

Chapter 11

Sustainable, Low-carbon Buildings and
Transportation: Climate imperatives in
urbanising Asia

Chapter 11

Sustainable, Low-carbon Buildings and Transportation: Climate imperatives in urbanising Asia

Maricor D. Muzones, Eric Zusman, Frank Hiroshi Ling, Hitomi Kimura and Takuro Kobashi¹

1. Introduction

How can a rapidly urbanising Asia pursue a sustainable, low carbon development path? This chapter seeks to provide some answers to this question. The chapter demonstrates that there are few studies exploring the link between sustainable consumption and climate change in Asia. It then suggests that understanding this relationship is critical in the region because unsustainable lifestyles and consumption behaviour could dramatically increase the region's energy use and greenhouse gas (GHG) emissions.

The relationship between sustainable consumption and climate change also merits greater understanding because many of the world's low cost GHG mitigation opportunities involve policies that promote sustainable lifestyles and behaviour in two of Asia's fastest growing sectors: buildings and transportation. With the region's rapid urbanisation, timely, if not early, action in these sectors is critical not only to avoid the lock-in of unsustainable development driven by carbon-intensive technologies but a "lock in" into unsustainable lifestyles and systems of services provision as well. Moreover, from a climate perspective the transformation of energy consumption in these two sectors will be crucial to help keep global temperature rise within 2 degrees Celsius above pre-industrial temperatures. This chapter discusses these opportunities and how barriers to realising them can be overcome at the local, national and international levels.

The chapter is divided into six sections. The next section reviews international policymaking processes and research that has begun to link sustainable consumption

Chapter Highlights

This chapter seeks to present how a rapidly urbanising Asia can consume more sustainably through low carbon lifestyles and practices, particularly in two of the most carbon-intensive sectors: buildings and transport. In doing so, key stakeholders in the buildings and transport sectors must recognise and work towards removing the barriers on the following:

- Managing the consumption of energy services in the buildings and transport sectors will be a key challenge for sustainable consumption and low carbon growth in Asia.
- Government support through subsidies and informational campaigns can help to accelerate deployment and drive economies of scale for energy efficient technologies and practices in the buildings sector.
- Public works like bus rapid transit (BRT) and district heating and cooling (DHC), which can only be carried out by the government, are critical to energy and fuel efficiencies.
- International frameworks under the UNFCCC and bilateral and multilateral exchanges can be extended to climate goals as well as sustainable development.

and production (SCP) and climate change. It also demonstrates why there is a need for more research on the relationship between these two issues in Asia, particularly in the buildings and transportation sectors. The third section presents the trends in energy demand and corresponding GHG emissions in these sectors. The fourth and fifth sections outline a number of mitigation opportunities related to sustainable lifestyles and behavioural patterns as well as obstacles to realising them in the buildings and transport sectors. The final section concludes with recommendations for integrating sustainable consumption into international climate negotiations and other international policy processes as well as integrating climate concerns into consumer-oriented policies at the national level. The entire chapter focuses chiefly on the sustainable consumption component of SCP.

2. Sustainable consumption and climate change in urbanising Asia

The importance of SCP came to international prominence in Agenda 21 at the United Nations Conference on Environment and Development (UNCED 1992) and Johannesburg Declaration at the World Summit on Sustainable Development (WSSD 2002). The WSSD, for example, characterises changing consumption and production patterns as essential to sustainable development, while Agenda 21 indicates that changing consumption patterns can make energy use in key sectors more sustainable. A few years after the release of Agenda 21, climate change entered into the discussions over SCP in a background paper that the Commission on Sustainable Development (CSD) prepared for the Marrakech Process (CSD 2006). More recently, SCP has drawn attention from climate change negotiators from developing countries who have criticised developed countries for their unsustainable lifestyles and consumption patterns (UNFCCC 2009).²

While the link between SCP and climate change has been made recently in international policymaking processes, for over a decade researchers have noted that sustainable lifestyles and behavioural changes can reduce energy use. Goldemberg (1996), for example, has argued that most of the strategies that promote sustainable energy futures have dealt with technical solutions such as switching from fossil fuels to renewable energy, but a less studied strategy is to change energy and fuel intensive *consumption patterns and lifestyles*. Herring and Sorrell (2009) have also endorsed a lifestyle-centred approach, cautioning that improving energy efficiency alone may not be as effective in reducing energy demand as generally assumed. This is due to the “rebound effect” wherein improvements in energy efficiency that reduce the marginal cost of energy services such as travel can lead to an overall increase in the consumption of those services. De Zoysa (2009) has taken this logic one step further and given it a regional focus, arguing that it is important for developing countries in Asia to integrate sustainable consumption criteria into regional and national policies, including climate policies.

While there have been efforts at the national level to enact policies and measures to address SCP (see Table 11.1 for examples from the buildings and transportation sectors), much remains to be done to significantly reduce energy use and achieve a substantial GHG emission reduction.

Table 11.1 Examples of national SCP policies and measures in transport and building sectors

	Policies/Measures	SCP
Transport		
India	The National Conservation Strategy and Policy Statement on Environment and Development (transport)	Outlines government's goals and projects for achieving sustainable lifestyles and the proper management and conservation of resources.
China	Consumption tax	Promotes the consumption of smaller, more efficient and less polluting cars through tax exemption grants.
Indonesia	Vehicles Emission Standard for Road Worthiness	Sets the limit for carbon monoxide and HC emissions for vehicles to pass road worthiness test.
Singapore	Weekend Car scheme	Introduced before the implementation of the road pricing scheme, it aims to provide further incentive to reduce frequency of vehicle use (e.g., a car owner who participates in this scheme receives a rebate and only pays 30% of the normal road tax).
Buildings		
China	National Energy Efficient Design Standard for Public Buildings (2005)	Sets target at 50% energy reductions compared to pre-existing buildings; targets to be achieved by improving energy use in the building (22%) and performance of the air conditioning system (28%).
	Green Building Evaluation Standard (2006)	Provides standards to quantify the sustainability of buildings using energy consumption data; Ministry of Construction awards a certificate for buildings that pass certification criteria.
Thailand	Energy Codes for "Designated Buildings" and Government Buildings (1995)	Sets envelope, heating and lighting standards for large designated and public buildings; requires energy audits for existing buildings.
ASEAN	ASEAN Regional Energy Benchmarking of Buildings; Regional Energy Efficient Building Award Programs	ASEAN-sponsored programmes to benchmark energy efficient buildings and reward best practices.
India	Energy Conservation Act	Provides for the legal framework, institutional arrangement and a regulatory mechanism to promote energy efficiency; includes energy efficiency programmes for government buildings, development of energy conservation building codes, a standards and labelling programme for electrical appliances, education and awareness campaign to promote energy conservation; and provided the basis for the 2001 Energy Conservation Building Code.
	Energy Audit Program (2007)	Establishes an audit programme for all buildings over a specified connected load.
	National Green Building Rating System	Considering establishing a voluntary system for builders and individuals.
	Pilot Programme of Renewable Energy in Buildings	Demonstrates renewable energy application (i.e., solar) on buildings.
Indonesia	National Master Plan for Energy Conservation (2005)	Forms part of strategy to reduce energy intensity by 1% per year; requires energy intensive buildings to undergo an energy audit.

Source: WRI SD-PAMs Database 2009; and Huang and Deringer 2007

There are several reasons that sustainable consumption and climate change deserve more attention in a rapidly urbanising Asia. For several decades, the region has been the fastest growing economic region, except for the financial crisis in 1998. This growth in Asia has been underpinned by large scale urbanisation. Table 11.2 shows the region's projected urbanisation trends from 1950 to 2030. With urbanisation, changing consumer preferences are driving much of the increase in energy use in Asia. And while technologies will help deliver the much needed emission reductions from the buildings and transport sectors, policies targeting lifestyle or behavioural change at the end-user's level will be crucial in reducing emissions in these sectors.

Table 11.2 Urbanisation trends in Asia 1950-2030

	GDP per capita (PPP,\$) 2003	Population (million) 2005	Urban Population (million) 2005	Proportion Urban			Estimated Increase in Urban Population	
				(%) 1950	(%) 2005	(%) 2030	(million) 2005–2030	(%) 2005–2030
World		6,453.6	3,172.0	29	49	61	1,772.7	56
Asia		3,917.5	1,562.1	17	40	55	1,102.2	71
Malaysia	9,512	25.3	16.5	20	65	78	10.8	66
Thailand	7,595	64.1	20.8	17	33	47	14.6	70
China	5,003	1,322.3	536.0	13	41	61	341.6	64
Philippines	4,321	82.8	51.8	27	63	76	34.8	67
Sri Lanka	3,778	19.4	4.1	14	21	30	2.4	59
Indonesia	3,361	225.3	107.9	12	48	68	80.0	74
India	2,892	1,096.9	315.3	17	29	41	270.8	86
Viet Nam	2,490	83.6	22.3	12	27	43	24.5	110
Pakistan	2,097	161.2	56.1	18	35	50	79.3	141
Cambodia	2,078	14.8	2.9	10	20	37	5.8	197
Bangladesh	1,770	152.6	38.1	4	25	39	48.4	127
Lao PDR	1,759	5.9	1.3	7	22	38	2.3	177

GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PPP = purchasing power parity, PRC = People's Republic of China.

Sources: United Nations, *World Population Prospects: The 2002 Revision; World Urbanization Prospects: The 2003 Revision*; and United Nations Development Programme, *Human Development Report 2005*.

Source: ADB 2006

Urbanisation has indeed brought hundreds of millions out of poverty, but at the same time, has ushered in a consumer economy based on Western patterns of consumption which, as Chapter 1 explained, are completely unsustainable. Between 1950 and 2005, the world's urban population expanded from 29% to 49%. For the first time in human history, more people are living in cities than in rural areas. By 2030, the population living in cities will reach 61%, an increase of nearly 1.8 billion with most of them in Asian developing economies. The urbanisation trends and their resulting increases in GHG emissions stand in contrast to the levels that science suggests are necessary for properly addressing climate change.

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC)-Working Group III has stated that a global temperature increase of 2 degrees Celsius above the pre-industrial level should not be exceeded in order to avoid dangerous influence on the planet's climate. This 2-degree target was subsequently built into the Copenhagen Accord in 2009. Reductions of up to 80% in emissions are needed to meet this goal, although current commitments fall far short. Thus, there is a critical need to move away from today's energy and fossil fuel intensive consumer-driven economy in order to properly address the climate problem.

While trends in energy use deserve attention, another dimension of the relationship between sustainable consumption and climate change is just as important. This second dimension reflects the fact that per capita energy consumption and associated GHG emissions of many countries in Asia are still significantly lower than the world average of 1.82 tonnes of oil equivalent (toe) and 4.38 tonnes CO₂ equivalent, respectively, in 2007. In fact, the per capita energy consumption of India and Indonesia is several times below that average with 0.5 toe and 0.8 toe, respectively. Additionally, the region's per capita electricity generation is estimated at 1,800 kWh, still 37% below the world average of 2,870 kWh (ADB and APEC 2009). More alarming is the fact that about 1.5 billion people or about 22% of the world's population still do not have access to electricity (IEA 2008). Of this number, more than half live in India, Indonesia and Bangladesh, and more than 85% live in the rural areas. As they migrate to urban areas, energy demand will increase significantly.

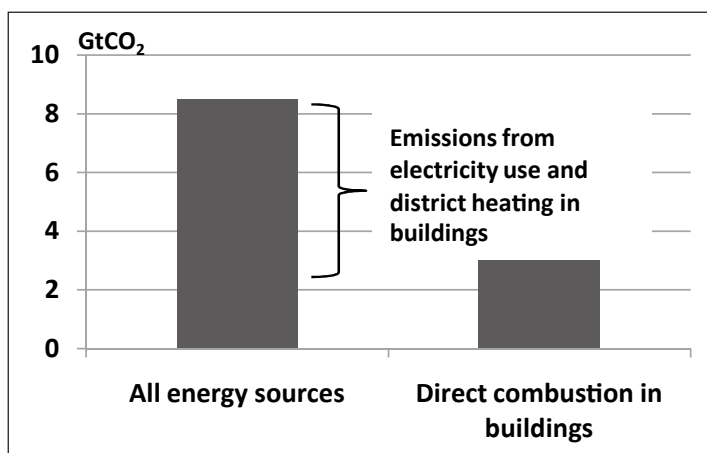
The region's lack of access to energy points to key considerations and possible tensions. For much of Asia, increased energy use will be essential to achieving basic development needs. Although Asia's rapid economic growth has lifted more than 350 million people out of poverty, increased energy use will be needed to reduce the proportion of underweight children, eradicate extreme poverty and hunger and reach other Millennium Development Goals (MDG). Indeed, since the Asia-Pacific region is home to more than half of the global population with the largest number of people in poverty, adequate provision of energy will be integral to regional and global poverty relief efforts (UN-DESA 2002). Therefore, it is important that policies for mitigating GHGs also enable Asia to pursue a low carbon development path that does not deprive the region of urgently needed development.

While researchers and international policymaking processes have advocated policies promoting sustainable consumption to address both development and climate change, progress on the ground has been limited. One of the few studies tracking SCP strategies such as eco-labelling finds that they are still constrained in their ability to motivate meaningful changes in consumer behaviour (Cohen 2008). This is partly because SCP strategies need to take a systems approach, one that considers actions within social structures and seeks to carry objectives through the production and consumption chain and into the social and physical infrastructure in which consumption takes place (European Environmental Bureau 2009). But it is also because studies on the barriers to promoting the system changes needed for sustainable low carbon lifestyles and behaviour are limited. The remainder of the chapter will consider not only the potential for low carbon consumption and development, but how obstacles to realising it can be overcome in the buildings and transport sectors in Asia.

3. Trends in building and transport emissions in rapidly urbanising Asia

3.1 Buildings

Buildings are responsible for almost 40% of global energy use and about 30% of global GHG emissions (UNEP 2009). In 2004, emissions from the residential and non-residential buildings sector (including electricity use) amounted to 8.6 GtCO₂eq from CO₂, 0.1 GtCO₂eq from N₂O, 0.4 GtCO₂eq from CH₄ and 1.5 GtCO₂eq from halocarbons (including CFCs and HCFCs). Figure 11.1 shows the carbon emissions from energy use in buildings. It demonstrates that emissions from electricity use and district heating at the user level account for more than three times the amount of CO₂ from direct combustion of fossil fuels. The importance of the user level is also supported by data showing CO₂ emissions through electricity use in buildings increased annually at 2% from 1971 to 2004.

Figure 11.1 CO₂ emissions from buildings, 2004

Source: Levine, et al. 2007

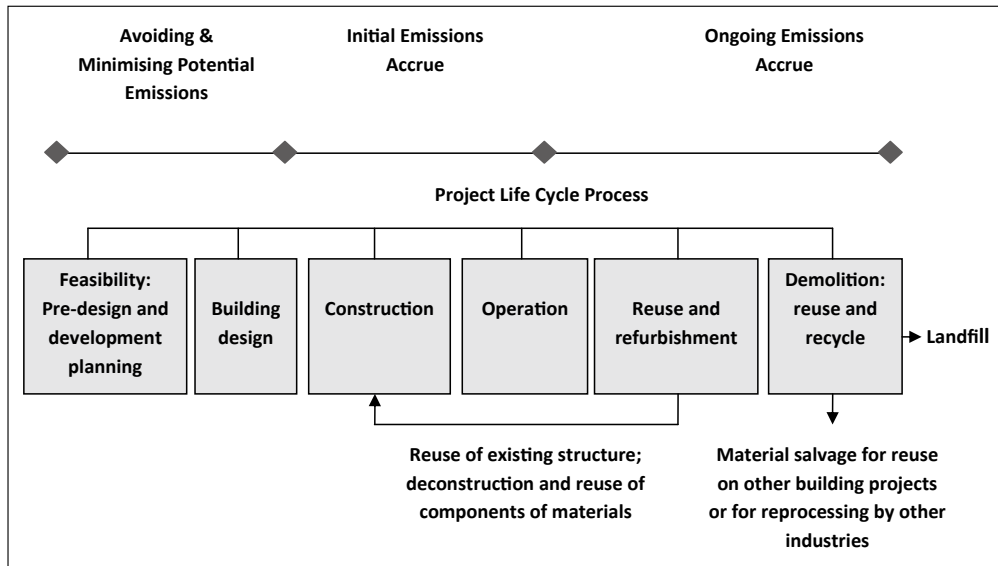
Urbanisation trends in Asia suggest there will be a dramatic increase for energy services in residential and commercial buildings. For example, commercial energy consumption is currently 14 times higher in developed than in developing countries. Moreover, energy consumption by commercial buildings is projected to be the highest-growing end use sector for energy in developing countries (EIA, US 2008). The buildings sector encompasses a wide variety of structures, including residential buildings like family homes and multi-family complexes, and commercial buildings such as shopping malls, high-rise offices, and refrigerated warehouses. In both residential and commercial buildings, the end-uses of energy can be roughly broken down into heating, cooling, refrigeration, lighting, appliances and electronics. These end-uses primarily rely on electricity but for various heating needs they may also require natural gas and oil.

In China, buildings account for almost 25% of the country's total primary energy consumption as well a quarter of its annual GHG emissions. With about 45% of China's population living in urban areas and projections for 60% of the population to be urban by 2030, a significant increase in the buildings' demand for energy services is very likely (Li 2008).

Growing GHG emissions from buildings are mainly driven by increasing electricity consumption. With total primary energy demand in the region projected to increase from 4,025.3 Mtoe in 2005 to 7,215.2 Mtoe in 2030, this translates to growth in per capita energy demand that is 50% higher than the 2005 level (ADB 2009). Per capita electricity demand projections likewise show an increase from 1,344 kWh in 2005 to 2,530 kWh in 2030 with an annual growth rate of 2.6% (ADB 2009). Developing Asia's CO₂ emissions from electricity use for commercial buildings is higher than all other regions. On the other hand, residential buildings are likely to account for the largest regional increase of CO₂ emissions at 42%.

Figure 11.2 shows the life cycle phases of buildings as presented by Graham (2003). Using a life cycle approach, trends show that the operational phase of a building by far accounts for the greatest proportion of energy use. Energy consumption during this phase depends on a wide range of interrelated factors which include climate and location, level of demand, supply and source of energy, building design and construction materials, and the level of income and behaviour of its occupants (UNEP 2009).

Figure 11.2 Life cycle phases of buildings

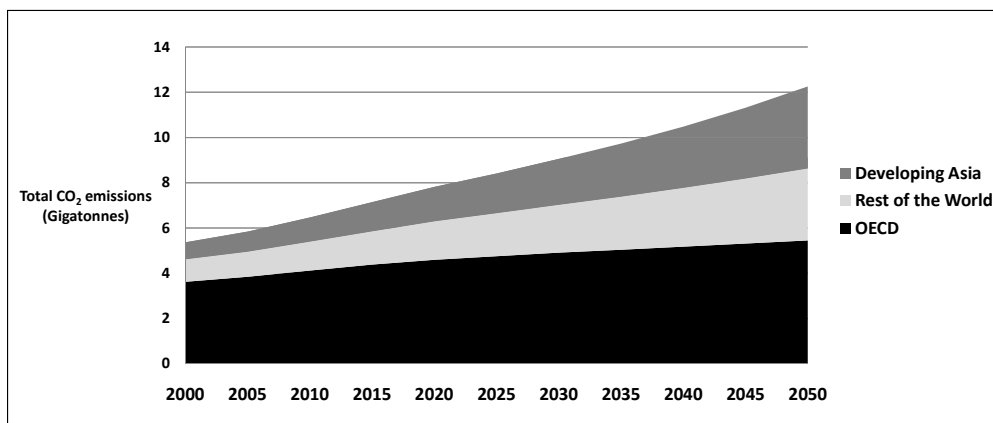


Source: UNEP 2009

3.2 Transport

Economic development, population growth and urbanisation have also contributed to a sharp rise in GHG emissions from the transport sector. The transport sector accounts for nearly a quarter of the world's CO₂ emissions from fossil fuel combustion and 13% of overall GHG emissions (IEA 2008). Between 1970 and 2005, global transport-related GHG emissions grew 130%, with much of the recent growth coming from a rapidly motorising Asia. For example, Asia's transport-related CO₂ emissions increased more than three-fold from 0.21 to 0.76 gigatonnes of CO₂ between 1980 and 2005 (Timilsina and Shrestha 2009).

But while Asia's transport emissions increased significantly in recent years, they could rise even faster in the future. Final energy demand for Asia is estimated to grow 2.2% annually from 2005 to 2030. Within these final demand figures, an estimated 2.9% annual growth for transport is forecast to outpace all other sectors. Moreover, as demonstrated in Figure 11.3, rapid growth in the sector's energy use will make developing Asia increasingly responsible for the world's transport-related CO₂ emissions. In 2000, developing Asia contributed 14% or 0.75 gigatonnes of the world's total transport-related CO₂ emissions—by 2050, transport-related emissions in the region are projected to reach 30%.

Figure 11.3 Total CO₂ emissions from the transport sector (2000-2050)

Source: WBCSD 2004

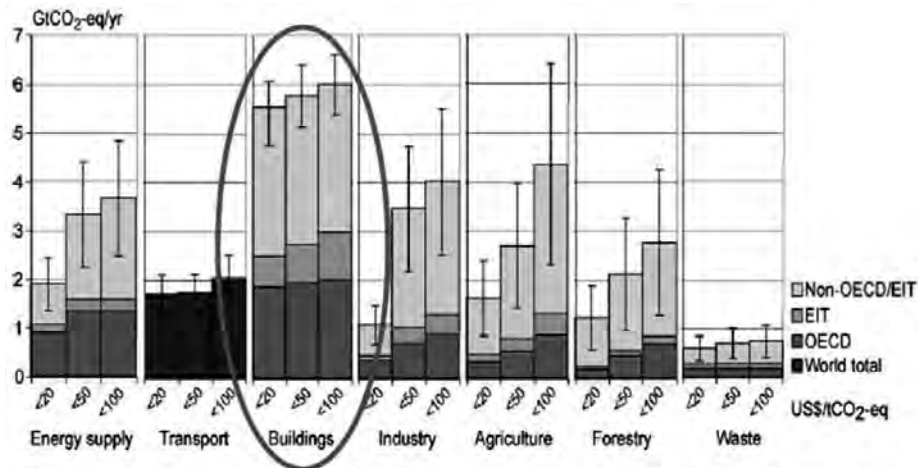
Transport emissions are a function of the volume of transport activity, the amount of energy by each type of activity, the type of fuel used to generate that energy and the mix of modes. The way that Asia's policymakers manage these four variables—particularly energy consumed by type of vehicle and the amount of overall vehicle activity—will influence future emissions. For example, the World Business Council on Sustainable Development (WBCSD) has found that an 18% improvement in per unit energy consumption will not be enough to offset an anticipated 123% increase in transport activity for light duty vehicles by 2050 (WBCSD 2004). This finding is particularly relevant for Asia since countries such as China could see vehicle stocks increase from 37 million in 2006 to 270 million in 2030 (IEA 2007).

The dramatic rise in the number of vehicles suggests policymakers in Asia must not only seek to make each vehicle more efficient but identify strategies that curb travel demand without sacrificing mobility and access. There are many opportunities to achieve this balance in Asia's transport sector. The next section demonstrates that for both transport and buildings most of these opportunities are not only low carbon but also low cost.

4. Mitigation opportunities and barriers in the building and transport sector

As shown in Figure 11.4, the good news is that compared with other major emitting sectors, the buildings sector has the greatest potential for delivering reductions in GHG emissions and at the least cost using currently available technologies (UNEP 2009). Levine et al. (2007) concluded that there is a global potential to reduce approximately 29% of the projected baseline emissions by 2020 cost-effectively in the residential and commercial sectors, the highest among all sectors studied in their report. The estimated energy savings of at least 75% is expected to come from new buildings through a systems approach application in building design and operation.

Figure 11.4 Estimated economic mitigation potential by sector and region



IPCC AR-4: Estimated economic mitigation potential by sector and region using technologies and practices expected to be available in 2030. The potentials do not include non-technical options such as lifestyle changes. (WGIII Figure SPM.6)

Source: UNEP-SBCI 2009

Rapid growth of new buildings in developing countries and the low rate of replacement of energy-inefficient buildings are major contributors to emissions from the buildings sector. The WBCSD recommends that governments, businesses and individuals aggressively reduce energy use in new and existing buildings to reduce emissions by 77% or an estimated 48 gigatonnes (against a 2050 baseline) to stabilise atmospheric CO_2 concentrations at the level called for by the IPCC (WBCSD 2009).

The key to altering the region's GHGs is identifying and taking advantage of affordable abatement opportunities. Studies have demonstrated it is economically and technically feasible to reduce global emissions by 35% from 1990 levels and 70% from 2000 levels by 2030. Reductions of these magnitudes would keep the world within a two degree increase of pre-industrial temperatures (McKinsey 2009).

Utilising marginal abatement cost curves to identify low cost mitigation options has attracted interest because they can demonstrate which sectors and interventions have the lowest cost mitigation opportunities. For example, these studies have demonstrated that the main sectors with mitigation costs below \$90 per tonne globally in 2030 are the energy supply and industrial sectors (17 GtCO_2e), forestry and land sectors (12 GtCO_2e) and the waste, transport, and buildings sector (12 to 14 GtCO_2e). The transport and building sectors are particularly noteworthy because 3.7 to 5.1 GtCO_2e of the potential estimated reduction 12 to 14 GtCO_2e comes from more sustainable consumption practices like those listed in Table 11.3 (McKinsey 2009). Indeed, Levine et al. (2007) has reminded us that understanding which technologies/end uses entail the lowest unit abatement costs for society, as well which ones offer the largest abatement potential, would be crucial from a policy-design perspective.

Table 11.3 Low cost reductions from sustainable consumption

Sectors	GtCO ₂ e per year in 2030	Assumed reductions
Buildings	1.5	-2% change in HVAC -20% change for water heating; appliances; and lighting -20% reduction in floor space for new buildings
Transport	0.5	-Consumers: smaller cars, driving more efficiently, driving less -Commercial-increased travel capacity, improved travel planning
Transport (Air)	0.2	-20% reduction in travel
Mode shift	0.2-0.4	-5-10% road shift by switching to rail, bus, walk, or cycle
Agriculture	0.6-1.8	-20% reduction in meat consumption in the developed world; replace 0-50% meat from cattle, goats and sheep with other meat
Spill-over effects to industry	0.8	-15% cement buildings -10% iron and steel -5% steel buildings -5% steel transport

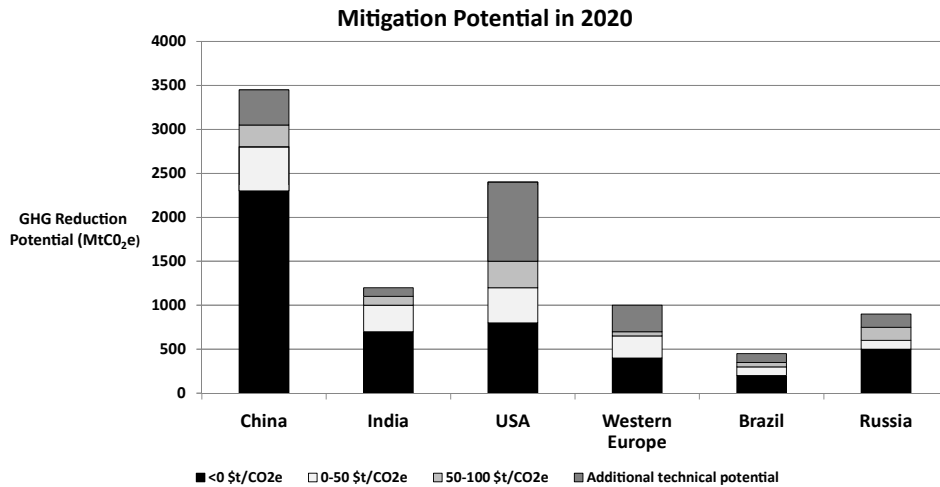
Source: McKinsey 2009

Beyond the fact that many of these opportunities involve changing behaviour and lifestyles, there are two reasons that actions in these sectors tend to be low cost. The first refers to the energy saved over the lifetime of the investment. In some cases, the energy costs saved over time can be greater than the “cheaper” standard technology to which the option is compared, thereby making the low carbon alternative a negative cost.

The second reason is that they can avoid a lock-in effect. A lock-in effect refers to the difficulties of changing infrastructure with long lifetimes such as buildings or highways once they are constructed. Constructing new equipment and infrastructure tends to be more affordable than retrofitting or replacing old equipment and infrastructure. Therefore it is relatively cheaper to pursue mitigation options in sectors where new energy conserving infrastructure can be built.

A similar point relates to the region with the greatest low cost mitigation opportunities. As suggested in the previous section, Asia's energy use is still low but increasing rapidly. Moreover, much of Asia's energy-related infrastructure will need to be constructed over the next few decades. The time is consequently ripe to introduce measures that can encourage infrastructure investments that would promote sustainable lifestyles and thereby minimise energy and fuel consumption.

The reduction potential from these opportunities is illustrated in Figure 11.5 which shows the amount of GHGs that can be mitigated at low cost in different countries (Hanaoka et al. 2008). The next section will evaluate efforts to take advantage of these opportunities in the building and transport sector in Asia.

Figure 11.5 Low cost mitigation potential

Source: Adapted from Hanoaka et al. 2008

4.1 Mitigation opportunities in buildings

Power use in buildings is arguably the lowest hanging fruit of energy consumption reductions. Not only would GHG emissions be substantially cut, lower costs would be offered to the end-user of many of these appliances. Thus, spurred by high fuel prices and growing concerns over energy security, national governments in Asia have implemented various measures to improve building designs and appliances. These include voluntary programmes, building and appliance standards and labels, educational programmes, best-practice and benchmarking programmes, state market transformation programmes, financing, and public sector procurement.

Mandatory and voluntary standards and labels for appliances have already been instituted in 60 developed and developing countries. Due to the broad range of energy efficient appliances, each type of appliance has its own regulations. In the U.S., which is a leader in energy efficiency standards, more than 40 household appliances are subject to federal mandatory and/or voluntary energy performance standards. China has also implemented minimum performance requirements for air conditioners and refrigerators over the past several years.

At the building performance level, the International Energy Efficiency Code, developed by the International Code Council which is notable for its building codes and standards, has drawn interest in Asia. The Chinese government has already implemented a “regulation on energy conservation in civil buildings” (State Council 2008), which sets a legal framework for building energy performance assessment. In addition, the certification process of green buildings (some property development programmes have been accredited as “green buildings” by the Ministry of Construction and the international Leadership in Energy and Environmental Design (LEED) label) can also serve as a reference for third-party assessment thereby institutionalising the energy efficiency certification process through market mechanisms.

Although most of the potential savings in efficiency are found in the residential and commercial sectors, the government also plays a significant role in accelerating the

commercialisation of end-use products. Public sector procurement is one of the largest sources of end-use consumption and can help to drive economies of scale early in the deployment of new technologies. At the international level, the Agreement on Government Procurement by the World Trade Organization (WTO) serves as a model for purchasing efficient appliances used in public and government buildings. China, Korea, and Japan have already implemented strategies for purchasing energy-efficient goods for government use.

Many efficiency policies today are initiated at the national level. However, the actual management of these technologies will often occur at the urban and local levels and between different ministries. This suggests the need for a close working relationship between national and local governments for effective policy implementation. For example, in China, the Ministry of Construction has already commenced the implementation of urban district heating reform in northern cities with cooperation from the Ministry of Finance. In 2007, a RMB 900 million scheme was approved to subsidise the installation of heat metering and thermal retrofitting in 14 provinces in colder regions. The fund was transferred from the central government to the provinces directly to undertake the housing retrofitting (Ministry of Construction, PRC 2008).

In contrast to the above policies, many regions in China and India, in addition to other developing Asian countries, which are yet to have access to electricity, have different energy requirements. The policies in the context of most developing economies focus on fuel use, namely biomass, which is the primary fuel for cooking. In the longer term, these regions will likely move towards greater electrification. Driven by urbanisation, they could either replicate the lifestyles found in modern Asian cities—or pursue lower carbon lifestyles. Thus, there is an enormous opportunity to not only retrofit current infrastructure, but to introduce measures for minimising energy and fuel consumption in buildings that are yet to be built. The same applies to the infrastructure and planning in the transport sector, the focus of the next subsection.

4.2 Mitigation opportunities in the transport sector

Reducing emissions from the transport sector can be categorised as: (i) reducing unnecessary travel through land use planning, congestion charges and non-motorised transport; (ii) shifting or retaining mode share of mass transport; and (iii) improving energy intensity through fuel switching or fuel efficiency standards. This section focuses on the first two options—reducing travel activity and shifting modes—since they can support the lifestyle and behavioural changes that are central to sustainable consumption.

Unlike developed economies, many Asian cities have the advantage of high-density and mixed-use environments, reducing distance travelled and energy use. Currently, cities in Asia have population densities that average 150 people per hectare, whereas density figures in North American cities are between 15 to 26 persons per hectare. In addition, many cities in Asia have high levels of non-motorised transport (walking and cycling). For example, 65% of travel in Chinese cities occurs from non-motorised modes (Kenworthy 2006).

Additionally, several cities in the region have reduced transport energy with land use planning. The obvious case is Singapore, which beginning with a plan for a compact city in 1971 and through road pricing schemes in the 1990s, has limited growth in energy-intensive personalised transport. More than 50% of households and 40% of places of work are located near the mass transit system and vehicle ownership has remained at a comparatively low 100 cars per 1,000 people in Singapore (Olszewski 2007). In

Shanghai, an innovative license plate auctioning system has brought the number of vehicles to one-sixth the level of auto-friendly Beijing (Gordon and Sperling 2009). Finally, lower income cities such as Surabaya, Indonesia have improved the integration between housing and transport, making both more sustainable and low carbon (Kenworthy 2006).

An interesting trend has been the increase in bus rapid transit (BRT) programmes in Asia. A BRT is a bus system that runs on segregated lane similar to an on-road subway and offers passengers several service amenities such as sheltered boarding stations (Wright and Fulton 2005). As of this writing, there were more than 30 BRT systems in Asia. Most importantly, several of these projects have improved lifestyles and reduced the city's carbon footprint. For example, the first line of Jakarta's BRT has saved travel time and lowered emissions of GHGs (Ernst 2006; Matsumoto 2007; Sutomo, Romero, and Zusman 2008). There are also positive examples of light rail and metro rail in developing Asia's densely populated cities. For example, the Delhi metro has been credited with serving 2.26 million passengers daily and mitigating an estimated 38,000 tonnes of CO₂ annually since its 2006 completion (Sudo 2009).

Encouragingly, several programmes have been launched to scale up improvements in public transport. For example, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in India is a government-initiated programme to allocate approximately \$25 billion to urban development projects in 63 cities over a six year period from 2005-2012. Much of the JNNURM money is slated for public transport improvements (Agarwal and Zimmerman 2009).

5. Barriers to mitigation opportunities in the buildings and transport sectors at the end-users level

In formulating a sustainable low carbon consumption strategy, a number of stakeholders are involved beyond the actual energy consumer. These range from the government to investors to property developers to utilities. As such, there is also a greater probability of encountering barriers, including financial, institutional, social and cultural obstacles. Among these barriers, the lack of consumer choice, high consumer costs, and limited consumer awareness pose the greatest challenges. These challenges are discussed below with reference to Asia's buildings and transport sector.

5.1 Buildings

Consumer choice

For buildings that are already built, consumers lack choices in improving energy efficiency of the end-uses. The very nature of urban energy structures often prevents consumers from making those choices. An analysis from the International Institute for Applied Systems Analysis (IIASA) shows that energy from urban systems are determined by, in order of importance, spatial division of labour, urban form, end-use efficiency, integration of existing systems, and fuel substitutions (Grubler 2009). Consumers lack influence over all of these factors except for energy end-use. And while consumers can desire more efficient buildings and appliances, whether they actually do so requires resolving a related set of principal-agent or PA problems.

In Asia's buildings sector, the PA problem is a major barrier to improving energy efficiency (Murtishaw and Sathaye 2006; IEA 2007). While all stakeholders realise that lower GHG

emissions are attained through lower energy use, the problem lies with who pays for and benefits from these improvements. PA arises when investors who put in money to improve efficiency do not necessarily receive the benefits of energy saved. As long as the landlord pays for the improvements and the tenant pays the energy bills, the investment will not be made.

Similarly, an opposite PA problem arises when the energy bills are paid by the landlord, leaving the tenant with no incentive to moderate energy use. In China, the current billing and pricing system and the regulatory framework give no incentive for end users to save energy for heating, which accounts for more than 40% of energy consumption in urban buildings and has the largest potential for energy and carbon emissions savings. Despite a significant reduction in heating intensity as a result of the 1995 National Energy Efficiency Standard for Heating in New Residential Buildings, the average heating consumption in a house complying with the national code in Northern China is still twice as high as in the most efficient houses in the Baltic region including Sweden, Denmark, the Netherlands and Finland. Under the current situation, neither home builders nor property developers have incentives to build higher efficiency housing since that entails extra costs. As heating consumption is billed on the basis of floor space area instead of actual consumption, consumers are not given a price signal to conserve energy and no economic incentive is available for developers to build highly energy-efficient houses.

Consumer costs

High initial costs have always been a major barrier to the investment of energy-efficient infrastructure and buildings (IPCC 2007). Many investors realise that in the long run more money is saved through efficiency. In some cases, for example with energy saving light bulbs, such investments are affordable; however, psychological attachments to existing technologies can prevent the adoption of new technologies. In other cases, these improvements will require substantial financial resources for the investor. Yet, due to lack of access to capital, they are not able to make such investments. Many borrowers from low-income groups and small businesses may not be deemed credit worthy to take out loans for building improvements.

In Asia, the result has frequently been that the potential for small and large energy efficiency projects remains untapped. Many regions do not have adequate financial institutions to offer credit to investors who want to make efficiency improvements. Similarly, while efficiency investments are relatively safe with reliable paybacks, many lenders do not know about the low risks of efficiency related investments. Thus the government can step in to bring down costs for consumers or help to drive industry towards lower costs.

The Chinese government has been actively helping its industries to sell energy saving products. In June 2009, the Ministry of Finance promulgated the “provisional measure of management on promoting energy-saving product by giving subsidies” (Ministry of Finance, PRC 2009). This programme subsidised companies that were manufacturing energy saving products and allowed them to pass the savings on to the consumers. The aims were not only to orientate consumers towards more energy efficient choices, but to also make them aware of these products.

In addition, the government can play a significant role in driving down the costs of new technologies. Public sector procurement can help to drive economies of scale during early stages of deployment.

Public works projects also enable overall efficiency improvements in many communities. For example, in China, the Ministry of Construction has already commenced the implementation of urban district heating reform in northern cities with cooperation from the Ministry of Finance (Ministry of Construction, PRC 2008).

Consumer awareness

The lack of building standards and labelling for appliances is a barrier to the adoption of energy efficiency among the general population. Building developers and appliance manufacturers need to communicate the potential contribution to financial savings and reduced emissions through their products (Martinot and Borg 1998). Thus, the government needs to step in to enforce standards and aid in the communication process. There are many examples where these efforts are greatly aided by government sponsored labelling programmes that verify manufacturer claims. Indeed, many property buyers do not trust the stated energy performance from property developers. Thus, consumer awareness also entails the involvement of government agencies that can establish and maintain standards, aid in verification, and communicate benefits to the general public.

At the end-use level, the question arises: which choices have the greatest impacts and which ones can be avoided? Is reducing consumption the best solution? The answers depend on many variables including values and personal preference but part of the challenge is the lack of relevant information available for consumers.

In order to avoid the unsustainable patterns of consumption that characterise developed economies, life-cycle assessment (LCA) is a powerful tool to help understand the contributions that consumer decisions have on GHG emissions. LCAs have many benefits across the supply chain. Not only does it enable end-use consumers to understand their own carbon footprint and externalities, it will help to establish a pricing system that reflects the environmental costs of products as well as helping producers to differentiate their products and improve the efficiency of their supply chain.

Moreover, the information from LCAs will work hand-in-hand with a carbon market by generating credits for investments in low carbon innovations. The linkage of reliable information and the pricing system helps to establish an economic relationship between the production process, consumption, and climate impacts, ultimately leading to greater resource and carbon efficiency.

5.2 Transport

In the Asia-Pacific region, there are many remaining challenges to match the successes achieved to date. With urbanisation, many Asian cities are experiencing a sharp increase in travel demand. For example, in China and India, travel demand is growing at more than 5% per year. Moreover, while most cities are densely populated, de-concentration and the resulting increases in distances travelled and energy consumption have become increasingly evident in Asia. Smaller cities such as Bandung, Indonesia have seen the emergence of communities and commuters on the city's peri-urban fringe (Perera and Permana 2009). In addition, deliberate attempts to replicate Singapore's success with compact cities have not always been successful. For example, poorly integrated land use plans undermined attempts to limit city growth in Bangkok (IGES 2004).

Moreover, public transport is declining across cities in developing Asia (Table 11.4). There are growing concerns that improvements in public transport service and quality

will not come soon enough to reverse these trends. For example, in India, a dedicated city bus service operates in only 17 of the country's 35 cities with populations over one million (Singh 2005). Other concerns are related to the affordability of public transport for low income segments of the population (Tiwari 2007).

Table 11.4 Public transport mode share in Asia

City	Earlier year	Public transport as a percentage of motorised trips	Later year	Public transport as a percentage of motorised trips
Bangkok	1970	53	1990	39
Kuala Lumpur	1985	34	1997	19
Seoul	1970	67	1992	61
Tokyo	1970	65	1990	48
Shanghai	1986	24	1995	15
Guangzhou	1995	33	2002	20

Source: Adapted from Hook 2002; Wright and Fulton 2005

Moreover, there are more innovative modes that have not performed as well as initially anticipated. For example, though Jakarta's BRT programme's first line has become popular, the project's other lines have had lower occupancy rates and saved less time and energy (Sutomo, Romero and Zusman 2008). In other cases such as Delhi's BRT, operational issues on a 5 km pilot line have led to that portion of the road being called "the corridor of chaos." More generally, some have argued that BRT programme differences in decision making structures are not likely to operate as well as in Asia (Houssain 2006). There have also been concerns about the financing of more ambitious overhauls of public transport systems. In the case of the JNNURM, delays in the delivery of bus orders have dampened enthusiasm for the programme. The bottom line is that for many of the strategies that seek to reduce energy through lifestyle and behavioural changes, there are many barriers. The following discussion draws upon examples from Malaysia, India and Indonesia to illustrate some of these barriers.

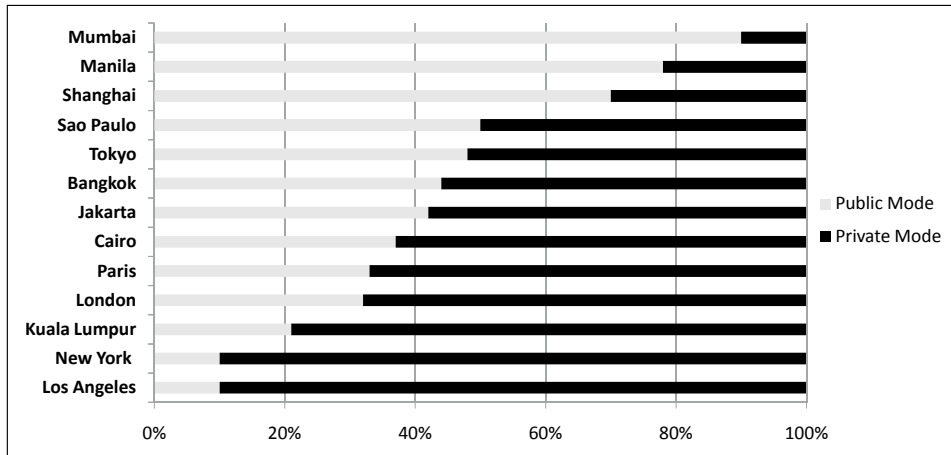
Consumer choice

The lack of consumer choice is a key barrier to sustainable modes of transport. A case in point is Malaysia's fastest growing city, Kuala Lumpur, where vehicle-friendly development plans resulted in constraining transportation choices. As shown in Figure 11.6, Kuala Lumpur has an almost 80% mode share of private transport. With the city's rapid development in the 1980s and 1990s came the emergence of a consumer-oriented middle class and growing demand for suburban lifestyles and housing. This growth contributed to the development of residential districts such as Gombak and Petaling and the transformation of the neighbouring State of Selangor into a population centre, leading to an overall increase in the number of vehicles and motorised trips. To a significant extent, Kuala Lumpur has followed the North American pattern of motorisation "complete with the proliferation of expressways and big-box shopping centres" (Bunnell, Barter and Morshidi 2002).

In the 1980s, the government invested heavily in the construction of more than twenty new roads and road improvement projects covering the greater Klang Valley that surrounds Kuala Lumpur. The construction of roads temporarily reduced congestion in the city centre but induced travel demand outside it. This has made it difficult to reverse trends that saw public transport in Kuala Lumpur fall from an already low 34% of mode share in 1985 to 19% in 1997 (Wright and Fulton 2005).

In addition, government support of the country's car industry added to these difficulties. Kuala Lumpur has recently invested in a light rail transport system that will be integrated with feeder buses and commuter rail. It nonetheless remains to be seen how the system will affect commuting patterns after vehicle-dependent lifestyles have become well established.

Figure 11.6 Public transport mode share



Source: UITP 2001

The case of Kuala Lumpur illustrates the need for long term planning that prevents a lock-in into energy intensive transportation patterns. Thus, early action is recommended for parts of Asia that are urbanising. Nevertheless, initial costs for sustainable transport modalities can be prohibitively expensive.

Consumer costs

Cost barriers have proven particularly challenging in countries with rapidly urbanising poor populations. High costs, for example, have been the chief obstacle for many of the 10 million inhabitants of Delhi, India. Although a master plan was developed to encourage mixed land use planning in 1990, the city has witnessed a sharp increase in urban migrants who have settled outside the planned zoning over the past two decades. The result has not only increased travel for work and other essential needs, but it has also created demand for affordable public transport. While high profile projects such as the Delhi Metro have absorbed some of this demand (Sudo 2009), they have also been too expensive for many consumers to use on a regular basis (Tiwari 2007).

The high fares of the Delhi Metro are symptomatic of a deeper problem. Designing a sustainable financing model for public transport often requires affordable fares while keeping the system financially viable. When fares are too low, service providers find it difficult to cover operational costs and “afford even routine maintenance and vehicle replacement, let alone system modernization and expansion” (Pucher 2004). Delhi has dealt with this problem better than many other cities in India. Delhi developed a public-private partnership that contracted service provision for public transport to private operators in the early-1990s and, after some initial growing pains, found competition between private providers to be an effective way of coping with rising demands for quality transport (Kharola 2008). India's JNNURM also holds promise to support Delhi and other

Indian cities in their efforts to improve the performance of their bus systems (Agarwal and Zimmerman 2009).

The next big challenge will be to keep the quantity and quality of service high so that consumers will continue to rely on public transport as their incomes grow. Motorised vehicles in many major Indian cities have increased between 30% and 40% in just five years from 1995 to 2000 (Singh 2005). This reflects the draw of increasingly affordable motorcycles, and the small Nano car, as well as underpriced fossil fuels. Making consumers aware of the full costs of personalised transport is another challenge to low carbon transport in Asia.

Consumer awareness

Nowhere is the challenge of sensitising populations to transportation costs greater than Indonesia where awareness of energy savings is low because subsidies keep fuel prices low. Subsidies are intended to allow poor populations access to energy, but they often miss their intended target and become politically difficult to remove once in place (UNEP 2008). Since becoming an oil importer in 2004, the Government of Indonesia has used up to 3.2% of its annual budget to subsidise fossil fuels. This not only made Indonesia's fuel the cheapest in Asia, but also contributed to an increase from 10 million to more than 50 million vehicles between 1990 and 2007 (Suhadi 2009). Fortunately, awareness of these costs has also increased recently. In October 2008, the Government of Indonesia cut subsidies on premium gasoline and diesel by approximately 30%. When cutting the subsidies, the government also used a public education campaign to explain their full costs to the public. In addition to easing inflation, the cost increase from the subsidy reductions caused some to drive less. It is nonetheless important to point out that governments should ensure that the money saved from subsidies is reallocated to other social welfare needs.

There have also been other ways to sensitise consumers to the value of low carbon transport in Indonesia. Jakarta's car-free day is a good example. The city's car-free day began as an annual event supported by nongovernmental organisations (NGO) in 2002. It has since grown into a government-supported initiative that is held every Sunday in one of Jakarta five administrative municipalities. Car-free days attract crowds of up to 5,000 and help educate the public about the virtues of non-motorised transport. Public transport is also promoted since Jakarta's bus rapid transit (BRT) programme is the only mode allowed to run on the closed-off segment of the road. Following upon the success of Jakarta's programme, other Indonesian cities such as Surabaya, Bogor, and Yogyakarta have begun to hold their own car-free days. The programme's popularity suggests that raising awareness about energy savings also requires demonstrating some of the intangible benefits of non-motorised and public transport to consumers (Dillon and Damantoro 2008).

6. The way forward

The link between consumerism and climate change is clear. A fast rising proportion of the GHGs released into the atmosphere each year can be traced to buildings and transport services consumed by individuals, households, and the government sector. With a consumer driven global economy dependent on fossil fuels for energy, each decision affects the amount of GHGs released. While the notion of sustainable consumption has been around for many years, it has been beset by various social, financial and institutional barriers, however, the explosion in interest among the political and business sectors to address the climate problem has added impetus to retool the economy for

sustainable consumption. With energy, and consequently the GHGs that underlie climate change linked to consumption behaviour, policies and measures are needed to make this transition. This chapter has identified key barriers and solutions for rapidly urbanising Asia to move away from the carbon intensive patterns of growth seen in industrialised countries and onto a path of sustainable consumption in the buildings and transportation sectors. The actions undertaken by individuals have direct impacts on sustainable consumption but equally important are those made by industries that make products and the government as a consumer. In the context of measures including incentives, LCA, and the international policymaking process, this chapter identifies the way forward for each stakeholder in order to move towards sustainable consumption. Moreover, the international framework is a critical player in mobilising financing and resources to economies that cannot achieve these changes on their own.

6.1 Consumers

The lack of consumer awareness is a major barrier to making sustainable consumption choices. Policies to educate the public on the benefits and impacts of their choices are effective tools. For example, eco-labelling programmes have proven effective in many developed countries and have helped to drive consumer confidence in energy efficient products and driven their sales. These labels help consumers make choices in line with their values and preferences and help to increase awareness for such products. At the same time, LCA offers a powerful way to help compare the consequences of choices by systematically estimating the performance of a product or service. These tools not only inform the consumers of the initial cost of purchase but also their impacts on energy and fuel use, as well as social impacts over its lifetime.

Another major barrier is the high capital costs associated with making the right choices for sustainable consumption. Even if individuals know of the long term benefits to themselves and society, they may not have the financial capacity to acquire their preferred options. Government programmes for rebates, for example, can help consumers make a more sustainable choice, for example, by choosing energy efficient appliances and electric vehicles that require less fuel. Another tool is a price on carbon. Although consumers are not directly affected, the final price reflects the embedded carbon associated with the manufacturing of a product. This helps to create more sustainable, yet more expensive products to compete on a level playing field with conventional technologies, which are often underpriced, as their prices do not reflect externalities associated with their GHG emissions.

6.2 Producers

In order to help manufacturers mass produce sustainable products, a set of incentives can be made available to encourage the production of more sustainably performing products. The government can provide support in the form of subsidies for manufacturers who can then pass on the savings to the consumers. In addition, other programmes can help retool factories to incorporate sustainable consumption technologies into the final product. At the same time, penalties can sway producers away from older, unsustainable technologies in the building and transport sector.

The growing movement of corporate social responsibility (CSR) is also a driver for consumers to improve both the environmental and social impacts of their consumption. Eco-labelling policy initiated on the production side has forced manufacturers to innovate their process for greater efficiency and is a tool to build up an environmental image among consumers.

6.3 Government

In contrast to choices that are available to consumers, infrastructure and urban planning are typically the responsibility of the public sector. The lack of good governance has led to a lock-in into carbon intensive practices and patterns of unsustainable consumption in the buildings and transportation sectors. At its disposal, government agencies can engage in urban planning and green purchasing. In evaluating policy options, governments can employ a co-benefits approach, an approach that finds synergy in addressing local problems that have global consequences.

Studies have shown that urban planning and public works by the government play a bigger role in managing the overall efficiency of urban systems. For many regions that are developing, there is a great opportunity for local authorities to design urban regions in such a way that optimises the spatial location of different sectors of the economy and the co-location of resources for industry. Public infrastructure provision, such as the management of public transportation resources and utilities is often the only way to fund and run projects that cannot be carried out by the private sector alone. These include light rail systems, BRT, and district heating and cooling.

As a major buyer of products and services, the public sector can drive economies of scale through “green purchasing.” By making initial purchases of new products, this not only helps to drive economies of scale, it also gives confidence to individual consumers. Thus, governments should initiate and set examples through the adoption of green procurement policy, green buildings, and diversifying energy options.

Most of the important actions happen at the local and national levels. However, the international and regional regimes can play a role in accelerating sustainable consumption in the buildings and transportation sectors. By the same token, national governments and domestic stakeholders can help shape the direction of multilateral and bilateral processes or conventions that impact on climate change and sustainable consumption. At the international level, negotiations on the post-2012 climate regime, particularly related to carbon pricing, technology transfer and financial mechanisms, could encourage national governments to institute policies and measures incentivising sustainable consumption in the buildings and transport sectors. In this context, governments at the local and national levels have a crucial role in reorienting consumption choices towards low carbon and sustainable patterns of resource use.

Notes

1. We are grateful for the useful discussions with Atsushi Watabe and Takashi Otsuka on the early versions of the draft, and to Jane Romero for data in the transport section.
2. In recent years, some developed countries have begun integrating elements of sustainable consumption in policies intended to achieve Annex-1 Kyoto Protocol reduction targets.

References

- Agarwal, Om Prakash and Samuel L. Zimmerman. 2008. "Toward sustainable mobility in urban India." *Journal Transportation Research Record: Journal of the Transportation Research Board* 2048:1-7.
- Asian Development Bank (ADB). 2006. *Urbanization and Sustainability in Asia: Case Studies of Good Practice*. On-line edition available at <http://www.adb.org/Documents/Books/Urbanization-Sustainability/default.asp> (Accessed 2 December 2009).
- Asian Development Bank (ADB). 2009. *Energy Outlook for Asia and the Pacific*. Manila: ADB.
- Bunnell Timothy, Paul A. Barter, S. Morshidi. 2002. "City profile: Kuala Lumpur metropolitan area, a globalising city region." *Cities* 19:357-370.
- Cohen, Mark A. and Michael P. Vandenbergh. 2008. *Consumption, happiness, and climate change*. Discussion paper. October 2008. Resources for the Future: Washington, DC.
- CSD. 2006. *Background Paper #3, 14th Session of the Commission on Sustainable Development. Sustainable Consumption and Production: Energy and Industry*.
- Dalkmann, Holger and Charlotte Brannigan. 2007. *Transport and climate change: module 5e, sustainable transportation sourcebook. GTZ Germany* http://www.sutp.org/component/option,com_docman/task,doc_details/gid,383/lang,uk (Accessed 10 October 2009).
- De Zoysa, Uchita. 2009. Integrating sustainable consumption in Asian climate change policies. http://www.iop.org/EJ/article/1755-1315/6/58/582012/ees9_6_582012.pdf?request-id=a74c4244-662d-4ee9 (Accessed 2 June 2009).
- Dillon, Harya Setyaka and Tory Damantoro. 2008. How effective is car free day in improving urban air quality? A case study of Jakarta. Paper presented at the Better Air Quality Workshop. 13-14 November 2008. Bangkok, Thailand.
- Ernst, John. 2005. "Initiating Bus Rapid Transit in Jakarta, Indonesia". *Journal Transportation Research Record: Journal of the Transportation Research Board* 1903:20-26.
- Energy Information Administration (EIA, US) 2008. *International Energy Outlook 2008*. [http://www.eia.doe.gov/oiat/archive/ieo08/pdf/0484\(2008\).pdf](http://www.eia.doe.gov/oiat/archive/ieo08/pdf/0484(2008).pdf) (Accessed 22 October 2009).
- European Environmental Bureau (EEB). 2009. *Blueprint for European sustainable consumption and production: finding the path of transition to a sustainable society*. May 2009. EEB: Brussels, Belgium.
- Goldemberg, Jose. 1996. *Energy, environment & development*. Earthscan: London. 137-141.
- Gordon , Deborah and Daniel Sperling. 2009. Surviving two billion cars: China must lead the way. *Yale Environment* 360. <http://www.e360.yale.edu/content/feature.msp?id=2128> (Accessed 26 October 2009).
- Grubler, Arnulf. 2009. *The Urban Sustainability Challenge. A Presentation at the International Symposium on Realizing Low Carbon Cities: Bridging Science and Policy*. Held in Nagoya, Japan on 16 February 2009, available at http://www.gcp-urcm.org/files/A20090216/2_Grubler.pdf (Accessed 27 July 2009).
- Hanaoka, Tatsuya, Osamu Akashi, Yuko Kanamori, Tomoko Hasegawa, Go Hibino, Kazuya Fujiwara, Mikiko Kainuma, and Yuzuru Matsuoka. 2008. Global greenhouse gas emissions reduction potentials and mitigation costs in 2020 -methodology and results. CGER-Report. Center for Global Environmental Research, National Institute for Environmental Studies, Japan.
- Herring, Horace and Steve Sorrell. 2009. *Energy efficiency and sustainable consumption: the rebound effect. Energy, climate and the environment series*. Palgrave Macmillan: Hampshire, England.
- Hook, Walter. 2002. "Does it make sense for China to motorize?" *Sustainable transport* Fall 14:2, 19, 29.
- Hossain, Moazzem. 2006. "The issues and realities of BRT planning initiatives in developing Asian cities." *Journal of Public Transportation* 9(3):69-88.
- Huang, Joe and Joe Deringer. 2007. *Status of Energy Efficient Building Codes in Asia (China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, India)*. Hong Kong: The Asian Business Council. 31 March 2007. http://www.efchina.org/csepupfiles/report/200962525818511.6156411397687.pdf/07_0710F_10_countries_code_review.pdf (Accessed 30 November 2009).
- International Energy Agency (IEA). 2007. *World Energy Outlook (WEO) 2007*. Paris: OECD/IEA.
- . 2008. *World Energy Outlook (WEO) 2008*. Paris: OECD/IEA.
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007 - Mitigation of climate change (Vol. 3) contribution of working group III to the fourth assessment report of the IPCC*. Cambridge: Cambridge University Press.
- International Union of Public Transport (UITP). 2001. *Millenium Cities Database*. Brussels, Belgium.
- Kenworthy, Jeffrey. 2006. "The eco-city: ten key transport and planning dimensions for sustainable city development." *Environment and urbanization* 18:67-85.
- Kharola, Pradeep Singh. 2008. "Financing urban public transport." *Urban transport journal* 7(2):70-83.

- Levine, M., D. Urge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, A. Mongameli Mehlwana, S. S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino. 2007. Residential and commercial buildings. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer. <http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter6.pdf> (Accessed on 22 November 2009).
- Li, Jun. 2008. "Towards a low carbon future in China's building sector – A review of energy and climate models forecast." *Energy policy* 36(2008):1736-1747.
- Martinot, E. and Borg, N. (1998). "Energy-efficient lighting programs: experience and lessons from eight countries." *Energy Policy* 26(14):1071-1081. http://www.ee-21.net/download/Martinot_Borg_EP26.pdf (Accessed on 15 November 2009).
- Matsumoto, Naoko. 2007. Analysis of policy processes to introduce Bus Rapid Transit systems in Asian cities from perspective of lesson-drawing: cases of Jakarta, Seoul, and Beijing. In *Air Pollution Control in the Transportation Sector: Third phase research Report of the Urban Environmental Management Project*. Hayama, Japan: IGES.
- Ministry of Construction, People's Republic of China. 2008. Intensified efforts for promoting energy-saving in construction and disseminating green buildings through differentiated guidance, better supervision, and institutional innovation. <http://www.cin.gov.cn/hydt/200811/W020080226466052039405.doc> (Accessed 28 September 2009).
- Ministry of Finance, PRC. 2009. *Circular of the Ministry of Finance Republic of China and the National Development and Reform Commission*. <http://www.cbminfo.com/eng/tabid/1394/InfoID/291287/Default.aspx> (Accessed 15 December 2009).
- Murtishaw, Scott and Jayant Sathaye. 2006. Quantifying the effect of the principal-agent problem on US residential energy use. LBNL Review.
- McKinsey & Company. 2009. Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve. http://solutions.mckinsey.com/climatedesk/default/en-us/contact_us/fullreport/requestfullreportok.aspx (Accessed 15 July 2009).
- Olszewski, Piotr. 2007 "Singapore motorisation restraint and its implications on travel behaviour and urban sustainability." *Transportation* 34:319-335.
- Perera, Ranjith and Ariv Permana. 2010. Integrating land use, transport, energy and environment to capture co-benefits: the case of Bandung, Indonesia in low carbon transport in Asia: strategies for optimizing co-benefits, eds. Zusman, Eric, Srinivasan, Ancha and Dhakal, Shobhakar. London: Earthscan.
- Pucher, John, Nisha Korattyswaroopam and Neenu Ittyerah. 2004. "The crisis of public transport in India: overwhelming needs but limited resources." *Journal of public transportation* 7(3):95-113.
- Singh, Sanjay. 2005. "Review of urban transportation in India." *Journal of public transportation* 8(1):79-97.
- State Council, PRC. 2008. *Regulation on energy conservation in civil buildings. Enforcement and implementation*. 1 October 2008. Ministry of Housing and Urban/Rural Development.
- Sudo, Tomonori. 2009. CDM in Urban railway sector and JICA's cooperation. The 4th Regional EST Forum in Asia, 25 February 2009, Seoul, Republic of Korea.
- Suhadi, Dollaris Riauaty, 2009. Developing and strengthening policies and capacity on sustainable transport. Presentation at the Sustainable urban mobility in Asia summit, Delhi, India. 29-30 October 2009.
- Sutomo, H., Jane Romero and Eric Zusman. 2008. The co-benefits of Jakarta's bus rapid transit: obstacles and opportunities. Hayama, Japan: IGES.
- Timilsina, Govinda and Shrestha, Ashish. 2009 "Transport sector CO₂ emissions growth in Asia: underlying factors and policy options." *Energy Policy* 37(11):4523-4539.
- Tiwari, Geetam. 2007. "Urban transport in Indian cities." *Urban Age* November 2007:1-4. http://www.urban-age.net/0_downloads/archive/_mumbai/Newspaper-essays_Tiwari.pdf (Accessed 31 October 2009).
- United Nations (UN). 2009. The millennium development goals report 2009. http://www.un.org/millenniumgoals/pdf/MDG_Report_2009_ENG.pdf (Accessed 31 October 2009).
- UN Conference on Environment and Development (UNCED). 1992. Agenda 21. <http://www.un.org/esa/dsd/agenda21/> (Accessed on 10 June 2009).
- United Nations Department of Economic and Social Affairs (UNDESA). 2006. Sustainable Consumption and Production: Energy and Industry. Background Paper #3, 14th Session of the Commission on Sustainable Development. http://www.un.org/esa/sustdev/csd/csd14/documents/bp3_2006.pdf (Accessed 17 June 2009).
- United Nations Department of Economic and Social Affairs (UN-DESA). 2007. Sustainable Consumption and Production: Promoting Climate-Friendly Household Consumption Patterns.

- . 2002. Johannesburg Plan of Implementation of the World Summit on Sustainable Development. http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIChapter0.htm (Accessed 24 June 2009).
- United Nations Environment Programme (UNEP). 2009. Submission of the United Nations Environment Programme (UNEP) Sustainable Building Initiative (SBCI) to the Ad-Hoc Working Group on Long-Term Cooperative Action under the Convention (AWG-LCA). <http://www.unfccc.int/resource/docs/2009/smsn/igo/044.pdf> (Accessed 23 November 2009).
- . 2008. Reforming energy subsidies: opportunities to contribute to the climate change agenda. http://www.unep.org/pdf/PressReleases/Reforming_Energy_Subsidies2.pdf (Accessed 24 June 2009).
- . 2009. Buildings and Climate Change: Summary for Decision Makers. <http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf> (Accessed 5 December 2009).
- United Nations Framework Convention on Climate Change (UNFCCC). 2009. Fulfillment of the Bali Action Plan and components of the agreed outcome. Note by the Chair. Part I (FCCC/AWGLCA/2009/4(Part I)). <http://unfccc.int/resource/docs/2009/awglca5/eng/04p01.pdf> (Accessed 24 June 2009).
- World Business Council for Sustainable Development (WBCSD). 2004. Mobility 2030: Meeting the challenges to sustainability. World Business Council for Sustainable Development, Conches-Geneva.
- World Resources Institute (WRI). 2009. Sustainable Development Policies and Measures Database. <http://www.wri.org/project/sd-pams> (Accessed on 05 October 2009).
- World Summit on Sustainable Development (WSSD). 2002. Johannesburg Declaration.
- Wright, Lloyd and Lewis Fulton. 2005. "Climate change mitigation and transport in developing nations." *Transport Reviews* 25(6):691–717.