionate amount of time collecting wood and carrying water, cutting into time for schooling and revenue-generating activities.

Furthermore, women and children are particularly vulnerable to illness caused by cooking with fuel wood or other biomass. Working indoors over open fires in smoky conditions exposes them to harmful levels of gases, particulates and dangerous compounds such as carbon monoxide, benzene and formaldehyde. A report to the Commission on Sustainable Development in 2006 estimated that globally 1.6 million deaths per year were due to pneumonia, chronic respiratory disease and lung cancer. In 2002, as a result of indoor air pollution, 483,000 people, including 288,000 children under the age of five, died from pneumonia and other acute infections of the lower respiratory tract in Southeast Asia alone.[25]

A low carbon development path must entail appropriate stakeholder involvement in order to address gender issues as well as other social issues to achieve a balanced development. Its socio-economic co-benefits comprise increases in farm income (McCarl and Schneider 2000), new job opportunities, social infrastructure development, recreation enhancement and health benefits.

1.1.4 Environmental challenges and their implication to the energy sector

Conventional fossil energy exploration, processing, transformation and utilization adversely impact the natural environment. This is especially the case in developing countries in the Asia and the Pacific region where economic growth is based on low-quality energy consumption patterns. In a big challenge in this region is to protect the environment as the economies become more developed. Serious issues in this area include air pollution and GHG emissions, worsening water quality and water availability, ecosystem degradation, resource and energy shortages and regional environmental factors. As proclaimed by the global scientific community, the main environmental challenge is climate change due to its huge adverse impacts on social and economic development.

- **<u>GHG emissions</u>**

Human-related GHG emissions are the main cause of climate change. The reduction of these emissions would be the most effective way to address climate change. However, in Asia and the Pacific, any action in this direction would clash head on with the region's top priority of economic development and raising living standards, especially in developing countries.

Over past decade, CO_2 emissions in Asia and the Pacific jumped from 9.8 billion in 1990 to more than 13 billion in 2006. The surge was biggest from 2000 to 2005 when economic growth stood at 5.6 per cent as compared to the world annual growth rate of 3.1 per cent[26]. By far, the region is the largest overall emitter in the world, led by China, India, Japan, Republic of Korea and Australia. In China, driven by the fast economic development, the CO_2 emission reached to 28 billion tons[27] by 2009 with the annual growth rate of 5.6 per cent[28]. Thus far, the energy consumed is low-quality compared with other regions in the world. The CO_2 emission per unit of GDP in Asia and the Pacific is higher compared with the world average level of 0.6 tons CO_2 emission per thousand GDP (USD in 2005) in 2008, especially in the developing countries of the region such as in China, India and Thailand where the amounts are 2.1 tons, 1.4 tons and 1.3 tons, respectively. .

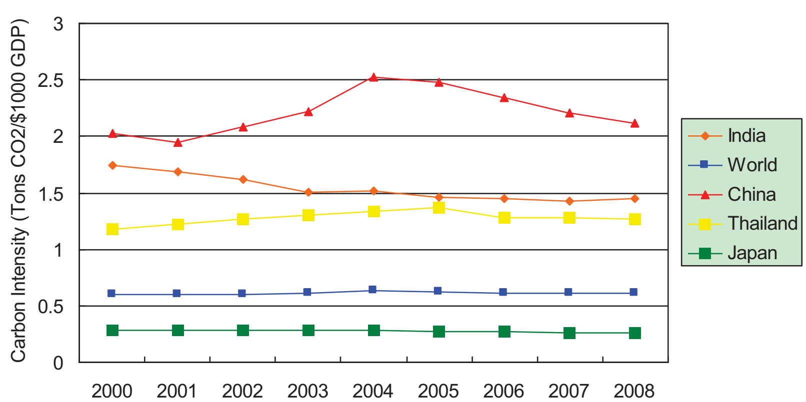


Figure 1-7. Carbon intensity using market exchange rates[29]

According to the IEA World Energy Outlook 2006, the Asia-Pacific region is likely to sustain faster than average economic growth, which, in turn, will likely increase the region's share of energy-related CO_2 emissions 45 to 55 per cent between 2005 and 2030[30], and reach to 17.8 billion tons of CO_2 in 2030 at a growth rate of 2.3% per year[31]. To combat climate change and at the same time attain economic sustainability, countries should implement measures that foster energy exploitation, processing, production and utilization in a low carbon way.

- **Air pollution**

Sulfur Dioxide (SO_2) and Nitrogen Oxides (NO_x) are the main air pollutants in the region. They mostly come from the burning coal, the largest source of fuel, and fuel used to run the region's rapidly expanding transportation sector.

SO_2 in the region accounts for 50 per cent of global emissions[32], most of which is produced in developing economies, such as China, India, and Thailand where coal is the dominant source of energy. Without effective emission control standards, SO_2 emissions are projected to increase at a steady pace as energy consumption rises in line with economic growth. Specifically, in China, SO_2 emission in 2005 reached to 26 million tons[33] with an annual growth rate of 5.4 per cent compared to 20 million tons[34] in 2000. The Chinese government put into place a series of policies for energy conservation and emission reduction, leading to the reduction of SO_2 emission to 23 million[35] in 2008. However, compared with developed countries the SO_2 emission level was still higher.

NO_x is the second-biggest pollutant emitted in Asia-Pacific and ranks as the second-biggest pollutant tied to global warming. NO_2 emissions increased from 3501.9Gg in 2000 with the total share of 38.8 per cent of emissions to 4065.6 Gg in 2006 with a share of 43.2 per cent. The jump can be attributed to the expanding transport sector, especially in the number of vehicles. [36]. NO_2 emissions are expected to increase further in developing countries as more motor vehicles go on the road. This, in turn, will result in acid rain formation, eutrophication of bodies of water and ozone damage.

- **Water pollution**

Water pollution is one of the most serious environmental problems in Asia-Pacific, especially in large cities and their surroundings. The water quality in Asian rivers is worse than the world average level with biological oxygen demand 1.4 times higher, suspended solids four times higher and bacteria three times higher. These conditions reduce the amount of available freshwater, result in sanitation and health problems and destroy the water ecosystems[37].

- **Ecosystem degradation**

Unreasonable forestry resource utilization, land using change and frequent droughts have resulted in the increasing trend of desertification in the region. Water degradation is emerging in many developing areas.

For example, the Coringa mangrove ecosystem in the east coastal of India continues to degrade as the earth's temperature increases. Most of the coral reefs have disappeared over the last decades of the twentieth century, and many mangrove areas were lost. In addition, wetlands are also being threatened. Lower rainfall and droughts in most delta regions of Pakistan, Bangladesh and India have caused wetland to dry up and severe degradation of ecosystems[38].

- **<u>Resource and energy shortage</u>**

Water availability per capita in Asia-Pacific is 4,200m^3/capita per year, only a little more than half the world average of 7,000m^3/capita[39]. In most areas of Asia and the Pacific, water availability has rapidly decreased. It is well-known that the Islamic Republic of Iran and Afghanistan suffer chronic water shortages. Despite good rainfall, the Pacific countries also suffer from water shortages because of insufficient investment and technology for water storage and inadequate water demand management[40]. In China, the water supply situation in cities is deteriorating.[41] A survey of 600 cities showed that two thirds of them face water supply shortages and one sixth is even worse[42].

Meanwhile, rapid economic expansion has boosted total energy consumption, especially among developing countries. This has, consequently, worsened the energy balance, particularly in South Korea, Japan, Singapore, Turkey, and the Pacific nations where the energy dependence rate is 100 per cent.[43]

- **<u>Global and regional environmental issues</u>**

Though well-recognized as an urgent global issue, rallying the international community to effectively deal with climate change remains a major challenge. All countries much address this issue. The international community needs to call for each individual country to reduce GHG emissions. With objectives set for developed countries and voluntary actions prescribed to developing countries that request financial and technical assistance from developed countries.

Specifically, in the Asia-Pacific region there are many environmental issues cutting across national boundaries. The Mekong regional environment issue is one example. The middle and upper watersheds of the river affect water availability and quality, productivity of fisheries, and hydrological conditions in downstream riparian countries such as Cambodia and Vietnam. Transboundary acid rain in Northeast Asia is another regional issue which also strains interstate relations. Tackling regional environmental issues requires close cooperation across boundaries.

If no action is taken towards developing a low carbon future, strains on the environment will worsen both in the region and globally. A low carbon development path would not only reduce GHG emissions and improve local and regional environmental conditions but increase the amount of available renewable energy and clean energy. This, in turn, could increase national energy security.

1.2 Availability and R&D of clean energy technologies in Asia and the Pacific

Clean energy technologies are essential parts of a low carbon development path. They comprise clean power technology, clean heating technology, liquid biofuels and energy efficiency. Some of these technologies have already been deployed in Asia and the Pacific because of their low carbon intensity and environmental benefits. But costs remain an issue.

- **Challenges of clean energy technologies**

Among the clean technologies applied globally are clean power technology, clean heating and gas technology, clean coal, biofuels and energy efficiency technologies. Research and practice both show that the application of these technologies significantly reduces CO2 and other GHG emissions. However, compared to conventional energy technologies, the investment and production costs of clean energy technologies, especially in developing countries are generally higher. The higher costs are attributed to the following:

- High cost of technology investment, high production costs;
- Technology uncertainty. Some of the historical development of new technologies is limited; there are still many uncertainties, such as the use of carbon capture and storage (CCS) technology in which of CO2 emissions have leaked underground.
- Technology security issues, such as the development of nuclear power, nuclear technology, will lead to some political and security issues.
- Key technologies rely on developed countries in areas such the production technology of fans or solar panels.
- Technologies development is affected by resource constraints, such as solar, wind and geothermal power generation.
- Some clean technology also brings environmental and social problems, such as hydropower development on the geological, ecological environment or the promotion of biofuels on food security.

For the Asia and the Pacific region, the key point of technologies is to obtain proper and mature clean energy technologies that can be adopted by individual countries. The availability analysis of different clean technologies is elaborated below.

1.2.1 Clean power technology

Clean power technology is essential for developing a low carbon development path. Discussed below are examples of widely used clean power technology

- **Small hydro power**

Small hydro power technology is very mature and used extensively in Asia- Pacific, mainly in mountainous countries, such as Nepal. By 2008, small hydro power generation was deployed widely in China with a capacity of 65GW while in Japan the capacity reached 3.5 GW and in India, it was 2GW. The capacity deployed among the three countries accounted for 70 per cent of the world total.[44] In addition to the environmental benefit, the small hydro power could be used to provide electricity to rural and remote areas. This results in a higher national electrification rate, an increase in local agricultural production and more income.

- **Geothermal power**

The largest groups of geothermal power plants in Asia-Pacific are in the Philippines and Indonesia. The installed capacity for geothermal energy power in the Philippines is 1931MW, making it the world's second biggest geothermal power producer after US, providing 18 per cent of national energy consumption[45] and 27 per cent[46] of the country's total electricity production generated in power plants, which will reach to 3131MW in 2013. Geothermal power has high capital and operational costs. Also, the technology still needs to overcome lingering problems such as erosion and the high costs for drilling wells, which accounts for half of the total investment and adversely affects land stability.

- **Big dam**

Compared with conventional power generation big dam technology deploys low carbon intensity with 6.5 and 44g CO_2e/KWhe. The Asia-Pacific region has witnessed tremendous growth in the hydroelectric sector. Its cumulative installed capacity grew from 205,422 MW in 2001 to 295,764 MW in 2008[47], principally on the back of strong growth in the leading hydro power nations of China, Japan, India and Australia. The technology of hydro power is very mature and the capital cost is comparable with that of coal-fired power generation. However, careful consideration must be taken before big dams are built. The deployment of unpractical hydro power deployment could adversely affect the ecosystem as a whole. In addition, hydro power generation projects often entail large-scale rehabilitation and resettlement of local residents, particularly in submergence areas, affecting its overall success.

- **Wind power**

Wind energy is the fastest growing clean energy power in the region with. China and India ranked number four and five in the world as of 2008 with an install capacity of 12 GW and 9 GW, respectively. The combined figure accounts for 20 per cent of the world capacity. The two countries rank second and the third, respectively in terms of newly installed capacity with a combined share of 40 per cent of the world total.[48] After many years of development, wind power plants are deemed a mature technology that is commercially viable. The installed cost averaged reduced to €1,300 per kW in 2007[49]. The power generation cost from wind currently averages $0.04–$0.05/kWh[50] and is expected to decline as investment and generation costs fall.

Of note, the capacity factor of wind power is very low, about 20~40 per cent.[51]. This is because wind speed is not constant and wind farms cannot operate at total capacity. With a 20 per cent penetration limit for incorporation, only about 5 per cent of all grid systems deploy wind energy. These systems are mostly in Europe. The variability of wind power is a major hurdle for this energy source to gain widespread use.[52]

- **Biomass power**

Biomass power generation provides good co-benefits, such as environmental protection, waste utilization and energy supply, all of which are important for renewable energy development in Asia and the Pacific. In China, biomass power generation installed capacity including direct combustion of straw and rice husk, wood wastes and landfill gas reached 3136 MW in 2008[53]. The national demand for wood fuel in Sri Lanka and Bangladesh comes close to 70 per cent of totally fuel in each country. [54]. In Sri Lanka, for example, fast-growing trees continue to provide the feedstock for biomass power generation.

- **Solar power**

Solar power technology is applied through solar photovoltaic (PV) and concentrated solar power (CSP). In Asia-Pacific, solar PV power plants are in the Republic of Korea, China, Thailand, India and Australia. Currently, the high cost of power generation is a big obstacle for deploying solar PV and CSP. In addition, as an intermittent power source, the required backup serves as drawback to implementation. CSP currently is in the demonstration stage in the region, and its capital cost runs about $2,500 to $4,000 per kw, nearly two times the cost of biomass power but less than nuclear and geothermal power. Also, the operation cost is $0.12~0.18/kWh[55], two times the amount for coal-fired power. The costs, however are expected to fall to $0.06/kWh [56] by 2015 due to improved efficiency and the mass production of equipment.

- **Clean coal technology**

Coal will remain the dominant energy in the region in the short term. Thus, clean coal technology stands to play a key role in low carbon development. This technology, primarily integrated gasification combined cycle （IGCC） and CCS, can notably reduce CO_2 emissions. Table 1-1 shows that, the technology of IGCC and CCS has GHG emissions of 22g CO_2e/KWh, only one tenth of a normal coal-fired plant.

IGCC has a high power generation rate, capable of treating pollutants and carrying out de-sulfurization. It costs little to operate but is expensive to set up and conserves water. When deployed, CO2 is treated by way of CCS. Many Asia-Pacific countries are building IGCC demonstration plants and some already exist in Japan, China, India and Singapore. [57] However, IGCC is still in the demonstration stage, and it is rather complex and expensive. According to relevant data, the capital cost ranges from $1,000 to 1,500 per KW, twice the cost of a normal coal-fired plant. Based on technical data from demonstration projects in Asia-Pacific, when the utilization is less than 5500 hours and rate of return of investment is 8 per cent, the average on-grid price (tax inclusive) of the operation term is $0.06-0.09/KWh, 50 per cent higher than that of normal coal-fired plant in the region[58].

CCS technology is in the stage of experiment and demonstration. Despite numerous pilot plants and being deployed already in Australia, China and Japan, it is rarely cited as a critical option in the portfolio of solutions available to combat climate change. The technology is capable of storing 10 to 40 percent of the energy produced by a power station. However, it is plagued with concerns that the safe and permanent storage of CO_2 cannot be guaranteed and the leakage rates, although very low, could undermine any climate mitigation effect.[59] The cost competitiveness at a carbon price is in the range of $50-100/ton[60], significantly higher than the price in the carbon market.

- **Nuclear power**

Nuclear power is a major source of carbon-free energy with carbon intensity of 60~65g CO_2e/KWhe and has the potential to be instrumental in helping to phase out the use of fossil fuels. Nuclear power in the Asia-Pacific region is growing significantly. Japan generates 28 percent of its electricity from nuclear power with 55 units in operation[61], the most in Asia. As of 2008, China had 11 nuclear power reactors spread out over four separate sites. It plans to build 100 reactors, all to be ready for operation or under construction by 2020, in addition to other reactors planned or under construction[62]. Even though nuclear power is a mature technology, it involves high capital costs, which vary widely from $2,950/kWe (overnight cost) to a conservative estimate from Moody's Investors Service of between $5,000 and $6,000/kWe[63]. It has lower fuel costs but higher operating and maintenance costs.[64] The operation cost of a nuclear power plant is estimated at $0.067 per kWh[65], a little higher than for coal-fired plants. Nuclear power has been plagued by a range of problems, including safety concerns, radioactive waste disposal, the diversion of technologies and the spread of nuclear weapons and weapons-applicable to nuclear technology and information, referred to as nuclear proliferation. All this makes the deployment of nuclear power controversial.

- **Comparison of different power generation technologies**

Table 1-1 shows the carbon intensity from different power technologies. Compared with conventional coal, oil or gas-fired power generation, the other power technologies have low GHG emission through their life span. According to the table, the cleanest technologies are small hydro power generation and geothermal power with T_L technology, both with less than 5gCO_2e/KWhe, followed by IGCC with CCS technology with 22 gCO_2e/KWhe and then nuclear power technology with about 60~65 gCO_2e/KWhe. Next are big dam and wind power with about 10~40 gCO_2e/KWhe followed by biomass power and geothermal power technologies (T_H) with 90~150 gCO_2e/KWhe. For Solar PV and CSP, the carbon intensity range is wide based on different solar resources. Except for hydro power, these technologies have higher capital investment and operational costs than for coal-fired power.

Table 1-1. Characteristics of different power generation technologies

Technologies	Carbon Intensity (g CO_2e/KWhe)	Capital Cost ($/KW)	Operation Price($/ kWh)	Maturity
coal-fired power	176~268[66]		0.04 - 0.05	Commercialized
Oil-fired power	116[67]			
small hydro power	1~3[68]			
big dam	6.5~44[69]			
Wind power	10~40[70]	1,300	0.04–0.05	
Biomass power	95(Europe and UK), 148(north American [71]	1,400-1,600 for direct combustion in China	0.09-0.10[72] for direct combustion in China	
Geothermal power	T_L 0–1, T_H 91–122[73]	3,000-7,500	0.06-0.15[74]	
Nuclear power	WL60, WH65[75]	2,950-6,000	0.067	
Solar Photovoltaic	53~217[76]		0.15- 0.22	Commercializing
IGCC+CCS	22[77]	IGCC(1,000 ~ 1,500)	0.04-0.09[78]	Demonstration
CSP		2,500-4,000	0.12-0.18	

TL = low-temperature/closed-circuit (geothermal doublet), TH = high-temperature/open-circuit, WL = Light Water Reactors, WH = Heavy Water Reactors

1.2.2 Clean heating/cooking technology

Clean heating technologies, which involve the use of solar water heaters (SWH) and biogas, are mature and competitive. SWH consumes less energy and their GHG emissions are only 20 per cent of electrical water heaters and 50 per cent of the emissions of gas water heaters[79].Also, SWH has a short payback period and can be developed quickly. Bangladesh had 150,000, solar home systems (SHS) in 2007, up from only 20,000 in 2003[80]. The country's renewable energy business is now reported to be the fastest growing "green industry" in the world. About 2.5 million inhabitants now get their power from solar energy. The payback period of SWH ranges widely depending on the heating system it is replacing, the electricity and gas prices and the solar energy source. In the China's Yunnan region, a good location for solar energy, the period payback of SWH is about 6.3 years[81], while in Pakistan, it takes 1.4 years.[82].

Biogas is mainly produced from manure and organic waste through aerobic digestion. It has a positive impact on the local environment as it avoids CH_4 (methane) emissions, which are far more harmful to global warming that CO2. In Asia-Pacific, biogas is mainly produced and used in rural areas for cooking.

The number of Chinese households that use biogas reached 32 million in 2008. The annual output stood at 12.4 billion cubic meters, and the biogas projects of livestock farm totalled 28,300, with a pool volume of 3.03 million cubic meters and annual output of 379 million cubic meters[83].

Biomass briquettes are made from agricultural waste or wood waste, and are used to heat boilers in manufacturing plants or for applications in developing countries, that aim to improve heat efficiency and reduce GHG emission. A biomass briquette has only 2–19 percent of the emissions of comparable sources of energy[84]. This technology is being commercialized but production in developing countries is limited due to lack of suitable equipment.

The use of heat pumps is also effective for space heating. This technology is the fastest-growing means of exploiting geothermal energy, with a global annual growth rate of 30 per cent in energy production[85]. Most of the new heat pumps are being installed to heat buildings. But, the technology has a low capacity factor as buildings only need to deploy it during winter. In countries that are highly dependent on electricity production such as China or India, a heat pump may result in 1 or 2 tons more CO_2 emissions than a natural gas furnace. The economic benefits of the technology are relatively good, with a 2-6 year payback period compared to 3-8 years for oil and 12-13 years for natural gas.[86]

1.2.3 Liquid biofuels

The production and use of biofuels has increased dramatically in the past few years, primarily due to higher oil prices, national security concerns and environmental considerations. In 2007, total bioethanol production was 2.5 billion litres in Asia and the Pacific, about 5 per cent of the world production. China, Thailand and India are the main producers of this source of energy[87]. China, Thailand, India and Pakistan are the main sources of biodiesel in the region, with palm oil and jatropha serving as the predominate sources of feedstock.

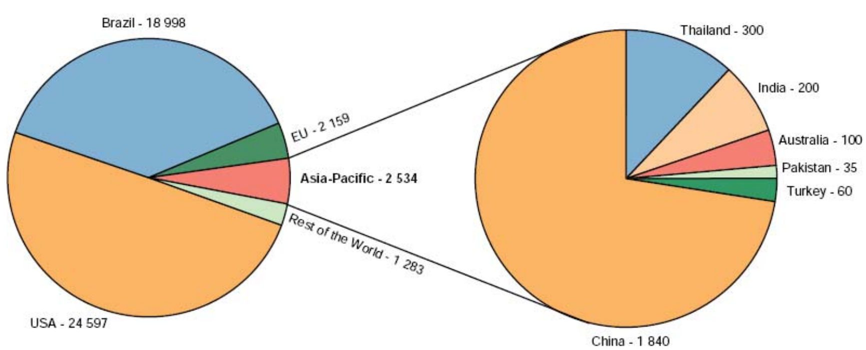


Figure 1-8. Major fuel ethanol producers, 2007, millions of liters

(Source from ESCAP, Sustainable Agriculture and Food Security in Asia & the Pacific, 2009)

The carbon intensity of bioethanol and biodiesel depends on the feedstock used. Table 2-1 shows the various levels using different combinations. Compared with the first generation of bioethanol, produced from crops such as sugarcane, corn and cassava, the second genera ration, or cellulose bioethanol, is more beneficial to the environment, with a 90 per cent GHG emission reduction. However, this technology is still in the R&D stage and production costs range from 0.50$/L to 0.59$/L[88], much higher than for corn ethanol which cost 0.32~0.40$/L[89]. The production cost of biodiesel from waste cooking oil is about 0.68$/L in Thailand while for palm oil, it is 0.86$/L[90].

Table 1-2. Different biofuels technologies

Technologies	carbon intensity (g CO_2-eq/KWhe)	Maturity
Gasoline	346[91]	
Diesel	341[92]	
Bioethanol		
sugarcane	239~264 [93]	commercialized
corn	279~436 [94]	
cassava	128[95]	
cellulose	35[96]	R&D
Biodiesel		
waste cooking oil	151~205[97]	commercialized
palm oil	176[98]	

Biofuels offer many environmental advantages and co-benefits but its production and utilization is under scrutiny. When discussing this topic, popular media and scientific journals cite its effect on moderating oil prices, the "food vs. fuel" debate, carbon emissions levels, sustainable biofuel production, deforestation and soil erosion, water resources, human rights issues, poverty reduction potential, biofuel prices, energy balance and efficiency, and centralized versus decentralized production models. Ultimately, the acceleration of the production and utilization of biofuels must take into account the impact on food security, water resources, land utilization and other social aspects.

1.2.4 Energy efficiency technologies

Energy efficiency is the single largest prospective deliverer of GHG reductions, due to its high potential and low cost compared to other alternatives[99]. Technologies that make the use of energy more efficient ultimately reduce energy demands and contribute to the universal goal of sustainable development.

There are a wide range of energy efficiency improvement technologies for a variety of different applications suitable for implementation in developing countries. In the industrial sector, combined heat and power (CHP) is widely used as it often improves the energy efficiency by 30 per cent. Heating can be a substitute for a small boiler heating system. It improves the energy efficiency by 50 per cent and reduces the GHG emission to 0.22 $kgCO_2e/kWh$[100]. Waste heat and pressure recovery are now extensively deployed in the steel and iron, coal, building materials, chemicals and textile sectors.

CHAPTER 2.
Approaches and Perspectives

This section examines how a low carbon development path is defined, and the various approaches and perspectives used to understand this concept.

2.1 What is a low carbon development path[101]? Consensus and Debates

The concept of a low carbon development path is evolving, and little information exists that provides a clear-cut definition. Instead, there is a range of views regarding what constitutes low carbon development.

This concept depends on the specific situation of each country/region (such as economic model, development status and energy endowment), making it neither necessarily possible nor necessary to have a uniformed definition across countries.

Generally though, the concept centres on the terms" low carbon" and" development".

"Low carbon" is viewed as something (i.e. a technology, economy), which aims to minimize GHG emissions, especially CO2 emissions. Some countries and organizations (i.e. European Commission) refer to a low carbon economy, but not with a clear working definition; the concept is rather vague, consisting of a comprehensive strategy that touches on a range of sectors including manufacturing, industry and energy.

That said, a group of leading experts working in this area met to decide on a definition of a low carbon society.

The group agreed that a low carbon society must:

- "take actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within society are met;
- make an equitable contribution towards the global effort to stabilize the atmospheric concentration of CO_2 and other greenhouse gases at a level that will avoid dangerous climate change, through deep cuts in global emissions;
- demonstrate a high level of energy efficiency and use low-carbon energy sources and production technologies; and
- adopt patterns of consumption and behaviour that are consistent with low levels of GHG emissions" (Skea and Niskioka 2008: 6).

While the meeting's objective was to come up with a definition covering all national circumstances, the group recognized that the implications would be different depending on the country. For instance, it suggested that for Organization for Economic Co-operation and Development (OECD) nations, a low carbon society would require making deep CO_2 emissions cuts. This implies that systemic changes must be made throughout society, including technologies, social changes and lifestyle behaviours. For developing countries, pursuit of a low carbon society must come hand in hand with the pursuit of development goals (Skea and Niskioka 2009).

But even so, concepts such as “sustainable development”, “equitable contributions”, “dangerous climate change” among others in the above statement are still being debated and have different interpretations depending on the context.

As most developing and emerging economies are unlikely to stray from the imperative that economic growth is synonymous with development, a pragmatic approach for the Asia-Pacific region recognizes that pursuing a low carbon development path involves continued attention on economic development but through strategies that contribute less GHG emissions, such as through energy diversification, energy efficiency and carbon sequestration activities. A low carbon development pathway is any development pathway that is lower (in terms of GHG emissions) than the one that would be otherwise taken.

One useful approach on low carbon development from a developing country perspective is put forth by Professor Jiahua Pan, executive director of the research centre for sustainable development at the Chinese Academy of Social Sciences and member of the Global Climate Network. Pan (2005). Here, low carbon development is considered within the objective of human development. The notion is that while this path also seeks to minimize GHG emissions, “no restriction should be placed on development goals that are directed to enhance the welfare of the poor at large. Development goals are not compromised for reasons of emissions control” (2005: 101). But, luxurious or wasteful emissions (viewed as those that do not meet basic human needs such as shelter or food) should be discouraged. It is within this context that a low carbon development path should be pursued.

However, even as Pan (2005) points out, there are some challenges with this approach. For instance, what about the negative implications associated with generating electricity from coal, such as health problems including increases in respiratory illnesses, which could be seen as ”decreasing” a nation’s ability to meet its basic needs?

Also, how is a “basic need” defined? For example, electricity used to provide heat for cooking and light, could be considered as meeting basic needs. But what about electricity for computers and /or televisions? Some could argue that through televisions and computers, people access information (thus encouraging education which often improves one’s socio-economic situation). But what about televisions shows and computer activities considered “entertainment” such as online gaming or social networking through the Internet?

Researchers Velmurugan Thavasi and Kilaparti Ramakrishna (2009) who also tackle the issue of low carbon development argue that because many Asian nations are developing, a core part of any low carbon development strategy should consist of promoting competitive markets through liberalization based on the premise that in addition to keeping energy affordable, “increased competition and improved market structures should spur investments” (2009: 3).

Despite continued advocacy for liberalization, pursued in the energy sector since the 1990s, evidence regarding its successful application is far from proven.

Some experts argue that increased privatisation and liberalization of the energy sector failed as governments in both industrialized and developing countries only undertook these actions half heartedly, or stopped them when not fully realized as these decisions were not politically popular (i.e. reducing subsidies on fuel and electricity), thus discouraging investment in this area (Vedavalli 2007).

Others, on the other hand, purport that the liberalization and privatization model was too generic; its application for many developing countries did not translate well into local circumstances, due to low indigenous capabilities in certain areas, dependence on foreign consultants and donor conditionality (Ockwell *et al.* 2009a).

It is not inevitable that countries in the Asia-Pacific region will follow the exact pathway of the OECD nations as they pursue the dual goals of economic development and addressing climate change. Rather, "the opportunity exists for the emerging economies to drive new innovation trajectories that bypass, and avoid lock-in to those regimes and systems most responsible for global climate change" (Ockwell *et al.* 2009a: 4). Low carbon strategies taken by countries such as China and India can serve as examples for less developed countries to pursue at later stages of their development.

Ultimately, each country must decide what their vision of low carbon development entails. For example, Thailand views a low carbon economy as consisting of three prongs: 1) energy security; 2) a sufficient economy (or one that meets the needs of people without encouraging excess in their lifestyles); and 3) regional and international cooperation, through research and development and technology transfer (Yoohoon 2009).

Yet similar facets occur within the range of perspectives on low carbon development. These aspects include:

- integrating low carbon policies with other policy objectives;
- a low carbon development path involves systemic changes, suggesting a paradigm shift;
- a portfolio of technologies and options will be required to achieve a low carbon development path;
- the need for behaviour change; and
- the need for financing for these transitions.

First of all, many experts agree on the need to integrate low carbon policies with other policy objectives. For example, in addition to economic development as noted above, energy security, poverty alleviation and innovation are also key goals for policymakers.

The world is highly interdependent, where trade, manufacturing and services are often produced in various countries and regions. This global system is also very dependent on fossil fuels. These resources are characterized by major shifts in prices that are in a constant state of flux depending on a complex range of factors involved with supply, demand and speculation. Countries are thus increasingly becoming concerned about energy security. This phenomenon is not new with the most recent example in history being the responses by countries and communities taken after the oil shocks of the 1970s. The resurgence of energy security as one of governments' high priority areas has important implications in any transition to a low carbon society at the global level, as major powerhouses such as the U.S., and in Asia, such as India and China, are heavily reliant on their domestic coal reserves to meet their energy needs. For instance, in 2006, China relied on coal for 69 per cent of its primary energy needs, and globally China was the largest producer and consumer of coal (US DOE 2006).

In China, total energy production has kept pace with total energy demand to reduce vulnerability to events (i.e. terrorism, civil unrest, cartel actions) occurring elsewhere. This is the result of the Chinese government's efforts to achieve energy self-sufficiency as much as possible.

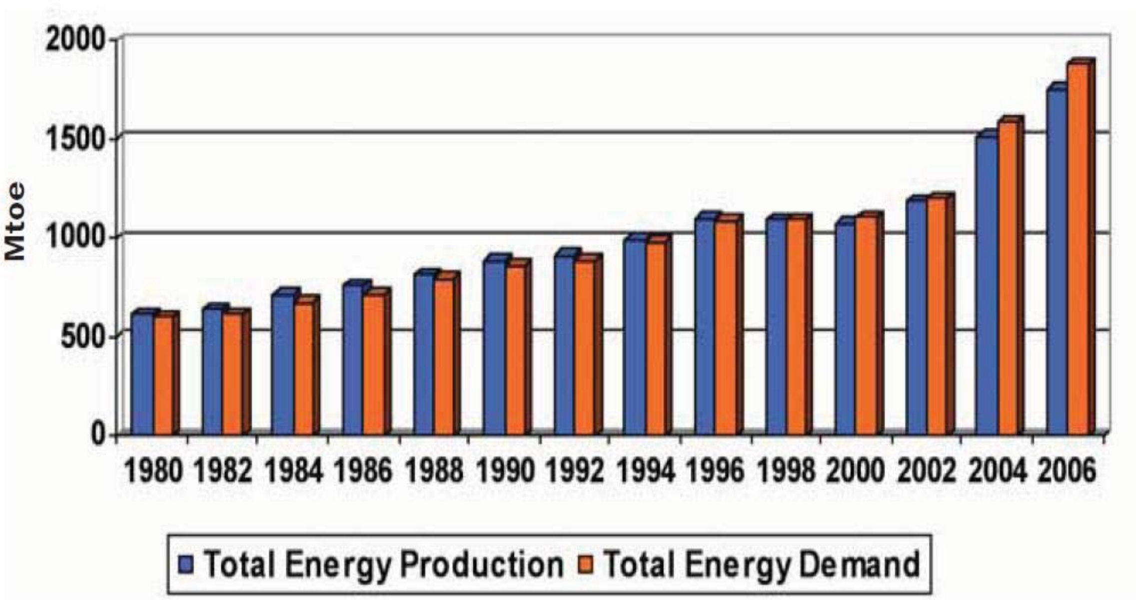


Figure 2-1. China: Total Energy Production and Demand

Source: Wang and Watson, 2009, China's Energy Transition – Pathways for Low Carbon Development, p. 11

In other words, energy security efforts can be but are not necessarily compatible with climate mitigation efforts. Many equate energy security with decreasing imports and increasing production of domestic energy resources but there are other aspects to energy security. For instance, threats to energy supplies can come from domestic sources too[102] (Wang and Watson 2009).

With many sources of renewables available within countries (i.e. wind, solar, biomass [although biomass can be exported]), pursuing energy security and climate change goals can be consistent. However, there are some important exceptions, including, as noted above, coal, which is abundant in a number of large GHG emitting countries. Coal emits nearly twice as much carbon dioxide per unit of energy combusted as natural gas (US DOE 1993).

Life cycle analysis [103] on Coal to Liquid (CTL), a technology being pursued as an alternative to oil imports in China, the U.S., Australia, and South Africa (with origins based on the sanctions imposed under apartheid), and considered in other countries such as India, show that emissions in road transport are almost double those from using crude oil (Stern 2006). Also, coal in some countries is of lower quality, less efficient, such as in India where the coal has higher ash content. Energy security provides motives for further exploration into unconventional sources of fossil fuels including tar sands and oil shale.

Another key priority for governments in Asia is access to energy. Researchers Wang Tao and Jim Watson (2009), in their study examining low carbon pathway scenarios for China, note that poverty alleviation remains high on the government's agenda as income disparity – along with environmental degradation - has also been identified as a key source for increasing social unrest and potential instability in that country.

As stated earlier, in the Asian-Pacific region, as with much of the developing world, the majority of people without electricity are living in rural areas (Modi 2005; Vedavalli 2007). At the same time, urban areas are growing in the region. A number of newcomers to the cities arrive in the poorer areas of these cities – often lacking in modern cooking fuels, only intermittent access to electricity looking for better opportunities.

Rural electrification and access to energy are therefore major priorities for many of these governments. Some suggest that rather than pursuing centralized options for power generation, more decentralized approaches (which can often be more efficient due to less electricity loss involved in transmission and distribution over larger distances) can better serve the needs of rural communities and remote energy users (Bongars 2006). Small scale, decentralized options can also remove the need to be connected to the grid, an extremely expensive option for some remote communities. For example, one key goal of the Government of Bangladesh under their revised National Energy Policy of 2004 is to have the country be completely electrified by 2020. In addition to centralized options, the country has one of the highest rates of SHS mainly in rural, off-grid areas, where electricity is generated through PV for household and /or commercial use. As of 2009, there were about 18, 000 SHS installed in that country, with three CDM projects, projects targeting for about 30, 000 SHS (mainly for rural areas) and two more projects aiming for over 800, 000 SHS each, with support from the World Bank -- undergoing the CDM validation process (Kumar Biswas and Ahsan 2009).

Table 2-1. Rates of Electrification in the Asia-Pacific Region, 2004

Electrification access rate in Asia and the Pacific

Region	Country	Level of electrification (%)
South Asia	Bangladesh	32.5
	India	43
	Nepal	15.4
	Pakistan	52.9
	Sri Lanka	62
Southeast Asia	Cambodia	15.8
	Indonesia	53.4
	Laos	NA
	Malaysia	96.9
	Myanmar	5
	Philippines	87.4
	Singapore	100
	Thailand	98.5
	Vietnam	75.8
East Asia Pacific	China	98.6
	Fiji	80
	Kiribati	40
	Papua New Guinea	46
	Micronesia	45
	Samoa	95
	Tonga	85
	Vanuatu	26
	Solomon Islands	15
	Timor-Leste	22
	Marshal Island	100
	Palau	60

Source: Urmee, Harries, and Schlapfer, Renewable Energy, Issues related to rural electrification using renewable energy in developing countries of Asia and Pacific February 2009, p. 355

Also, as suggested earlier, implementing policies that move towards a low carbon development path can bring about a transition to a more knowledge-based, innovative economy. Lord Nicholas Stern (2006) suggests the power sector is one area where R&D efforts have been neglected. In the U,S, in 2003, for instance, R&D as a share of total turnover (termed R&D intensity) in the power sector was only 0.5 per cent compared to 3.3 per cent in the car industry, 8 per cent in electronics and 15 per cent in pharmaceuticals. These figures compare with the rest of the OECD nations, where a study in 2002 of these nations showed a R&D intensity of 0.33 per cent in the power sector versus 2.65 per cent in the manufacturing sector.

It is therefore important to link actions towards a low carbon development path with science, technology and innovation (ST&I) policies. Innovation centres on developing novel products, processes, services and knowledge. There is much discussion on innovation in developing countries within technology transfer literature, involving the transfer of equipment, knowhow skills (how a technology works) and know why skills (the principles behind the technology) (Lall 2000; Bell 1990). Others refer to this process as technology cooperation (Heaton, Banks et al. 1994; Martinot, Sinton et al. 1997) to better account for interactions and multiple ways in which flows of learning and interchanges occur between actors. For instance, one of the "myths" of technology transfer that continue to permeate discussion is the notion that the transfer of technological capacity flows from North to South (van Tilburg *et al*. 2009), but there are numerous examples of South-South cooperation and North-North cooperation. For instance, Siemens, General Electric and Mitsubishi, leading players in the wind energy sector, have all decided to locate manufacturing facilities within the UK (UK DECC 2010a), recognizing the country's expertise and potential in offshore wind energy development.

Technology cooperation is considered one way in which countries, regions and/or firms can acquire technological capacity. The concept of technological capacity has been defined in a number of ways. In essence, it is "those aspects, both embodied and non-embodied (i.e. human resources, infrastructure, technical and scientific skills) that cause technological change" at the level of the firm, country or region. (Rogers 2003: 29). Often, technological capacity is encouraged to develop a niche in highly complex technologies as well as other knowledge- and learning-intensive industries (i.e. financial services). The view is that acquisition of technology from elsewhere assists in fostering an ability to innovate. A rich and extensive body of literature exists in this area, centred on the question of how to increase technological capabilities and innovation in the developing world. Many articles claim that technological capacity can be improved through actions countries can undertake such as investment in technical education and management skills of providing incentives for firms to innovate. (Enos 1991; Rogers 2003). These actions increase the abilities for actors to absorb and adapt technologies, termed absorptive capacity (Hoekman 2005).

Collaborative initiatives, involving actors and organizations from various countries can also realize indigenous innovations. An important opportunity also exists for Asia to capitalize on investments made in various countries' national systems of innovation, which is considered a country's infrastructure, and its ability to undertake activities related to innovation, such as research and development. Aspects include universities, and expertise and research and development institutes in the public and private sectors (Ockwell et al. 2007).

Asia can draw from its global advantages, which include, among others, a rich resource base, large numbers of highly skilled people and cheaper salaries, to develop production processes for "green technologies" and to make conventional industries more energy efficient. The transition of Asia from being the "world's factory" to the 'world's research and development centre in the area of low carbon energy technologies is already occurring. For instance, India's Suzlon Energy and China's Goldwind are leading global players in wind energy, and these countries are increasing their manufacturing capacity at a profound rate in the area of PV.

The second area under discussion involves the argument that a low carbon development path involves systemic changes, suggesting a paradigm shift; the "transformation of energy systems" (Stern 2006: 300). In other words, effectively addressing climate change requires action on a societal scale, ranging from shifts to new or improved technologies in key sectors such as power generation, transportation and how energy is being used. In addition, action is required globally, in both the industrialized and developing world.

This is being done through rethinking the production process, and by emphasizing energy efficiency rather than constantly finding ways to increase energy generation. In 1976, Walter Stahel, while working in Europe, analyzed the processes used to create various products from cars to buildings. He concluded that enormous amounts of resources would be saved through the recycling of materials. He claimed that 75 per cent of industrial energy use was for mining or production of basic material such as steel and cement versus 25 per cent which was used to make these materials into finished goods, such as machines and buildings. He also noted that as less energy was being used, more people were being employed to make these materials into finished products, or through recycling of previously used materials. Proponents of this view argue for a new way to reassess gross domestic product (GDP}, to incorporate other facets such as environmental degradation, rates of health and quality of life (Lovins 2008). Ockwell's (2008b) piece also highlights potential limits to decoupling economic growth and a low carbon development path (e.g. Ockwell suggests that delinking economic growth and carbon emissions in the U.S. may be accounted for more by fuel switching rather than energy efficiency technologies, a claim often made, He goes on to explain that through the rebound effect of energy efficiency, the notion that as things become more energy efficient, people's behaviour may change i.e. they wash their clothes more, drive more; this behaviour reduces the predicted overall energy savings impact.

Thirdly, most experts agree that a portfolio of technologies and options is required to achieve a low carbon development path. Actions in the areas of energy efficiency and conservation, substituting carbon intensive energy sources with low carbon energy technology options, such as solar and wind and avoiding deforestation, are necessary parts of a low carbon development path. There is no one "silver bullet", or solution, as each technology and option has its limitations. For example, when referring to ways in which to decarbonize transport, hydrogen vehicles and or electric vehicles are espoused as being excellent options. However, transitions to these technologies raise a number of other questions including "Where is the hydrogen being derived from? Where is the electricity coming from?"; of which the answers – if not examined thoroughly – may entail more dependence on carbon intensive options such as coal or oil (Stern 2006).

An example of a low carbon development pathway, particularly relevant for developing Asia, considers the notion of "leapfrogging" in the area of environmental technologies. This idea has been put forth by a number of scholars including Jacob Goldemberg (1998) and Kevin P. Gallagher (2006). Leapfrogging proposes that developing nations can "catch up" to industrialized nations through skipping some of the more dirty stages involved in industrialization. Leapfrogging can occur at various levels including a country's overall development pathway, through the development and production of new technologies in developing countries, and finally, through the use of new technologies (Sauter and Watson 2008). As these countries, regions and communities jump from older, inefficient technologies to newer technologies, they can develop skills in technological capacity. Firms can also draw from expertise in other areas and bring it to the low carbon energy regime. For example, in China, the domestic automotive firm BYD Auto, founded in 2003, stems from the leading global lead battery manufacturer and has been selling plug-in hybrid vehicles in that country since December 2008 (Wang and Watson 2009).

The fourth point is that transitioning to a low carbon development path entails not only technology choice, but also social choice. It recognizes that behavioural and lifestyle choices can have a profound impact on carbon emissions, potentially creating social "carbon lock-in" (Wang and Watson 2009).

A lot of the literature has emphasized the need for behaviour change. For instance, the Japan-UK Research Project on a "Roadmap to a Low Carbon World" argues that consumers have the potential to play a major role on carbon emissions, but that they need to be empowered in their choices through information and advice (Japan-UK Working Group 2008). Stern (2006) also recognizes that carbon lock-in is further reinforced, as people are accustomed to existing technologies, therefore making behaviour change more difficult. Nevertheless, there is increasing recognition that the acquisition of more "stuff" does not equate to more happiness. Studies also echo this view, noting that "even though initially, the more people consume, the happier they will be, in countries with average incomes in excess of $15 000, there is virtually no correlation between increased income and increased life satisfaction" (Jackson 2008: 50).

For instance, the UK's New Economics Foundation developed the Happy Planet Index (HPI) in 2006. The HPI is an alternative measurement to typical economically based metrics, such as GDP or annual income per capita indicating wealth. Instead, the HPI looks at three key factors – life satisfaction, life expectancy and ecological footprint on the planet. Countries with the top spots in Asia were Viet Nam, Bhutan, Sri Lanka and the Philippines. Those on the lower end were the Republic of Korea, Pakistan, Laos and Singapore (NEF 2006). This recognition has seen more movement towards "downshifting", or reassessment of one's lifestyle and opting for one more conducive to environmental and spiritual harmony, and simplicity from individuals, communities and governments.

One proxy by which to determine people's interest in changing their behaviour is through surveys that assess a person's willingness to pay (WTP) for new technologies and/or services (i.e. a premium to have household electricity come from renewable sources). However, studies from the developed world indicate there is a sharp difference between what people say they are willing to pay, and actually implementing these changes (Wustenhagen and Bilharz 2006).

In addition, many experts suggest that economics is only one aspect involved in a person's decision-making process. Other social and psychological aspects are also paramount. The UK's Foresight report entitled "Powering Our Lives" (2008) provides a comprehensive overview on behaviour change. The report notes that behaviour change is often equated to consumption of energy, but is actually farther reaching, including aspects such as influencing the political decision making process (through lobbying, voting) among other areas. "People's actions are rooted in social values, and…the influence of values on behaviour is mediated by more specific processes, for example beliefs, norms, identity processes and intentions to act. These influence the choices that people and organizations make" (Foresight Report 2008: 93).

Debates also are taking place regarding whether this behaviour change should be mandatory, using a top down approach from the government, or other central powers, or voluntary approaches, which emphasize individual choice. Ockwell *et al*. (2009b) critique both of these approaches, drawing from communications campaigns of the United Kingdom to elicit behaviour change in order to reduce carbon emissions in that country. They suggest that people are constrained by social (i.e. cars as status symbols) and structural (e.g. lack of affordable public transport) impediments, while at the same time they recognize the political unpopularity of government actions that are perceived to be dictating individual behaviour or constraining individual choice. Their approach advocates a combination of top down and bottom up approaches, which would create a demand for regulation and the encouragement of local, grassroots-based mobilization.

It is not clear if this pronounced emphasis on behaviour change would be as relevant for developing countries. For instance, in many developing countries, climate change is not as well known among the general populace.

Interestingly, a survey conducted by the Hongkong and Shanghai Banking Corporation Limited (HSBC) in both industrialized and developing countries in 2007 on climate confidence, indicated that of the respondents that were aware of climate change, those in India showed the highest level of concern about climate change (60 per cent of participants viewed it as their top concern), the highest commitment to change (along with Brazil), and the highest level of optimism that society would be able to effectively address this challenge. These numbers were higher than respondents from some developed nations including the U.S. and the UK (Jackson 2008). However, the reality in developing countries can be quite different than these numbers suggest. Among the people that are aware of climate change and possess the desire to do something about it, in cultures where many people live day by day or month to month, many of them cannot afford the upfront costs of a more efficient, less carbon intensive technology, even if studies show they are cheaper in the long run (Mallett 2007).

The final area of discussion centres on how to effectively pursue a low carbon development path. Although disagreement occurs regarding which sector of society is best placed to lead this process (public sector, private sector, community groups, or a mixture of these groups and others), there is general consensus on the need for financing for these transitions.

According to the IEA's World Energy Investment Outlook of 2003, more than $16 trillion is needed in energy investments from then to 2030. The IEA suggests that global finances are adequate to meet this requirement but will only occur if conditions within this sector are attractive for this investment. In the 1990s, the prevalent view was that the private sector would take on this role. For this reason, energy reforms, through liberalization and privatisation of state-owned enterprises were being promoted (Vedavalli 2007).

After the mixed and modest gains achieved with energy sector reforms globally in the 1990s and early 2000s[104], many expert have argued for a third way to increase energy for development; one that is between markets with a free reign and government control of the economy.

Foreign Direct Investment (FDI) continues to be promoted as a means through which developing countries can obtain private capital. However, one challenge with becoming too reliant on this approach is that there is a risk of rapid capital flight should investors decide to turn their efforts elsewhere. This happened in Asia and other developing countries after the 1997 Asian crisis spooked investors, as shown in the table below (Vedavalli 2007).

Table 2-2. Share of Private Capital in Total Incremental Power Sector Investment in Developing Countries

Region	1996 (%)	1997 (%)	1998 (%)
East Asia	68	31	17
South Asia	38	9	5
Latin America and the Caribbean	86	55	34
All developing countries	40	19	11

Source: Vedavalli, 2007, Energy for Development, p. 72

The large amount of finances required to effectively transition economies can come from a number of sources, where the private sector remains key for investment, but government engagement is also necessary, to spur more private sector involvement. Stern (2006) argues for an increase in public sector energy R&D funding from $10 billion to $20 billion on the grounds that energy sector returns are quite low. He says this is because the industry is highly regulated and risk adverse with many technologies only becoming commercially viable after several decades. The increased funds can be used to kick start investment in under-researched and developed areas, encouraging private sector investment.

2.2 The Economics of Boldness: A new Climate Change Economics towards a Low Carbon Development

This section calculates direct and related costs of climate change action for developing countries in Asia, by regions. The calculations are done by considering simultaneously impacts costs with mitigation, adaptation costs and carbon inflows. It argues that, in general, early bold action and response strategies in an overall deep mitigation trajectory is as a rule a better approach then passive ones taken at a later stage within a global shallow outcome. This is because of the magnitude of the impacts, and the common but differentiated responsibilities they have.

Also, this section argues that countries could minimize costs if they take a substantial level of mitigation action early on in the process, regardless of the actions of other countries. This is particularly true for developing countries that emit a relatively low amount of GHG. Based on this, the section makes the case for developing countries to press for low carbon global trajectories in their quest for a low carbon economy while simultaneously calling for the climate change regime to move in a similar trajectory.

The chapter is divided in six sections. After the introduction, section I describes the character of the approach taken; section II outlines the reason why it is best for developing countries to support a bold outcome; in section III, the scenarios and modelling tested are explained; section IV discusses the results obtained and what they mean; section V outlines the relationship between adaptation and mitigation, and the related coalitions; and the last section explains the instruments needed to deliver this strategy.

2.2.1 Some General characteristics of the approach taken

In a nutshell, the chapter contrasts the outcome from two scenarios. In the first one, developing countries make clearly defined net atmospheric contributions in the form of emissions reductions, in exchange for deeper cuts made by Annex One countries[105], industrialized countries and economies in transition, that what was specified under the Kyoto Protocol. Under the other one, developing countries make no emission cut commitments and developed countries take a passive approach in reducing GHG emissions.

The climate regime is characterized as double trajectory game as it contrasts two pathways, with two corner solutions (bold and deep and shy and shallow), reached through several iterations, with mitigation and compliance costs growing mostly lineally, but impacts non lineally. Global compliance and impacts costs trend lower as more ambitious steps are taken and the number of large GHG committed to the actions increase. At the same time – with variations - carbon revenue increases as actions and markets became increasingly broad, flexible and deep. To assess this, the chapter considers simultaneously mitigation, adaptation and impacts with the carbon inflows and the different options they entail.

2.2.2 Why moving boldly? Bold and Shy negotiation positions and first mover advantages

This section argues that for a developing country, a bold trajectory both domestic and global is preferable to its reverse for two main reasons:

- The major costs for developing countries are found in the impacts or affects of the actions The impacts increase more proportionally with mitigation action (i.e. mitigation costs do not grow as fast as those of impacts).
- Due to the principle of common but differentiated responsibilities (the larger share of emissions that the developed countries have already placed in the atmosphere), bold actions in developing countries does not need to be as intense as those taken in developed countries.

Thus, in a bold action scenario, developing countries would ”buy”’ more reduced impacts – and thus, suffer substantially lesser aggregate costs- than in a shy scenario. Based on this, the argument can be made for countries to press for low carbon global trajectories while deploying low carbon development pathways, and simultaneously seeking a climate change regime that moves in a similar trajectory.

Moreover, even if action taken in developed countries were not very deep, there would still be several arguments supporting substantial early domestic action on mitigation by developing countries. Also, co-benefits linked to the timing of the transition to the lower carbon economy would emerge. This would include savings in the cost of carrying out actions which, in turn, would free up funds for the adoption process. In addition, in a low carbon world, the savings in energy costs would be lower than in a global economy that consumes high amounts of fossil fuels. Two cases supporting this are Brazil's biofuels project and France's drive towards mitigation. With the benefits of hindsight, these options, which might have seen folly in the past, are now seen as visionary. .

This scenario also offers co-benefits and ancillary ones linked to domestic factors. The environment would benefit significantly in both the larger developing economies, such as India and China, and in the smaller economies. In China, in particular, clean air is becoming a sort of luxury good across its cities; other additional co-benefits include enhanced competitiveness, enhanced energy security and diversification and, improved traffic systems.,

This would turn into a foreign policy stance. Under a shy policy scenario, key aspects of a global mitigation policy would not be considered expect for those pertaining to requests for further emission cuts, and developing countries would make if clear no further actions would be considered until Annex I countries take some initiatives such as offer more funds for the effort. Middle income developing countries would focus on ad hoc, specific issues within a deal such as adaptation, finance or, the role of specific project instruments like CDM. They also would make no serious efforts to mainstreaming and/or coordinate mitigation across sectors within domestic policies.

In a bold scenario however, countries would take a much more proactive international stance, seeking to influence Annex one parties to make more substantial cuts. They would focus on mitigation, rather than adaptation, and make cuts earlier than required and deem them as a deviation from business as usual (BAU) while given them the classification as early movers. They would also be prepared to walk the walk and talk the talk, preach with example, and deliver the reductions required.

In this scenario, additional co-benefits could also emerge. Developing countries would then be in better positions to negotiate mitigation policy, where most of the investment opportunities are likely to arise in the future either because of carbon benefits, or higher costs of fossil fuels. They would also be in a position to redirect investment flows to a larger number of entities that emit GHG, leading to further emission reductions.

<u>Which scenario better suits developing countries?: Testing some key hypotheses</u>

To assess this case, contrasting costs of a high ambition scenario to a low ambition one were assessed More specifically, the objective was to determine whether a developing country would be better off in a shallow global reduction scenario with no Non Annex 1 countries, developing countries as set in the Kyoto Protocol making any mitigation commitments or in one with deep cuts by Annex-1 Countries parties, but with some mitigation commitments from Non Annex 1 countries. The hypothesis states that developing countries would be better off under the bold case scenario. A related issue under this hypothesis was how much would carbon markets and flows expand, and if they would be large enough to pay the additional costs implied in the expanded mitigation commitment supported by larger contributions as set in a deeper cutting deal.

In this analysis, regional costs from two sources were considered, with initial effects resulting from reduced carbon markets and cuts in investment aimed at developing a low carbon economy. Subsequent impacts. (i.e. in post 2020), that come from changes in the climate must be taken into account. They could be assessed by considering all costs of impacts, mitigation, adaptation and carbon inflows, under different UNFCCC scenarios, ranging from very low to very high, and using both impact and carbon flow modelling.

More precisely, the first hypothesis stated that a shy scenario (scenario 1 below) with adaptation and impacts costs but no mitigation costs and associated carbon inflows for developing countries would be more expensive than the bold scenario (scenario 2) with adaptation, mitigation, and impacts costs and carbon inflows. This would be the case under the shy scenario where mitigation costs were non-existent for developing countries, and impacts would rise, as carbon flows were reduced. The reverse would be true under the bold scenario, where mitigation costs would rise, but impacts would diminish and carbon inflows increase. This was the result from the different cost trajectories, where mitigation costs grow lineally, but impacts grow more than non-lineally. Figure 2-2 outlines the hypothesis that boldness is beneficial if total costs in the first scenario are smaller than total costs in the second one.

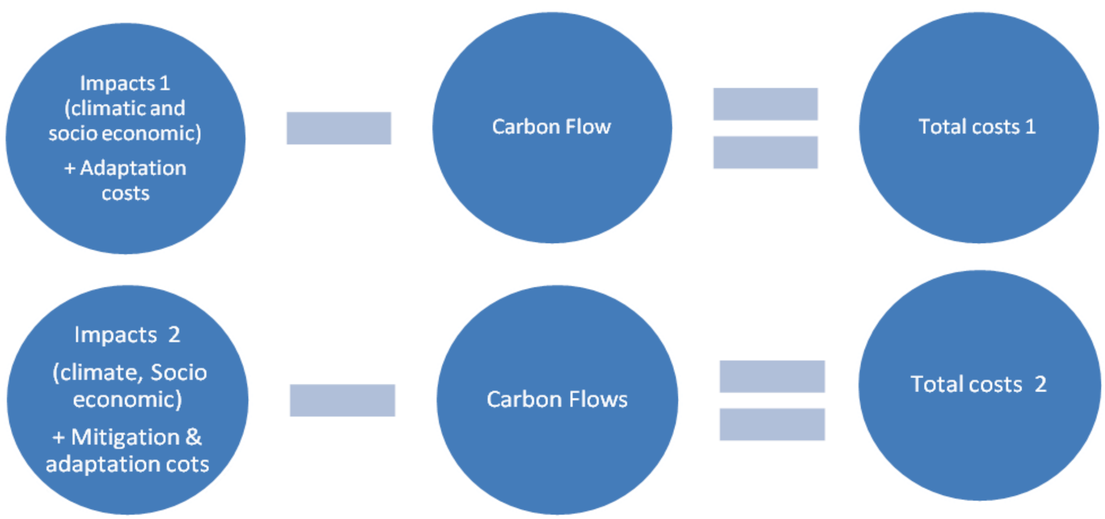


Figure 2-2. Hypothesis on scenarios

How to increase commitments and markets simultaneously?

In this context, the more ambitious scenario 2 also implied that the deeper emission reductions created global carbon markets with a larger carbon flow and low carbon investment demand (and increased carbon inflows to the bolder region) while simultaneously reducing the long-term impacts the region faced. Larger reductions made by developing countries would be classified as a non-offsetting contribution and shown through net reductions delivered by national plans and programmes. These would go side by side with the increased revenue generated by the additional global carbon reduction demand.

Graphically, this could be schematically translated into a formula stating that overall reductions (R) would be equal to:

R = X + N + M

Where

X = domestic reduction already placed in the market with no additional demand (i.e. sold into existing markets, and not accounting for by developing countries)

N+M = Additional carbon demand expressed in terms of additional cuts by Annex 1 countries

N = Percentage of demand generated which is accounted for but: a) not sold and b) is reflected through an ad-hoc mitigation instrument

M = Reductions generated and sold as CERs -or within a new mitigation instrument, as uERUs (unilateral reduction units).

In all cases, however, this line of the argument entailed the creation of new reduction instruments and/or approaches, capable of simultaneously selling a larger amount of domestic reductions by Non Annex 1 countries early on and delivering a greater amount of non –offsetting reductions by Non Annex 1 countries. This approach would allow countries to use the low carbon development pathways to deliver the range of contributions required under the bold scenario.

2.2.3 Scenarios tested and modelling

To outline the extent of the hypothesis, five scenarios were assessed, ranging from very shy to very bold. They are presented in table 2-1. Because of the wide variations, analysts were able to look at how the responses developed among different parties within a continuum. Each scenario considered either the most likely situation under the negotiation conditions, or some of the proposals by the negotiating parties. The least ambitious scenarios assumed that Annex 1 countries failed to deliver the commitments they had placed on the table by mid 2009. After that, the current scenarios were assessed (i.e. with the pledges at the time), the first one (around a 14 per cent cut set by Annex 1 countries set in 1990), a very ambitious but viable one (i.e. a reduction of 24 per cent cut set in 1990); and those suggested by the Group of 77 and AOSIS (i.e. to reach a 45 per cent reduction by 2020). This implied increasing Non Annex 1 countries' commitments in terms of emission reductions,: in the first two scenarios, Non Annex 1 countries made no BAU deviation while in the last three, they made increasingly ambitious BAU deviations. Parallel carbon markets were modelled with increasing degrees of flexibility.

Table 2-3. Scenarios for different models

The scenarios to run the models within...

Went from around -5% to -45% from 1990 on 2020; to -35% and -95% from 1990 on 2050...

	Low			Current			Effort			High			Extreme		
	2020	2030	2050	2020	2030	2050	2020	2030	2050	2020	2030	2050	2020	2030	2050
USA	10%	10%	10%	0%	-35%	-35%	-15%	-35%	-80%	-24%	-40%	-80%	-45%	-60%	-95%
OECD Europe	-15%	-15%	-15%	-20%	-35%	-35%	-25%	-35%	-80%	-30%	-40%	-80%	-45%	-60%	-95%
FSU	-15%	-15%	-15%	-15%	-35%	-35%	-25%	-35%	-80%	-40%	-40%	-80%	-45%	-60%	-95%
Japan	-8%	-8%	-8%	-9%	-35%	-35%	-15%	-35%	-80%	-24%	-40%	-80%	-45%	-60%	-95%
Canada	10%	10%	10%	-1%	-35%	-35%	-10%	-35%	-80%	-24%	-40%	-80%	-45%	-60%	-95%
Oceania	-5%	-5%	-5%	-14%	-35%	-35%	-20%	-35%	-80%	-24%	-40%	-80%	-45%	-60%	-95%
Non-Annex 1	BAU	BAU	BAU	BAU	BAU	BAU	-10%	-15%	-20%	-20%	-25%	-35%	-30%	-40%	-40%

NB: A1 targets are relative to 1990, NA1 targets are relative to BAU.

....and with no BAU deviation in DCs to -10, -15, and -30% (2020, 2030, and 2050), to -30, -40, and -40% (idem) ...

While carbon markets went from having no trading at all to being perfectly flexible, encompassing forest and all sectors

	1	2	3	4	5
Target scenario	Current / Low (Carbon scenario 1)	Effort (Carbon scenario 2)	High (1) (Carbon Scenario 3)	High (2) (Carbon Scenario 4)	High (3)/Extreme (1) (Carbon Scenario 5)
Sectors in Market NA1 (excluding forestry)	None	Power Only	Power and Industry	Power, Industry, Transport	All sectors
Supplementarity Restrictions	10%	40%	50%	80%	100%
Forestry Rules	No more than 5% cdm	30 % gets into market (with a 50:50 division with a parallel market/fund)	50% market fungible	80 market fungible	100 market fungible

An initial modelling run under the current scenario was commissioned independently to assess impacts under BAU conditions. These test runs were tasked with specific scenarios to be assessed with PAGE, a combined climate and economics costs analysis model. A complete set of five scenarios was subsequently assessed through PAGE 2002. At the same time, a carbon flows originator, a very simplified version of GLOCAF, a tool to model global market finance, was used to assess those same scenarios.

BOX 2-1. Modelling Approach

As research advanced, PAGE 2000 was used to assess regional impacts globally. This model includes the five reasons for concern under the IPCC, namely risks to unique ecosystems, to extreme climate events, the distribution of impacts, their aggregate level, and future large scale discontinuities (IPCC 2001 a, p.5), and assesses impacts of emissions of the primary greenhouse gases, CO2 and methane, including changes in natural emissions stimulated by changing climate, plus modelling of a third gas whose force is linear in concentration, and other greenhouse gases such as N2O and (H)CFCs. It takes into account the greenhouse effect derived from the accumulation of anthropogenic emissions of GHG, and the increased radiation forcing those results; the cooling from aerosols (considering sulphate cooling to be greater in large industrialized regions), and the nonlinearity and transience in the damage caused by global warming, where impacts are aggregated over time using time varying discount rates. These, in turn, are assessed in terms of an annual two sectors –economic and non-economic- with adaptation measures and the possibilities of large-scale discontinuities included as linear probability as the global mean temperature rises above a threshold. A detailed description of the model can be found at Hope (2006).

Carbon flows and related finance were assessed using a simple quantitative modelling framework, with the same range of scenarios. The framework combined greenhouse gas emissions targets, marginal cost curves for abatement, and an international carbon market with utility maximizing rational actors. Individual regional targets added up to a global target, while regional marginal abatement costs curves outlined regional costs –regions abated up to the point where their marginal cost of abatement is equal to the equilibrium market price. Equilibrium is found where supply matches demand and countries minimize their abatement costs for their given targets. A description of the basic model can be found at Gallo et al (2009), together with an evaluation of the underlying data.

To illustrate carbon market expansion, trading was modelled to progressively encompass more sectors, from none, to one that included a severely limited CDM, then only the power sector, and successively adding subsequent global sectors until all were tradable. Restrictions to trading were progressively eliminated, and forests were increasingly taken into account. This was sought to illustrate a progressive expansion of the scope and depth of carbon markets, and the payoffs to the region. Financial flows were calculated by multiplying quantities traded with carbon prices, and discounting abatement costs.

2.2.4 Preliminary results – and what they mean

Results for impacts, mitigation, and carbon inflows were calculated sequentially. Initially, the results for impacts were calculated using PAGE 2002 as described in the section above. This section calculates these costs (or benefits) on the aggregate for Southeast Asia, South Asia, and East Asia.

Table 2-4. Costs of impacts in South East and South Asia

Costs in US$ Million

	2020	2030	2040	2050	2060	2080	2100	NPV
Low	76207.14	188263.1	300319.1	628538.5	956757.9	2753575	7050382	93632020
Current	75952.09	184467.2	292982.4	602801.1	912619.8	2547594	6241389	79944890
Effort	75074.53	177886.2	280697.9	564461.4	848224.8	2286346	5464058	71743960
High	74010.29	170584	267157.8	527115.1	787072.4	2081474	4906669	65181350
Extreme	71813.4	159810.9	247808.3	479916	712023.6	1878473	4426929	59532380

Costs due to larger population (and more of it along a shoreline) –impaqct multiplier similar to that of LAC.

Costs in terms of GDP going from less that 1% of GDP per year for 2020, to almost 18% (in low scenario); and then to 12% in more ambitious scenarios.

[1] UNEP, 2005 –Latin America Responses to Climate Change; GEO Andino, 2002; GEO America Latina y El Caribe, 2003.

In Southeast Asia, the net present value of impact costs would go from $93 trillion from 2020 to 2100 in the most shy scenario, down to $59 trillion in the same period for the bold scenario. In East Asia, the same numbers would imply a net present value (NPV) cost going from $9.5 trillion, down to $5.9 trillion for the same period.

Table 2-5. Costs of impacts in China

Year	low	current	effort	high	extreme
2020	241.67	239.70	223.54	231.49	215.13
2030	736.84	703.55	573.10	629.78	516.70
2040	1,232.00	1,167.39	922.66	1,028.08	818.27
2050	4,124.81	4,346.00	3,172.41	3,674.96	2,687.05
2060	8,249.62	7,524.61	5,422.16	6,321.85	4,555.83
2070	28,552.42	25,349.66	18,149.24	21,285.22	15,034.46
2080	48,855.22	43,174.72	30,876.32	36,248.59	25,513.10
2090	125,463.56	107,205.36	77,533.21	90,535.40	64,574.05
2100	202,071.90	171,236.00	124,190.10	144,822.20	103,635.00
Totals	**9.56E+07**	**8.16E+07**	**7.15E+07**	**6.50E+07**	**5.93E+07**

•The total costs in NPV at 2% go from 95 to 59 trillion dollars in constant dollars; the difference between one scenario and the other is around 35 trillion dollars. This alone is more that the amount invested in energy infraestructure in the world up to 2030.

•Impacts likely to be related to water and agriculture, and potentially in lower income sectors; however, potential significant loses related to infrastructure in coastal and low lying areas.

•Impact cost participation in GDP much lower than either in LAC, SEA or South Asia, due to the substantially larger size of the Chinese economy - China can afford to wait.

In the same period, a calculation was made of what would happen under a perfectly free market, where market restrictions were progressively eliminated, including supplementary restrictions (i.e. the purchase of project units in carbon markets). In addition, the markets would progressively take in an increasing number of offsets coming from forestry.

To calculate this, the global flows calculator as described above, was used for each of the scenarios mentioned in this section. Mitigation costs were discounted from the carbon inflows to produce net costs. The results are presented, under an increasingly liberalized market condition, in both of these regions.

Southeast Asia is better off under all scenarios, as their costs are minimized. This region includes the countries in Southeast Asia and a number of AOSIS countries in the South. Pacific. However, its impacts are substantially higher than those in the Latin America and Caribbean (LAC) region (another area analyzed), where there is a higher concentration of inhabitants living close to the sea. In Southeast Asia costs fluctuated between $69 billion and $76 billion, while in LAC, costs moved in a range of $14 billion -15 billion in 2020, for the same period. However, in the former net costs are around $2.7 billion, as mitigation costs are higher and carbon inflows are lower. The results show that while the forests in Southeast Asia contribute to carbon inflows, they do not counteract all impacts but only cover mitigation expenses, minimizing the impact results in all scenarios.

Thus, overall costs in Southeast Asia are minimized in all scenarios, but the region would not enjoy net benefits in any them. This is the case even under the same conditions that enabled the forest-rich LAC region to maximize benefits. The boldness hypothesis also holds up in this case. Southeast Asia is better off under a bold equilibrium where a net contribution is made under flexible markets conditions. In a shallow scenario, there is no net contribution.

The tables below show total costs as ambitions increase in Southeast Asia, South Asia, and East Asia when considering all costs (mitigation, adaptation, carbon inflows and impacts).

The total cost in Southeast Asia decline yearly as the ambition increases in the scenarios.

Meanwhile for South Asia, they only decline up to the effort scenario – if ambition increases beyond that point, the costs of mitigation rise substantially, and are not offset by the combined inflow of carbon revenue and diminishing impacts. The region ends up being better off until the effort scenario, with a 10 percent emission reduction targeted for 2020 set in 1990), a 14 percent emission reduction targeted for 2030 set in 1990 and a 20 percent emissions reduction targeted for 2050 set in 1990. The situation worsens under subsequent scenarios as BAU deviation levels increase. This can be attributed to the high level of impacts, the reduced carbon inflows it experiences and the increased costs as these appear in the higher ambition scenarios for developing and Annex 1 countries.. However, they start going up again in 2050 as ambition increases substantially everywhere.

Finally, in the case of East Asia, they hold off in the low and current scenarios, while in the effort scenario they hold after 2030. However, results hold later in 2040 and 2060, due to the role of forestry. If markets are completely flexible, resources would go first to forest-rich countries, and then to China and India, which have a larger potential for mitigation. If forestry is part of the equation later, or given a smaller role in the mix, the income for Southeast Asia and South Asia increases. This is reflected in their negotiation stance.

Table 2-6. What happens when contrasting these scenarios with parallel market expansion

What happens when contrasting these scenarios with parallel market expansion...

South East Asia -holds in all cases

The hypothesis holds in all cases; Impacts reduced by 6 GDP points per year; domestic & int. action reduces additional GDP loss

SE Asia	2020	2030	2040
Low	76207.1	188263	628539
Current	75773	181467	599709
Effort	74167.2	174509	544640
High	72818.2	170290	529927
V. High	69068	169810	472868

India and South Asia - holds to an effort scenario

Holds from a -10 (2020), -15 (2030) and – 25 (2050) deviation from BAU to a -20, -25, -35% deviation from BAU.

S. Asia	2020	2030	2040
Low	76207.1	188263	628538.5
Current	75599.6	179938	594657.8
Effort	74951.3	175741	499479.7
High	78758.3	178095	500932.8
V. High	87696.9	195976	454623.9

China and East Asia –kicks in later

Holds from the current scenario and up to the medium to long term; this as gains from early forestry entry subside, and the larger potential of Chinese mitigation kicks in.

China	2020	2030	2050
Low	241.67	736.84	4124.81
Current	-531.83	-14795.07	-14449.7
Effort	592.96	-7888.12	-125709.6
High	10522.21	6811.2	-65194.56
V. High	10505.86	6698.12	-66182.47

Coincidences and differences

Finally, the results also show differences between regional interests, particularly in relative terms. For instance, while forest-rich countries would benefit on the aggregate from flexible carbon market expansion, Southeast Asia and South Asia would minimize costs in most, but not to the same degree. Meanwhile, a bold action still would pay off in both regions, the former ending up relatively better off, and the latter more likely to press for additional exogenous financial support to compensate for the substantial costs they would incur. . In addition, results tend to vary as the scope of the markets is modified. As noted, if the consideration of forests enters into markets later, or allocated a smaller portion of the mix,, the income for Southeast Asia and South Asia increases. This is reflected in their negotiation stance.

From another perspective, if the market does not take into account forestry early on, most of the resources would go first to China and India, and then to Southeast Asia as the opportunities for reductions in the former two are much larger, and inefficiencies in India would pave the way for quick gains early on in the process

2.2.5 Some consequences –mitigation, adaptation, and coalitions to deliver

Climate change impacts are found to be the main driver of costs for all countries. Consequently, if these countries were to focus on adaptation alone, this would only cover costs - to an extent- in the early years up to 2020. However, as these keep growing more than lineally after 2020 and at a greater pace after 2040, the magnitude of these costs suggests that adaptation finance would have difficulty covering their costs, adaptation without mitigation would not work in the long run.

Based on the above findings and assuming the hypotheses still hold across these regions, countries in particularly vulnerable areas should outline policies and actions which could lead to accountable net reductions. As an example, forests would be considered a principal source of reductions as they provide substantial benefits., Countries under this scenario would press for Annex 1 countries to deliver substantial additional reductions.

The numbers also show there is potential for a coalition of countries of Latin America, Southeast Asia, and a significant part of AOSIS to achieve a bold outcome. The data show that if the participants are willing to go beyond -10 BAU (2020), -15 (2030) and -30 (2050) the action could also eventually gain the support of India and other countries in South Asia. As the overall narrative implied, when taking into account all the costs under consideration, a middle income developing country in these regions is better off agreeing to take up to a 30 per cent cut from BAU if Annex 1 countries agree to emissions cuts that range between17 per cent and 24 per cent from 1990 levels. It must be noted that this condition does not depend on all Annex 1 countries agreeing to a cut as long as ambitious targets are agreed by the key players. This alone will ensure that temperatures would be kept within a 2 degree trajectory. As well, smaller middle income developing countries and Annex 1 countries would begin pressing larger emerging economies to make additional substantial cuts. These contributions could raise the level of action by parties that have not been considered in the past to be key players. If all middle income developing countries with less that 0.5 Mtons absolute emissions are accounted for in Asia, Latin America and Africa, they could well deliver between 0.7 to 1.2 Gtons –a number on par with the one produced by China, or the U.S. This would, in turn, contribute directly to further reduced impacts in those regions.

BOX 2-2.

And if taken -could it make it?

The chances of a virtuous cycle at scale

Total global emissions going from 49 - 50 Gtons for 2020 on one end – 48 on the other.

MICs could contribute a substantial scale of emission reductions – between 0.7 to 1.2 G, from countries emitting less than 0.5 Gtons in SEA, LAC, AOSIS and Africa are considered.

not that far from China proposed reductions (1.3 Gtns). Not that far from those committed by the US.

Expanding current numbers with further reductions in LAC, SEA - and even Africa - might provide a solid political platform for:

1) Further Gtons from other industrialized parties so far reluctant to do more,

2) Commitment to higher end reductions from the BASIC and non BASIC industrializing countries, and

3) in aviation and maritime sectors.

A virtuous cycle develops at the necessary scale:

enhances chances of forming larger coalitions encompassing larger emitting parties and gradually but promptly move to to trajectories with reductions below 2 degrees.

Reduces costs of required mitigation targets by A1 parties would be diminished (compared to the alternative, where these regime mechanisms were not present).

This would require coordinated bold positions from members across the different negotiation groups.

Thus, when taking into all the costs, alliances for bold but differentiated action would be better for all participating countries. To achieve this, strong leadership is needed to strike up deals between developing countries within the UNFCCC, with those that have already set a boldness strategy. The latter group may have to commit some of its own resources in terms of mitigation to make the shift to a low carbon trajectory possible. Of note, the alliance would make the two groups allies instead of adversaries of other developed countries trying to achieve a similar outcome within the same negotiation context. These considerations apply to countries but they can also be used to help illustrate some options and consequences for political action by subcountry units, and/or lower levels of government.

2.2.6 The range and delivery mechanism for the required contributions

Low carbon development pathways would fit perfectly with the strategy described in this chapter. These can be deployed through Strategic Program Approaches (SPAs) and defined in this context as the purposeful implementation of sets of measures by public or private agents within a sector or region, devised to substantially increase the capacity to overcome barriers and aggregate projects by means of financial, policy and/or project implementation structures. SPAs are not the same as low carbon development paths or specific national appropriate mitigation actions (NAMAs), voluntary emission reduction measures. They can be used in developing and operating the latter or to expand them to cover the whole economy and pave the way for a low carbon growth path. All these activities would consider mixing actions with the CDM and be supported by net self-financed contributions from developing countries. They also need to put in place a way to deliver these reductions that is agreeable to the participating parties.

SPAs would seek to measure all reductions, whether they are sold or not, to enable a country to decide its best course. With reliable data, countries can decide whether to sell some of the reductions it has not been selling through new instruments and units, or alternatively, to account for them as a net reduction. The programme requires the use of nested accounting, with a double baseline to take into account actions at the project and programme level within a national scope, and avoid double accounting the former in the latter, or sold reductions within countries reductions. The basis of this would be to eventually drop the project accounting altogether, and use only the national one. As a result, a country would be capable of accounting for the delivery of a set of net national domestic reduction contributions, while increasing the size of international markets for low carbon technologies and practices.

For this approach to be successful, developing countries in Asia need to be leaders, not be led. Low carbon development pathways are a powerful to achieve that.

CHAPTER 3.
Approaches to demonstrate the benefits of a low carbon development path

Pursuing a low carbon development path combined with the mitigation of climate change is essential to achieve the ultimate objective of the UNFCCC that also encompasses sustainable economic growth and meeting social development needs.

This chapter discusses co-benefits from a low carbon development path in three areas, widening access to energy services, green buildings and improved transport system.

3.1 Widening access to energy services

3.1.1 Status of the issue: Quantitatively and qualitatively

Since 1990, the Asia-Pacific region's total energy consumption has increased significantly, especially in China, India and other middle-income developing economies. The region's energy production also grew significantly o 5,400 Mtoe in 2007 accounting for nearly 60 per cent of energy production in the world[106]. Fig. 3-1 shows that coal and oil are the leading energy sources for the region. In Asia, excluding China, they comprise shares of 27.9 per cent and 29.1 per cent , respectively, of the primary energy supply while in China alone the shares are 65 per cent and 18.1 per cent, respectively, and in the OECD pacific region they account for 25.9 per cent and 41.9 per cent, respectively..

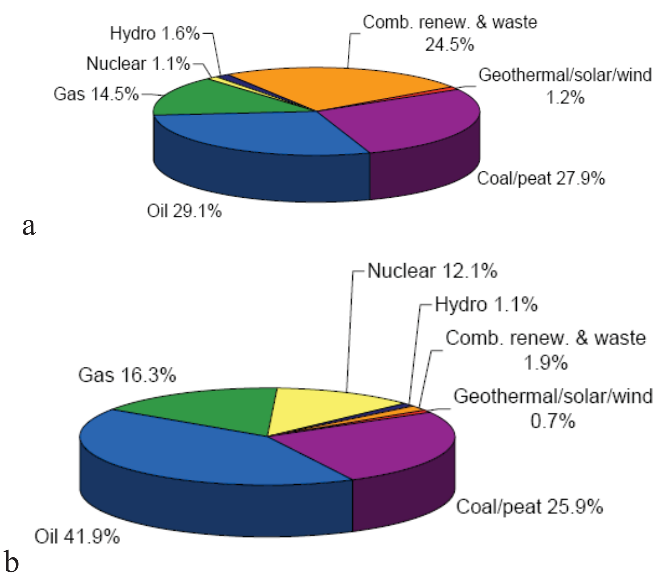


Figure 3-1. Share of total primary energy supply in 2007

a: Asia excluding China IEA Energy Statistics b: OECD Pacific

(Source from IEA Energy Statistics)

The apparent energy consumption per unit of GDP decreased from 312 kilograms of oil equivalent per 1,000 GDP (2005 PPP dollars) in 1990 to 226 in 2007, which is higher than the world average level of 186[107]. With the energy intensity decreasing the carbon intensity also decreased from 665 grams per 1,000 (2005 PPP dollars) in 1990 to 646 in 2006, but still higher than the world average level of 537 in 1990[108]. This indicates that in Asia-Pacific, particularly in developing countries, energy production is low quality and utilization is inefficient. For instance, the power generation in India, 943 grammes of CO_2 per kWh of electricity produced as of 2005, more than 50 per cent higher than the average for the world[109].

The energy needs and services of inhabitants in remote and rural areas need to be singled out. Many of them are unable to access modern energy services or the services they receive are erratic and unreliable. In addition, most of them rely on biomass or dung for cooking and heating, on kerosene wick lamps, batteries or candles for lighting, and/on human or animal energy-based mechanical power for agro-processing or transport. In general, this sector of the population utilizes low-quality energy which emits large amounts of GHG and is confronted with other environmental and ecological issues.

3.1.2 Business as usual and related socio-economic and environmental implications

Primary energy demand in the Asia-Pacific region is projected to increase from 4,025 Mtoe in 2005 to 7,215 Mtoe in 2030 at an annual rate of 2.4 per cent.[110]. Coal is projected to comprise the biggest share as a source of primary energy at 38.3 per cent in 2030, followed by oil with a 27.0 per cent share.[111]

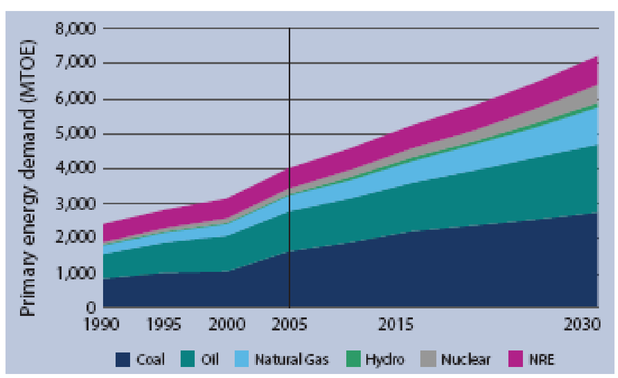


Figure 3-2. Primary energy demand in Asia and the Pacific 1990–2030

(Source from Asia Pacific Energy Research Centre 2009)

Total electricity generation in the region is projected to increase from 6,068 TWh in 2005 to 14,016 TWh in 2030, with an average annual growth rate of 3.4 per cent. Nearly three-quarters of the total electricity generation will be taken up by China, India and Japan, accounting for shares of 45.5 per cent, 17.2 per cent and 9.4 per cent, respectively.[112]. Due to resource availability and price competitiveness compared with the other types of energy, coal is expected to be the main source of electricity generation, accounting for 52.0 per cent of total electricity production in 2030, with the proportion in East Asia and South Asia set to be higher than the average level.

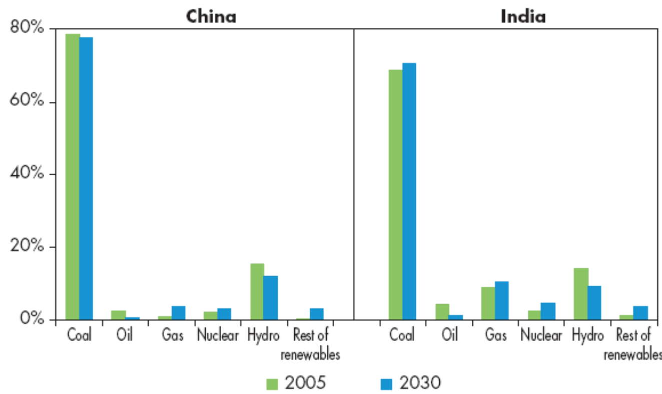


Figure 3-3. Fuel mix in power generation in China and India in the BAU

(Source from IEA World Energy Outlook 2007 - China and India Insights)

If no action is taken and power sector growth is in line with projections, CO_2 emissions are expected to increase at an annual rate of 2.6 per cent through 2030, or an increase of 90 per cent based on the 2005 level while the share from the power sector may increase from 46.3 per cent in 2005 to 49.3 per cent in 2030. The emission rate will be greater for developing countries in the region, due to their higher economic growth rates. For example, the GHG emission by power sector is projected to reach 6202 $MtCO_2e$ with an annual growth rate of 3.7 per cent, accounting for 54.2 per cent of total emission[113.] This emission growth will aggravate the effects of climate change, such as the impact on agriculture, land resources and biodiverstity.

The fast growth of the energy sector will adversely affect society and the economy. Countries with limited supplies of fossil fuel face the dilemma of having to increase their imports of energy to meet growing demand. This, in turn, will raise concerns about energy security. Net energy imports in Asia-Pacific are expected to more than double, from 585 Mtoe in 2005 to 1,385 Mtoe in 2030. In East Asia, alone, the growth rate may nearly triple from 349 Mtoe in 2005 to 970 Mtoe in 2030. The oil import dependency will increase to 80% in 2030 from 50% in 2005[114].

A large chunk of the public funds available are targeted for setting up new power plants and related to infrastructure to meet the rising demand. China is projected to invest 3,700 $ billion in energy infrastructure from 2006 to 2030, nearly three quarters of total investment will go to power sector[115].

Under this scenario, other pollutants generated in the power sector such as such as SO_2, NOx and Suspended Solid (SS) would also increase, adversely affecting human health and causing environmental problems, such as acid rain, reduced visibility and ground-level ozone formation. The water system would also suffer. Both the discharge of wastewater and water consumption are expected to rise significantly in line with greater production. These factors would worsen water quality and result in increased water shortages.

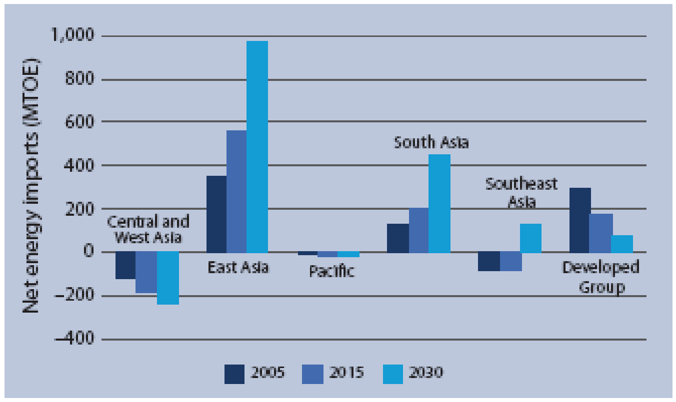


Figure 3-4. Net energy Imports by subregion 2005, 2015, and 2030

(Source from APERC analysis 2009)

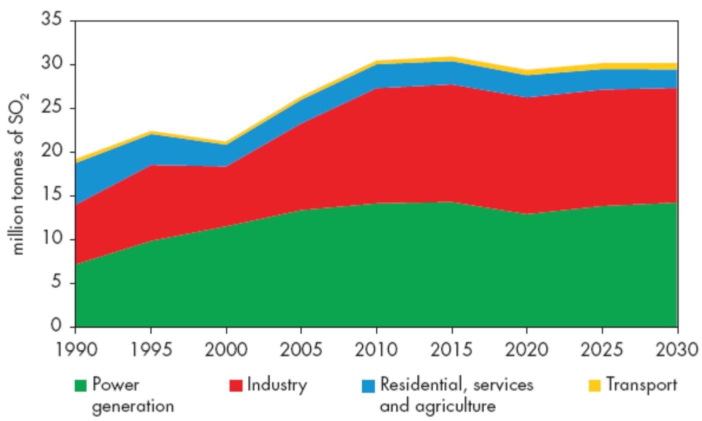


Figure 3-5. SO_2 Emissions by sector in the BAU

3.1.3 Project and trends towards 2030/2050

Under an alternative policy scenario with low carbon development, energy, demand in the region is projected to be 6,920Mtoe by 2030, a 13.6 per cent reduction compared to BAU[116].

In China, if effective policies for improving energy efficiency take effect, the power generation will decrease 12 per cent compared to BAU, with the proportion of coal in the energy supply decreasing to 64 per cent from 78 per cent in BAU[117]. Similar to China, total electricity generation in India under the alternative policy scenario would reach 2,305 TWh in 2030, 17 per cent lower than under BAU. The share of electricity produced from coal would drop from 55 per cent to 71 percent in the BAU[118] .The energy-related CO2 emission is projected to decrease by nearly 50 per cent in China and India.

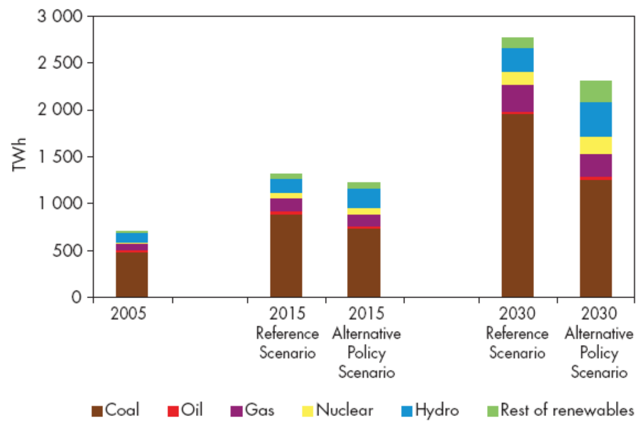


Figure 3-6. India's power generation fuel mix in the reference and alternative policy scenarios

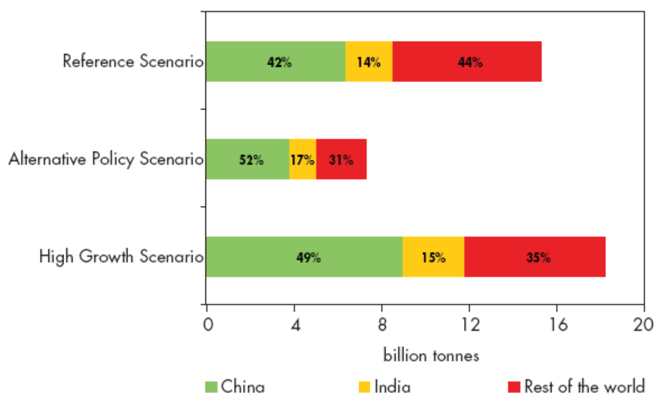


Figure 3-7. Incremental energy-related CO_2 emissions by region and scenario 2005-2030[119]

Note: Reference scenario is the one that utilizes BAU. In the Alternative Policy Scenario, energy demand grows more slowly as existing government policies to curb demand growth are enforced more strictly and new policies now being discussed are introduced. In the High Growth Scenario, faster economic development drives energy demand higher.

Widening access to energy services trends set under a low carbon development path targeted for 2030/2050 could be achieved in the following ways:

- by the supporting policies;
- economic incentives;
- research, development and deployment (RD&D) of technologies in the areas of renewable energy; and
- energy efficiency.

In addition to emission reduction, these steps would l contribute co-benefits in social and economic areas.

3.1.4 Projection of the use of renewable energy and energy efficiency in addressing these issues

Controlling CO_2 emission in the power sector could be achieved by reducing demand for electricity or shifting the power to low-carbon alternatives.

Improvements in energy efficiency made in electricity-consuming sectors to reduce demand for electricity production, is estimated to provide a net emissions savings globally of approximately 4.4GTCO_2e per year in 2030[120]. These improvements are particularly important for cutting emissions in the power sector, which comprises half of the targeted reductions in some countries.

The loss of the electricity in the transportation process accounts for a large proportion in the developing countries, such as in China. According to ECOFYS, a leading consultancy company on energy issues, in 2007, China and India could save about 27 per cent and 35 per cent, respectively, of all fossil electricity produced when deploying highly efficient power stations – and much more with CHP by 2030. In the Alternative Policy Scenario by IEA, the new coal-fired power plants are as efficient as those built in developed countries. The average gross efficiency is expected to increase from 32 per cent in 2005 to 39 per cent in 2030, coming much closer to the OECD average of 42 per cent by 2030[121].

Renewable energy is a promising source of low-carbon energy and can improve energy security by adding diversity and domestic supply to the energy mix. The Asia-Pacific region is well endowed with renewable energy resources, with 40 per cent of the world's total hydroelectric technical potential, and about 35 per cent of its annual solar and high temperature geothermal energy potential. It also has substantial potential to produce biomass and wind energy.[122] Utilization of renewable energy offers great strides in cutting GHG emissions. The IEA estimates that a 50 per cent reduction in CO_2 emissions by 2050 would require an increase to 46 per cent share of renewable energy in global power generation. In 2006, about 18 per cent of global final energy consumption came from renewable energy, and hydropower was the largest renewable source, providing 3 per cent of energy consumed, followed by solar hot water/heating, which contributed 1.3 per cent. In the Alternative Policy Scenario China's share of renewable energy in power generation would rise steadily, to reach 24 per cent of total electricity generation in 2030. The share of hydropower in electricity generation would reach 17 per cent in 2030, up from 12 percent in the Reference Scenario. Wind power and biomass would also increase greatly[123].

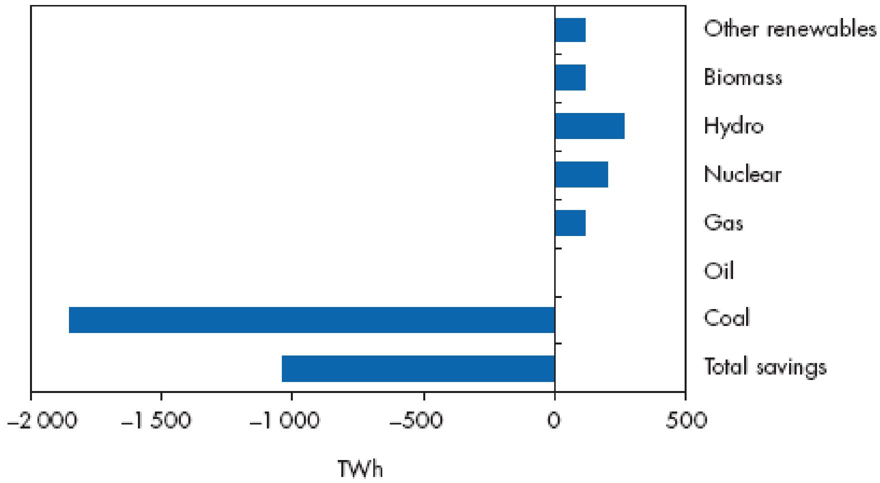


Figure 3-8. Changes in China's electricity generation in the alternative policy scenario and savings relative to the reference scenario, 2030

Nuclear power could contribute significantly to climate change mitigation due to its low carbon intensity and cost-competitiveness. In China, nuclear power is expected to rise to 55 GW by 2030 with the electicity generation share comprising 6 per cent, compared with 31 GW in the Reference Scenario[124].In India, nuclear power capacity in the Alternative Policy Scenario would reach 24 GW in 2030, compared with 17 GW in the Reference Scenario. The share of nuclear power in total electricity generation would rise from 2 per cent in 2005 to 8 per cent in 2030, compared with 5 per cent in the Reference Scenario[125].

CCS is an important mechanism for the continued use of coal for power generation. The combined potential for CCS across power and other industry sectors is projected to be up to 3.3 - 4.1 GtCO_2e per year by 2030 in the world. In India, a preliminary analysis indicates a potential for disposal of 45 MtCO_2e per year including storing CO2in depleted oil and gas fields and saline aquifers or using it for enhanced oil recovery[126].

Energy efficiency improvements and renewable energy utilization are the two main aspects for the approach of widening access to energy services. However, it cannot be achieved without an effective supporting policy. .

3.1.5 Required policy intervention and needs for the betterment of enabling environment

To promote a low carbon development path for the energy sector, governments must set regulations and policies that advance the deployment of renewable power, nuclear energy and CCS utilization and encourage improvements in power efficiency. The following are the main considerations:

- Enabling an environment for energy efficient improvement through carbon tax, nature source tax, phase-out mechanism and subsidies supporting high efficiency. Strategies that foster efficiency and conservation in the power sector by reducing electricity demand and fossil fuel consumption can be implemented rapidly.

- For renewable power that is not cost competitive, such as wind power, solar power and biomass power, policymakers should design suitable incentive systems, including direct capital investment subsidies feed-in-tariffs, tax exemptions or reductions and low interest rate loans to encourage investment by energy companies. In additon, goverments should directly support R&D of renewable energy technologies.
- In many countries, grid connection of renewable power is a big obstacle for renewable energy development due to the limited scale and electricity quality. To rectify this, governmenta should set regulations that make setting grid connection complusive, issue green green electricity certifications, and set technology standards and codes or requirements.
- Force market operators of electricity or fuel to have an Increasing Share of Clean Renewable Energy.
- Encourage pilot and demonstration projects dedicated to CCS technology. This technology offers good potential to reduce operating costs.

To achieve the overall objectives of a low carbon development path, the suggestions mentioned above need to be integrated into existing policies dedicated to GHG reductions. As mentioned early, the co-benefits of the path include contributing to the mitigation of climate change, widening energy access for people in developing countries especially, in rural areas, and guraranteeing energy security.. These co-benefits are explained in detail below.

3.1.6 Co-benefits

Making coal-fired power more energy efficient and deploying increased amounts of renewable energy and nuclear energy could reduce air pollutants emission, and enhance national energy security, which is essential, especially in energy shortage countries.

Under the Alternative Policy Scenario, GHG emissions are projected to drop considerably by 2030 compared to the Reference Scenario. SO_2 emissions are projected to be 25 Mt or 29 per cent lower, of which 22 Mt occurs in non-OECD countries mainly in the Asia-Pacific region.

Meanwhile, by cutting the use of coal in industry and for power generation under the Alternative Policy Scenario, SO_2 emissions peak around 2010 and then decline. These emissions would be 20 per cent lower than in the Reference Scenario by 2030[127]. NOx emissions would be 19 per cent lower, or fall by 16 Mt, of which 13 Mt is attributed to lower emissions from non-OECD countries. Emissions of particulates (PM2.5) also decrease, compared with the Reference Scenario, which is dominated by the figures for China and India[128].

Actions to shift more power to renewables and nuclear energy along with improving energy efficiency have strong social benefits. Among them, health conditions would improve. Local inhabitants stand to benefit from cleaner air and water that would result from reduced consumption of fossil-fuels.

Renewable power is the new economic growth point for developing countries, providing an impetus for the power section to attain sustainable development. Development in this area would capitalize on the situation and take a leading role in promoting the use of renewable energy under a low carbon development growth path. Also of note, actions for energy efficiency improvements and renewable energy utilization provide green jobs for local inhabitants.

Research conducted by Johannes Bollen explains the cost benefits of reducing GHG emissions. The research results show in all the areas covered total benefits outweigh total costs in the long term. Mitigation costs vary by region and are much higher in India and China than in OECD countries. In the OECD, the benefits exceed the costs leading to net benefits over the entire time period. In China, policies promoting the use of low carbon energy are profitable from 2030, while in India this is not the case until 2050. After 2050, the benefits of reduced air pollution exceed the cost substantially in all three regions. [129]

3.2 Green buildings

3.2.1 Status of the issue: quantitatively and qualitatively

Building energy consumption accounts for about 40 per cent of the world's terminal energy consumption and makes up a similar proportion of carbon dioxide emissions.

In the Asia-Pacific region, the building sector, comprising residential and commercial sectors, is the second largest consumer after industry. Thanks to higher standards of living and larger urban populations, energy consumption in developing countries is growing rapidly. For the Asia-Pacific region in 2007, energy consumption was about 937 Mtoe, accounting for about 27 per cent of the region's final energy consumption, while in China and India, the building sector share in final energy consumption was 25.3 per cent and 41.4 per cent, respectively, much higher than the developed countries in the region[130].

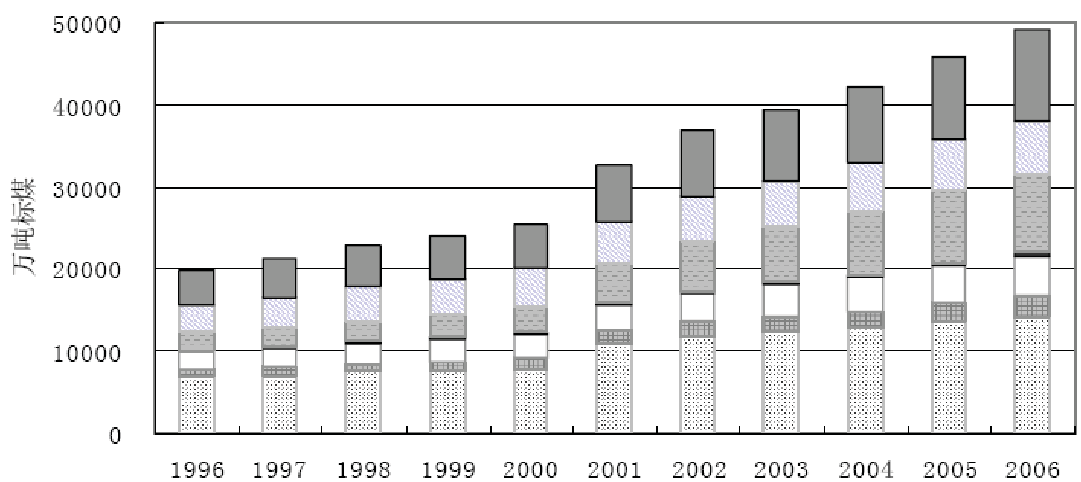


Figure 3-9. Total building energy growth history in China

(Source from Jiang Yi, Building Energy in China—status, obstacle & solution)

Heating and hot water are the top energy end users in the building sector. For example, space heating and hot water account for over 60 per cent of the average household's energy use in Austrialia, As for commercial buildings, lighting and air conditioning are the the two highest end users, accounting for 26 per cent and 21 per cent, respectively, of total energy use[131]. In China, space heating and hot water account for 59 per cent of the average household's energy use for residential buildings, and space heating accounts for 45 per cent for commerial buildings.[132]

Energy use per unit area or per capital is lower for developing countries in Asia-Pacific when compared to developed countries but the gap should lessen in line with the rapid pace of economic development..

3.2.2 Business as usual and related socio-economic and environmental implications

Energy consumption and the emissions that result from it are expected to rise significantly from now until 2030 due to steady growth foreseen in developed countries and rapid growth in developing countries. In China, driven by increasing floor area and heating zones as well as extensive use of air conditioners, energy demand in the residential sector is expected to rise 1.1 per cent per year over 2005-2030 in the Reference Scenario[133]. In India the growth rate is higher at 1.6 per cent.[134].

Under the business as usual model, the share of biomass, which is mostly used for rural space heating and cooking, is projected to drop from around two thirds in 2005 to 36 percent in 2030, as more people switch to commercial fuels and the urban share of the population rises. The fuel mix of residential energy consumption is expected to change markedly in China (Fig. 2-10[135]). The main energy source in India is from biomass, but its share of the energy mix is projected to drop to 59 per cent in 2030 from 70 per cent in 2005 (Fig. 4-11[136]). The use of biomass in operating inefficient stoves causes indoor air pollution, which causes deforestation, soil erosion and health issues

Excluding biomass, energy demand from the residential sector is expected to increase 3.8 per year per year over the projection period. Driving this is increased floor space. Some 800 million square meters of new urban residential floor space is projected to be built annually to 2030 to accommodate the growing urban population and meet the demand for larger dwellings[137]. According to the World Energy Outlook 2007, the residential and services in China will produce 715 MtCO_2e by 2030 with a 1.7 per cent annual growth rate.

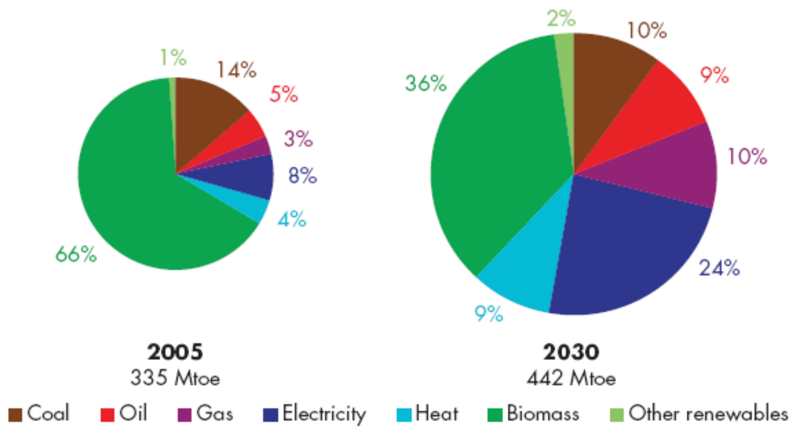


Figure 3-10. Residential energy consumption by fuel in China, 2005 and 2030

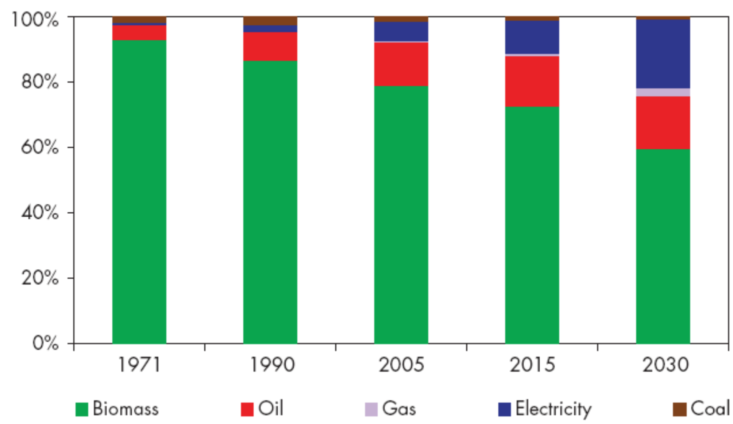


Figure 3-11. Residential fuel mix in the reference scenario in India

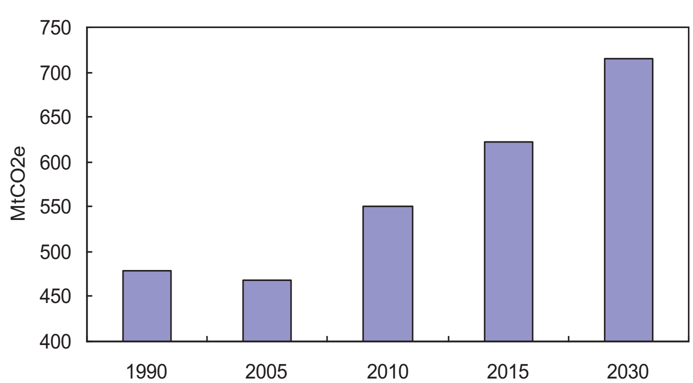


Figure 3-12. Energy-related CO_2 emissions by residential and services in the reference scenario in China

Energy consumption is also set to increase in developed countries. GHG emissions in Australia's building sector is projected to grow from 130 Mt per year in 2005 to 210 Mt by 2030 with an annual growth rate of 1.9 per cent that is projected to reach 280 Mt by 2050. Fig. 3-13 shows that CO2 emissions in Australia's building sector are projected to rise annually with growth rates of 1.3 percent for the residential dwellings and 2.1 for commercial buildings.[138] The rates are higher than ones projected for China.

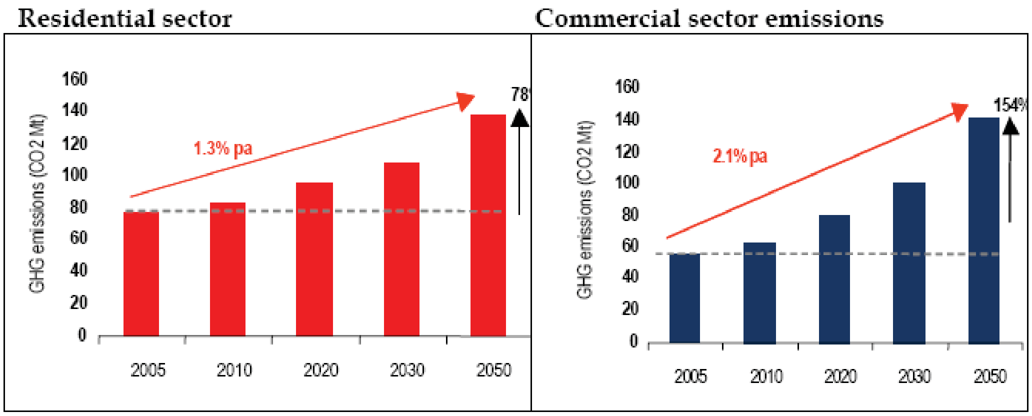


Figure 3-13. Buildings sector emission projections in Australia

In brief, the statistics above show that when taking into account the steady growth of the building sector in developed countries and rapid growth in developing countries, the amount of GHG emissions under the business as usual model will increase faster and be much larger than under the low carbon development model elaborated below.

3.2.3 Project and trends towards 2030/2050

The Alternative Policy Scenario for a low carbon development path assumes that efficiency standards and labelling requirements would be met and strengthened and more stringent building codes would be implemented. Under the path, energy consumption in the building sector would fall considerably on the back of more energy-efficient buildings and appliances.

China's residential energy use is projected to be 18 per cent lower in 2030 in the Alternative Policy Scenario than in the Reference Scenario, of which 30 percent of the decline is attributed to electricity savings. Supporting these projected savings are planned measures to make appliances more energy efficient. Appliances were targeted because they currently have low energy efficiency and ownership of them is expected to surge in the next few decades. In China, by 2030, the average new refrigerator and air conditioners are assumed to be 32 per cent and 35 per cent, respectively, more efficient than the 2005. This alone would cut electricity use by 83 TWh in 2020 compared with the Reference Scenario, and the savings would double by 2030. Improvements in lighting, water heating, and other appliances are expected to bring about savings of around 110 TWh in 2030[139].

In India, energy demand in the residential and services sectors would be 12 per cent lower in 2030 than in the Reference Scenario, mainly coming from biomass and electricity. Fuel-switching away from biomass and the installation of improved cooking stoves and biogas digesters in rural areas would decrease biomass demand by almost 21 Mtoe, or 14 per cent, compared with the Reference Scenario. Fossil-energy use in these sectors would be reduced by 13 per cent in 2030 as a result of more energy-efficient buildings and the widespread adoption of solar energy for water heating in buildings.[140].

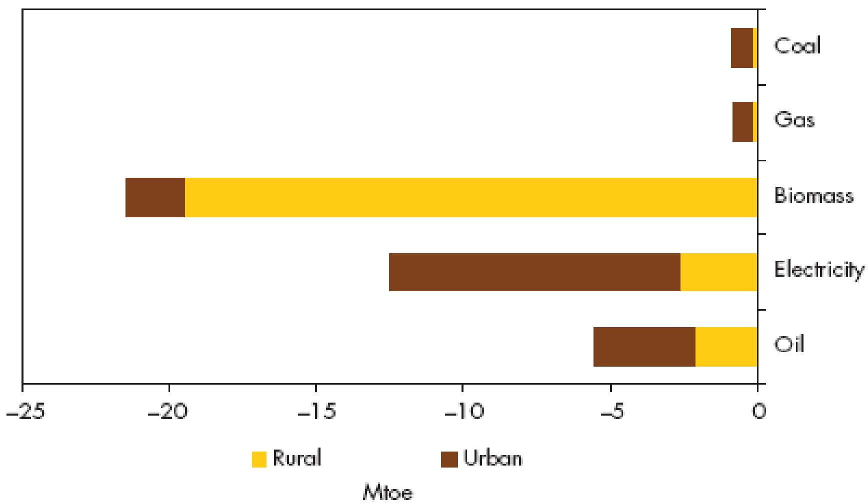


Figure 3-14. Reduction in final energy consumption in the residential and services sectors in the alternative policy scenario by fuel in India, 2005-2030

Most studies on GHG abatement potential from energy efficiency gains in developed economies report potential reductions of between 20 and 40 per cent[141]. The necessary adjusments making the efficiency gains could be done by renovating buildings and increasing the use of high-efficiency devices. As an example, in Austrialia, compared to the BAU, GHG emissions would be cut to 150MtCO2e in 2030 and 180 MtCO2e in 2050, reduced by 28.6 per cent and 35.7 per cent (Fig. 3-15[142]).

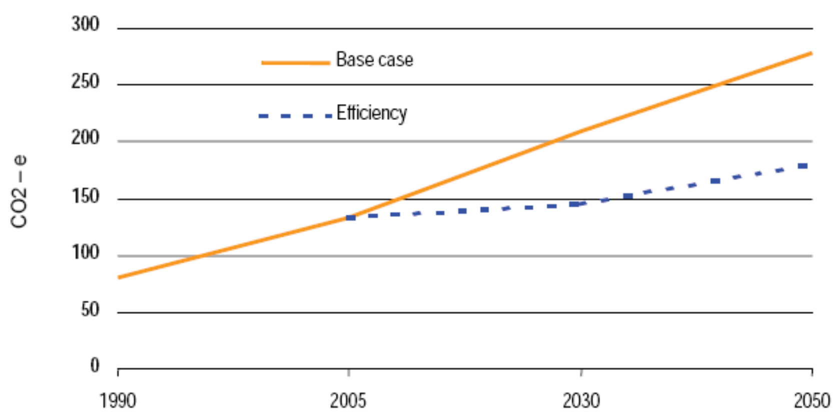


Figure 3-15. Estimated change in total GHG emissions through adoption of energy efficiency measures in Australia

Based on figures in the graph above, GHG emissions from the building sector could be reduced significantly through the adoption of energy efficiency measuresand appropriate technologies. The co-benefits to the environment, society and economy would be achieved at the same time.

3.2.4 Use of renewable energy and energy efficiency technologies in the building sector

Many operating mature technologies can be used to abate GHG emissions in new and existing residential and commercial buildings. They were mainly developed in efforts to improve energy efficiency and the introduction of new technologies. Recent changes are summarized below:

- space heating and cooling — adoption of more efficient appliances, better insulation, use of building energy management systems and adoption of other building shell measures;
- hot water — adoption of more efficient appliances, improved fittings and reduced water use, more efficient water heating systems and technologies, including solar heating;
- lighting — put in place energy efficient light fittings, use of efficient fixtures, timers and linear fluorescent lights for interior, exterior and parking lighting;
- appliances — use of more efficient appliances reducing standby losses;
- standby electricity — adoption of devices that achieve low standby energy use;

Table 3-1[143] shows the estimated impact of abatement for the residential sector in Australia. In three areas, refrigeration, lighting and hot water, efficiency gains are projected to be more than 70 per cent, For the commerial sector, the potential abatement mainly comes from heating and ventiliazaion, which accounts for nearly 60 per cent of the total abatment.

Table 3-1. Residential sector in Australia — estimated impact of abatement

Category of energy use	*Efficiency gain*	*GHG savings in 2050*
	%	Mt pa
Refrigeration	70	13.2
Light	76	7.6
Hot water	61	12.0
Stand by	71	8.1
Cooking	0	0
Space heating	47	5.7
Cooling	70	5.9
Other	0	0
Total	**48**	**52.6**

Table 3-2. Commercial sectors in Australia — estimated impact of abatement

Category of energy end use	*Potential abatement (% of BAU energy consumption)*
Air conditioning	37
Appliances	38
Heating and ventilation	59
Lighting	12
Water heating	28

The application of proper technologies pertaining to renewable energy and energy efficiency in the building sector could make significant contribution in the effort to reduce GHG emissions. It could alos provide many co-benefits. These objectives will need effective supporting policies and economic incentives and other supporting mechanisms.

3.2.5 Policy intervention and needs for the betterment of enabling environment

Governments especially in developing countries need to impose a range of measures to fully exploit the potential efficiency gains in the building sector. Below are some examples:

- Set building codes or energy efficiency standards for new buildings. The codes need to be communicated widely, monitored and verified for implementation. Energy and building codes should be revised based on life cycle. New sets of mandatory building codes and standards should be improved, which would be verified during the design process and not during the actual building process. New buildings need to be designed and constructed based on more stringent energy efficiency standards.
- Raising the energy efficiency of existing buildings through cost-effective voluntary action in response to better information about building energy use.
- Setting energy efficiency performance standards and labels for appliances and lighting. These have increasingly proven to be effective ways to transform markets and stimulate the adoption of new, more efficient technologies and products, which are among the most cost-effective instruments across the economy to reduce GHG emissions,
- Mobilizing public support to use low carbon technologies and high energy efficiency appliances would also be essential. For example, governments need to disseminate information on the energy efficiency performance of buildings as well as provide feedback to the public on its actions in this area. Building public awareness of energy-savings opportunities should also be directed at architects, engineers, interior designers and professionals in the building industry, including plumbers and electricians, as they often are major impediments to the construction of low-energy buildings.
- Energy prices, pricing schemes, energy price subsidies and taxes. Market-based energy pricing and energy taxes represent a broad measure for saving energy in buildings.

- Public sector leadership programmes and public procurement policies. Government agencies, and ultimately taxpayers, are responsible for a wide range of energy-consuming facilities and services such as government office buildings, schools and health care facilities.
- Promotion of energy service companies (ESCOs) and energy performance contracting (EPC).

China has made gains in cutting energy consumption in the building sector in the past few years. There has been a sharp increase in the construction of energy efficient commercial buildings while at the same time, technologies and energy saving and renewable energy equipment have been utilized. In addition, household biogas and solar energy has been widely promoted in the rural areas.

In addition, the Ministry of Housing and Urban-Rural Development of China released an industry standard that and will further formulate and enforce the implementation of stricter standards on energy saving, water saving and recycling of materials. Although the country's building industry is expected to grow rapidly, there is hope the sector could play a key role in lowering GHG emissions with the adoption of efficient measures. Consequently, social and economic benefit could also be achieved.

3.2.6 Co-benefits

Through climate change mitigation, there are some co-benefits such as reduction in local and regional air pollution. For example, in China, replacement of residential coal-burning houses by large boiler houses providing district heating is among the abatement options providing the largest net benefit per ton of CO_2 reduction. The replacement of firewood could reduce the level of forestry deforestation and alleviate ecological damage and improve indoor air quality. As well, appliances that are energy efficient reduce household costs.

The green building also offers economic benefits, social benefits and other kinds of environmental benefits. For instance, the benefits can be well delineated in programmes to encourage renewable utilization in residential buildings in rural areas. The biogas projects provide electricity, heating to the rural residents. This frees up the household from using firewood for cooking, resulting in cleaner indoor air, a health benefit. The straw and livestock wastes reused as the resource of the biogas projects in the rural area can improve the local environment and the utilization of the organic fertilizer from the projects can replace the chemical fertilizer, eliminating soil and water. Meanwhile, related industries would grow on the back of increased use of their products in the rural areas and this, in turn, would result in more green jobs. In 2009, China invested 3 billion RMB (US$350 million) in rural biogas projects. This will provide 100,000 jobs and 1.2 billion RMB ($1.8 million) in income for farmer technicians.

Many researchers and organizations have conducted studies on the quantitative effects renewable energy has on the economy, environment and society. These studies prove that the benefits from the low carbon building far outweigh the costs.

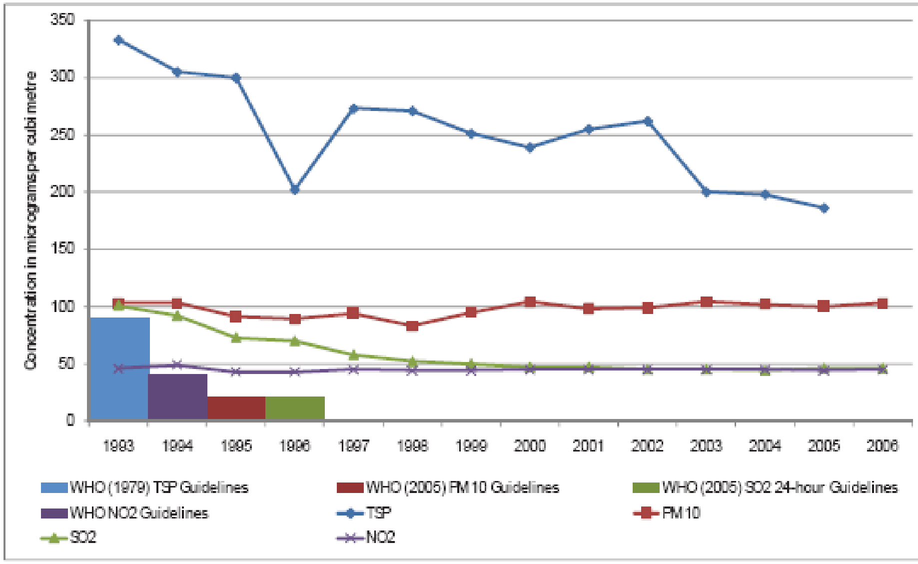
3.3 Improved transport system

3.3.1 Status of the issue: Quantitatively and qualitatively

Asia-Pacific countries are witnessing a rapid increase in the number of motor vehicles on the road as the economies expand. In China, the number has increased almost seven-fold since 1990, from 5.5 million vehicles to almost 37 million in 2006[144]. In the Republic of Korea, the growth rate was 15.7 per cent while in Indonesia it was 8.6 per cent and in Malaysia it was 9.6 percent.[145].The most spectacular increase has been for light duty vehicles (LDVs) — cars and Sports Utility Vehicles (SUVs), both heavy consumers of energy.[146].

The jump in the number of vehicle has pushed up energy consumption in the region from 400 Mtoe in 1990 to nearly 600 MTOE in 2007, registering annual growth of 2.6 per cent, most of which was for gasoline and diesel. In China, gasoline represents 90 per cent of LDV fuel demand[147].In the region, the transport sector produces a significant amount of GHG emissions, comprising 12.5 per cent [148] of total CO_2 emissions in 2005 or 1,505 million tons of CO_2 emissions, of which 80 per cent comes from road transportation[149].

The transport system has a strong adverse impact on the environment. It generates a variety of environmental pollution problems, including urban air pollution which creates bad health conditions, Figure 3-16 shows air quality levels in selected Asian cities over the period 1993–2005. The air quality during that timeframe was below the standard set in the World Health Organization (WHO) guidelines. The bad air claimed about 530,000 people's lives[150]. Also of note, heavy traffic in urban areas increased noise pollution.



Note:
- TSP total suspended particulates;
- PM_{10} particulate matter with diameter of not more than
- 10microns;
- WHO World Health Organization

Source: GHD, based on data from CIA Asia website viewed 1 Dec 2009

Figure 3-16. Average annual ambient a levels of selected Asian cities[151] against WHO guidelines 1993-2006[152]

With more vehicles on the road, traffic jams in urban areas in the region have become a serious and common problem, resulting in the waste of a lot of energy and time.[153] Americans are estimated to lose on average seven days per year from traffic jams.[154]. According to research by Earth Village, traffic jams in Beijing equate to economic loss of about $880 million.[155]

3.3.2 Business as usual and related socio-economic and environmental implications

According to the Asian Development Bank (ADB) Energy Outlook 2009 for Asia and the Pacific, the transport sector is projected to post the largest demand for primary with a growth rate of 2.9 per cent per year through 2030. Oil demand for the transport sector is expected to climb 400 Mtoe to 1000 Mtoe by 2030 compared to 600 Mtoe in 2005. Gasoline is expected to remain the primary source of energy in this sector.

The increase in energy demand is expected to mostly come from the greater amount of vehicles in developing countries. An additional 230 million cars are projected to be on Chinese roads between 2005 and 2030. This number is expected to reach 270 million in 2030[156]. LDVs will make up the bulk of the new vehicles, rising from 22 million to more than 200 million. By 2030, China is projected to be the biggest country in term of energy demand for the transport sector in the world. The usage could top 420Mtoe, based on a 5.5 per cent annual growth rate between 2005 and 2030 set in the Reference Scenario[157].

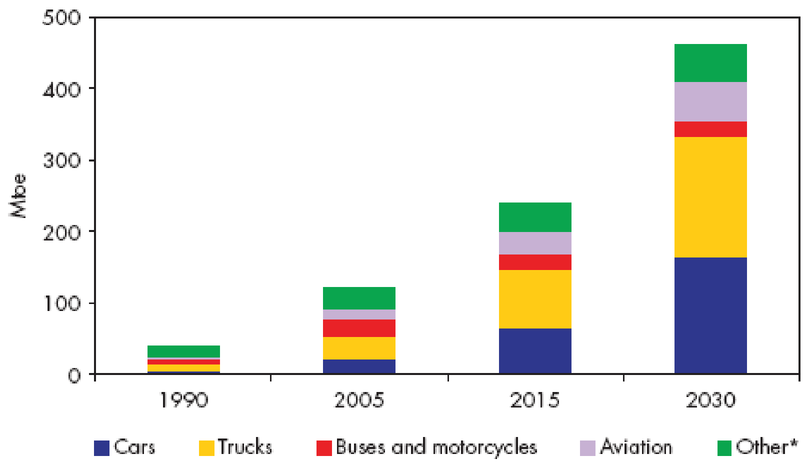


Figure 3-17. China's transport energy demand by mode in the reference scenario

GHG emissions in Asia-Pacific are set to increase as the transport sector expands. The transport sector will play a considerable role in developing a low carbon development path. CO2 emission from the transport sector are expected to increase at annual rate of 2.8 percent to 2030. Based on this, the sector's share of total CO_2 emissions in the region would increase from 12.5 percent in 2005 to 13.7 per cent in 2030. The power sector where CO_2 emissions are expected to increase at an annual rate of 2.6 per cent through 2030[158] is the second largest emitter. By 2050, CO_2 emissions from transport in the ESCAP region are forecast to more than double[159].

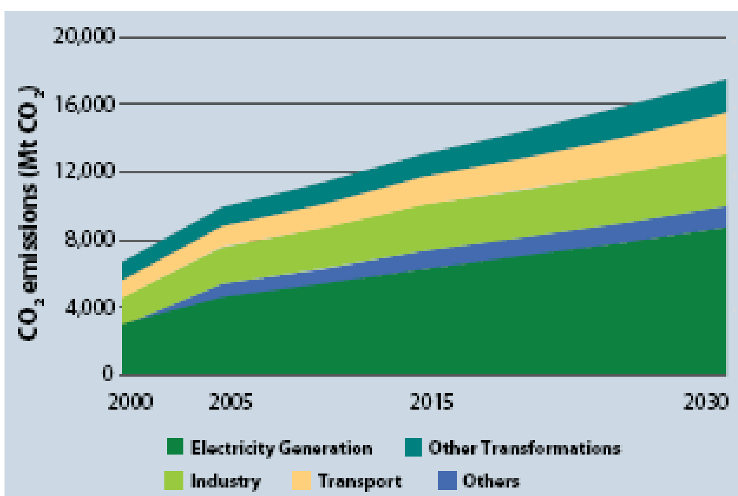


Figure 3-18. CO_2 Emissions 2000–2030

(Source from ADB Energy Outlook for Asia and the Pacific 2009)

According to the Review of Development in Transport in Asia and the Pacific 2007, if governments do not put in place measures to develop sustainable transport, the implications would be significant, including worse road congestion in many urban areas and at major freight corridors in both developed and developing countries, increased road fatalities with the number projected to be around 610,000 by 2020, worse air quality and noise pollution.

In addition, poverty reduction will primarily be limited to the "trickle-down" effect, with 40 per cent of all poor people living in urban areas by 2025. The adoption of a low carbon development path is essential to curtail the possible devastating effects from the expanding transport sector. The path should include energy efficiency programmes, faster development of advanced vehicle technologies and a shift to public transport.

3.3.3 Project and trends towards 2030/2050

450 Scenario, which limits the long-term concentration of GHG in the atmosphere to 450 parts per million of CO_2-equivalent (ppm CO_2-eq), is an objective gaining widespread support around the world. It entails more efficient petroleum-powered vehicles, increased biofuels consumption and a larger share of advanced plug-in hybrid and pure electric vehicles among passenger cars. This scenario is similar to the low carbon development path for the transportation sector.

According to the World Energy Outlook 2009, under the 450 scenario, the transportation sector worldwide would reduce its CO_2 emissions by about 670 Mt (or 9 per cent) by 2020 and by 1.6 Gt (or 18 per cent) by 2030, compared with the Reference Scenario, with total emissions of 7.1 Gt in 2020 and 7.7 Gt in 2030 (Fig. 4-19) .Most of the emission reduction would come from road savings with the deployment of hybrid vehicles, pug-in vehicles and electric vehicles (Fig. 3-20).

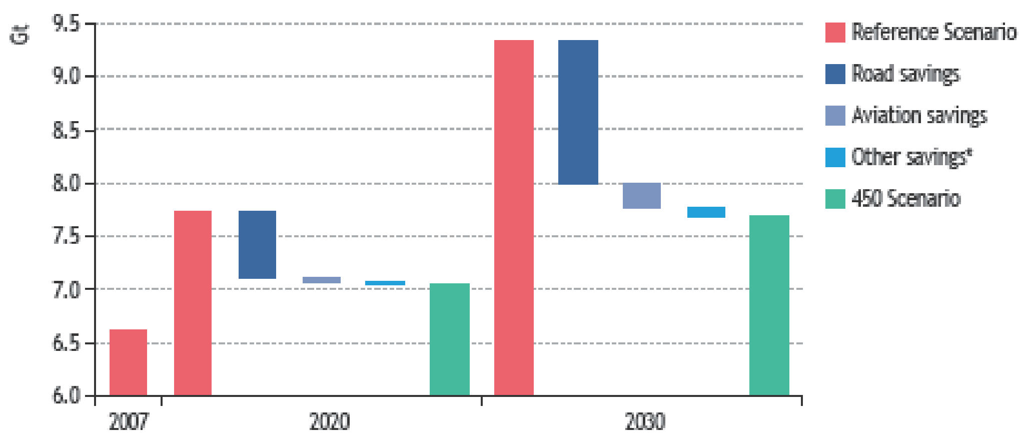


Figure 3-19. Energy-related CO_2 emission reductions in the world in transport by sub-sector in the 450 Scenario compared with the Reference Scenario

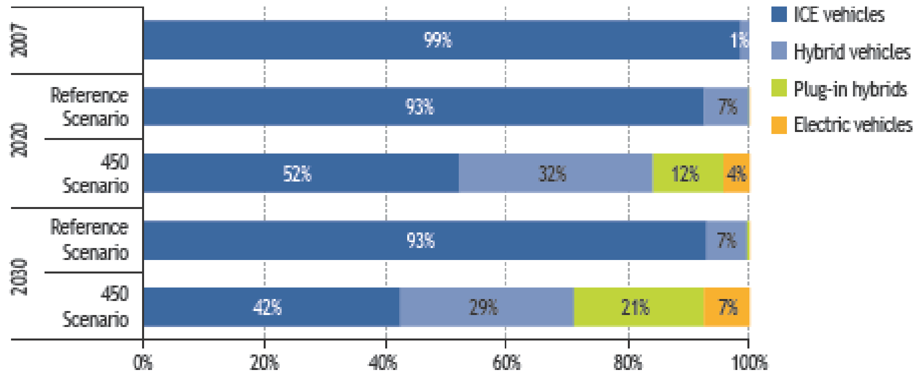


Figure 3-20. Share of global passenger vehicle sales by engine technology and scenario

Under the 450 Scenario, GHG emissions for the transport sector in China would increase from 2007 to 2030 and with the emission share of 9 per cent and 17 per cent, part of this would be contributed by increased use of hybrid vehicles before 2020 and plug-in vehicles and electric vehicles after 2020 (Fig. 3-21). Also helpthe traditional fuel vehicles would have better energy efficiency with the average car fleet CO_2 intensity decreasing from 235g/km in 2007 to 135 g/km by 2020 and 90 g/km by 2030.

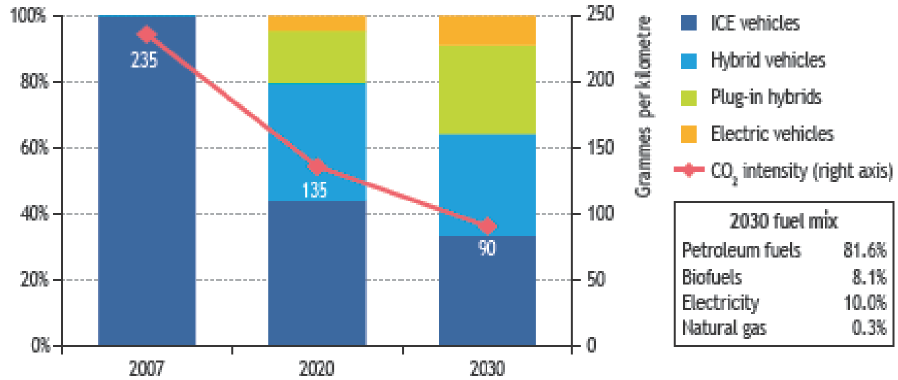


Figure 3-21. Chinese share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario

(Source from IEA World Energy Outlook 2009)

In India, oil savings would be 30 Mtoe, or 20 per cent by 2030 under the 450 Scenario compared to the reference scenario. Behind the savings would be faster uptake of advanced vehicle technology, a shift towards public transport and increased use of liquefied natural gas (LNG) and biofuels. Biodiesel is estimated to account for 69 percent of the biofuels in use by 2030, with ethanol blended into gasoline making up the rest.

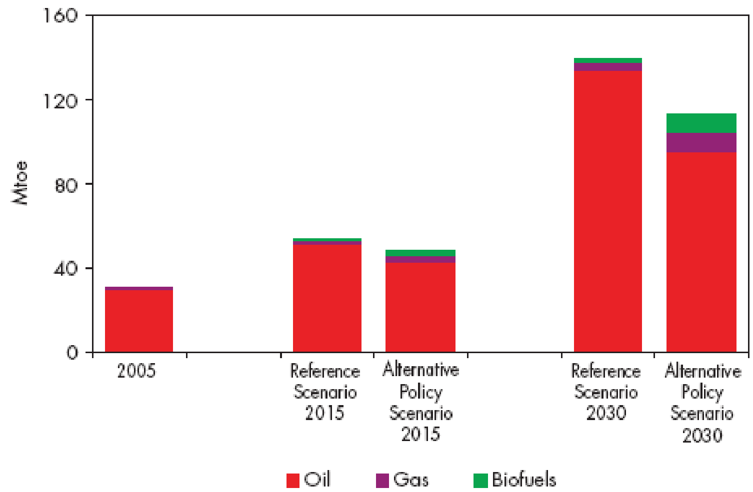


Figure 3-22. Road transport energy use in India in the reference and alternative policy scenarios (Source from IEA World Energy Outlook 2007-China and India Insights)

In addition to the large reduction in GHG emission when compared with the BAU Scenario, under a low carbon development path, the transportation sector would generate other kinds of benefits, such as improved air quality and employment opportunities.

3.3.4 Projection of the use of renewable energy and energy efficiency in addressing these issues

Figure 3.23 identifies ways to reduce CO_2 emission in the transport sector. They include developing public transport to reduce consumption by vehicles, developing clean alternative fuels to improve efficiency of combustion and reducing traffic jams.

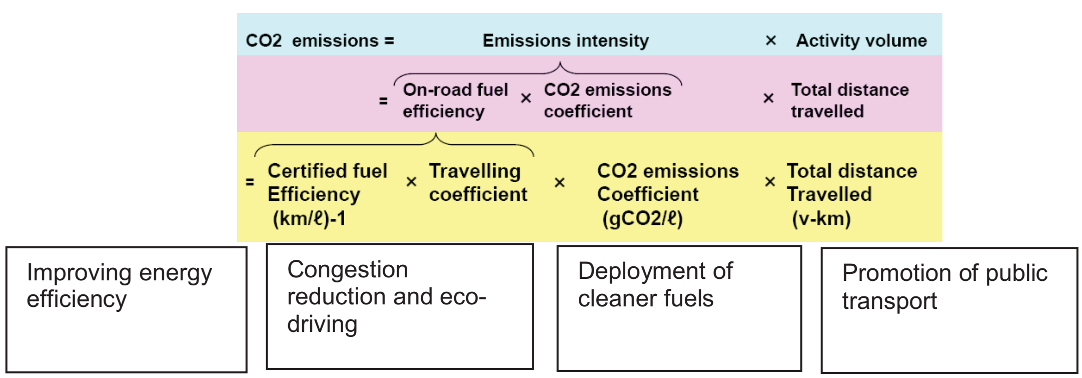


Figure 3-23. Measures to reduce the CO_2 emission from transport sector

1) Promotion of public transport

CO_2 emissions come mainly from private cars and taxis, with public transport accounting for only a small portion. Development of public transport, such as bus rapid transit systems and mass rapid transit systems and reducing travel by private cars are important and promising means to reduce GHG emissions. These steps would also help relieve traffic jams.

2) Deployment of cleaner fuels

Increasing the use of cleaner transport fuels has been a challenging goal for many Asia-Pacific countries. These include the development of hybrid vehicles, plug-in hybrids and electric vehicles.

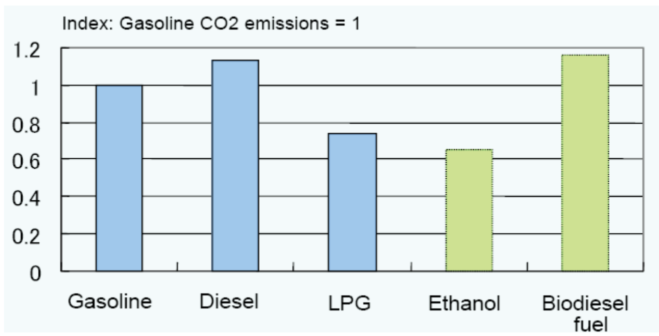


Figure 3-24. CO_2 emission coefficients of Automotive Fuels

(Source from Japan automobile research institution)

3) Improving energy efficiency

Facing double pressure from the energy crisis and global warming, automobile companies worldwide are working hard to boost energy efficiency of fuel,[160] including using lighter materials for moving parts such as pistons, crankshaft, gears and alloy wheels, thinner engine oils that require less energy to circulate and turbo steamer by applying the heat from the engine to spin a mini turbine to generate power as well as by replacing tires with low rolling resistance (LRR) models.

4) Others

Non-technology measures could also reduce CO_2 emissions, such as alleviating road congestion through better urban planning and the eco-driving. To implement these plans, governments must invest heavily to upgrade transport infrastructure, which can mitigate the traffic congestion and improve the actual fuel economy.

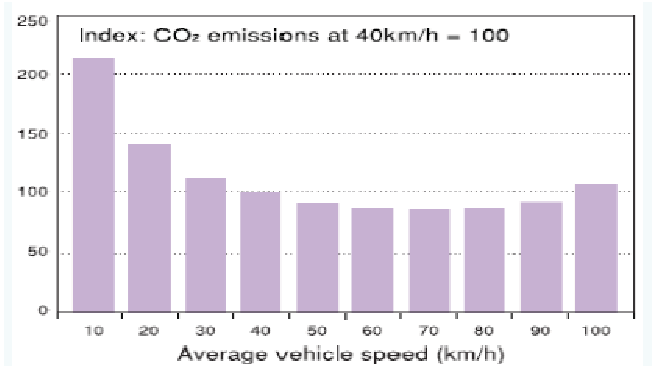


Figure 3-25. Impact of vehicle speed on CO_2 emissions

(Source from Japan automobile research institution)

3.3.5 Required policy intervention and needs for the betterment of enabling environment

Using the four aspects mentioned above as a basis, the countries in Asia and the Pacific should put in place technical, economic and management measures based on their particular situations. Generally speaking, governments could put more effort in this area by developing public transport, placing more investment in rail transit and bus rapid transit and strengthening the maintenance and operation of public transport and improving the quality of the service. In terms of clean fuel and combustion efficiency, governments could provide subsidies or set a preferential tax policy to promote technological innovation and encourage more automakers to participate in the research and development and demonstration of clean fuel cars, a move that would accelerate commercial production. Meanwhile, measures pertaining to infrastructure maintenance could also be made; the government could also take steps to relieve traffic jams through different options.

Table 3-3. Policies to promote low carbon transport

Measures	Policies needed
Develop public transport	• Strengthening the building of rail transit and Bus Rapid Transit • Strengthening the maintenance and operation of public transport system • Raising awareness of low carbon transport to citizens
Promote cleaner fuels	• Setting medium and long term goals • Setting automobile standards on clean fuels such as biodiesel and ethanol) • Providing subsidies or economic incentives to encourage the sales of clean fuel cars • Increasing the accessibility of clean fuel • Providing subsidies for use of clean fuel cars
Improve combustion efficiency	• Strengthening technology development and demonstration • Providing financial support to automakers for technology development
Others	• Facilitating construction of infrastructure • Plan transport systems in a scientific and logic way • Providing strict training on driving; • Encouraging small cars and discouraging large car for tax reduction or exemption

3.3.6 Co-benefits

Under a low carbon development path scenario, oil savings in the Chinese transport sector would amount to 2.1 mb/d in 2030, accounting for around two thirds of the total reduction of the country's oil demand, compared with the Reference Scenario (Table 3.4[161]). CO_2 emissions could be cut to 94 Mt in 2030, or 23.4 per cent less than the amount projected under the Reference Scenario while in India the reduction could 22 per cent. [162].

Table 3-4. China's Transport Energy Consumption and Related CO_2 Emissions in the Alternative Policy Scenario

	2005	2015	2030	2005-2030*	Difference from the Reference Scenario in 2030	
					Mtoe	%
Road	78	166	283	5.3	–73	–20.5
Cars	*24*	*61*	*121*	*6.8*	*–43*	*–26.2*
Trucks	*31*	*82*	*138*	*6.1*	*–30*	*–17.9*
Other	43	67	84	2.7	–20	–18.9
Total energy (Mtoe)	**121**	**232**	**367**	**4.5**	**–93**	**–20.2**
CO_2 emissions (Mt)	**337**	**634**	**961**	**4.3**	**–294**	**–23.4**

To deploy new technologies in China, capital investment must be shifted to the transport sector. Additional investment needed relative to the Reference Scenario would be nearly $25 billion in 2010-2020 and $55 billion in 2021-2030.

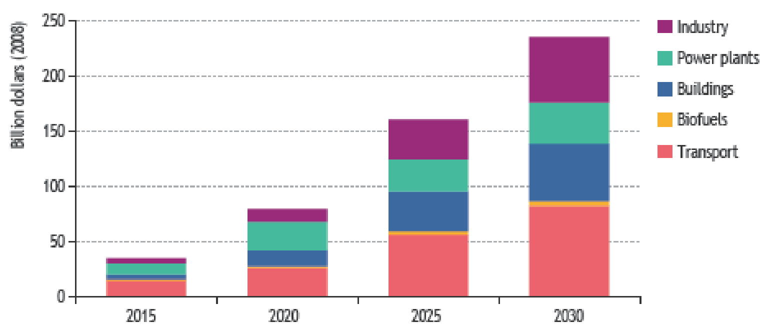


Figure 3-26. China additional investment in the 450 Scenario relative to the Reference Scenario

(Source from IEA World Energy Outlook 2009)

In addition, the deployment of high energy efficient cars would reduce household expenditures on transport services. Projections indicate that this would reduce nearly one third of household expenditures in India by 2030. (Fig. 3-27).

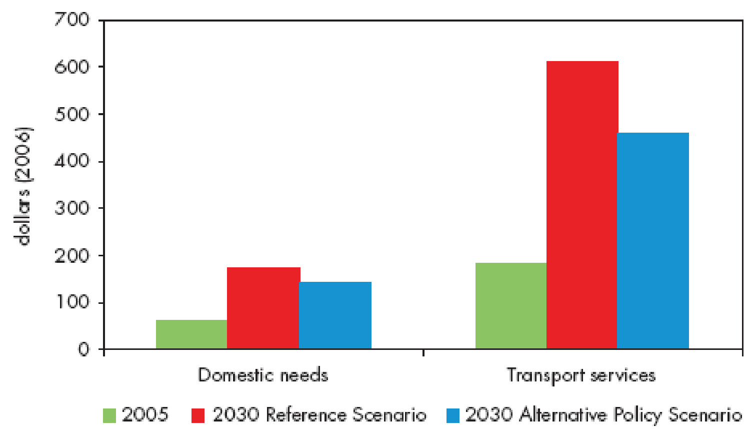


Figure 3-27. Annual Energy-Related Expenditure per Household in India

(Source from IEA World Energy Outlook 2007-China and India Insights)

The positive effects of adopting a low carbon development path are quite notable with regards to the transport sector. Air quality would improve while the promotion of more efficient petroleum-powered vehicles and clean energy cars would create more green employment opportunities, In addition, the development of new industries for the transition would contribute economic development in developing countries. These actions could also provide an opportunity for developing counties to take a leading role in new industries in this area and help alleviate poverty. Furthermore the promotion of public transportation would mitigate traffic jams as well as other bad effects caused by road congestion.

3.4 Case Studies

Some countries in Asia and the Pacific region have already set targets for cutting CO2 emissions. Japan, for example, has targeted to reduce CO2 emissions 25 per cent by 2020. China and India, two developing countries in the region, also set emission reduction targets even though they are not obligated to do so under the Kyoto Protocol, an international agreement linked to UNFCC that sets binding targets for 37 industrialized countries and the European community for reducing GHG emissions. Other countries in the region have not set specific CO2 emission reduction targets but instead have put in place measures to promote the deployment of renewable energy and improve energy efficiency. These countries' policies and actions as well as their benefits are analyzed in this chapter.

Table 3-5. CO_2 emission targets in Asia and the Pacific

Countries	Target	Basis	Remark
Japan	25% by 2020 80% by 2050		CO_2 emission
Australia	13%-31% by 2020	2007	CO_2 emission
China	40%~45% by 2020	2005	CO_2 emission per GDP
India	20%~ 25% by 2020	2005	CO_2 emission per GDP
Indonesia	26% by 2020		CO_2 emission

3.4.1 Japan

Japan is a net importer of energy. In 2007, the country's primary energy supply stood at 514 Mtoe while its energy production was less than 100 Mtoe. Its primary source of energy was oil, with a 44.8 per cent share followed by coal, with a 23.3 per cent share. .

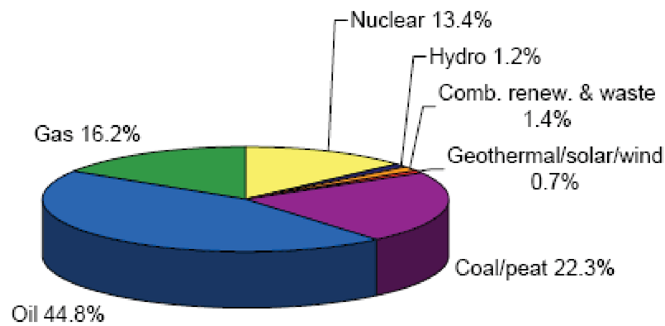


Figure 3-28. Share of total primary energy supply in Japan 2007

(Source from IEA Statistics)

3.4.1.1 Policy and action

Because of it large dependence on energy imports, Japan has put a lot of resources in energy conservation and the deployment of renewable energy. It has also set a series of measures to meet it obligations of the Kyoto Protocol.

In 2008, Japan's Cabinet approved the "Toward a Low Carbon Society Action Plan". The main components of the plan include financial support, innovative technological development and promotion of existing technologies, emission trading, carbon tax, visual promotion and implement new measure to support the transition. .

1) Laws and regulations:

- The Energy Conservation Law, revised in 2002, promotes an energy management system for large commercial buildings and energy conservation measures for buildings at the construction stage.
- Renewable Portfolio Standard Law (2002) mandates electric utilities to achieve a fixed level of electric power generated from new energy, directly or indirectly.
- The "Draft Basic Law for Global Warming Measures", enacted in March 2010, outlines the basic direction the country will take to achieve mid- and long- term targets. The Ministry of Environment is preparing a roadmap with measures and policies to meet CO_2 emission reduction targets of 25 per cent by 2020 and 80 per cent by 2050. It mainly focuses on energy supply, the manufacturing industry, community development and everyday life. For energy supply, next generation

energy is being promoted, with a target for renewable energy to comprise over 10 per cent of the energy share by 2020 and the 100 per cent usage of smart grid by 2030. The manufacturing sector is targeting to reduce energy consumption 30-40 per cent by 2050.

2) Investment and financing mechanisms

The government is providing subsidies and preferential taxation for the introduction of solar power, wind power and biomass generation etc. In November 2009, it launched a buyback programme of surplus electricity beginning with the PV power. The initial purchase electricity price was set at $0.48/kWh for households (less than 10 kW) and $0.24/kWh for others. The programme aims to promote technical improvement and industry development of PV. Tax reductions and subsidies for the purchase of eco cars such as hybrid and electric cars are also in place.

3) Marketing mechanism

A cap and trade carbon emission programme was introduced by the Tokyo Metropolitan Government on 1 April 2010. A total of 1,400 company offices and factories will be involved in the programme. Over the next five years, Company offices will be required to reduce its carbon emissions by 6 per cent while factories will need to cut them by 8 per cent. If an entity is not able to reduce its emissions, it can buy credits at a price of 1.3 times the amount of its shortfall. .

The "Demonstration of Next-generation Energy and Social Systems" programme is an initiative to promote the construction of a smart grid. In April 2010, four cities were selected as sites for the demonstrations.

In May 2009, the Japanese government launched its "household appliance eco-point system", which grants points to consumers who purchase air conditioners, refrigerators, and TVs that receive terrestrial digital broadcasting services when these appliances receive a rating of four or more stars in a national system of energy-efficiency standards[163].

3.4.2 China

China is largest energy consumer in Asia-Pacific, with a total primary energy supply of 1,955 Mtoe in 2007. Its main source of energy is coal with a 65 per cent share of total supply followed by oil with an 18.1 per cent share. (Fig. 4-2). The country's total CO_2 emissions ranked first in the world, increasing from 3,000 Mt in 2000 to more than 6,000 Mt in 2008(Fig. 4-3).

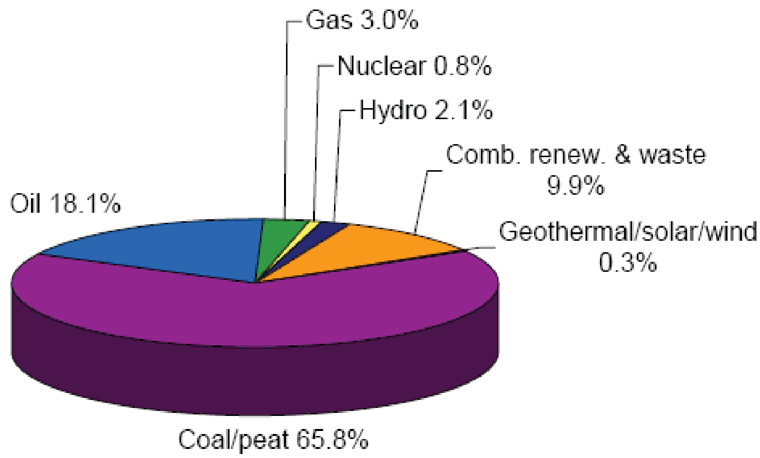


Figure 3-29. Share of total primary energy supply in China 2007

(Source from IEA Statistics)

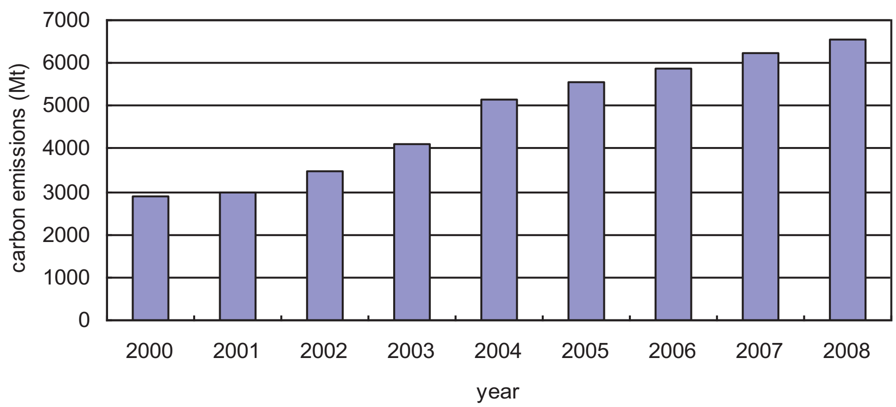


Figure 3-30. CO_2 emission in China from 2000 to 2008 (Data from IEA Statistics)

3.4.2.1 Policy and action

China has been proactive in working toward developing a low carbon economy. In November 2009, the country set a goal to reduce the intensity of CO_2 emissions per unit of GDP in 2020 by 40 to 45 percent compared with the level of 2005. Prior to this, it set plans to reduce energy consumption per GDP by 20 per cent and increase renewable energy from 7 per cent to 10 per cent in the total energy mix.

In July, 2007 China's **National** Climate Change Program was issued, which laid down policies and measures to address climate change, contributing to the development of a low-carbon economy in China. Soon afterwards, Projects on Climate Change Program were commenced at Provincial Levels and China's Policies and Activities to Combat Climate Change were issued.

In addition to the above cross-cutting policies there are specific policies and measures employed for low carbon economy development, including renewable energy development and energy efficiency improvement.

1) Renewable energy development

China issued the Renewable Energy Law in 2005. It has six parts, establishing national targets, grid connection priorities, classifying tariffs for renewable power, sharing costs at the national level, renewable energy special fund and policy offering favourable credit and tax treatment.

In addition, the government has put in place policies and measures aimed at supporting the development of renewable energy. They include specific development targets, subsidies for renewable energy production and utilization, direct financing support for renewable energy deployment and tax exemptions and reductions.

Renewable energy development target

In February 2002, China passed groundbreaking law to promote renewable energy. Table 4-2 provides a list of targets set in the Renewable Energy Law.

Table 3-6. Renewable Energy Development Target

Renewable energy	2010	2020
Hydropower	190 GW	300 GW
Big dam	140 GW	225 GW
Small hydropower	50 GW	75 GW
Biomass power	5.5 GW	30 GW
Biomass briquette	1 million ton	50 million ton
Biogas	19 billion m3	44 billion m3
Bioethanol	2 million ton	10 million ton
Biodiesel	200 thousand ton	2 million ton
Solar energy	300MW	1.8 GW
Off-grid solar power	150MW	300 MW
Solar power on roof	50 MW	1000 MW
On-grid PV power	20 MW	200 MW
CSP	50 MW	200 MW
Solar power in other field	30 MW	100 MW
Wind power	5000MW	30GW

Subsidies for renewable energy production

To counteract the price differences between coal-fired and renewable energy power, the government provides subsidies.

Since 2006, the government has set the price of wind power based on a guidance price issued through a concession tender. Generally, a subsidy of less than 0.25 yuan/kWh ($0.037/kWh) is added to electricity generated from wind plants based in local coal-fired plants. Meanwhile, in n July, 2009, the government issued a directive explaining its “Wind

Power Grid Tariff Policy". The directive states that the electricity price for wind power is divided into four parts based on resources and construction conditions. It also set the online electricity price rates at $0.075 /kWh, $0.079/kWh, $0.085 /kWh and $0.090 /kWh.

The price of biomass power is 0.35 yuan/kWh ($0.051/kWh), of which 0.10 Yuan/kWh is a temporary subsidy set by the government based on the price of coal fire power. Subsidies will be provided for the first 15 years of operation.

Subsidy support is being provided for other types of renewable energy as well. For example, producers of biomass briquettes are eligible to receive funds if they use more than 10,000 tons of straw and have stable end-users.

<u>Investment support</u>

The government has invested heavily to support the production of biogas in rural areas and combat pollution at farms with livestock. Since 2003, it has helped fund construction in this area, including household digesters and biogas plants.

Since 2009, financial support has also been granted for buildings that use renewable energy including those that are heated by heat pumps or solar energy. For PV buildings, the government provides direct capital support if the installed capacity is more than 50kWp. In addition, CSP can also receive investment support.

<u>Renewable energy development fund</u>

The Ministry of Finance set up a fund in 2008 to support biofuel, wind and solar energy. The fund supports R&D, the issuance of standards, project demonstrations, development of renewable energy in rural areas, renewable energy power projects in remote areas and the establishment of a resource assessment and information system

Tax incentives to support the deployment of renewable energy are also in place. As an example, the value added tax and income tax assessed to biogas power plant are cut to 13 percent and 15 percent, from 17 per cent and 33 per cent, respectively.

2) Energy efficiency improvement

China's 11th five year plan set specific goals for a decreasing energy and resource intensity. They include the following:

- energy consumption per unit of GDP to be cut by 20 per cent;
- water consumed per unit of industry value added to be reduced by 30 per cent;
- effective utilization coefficient of field irrigation water to be lifted to 0.5 per cent; and
- rate of industrial solid wastes utilized to be rise to 60 per cent.

The Energy Conservation Law was revised in 2007 to add a series of preferential policies, including multiple tax exemptions and reductions, consumption-related taxes, natural resource-related taxes and other tax benefits. The revision became effective in 2009.

In a broader perspective, the government has targeted three key sectors, industrial, transportation and building, for improving energy efficiency. The following gives the specific policies and actions for these sectors.

Industrial sector

It carried out a phase-out mechanism for high energy efficiency and high pollution technology, equipment and products. In 2005, the National Development and Reform Commission (NDRC) issued the "Guidance of Industrial Structure Adjustment." The report classifies technologies based on which should be promoted, which should be used on limited basis and which should be phased out.

In 2006, the Top-1000 Enterprises Energy Efficiency Program was set up. Thirty provincial governments and enterprises enrolled in the programme in which the central government is responsible for tracking, instructing and supervising the activities of 1000 enterprises with regards to energy utilization. As part of the process, the government periodically releases status reports and revises safeguard measures. Participants in the programme account for 33 per cent of the total national energy consumption and 47 per cent the industrial energy consumption.

Local governments, meanwhile, have set different award standards and administration measures, which greatly encourage industrial enterprises to deploy high efficiency technology and equipment. For instance, enterprises that invest in equipment used for environmental protection, energy or water conservation may be eligible for a corporate income tax credit equal to 10 per cent of the investment value[164].

Transportation sector

China has taken various steps to promote energy conservation in the transportation sector. In November 2007, the "Administrative Regulation of New Energy Vehicle Production Entry" took effect. A little over a year later, the government launched the "10 Cities and 1000 Vehicles" programme, to promote electric vehicles and new energy vehicles, in public transportation, taxis, public businesses and municipal, and postal services fields.

In another initiative, the Ministry of Science and Technology set new subsides for the adoption of Hybrid Vehicles, Electric Vehicles and Fuel Cell-Based Vehicles in February 2009[165];

Local governments are also playing a role in this area. They are promoting the improvement of energy efficiency through a local energy conservation and emission reduction fund. In 2009, the city of Shanghai set up a fund dedicated to energy conservation and emission reduction of transportation. The fund grants 1,500 yuan ($220) per ton oil equivalent (toe) or 3,000 yuan ($440) per toe to qualified projects.

Building sector

Several standards for building energy efficiency have been issued in recent years by various government agencies. One example is the "Energy-Saving Design Standard of Pubic Building", which sets energy efficiency levels for washing machines and air conditioners.

Financial support has been a key tool for improving energy efficiency in the building sector. In 2007, the government began a programme to help consumers deploy energy conservation measures with subsidies on lighting. Large consumers in rural areas are eligible to receive a 50 per cent subsidy. Another fund was launched in January 2010, which is aimed at encouraging the use of energy savings by transforming the local lighting products market. Its ultimate goal is to phase out incandescent lamps from the market. .

3.4.2.2 Co-benefits

1) Economic benefit

Low carbon economy development provides new development opportunities for industries. One area of note is wind power. By 2008, this fast-growing source of power's installed capacity in China was more than 12 GW, making the country the fourth largest producer of wind power in the world.[166]. Electricity production from wind power has increased significantly since 2000 from 0.58 billion kWh to more than 12 billion kWh in 2008. As of 2008, wind power's share of total power in China was 0.4 percent. (Fig. 4-4).

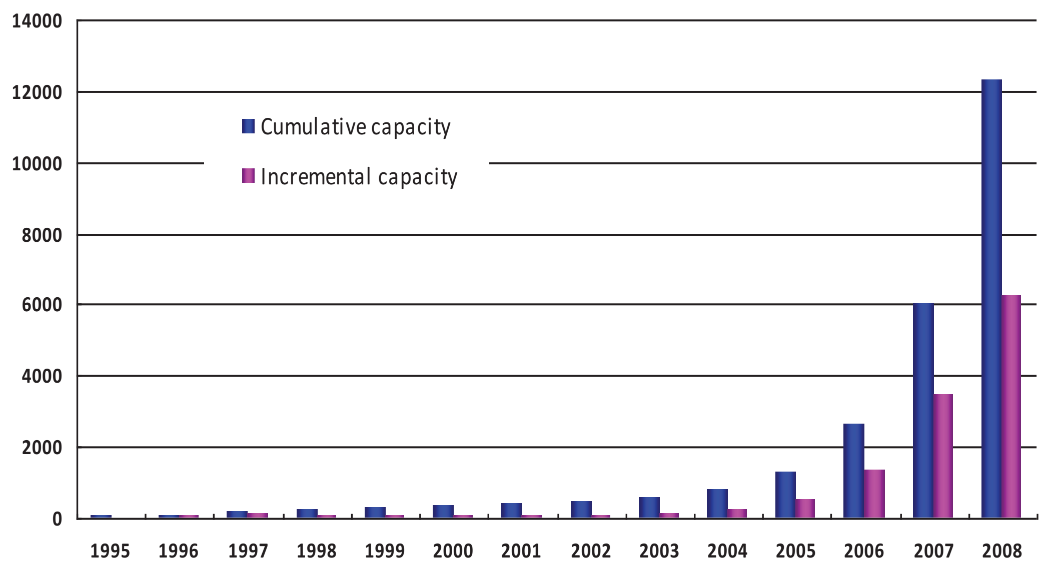


Figure 3-31. Incremental capacity and cumulative capacity in China from 1995 to 2008

(Source from Zhang Xiliang, Observations on China's Strategic Responses to Climate Change.)

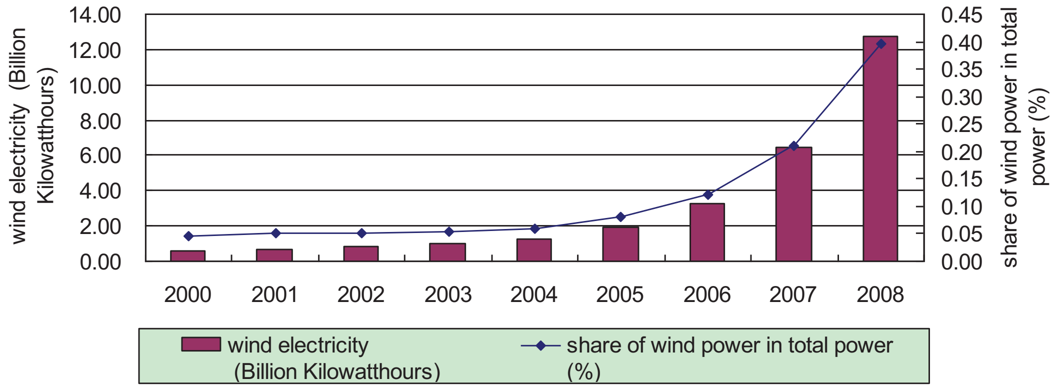


Figure 3-32. Wind power production and its share in total power from 2000 to 2008

(Data from U.S. Energy Information Administration)

Statistics show that the average per kW investment is $1, 511 for wind farm in 2008[167], and the total investment was about 9 billion for wind farm construction in 2008, which actively pulled GDP to increase. Prior to 2004, there were less than five power equipment manufacturers in China, whose market shares in total was less than 15 per cent. As of 2008, the number of domestic wind turbine manufacturers increased to 70 and among the newly added installed capacity, the market share of domestic and joint venture businesses increased to 75.4 per cent.

2) Environmental benefit

The environment obviously benefits from the development of a low carbon economy, merely by the reduction in emissions of GHG and other pollutants. As of 2008, the use of wind as a power source for electricity has resulted in emission reductions of about 12.05 $MTCO_2e$, 39,000 tons of SO_2 and 34,000 tons of NO_x[168]. Under the 11th five year plan, the utilization of 150 million high efficiency lighting provided savings of 29 billion kWh of electricity, which in turn reduced 29 $MTCO_2e$.

3) Social benefits

Social benefits from a low carbon economy development include off-grid wind power and solar power deployment in rural and remote areas. In 2008, China produced 78,411 small- and medium-sized off-grid wind turbines, with the year-over-year growth of 9.6 per cent, the total capacity of 73 MW[169]. It is estimated that there are about 0.19 million small wind turbines still being used with the installed capacity of 57 MW and the annual power generation of 83 GWh[170].

3.4.3 India

India's energy supply was nearly 600 Mtoe in 2007. The country is well endowed with coal, which accounted for 40.8 percent of the country's total energy supply. On the other hand, it has very limited local supply of oil assets and relies of crude imports to meet 71 per cent of its needs.[171]. By 2008, India was the world's fourth largest emitter of CO_2, amounting for more than 1,500 Mt.

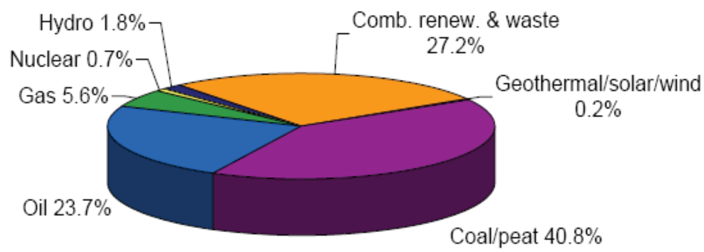


Figure 3-33. Share of total primary energy supply share in India 2007

(Source from IEA Statistics)

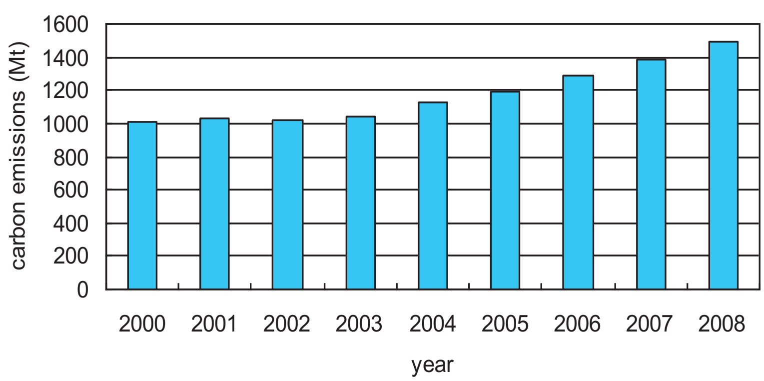


Figure 3-34. CO2 emission in India from 2000 to 2008

(Data from IEA Statistics)

3.4.3.1 Policy and action

In June 2008, India issued the "National Action Plan for Climate Change". The plan is comprised of eight missions relating to mitigation and adaptation and sets priority areas in addressing climate change issues. Its objective is to tackle global warming without adversely affecting economic growth. Previously, the government has taken steps to promote renewable energy deployment and energy.

Regarding renewable energy, the government put in place the "New and Renewable Energy Policy" in 2005. This plan focuses on accelerating the deployment of renewable energy through indigenous design, development and production. Meanwhile, the "Rural Electrification Policy", set in 2006, promotes renewable energy technologies where grid connectivity is not possible nor cost-effective.

The government has taken various steps with regards to energy conservation and efficiency. The Energy Conservation Act, which took effect in 2001, aims to reduce energy consumption across sectors while the Bureau and Energy Efficiency (BEE) was established to institutionalize energy efficiency measures, monitor them and set application for measuring them at plants.

India has put together some comprehensive policies for low carbon economy development. “Integrated Energy Policy”, published in 2008, focuses on mass transportation, renewables, accelerated development of nuclear and hydropower, technology missions for clean energy and R&D on several climate change-related technologies. Other initiatives include the Electricity Act 2005, Tariff Policy 2003 and Petroleum & Natural Gas Regulatory Board Act 2006, all of which focus on in part augmenting and diversifying energy options, sources and energy infrastructure and implementing feed-in tariffs for renewable energy.

In addition, the government published “The National Policy on Biofuels”, in which a 20 per cent target was proposed for blending biofuels both for bio-diesel and bio-ethanol by 2017.

India has set management mechanisms and financial incentives to foster the use of renewable energy and an enhance effort directed at improving energy efficiency. Recently, the country introduced the renewable energy exchange mechanism, which provides energy certification and accelerates the use of hydro power, wind power and solar energy.

As for the financial incentives, subsidies and grants for low carbon development are under consideration. Bioethanol already enjoys a concessional excise duty of 16 per cent and biodiesel is exempted from excise duty.

Recently, the Ministry of New and Renewable Energy initiated incentives for developing solar water heating. Among them are subsidies, soft loans, concessional duties on raw material imports and excise duty exemptions on certain devices/systems. The government is encouraging the installation of solar water heating systems through a soft loan scheme, which is operated through the Indian Renewable Energy Development Agency Ltd and banks. Under the scheme, soft loans are granted at 2 per cent to domestic users, 3 per cent to institutional users that do not account for accelerated depreciation and 5 per cent to industrial/commercial users that account for depreciation in its financial records. The government also provides an interest subsidy, and a 5 per cent rebate on property taxes and capital subsidies are available for registered institutions and commercial establishments that install water heating systems.

Regarding international collaborative actions, of note, India hosts a number of CDM projects in renewable energy and energy efficiency. As of 8 January, 2010, a total of 478 of theses projects had been successfully registered with the executive board of UNFCCC. The country has the largest number of UNFCC-registered CDM projects with a 23.8 per cent share of the total projects. Number two is China. The registered projects in total average 40,195,147 tons of CERs (certified emission reductions), a type of emissions unit issued by the Clean Development Mechanism, each year. India is also a partner of the Asia Pacific Partnership on Clean Development and Climate (APPCDC), which promotes the development, deployment and transfer of clean and efficient technologies.

With support from the World Bank, India is working with a team dedicated to developing a low carbon growth model to be used as a planning tool to analyze key sectors and assess the impact of policy choices on GHG emission levels.

3.4.3.2 Co-benefits

According to India Energy Outlook 2007, the country has good potential for solar energy development. Most parts of the country experience about 300 clear sunny days in a year and the daily average solar energy incident ranges from 4 kWh/m^2 to 7 kWh/m^2. The country is estimated to have a potential collector area for solar water heating of 140 million sq. m. However, the installed capacity comprises a 1.5 million sq. m collector area as of 2007[172]. The solar water heater can replace electricity or other fuels used for heating heater. Estimates indicate that in 2007, the use of solar water heating systems offset 435,000 tons of CO2 emissions in 2007[173].

India is the fourth largest market worldwide for wind power, following Germany, U.S. and Spain. Locally based Suzlon Wind Energy company is one of the world's top producers of wind energy technology.

3.4.4 Thailand

Thailand is heavily dependent on imported energy. In 2007, the country imported 50 per cent of its energy supply. Its primary energy supply is about 124 Mtoe, mainly coming from oil with share of a 40.4 per cent to the total supply followed by gas with a 27.3 per cent share. (Fig. 4-8).

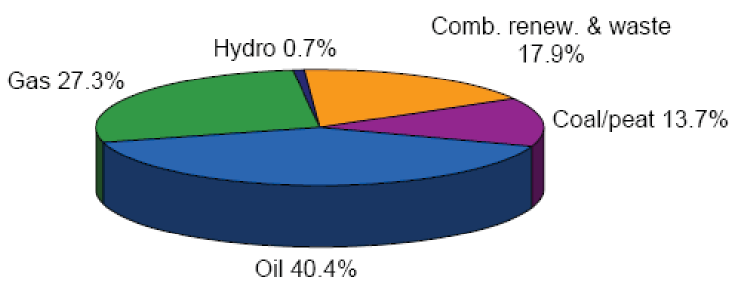


Figure 3-35. Share of total primary energy supply in Thailand 2007

(Source from IEA Statistics)

Thailand produces only 0.8 per cent of the world's CO_2 emissions, and has a lower per capita emission rate than the global average (3.25 metric tons in 2002, compared with 3.97 per capita worldwide)[174]. However, Thailand's total CO_2 emissions increased from 162 million tons in 2000 to 254 million tons in 2006 (Fig. 3-9). The energy sector is the biggest emitter in Thailand, with the main contributors being the power, industrial and transportation sectors.

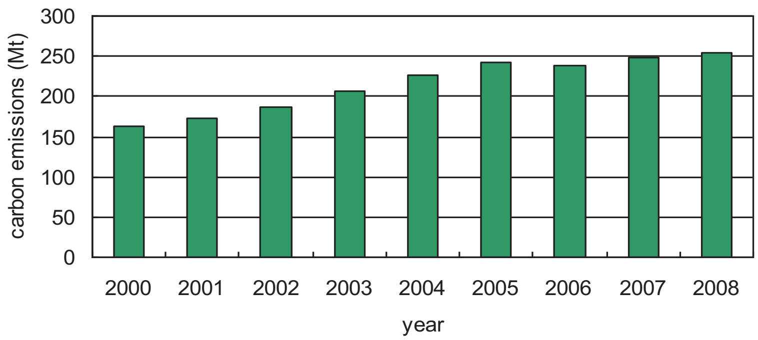


Figure 3-36. CO_2 emission in Thailand from 2000 to 2008

(Data from IEA Statistics)

3.4.4.1 Policy and action

"The National Strategic Plan on Climate Change 2008-2012" set six strategies to respond to climate change, including capacity building for institutions and personnel, reduction of GHG emission and increase absorbing sources of GHG and support research and development to understand better the impact of climate change.

To reduce CO_2 emission in the long term, the government has set an action plan for energy development. "The Alternative Energy Development Plan (2008-2022)" aims to increase the share of alternative energy in the country's energy mix to 20% from 6% in 2008. This action would, consequently, increase energy security, promote the use of green energy in communities and enhance the development of industries dedicated to alternative energy technology. The following are measures taken to promote energy development.

<u>Feed-in –tariff</u>

The Thai government provides a feed-in-tariff to supplement the normal purchasing tariff of electricity to the nation grid. The feed-in-tariff is set based on the renewable energy source for power generation as indicated in Table 4-3. . The payment will last for seven years for all sources expect wind power and solar energy, which will span 10 years.

Table 3-7. Feed-In-Tariff for Promoting Renewable Energy

Source of Energy	Adder cost (Baht / kWh)	To Replace Diesel Generation (Baht / kWh)	Special in 3 Most Southern Provinces (Baht / kWh)
1. Biomass			
- Installed capacity ≤ 1 MW	0.50	1.00	1.00
- Installed capacity > 1 MW	0.30	1.00	1.00
2. Biogas			
- Installed capacity ≤ 1 MW	0.50	1.00	1.00
- Installed capacity > 1 MW	0.30	1.00	1.00
3. Municipal Solid Waste			
- Anerobic Digestion or Landfilled Gas	2.50	1.00	1.00
- Combustion or Thermal Process	3.50	1.00	1.00
4. Wind Power			
- Installed capacity ≤ 50 kW	4.50	1.50	1.50
- Installed capacity > 50 MW	3.50	1.50	1.50
5. Small Hydro Power			
- Installed capacity < 50 kW	1.50	1.00	1.00
- Installed capacity 50 kW - 200 kW	0.80	1.00	1.00
6. Solar Energy	8.00	1.50	1.50

Source: Areerat Yoohoon. Low Carbon Economy. Asia-Pacific Forum on Low Carbon Economy. Beijing International Convention Center Beijing, China, 17-18 June 2009.

Soft loans

The government established the Energy Conservation Promotion Fund under the Energy Conservation Promotion Act in 1992 to promote investment in energy efficiency projects. "Energy Efficiency Improvement Program (2008-2011)" was designed to reduce energy demand in the industrial. transportation and residential sectors by about, 4.4 per cent, 4.7 per cent and 1.7 per cent, respectively.

A programme was set up to stimulate and leverage commercial investment for energy efficiency improvement and to familiarize commercial banks with the lending area and potential opportunities. Under it, the Thailand Energy Efficiency Revolving Fund through financial institutions finances projects aimed at improving energy efficiency and developing and increasing utilization of renewable energy. The fund offers loans with a maximum interest rate of 4 per cent and maximum loan period of seven years.

Board of Investment privileges

Thailand's Board of Investment has waived duties on imported equipment and machines used to develop renewable energy and in energy efficiency projects. It also allows companies involved in energy development-related projects to book 1.25 times the actual investment capital for tax calculation and stagger tax deductions over a 5-year period to lessen the tax burden. In addition, income taxes resulting from selling renewable energy or energy saving products are exempted for a certain period to a maximum of eight years.

Demand-Side Management (DSM)

DSM was set in 1993, when the Electricity Generating Authority of Thailand launched a

$189 million DSM Program, with support from the National Energy Policy Office. The programme aims to improve the capability of the power sector to deliver cost-effective energy services and promote the adoption of energy-efficient equipment throughout the country.

Between 1993 and 1996, the DSM office initiated four programmes to address energy use for lighting, refrigerators, air conditioners and commercial buildings. Between 1996 and 1998, the National Energy Policy Office launched about 15 new DSM operations, including compact fluorescent lamps, street lighting, green leaf, new buildings, brown rice, high-efficiency motors, low-loss ballasts, pilot Energy Services Company (ESCO) and, load management..[175]. Below is a list of the incentive mechanisms used in these programmes:

- bulk distribution and partnership with franchised retail outlets allowed substantial reduction in transaction costs;
- grant funds used to pay for higher incremental cost of high-pressure sodium vapour lamp;
- demonstration buildings, technical assistance and possible financial incentives;
- promotional campaign in partnership with Ministries of Health, Agriculture, and Education in Brown Rice; and
- interest-free loans and demonstrations for energy-efficient motors.

ESCO Fund

The ESCO Fund is part of the Energy Conservation Promotion Fund. It was set up as a source of venture capital investment for private operators involved in energy efficiency and renewable energy projects with the target to assist small, medium enterprises (SMEs) and smaller projects.

3.4.4.2 Co-benefits

The above policies and actions have resulted in notable energy savings. The Revolving Fund has reduced power demand by more than 200 MW and oil imports by more than 400 million litres per year. ESCO Venture Capital has helped fund 17 projects that are estimated to have provided energy savings of 446 million baht, ($16 million). The projects include biomass-fired power plants, solar power plants and energy efficiency improvement in air conditioning systems

The policies provide great benefits to the environment as well.. Specifically, through the DSM, the CO_2 emission reduction increased from 2.32 million tons in 2000 to 5.86 million tons in 2008 (Table 4-4).

Table 3-8. Operating Performance of DSM during 1993 Operating Performance of DSM during 1993-2008 [176]

programmes	Peak demand reduction (MW)		Energy conservation reduction (GWh/yr)		Carbon dioxide emission reduction (Million tons)	
	Jun 2000	Mar 2008	Jun 2000	Mar 2008	Jun 2000	Mar 2008
1. 36 and 16 watt fluorescent lamp	388	402	1,892	1,958	1.39	1.45
2. EE compact fluorescent lamp	9.8	10	56	57	0.04	0.04
3. EE refrigerator	84	314	849	2,626	0.68	1.86
4. EE air-conditioner	84	756	316	3,771	0.24	2.37
5. EE electric fan	-	14.7	-	131	-	0.06
6. street light	-	-	17	17	0.01	0.01
7. EE ballast	1.3	16	5.6	77	0.04	0.04
8. Energy –efficient motors	-	0.2	-	1.2	-	-
9. Green building	2.6	2.6	10	10	0.01	0.01
Total	569	1,514	3,150	8,649	2.32	5.86

CHAPTER 4.
Strategies to pursue a low carbon development path - some success stories

There is enormous potential to reduce carbon emissions. For example, one study shows that through more efforts on energy efficiency and conservation, it is possible to reduce India's energy intensity by up to 25 per cent from current levels (Lovins 2008). Despite major advances in the US' energy productivity in the past thirty – forty years, "well over half the energy harnessed is converted to waste heat rather than being used to meet energy needs" (Flavin 2008: 80).

The rationale for pursuing low carbon development varies from country to country but generally include 1) addressing climate change, 2) encouraging economic growth through various measures such as innovation and job creation, 3) to increase energy security. Many developing countries are also concerned with 4) social development, including ways to meet electrification goals. Another factor which plays a role is the political commitment to this issue by key government leaders. For example, in Germany, a world leader in renewable energy, investment really kicked off under the leadership of the coalition between the Green Party and socialist (red) party in 1998, both very committed to these three issues (Runci 2005). Three key areas where systemic changes must focus are:

1. reducing energy demand through efficiencies and lifestyle changes;
2. shifting to low carbon technologies;
3. carbon capture and storage. (Flavin 2008).

Other carbon sequestration activities, including reducing deforestation, are also important.

In Asia, a number of nations that are key drivers in various aspects of this vision. For example the Republic of Korea established a "Low Carbon, Green Growth" development strategy in 2008, which sets the direction of their energy policy until 2030.

Guided by energy security, energy efficiency and environmental sustainability, Korean energy policy focuses on four areas:

1) reducing energy consumption and improving efficiency - through moving towards a service-oriented economy and through various measures in industry (R&D to improve efficiency of industrial equipment), transport (support to produce green cars, raising fuel standards and increasing public transit), residential and commercial (green buildings) and the public sector (procurement);
2) reducing the use of fossil fuels and increasing the use of clean technologies (renewable energy will be 11 per cent and nuclear 28.7 per cent of the energy mix by 2030, an increase from 2.4 per cent for renewables and 14.9 per cent for nuclear in 2008);
3) encouraging the green technology industry ($11 billion government investment into R&D for this area to 2030, build large- scale test area for these technologies, encourage energy state-owned enterprises to purchase green technologies); and

4) ensuring its citizens have access to affordable energy (ensure all low income households spend no more than 10 per cent of their budget to meet their energy needs, assistance for low income families to acquire energy efficient products) (IEA 2008). Koruda 2009).[177]

The Republic of Korea's leadership in this area has inspired regional groupings, such as Association of Southeast Asian Nations ASEAN and the East Asian Climate Partnership, to pursue this strategy.

Another example is with the governments of Japan and the UK. They have created a three-year research project, drawing on expertise in both countries and beyond to discuss a "Sustainable Low Carbon Society". A workshop held under the auspices of this group discussed aspects of a low carbon society – including meeting the dual goals of sustainable development and a low carbon development path, the role that consumers can play, investment in alternative technologies, among other areas.[178]

That said, recognizing that a portfolio of policy options are required for an effective transition, various experiences and initiatives undertaken by certain countries, regions and communities will be useful to examine, rather than seeking out an optimal "all encompassing" approach moving towards a low carbon development path. For instance, the pathway and policy options chosen by the Republic of Korea, a nation with years of investment in their national systems of innovation and technological capacity, and heavily dependent on the exports of finished products to the United States, Japan and the European Union, among others, for GDP growth, were considered most relevant to that country. However, this pathway may not be as appropriate for another Asian nation, such as Cambodia, where the key areas contributing to the economy are tourism, exports of textiles (the US is the principal market), agriculture and construction (ADB 2009).

It is important to understand what is occurring worldwide. Some renowned success stories on the adoption of renewable energy technologies include policies encouraging electricity from PV in Japan and Germany, and wind energy in Germany and Denmark. These next sections highlight some experiences found throughout the world in the three areas identified above (reducing energy demand, substituting carbon intensive to low carbon energy options and carbon capture and storage) deemed essential in transitioning to a low carbon society.

4.1 Reducing energy demand through efficiencies and lifestyle changes

The first area discussed centres on reducing energy demand through increasing efficiencies and changing lifestyles. One policy option involving the reduction of energy demand being pursued, comes from California. In this state, electricity utilities' profits are not linked to electricity sales, but instead on providing the best service at the least cost. For this reason, electricity use rates per capita in California are much lower than the rest of the country. The main rationale for pursuing this policy was due to energy security in the aftermath of the oil shocks of the 1970s, and also at a state level, because the state has little coal reserves and nuclear energy was considered rather expensive (Shaw 2009). Some experts have criticized the programme for increasing the costs of electricity as well as increasing electricity imports (which are more carbon-intensive) (Tanton 2008 cited in Shaw 2009), but, nevertheless, the differences between California and the rest of the U.S. regarding electricity use are profound. Also, programmes were put in place to assist low-income customers.

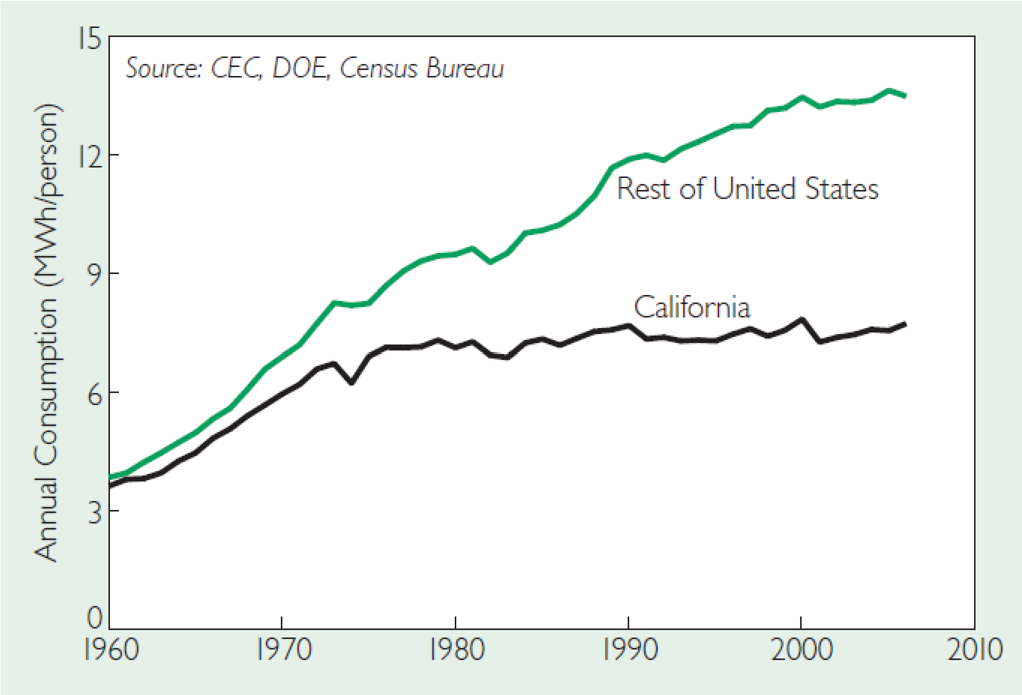


Figure 4-1. Electricity Use Per Capita, California and the Rest of the United States, 1960-2006

Source: Flavin, Building a Low Carbon Economy, State of the World 2008, p. 89

Other countries have established mandatory stipulations against certain forms of technologies deemed less efficient, such as Australia, which is phasing out incandescent light bulbs[179], and countries in the EU (Lovins 2008).

With a reduction in energy use and climate change as rationale, the IEA proposed another alternative approach in 1999, through something termed the "One Watt initiative". The idea is to have countries standardize their standby power standards (or the power consumed by electronics, appliances, and other devices, when not being used, or when in standby mode, sometimes termed 'vampire power'), to ensure they consume no more than one watt per device. On an individual basis, the power consumption is small, but when aggregated together, the amount is substantial. According to IEA's estimation, standby power is responsible for 1 per cent of global CO2 emissions. The Republic of Korea announced they would pursue the One Watt initiative, while other countries such as China and Japan also have stronger standards on standby power (IEA 2005).

Examples to encourage energy efficiency and conservation are also found in various nations of the developing world. For example, Brazil, which is heavily dependent hydropower, requires electricity utilities to spend 1 per cent of their annual revenue on energy efficiency projects. This directive was made after droughts in 2000- 2001 caused a series of *apagão*, or blackouts. Of this amount, half must be allocated to R&D projects (Rodrigues and Matajs 2005)

Countries in Asia are also taking encouraging steps in this area. Fundamental drivers for these countries to pursue a low carbon development path include energy security, as well as environmental concerns hand in hand with the goal of pursuing development. However, some variations exist regarding the prioritization of rationale and how best to achieve low carbon development. For instance, some countries view energy security as the utmost priority, while others have poverty alleviation as their overarching goal. Some Asian countries, such as Thailand and Indonesia, emphasize R&D in these areas through international / regional cooperation and technology transfer (Sumiarso 2009; Yoohoon 2009).

Countries also vary regarding which specific areas they wish to promote for cooperation. For example, citing reasons such as contributing to addressing climate change and socio-economic development for that region, Mongolia is emphasizing opportunities for very large scale PV in the Gobi desert (between 100 MW – 500 MW) and nuclear energy, as that country has uranium reserves (currently ranked 25^{th} globally) (Dorjpurev 2009).

Indonesia is also undertaking efforts to encourage energy efficiency. At the highest levels, that country is seeing a shift in the paradigm which has mainly focused on energy supply policies in the past, to a more comprehensive energy policy framework, stressing demand-side management of energy. Specific actions include energy audits for industry and buildings through a partnership programme between government and industry (Sumiarso 2009).

Other policy options being pursued by countries focus more on voluntary behaviour change. For instance, the UK established public education and outreach programs such as "Are You Doing Your Bit?" 1998-2000 and the UK's Energy Saving Trust's "Act on CO_2", which some argue have helped create awareness about climate change, but failed to mobilize the public to take action (i.e. make them care enough and be motivated and able to take action) (Ockwell et al. 2009b).

Canada promoted the "One Tonne Challenge" in 2004-2005, a programme aimed at encouraging Canadians to reduce their carbon footprint by one tonne per year per person through taking more public transit, recycling and composting and undertaking home renovations to increase energy efficiency. Canadian residents are estimated to be responsible for 30 per cent of the country's GHG emissions, when taken together, and about half of these emissions come from transportation. This programme was scrapped in 2006 when the Conservative Party of Canada became the governing party.

Criticisms of this programme were similar to those found in the UK on their public education and outreach initiatives on climate change. Canada's One Tonne Challenge was deemed successful in terms of raising awareness about climate change and the ability for Canadians to do something about it, but the campaign only had mixed results as many people were not clear how to reduce their individual carbon emissions by one tonne, and found some of the options offered were difficult to implement (i.e. for some in smaller towns, public transportation is sparse and instilling an organic composting programme would require many hours of discussion at town council meetings) (Environment Canada 2006).

4.2 Shifting to low carbon technologies

The second area where policies and programmes must focus on to pursue a low carbon development path is shifting from carbon intensive to low carbon technologies. Although some changes are occurring, fossil fuels remain an important part of the world's energy sources. For instance, the US DOE's International Energy Outlook 2009 shows that global electricity will still largely rely on fossil fuels in 2030.

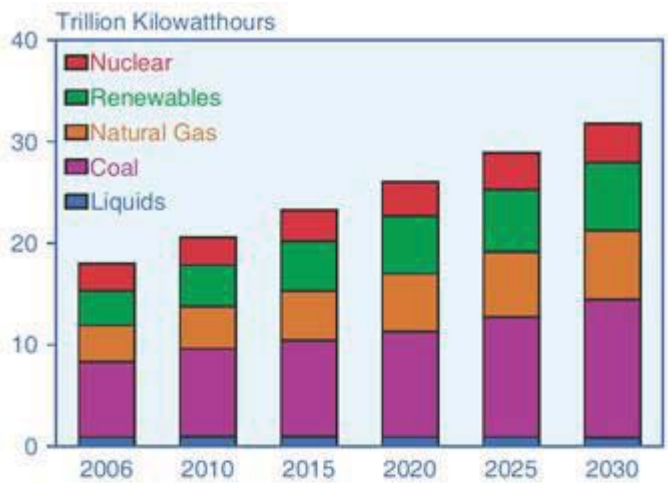


Figure 4-2. World Electricity Generation by Fuel, 2006-2030

Source: US DOE's Energy Information Administration, May 2009, International Energy Outlook http://www.eia.doe.gov/oiaf/ieo/highlights.html

Developing countries are moving forward with major infrastructure projects to meet their surging energy demand. Thus, presenting an opportunity to direct this investment toward low carbon energy alternatives (Lewis 2010).

Ideas put forth include decarbonizing the transportation sector from one based on fossil fuels to vehicles operating from electricity, hydrogen or biofuels, and through emphasizing more public transit.

In the power generation sector, one technology receiving a resurgence of interest is nuclear power, purported to be a way to meet increasing energy demand through a carbon-free alternative. The U.S., China and counties in Europe all have plans to build or are currently building nuclear power stations in the coming decades. The Republic of Korea is also expanding their nuclear power programme as a way to meet increasing demand from power generation, with 12 power plants planned (eight of these are already under construction). By 2030, nuclear power is expected to account for 59 per cent of electricity sources in that country, versus 26 per cent in 2007. The government suggests it will engage the public through facilitating dialogue and by making the decision making process transparent. The country is also continuing their R&D in this area[180], hoping to export Korean technology to other countries looking at this option (IEA 2008).

This option must be considered carefully however, as – in addition to the risk for local opposition due to disposal issues, leakage and safety concerns – it is expensive and time consuming (building a single plant can take 10 years if not more) (Flavin 2008).

Other sources proposed as low carbon alternatives to generate electricity are renewables. Some of the better-known examples include Germany and Japan's efforts to promote PV technology.

In Germany, market demand for PV was 1.68 GW in 2008. This is quite a feat for a country not known for top-notch solar conditions. Germany's success in this area can be traced to several factors. The first was the government's feed-in-tariff developed in the Renewable Energy Sources Act (shortened to EEG in German), established in 2000 and updated in 2004, where independent power producers were guaranteed a fixed tariff (considered profitable to potential investors) for a 20-year period. The minimum fee guaranteed for a PV system installed in 2007 was 37.96 cents per kWh generated (compared to about 3 cents per kWh for electricity generated from fossil fuels in Germany in 2005!), for 20 years. The rate is higher for smaller systems integrated into buildings. The second aspect is the fact that German research institutes have close relationships with German PV producers. Linked to the EEG, German producers and research institutes had an incentive to improve efficiency and reduce costs further (Sosemann 2007).

Initial research in this area in Germany – as in many countries -- began as a reaction to the global oil crises of the 1970s, when energy security was paramount. However, in the 1990s (i.e.. in 1998, when a 'Red-Green' coalition was elected in Germany) although energy security was also a concern, the main driver for Germany's pursuit of these policies transitioning to a low carbon economy was due to environmental concerns, particularly global climate change (Runci 2005).

Yet, as indicated in the figure 5.3, Germany (the world leader for PV for a number of years) was moved into second place, due to surging demand from Spain (2.46 GW). This demand has also largely been traced to favourable policies in place in that country, as well as more favourable climate conditions.

While the German experience is definitely to be lauded, some critics have pointed out that because the price for electricity offered by Germany for PV was so high, it kept the manufacturing base for solar panels high too – as investment rushed in, a shortage of panels lea to even higher prices. Furthermore, some suggest that as Germany emphasized wholesale electricity, other important investment areas such as energy efficiency and conservation were neglected (Kho 2009).

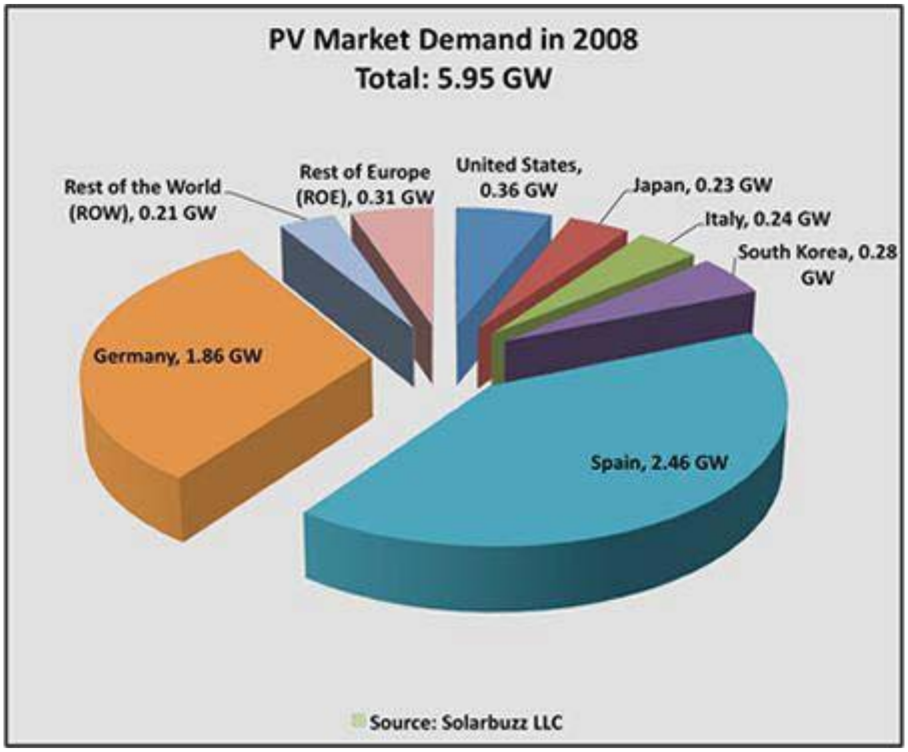


Figure 4-3. Global Photovoltaic Market Demand in 2008

Source: Solarbuzz. (2009). "Market Demand for Photovoltaics 2008." Retrieved June 1, 2009, from www.solarbuzz.com/Marketbuzz2009-intro.htm.

However, the subsidies offered to PV producers in Germany may not be feasible for many developing countries in Asia. Another example can be found in Japan, where the price differential between PV electricity and electricity from other sources is not as great.

The rationale for Japanese action on these initiatives, similar to Germany and other nations, was threefold: 1) to increase energy security; 2) growing environmental concerns, such as global climate change; 3) to stimulate economic growth through job creation and spurring innovation.

Japan, initiated the Sunshine programme in 1974, after the first oil shock to develop national technology alternatives to fossil fuels. It was renamed the new Sunshine programme in 1993 and ran until 2000 (Aranti 2002). The Japanese government also takes meeting its obligations under the Kyoto Protocol very seriously. In 1994, Japan offered rebates as high as 50 per cent to purchase a PV system in their “Residential PV System Dissemination Program”, but they since were phased out in 2005. Encouragingly, due to technical advances with the technology, the cost of this technology is about the same at present as it was a decade ago with the rebates taken into account (90 per cent of the Japanese PV market is households). The government is currently shifting subsidies from the household market to commercial and larger-scale applications. Japan has supported PVs through a mandate to have 10 per cent of their electricity come from PV by 2030. Japan’s success in this area has also been linked to their culture, which is tied to nature, and the fact that it has some of the most expensive electricity rates worldwide (about US 21 cents per kWh in 2005). In addition, PV systems are manufactured within Japan (and cheaper on a worldwide basis), and there are strong links between industry, academic research institutions and government agencies (Foster 2005). But, informal discussions have indicated that Europe is now the global leader in this area due to Japan's subsidy reductions.

China has also recently embarked on an ambitious Golden Sun Policy in July 2009 providing subsidies for 500 MW of PV projects until 2012 in an effort to support the domestic solar industry as a response to reduced overseas demand for PV panels in Germany and Spain. The idea of the policy is to support large scale PV, which complements their Solar Roofs Program from March 2009, which focuses on rooftop PV (Wong 2009).

Although China's programmes are relatively new, Germany and Japan's experience show that the importance of legislation and policies to support the development of a renewables market cannot be underestimated. For instance, in Germany, there was huge growth in the industry, not only PV, but also wind, biomass and other renewable energy sources, after the introduction of the 2000 Renewable Energy Sources Act.

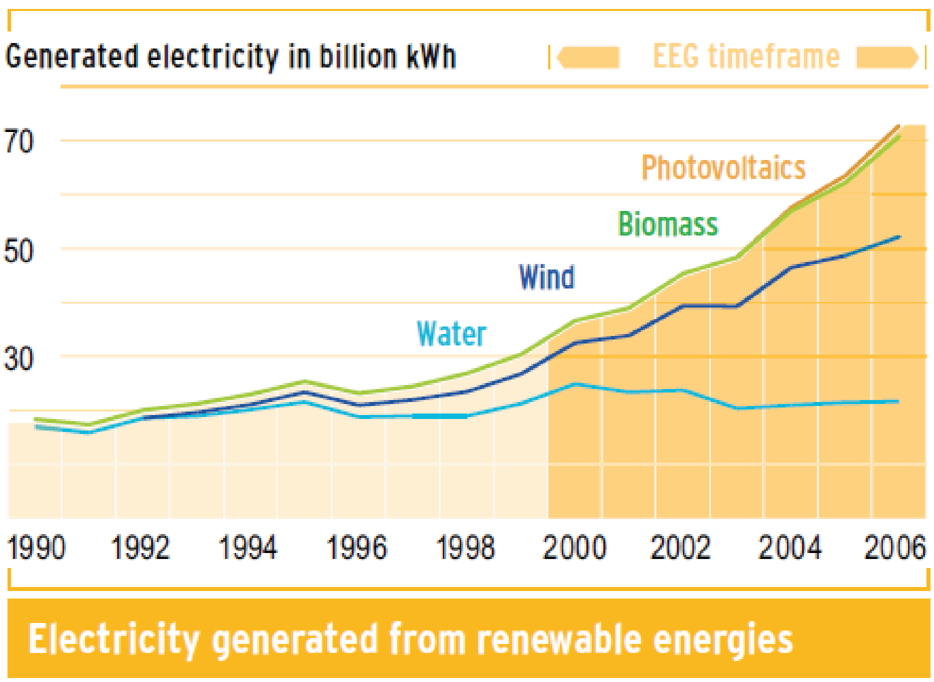


Figure 4-4. Electricity Generated from Renewables in Germany

Source: Sosemann, 2007, EEG - the Renewable Energy Sources Act - the Success Story of Sustainable Policies for Germany, German Federal Ministry for the Environment. Berlin, BMU, p. 5

When discussing the potential for standards to elicit change, there is little consensus on whether or not these standards must be mandatory or voluntary. Those that argue for a mandatory approach, highlight cases in which rapid rates of adoption occurred only after such legislation. For instance, a number of communities are drawing from the example of

Israel who made it mandatory for buildings to use SWHs in 1980, mainly for energy security reasons. That country is one of the world's leaders in this technology, where SWHs are commonplace.

In Spain, the Barcelona Solar Ordinance was implemented in August 2000. The legislation came into force after an 18 month "grace period" to allow builders, architects, engineers and other residents, time to adjust. Here, the city made it mandatory for all new buildings to have 60 per cent of their heating requirements come from solar water heaters [181], and 100 per cent for swimming pools. Before the ordinance, less than 2000 m_2 of SWHs were installed in Barcelona, versus 30,000 m_2 in 2005. This model was also pursued in other Spanish municipalities such as Pamplona, Madrid and Sevilla, as well as at the national level, where new buildings must ensure that 30-70 per cent of their domestic water is heated through this technology (Menanteau 2007).

Cities in the developing world are also intrigued and actively pursuing the Barcelona model. For instance, the municipal government of Mexico City passed a law in April 2006, making it mandatory for new commercial buildings (housing 50 or more employees) to source at least 30 per cent of their hot water needs from SWHs. In Brazil, the Cidades Solares (cidadessolares.org.br) initiative headed by environmental NGOs, Vitae Civilis and Ekos Brasil, and a trade association, the Brazilian Association of Refrigeration, Air Conditioning, Ventilation and Heating - National Department of Solar Heating, or Associação Brasileira de Refrigeração, Ar Condicionado, Ventilação e Aquecimento - Departamento Nacional de Aquecimento Solar (ABRAVA – DASOL) are working together to mobilize governments at various levels (especially municipalities) to adopt legislation requiring SWHs providing heating for water for a minimum percentage of buildings (Vitae Civilis 2008).

Other government policy drivers include renewable portfolio standards (RPS), where countries, states, regions and communities have a mandatory or voluntary goal to have a certain portion of their energy come from renewables. This policy is in place in a number of countries in the EU and many states in the U.S. including California, New Jersey, Pennsylvania, and Minnesota. Brazil, the U.S. and the EU also require that a minimum proportion of biofuels be blended with gasoline and diesel fuel.

Asia has also been playing an increasing role on the world stage with respect to renewables. The Indian PV sector, which originated from rural electrification and energy security programmes of previous decades, has seen some major growth since two additional relatively new national policies:

1) The Government of India's Semiconductor Policy Guidelines in September 2007, which is essentially a tax holiday until March 2010. The policy guidelines include a Special Incentive Package Scheme (SIPS) (a 20 per cent or 25 per cent subsidy for capital costs) for setting up semiconductor fabrication and other ecosystem units, including PV, and Special Economic Zones (SEZs), where numerous tax breaks are available and PV manufacturing is an eligible activity.

2) Electricity Generation Based Incentives (GBI) – here the Ministry of New and Renewable Energy (MNRE) will provide a subsidy for grid connected PV power

plants. The limit for the subsidy is up to 1 MW per project, 5 MW per developer in the country, and 10 MW per state, up to a total of 50 MW countrywide. The MNRE will guarantee PV project developers a tariff of 15 rupees ($.33) per kWh. In some cases, the MNRE will need to pay the difference between their guarantee and what the state electricity agency offers. For example, at present, the state electricity organization offers four rupees per kWh in West Bengal while in Gujarat, the state electricity organization offers a little over 15 rupees per kWh.

The Philippines – with the two key drivers being addressing climate change and increasing energy security also has a renewable energy plan in place to double the country's share of these sources, which was 43 per cent of primary energy sources in 2008 and to assess the feasibility of various renewable energy policies such as a feed-in-tariffs scheme and RPS., renewable energy portfolio standards. (Bariso 2009).

Some developing countries may be interested in the co-benefits of having renewable electricity, through decentralized options including small hydro or wind-solar combined system, to provide electricity to low-demand rural areas, as part of the development effort to increase rural electrification. This could benefit from foreign development aid, as well as funds from the CDM market.

As indicated in other studies examining technology transfer and cooperation of environmental technologies in the developing world including the potential for these countries to leapfrog, decision makers must also place attention on building up a country, region, or community's technological and absorptive capacity.

4.3 Carbon Capture and Storage

The third area to be discussed when examining a low carbon development path is CCS, where CO_2 is separated (or captured) from fossil fuels, either pre or post combustion, used to generate energy from large stationary sources – such as a coal-fired power plant or a hydrogen production plant. Once separated, the CO_2 is then transported to a storage site not necessarily close to the stationary source, often by pipeline, and then injected into a suitable geological formation for long-term storage.

Coal is forecast to remain a large source for electricity generation in the short to medium term. For a number of Asian countries, it is the number one source of electricity (i.e. in Mongolia, coal met 93 per cent of that country's electricity needs in 2007 (Dorjpurev 2009)). As shown in Figure 5.2 above, the US Department of Energy's International Energy Outlook suggests it will remain the largest source for electricity generation by 2030.

Largely due to cost and energy security concerns, many policymakers realize that China, India and the U.S, among other heavy coal users, are not likely to completely abandon this energy source. For this reason, there are many carbon capture and storage demonstration projects in the works. Some challenges with adoption of CCS to date include the fact that there have been a few projects up and running to date. Although some small-scale projects are in place throughout the world (including Weyburn, Saskatchewan, Canada and Scottish Power's recent seven month trial of CCS at a 1MW power plant in Fife in May 2009[182]), there are no large-scale projects operational. Also, the IPCC, in their 2005 report examining the feasibility of CCS, have suggested that adding CCS capability to gas or coal-fired power plants can increase the cost of electricity generated at that plant by 37 - 91 percent (Beauregard-Tellier 2006; IPCC 2005).

On the other hand, studies indicate CCS will be an important part of mitigation efforts. For instance, the IPCC's special report on CCS of 2005 notes that CCS will likely be 15-55 per cent of global cumulative mitigation efforts up to 2100. A modelling study by the Global Energy Technology Strategy programme suggests that without CCS the costs of stabilizing atmospheric concentrations of CO2 would triple (Stern 2006). In three of the four scenarios from Wang and Watson (2009), results indicate that 70-90 per cent of coal-fired power plants will have to be installed with CCS.

A number of countries such as the U.S., India and China are continuing to build (or are planning to build) hundreds of new coal-fired power plants. The governments of the US, EU, Japan and China are all funding CCS programs but some experts are surprised at how slow they are moving given "the urgency of climate change and the fact that much of the power industry expects CCS to allow continued reliance on the hundreds of coal fired power plants" (Flavin 2008: 79). Research is needed in numerous areas, including the identification and testing of geologically appropriate places to store CO_2 in the long term.

In developing Asia, a number of countries with coal reserves are continuing to develop them to help meet their energy needs. One such country, Bangladesh has expressed its interest in acquiring state of the art technology from the developed world to pursue this resource in a more sustainable manner (Kumar Biswas and Ahsan 2009). China is taking the lead in this area through their joint project with the EU called the "Near-Zero Emissions of Coal initiative". The initiative, which began work in 2006, is scheduled for completion in 2014. This is a joint venture project where China and the EU are both developing and demonstrating near-zero emissions coal technologies through carbon capture and storage by 2020 (Stern 2006).

Further exploration of this initiative may yield interesting insights to address needs in both developed and developing countries. A recent study from the UK and India on the barriers to the transfer of low carbon energy technologies suggest that international collaborative RDD&D initiatives can be an important way forward as they can have a significant impact on technological capacity development while also offering interesting ways around issues related to Intellectual Property Rights (IPRs) – where parties establish at the start of the collaboration that they will share IP as they work together. That study also suggests that international collaborative RDD&D initiatives are particularly important for those technologies in the early stages of RDD&D (such as CCS), as they may be able to address the concerns of countries and companies with maintaining their comparative advantages (Mallett et al. 2009).

4.4 Cross cutting

This area leads into the final section of success stories to be examined. Here, there are a number of issues, which can have an impact on potentially all three areas (efficiency and conservation, energy source switching, and carbon capture and storage). These issues include:

1) collaboration between countries, regions, communities and individuals; and

2) institutional issues

Encouragingly, collaborative research, development, demonstration and /or deployment (RDD&D) to address climate change, as well as other goals such as energy security, poverty alleviation and innovation, are prolific. At the international level, examples include those led by international organizations such as the United Nations and the International Energy Agency (i.e. TT: CLEAR[183], Indian Solar Loan Programme[184], a number of the IEA's Implementing Agreements[185], Networks of Expertise in Energy Technology (NEET)[186], Photovoltaic Market Transformation Initiative (PVMTI)[187]), a number of countries / communities (e.g. the EU's Seventh Framework programme[188], Asian Pacific Partnership on Clean Development and Climate[189], C40 Cities Climate Leadership Group[190], the Climate Technology Initiative[191]), one country (programmes of the United States Agency for International Development (USAID)[192], and the US Department of Energy's National Renewable Energy Laboratory (NREL)[193], programmes of the Japan International Cooperation Agency (JICA)[194] and NGOs (energy efforts of Practical Action[195] in the United Kingdom, The Energy and Resources Institute[196] in India). These are but a few examples.

The challenge with some of these initiatives, especially those led by one country with a particular political agenda, is that their status may not be as certain once that political party is no longer in power. Well-known examples include the various multilateral initiatives created by the U.S, under President George W. Bush (which some claim were created to counterbalance the existing climate change regime under the United Nations) including the Carbon Leaders Sequestration Forum, International Partnership for the Hydrogen Economy, and Methane to Markets. While the present administration in the U.S. appears as if they will continue previous efforts in these areas, it would be useful to have any developments feed into the ongoing climate change process initiated under the UN.

At the national level, some examples include the United Kingdom's Energy Technologies Institute[197], a company formed by a partnership between firms in the private sector and government agencies. The goal of this company is to provide funding for projects to bridge the gap between technologies proven in the laboratory and applying them commercially. The thrust of the company is to focus on long-term technologies to transition to a low carbon development economy from 2020 to 2050 (ETI 2009).

One key component of the more successful collaborations is that they include key players (the public sector, private sector and academia). This echoes the triple helix model in innovation studies where industry, the academic sector and governments at various levels (nation, region / state, and local) work together to innovate. The argument is that projects with more sources of leadership and support will be more likely to succeed (Etzkowitz et al. 2005). Ideally many advocate for more participatory approaches, engaging the public in the decision making process, although a number of problems have been identified in case studies when attempting to pursue this approach (See Ockwell 2008a for further information).

Another important area which transcends various efforts to transition to a low carbon development path centres on institutions. Several countries have initiated changes in their institutions in order to respond to the transition of a low carbon economy. For instance, in October 2008, the UK decided to amalgamate their resources at the federal level working on energy and climate change issues into a new agency, called the Department of Energy and Climate Change (DECC), establishing a new minister to head this portfolio. Previously, climate change issues were handled under the Department of Environment, Food and Rural Affairs (DEFRA) and energy under the Department for Trade and Industry (DTI), then termed the Department for Business, Enterprise and Regulatory Reform **(**BERR), which since June 2009 is the Department for Business, Innovation and Skills (BIS).

In France, the Ministry of Environment, Sustainable Development and Sustainable Planning created a consultative group with industry players, other government departments and community groups, termed the "Grenelle de l'Environnement", as a way to exchange ideas on a low carbon society.[198]

Changes within institutions can also permeate throughout, causing the whole organization to shift. For instance, the ADB has made climate change one of its top priority issue areas, providing $1.7 billion in funds to support wind power projects in China and India, energy efficient lighting for low income households in the Philippines, and mass transit systems in a number of Asian cities. The ADB also created a $40 million Climate Change Fund and a $40 million Asia Pacific Disaster Response Fund (Kuroda 2009).

To conclude, it is important to create and sustain demand for these technologies, options and behaviours, domestically as well as internationally. More often that not, government policies have been key drivers to promote transitions to a low carbon economy. However, policymakers recognize that pursuing a low carbon development path will have implications in other areas, and so must be examined in the context of other high priority policy areas such as energy security, innovation / the potential for green growth, poverty alleviation and sustainable economic growth.

CHAPTER 5.
Financing and investment challenges and instruments

The transition from an economy based on high carbon fossil fuels to one that relies on low carbon clean technology requires a tremendous amount of capital and must be done in a relatively short period of time. Much of the funding will be directed at accelerating the development to green technologies with the aim to make them price competitive.

5.1 Higher investments costs than expected

Taking on the challenge of climate change will definitely come at a high cost. Large investments must be made in clean technology, clean energy infrastructure, and energy efficiency to develop a low carbon development path. The costs to achieve this are mounting and now are much higher than previously estimates. Low carbon clean technology is the key to developing a low carbon development path, and new technology applications always require high upfront investment. The costs include direct financial cost, potential damages to the economy and other social costs (i.e. loss of jobs and livelihoods, further inequality among certain groups).

A UN study estimated that $200-210 billion worth of additional investment and financial flows would be necessary to return GHG emissions to current levels.[199] "New Energy Finance and the World Economic Forum estimate that at least $515 billion needs to be invested annually in clean energy over an extended period to keep carbon emissions from reaching a level deemed unsustainable by scientists."

A report entitled, "Energy Security and Sustainable Development in Asia and the Pacific" explains the higher investment cost of the energy system in the future. Statistics from the report show that the cost of expanding and modernizing the region's energy systems on the baseline scenario would be $375 billion annually—over $9 trillion in total. The report explains that China, for example, would need to spend $1 trillion on transmission and distribution networks alone and India would need to spend close to $700 billion in the electricity and oil sectors. For a sustainable energy scenario, however, the report estimated that energy demand would be less—$8.3 trillion—saving nearly $766 billion.[200]

If the governments of developing countries fulfil the commitments they made in 2004 in the Bonn International Action Plan[201], this would mean an additional 80 GW of renewable (other than large-scale hydropower) capacity by 2015, requiring $90-120 billion, or about $10 billion per year. Since not all developing countries made commitments at Bonn, the actual investment could be much higher. Investment as well as generation costs vary greatly among renewable energy technologies.

Moreover, a huge amount of investment will be needed to expand the region's energy infrastructure — especially in the power sector. Financing is a major challenge, exacerbated by the recent global financial crisis, which has forced energy companies to cut back on capital spending and delay or cancel projects.

5.2 Uncertainties on clean energy investment and risks

In 2006, global investment in clean energy alone reached $100 billion. The challenge for developing Asia-Pacific countries is how to capitalize on the increasing allocation of private capital to the clean energy sector, specifically, how to attract a greater proportion of this investment to the region. Investment in clean energy projects globally— particularly renewable energy projects— tends to originate from the private sector. Based on the requirements of private investment capital, it has been most active where well-designed and implemented policy and regulatory directions from governments have promoted such investment.

There are two main risks in clean energy investments, one is energy infrastructure investments, and the other one deals with deployment of low carbon technologies.

First of note, , the risks associated with energy infrastructure investments are different from those in other types of investment. It can be divided into two types, namely, commerce and policy. Commercial risks are connected with developing and constructing the project and include interest-rate changes, inflation, currency risks and movements in international prices of raw materials and energy inputs. The policy risks include changes in the regulatory framework, war, civil unrest and strikes.

Secondly, investment in innovation is an uncertain process; the outcome of the investment, the marketability of the product and the costs required are all uncertain. This is especially the case with low-carbon innovation where there is additional uncertainty about the future price of carbon and the commercialization of technologies.[202] There can be a long period between an initial investment in technology and the time that it becomes profitable. Private firms may not be prepared to invest enough in a new technology if they have to wait a considerable time for the rewards. There is a high degree of uncertainty around the costs associated with the wider deployment of low carbon technologies. The risk of deployment with low carbon technologies entails risk of innovation and longer payback periods.

Uncertainties associated with the carbon price and the future direction of the carbon market and regional governments' commitment to energy sector reform also serve as deterrents in investment in clean energy, i.e. the process of negotiations under UNFCCC will largely affect the capital flow and technology deployment which are the key of a low carbon development path It is demonstrated that all the details could not be agreed upon in Copenhagen in 2009 and most of these details would have to be elaborated in post-Copenhagen.

5.3 Challenges for private enterprises

Financing for the private sector is always a problem for the countries in Asia and the Pacific, especially developing countries.

Some studies on environmental management and green innovation show that most companies have been slow to adopt environment-related improvements. This somewhat negative picture of limited responsiveness extends to the take up of ”win-win” and ”low hanging fruit" opportunities and to engagement with environment-related business support. Studies attribute this limited responsiveness on the part of most private enterprises to a number of internal and external barriers, but particularly to a lack of market, regulatory and fiscal signals and doubt among owner-managers relating to the business case for sustainability.[203]

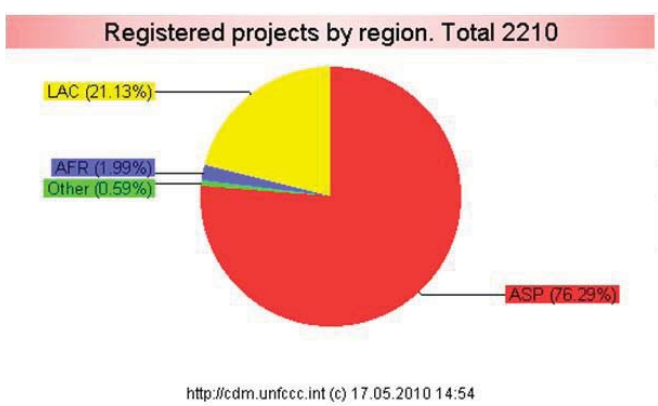
For example, private enterprises made a huge contribution in China's rapid transition into a market economy. However, as the private enterprises grew, the financing problems also emerged, which restricted its further development. The major reasons behind this were the poor financial conditions of the private enterprise, an imperfect financial mechanism and the absence of related policy to support them.

To solve the problem mentioned above, the government should set policies and regulations that assist the enterprises, develop innovative financing schemes, open up more financial services while private enterprises should strengthen their manage.

5.4 Lessons in Clean Development Mechanism (CDM)

CDM is one of the three Kyoto Mechanisms designed for the purpose of global GHG emission reductions. It is a system by which Annex I countries (i.e. industrialized states) and their companies can form a partnership with renewable energy or emissions displacing project developers in developing states.

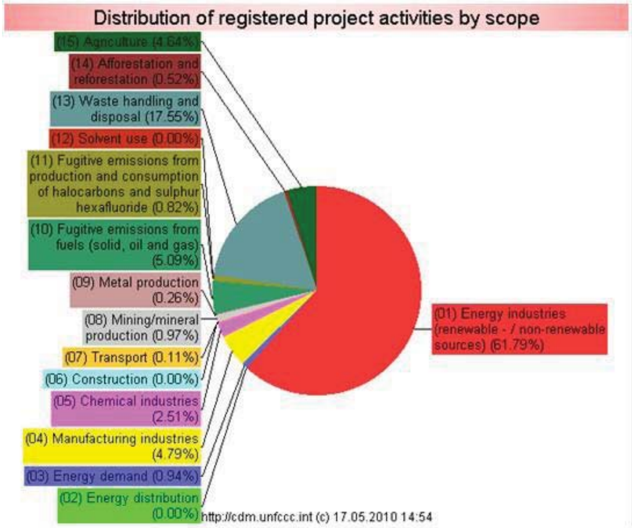
Since February 2005 when the Kyoto Protocol came into effect, the CDM market has grown rapidly in Asia and the Pacific. As of 17 May 2010, the region had more than 1,600 CDM registered projects. More than 60 per cent of them were energy related—for renewable energy or improving energy efficiency (i.e. fuel switching).



Region	Number of projects
NAI-Africa	44
NAI-Asia and the Pacific	1686
NAI-Other	13
NAI-Latin America and the Caribbean	467

Figure 5-1. Registered projects by region

Registration



Sectoral Scope*	Registered Projects
(01) Energy industries (renewable - / non-renewable sources)	1651
(02) Energy distribution	0
(03) Energy demand	25
(04) Manufacturing industries	128
(05) Chemical industries	67
(06) Construction	0
(07) Transport	3
(08) Mining/mineral production	26
(09) Metal production	7
(10) Fugitive emissions from fuels (solid, oil and gas)	136
(11) Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride	22
(12) Solvent use	0
(13) Waste handling and disposal	469
(14) Afforestation and reforestation	14
(15) Agriculture	124

Figure 5-2. Distribution of registered project activities by scope

Despite initial expectations the CDM would become an effective tool to promote sustainable and many developing countries set to join the CDM bandwagon, barriers continue to implementing it remain salient. Especially, the mechanism's high expectations for technology transfer and finance have yet to materialize in most countries. Many countries have not taken full of advantage of CDM. For example, Indonesia has the potential to develop CDM projects that could generate 235 million certified emissions reductions (CER) by 2012, but only 12 projects with a potential to generate 13 million CERs by 2012 were registered to date.[204]

One barrier is financing. Many CDM projects in the region have been unable to get off the ground due to insufficient underlying financing. To overcome this, innovative options should be explored such as the use of official development assistance and other multi-source funding approaches to cover projects risks, especially in least developed countries (LDC) and middle-income countries. Other concerns include complex modalities for project approval, lack of a development dividend in projects delivering high CER, uncertainty over post-2012 carbon credits, and uneven geographic distribution of projects within Asia-Pacific. Developing countries in Asia, in close collaboration with the UNFCCC Annex I parties, should strive to remove each of these barriers so the power of market mechanisms can be fully exploited, particularly for the most vulnerable segments of society.

5.5 Obstacles in carbon market

Carbon trade has the potential to confer the biggest flow of funds to developing countries – estimated to be between $20 billion and $120 billion per year, But to become an operational long-term global regulatory framework with differentiated responsibilities and intermediate target must be put in place. New financial instruments are required, especially to ensure market continuity in the post-2012 period.

The obstacles to developing a carbon market include strict limitations on the post-2012 CDM Market; bottlenecks in the CDM which is higher credit price and costs for the European Union (EU) and project developers, respectively; the other obstacle is quick link between the international transaction log (ITL) and the European Community Independent Transaction Log (CITL) is necessary to physically import CERs into the Emission Trading System (ETS) and thus abate delivery risk.[205]

Promising advances in clean technologies combined with rising oil prices have created a dramatic increase in renewable energy investments over the last several years. However, inclusive results at the Copenhagen Climate Conference in 2009 and failure to establish a price on carbon could hinder even existing projects aimed at promoted low carbon development. The agreement – the Copenhagen Accord – is a political declaration with no legal status. Consequently, there is still an urgent need for an agreement that keeps the Kyoto Protocol elements alive, and which also leads the Bali Action Plan elements into another legally binding treaty in order to establish a strong legal architecture.[206]

Trade disruption and trade wars are a distinct possibility if not global agreement is reached. As countries begin to address climate change and incur the associated costs, disruptions in trade due to uneven regulation on carbon emissions would only exacerbate the ability to adapt to and mitigate the consequences of climate change. Fragmentation without a global agreement would result in higher costs for businesses in the transition to a low carbon development path. .[207]

5.6 Global Financial Crisis

The global financial crisis has affected Asia-Pacific countries in varying degrees. Cambodia, Singapore, Malaysia and Thailand slipped into recession in either late 2008 or early 2009, while growth in Indonesia slowed to its weakest pace in ten years. For the region as a whole, economic growth fell from 6.4 per cent in 2007 to 4.3 per cent in 2008. Neighbouring economies, including China and India, have been relatively less affected. The crisis has therefore raised questions as to whether the region needs to shift away from its traditional export-driven model of economic development towards greater reliance on domestic demand and regional demand.

FDI inflows into the region, historically a key driver of economic expansion, have also fallen dramatically as international companies have scaled back their spending.[208] The financial crisis has adversely affected corporate investment across the energy sector, with lower credit availability and rising interest charges. Many companies have had to reassess their balance sheets and rein back investment plans, with highly geared companies particularly hard hit. Smaller firms and companies in emerging sectors, such as solar or biofuels, have been disproportionately affected; global biofuels investment in the first quarter of 2009 was 75 per cent lower than the same period the previous year. In the transport sector, a slump in demand has curbed the production of new, more efficient vehicles.

And because the economic and financial crisis is global in the sense of having negative spillover effects on many economies, many countries have had to design and implement adjustment policies to mitigate the risk of economic recession and financial disorder. Economic stimulus packages vary in detail from country to country. One common feature is expanded fiscal expenditures on economic and social infrastructure.[209] Therefore, the stimulus packages in the countries also bring a chance for low carbon production and low carbon technology deployment.

All in all, the financial crisis has exacerbated the difficult challenge of financing the transition to a low carbon economy for many countries Asia-Pacific countries, and it may delay the process.

CHAPTER 6.
A Policy Framework in Support of the Development of a Low Carbon Economy: Challenges, Principles and Strategic Considerations.

Setting an effective policy framework to make the urgently needed transition to a low carbon economy is not only a major step in the process but a large challenge.

One of the most important policy objectives is to increase energy efficiency and encourage widespread consumption of renewable energy. Some of the current barriers to this process include legal or institutional issues, financial matters and lack of awareness or information.

This chapter first looks at the policy framework from a legal, political and institutional perspective. It then points out guiding principles for working toward a low carbon

6.1 Laws, regulations, rules and standards

A low carbon development path needs it own set of supporting laws, making it necessary to revise national laws including regulations, rules and standards.

6.1.1 Laws/Legislation

Many Asia-Pacific countries have already revised and amended some of their laws/legislation or issued new laws to promote renewable energy and make use of energy more efficient but still related laws directed at developing a low carbon economy are urgently needed. In fact, no country in the region has enacted legislation that completely overturns current development paths in favour of a low carbon development path.

Japan's actions provide a good example of this. The country's Climate Change Policy Law supplements the 1993 Basic Environment Law, which set as a national goal the establishment of sustainable society. The Law Concerning the Promotion of the Measures to Cope with Global Warming (or Climate Change Policy Law), which was enacted in 1998, was prepared for the Kyoto Protocol Target Achievement Plan, and was subsequently approved by the Cabinet in 2005. This plan not only set GHG reduction target of 6 per cent under the Kyoto Protocol but also pursues long-term, continuous emissions reduction. The enabling legislation, however, focuses on the short-term objectives and does not stipulate a legal requirement to achieve a low carbon economy.

Recent laws set in China are another example. In the past few years, China has enacted two significant laws pertaining to energy development, The Renewable Energy law, which took effect in 2006, and the Energy Conservation Law, which became effective in 2008. Despite this legislation, China still lacks a complete set of energy laws for comprehensive energy deployment to guarantee energy security, energy supply and energy trade as well as the successful transmission to low carbon economy (LCE).

6.1.2 Regulations

Some countries in the region have in place related laws about energy or the environment but lack specific regulations are still missing.

For example, China enacted the Renewable Energy Law more than two years ago but has yet to put in place concrete regulations. And there are also no concrete implementation rules in "Circular of the Ministry of Finance of the People's Republic of China, on Printing and Issuing the Provisional Measures for Administration of Special Capital on Developing Renewable Energy Resources" issued by Ministry of Finance, particularly no preferential policies available for rural biomass development, which hinders the development of biomass energy.

6.1.3 Rules and standards

Many countries in Asia-Pacific still lack the necessary related rules and standards. China, for instance, is still formulating regulations pertaining to energy use in buildings to correspond with the 2-year –old Energy Conservation Law. Standards for other facets of society need to be improved as well to make the law the effective.

Many new rules and standards need to be set for the transition to a low carbon economy. Among them are:

- emission standards and corresponding criteria for various industries; and
- criteria for the approval of construction projects in the following sectors:

1. iron and steel;
2. non-ferrous metallurgy;
3. building materials;
4. chemical industry;
5. power generation and light industry; and
6. fuel standards,

Energy efficiency standards, and other standards related to a low carbon economy are also urgently needed.

The U.S., for example, is looking to establish new low carbon standards, with the state of California's Low Carbon Fuel Standards setting the precedence. Policymakers believe that the most direct and effective policy for transitioning to low-carbon alternative transportation fuels is to spur innovation with a comprehensive performance standard for upstream fuel producers. Under this assumption, the transition to a low carbon development path requires a lot of new standards.

In addition to setting standards, many need to revise one already in place. At the same time, although some countries have developed some standards, they are still needed to be improved. For example, China's Energy Conservation law established a certification system for energy saving products. The policy framework provided by the law included the following:

- to implement compulsory energy efficiency standard for some products;
- to authenticate energy saving products and;
- to list government procurements by priorities.

This policy is largely instructional and has flaws in terms of results, such as inconsistency between different certification standards and lack of economic incentives.

6.2 Policies

A series of policies is required drive the absolute reductions of GHG emissions necessary to address climate change. No single policy will be sufficient to enable a low-carbon future by 2050. Clear and consistent policy signals are urgently needed. The policies need to be broad (economy-wide) and technology-specific.

6.2.1 Economic policies

For the many countries in the region, where economic development is the main priority in their economic policies, pursuing a low carbon economy presents a big challenge.

The policymakers in developing countries of Asia-Pacific prefer to meet basic developmental needs before addressing climate issues. To illustrate, large rural populations in Asia lack access to modern energy sources (i.e. nearly 54 per cent of the people in Indians lack access to electricity). Since there is a strong correlation between economic development (GDP) and energy consumption, policymakers want to ensure these populations have access to reliable electricity. However, many of the current sources of dependable energy (i.e. coal-fired power plants) will increase GHG emissions. Policymakers do not want to risk pursuing more innovative energy options that may turn out to be unreliable.[210]

As a consequence, policymakers, especially those working for local government, are confronted with the challenge to bypass short-term benefits in favour of seeking results for the long run. Developing a low carbon development path will entail of lot of juggling of economic policies with those related to energy conservation and development.

6.2.2 Energy policies

A government's energy policies are extremely important. They strongly affect a country's energy security, economic development pattern and international trade, and in turn, influence the standard of living. These policies are dominated by exploration and production, depending of course on each country's available energy resources. China's energy policy, for example, aims to secure domestic supplies while increasing international exports.

The relatively low status accorded to climate change is also related to natural resource endowments. India has large coal reserves (estimated to be about 234 billion tons in 2002) and therefore has a carbon-intensive energy system. China also has a carbon-intensive energy structure, with coal accounting for 66-75 per cent of primary energy consumption from 1980 to 2006. The reversal of policies to improve energy security, such as switching from oil to coal in Indonesia and Vietnam, and from forest protection to deforestation to grow biofuels in Malaysia and Indonesia, are similar illustrations of how easily exploited natural resource endowments can increase GHG emissions. For example, Indonesia's energy policy to rapidly expand coal-fired power generation will increase GHG emissions from coal burning by 20 times between 2005 and 2025[211].

With differing energy bases, the countries in Asia-Pacific have to adopt different energy policies to achieve the balance between energy demand and economic development.

For example, Coal will remain China's major primary energy source for a long period. The country is in a stage of rapid industrialization and urbanization, with two thirds of its primary energy needs met with coal - about 70% of its electricity comes from coal-fired plants. Its large-scale infrastructure construction needs enormous quantities of steel, cement and electric power. Although China continues to optimize its energy supply structure, it has abundant coal, little petroleum and inadequate natural gas.

Therefore, the challenge is to design appropriate energy policies that are neutral enough in this stage to promote the development of the economy and deployment of country's energy resources, while transitioning to an optimized energy structure.

6.2.3 Environmental policies

There are two main challenges for the environmental policies for the countries in Asia and the Pacific.

First of all, environmental policies have a lot of room for improvement.

Secondly, the environmental policies already in place must be carried out and enforced. Many local governments glaze over the policies as they often hinder policies directed poverty reduction and economic development, generally a top priority among developing countries.

6.2.4 Other policy considerations

New technologies are vitally needed to make the transition to a low carbon economy and to achieve these governments must implement policies that promote innovation. That said, without lowering the cost disadvantage of renewable electricity generation, providing support for innovation to improve energy efficiency is unlikely to be a cost effective way of reducing emissions. Similarly without innovation in the way electricity supply companies interact with their customers through smart meters, the potential costs of dealing with the intermittency of renewable energy are higher. The effectiveness of supporting innovation in one sector will often be dependent on the deployment of low carbon technology in other sectors of the economy.[212]

Accordingly, there is a clear need to initiate and sustain policies to push and pull low-carbon technologies into the market. Without such policies, businesses, consumers, and citizens are missing opportunities for cost-effective GHG reductions and investment for the future. A variety of policies, public and private partnership and broad societal engagement are needed. Characteristics of the energy sector — long capital investment cycles, a high degree of system inertia, and the tendency for past developments to strongly influence current technology choices — highlight the need to begin now to promote technological change and enable far-reaching deployment over the next 50 years[213].

6.3 Institution and mechanism

Apart from various research committees and think tanks, there is no evidence of countries establishing specific institutions to implement a low carbon development path. Generally, the broad goals of setting up a low carbon economy (LCE) or low carbon society are handled either by national councils for sustainable development or by national councils on climate change, with implementation delegated to energy, environment, and sector agencies.

For example, in Japan, immediately after adopting the Kyoto Protocol in December 1997, the government set up the Global Warming Headquarters (GWH), chaired by the prime minister and with all line ministries represented. The GWH drew up Guidelines on Measures to Prevent Global Warming in 1998, which allocated responsibilities to each sector to reach specific emission reduction targets, backed by the Climate Change Policy Law. Moreover, the prime minister's office established an Advisory Panel on Climate Change in February 2008 to discuss various issues regarding the pathways to develop a LCS and Japan's contribution to the global community.[214]While the guidelines clearly refer to activities which will assist in moving Japan towards a low carbon development path, this is not a specific mandate or objective of the GWH.

After signing the Kyoto Protocol in 1997, South Korea established an inter-,ministerial committee (IMC) on the UNFCCC in 1998, chaired by the prime minister, supported by five task forces and an expert pool drawn from nine research institutes. This arrangement was expanded in 2001 to include a new task force on general coordination, headed by the Office for Policy Coordination. Separated from and working independently of the IMC, a Presidential Commission on Sustainable Development was established in 2000. The new government in 2007 has emphasized that the climate change crisis can be converted into an opportunity for green economic growth. So far, however, there has been no change in national institutional arrangements related to climate change.[215]

Due to its uncontrolled forest fires, Indonesia is regarded as possibly the world's third largest emitter of GHG. The 2007 National Action Plan on Climate Change sets out institutional arrangements for implementing Indonesia's commitments (and opportunities for development funding) under the Kyoto Protocol, such as the National Committee for the CDM established under a Ministry of Environment decree in 2005.[216] However, as there is no supreme body in charge of low carbon development, institutional arrangements are uncoordinated with the ministers of environment, forestry, energy and mineral resources, and national development planning all playing a role.

6.4 Some Guiding Principles

To address these challenges, a low carbon development path must be effective and at the same time have strong political support. .

6.4.1 Build upon political consensus

The low carbon development path should be supported by a number of political constituencies and able to build a broad political consensus. To be politically feasible, policies and measures that attempt to address climate change and energy security must build this political consensus by addressing a number of issues.

6.4.1.1 Develop an appropriate time horizon

A low carbon development path will exist on a time horizon that extends beyond current political and investment cycles.

Adopting a low carbon development path require solutions that are implemented today and sustained and adjusted over the medium- to long-term. Therefore the development of a low carbon development path involves confronting the inertia of our current energy system (the cost and business advantage built up through a century of infrastructure projects and trillions of dollars of investment) as well as adapting to future uncertainties.

It is highly unlikely that policymakers today could draw up energy and climate policies that will withstand the test of time, because the problems will continue to change and our understanding and capabilities will continue to evolve. Therefore, the policies and measures for low carbon development should be updated and improved periodically.

Given the sheer number of variables in play, policymakers will need to establish a long-term process that is broken down into manageable pieces, with measurable milestones on the way toward the ultimate goals. This approach allows for time to implement a policy, evaluate its effectiveness, and make changes based on new information, tools, and external conditions.

6.4.1.2 Recognizing costs

Adopting a low carbon development path will require a fundamental transformation in the way the world produces and uses energy. Many scenarios have estimated that it would need a large incremental investment and cost in this process. As such, policymakers should recognize that the steps to address energy security and achieve the low carbon transition will not be easy or without costs. It will be important to create opportunities for economic gain in an effort to counterbalance the costs. However, it is also important to consider the eventual costs to society of doing nothing. While certain kinds of energy may be more expensive today, the costs incurred will likely be much higher in the future if energy security is not addressed and low carbon development path is not adopted now. A number of reviews estimate that preparation for this transmission will cost significantly less if efforts are made at earlier time.

Therefore, potential solutions do not need to be cost-free but be economically viable. The public's willingness to pay may be high if it is the best option for achieving economic growth and addressing the climate change issue. Demonstrating cost-effectiveness will be necessary to make the case for such disbursement of public funds.

6.4.1.3 Integrated with other political priorities

The low carbon development path is a path based on the country's development stage and resource situation and achieves the balance of economy and environment. Without abandoning the existing policies, it is necessary to combine the policies needed for the low carbon development with other policies.

Creating policy contradictions or unintended consequences is a danger that any policymaker faces, but it is particularly important to be aware of these challenges when making low carbon development policy. Energy and low carbon development policy measures have a tendency to spill over and can quickly run up against other policy priorities such as trade, security, foreign policy, agriculture, and science and technology policy. Policymakers must recognize the links between these sectors and plan accordingly.

As it is unlikely that policies or investments made will be entirely without impacts on other sectors, it will be important to become more aware of the trade-offs and make educated and well-communicated decisions while endeavouring to manage such trade-offs. Policymakers must effectively manage the competing political constituencies that will be involved because their interests have somehow become intertwined. For instance, efforts to promote greater production and use of biofuels have yielded some unintended consequences, such as the increased price of corn and corn-derived products, stress on land and water resources, the potential for stranded assets going forward and an expensive and far-reaching subsidy program on top of existing farm subsidies. Managing these trade-offs and the affected constituencies is crucial to building the necessary buy-in for an approach to be politically feasible.

6.4.1.4 Creating space for development needs

Currently, the first priority for most countries in the Asia-Pacific and Pacific region is economic development and poverty reduction. Consequently, during the process of adopting a low carbon development path, achieving sustainable economic development must be placed at the top of the list.

Generally speaking, developed countries are largely responsible for the historical emissions that have led the world to the current climatic precipice. At the same time, developing countries are a large and influential source of emissions going forward. Thus, it is crucial for emerging economies to be engaged in global climate mitigation efforts. International agreements must recognize the inherent need of societies to develop and increase standards of living, especially for the large portions of society living in poverty and without access to modern energy services.

Therefore, the low carbon development path in the region must combine with national conditions especially the development stage of each country, providing potential for development, and policymakers must recognize and deal with these concerns while taking climate change into consideration. Different types of commitments and targets for a low carbon strategy, commensurate with developing countries' national circumstances, must be incorporated into this low carbon development path.

This brief review of the institutional arrangements surrounding climate change and its relationship to a low carbon development path, for the major GHG emitting countries in Asia-Pacific is fairly representative of the other countries in the region. Almost all countries have recognized that sole responsibility for climate change and moving towards a LCS cannot be relegated to their environmental agencies alone. As these are cross-cutting issues, requiring inputs from almost all ministries, generally an intergovernmental low carbon development committee or commission has been created under the office of the head of state.[217]

Moreover, the biggest problem in many countries is not the lack of the related laws or regulations, but poor implementation of the existing policies. So, both mandatory and incentive mechanisms for the better implementation of the policy are urgently needed. In addition, the lack of an overall plan to promote low carbon development within the government is also a big challenge.

6.4.2 And be effective…

In this context, an "effectiveness principle" could translate into the ability to limit and adapt to global climate change and secure adequate supplies of reliable and affordable energy and, meanwhile, achieve the economic growth. Several factors are important for the energy sector to ensure that a climate change mitigation and energy security policy framework can achieve these goals in adopting a low carbon development path. To be successful, policies and measures should do the following:

6.4.2.1 Adopting a regional and integrated approach

The effects of climate change are global in nature, as are the sources of GHG emissions. Combating climate change, therefore, will require coordinated action by the whole world, including all countries in the Asia-Pacific region. No country can solve the problem acting alone. The region as a whole mush participate and cooperate in the effort to craft an effective solution., Participation from major new emitters like China and India is vital..

Moreover, the interdependent nature of the regional economy makes the Asia-Pacific region inextricably linked to regional and global energy security. Because energy security relies on diversity of fuels and suppliers, companies and policymakers should adopt a regional approach to energy security. Despite growing calls for energy independence, global energy markets offer flexibility, efficiency, and savings that are important to maintain. Countries in Asia and the Pacific must learn to recognize the interdependent nature of their energy security. Given the interconnected nature of global energy markets, countries in this region will continue to rely on one another for their energy supplies for the foreseeable future. It is important to resist the isolationist pursuit of energy independence at the expense of regional cooperation and trade.

The low carbon approach should take into consideration all economic, social and environmental factors, and include all the related sectors, especially the energy-generating sector, the industry sector, the building sector and, transport sector. This low carbon approach should be integrated in local and national government, the businesses and the civil society plan and programmes.

Most studies demonstrate that the earlier of a regional and integrated approach is developed and agreed, the more effective the efforts on low carbon development, especially on addressing the climate change.

6.4.2.2 Promoting but don't dependent on technology breakthroughs

Adopting a low carbon development path will require new technologies, so investment in new technology solutions is of great importance. Government policies and, direct funding should both focus on technology innovation and deployment, especially the deployment of practical technologies. Economic incentives and mechanisms should facilitate the involvement of the private sector in the deployment of low carbon technology, such as an enhanced CDM or the development of new mechanisms. Decision makers must take a long-term view and make a sustained commitment to technology development so that the world is properly positioned to take advantage of new market opportunities.

However, policy solutions must not be based on overly optimistic assumptions about the pace of technological development. It is important to recognize the limitations of existing technology and not to underestimate the time it takes for new technologies to reach commercial- or wide- scale deployment. Development of new technologies that enable widespread use of cellulosic ethanol, carbon capture and sequestration, hydrogen fuel cells, and even nuclear fusion in the distant future, as well as transformative materials and battery technologies, have the potential to transform current energy systems. Innovation and development will clearly be important, but solutions should not be based on assuming technological miracles. Policies and measures must be crafted to drive innovation and diversity while allowing markets and behaviour to change in a way that is consistent with policy goals.

6.4.2.3 Applicable to a robust range of future scenarios and adjustable to evolving circumstances

Because future climate change and energy security scenarios are so uncertain, policies and measures to address the issues in adopting a low carbon development path cannot depend on any given set of energy supplies or climate impacts.

Instead, policies and measures must be flexible and adaptable enough to succeed in any of the political environments of those countries in the Asia and the Pacific region and should be designed with enough foresight that they continue to push toward the desired outcomes regardless of unanticipated developments along the way. At the same time, policies must provide enough certainty and stability to encourage adequate investment.

CHAPTER 7.
Strategies and policy recommendations in promoting a low carbon development path for the energy sector

7.1 Strategies

7.1.1 How to establish and implement a low carbon growth country strategy

There are usually seven steps adopted to establish and implement a low carbon growth country strategy step by step.

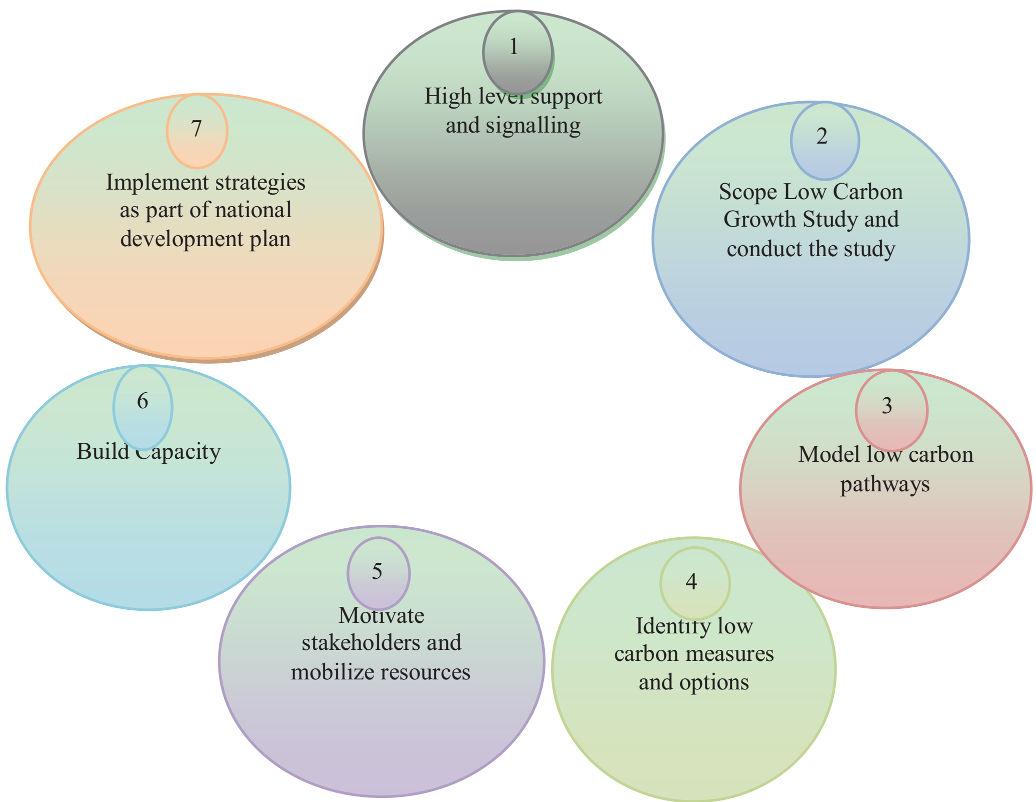


Figure 7-1. Steps to establish and implement a low carbon growth country strategy

Step 1. High level support and signalling

Governments need to support the low carbon development path, and with this support society would be mobilized to participate in the process.

National priorities and goals for economic development determine the targets and goals of the low carbon strategy in this phase.

Step 2. Scope Low Carbon Growth Study and conduct the study

The establishment of the strategy should be based on a thorough study and survey of the nation's development situation and resource distribution. The study should identify priority activities for the government at this stage of developing a low carbon economy, gather and analyze data and propose flexible approaches to study design and implementation that respond to the national priorities.

Step 3. Model low carbon pathways

Based on the comprehensive study above, the low carbon pathway would be developed with the following four main methodological steps to build a low carbon development and emission profile for the economy[218]:

- Estimate the future course of GHG emissions consistent with the national long-term development objectives and business-as-usual development.
- Identify and quantify low carbon options.
- Assess the associated costs of low carbon options.
- Assess the co-benefits of low carbon options, including economic and energy structure improvement, energy conservation, environmental protection and poverty alleviation.
- Build a low carbon emissions scenario(s). Maintain consistency with the long-term national development objectives.

Underlying the four steps is a range of approaches and assumptions that reflect differences in study objectives, methodologies used for sector analysis or modelling, variations in the start and end dates for low carbon modelling (many run to 2030 consistent with IPCC, and alternative approaches for defining baseline or business-as-usual scenarios.

BOX 7-1. India's Low Carbon Growth Model

The Government of India worked with the study team to build a Low Carbon Growth (LCG) model that can be used as a planning tool to analyze key sectors and assess the impact of policy choices on GHG emission levels. It is a bottom-up, engineering model that is based on Excel/Visual Basic programs making it user-friendly, low-cost, and available for continuous use.

The model considers five major sectors in the economy: electricity transmission, transportation, residential, nonresidential buildings, and industry, which together accounted for 60% of India's greenhouse gas emissions in 2004, and more than 400 possible interventions. The model enables planners to analyze future demand for emission-producing activities, estimate associated costs, and calculate GHG emissions under different development scenarios to 2030. The India LCG model builds energy demand from the bottom up and matches supply with demand. Demand in each sector is assessed from a simulation analysis of a number of variables, including Gross Domestic Product, population, age distribution, household size, income, and location (urban or rural).

The model has been used in India to generate various low carbon scenarios based on India's sector plans, the 11th and subsequent Five-Year Plans, and consultations with sector specialists. The model will be transferred to the Planning Commission after study completion.

Adapted from "India: Strategies for Low Carbon Growth," Preliminary Report, World Bank, June 2009.

Step 4. Identify low carbon measures and options

Transition to a low carbon development path requires new policies or amendments to existing ones.

By drawing on modelling results and cost benefit/sensitivity analysis above, priority low carbon measures, which focus both on technological interventions, as well as supporting policy, regulatory, and institutional frameworks are determined.

Step 5. Motivate stakeholders and mobilize human resources

The low carbon development need everyone's participation and it is necessary to mobilize this resource extensively.

Energy conservation requires participation from businesses as well as the whole civil society.

Policymakers need to engage local government's early on in the process.

The private sector must help finance and in invest in the strategy.

Step 6. Build Capacity

Capacity building, particularly in the government, is an important guarantee implementing the low carbon development strategy.

Capacity building could be facilitated through structured, regularly scheduled interactions among team members, government ministries, experts, and stakeholders, as well as through workshops and meetings centred on cross-sector discussions.

Capacity building for cross-sector engagement is also important. Cross-sector communication is built on existing expertise and knowledge in individual sectors, such as energy and transport, to support the development of an integrated view of low carbon growth opportunities and priorities across the economy. Regional and international workshops and meetings further enable national teams to learn and share actions plan with their representatives from neighbouring countries and peers globally.

Step 7. Implement strategies as part of a national development plan

With the study and preparation above, the low carbon development strategy could be implemented as part of national development plan, and together with other national plans.

Establish a cohesive institutional framework as well as support policies and regulations for effective implementation across many sectors.

Finance the upfront costs of low carbon interventions.

Create partnerships for implementation.

Motivate the national and local government to work together to implement the strategy.

7.1.2 Socio-economic development strategies

Sustainable development must be the root for the socio-economic development strategies used to achieve a low carbon economy in the Asia-Pacific region. "Low-carbonization" should be one to the key targets of these strategies for the short- and medium-term along with improving energy efficiency and the achievement of energy-saving and pollution control targets.

The strategies should lay the groundwork for lowering energy consumption intensity, increasing carbon productivity and achieving a gradual decoupling of carbon emissions and economic growth. All in all, they should aim to reduce the negative effects from mitigating climate change through various integrated measures.

Furthermore, each country in the region needs to draw a national socio-economic development strategy on low carbon development in a timely fashion. The strategy should be:

- based on the experience and trends of low carbon development of other countries;
- deemed as one of the majors goals for social and economic development in the medium and long term; and

- included in the national sustainable development strategy, for overall planning, implementation and promotion.

A national consensus of the goal and targets for the transition to the low carbon economy must be reached. The next step would be to communicate the plan in simple by powerful language as well as visually and backed it up with extensive economic, social, and environmental studies. Once this process is in motion, local government would then be able to set appropriate long-term and short-term goals and targets.

The long-term targets should take into consideration the following items:

- economic growth and social development with an emphasis on poverty alleviation;
- natural resource endowments; and
- stabilization of the global atmosphere so that human interference no longer threatens runaway climate changes.

The short-term targets need to consider the following;

- current status of each country;
- resource distribution and technological maturity;
- the allowable peak GHG concentrations, while noting that the larger the peak the longer it would take to reach it and the longer the atmosphere will need to re-adjust.

Also of note, in the coming decades, there is distinct possibility global warming will trigger irreversible changes that could threaten the survival of some countries and possibly humanity. Melting ice sheets and glaciers could raise sea levels to the extent that the world will have to deal with hundreds of millions of environmental refugees. Therefore, the height of the peak and the number of years to reach it are even more important than the long-term target for stabilization.[219] So to some extent, short-term targets of low carbon development need to be more stringent to gain more control of the potential in the short term.

7.1.3 Energy strategies

Energy strategies play a key role in a country's economic development and energy security, with energy being the prominent element in the transition to a low carbon economy. nt. The energy strategies should ensure both the quality and security of energy supply, energy consumption and energy trade, and the economic development of the country. The following energy strategies must be considered when developing a low carbon development path.

<u>Optimize energy structure</u>: To decreasing the proportion of fossil fuels and increasing clean low-carbon energy in the energy consumption structure, a key element in a plan for developing a low-carbon economy;

Promote energy diversification: To facilitate oil and gas exploitation, and develop renewable energy sources including hydropower, nuclear power, wind, solar, bio-energy, with the aim to increase supplies of clean energy and promote renewable energy development. To focus on the development and supply of new and renewable energy, to explore coal bed methane through development of clean coal power generation, wind energy, hydro-power, to adjust terminal energy consumption structure through adjustment of supply structure, to introduce new technology into the energy-intensive sectors such as chemistry and metallurgy to improve energy efficiency and avoid "lock-in" effects.

Improve energy efficiency: This is the most important solution for addressing climate change and transitioning to a low carbon economy. To build a new legal system which set the standards and identification of energy efficiency, and put in place corresponding tax policies that improve energy efficiency and foster sustainable development,.

Adjust industrial structure: To decrease the proportion of high energy consuming industries and products and promote development of energy saving and energy efficient industries. Adjustment of energy industrial structure is critical to maintaining economic development and energy security. In this case, governments need to take a very active role and provide planning and, guidance for the implementation as well as monitor to make full use of the existing policies and incentives to achieve this goal.

Build enabling environment for energy development: Strengthen technology innovation, environmental protection and international cooperation, as a means to set up a stable, economic, clean and safe energy system. Strengthen the implementation of various laws and regulations on renewable energy. Provide a general overall plan as well specific ones targeting wind, solar and geothermic energy to improve the utilization and increase the supplies of renewable energy.

7.1.4 Technology and R&D strategies

The development of commercially viable low carbon technology is a key factor in moving toward a low carbon economy. This requires extensive R & D.

Technology and R&D Strategies are key support mechanisms for the low carbon development path and must be established in the early stages of the process.

The Asia-Pacific region can draw from its global advantages in the race to develop production processes for “green technologies” and to make conventional industries more energy efficient. Among the advantages are a rich resource base, large numbers of highly skilled workers and low salaries,. The transition of Asia from being the ”world’s factory” to the ”world’s research and development centre” in the area of low carbon energy technologies is already occurring.

To encourage the development of the low carbon technology and R&D in the Asia-Pacific region, the following actions need to be undertaken.

- Governments should seek to develop stronger collaborative partnerships with the private sector on large-scale RD&D projects. The technology and R&D Strategies should actively integrate the private sector's involvement;
- Promoting investment in R&D for technological innovation and increasing public RD&D in innovative clean energy technologies. In addition to providing more funding for low carbon infrastructure, the government should also set up carbon funds to promote investment on low carbon and development;
- Set up a low carbon R&D centre and, demonstration platform to promote development and application of low carbon technologies.
- Strengthen the fundamental research on new energy;
- Promote R&D of new energy and renewable energy technologies, develop the core technologies with self-owned intellectual patents;
- Develop cutting edge technologies on low carbon economy, achieve technological breakthroughs in energy saving, renewable energy, nuclear energy, carbon capture and storage, clean automobiles;
- Build proper systems to develop and maintain talents on low carbon technologies; and
- Strengthen protection of IPRs.

7.1.5 Other strategies

Establishing partnerships with bilateral and multilateral cooperation

Mush stronger collaboration is needed to make headway in tackling the foreseeable climatic and financial risks. Going forward, international collaboration seems to and effective and acceptable way to promote the necessary changes to address the common challenges.

A consensus on a low carbon development path would be instrumental getting international entities to combine expertise in developing low-cost, zero-carbon technologies as well as exchange information on clean energy technologies.

To accelerate innovation strategies and finance mechanisms that support rapid development and deployment of promising low carbon technologies – CCS, biomass and biotechnology, renewables and end-use energy technologies or hydrogen systems – may require separate and cooperative, technology-specific research, development and deployment at a global level[220].

a) Bilateral partnership

If the world hopes to avoid the worst consequences of global climate change, developed and developing nations—have no alternative but to become far more active partners in developing low-carbon economies.

To prevail in such a common effort, both groups of countries need not only bold leadership and a new set of national policies, but also a path-breaking cooperative agenda that can be sustained over the long run.

During a time of global economic upheaval, a strong bilateral effort to address the twin challenges of climate change and energy security can succeed while also contributing to economic recovery and laying the foundation for a prosperous, new, low carbon economy in all countries, especially those in Asia and the Pacific.

Benefits that can be derived from bilateral deals include the following:

- Joint ventures between companies have the advantage of flexibility and can mobilize private sector funds and technology for larger projects and areas of new market potential by spreading risks and capital among the partners.

- Multinational companies are increasingly willing to invest in projects, not only to receive commercial returns or manage a carbon compliance position but also to gain long-term strategic market advantage.

The priority areas of bilateral collaboration for the low carbon economy in this region should include:

<u>Deploying clean coal technologies</u>: The likelihood that many countries in this region will continue to rely heavily on coal for many years to come necessitates immediate and large-scale investments in the research, development, and deployment of new technologies for the capture and sequestration of carbon emissions from coal-fired power plants.

<u>Improving energy efficiency and conservation</u>: Many countries have significant potential to lower their carbon emissions through low-cost, and even free, energy efficient measures that would have considerable impact on each country's "carbon footprint" and energy security.

<u>Developing an advanced electric grid</u>: This is particularly applicable to countries that rely on outdated, decentralized and inefficient electrical transmission systems. They could profit from research, development, and adoption of new "smart grid" technologies capable of enabling these systems to handle larger quotients of low-carbon energy, making renewable sources of power cheaper and more efficient.

<u>Promoting the utilization of renewable energy</u>: Most countries in Asia-Pacific need to accelerate the use of solar, wind and other renewable sources of energy to de-carbonize their respective electricity systems, expand their low-carbon economies, and thereby, diminish their carbon emissions per unit of GDP.

<u>Quantifying emissions and financing low-carbon technologies</u>: To help facilitate cooperation in the above areas, it is important to continue to jointly address the cross-cutting issues of quantifying and projecting emissions, and financing technology development and deployment.

b) Multilateral cooperation

Cooperation between international organizations to achieve a low-carbon economy is a key solution to address climate change. Enhanced action and international cooperation on adaptation is urgently required to ensure the implementation of activities to support projects, programmes, policies and other activities in developing countries related to mitigation, adaptation, capacity building, technology development and transfer.

The Asia-Pacific region has many energy-related initiatives and programmes at both the subregional and regional levels, dealing with such issues as fossil fuel, electric power, renewable energy and energy efficiency. A number of organizations are involved in regional and subregional decision making on energy. At the regional level, these include ADB, Asia-Pacific Economic Cooperation (APEC), and the Asia Pacific Energy Research Centre (APERC). Subregional organizations have also initiated studies and programmes on energy, including the Association of Southeast Asian Nations Centre for Energy (ACE), the South Asian Association for Regional Cooperation Energy Center (SEC), and the Pacific Islands Applied Geoscience Commission (SOPAC). Currently there are at least 43 active initiatives, of which 17 are intergovernmental, 13 are programmes, 9 are partnerships, and four are networks.[221]

South-South cooperation: South-South cooperation serves as important international cooperation channel, especially for the Asia-Pacific countries. One major opportunity for South-South cooperation is in sharing information on renewable energy technologies for providing remote villages or isolated islands with off-grid electricity. Some countries can provide the infrastructure and supporting systems for promoting and deploying renewable energy technologies to developing countries in need.

These technologies can be transferred in various ways including transferring key technical knowhow, manufacturing and assembling machinery and equipment, manufacturing components, setting up joint ventures, sharing profits and risks, and licensing production. Companies can also establish factories in other countries and keep down production costs by manufacturing locally.[222]

BOX 7-2. China and India cooperate on energy issues

To strengthen bilateral cooperation, China and India have established an annual dialogue on energy. The partnership comes at a time when the two countries are increasingly at odds in their efforts to acquire energy supplies to fuel their fast growing economies.

Energy companies from both countries have also nailed down five memoranda of understanding to share information and strengthen cooperation in exploration, development, and production of oil and natural gas. Both sides agreed to seek partnerships in investments and in the construction of liquid natural gas pipelines and terminals.

The Ministry of Foreign Affairs of China hailed the agreement, saying that cooperation with India would not only benefit peoples in both countries, but also be conducive to peace and stability in South Asia and to the strengthening of South-South cooperation.

The new alliance, aimed at preventing the two nations' competition for oil assets from pushing up energy prices, symbolizes their increasingly assertive role in global energy politics. China is currently the world's second largest energy consumer, while India is the sixth.

In November 2005, China and India teamed up on a joint offer to buy PetroCanada's 37 per cent stake in the largest oil company in the Syrian Arab Republic. The successful deal was the first time oil magnates in the two nations have joined forces in overseas expansion.

Many other opportunities are possible form South-South in the region because of the wide discrepancies between the countries. Countries like China and India, which have achieved higher levels of growth in different renewable energy subsectors, could share experiences with the least developing countries such as Lao Republic, and could make this knowhow more widely available through an effective knowledge management structure.

The UN has renewed its commitments to support South-South cooperation as an "important element of international cooperation for development". In addition, the United Nations Development Programme (UNDP) Special Unit has been mandated to foster South-South Cooperation, and serve as the focal point for other UN entities, agencies, programmes and funds.

The Asia-Pacific Partnership (APP)

The Asia-Pacific Partnership on Clean Development and Climate (APP) was established in 2006 as a multilateral public-private partnership, and the United States has emphasized voluntary initiatives to help achieve emissions reductions, entering into the Asia-Pacific Partnership (APP) with Australia, Canada, China, India, Japan and the Republic of Korea.

APP's objective is to promote activities for improving both global and regional environmental performance through the development and deployment of cost-effective cleaner technologies and practices. The partnership works with eight public-private sector task forces. They are as follows:

- aluminium
- building and appliances
- cement, cleaner fossil energy
- coal mining
- power generation and transmission
- renewable energy and distributed generation
- steel.

Governments and the private sector are working together on sharing best practices for operation and maintenance of power plants (in the electricity sector), the establishment of global common guidelines for energy-efficiency calculations and target setting (in the steel sector) and enhanced production processes through the uptake of best practices (aluminium) within each of these task forces.[223]

This partnership model has the potential to be scaled-up to contribute further to climate change mitigation activities, and the overall achievement of low carbon development path.

7.1.6 Strengthening institutions through their creation or reorganization

Many developing countries in the Asia-Pacific region look to their government as the key economic and social driver for the country. Based on this, institutions must be strengthened through adequate training and by motivating personnel, and/or reorganized to make them better prepared to adapt to the transition to a low carbon development economy.

Most countries address issues such as energy needs, environmental protection and poverty separately. However, integrating these policies would be far more effective on the grounds that meeting the needs of one sector does not make it more difficult to meet the goals of the others. Accomplishing this entails designing appropriate institutions and involving a wide range of stakeholders.

A specific national level agency or an inter-agency coordination mechanism could be established or integrated in the government agency that deals with climate change, but still deal specifically with issues regarding the transition to a carbon development path, with the authority to coordinate and deploy the resources the national and local level.

Government's performance monitoring systems in most developing countries of the region must be improved to promote low carbon development. For example, one option would be to include GDP of low-carbon economy development into the government achievements rating mechanism.

Ensuring policy consistency between national and regional levels and between regional and local levels is of key importance in developing a low carbon economy, and necessary for developing capacity building among the government departments to enhance their analytical and strategic capabilities.

7.2 Policies

There is no single silver bullet solution overcome the hurdles in the move towards a low carbon future. Instead, an approach which integrates strategies by combining policy incentives is needed to exploit the available technologies.

- Stringent regulatory measures pertaining energy conservation and reducing GHG emissions should be enacted with ample time for all levels of society to be prepared to take the steps needed in achieving the goals set in the nation strategy on these issues.
- The administrative body responsible for the low carbon transition should evaluate the effectiveness of economic incentives aimed at promoting efficiency, fuel diversity, low carbon technologies and clean fuels and reducing GHG emissions already in place.
- A top priority, programme must have all the essential elements to create an environment where the county would work collectively to improve energy efficiency and conserve energy.
- Integrate energy efficiency and energy conservation priorities into all aspects of domestic and international policymaking. Facilitate the development and deployment of technologies related to energy efficiency and energy conservation. Finance and invest in projects aimed at improving energy efficiency and energy conservation.
- Make full use of market allocation on resources and build an environment for marketing low carbon economic development; emphasize the role of marketing mechanisms and use market-based solutions to develop a low carbon economy.
- The government should be in the forefront of the effort to conserve energy. Governments at all level should monitor and guide energy conservation and pollution reduction programmes. They should also aggressively implement energy programmes within their own departments.
- More comprehensive education and public awareness campaigns are needed in Asia-Pacific, particularly in developing countries, to push the transition to a low carbon development path.
- The task of transitioning to a low carbon development path cuts across traditional departmental boundaries. To deliver the programme successfully, a comprehensive integrated system of measurement, reporting and verification must be put in place.

BOX 7-3. Measures to reduce greenhouse gas emission and enhance energy security

Renewable energy resources:

- Setting targets for an increase in the share of renewable energy (i.e. Renewable Portfolio Standards);
- Subsidies for renewable energy- based electricity generation (i.e. feed-in tariffs, grid connected photovoltaic roof-top programmes);
- Promotion of research and development on renewable energy;
- Shifts to smaller-scale and distributed technologies through funding renewable-based distributed generation systems in rural areas (i.e. solar home system, hybrid system).

Fuel switching and diversification:

- Setting targets for biofuel use (i.e. 5 per cent blending with gasoline);
- Diversify energy mix away from oil (i.e. switching from oil to natural gas);
- Development of alternative fuels i.e. gasohol, biodiesel).

Energy efficiency and conservation:

- Setting legislative measures for energy efficiency;
- Setting mandatory targets for energy efficiency (i.e. vehicle fuel efficiency standards, building energy standards, energy labelling standards for appliances energy monitoring);
- Subsidies for energy-efficient technologies;
- Higher taxes for larger vehicles;
- Funding R&D for energy/carbon efficient demonstration/pilot projects; and
- Establishing an ESCO.

Adapted from: "Asian Aspirations for Climate Regime beyond 2012", Institute for Global Environmental Strategies (IGES), 2006.

7.2.1 Command and control regulation

Energy conservation and GHG mitigation is not only one of the key goals of the low carbon development path, but also an important guarantee for the achieving it. As stated earlier, stringent regulatory measures for energy conservation and GHG mitigation must be enacted in the beginning stages of the transition to give the nation as a whole as well as local government ample time to act effectively in achieving the goals when the national strategy for a low carbon economy is established.

To enact stringent regulatory measures for energy conservation and GHG mitigation smoothly, the following steps to be taken.

The first steps involve:

- accelerate formulating and revising relevant regulations on energy production and conversation and GHG mitigation;

- formulate and promulgate energy law and revise laws that deal with coal and power and in other areas based on the principles of the energy law;
- enhance policies that encourage the development of clean, low-carbon energy and improving energy efficiency.

Grid connection of renewable power is prime example for the last step. This process is a big obstacle to the development of renewable energy in many countries due the limited scale and electricity quality. In that case, some regulatory measures impose compulsive regulations for grid connection and green electricity certification, and technology standards, codes or requirements should be considered.

The next set of steps entails the following:

- improve energy-saving regulations and standards;
- draw up necessary supporting regulations such as Electricity-saving Management Regulation, Petroleum-saving Management Regulation and Building Energy-saving Management Regulation;
- formulate and improve energy efficiency standards for large energy–consuming industrial equipment, domestic appliances, light appliances and motor vehicles;
- improve energy-saving design criteria of large energy–consuming industries, energy-saving standards for buildings; and
- accelerate the formulation of temperature control standards on building refrigeration and space heating.

The third group of steps include:

- strengthen the implementation of existing laws and regulations
- put in place regulations on environmental pollution control, especially at the local government level where they should be required to implement them strictly.

Of note, participation from local governments is essential as they have authority over business and take a leading role at the local level.

The final step would be to establish a measurement, reporting and verification system that guarantees the successful implementation of the stringent regulatory measures for energy conservation and GHG mitigation.

7.2.2 Market-based instruments

Economic incentives or market-based instruments, such as tradable permits, energy price, energy taxes and subsidies are an effective approach to ensure that the costs of environmental protection are more efficiently distributed and encourage innovation and investment in low carbon technologies. Policies must be gradually adopted in the Asia-Pacific region to ensure that energy prices are more cost-reflective and/or align more closely with world market prices.

In the region, energy and fuel prices vary greatly from one country to another as a result of regulated policies, low taxes and subsidies, all of which distort the market economy. Energy prices should be reformed and set in line with the development levels as low fuel costs and heavy subsidies often lead to unsustainable energy use and therefore, have a negative impact on the environment and energy conservation.

A useful way of adjusting prices and promoting renewable energy without undermining competitiveness is to adjust tax rates. Green tax reforms bring a double dividend—allowing governments to reduce income taxes without cutting public spending. Energy taxes lower the economic break-even point for technological and organizational measures to reduce energy consumption, accelerating the pace of energy-saving technological progress.

An energy subsidy is an important component of the macroeconomic policy of developing countries. While well-targeted subsidies are often essential for ensuring energy access by low income or disadvantaged sectors of society, poorly targeted fuel and electricity subsidies can lead to over consumption of energy and increased carbon emissions. Reducing these subsidies is politically difficult, but climate change provides an additional motivation, and carbon finance perhaps would become a source of funding to partly compensate the loss incurred.

With regards to the lack of cost competitiveness of renewable power such as wind power, solar power and biomass power, policymakers should design suitable incentive systems, including direct capital investment subsidies, feed-in-tariffs, tax exemptions or reductions and low interest rate loans. These measures would help push investments made by energy companies. In addition, governments should support R&D in renewable energy technology.

Carbon markets are set to play an important role in directing investment to support the transition to a low carbon economy. Market-based instruments such as carbon taxes, CDM or cap-and-trade schemes put a price on greenhouse gas emissions. The cap-and-trade system relies on markets to provide financial incentives to steer funding towards lower carbon and climate change resilient investments.

Procurement by governments and other institutional buyers could also stimulate the diffusion of energy efficient products, which, in turn, would set an example for corporate buyers and individual consumers. Governments could also exert influence through "indirect purchasing" by sending clear signals to their suppliers that they should offer energy-efficient equipment and follow energy-efficient practices.

There are many other kinds of economic incentives which could be established according to the specific requirements of a country. They include economic incentives for businesses' RD&D of clean energy technologies and energy savings by manufacturing firms and in civil consumption. Many economic incentives could be used, but inference and verification need to be developed thoroughly. Lesson learned from other countries could serve as an invaluable reference for this.

7.2.3 Awareness-based approaches

Governments and businesses should not be the only parties involved in a collaboration mechanism directed at low carbon development. Participation from all related stakeholders as well as the society in general is required. More training, education and publicity about climate change is needed. These actions must be combined with policy incentives to alter the general public's perception and thinking, increase the public's awareness on response to climate change with the goal to gradually reach a consensus on low carbon consumption behaviours and models. Joint actions with all the stakeholders are needed to resist the potential risks from climate change.

In addition to implementing a national strategy on low carbon economic development, governments should lead the effort to conserve energy and cut GHG emissions. This action should be promoted in the functions of everyday life such as production, transport and consumption. Education and campaigns on energy conservation need to be instilled in all levels of society. .

The government agency in charge of the transition to a low carbon economy should be tasked with creating public awareness of low carbon development with its ultimate goal being to mobilize society to participate in the effort. The transition must be elevated in status through more intensified training, publicity and guidance. Greater recognition of the transition as an important scientific issue, would spur an increase of published information on the subject.

7.2.4 Innovative mechanisms and instruments for post-2012 climate change regime

Innovative mechanisms and instruments are the important elements for post-2012 climate change regime as they stand exert enormous influence on the financing and technology flow. . A major consideration in the international post-2012 regime is for developed countries to help finance the low-carbon transformation in the developing countries.

The Bali Action Plan calls for the putting together "various approaches, including opportunities for using markets, to enhance the cost-effectiveness of, and to promote mitigation actions, bearing in mind the different circumstances of developed and developing countries." This means that market mechanisms will play a key role in a post-2012 agreement, and that there could possibly be an expansion beyond the current mechanisms.

Business in developing countries supports CDM extension and reform to drive the deployment of low-carbon technologies and practices more effectively. The specific reforms already put forward include:[224]

- The CDM Executive Board should refocus on its original mandate of scaling up issues, such as CDM function and operations, and use external organizations for project-by-project approval of activities. Efforts should be directed at reducing execution risk, timing and selection criteria and increasing predictability.

- Update the current assessment criteria for additionality to allow measurement on a wider basis, i.e. additionality could be measured for the whole renewable sector in a country, rather than project-by-project.
- Expand programmatic CDM to allow the large-scale "bundling" of programmes to increase volume and reduce costs and implementation time.

To reduce emissions and at the same time meet growing energy needs requires that advanced technologies are developed at a faster pace and are more cost effective. This would encourage wider uptake of zero- or low-emission technologies at the national and international level. Efforts in this direction require widespread use of all existing technologies and a major drive to boost energy efficiency and renewable energy, as well as continuing to strive for technology breakthroughs. Discovery and innovation in the energy sector is still capable of yielding unanticipated rewards with regards to GHG emission reductions and economic development.

Financing programmes for climate-friendly technologies established under the UNFCCC and multilateral organizations are not sufficient. A post-2012 climate change regime will need to include provisions to enable financing technology cooperation and promote technology R&D and deployment. This applies particularly to developed countries. One option would be for developed countries to agree to technology cooperation commitments under the UNFCCC, a move that would entail financing commitments for emission reduction actions as well as agreeing to undertake action at home and with like-minded countries on a bilateral, regional or multilateral basis.

Innovative instruments should aim to mobilize greater investment in low carbon technologies through, among others, levies on carbon consumption, natural resource consumption, incentives for energy efficiency and the recycling of emission credits. A comprehensive post-2012 climate change regime should focus on developing and expanding a combination of all available funding tools and financial instruments. These could include instruments for:

- promoting shifts in investment and financial flows to more climate-friendly and low carbon investments;
- scaling up international and public capital dedicated to climate-friendly and low carbon investments;
- optimizing the allocation of funds available by spreading the risks across private and public investors, such as by providing incentives for private investment in the early deployment of new technologies; and
- expanding available mechanisms (i.e. market-based mechanisms created under the Kyoto Protocol), maximizing synergies and complementarities, and establishing new financing tools.

With regards to the international society, although the COP15 held in Copenhagen did not achieve a satisfactory accord, the pace to low carbon development will not stop. After the COP15, a consensus was reached that mankind should pursue a low carbon development path. Many countries have already set ambitious low carbon development targets and adopted feasible measures, including countries in Asia. For example, China announced the target of a 40-45 per cent reduction in carbon intensity from 2005 levels by 2020. This will be embedded in the new five-year plan, together with strengthened actions on energy efficiency and low carbon sources of energy. It is notable that since Copenhagen, China has already adopted new measures requiring utilities to purchase more renewable energy.

A low carbon development path is not only an inevitable choice for sustainable development, but also a summit of future global competition. No matter what kind of accord is reached in the COP16, and no matter what kind of post-2012 regime is eventually formed, the countries in Asia and the Pacific should put an all out effort in achieving low carbon development.

CHAPTER 8.
A roadmap to development of national strategies for the energy sector in Asia and the Pacific region

This roadmap is designed to help policymakers in the Asia-Pacific region put their countries on a path to low carbon development. It helps these countries achieve sustainable economic growth while managing a secure, low-carbon energy system and receiving co-benefits in energy conservation, environmental protection, poverty alleviation and so on. It consists of a three-part framework for navigating this transition.

1. Establish a long-term vision for energy security and low carbon development.
2. Improve the energy system to promote low carbon technologies and practices.
3. Build enabling environment for the transition to low carbon development.

Within this framework, a series of specific policy recommendations for the policymakers are put forward, including a number of actions that should be taken in these countries.

8.1 Establish a long-term vision for energy security and low carbon development

8.1.1 Recommendation 1: Integrate energy security and climate change priorities into all aspects of domestic and international policymaking.[225]

It is not enough to pass energy or climate legislation, to sign long-term international commitments or to establish domestic targets and timetables. Supporting a long-term vision requires metrics to evaluate progress towards this vision, followed by incorporation of the vision into all aspects of governing, including economics, trade, agriculture, labour, development, land-use, transportation and foreign policy. For example, this vision should be central in designing upcoming economic stimulus efforts.

Responsibility for executing this vision must be shared by all branches of government, including states and local jurisdictions, the public and private sectors, international partners and individual citizens.

8.1.2 Recommendation 2: Consider the different stage of industrialization when shaping national low carbon development strategies.

There are some major differences among the developing countries in the Asia-Pacific region. In addition to historical factors, the premise of common but differentiated responsibilities also lies with a nation's ability to address global environmental challenges, such as climate change. Developing countries understand that the ability for countries at the stage of rapid industrialization like China and India, with high rates of economic growth, technological capacity and numerous natural resources, is very different than say a least developed country such as Afghanistan or Myanmar.[226]

For the countries at the stage of rapid industrialization

In the Asia-Pacific region, the countries at the stage of rapid industrialization like China, India, Thailand and the Philippines all face both opportunities and challenges to develop a low carbon economy.

First of all, for a longer term, embarking on a low carbon development pathway suits the basic trend of global energy being low-carbonized. This is also in line with their efforts to transform the way the economy grows, restructure the economy, achieve the targets of energy saving and pollutants reduction, as well as attain sustainable development. The opportunity exists for these countries to develop a low carbon economy so that some key sectors can gain a more competitive advantage in energy saving and pollution reduction technologies. As a result, these countries could reach the turning point of energy consumption and carbon emissions sooner.

But from a short- to mid-term perspective, these countries are somewhat stuck in their respective current stage of development. The transition to a low carbon economy is challenged by rapid economic growth, being at the very end of the value chain in international trade, increasing employment pressure, having an energy structure that is dominated by coal, lagging in technology development and inadequacies in its current institutions and policies. On the other hand, the failure to embrace a low carbon future would potentially put these countries at risk of being unsustainable and in an either/or position between economic growth and developing a low carbon growth path.

Therefore, the countries at the stage of rapid industrialization must abide by the general rule of economic society and climate protection and go along with the trend of developing a low carbon economy. In the meantime, they need to seek a low carbon development pathway that would better coordinate their long-term and short-term interests and also balance various policy targets.

For the least developed countries

Although least developed countries are quite diverse, there are some common patterns between them. They tend to suffer from low domestic savings that do not meet their investment needs. Many of them also are politically unstable, have weak governance and torn by conflict which has damaged infrastructure, diverted budgetary resources and deterred foreign investment. Least developed countries also tend to have limited internal markets and fewer trade opportunities. In addition, a good portion of them have been seriously affected by environmental degradation and other biophysical barriers that not only have weakened their access to natural resources but also undermined human health. The high proportion of traditional fuels in the energy consumption of least developed countries signals their inability to provide access to modern energy services - a major constraint to their economic and social development.[227]

Therefore, the least developed countries should pay more attention to promoting the increase of domestic savings to support energy infrastructure investment requirements, strengthening national capacity for energy planning and management to enhance the sustainability of the energy sector. In the meanwhile, they need to train local technicians to maintain the existing energy systems, and enhance the utilization of indigenous energy resources, such as biogas, and bioslurry as an organic compost fertilizer.

8.2 Improve the energy system to promote low carbon technologies and practices

8.2.1 Recommendation 3: Enhance energy efficiency and renewable energy utilization

Energy efficiency improvement and renewable energy utilization are the central components of the long-term vision and play a key role in the transition to a low carbon economy, as they support both energy security and climate change goals.

Energy efficiency improvement

Energy efficiency is called the low-hanging fruit for it alone could cut energy demand by 20-24 per cent and save hundreds of billions of dollars per year. Especially in countries with high energy prices and high energy intensities, energy efficiency is the most economic option for improving economic efficiency across sectors. Energy conservation and energy efficiency will help guide end-consumption and control GHG emissions by reducing energy demand.

Energy efficiency is widely accepted as the most cost effective way to mitigate climate change. It accounts for 50 per cent of the potential to halve energy related CO_2 emissions by 2050. A 1 per cent improvement of energy efficiency can reduce emissions by 1 per cent.[228] The benefits from energy efficiency are clear, including saving energy costs, alleviating energy dependency, decreasing vulnerability to energy price volatility, reducing emissions and improving the efficient use of natural resources. Energy efficiency can generate positive returns on investment and has the potential to promote high value adding activities and job creation. The deployment of energy efficient technologies can alleviate energy supply shortages and contribute to reducing energy investment costs.

Recommended actions to improve energy efficiencies in the Asia-Pacific region include:

- increase investment in energy efficiency improvement, including encouraging the involvement of private sector and other financing institutions;
- encourage a switch to energy-saving technologies;
- improve energy efficiency on both sides of the supply and demand equation for energy;
- reduce and better target subsidies to energy consumption;
- set goals and formulate action plans for improving energy efficiency in each sector of their domestic economies;
- develop adequate monitoring, enforcing and evaluating work during the policy implementation period, both voluntary and mandatory; and
- improve and establish integrated energy efficiency indicators to guarantee the energy efficiency improvement level throughout the country.

Box 8-1. China: Top-1000 Enterprises Energy Conservation Action in China

In 2005, the Chinese government announced an ambitious goal of reducing energy consumption per unit of GDP by 20 per cent between 2005 and 2010. One of the key initiatives for realizing this goal is the Top-1000 Energy-Consuming Enterprises programme. The energy consumption of these 1000 enterprises accounted for 33 per cent of national and 47 per cent of industrial energy usage in 2004. Under the Top-1000 programme, 2010 energy consumption targets were determined for each enterprise.

1008 top energy consumption enterprises in China were involved. The requirements for 1008 enterprises (including energy audit and Energy Conservation plan) have been identified, and incentives are applied to these enterprises in order to improve their energy efficiency. Based on the plan, the Energy Conservation target is saving 100 million tce by 2010. According to the action plan of the programme, the top-1000 enterprises shall: establish energy conservation organization, formulate energy efficiency goals, establish an energy utilization reporting system, conduct energy auditing, formulate an energy conservation plan, invest in energy efficiency improving, adopt energy conservation incentives and conduct training.

It is likely – depending upon the GDP growth rate – to contribute to somewhere between approximately 10% and 25% of the savings required to support China's efforts to meet a 20% reduction in energy use per unit of GDP by 2010.

Renewable energy utilization

Renewable energy is a promising source of low-carbon energy and can improve energy security by adding diversity and domestic supply to the energy mix. The Asia-Pacific region is well-endowed with renewable energy resources. It has 40 per cent of the world's total hydroelectric technical potential, and about 35 per cent of its annual solar and high temperature geothermal energy potential. It also has the substantial potential to develop biomass and wind energy.[229] Utilization of renewable energy can contribute to significant emission reductions. The IEA estimates that a 50 per cent reduction in CO_2 emissions by 2050 would require a 46 per cent in renewable energy's share of global power generation.

In 2006, about 18 per cent of global final energy consumption came from renewable energy; hydropower was the largest renewable source, providing 3 per cent of energy consumed, followed by solar hot water/heating, which contributed 1.3 per cent. But in the region, the contribution of renewable energy was much lower than the global level, as seen in fig. 8-1 below. Thus, there is greater potential for the utilization of renewable energy in this area. Table-8.1, which is based on estimates from ESCAP, illustrates the region's potential. The potential for the renewable use remains very large, exceeding all other readily available sources, and has been proposed as a potential primary energy source.

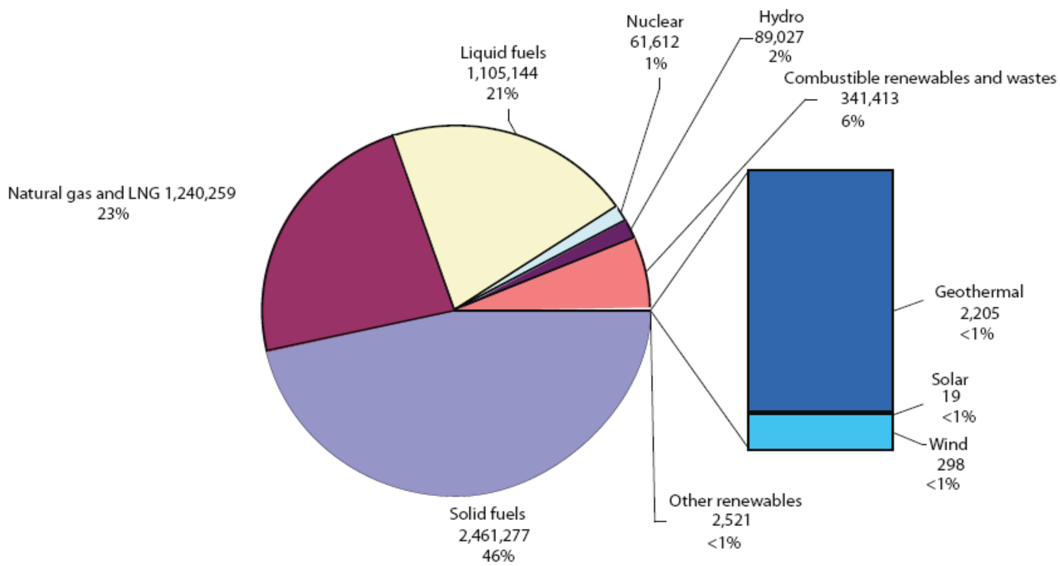


Figure 8-1. Current utilization level of all kinds of energy in Asia and the Pacific

(Source: Energy Security and Sustainable Development in Asia and the Pacific, Page 29, ESCAP)

Table 8-1. Some renewable energy potential resources potential

	Biomass energy potential, 2050[a] (Mtoe)		Solar energy potential (Mtoe/year)		Wind energy theoretical potential[b] ('000 TWh/ year)		Geothermal energy potential (TWh/year)		
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low temp (EJ/a)*	*High temp, conven-tional*	*High temp, conven-tional and binary*
ESCAP region	310	502	11,159	415,257	62	88	>430	4,020	8,000
World	5,398	9,458	37,618	1,190,336	500	483	>1,400	11,200	22,400
ESCAP % of world total	5.7	5.3	29.7	34.9	12.4	18.2	50.0	35.9	35.7

(Source: Energy Security and Sustainable Development in Asia and the Pacific, Page 29, ESCAP)

Globally, over the next ten to fifteen years, nuclear and renewables (in particular wind power) and improvements in the efficiency of fossil fuel generation are likely to play the greatest role while in the long-term, solar power may play a very major role.[230]

Despite the significant potential growth of renewables, these sources currently provide only a small fraction of the commercial energy in Asia-Pacific. The utilization levels of renewable energy are quite different among the countries in the region. For example, the highest use of biomass in modern applications is in Indonesia, Malaysia and Thailand. But for the whole region, generally speaking, the utilization level is lower. Narrowing the gap between the current low level of deployment of renewables and their high potential will require significant and sustainable policy solutions. There is no "one fits all" approach –

renewable utilization level of each country faces its own technical and economic hurdles. But based on results from a variety of studies, the following options and policy guarantees are needed:

- establishment of a long-term national target and national renewable portfolio standard;
- national testbeds for new electricity grid systems that enable a broader set of power supply options, including intermittent and distributed energy and combined heat and power;
- a predictable and transparent investment framework with more the financing channels for renewable energy deployment, removing non-economic barriers;
- a major RD&D effort focusing on the use of renewables beyond niche markets;
- continuous and consistent support (i.e., through tax credits) to help renewables become competitive with fossil fuels for electricity generation, such as mandatory and incentive policies.

8.2.2 Recommendation 4: Provide financial and investment supporting channels for low carbon energy system

Financial and investments towards a low-carbon economy must enable a large enough reduction in GHG emissions to avert a catastrophic rise in global average temperatures while at the same time promote sustainable economic growth. The investment decisions made in the next ten years will play a critical role in defining the world's long-term emissions trajectory as the infrastructure financed today will lock in technology for decades to come.[231]

The IEA estimates that an annual incremental investment of $ 1.1 trillion will be needed to reduce energy related CO_2 emissions by 50 per cent from current levels by 2050.[232] Over half of this investment is expected to be made in developing countries. Current levels of investment are insufficient and there is an urgency to increase and accelerate investment to slow the growth of CO_2 emissions and promote the transmission to the low carbon economy by 2020. In the Copenhagen Accord, Annex 1 countries agreed to provide scaled-up, new and additional, predictable and adequate funding to developing countries to finance action on mitigation, deforestation, adaptation, technology development and transfer and capacity building.[233] Market instruments, together with other financial tools, are anticipated to provide a significant proportion of this investment.

Traditional sources of funding will be insufficient to finance essential energy infrastructure. Countries in the Asia-Pacific region can therefore look more to national and international financial markets and channels. They will also be able to take advantage of environmental and carbon financing, such as the CDM though larger-scale financing would need to come from other arrangements, including a regional "special purpose vehicle"[234] for the transmission to a low carbon development path.

There are many national and international channels for a low carbon energy system, but to achieve an efficient financial market, policy options for financing are necessary. They included the following:

- ensure a competitive environment for both public and private institutions;
- encourage domestic savings;
- promote the development of financial markets and facilitate the creation of new financial instruments;
- promote domestic investment as well as foreign direct investment;
- introduce regulatory mechanisms, including those to ensure safety of investments;
- rationalize systems of energy pricing and taxation;
- ensure transparency and access to information; and
- Follow standard international accounting practices, with strong judicial and legal support.

In 2007, FDI in the region increased 28 per cent, reaching $372 billion – 2.4 times the yearly average for 2001-2005. Fig. 9-2 blow shows the FDI stock per cent of the GDP. The trend of FDI is increasing in this region.

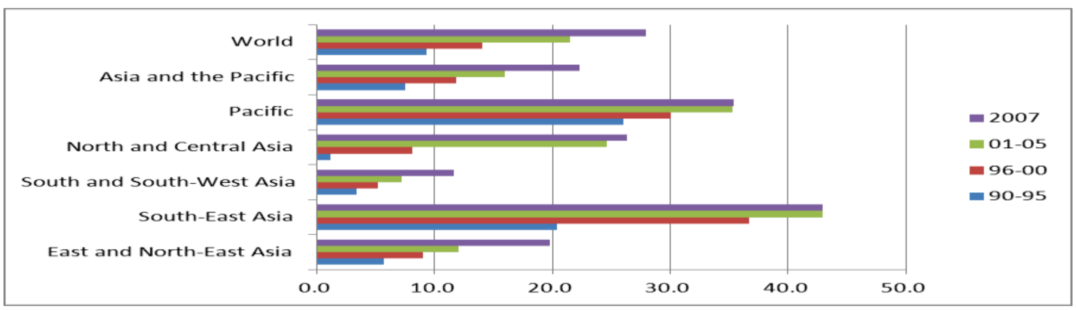


Figure 8-2. FDI stock % of GDP

(Source: The Statistical Yearbook for Asia and the Pacific 2008.)

So, attracting more FDI would be quite an important way for the countries in this region. And to adapt the preferential policies and improve investment environment is a good option to attract more foreign direct investment. And FDI represents an important source of capital and foreign exchange, and can also offer additional benefits in the form of technology and knowledge transfer.

Nevertheless, FDI still only accounts for a small contribution to the extra capital needed for investment, averaging around 8 per cent of gross fixed capital formation (GFCF). In most Asia-Pacific countries, the main financing source is domestic investment. Between 1998 and 2007, overall government revenue in this region went from 13.3 to 17.3 per cent of GDP, while government expenditure fell from 20.3 to 18.1 per cent[235], opening up opportunities for the private sector. However, all levels of government should take a more active role in funding the transition to a low carbon area especially for investment in infrastructure. Direct investment should favour the low carbon development strategy especially with regards to investment in infrastructure. Government policies should also play an important role in guiding the investments of financial institutions.

Businesses are responsible for 85 per of investment worldwide. To encourage them to put more money in low-carbon projects, public policy should provide a “pull” for the deployment of existing technologies and reduce risks to “push” incremental investment in emerging technologies. [236] Both public and private investment sources, including households, are important channels in the investment.

International funding pools are another important channel that could support an increase in financial transfers to developing countries. Pooled international funds, multilateral or bilateral sources, such as GEF, the World Bank or ADB are another important source of finance for low carbon development in developing countries. These funds have expanded rapidly in recent years, covering mitigation and adaptation costs across all sectors, and many are tailored to provide support to specific mitigation measures, specifically for countries which can also use the financing source for low carbon development. For example, the GEF Least Developed Countries Fund, Special Climate Change Fund and the Adaptation Fund under the Kyoto Protocol provide about $250 million per year to climate change projects, which cover renewable energy, energy efficiency, sustainable transportation, adaptation, new low-carbon energy technologies and capacity building.

Encouraging financial flows between developed and developing countries and participation of the private finance sector and global investment community are essential. Appropriate financial instruments must be designed to supply the funds such as National Trust Funds.[237] The Copenhagen Accord commits develop countries to:

- provide $30 billion in 2010-2012, with funding prioritized for the most vulnerable countries; and
- support a drive to mobilize jointly $100 billion per year for emission reduction, forest protection and adaptation in developing countries by 2020.

Table 8-2. Lists a range of the new financing mechanisms for mitigation at the international and national/sub-national level.

	International Schemes	National and Sub-National Schemes
Public Funds	ODA (multilateral, bilateral and decentralised cooperation) Multilateral Funds	Green economic stimulus Environmental Fiscal Reforms Export Credits Rebates & Subsidies Tax credits & Tax Free Bonds Low interest loans
Private Funds	Green Equity Finance Private investment funds Foundations Non-Governmental Organisations Global Philanthropic Foundations Corporate Social Responsibility (MNCs)	National Philanthropic Foundations Corporate Social Responsibility (National corporations)
Market-based mechanisms	Tradable Renewable Energy Certificates Carbon Cap-and Trade Mechanisms (CDM, JI, voluntary) Tradable Renewable Energy Certificates Green insurance contracts Prog. Approaches (NAMA, etc.)	Tradable Renewable Energy Certificates Utility DSM Green mortgages Tax free climate change bonds Domestic carbon projects
Innovative Instruments	Transaction Taxes (Tobin) International CC Finance Initiative Air Travel Levy Global Carbon Tax Debt-for-Efficiency Swaps International Carbon Auction Funds Int. non-compliance fees Efficiency Penny	Carbon Taxes Energy Taxes Auction of Emission Allowances National Non-compliance fees Green Investment Schemes Efficiency Penny

(Source: Charting A New Low-Carbon Route To Development - A Primer on Integrated Climate Change Planning for Regional Governments, United Nations Development Programme, Page 34, June 2009.)

8.2.3 Recommendation 5: Encourage R&D of clean energy technology

Developing advanced energy technologies that enhance energy efficiency and promote the use of new energy is essential to overcome current energy problems and achieve a low carbon development path.

Technology plays a fundamental role in advancing efforts to adopt a low carbon development path on three fronts:

1. accelerating the deployment of existing low-carbon technologies;
2. developing and deploying new breakthrough technologies for the longer-term; and
3. avoiding the locking-in of high-carbon technologies in developing countries.[238]

The Copenhagen Accord calls for the establishment of a Copenhagen Green Climate Fund, a High Level Panel to examine ways of meeting the 2020 finance goal, a new Technology Mechanism, and a mechanism to channel incentives for reduced deforestation.

The IEA's Energy Technology Perspective 2008 points out that new technologies are needed to cover the remaining 30 per cent of emission reduction in the future. Figure 9-3 shows the energy technology perspective in the emission reduction and it also reflects its potential role in the transmission to the low carbon development path.

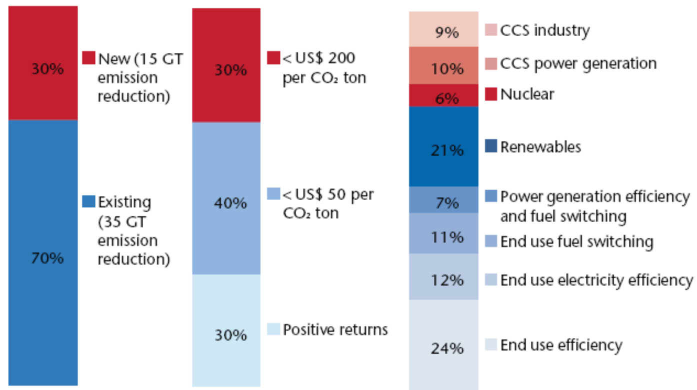


Figure 8-3. The IEA energy technology perspectives in 2008

(Source: Towards a low carbon economy, a business contribution to the international energy & climate debate, Page 5, World Business Council for Sustainable Development.)

Technological innovation will be the greatest drive force in development of low carbon industries. Governments should stipulate policies to encourage low carbon technological innovation in the following ways:

- Promoting investment in R&D for technological innovation and increasing public RD&D in innovative clean energy technologies and setting up carbon funds to promote investment on low carbon and development and related infrastructure:
- Setting up low carbon R&D center, demonstration platform to promote development and application of low carbon technologies; and
- Creating an optimized environment, actively attracting, training and retaining all kinds of high-level innovative talents with more flexible preferential policies.

Generally the private sector develops, owns, uses and deploys technology, rather than governments. Technology is essential for businesses to create value and generate wealth. In many circumstances, businesses invest in technological advances to enhance their competitive advantage. Policies related to R&D of clean energy technology need to benefit the private sector to some extent to ensure their participation. Governments should seek to develop stronger collaborative partnerships with the private sector on large-scale RD&D projects. Improvements in rules and regulations for RD &D, especially those that are creating unintended barriers, must also be promulgated at all levels of government. [239]

Government policy options for promoting the business to partake in RD&D include:

- providing funds for R&D institutions recognized by the government for the development of new energy technology;

- stipulating preferential tax policies for enterprises R&D, i.e. income tax exemption;
- making incentives for business RD&D of clean energy technologies; and
- making new energy products the first choice for public procurement.

It is also important to unleash the potential of existing low-carbon technologies, bring new technologies to the market and deploy available technologies for the countries, especially developing counties, in the transition to a low carbon development path.

Public procurement

Procurement by governments and other institutional buyers of energy-efficient products would set examples for corporate buyers and individual consumers. Governments could also exert influence through "indirect purchasing" by sending clear signals to their suppliers that they should offer energy-efficient equipment and follow energy-efficient practices.

Governments should select a strong lead agency to implement the changes and then introduce a standardized system of assessment. This would involve an assessment of the environmental impacts of a product at all stages of its life cycle, taking into account the environmental costs of securing raw materials, manufacturing, transporting, storing, handling, using and disposing of the product. The products which minimize environmental impacts should then be places on a list that is disseminated to government officials. Green public procurement also raises public awareness, shows leadership by the government and demonstrates to the consumers how to reduce environmental impacts by utilizing their purchasing power.

Policy options to enhance green public procurement could include:[240]

- standards and labelling programmes;
- basic laws and regulations;
- development of guidelines and budget system reforms.

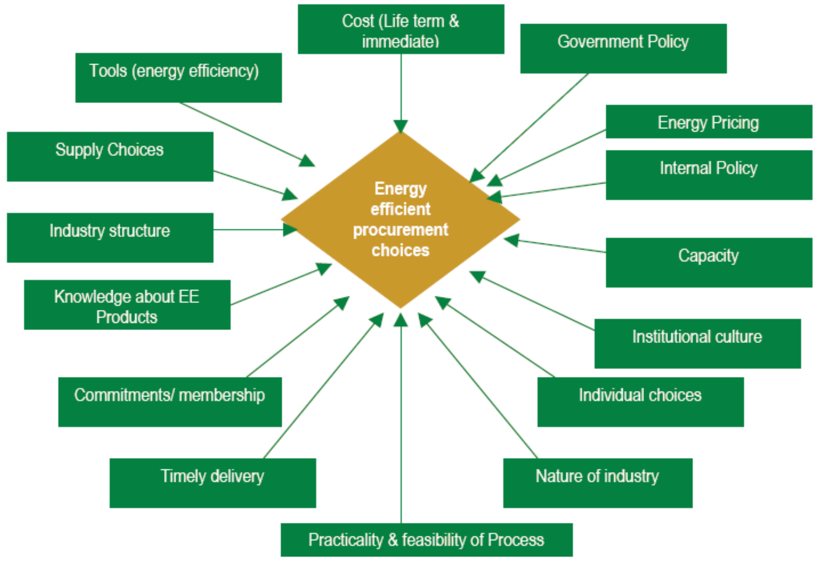


Figure 8-4. Factors need to be taken into consideration for energy efficient procurement

(Source: Sustainable Public Procurement Towards a low -carbon economy, The Energy and Resources Institute (TERI), India, August 2008, Page 58)

8.3 Build enabling environment for transition to low carbon development

8.3.1 Recommendation 6: Build an appropriate policy and regulatory framework for low carbon development

A coherent portfolio of policy measures and specific mechanisms are needed to drive the transition to a low carbon economy. The potential benefits of a low carbon economy will not be achieved without appropriate policies. They include financial incentives through carbon prices, taxes and subsidies, support for technology innovation, information and encouragement and regulation when needed.

The Asia-Pacific region needs to further strengthen its policy framework and accelerate the implementation of those policies towards achieving sustainable development. Strengthening an integrated policy framework on low carbon development and the means of implementation including institutional, financing, technological development and capacity building are all needed. A coherent portfolio of policy measures and specific mechanisms is essential to drive the transition to a low carbon economy. This will require all of the following:

- implementation of policy and regulation options for the transmission to a low carbon development path;
- stringent regulatory measures such as carbon emissions standards and emission target (such as the Carbon Reduction Commitment) for sectors such as transport, commercial buildings and housing;

- regulation or policy instrument to overcome market imperfections that prevent the net-profit-positive opportunities from materializing, i.e. through technical norms and standards;
- innovative policy and stable long-term incentives to encourage power producers and industrial companies to develop and deploy GHG-efficient technologies, especially the existing practical and the cost efficiency of promising emerging technologies;
- use of effective economic incentives or economic policy instruments (such as carbon tax, subsidies for renewable energy & energy efficiency and tax rebates.); and
- policy to stimulate low-carbon activities from general public (especially in energy consumption, transport and food).

Studies indicate that nearly Asia-Pacific countries have embarked on some form of a climate change strategy plan that contains elements of a low carbon development path. According to statistics, 38 National Adaptation Program of Actions (NAPA) have been received by the UNFCCC Secretariat, including Bangladesh, Bhutan, Cambodia, Kiribati, Maldives, Samoa, Tuvalu, and Vanuatu in Asia-Pacific.[241] Policy and legislation for renewable energy development have been adopted by some countries in this region. China, for example, enacted in 2006 a renewable energy law which stipulates the responsibilities of the government and society in developing and applying renewable energy. The Philippines, too, is in the process of approving a renewable energy bill. The Islamic Republic of Iran has also been developing a new law and has started to allow the participation of independent power producers.

So, the key point is how to integrate low carbon policies with other policy priorities and the existing policies in their own country. This requires a thorough analysis of existing policies, the economic stage of the country, industry structure and the energy situation.

8.3.2 Recommendation 7: Enhance institutional mechanism to support low carbon development

Institutional factors such as system, policy and government actions are important measures for GHG emission reduction. They include readying institutions for a low carbon development path, promoting a multi-sectoral coordination mechanism, allocating resources through economic means, improving relevant laws and regulations, adjusting the industrial structure, mobilizing the public to participate in a wide range of actions for the transition to a low carbon economy. If properly designed, such policies and measures will have a significant effect in both promoting sustainable development and controlling GHG emissions.

<u>The whole system for institutional mechanism</u>

Most countries usually address issues such as energy needs, environmental protection, and poverty, separately. However, when dealing with GHG emissions, it is more effective to integrate these policies. A key factor in the process is to put in place a decision making institution that includes a wide range of stakeholders. The following actions must be considered for the specific institutional mechanism:

Strengthen the responsibility of the government. All levels of government should integrate low carbon development into their economic and social development planning as an important part of implementing of circular economy and achieving sustainable development, establish proper regional and sectoral measures and enhance the ability of organization and implementation for the transition to a low carbon development path.[242]

Establish a national coordination mechanism for the transition a low carbon development path. After setting a long-term agenda for change, it is important to make sure specific institutions in government can deliver it. A specific national level agency could be established or integrated in the government agency that deals with climate change with the task of overseeing the transition to a low carbon economy. This entity would have the authority to coordinate and deploy the necessary resources at all levels of government. National policymakers must fully understand the policy implementation issues at the regional and local levels. Their involvement in assessing options and developing solutions will be central to ensuring that national policies support the implementation of decisions at the local level.

Improve government performance rating mechanism. Government performance rating plays in important role in strategy making, and if GDP of low-carbon economy development is connected with the government performance rating, the government strategy, planning, management, business promotion and investment attraction will be shifted to low-carbon economy development.

<u>Analytical and strategic capabilities of governments</u>

All levels of government should participate in the development of a low-carbon economy. Central governments should set policies and measures to facilitate the economic and social development. Faced with pressure on the environment and resources, they need to set practical and effective measures for the transition and consider both social and economic effects; local governments should make detailed plans in line with the strategies set by central government.

Meanwhile, both central and local governments must take the following steps:

- increase publicity on low-carbon energy, the economic factor and the technology and development mode;
- encourage more people to participate in the process;
- provide guidance to ensure effective implementation of the policies;
- monitor closely the implementation with regards to cost, administrative functions and consistency with existing laws.

Policy consistency between the national and regional levels and between regional and local levels is key in carrying out the transition. This requires greater emphasis at local and regional levels as well as additional political leadership from local authorities.

Setting new measures which aim to promote local and regional decision-making in the transition process would better reflect their priorities in national policy[243] and enable them to become more proactive. In particular they would play a key role in implementing a strategic approach at the regional level, and the regional economic strategy would become a key driver in its development.

A remit further to develop the partnership with local and regional bodies on low carbon development will be established as follows:

- Establish a new beacon councils theme on low carbon development path to promote innovative local approaches on generation and demand-side measures;
- Urge local authorities to list low carbon development as priority at a strategic level, for example, through their Community Plans and Housing Strategies, the low carbon development should be consistent with the new strategic approach to be developed at regional level;
- Encourage local authorities to take the leading role in developing and facilitating cross-sectoral partnerships and providing advice and encouragement; and
- Consult on arrangements to collect and make available data on the pattern of energy usage in local areas, to enable local authorities and regional bodies to target activity more effectively for the transmission to a low carbon development path.

Capacity building among government agencies is needed for the implementation of new policies supporting the transition. Some Asia-Pacific countries have already put some form of it in place.

Box 8-2. Capacity Building in Indonesia's Low Carbon Development Options Study

Indonesia integrated specific capacity-building activities into the study process. Leading to and following up on the 2007 Conference of Parties in Bali, the government sought to strengthen its capacity on climate change issues and impacts. The Ministry of Finance collaborated with the study team on activities to develop knowledge and experience in national and international settings:

• Learning by doing—Regular meetings with the working group to produce briefings resulted in rapid and focused knowledge building.

• Learning by engaging internationally—in 2007 and 2008, key staff in the Ministry of Finance and working groups participated in global events, presenting and collaborating with international counterparts.

• Learning through technical collaborations—In addition to collaboration on the low carbon growth study, interaction with donor-funded consultants and studies included UNDP, JICA, AusAID - Australian Government Overseas Aid and Danish International Development Agency (DANIDA), among others.

• Learning through Environmental Economics Course—Staff from the Ministry of Finance and the coordinating Ministry for Economic Affairs participated in an environmental economics course run jointly by the World Bank Institute and the Asian Development Bank.

Adapted from World Bank, "Low Carbon Development Options for Indonesia: Phase 1 Status Report and Findings," November 2008.

Monitoring and assessment

The Copenhagen Accord calls for broad terms for reporting and verifying countries' progress in transitioning to a low carbon economy. To carry this out a strong monitoring and assessment programme is needed along with proactive decision making to address shortcomings. The transition to a low carbon development past cuts across traditional boundaries, making interdepartmental collaboration another key element in implementing a successful plan. However, collaboration is not feasible unless the leadership guiding the transition is effective and strongly committed. For the programme to be successful as a whole, an integrated system of monitoring and assessment should be established and include the following:

- monitoring the introduction and impact of policies to deliver those low carbon development goals;
- monitoring the performance of low carbon strategies; and
- assessing the progress of the transition to a low carbon development path.

The backbone of a monitoring system should be an extensive range of low carbon development indicators set by governments and revised annually. , The focus need to be directed a smaller set of indicators to give a broad overview of whether the overall objectives for low carbon development are being attained.

Other kinds of monitoring and assessment programmes could be used as a reference such as the Environmental Monitoring and Assessment Program (EMAP), which evolved into an effective tool after being revised and improved since inception. .

In addition, NGOs stand to play an important role in developing the low-carbon economy. They could monitor the activities carried out by governments and enterprises in an effective way.

8.3.3 Recommendation 8: Make full use of public and private partnership to promote the transition of low carbon development

Public and private partnership (PPP) are positioned to play a prominent role in the transition to a low carbon development path. The private sector is a major source of innovation, capital and capacity that, given the right framework, can deliver a low carbon global economy. For governments to facilitate the release of private sector resources, they need to understand how capital markets and corporate investment strategies can be incentivized to deliver results consistent with sought after goals on carbon mitigation and improved access to energy.[244]

In its widest sense, a PPP can be defined as a long-term contractual agreement between the public sector and the private sector. Globally, PPPs are an increasingly popular tool used by governments to fund large scale infrastructure projects. One potentially effective type of PPP is the Build, Operate and Transfer (BOT) project (Build, Operate, and Transfer) in the power generation sector and pollution water plant. Figure 9-5 shows an effective way of the PPPs' operation.

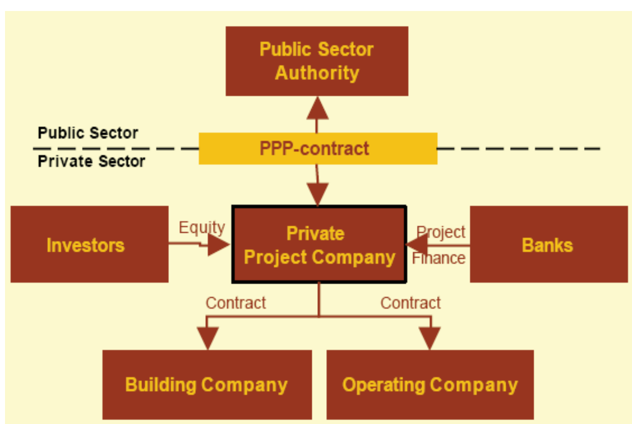


Figure 8-5. An effective way of the PPPs' operation

(Source: Dipl.-Ing. Frank Friesecke, The Increased Significance of Public Private Partnerships for Urban Development in Germany, October 2006)

Even though PPPs have assisted governments in accessing new financial capital and providing expertise for investments in cleaner power generating capacity, there remain kinks in this practice. For each project a thorough evaluation of costs, benefits and risks to governments and consumers is required. A cooperative governance model between public authorities and the private sector can contribute to the creation of an enabling environment, through the joint identification of the barriers to investments in the green economy and the policy choices for their removal.[245] Some recommendations that can provide a framework to develop PPPs are as follows: [246]

a) Obtain political and popular support for using PPPs. Local authorities should be involved in local level planning.

b) Involve the appropriate private sector actors early in the process and discuss the following options with them, including project design and ways of achieving low cost solutions, especially in sharing of risks and responsibilities.

c) Ensure that the needed regulations and procedures are in place so that PPPs can work, including:

   - competitive procurement procedures, especially transparency and flexibility;
   - provision of a stable and clear-cut legal and fiscal framework;
   - regulation of potential conflicts of interest; and

d) Set up projects with clear ownership and management structures and division of responsibilities:

   - by negotiating with the private sector partners;
   - by contracts which are clear and agreed; and
   - by an efficient and transparent allocation of risks and rewards;

e) Capacity Building

   - building comprehensive infrastructure and human resources in public sector;
   - human resource development in public sector institutions on technical and legal aspects to build capacities for negotiating partnerships;
   - support of and appropriate training for government officials;
   - private sector operators' technical and managerial skills need to be upgraded.

8.3.4 Recommendation 9: Enhance public awareness on low carbon development through public education

The general public's level of knowledge about the low carbon economy will affect participation into the course, and ultimately the realization of the goals. Better education and public awareness campaigns are needed in Asia-Pacific, particularly in developing countries, for a low carbon development path. Positive results could be achieved though the actions of a well-informed public working in tandem with civil society groups.

Thus, it is essential to promote public awareness campaigns. The campaigns should be undertaken through various means such as newspapers, TV, broadcasting and the Internet.

Media could serve as an effective tool to strengthen government guidance, promote corporate participation and raise public awareness.

Both producers and consumers need to be well informed. Governments can serve as an effective channel for providing and disseminating information on energy conservation. This would enable them to combine policy "push" with consumer "pull". They could also promote energy-efficiency products and solutions, while consumers can demand more efficient devices and practices. Some options are shown in table 9-3.

Table 8-3. Awareness campaigns-areas, target audience and technologies

End-user area	Target audience	Technologies
Buildings - Households - Commercial	Citizens Households Sustainable communities Property owners Architects and engineers Financial institutions Schools and universities	Energy efficient appliances Heating Cooling Lighting District heating Solar energy Others
Transport - Mass transportation - Private transportation	Decision makers Transport authorities and companies Local and regional authorities Financial institutions Citizens	Electric vehicles Biofuels Gasohol Integrated planning ICT NGV Hybrid Others
Industry - Manufacturing - Services	Decision makers Local and regional authorities Consumers Utilities ESCOs	Energy efficiency Cleaner production CHP Renewable energy Others

(Source: Energy Security and Sustainable Development in Asia and the Pacific, Economic and Social Commission for Asia and the Pacific, April 2008, Page 133)

From the experience of developed countries, the participation of governments, enterprises as well as the general public is essential for the development of a low carbon economy. The general public must make a serious effort to conserve energy in every aspect of their day-to-day life. They can also influence the direction of commercial enterprises through the consumption patterns and product choices. With the above in mind, it is of utmost importance that the public be made aware of the urgency in transitioning to a low carbon economy.

[1] BP Statistical Review of World Energy, June 2009, Page 7

[2] Data source: Statistical Yearbook for Asia and the Pacific 2009.

[3] Source: International Energy Agency; World Bank, World Development; World Population Prospects: The 2008 Revision Population Database. Online database, accessed on 10 September 2009.

[4] BP Statistical Review of World Energy, June 2009, Page 27

[5] Energy outlook for Asia and the Pacific, Asia-Pacific Economic Cooperation and ADB, October, 2009, Page 7

[6] Asian Aspirations for Climate Regime beyond 2012, Page 29

[7] Key Messages from the theme study: Energy Security and Sustainable Development in Asia and the Pacific, Economic and Social Commission for Asia and the Pacific, 64th commission session.

[8] BP Statistical Review of World Energy, June 2009, Page 41

[9] Towards a Low-carbon Economy, A business contribution to the international energy & climate debate, World Business Council for Sustainable Development– WBCSD, Page 4

[10] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008. Page 27

[11] Source: United Nations Statistics, 2007.

[12] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008, Executive summary.

[13] Update Trade and climate change, Volume 4, Issue 1, October 2009, TERI. Page 6-7

[14] Update Trade and climate change, Volume 4, Issue 1, October 2009, TERI. Page 8

[15] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008, Executive summary.

[16] ESCAP. Statistical Yearbook for Asia and the Pacific 2009;http://www.unescap.org/stat/data/syb2009/

[17] Low Carbon Development Path in Asia-Pacific – Background Paper, Dr. Peter N. King, November 2009, Page 13

[18] Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World, UNEP/ILO/IOE/ITUC, September 2008, Page 69

[19] Data source: Statistical Yearbook for Asia and the Pacific 2008.Page 121

[20] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008, Page 11.

[21] Data source: Statistical Yearbook for Asia and the Pacific 2008. Page 8

[22] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008, Page 11.

[23] ENERGY, DEVELOPMENT AND SECURITY , Energy issues in the current macroeconomic context, Prepared for UN Energy based on inputs from UNDP, World Bank, UNIDO, UNEP, FAO, ESCAP and UNDESA

[24] World energy outlook 2009, Page 561

[25] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008, Page 14.

[26] ESCAP. Statistical Yearbook for Asia and the Pacific 2008, page 200

[27] List of countries by carbon dioxide emissions.
http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions

[28] IEA..World Energy Outlook 2007-China and India Insights (Chinese version), page 171

[29] Data from U.S. Energy Information System,
http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=91&pid=46&aid=31

[30] ESCAP. Statistical Yearbook for Asia and the Pacific 2008, page 185

[31] ADB ,Energy outlook for Asia and the Pacific2009, page 308

[32] ESCAP. Statistical Yearbook for Asia and the Pacific 2008, page 191

[33] National Environmental Statistic Communique, 2005

[34] National Environmental Statistic Communique, 2000

[35] National Environmental Statistic Communique, 2008

[36] ESCAP. Statistical Yearbook for Asia and the Pacific 2009, page 203

[37] Yatsuka Kataoka,Overview Paper on Water for Sustainable Development in Asia and the Pacific. Asia-Pacific Forum for Environment and Development First Substantive Meeting, January 12-13, 2002. Bangkok, Thailand

[38] IFAD. Climate Change Impacts in the Asia/Pacific Region, United Nations Convention to Combat Desertification. page 4

[39] North-East Asia Subregional Report for the World Summit On Sustainable Development. World Summit on Sustainable Development- Task Force for the Preparation of WSSD in Asia and the Pacific, July 2001, page 26.

[40] Yatsuka Kataoka. Overview Paper on Water for Sustainable Development in Asia and the Pacific. Asia-Pacific Forum for Environment and Development First Substantive Meeting, January 12-13, 2002. Bangkok, Thailand

[41] Asian Development Bank. Water for All: The Water Policy of the Asian Development Bank

[42] UNEP. World Environment Outlook 2007, page 17

[43] ESCAP. Statistical Yearbook for Asia and the Pacific 2009, page 217

[44] http://en.wikipedia.org/wiki/Small_hydro

[45] http://en.wikipedia.org/wiki/Geothermal_power_in_the_Philippines

[46]http://ezinearticles.com/?Philippine-Geothermal---Worlds-2nd-Biggest-Geothermal-Power-Producer&id=1595665

[47] John G. Asia Pacific Hydro Power Market Analysis and Forecasts to 2013, Mar 13, 2009 http://www.prlog.org/10198289-asia-pacific-hydro-power-market-analysis-and-forecasts-to-2013.html

[48] GWEC. GLOBAL WIND 2008 REPORT, page 9

[49] Global Wind Energy Council. Latest News: Continuing boom in wind energy – 20 GW of new capacity in 2007, January 18, 2008.
http://www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews%5Btt_news%5D=121&tx_ttnews%5BbackPid%5D=4&cHash=f9b4af1cd0

[50] ADB. Clean Energy Applications in Asia and the Pacific, 2006. page 17

[51] Wikipedia website, http://en.wikipedia.org/wiki/Wind_power#cite_note-gwec2007-94 .

[52] Wind energy "penetration" refers to the fraction of energy produced by wind compared with the total available generation capacity.

[53] REN21. Background Paper: CHINESE RENEWABLES STATUS REPORTOCTOBER 2009, page 48.

[54] ADB, Clean Energy Applications in Asia and the Pacific.2006, page 7

[55] Poornima Gupta; Laura Isensee (Fri Sep 11, 2009 3:51pm EDT). "Google Plans New Mirror For Cheaper Solar Power". in Carol Bishopric. Global Climate and Alternative Energy Summit. San Francisco: Reuters & business world.in.Archived from the original on 14 Sep 2009.
http://www.businessworld.in/bw/2009_09_14_Google_Plans_New_Mirror_For_Cheaper_Solar_Power.html. Retrieved 2010-03-21.

[56] CSP and photovoltaic solar power Reuters

[57] Xu Shisen. Status and perspective of IGCC. IGCC workshop, 15－16 June, 2006, Beijing.

[58] ZHAO Dong-xu. Present Application Situation of IGCC in China and Related Suggestions, Electric Power Technologic Economics, 2007,19(6)

[59] Rochon, Emily et al. False Hope: Why carbon capture and storage won't save the climate Greenpeace, May 2008

[60] Report on Wilton Park Conference 866，CLIMATE AND ENERGY SECURITY-TOWARDS A LOW CARBON ECONOMY, 23–27, July 2007

[61] http://www.world-nuclear.org/info/inf47.html

[62] China ups targeted nuclear power share from 4% to 5% for 2020". Xinhua News Agency. 2008-08-05. http://news.xinhuanet.com/english/2008-08/05/content_8967806.htm. Retrieved 2008-08-13.

[63] How much. Nuclear Engineering International. 2007-11-20 http://www.neimagazine.com/story.asp?storyCode=2047917, Retrieved 2007-12-26 .

[64] NUREG-1350 Vol. 18: NRC Information Digest 2006-2007" (PDF). Nuclear Regulatory Commission. 2006. http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/, Retrieved 2007-01-22

[65] The Future of Nuclear Power, Massachusetts Institute of Technology, 2003, ISBN 0-615-12420-8, http://web.mit.edu/nuclearpower/ , retrieved 2006-11-10

[66] Darrel Thorson, Thermal Development BP Alternative Energy. Renewable Energy Policy Framework.

[67] Darrel Thorson, Thermal Development BP Alternative Energy. Renewable Energy Policy Framework.

[68] ISA, The University of Sydney. Life-Cycle Energy and Greenhouse Gas Emissions of Nuclear Power in Australia, November 2006,page 158

[69] ISA, The University of Sydney. Life-Cycle Energy and Greenhouse Gas Emissions of Nuclear Power in Australia, November 2006, page 159

[70] ISA, The University of Sydney. Life-Cycle Energy and Greenhouse Gas Emissions of Nuclear Power in Australia, November 2006,page 147

[71] UK Environment Agency, Biomass: Carbon sink or carbon sinner? April 2009, page 8

[72] LandMill. Development of Biomass Power Generation in Rural Areas: Component 1 - Biomass Power Generation: Barriers & Lessons Learned. DRAFT FINAL REPORT. February 2009, page 58.

[73] http://en.wikipedia.org/wiki/Emission_intensity

[74] http://en.wikipedia.org/wiki/Geothermal_power#cite_note-Bertani-14

[75] ISA, The University of Sydney. Life-Cycle Energy and Greenhouse Gas Emissions of Nuclear Power in Australia, November 2006,page 114

[76] ISA, The University of Sydney. Life-Cycle Energy and Greenhouse Gas Emissions of Nuclear Power in Australia, November 2006,page 157

[77] Darrel Thorson, Thermal Development BP Alternative Energy. Renewable Energy Policy Framework.

[78] Wikipedia website http://en.wikipedia.org/wiki/Carbon_capture_and_storage

[79] R. H. Crawford; G. J. Treloar; B. D. Ilozor; etc Comparative greenhouse emissions analysis of domestic solar hot water systems Journal Building Research & Information, 2003:34-47

[80] Raihan Elahi, Bangladesh Rural Electrification and Renewable Energy Development Project. Micro Finance to Promote Solar Home Systems

[81] Sun Zhiguo, Xie Jian, Fan Yayun, etc. Technology-economic analysis of solar water heater in Yunnan. Solar Energy, 2005, 2: 50-52

[82] R.A. Jabbar, M. Asif. Techno-Economical Analysis of Built-in-Storage Solar Water Heating System in Pakistan. Building Services Engineering Research & Technology, 2006l.27(1): 63-69

[83] REN21. Background Paper: CHINESE RENEWABLES STATUS REPORTOCTOBER 2009, page 68.

[84] Ann Kristin Petersen Raymer. A comparison of avoided greenhouse gas emissions when using different kinds of wood energy. Biomass and Bioenergy, 2006,30(7):605-617

[85] Lund, John W; Freeston, Derek H.; Boyd, Tonya L World-Wide Direct Uses of Geothermal Energy 2005, Proceedings World Geothermal Congress, 24-29 April 2005,Antalya,Turkey.

[86] http://en.wikipedia.org/wiki/Geothermal_heat_pump#Environmental_impact

[87] ESCAP. Sustainable Agriculture and Food Security in Asia & the Pacific, 2009. page 65

[88] http://en.wikipedia.org/wiki/Cellulosic_ethanol#Environmental_effects:_corn-based_vs._grass-based

[89] http://en.wikipedia.org/wiki/Cellulosic_ethanol#Environmental_effects:_corn-based_vs._grass-based

[90] BIOETHANOL AS A MAJOR SOURCE OF ENERGY. page 4.

[91] Proposed Regulation to Implement the Low Carbon Fuel Standard. Volume I: Staff Report: Initial Statement of Reasons" California Air Resources Board. 2009-03-05. http://www.arb.ca.gov/regact/2009/lcfs09/lcfsisor1.pdf. Retrieved 2009-04-26.

[92] Proposed Regulation to Implement the Low Carbon Fuel Standard. Volume I: Staff Report: Initial Statement of Reasons" California Air Resources Board. 2009-03-05. http://www.arb.ca.gov/regact/2009/lcfs09/lcfsisor1.pdf. Retrieved 2009-04-26.

[93] www.arb.ca.gov/fuels/lcfs/121409lcfs_lutables.pdf

[94] www.arb.ca.gov/fuels/lcfs/121409lcfs_lutables.pdf

[95] Thu Lan Thi Nguyen, Shabbir H. Gheewala, Savitri Garivait. Energy balance and GHG-abatement cost of cassava utilization for fuel ethanol in Thailand. Energy Policy.2007,35(9)

[96] http://en.wikipedia.org/wiki/Cellulosic_ethanol#Environmental_effects:_corn-based_vs._grass-based

[97] Greg Archer. Low Carbon Vehicle Partnership. UK approach to calculating biofuel carbon intensity. Challenge Bibendum Round Table 1 liquid fuels: clean conventional, bio & synthetic fuels for tomorrow 14th November, Shanghai, China

[98] Greg Archer. Low Carbon Vehicle Partnership. UK approach to calculating biofuel carbon intensity. Challenge Bibendum Round Table 1 liquid fuels: clean conventional, bio & synthetic fuels for tomorrow 14th November, Shanghai, China

[99] Ignacio J. Pérez-Arriaga. Regulatory Instruments for Deployment of Clean Energy Technologies. CAETS 2009 Calgary – July 14, 2009, page 5

[100] Mark Barrett, Robert Lowe,Tadj Oreszczyn, etc. How to support growth with less energy. Energy Policy, 2008, 36:4592–4599

[101] To be consistent with the rest of the papers and the language employed at the Expert Review Meeting (ERM), the term "path" is used through the paper. However, "path" can suggest that there is only 'one' way to effectively address climate change, while in reality there are various pathways which can be pursued, eliciting an effective transition to a low carbon economy. Therefore, the term "pathways" is an appropriate alternative.

[102] For instance, development of oil and gas in Western Canada has been subjected to ecoterrorism from (those believed to be) Canadians. See http://www.csmonitor.com/2008/1017/p99s01-duts.html

[103] Life Cycle Assessment, or Life Cycle Analysis (LCA) examines the environmental impact of a good or service throughout its entire lifespan (a cradle to grave approach). In the case of a product, this would include the energy, air and water pollution, and solid waste involved in the collection and transportation of raw materials, the process involved in making it a finished product (e.g. a water heating system), the distribution and use of the system, and finally its disposal (Macauley and Walls 2000).

[104] See Charles Moonga Haanyika (2006) "Rural electrification policy and institutional linkages" Energy Policy (34): 2977–2993 for an examination of these reforms and rural electrification goals for example.

[105] Industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

[106]ESCAP. Statistical Yearbook for Asia and the Pacific 2009, page 211

[107] ESCAP. Statistical Yearbook for Asia and the Pacific 2009, page 215

[108] ESCAP. Statistical Yearbook for Asia and the Pacific 2009. page 201

[109] World Energy Outlook 2007 - China and India Insights, page 486

[110] ADB. Energy Outlook 2009 for Asia and Pacific. page 7

[111] ADB. Energy Outlook 2009 for Asia and Pacific. Page 7

[112] ADB. Energy Outlook 2009 for Asia and Pacific page 17

[113] IEA. World Energy Outlook 2007 - China and India Insights, page 314

[114] IEA. World Energy Outlook 2007-China and India Insights (Chinese version), page 184

[115] IEA. World Energy Outlook 2007-China and India Insights (Chinese version), page 175.

[116] Economic and Social Commission for Asia and the Pacific. Energy Security and Sustainable Development in Asia and the Pacific. 2008, page 87.

[117] IEA. World Energy Outlook 2007-China and India Insights (Chinese version),page 231

[118] IEA. World Energy Outlook 2007 - China and India Insights, page 541

[119] Source from World Energy Outlook 2007 - China and India Insights.

[120] McKinsey, Pathways to Low Carbon Economy.2009, page 60

[121] IEA. World Energy Outlook 2007. China and India Insights, page 373

[122] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April 2008, Page 27

[123] IEA. World Energy Outlook 2007. China and India Insights, page 374

[124] IEA. World Energy Outlook 2007. China and India Insights, page 373

[125] IEA. World Energy Outlook 2007 - China and India Insight, page 540

[126] IEA. World Energy Outlook 2007 - China and India Insight, page 514

[127] IEA. World Energy Outlook 2007 - China and India Insight, page 369

[128] Benefits of investing in low-carbon technologies and energy efficiency

[129] Co-benefits of climate policy, Background Studies, Netherlands Environmental Assessment Agency (PBL), February 2009, Page 39

[130] ESCAP. Statistical Yearbook for Asia and the Pacific 2009. page 216

[131] The Centre for International Economics (Australia).The buildings sector and greenhouse: key facts. page 4

[132] IPCC Assessment Report 4, workgroup three- Residential and commercial buildings

[133] IEA. World Energy Outlook 2007 – China and India insights. Page 305

[134] IEA. World Energy Outlook 2007 – China and India insights. Page 476

[135] IEA. World Energy Outlook 2007 - China and India insights. Page 305

[136] IEA. World Energy Outlook 2007 – China and India insights. Page 477

[137] IEA. World Energy Outlook 2007 - China and India insights. Page 306

[138] The Centre for International Economics (Australian).The buildings sector and greenhouse: key facts. page 5

[139] IEA. World Energy Outlook 2007 - China and India insights. page 384

[140] IEA. World Energy Outlook 2007 - China and India insights. page 554

[141] CIE (Centre for International Economics) 2007, *Module A: cost abatement curve for energy efficiency in the building environment*, Discussion paper prepared for the ASBEC Climate Change Sub-committee, July.

[142] The Centre for International Economics (Australia), Capitalizing on the Building Sector's Potential to Lessen the Costs of a Broad Based GHG Emissions Cut. 2007. page 17

[143] The Centre for International Economics (Australia).Capitalizing on the Building Sector's Potential to Lessen the Costs of a Broad Based GHG Emissions Cut. 2007. page 19-21

[144] IEA. World Energy Outlook 2007, China and India Insight, Page 298

[145] Joyce Dargay. Vehicle Ownership and Income Growth, Worldwide: 1960-2030 page 5.

[146] IEA. World Energy Outlook 2007, China and India Insight, Page 298

[147] IEA. World Energy Outlook 2007, China and India Insight, Page 298

[148] ADB. Energy outlook for Asia and the Pacific 2009

[149] ESCAP. Statistical Yearbook for Asia and the Pacific 2008

[150] World Health Organization, 2004, Comparative quantification of Health Risks, Chapter 17, viewed on website of World Health Organization, 15 October 2007, http://www.who.int/

[151] TSP data aggregated from 17 cities; PM10 data from 32 cities; SO2 data from 31 cities; NO2 data from 29 cities.

[152] 20 Huizenga, C., 2008, Urban A M in Asia: status and trends , presentation to Regional Coordination meeting, Bangkok, January, viewed on the website of Clean Air Initiative for Asian Cities (CAI-Asia), http://www.cleanairnet.org/caiasia

[153] http://www.unmultimedia.org/radio/chinese/

[154] www.hetz.gov.cn/life/goodsnr.jsp?id=33116

[155] http://madeinchn.cn/thread-9-234-1-478.htm

[156] IEA. World Energy Outlook 2007, China and India Insights, Page 298

[157] IEA. World Energy Outlook 2007, China and India Insights, Page 297

[158] ADB. Energy outlook for Asia and the Pacific 2009

[159] Stern, Nicholas, 2006, The Economics of Climate Change: The Stern Review. Cambridge, UK: Cambridge University Press, viewed on web site of HM Treasury, 10 October 207, http://www.hm-treasury.gov.uk/

[160] Wikipedia website http://en.wikipedia.org/wiki/Fuel_economy_in_automobiles#Fuel_economy-boosting_technologies

[161] IEA. World Energy Outlook 2007, China and India Insight, page 380

[162] IEA. World Energy Outlook 2007, China and India Insight, page 537

[163] http://www.japanfs.org/en/mailmagazine/newsletter/pages/029766.html

[164] General office of the State Council, State Council Circular 512, December 6, 2007

[165] Ministry of Science and Technology, Provisional Measure on the Management of Government Subsides for Energy-Saving and New Energy Vehicles, February 11, 2009

[166] Lars Kroldrup. Gains in Global Wind Capacity Reported Green Inc., February 15, 2010

[167] REN21. Background Paper: Chinese Renewables Status Report October 2009. page 12

[168] These data are estimated based on emission factors of 0.943 tons of CO_2, 0.0306 tons of SO_2 and 0.266 tons of NOx for per MWh coal-fired electricity.

[169] REN21. Background Paper: Chinese Renewables Status Report October 2009. page 17

[170] REN21. Background Paper: Chinese Renewables Status Report October 2009. page 18

[171] KPMG. India Energy Outlook 2007. page 9

[172] KPMG. India Energy Outlook 2007, page 37

[173] It is about 0.29 tons CO_2 emission reduction for SWH replacing electricity heat in India.

[174] http://www.climate.org/topics/international-action/thailand.htm

[175] Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP), DSM in Thailand: A Case Study. October 2000

[176] Ms Napaporn Phumaraphand, Thailand DSM Programs: Financing Mechanism and Program Design the Keys to Success. ASIA Clean Energy Forum, ASIA Clean Energy Forum, June 4, 2008, Manila

[177] For further information, please see International Energy Agency (IEA). (2008). September 11, 2008. "Korea Goes for "Green Growth"." Retrieved June 3, 2009, from www.iea.org/Textbase/Papers/Roundtable_SLT/korea_oct08.pdf.

[178] For further information, please see Japan-United Kingdom Working Group. (2008). Roadmap to a Low-Carbon World - Full Report, Executive Summary. the Third Workshop of the Japan-UK Joint Research Project. Tokyo, National Institute for Environmental Studies (NIES)**:** 1-195.

[179] For further information, please see Government of Australia, "Phase-out of Inefficient Light Bulbs" http://www.environment.gov.au/sustainability/energyefficiency/lighting/,

[180] In 1987, the Republic of Korea entered a 10-year technology transfer agreement with Westinghouse (which was Combustion Engineering). The agreement was extended in 1997, with the aim of standardizing and indigenising the technology, making the country more self sufficient and able to develop reactors and power plants on its own. In 2007, Korea Hydro and Nuclear Power entered a joint venture agreement with Westinghouse, where they would develop state of the art nuclear technology together. The Republic of Korea is expected to have their own exportable design the AP+, by 2015, although Westinghouse will likely ensure that the country has properly addressed their IP, especially in competing markets such as China and the U.S. In the 1980s and 1990s, the Repbulic of Korea also purchased Canadian and French technology, using local content where feasible. World Nuclear Association. (2009). "Nuclear Power in North and South Korea." Retrieved June 1, 2009, from www.world-nuclear.org/info/inf81.html.

[181] Exceptions are allowed in cases where building developers submit a technical study indicating why 60% heating from this source would not be feasible.

[182] Notman, N. (2009). "UK's First CCS Pilot Plant Switched On." from www.rsc.org/chemistryworld/News/June/02060901.asp.

[183] http://unfccc.int/ttclear/jsp/index.jsp

[184] http://www.uneptie.org/energy/activities/islp/

[185] http://www.iea.org/Textbase/techno/index.asp

[186] http://www.iea.org/textbase/neet/index.asp

[187] http://www.pvmti.com/

[188] http://cordis.europa.eu/fp7/

[189] http://www.asiapacificpartnership.org/english/default.aspx

[190] http://www.c40cities.org/, supported by the Clinton Climate Initiative

[191] http://web.archive.org/web/20080209202956/http://www.climatetech.net/

[192] http://www.usaid.gov/our_work/economic_growth_and_trade/energy/index.html and http://www.usaid.gov/our_work/environment/climate/index.html

[193] http://www.nrel.gov/technologytransfer/

[194] http://www.jica.go.jp/english/operations/thematic_issues/energy/

[195] http://practicalaction.org/?id=energy

[196] http://www.teriin.org/

[197] http://www.energytechnologies.co.uk/Home.aspx

[198] See http://www.legrenelle-environnement.gouv.fr/grenelle-environnement/ (in French) for further information.

[199] Catalyzing capital towards the low carbon economy, James Cameron, Vice-Chairman & Co-Founder, Climate Change Capital Ltd. David Blood, Senior Partner & Co-Founder, Generation Investment.

[200] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, April, 2008. Page 79-80

[201] Bonn International Action Plan: Major outcome of the International Conference for Renewable Energies, was held in Bonn in June 2004 ("renewables 2004"), and 197 concrete commitments for developing RE were achieved.

[202] Alternative policies for promoting low carbon innovation, Report for department of energy and climate change, July 2009, Frontier Economics Ltd, London. Page 13

[203] Final Report for BERR Enterprise Directorate: SMEs in a Low Carbon Economy, Centre for Enterprise and Economic Development Research, January 2009, Page 4

[204] Climate Change Policies in the Asia-Pacific: Re-uniting Climate Change and Sustainable Development IGES White Paper, Page 24

[205] The role of finance sector in Korean carbon market, Park, Hyoung Kun

[206] Analysis of the Process, Outcomes and Implications of COP15/CMP5 by Rose Osinde Alabaster for AMCEN Secretariat, 2010, Page 3

[207] Champions of the Low Carbon Economy- Why CEOs are Ready for a Global Climate Agreement, by the UN Global Compact and Dalberg Global Development Advisors, Page 13-14

[208] World Energy outlook 2009, OECD/IEA, International Energy Agency (IEA), 2009, Page 541

[209] ECONOMIC STIMULUS PACKAGES: RETURNING TO GROWTH by PROFESSOR COMPTON BOURNE, Ph.D., O.E. PRESIDENT CARIBBEAN DEVELOPMENT BANK. APRIL 16. TRINIDAD AND TOBAGO. Page 2

[210] Climate Change Policies in the Asia-Pacific: Re-uniting Climate Change and Sustainable Development IGES White Paper, Institute for Global Environmental Strategies (IGES), 2008, Page 22

[211] Ibid.

[212] Alternative policies for promoting low carbon innovation, REPORT FOR DEPARTMENT OF ENERGY AND CLIMATE CHANGE, July 2009, Frontier Economics Ltd, London. Page 18

[213] Innovative policy solutions TO GLOBAL CLIMATE CHANGE, Pew center In Brief, Number 8, Further Resources .The Pew Center on Global Climate Change www.pewclimate.org.

[214] IGES White Paper, Chapter 8: Institutional Changes in Asia in Response to Climate Change, 21 June 2008, Page190

[215] IGES White Paper, Chapter 8: Institutional Changes in Asia in Response to Climate Change , 21 June 2008, Page 191

[216] Low Carbon Development Path in Asia-Pacific – Background Paper, Dr. Peter N. King, November 2009. Page 26

[217] Ibid.

[218] Low Carbon Growth Country Studies—Getting Started Experience from Six Countries Mitigating Climate Change through Development, Energy Sector Management Assistance Program, the World Bank and Carbon Finance-Assist Program World Bank Institute, September 2009.

[219] Low Carbon Development Path in Asia-Pacific – Background Paper, Dr. Peter N. King, November 2009, Page 33-34.

[220] Low-Carbon Technologies in the Post-Bali Period: Accelerating their Development and Deployment Christian Egenhofer, Lew Milford, Noriko Fujiwara, Thomas L. Brewer & Monica Alessi ECP Report No. 4/December 2007.

[221] Energy Security and Sustainable Development in Asia and the Pacific, Page 140, United Nations Economic and Social Commission for Asia and the Pacific, April 2008.

[222] Charlie Dou, "Wind power technology and China rural electrification", CTI Industry Joint Seminar: Successful Cases of Technology Transfer in Asian Countries, Hanoi, 8-9 March 2006.

[223] Towards a low carbon economy, a business contribution to the international energy & climate debate, World Business Council for Sustainable Development.

[224] Towards a low carbon economy, a business contribution to the international energy & climate debate, World Business Council for Sustainable Development.

[225] A Roadmap for a Secure, Low-Carbon Energy Economy, Balancing Energy Security and Climate Change, World Resources Institute and CSIS, January 2009.

[226] Alexandra Mallett, et al., "Section 1: Low Carbon Development Path – Importance, Perspectives and Trends", Low Carbon Development Path for Asia and the Pacific: Challenges and Opportunities to the Energy Sector, The Paper prepared for United Nations Economic and Social Commission for Asia and the Pacific, 2010.

[227] Energy Security and Sustainable Development in Asia and the Pacific, Page 184, United Nations Economic and Social Commission for Asia and the Pacific, April 2008.

[228] Toward a Low Carbon Economy: China and the World, FAN Gang, CAO Jing, YANG Hongwei, LI Lailai, SU Ming, Draft Paper prepared for the midterm review of the project "China Economics of Climate Change" December 14-15, 2008 Beijing, China.

[229] Energy Security and Sustainable Development in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), April 2008.

[230] Building a low carbon economy - the UK's contribution to tackling climate change, the First Report of the Committee on Climate Change, December 2008.

[231] Catalyzing capital towards the low carbon economy, James Cameron, Vice-Chairman & Co-Founder, Climate Change Capital Ltd. David Blood, Senior Partner & Co-Founder, Generation Investment Management LLP, Copenhagen Climate Council Secretariat. Page 6, May 2009.

[232] Toward a low carbon economy, a business contribution to the international energy & climate debate, World Business Council for Sustainable Development. Page 12, March 2009.

[233] Analysis of the Process, Outcomes and Implications of COP15/CMP5 by Rose Osinde Alabaster for AMCEN Secretariat, Page 6, 2010.

[234] Also referred to as a "bankruptcy-remote entity" whose operations are limited to the acquisition and financing of specific assets. The SPV is usually a subsidiary company with an asset/liability structure and legal status that makes its obligations secure even if the parent company goes bankrupt.

[235] Statistical year book 2008 for Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific. Page 162.

[236] Toward a low carbon economy, A business contribution to the international energy & climate debate, World Business Council for Sustainable Development. Page 12, March 2009.

[237] National trust funds are funds set aside to generate income for a particular purpose, with specific rules about how the proceeds can be used. They are flexible financial tools in which a relatively large sum is provided, under a specific legal arrangement, and the capital and/or interest is used over time. Depending on the capital base, a trust fund can provide a reliable income stream, grants, short-term credit, loan guarantees and/or foreign exchange. The original capital can come from domestic and/or external sources.

[238] Low-Carbon Technologies in the Post-Bali Period: Accelerating their Development and Deployment Christian Egenhofer, Lew Milford, Noriko Fujiwara, Thomas L. Brewer & Monica Alessi ECP Report No. 4, December 2007.

[239] Towards a low carbon economy, A business contribution to the international energy & climate debate, World Business Council for Sustainable Development, Page 5, March 2009.

[240] Towards a Low-carbon Economy, A business contribution to the international energy & climate debate, World Business Council for Sustainable Development– WBCSD, Page 4-5, March 2009.

[241] Low Carbon Development Path in Asia-Pacific, Ms. Liana Bratasida, Asia-Pacific Forum on Low Carbon Economy 19 June 2009 Beijing China.

[242] Toward a Low Carbon Economy: China and the World, FAN Gang，CAO Jing，YANG Hongwei，LI Lailai，SU Ming, Draft Paper prepared for the midterm review of the project "China Economics of Climate Change" December 14-15, 2008 Beijing, China. Page 39.

[243] ENERGY WHITE PAPER Our energy future - creating a low carbon economy, Presented to Parliament by the Secretary of State for Trade and Industry by Command of Her Majesty February 2003, Page 116.

[244] Investing in a low carbon energy future in the developing countries, World Business Council for Sustainable Development, 2007. Page 3.

[245] Charting A New Low-Carbon Route To Development, A Primer on Integrated Climate Change Planning for Regional Governments, United Nations Development Programme, June 2009. Page 73.

[246] Integration of European inland transport markets, Page 154. OECD, 2000.